

FAULT LOCATION AND PREVENTION IN REFRIGERATION CIRCUITS WITH HERMETIC COMPRESSORS

FITTERS NOTES

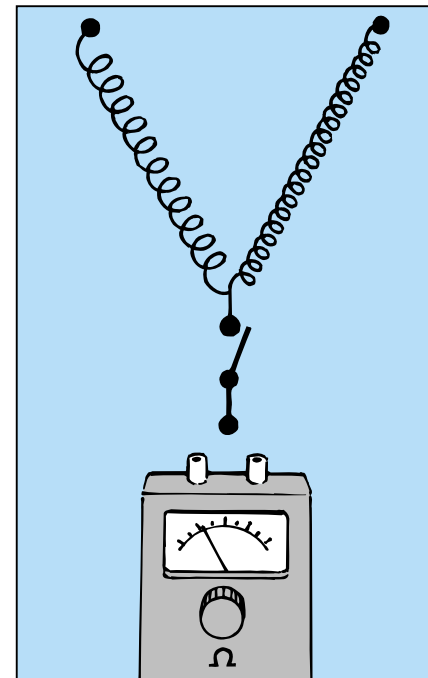
Refrigeration Controls

The Danfoss logo, featuring the word "Danfoss" in a white, stylized script font, set against a red rectangular background.

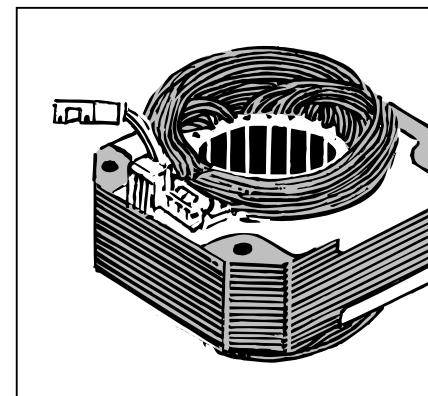
Compressor/system does not run (start)

Main switch drop-out	- Blown fuse - Short-circuiting to frame - Motor defect - Defective current lead-in - Electrical equipment
Compressor	- Compressor motor/motor protector mechanically blocked - Overload - Voltage/frequency - Pressure irregularity - Refrigerant type - Pressure equalisation - Fan drop-out
High and low-pressure switches	- Mechanical defect - Incorrect connection - Incorrect differential setting - Incorrect cutout setting - Pressure irregularity
Thermostat	- Mechanical defect - Incorrect connection - Differential too small - Incorrect cutout value

If the main fuse blows, the cause must be found. This will most often be a defect in the motor windings or motor protector, short-circuiting to frame or a burnt current lead-in which, in turn, causes main fuse drop-out. If a compressor motor refuses to start, always check the resistances first. All compressors have their main and start windings located as shown in the sketch. Resistance values are stated in **CN.10.D9.02** »Electrical resistance in compressor motors«.

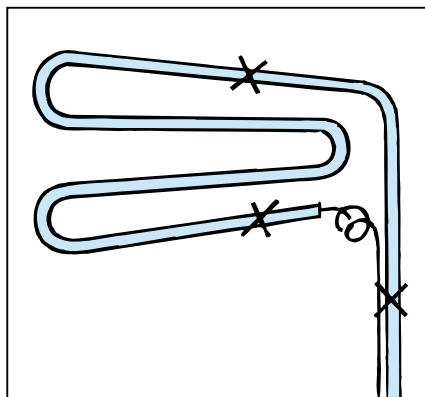


As a rule, a motor protection is built into all compressor motors. If the winding protector cuts out the motor, due to the heat accumulated in the motor the cut-out period can be relatively long (up to 45 minutes). When the motor will no longer run, resistance measurement will confirm whether a motor protector has cut out or whether a winding is defective. A mechanical seizure in the compressor will show itself by repeated start attempts accompanied by high current consumption and high winding temperatures that cause motor protector cutout.

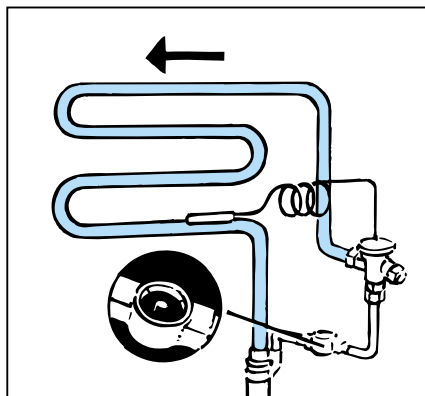


Compressor overload can be recognised by the compressor refusing to start or by starting and then stopping again after a very short time (via the motor protector). If the compressor is used outside its allowed application limits the usual result is overload. Application limits such as voltage tolerances, frequencies, temperature/pressure and refrigerant type are given in data sheet

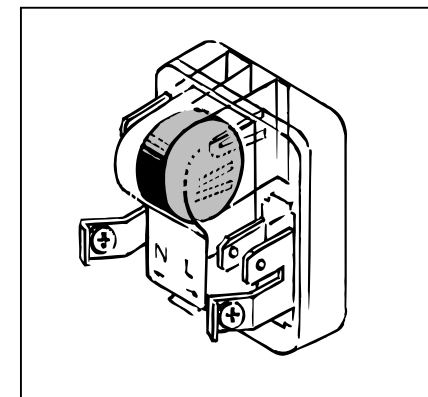
CB.32.B4.02. In systems not protected by a high-pressure cut-out switch on the discharge side, a fan motor which is defective or cut out via a motor protector can lead to compressor overload. Generally, the refrigerant quantity must be determined precisely. In capillary tube systems the most certain method is to take temperature measurements on the evaporator and suction line.



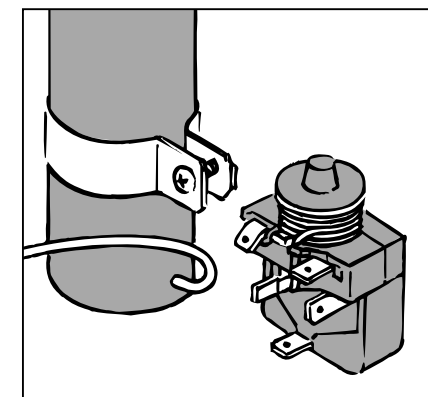
In systems with thermostatic expansion valve, charging must be checked using a sight glass. In both systems, the refrigerant quantity must be less than the quantity that can be accommodated in the free volume on the discharge side.



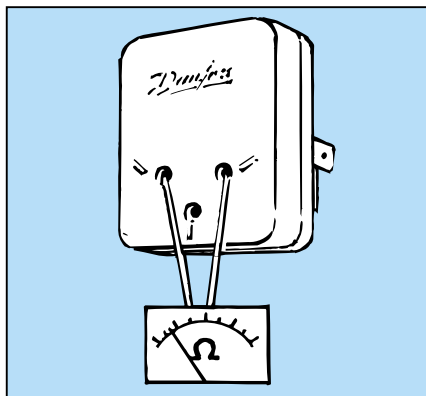
Compressors for capillary tube systems are usually equipped with a PTC LST starting device. Starting via a PTC requires complete pressure equalisation between the high and low-pressure sides on every start. In addition, before it can operate, the PTC requires a standstill time of about 5 minutes to ensure that the PTC component is cooled down in order to achieve maximum starting torque. When a “cold” compressor is started and the current is cut off a short time after, conflict can arise between the PTC and the motor protector. Because the motor retains heat, up to 20 minutes can elapse before normal start is possible.



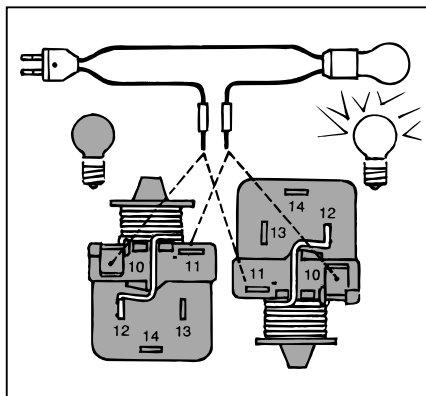
In systems where pressure equalisation on starting is not certain, the compressor must be equipped with an HST starting device. This also applies to capillary tube systems with a standstill time of less than 5 minutes. Defective or incorrect relays and starting capacitors can cause starting problems or that the compressor is cut out via the motor protector. Note the manufacturer's compressor data. If the starting device is thought to be defective the whole equipment must be replaced, including the relay and starting capacitor.



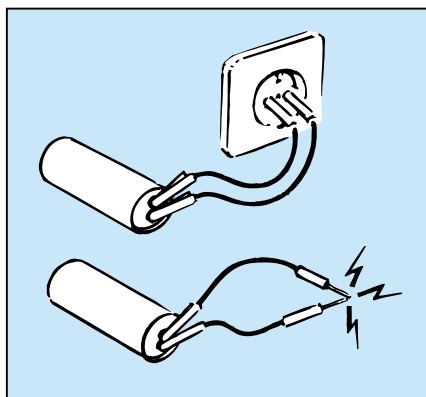
The PTC (25 Ω for 220 V mains and 6.5 Ω for 115 V mains) can be checked using an ohmmeter.



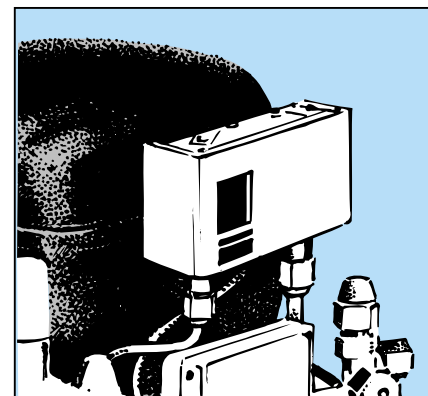
A starting relay can be checked with a lamp, see sketch. The relay is in order if the lamp does not light up when the relay is upright. The relay is also in order if the lamp lights up when the relay is upside down.



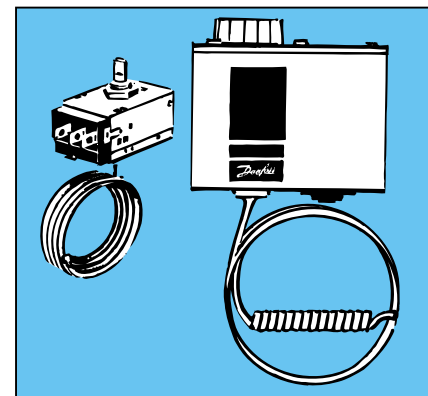
A starting capacitor can also be checked by applying rated mains voltage to it for a few seconds and then short-circuiting the leads. If sparks appear, the capacitor is in order.



In the German market, Danfoss offers condensing units with combined high and low-pressure switches that protect the compressor against excessive pressure on the discharge side and too low pressures on the suction side. If the high-pressure switch has cut out the system, a check should be made to see whether pressure irregularity is occurring. If the low-pressure switch has cut out, the cause can be insufficient refrigerant amount, leakage, evaporator icing and/or partial blockage of the throttling device. If there is no pressure irregularity on the high or low-pressure sides, the pressure switch itself must be checked. See Chapter 1 (Pressure switch) in »Fitters' Notes«.



The system can also cut out because of a defective or incorrectly set/sized thermostat. If the thermostat loses charge or if the temperature setting is too high, the system will not start. If the temperature differential is set too low, compressor standstill periods will be short and there might be starting problems with an LST starting device and shortened compressor life with an HST starting device. The guideline for pressure equalisation time using an LST starting device is 5 to 8 minutes for refrigerators and 7 to 10 minutes for freezers.



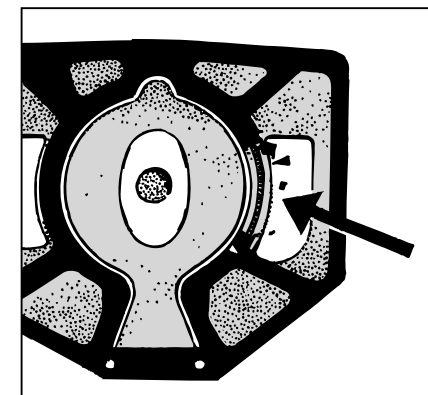
If an HST starting device is used, the aim is to keep the cut-in periods per hour as few as possible. Under no circumstances must there be more than ten starts per hour. See »Fitters' Notes,« chapter 2 (Thermostats) for information on thermostat setting and fault location.

The compressor/system runs, but with reduced refrigeration capacity

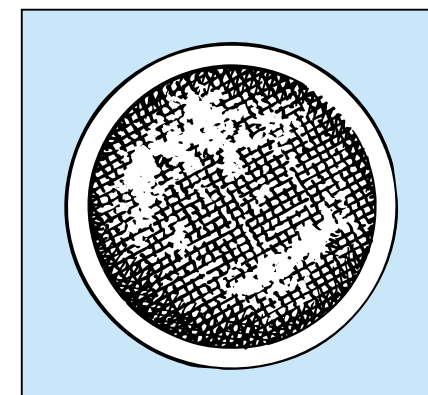
Compressor	Leakage Coking
Pressure irregularity	Blockage Non-condensable gases Moisture Dirt Fan defect Refrigerant loss Refrigerant overcharge Icing
Throttling device Capillary tube/thermostatic expansion valve	Static superheat setting Orifice size/diameter

Frequent causes of reduced refrigeration capacity are coking, and copper plating which lead to reduced life time of the compressor and burst gaskets in the compressor valve system.

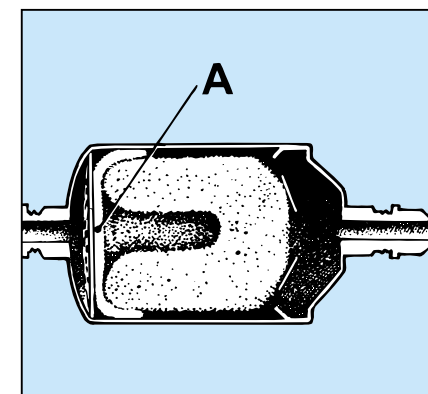
Coking occurs mainly as a result of moisture in the refrigeration system. In high temperatures, the presence of moisture also causes copper plating on valve seats. The burst gaskets are the result of an excessive condensing pressure and excessively high short-lived pressure peaks >60 bar (liquid hammer).



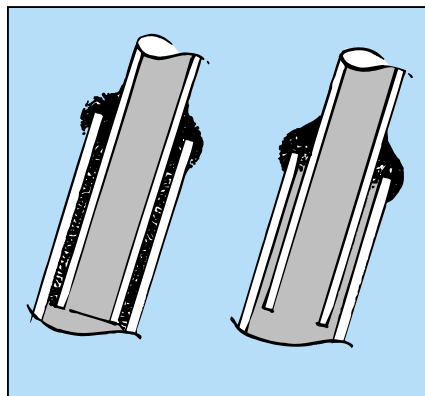
We recommend the installation of good quality filter driers. If the filter material is of poor quality, wear will occur which will not only cause the partial blockage of capillary tube and the filter in the thermostatic expansion valve, but it will also damage the compressor. (mainly seizure)



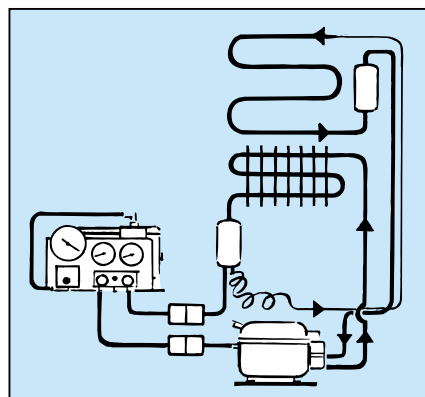
In general, commercial refrigeration systems must be equipped with filters having a solid core, e.g. type DN. See also chapter 5 (Filter driers and sight glasses) in "Fitters' Notes". The filter drier must be replaced after every repair. When replacing a "pencil drier" (often used in refrigerators) care must be taken to ensure that the filter material used is suitable for the refrigerant and that there is sufficient material for the application.



Poorly soldered joints can also cause system blockage. Making good soldered joints is conditional on using the correct soldering metal containing the correct percentage of silver. The use of flux should be limited and kept to as minimum as possible. See also chapter 8 (Connectors on compressors) in »Fitters' Notes«, or »Connectors for Compressors»
CN.10.B3.02.

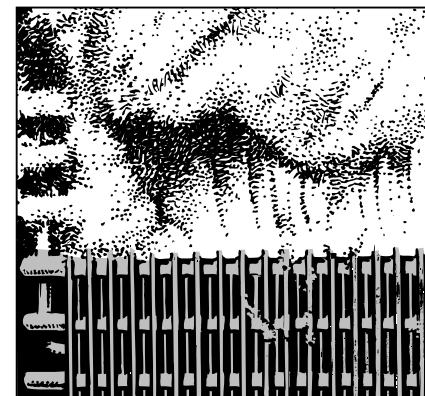


Poorly soldered joints can also cause leakage and thereby coking. In a refrigeration circuit the proportion of non-condensable gases should be kept below 2%, otherwise the pressure level will rise. The main purpose of evacuation is to remove non-condensable gases before the refrigerant is charged. This also produces a drying effect in the refrigeration system. Evacuation can be performed either from both discharge and suction sides, or from the suction side only. Evacuation from both sides gives the best vacuum. Evacuation from the suction side only makes it difficult to obtain sufficient vacuum on the discharge side. Therefore, with one-sided evacuation, intermediate flushing with the refrigerant to be used in the system is recommended until pressure equalisation is achieved.

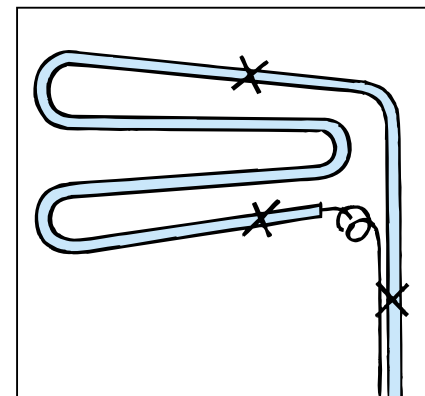


Dirt on the condenser and a fan motor defect can cause excessive condensing pressure and thereby reduced refrigeration capacity. In such cases the built-in high-pressure switch provides overload protection on the condenser side.

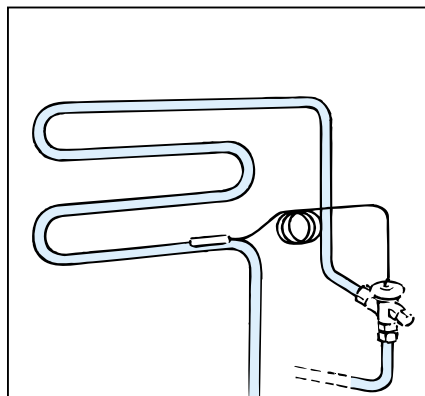
Note: The built-in motor protector does not give the compressor optimum protection if the condensing pressure rises as a result of a fan motor drop-out. The temperature of the motor protector does not rise quickly enough to ensure the protector cutout. This also applies when the refrigerant quantity is greater than can be accommodated in the free volume on the discharge side.



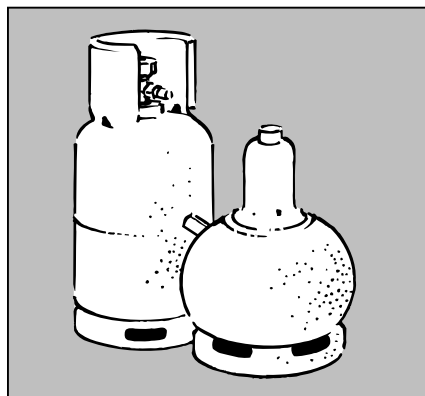
It is important to determine the quantity of refrigerant precisely - especially in capillary tube systems. The guidelines are that the temperature on the evaporator inlet must, as far as possible, be the same as the temperature at its outlet, and that as much superheating as possible must be obtained between the evaporator outlet and the compressor inlet. (The inlet temperature on the compressor must be about 10 K less than the condensing temperature).



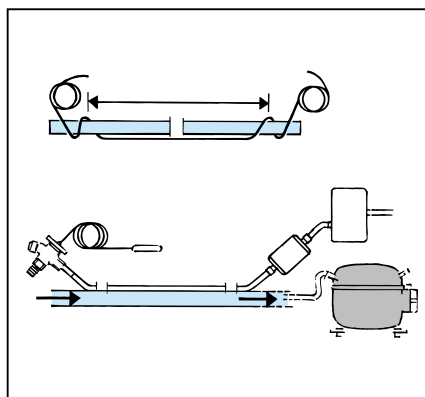
Overcharging of a refrigeration system equipped with a thermostatic expansion valve becomes critical when the charging quantity in liquid condition is greater than can be accommodated by the free volume in the receiver, i.e. the condenser area is reduced and the condensing pressure rises.



It is very seldom that there is too little refrigerant in a system, unless leakage occurs. Irregular icing on the evaporator is often a sign of insufficient refrigerant. This irregular icing does not only reduce the refrigeration output, it can also give problems in evaporator defrosting because the defrost thermostat sensor does not register the presence of ice. Therefore, precise determination of the refrigerant charge is recommended as a way of making sure that ice on the evaporator is evenly distributed.



The optimum system efficiency is obtained when a heat exchanger is fitted to ensure subcooling: about 5 K in systems with thermostatic expansion valve and about 3 K in systems with capillary tube. In systems with a thermostatic expansion valve the suction and liquid lines must be soldered together over a distance of 0.5 to 1.0 m. In capillary tube systems the capillary tube and suction line must be soldered together for 1.5 to 2.0 m.

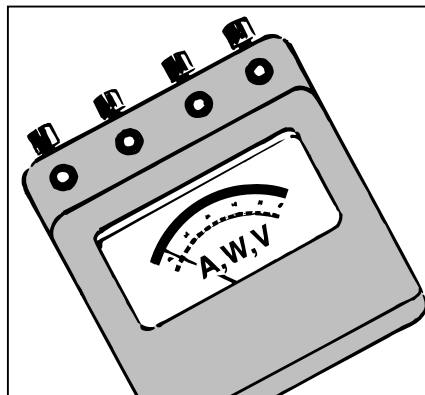


Power consumption too high

Compressor	- Signs of compressor wear - Motor defect - Reduced refrigeration capacity - Compressor cooling
Pressure irregularity	- Blockage - Non-condensable gases - Moisture - Dirt - Fan defect
Overload	- Application limits exceeded - Voltage/frequency - Pressure irregularity - Temperature - Refrigerant type

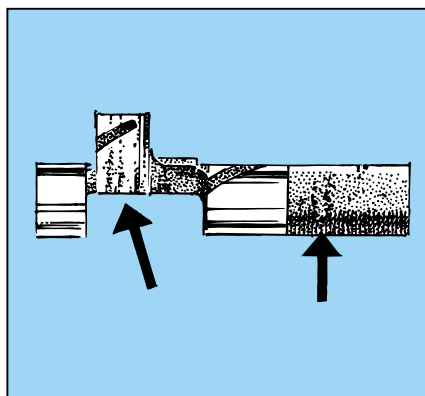
Pressure irregularity and overload often cause compressor defects that show themselves in the form of increased power consumption. Refer to the previous pages for information on problems with pressure irregularity and compressor overload seen from the system side.

Excessive evaporating and condensing pressures cause compressor motor overload which leads to increased power consumption. This problem also arises if the compressor is not sufficiently cooled, or if extreme overvoltage occurs. Undervoltage is not normally a problem in Western Europe because here the voltage rarely drops below 198 V.

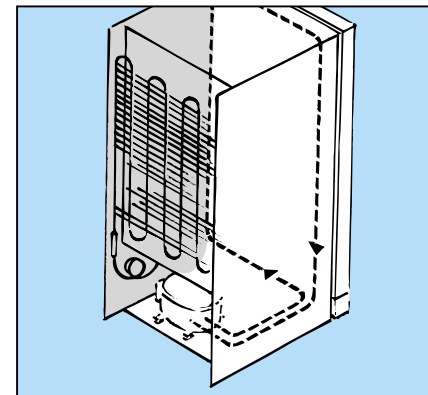


Constant overload will give signs of wear in compressor bearings and valve systems. Overload that causes frequent winding protector cutouts can also produce an increased number of electrical drop-outs.

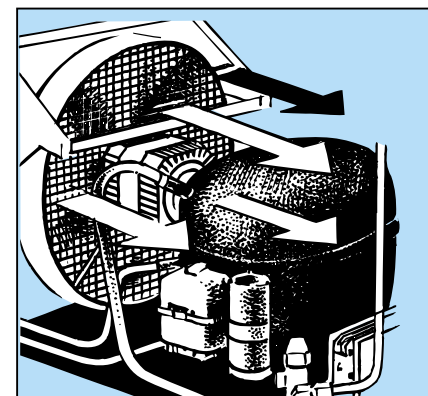
In cases where the application limits are exceeded, the system must be adapted. For example, by the use of a thermostatic expansion valve with an MOP that will limit the evaporating pressure, a pressure regulator, or a condensing pressure regulator. See also Chapter 4 (Thermostatic expansion valves) and Chapter 6 (Pressure regulators, KV valves) in »Fitters' Notes«.



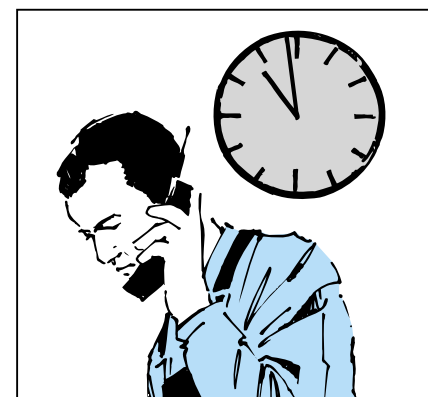
Static cooling (in certain circumstances an oil cooler) is sufficient for most household refrigeration appliances, provided that the clearances specified by the manufacturer are maintained, especially where a built-in appliance is concerned.



Commercial equipment should be fan-cooled. The normal recommended air velocity across condenser and compressor is 3 m/s.



A further recommendation is regular service on the refrigeration system, including cleaning of the condenser.



Noise

Compressor	Pressure circuit Oil level Clearance: piston/cylinder Valve system
Fan	Deformed fan blades Bearing wear Baseplate
Valves	»Whistling« from thermostatic expansion valves »Chatter« from solenoid and check valves
System noise	Liquid noise (mainly in evaporator)
Installation	Piping Compressor, fan and condenser brackets

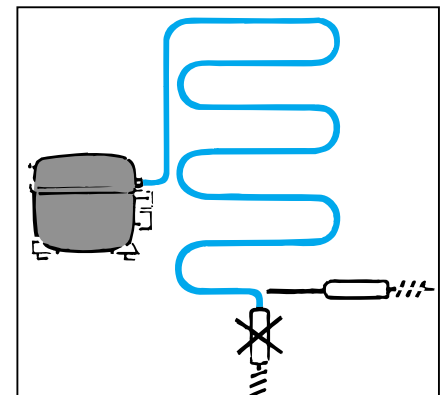
Danfoss compressors and condensing units do not normally give rise to complaints about noise. The noise level of compressors and, above all, fans is well in agreement with the demands made by the market. If occasional complaints are received, they usually arise from installation or system errors.



The rare noise problems that do occur are mostly because of production faults, e.g. discharge line touching the compressor housing, oil level too high/low, too much clearance between piston and cylinder, faulty assembly of the valve system. Such noise is easy to diagnose with a screwdriver used as a »stethoscope«.

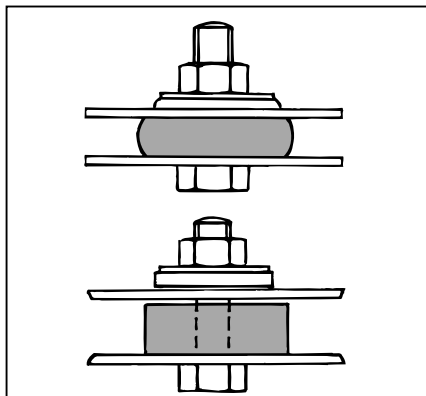


System noise is a critical factor in household appliances. Here, liquid noise at the evaporator inlet is characteristic. On the system side it is difficult to remedy this problem because what is involved is a mass produced equipment. If the filter is mounted vertically, it might help to mount it horizontally instead. However, it should be remembered that noise can be amplified by structure, e.g. with a built-in appliance. In such a situation, the manufacturer should be contacted.

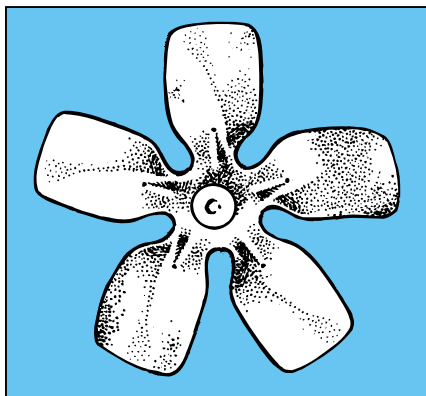


To prevent noise transfer, pipework should not be allowed to touch the compressor, the heat exchanger or the side walls.

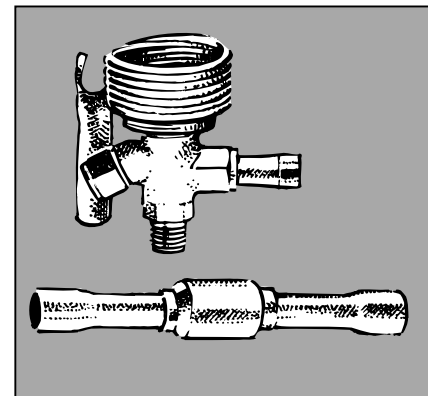
When installing a compressor, the fittings and grommet sleeves supplied must be used to avoid the rubber pads being compressed so much that they lose their noise-suppression properties.



Fans are used mostly in commercial refrigeration systems. Noise will be generated if the fan blades become deformed or touch the heat exchanger fins. Worn bearings also produce a great deal of noise. Additionally, the fan unit must be firmly secured so that it does not move in relation to its mounting bracket. Normally, fans have a higher noise level than compressors. In some circumstances, it is possible to reduce the noise level by installing a smaller fan motor, but this can only be recommended when the condenser area is over-sized.



If the noise comes from the valves, the cause is usually incorrect sizing. Solenoid and check valves must never be sized to suit the pipe connections, but in accordance with the k_v value. This ensures the min. pressure drop necessary to open the valve and keep it open without valve »chatter«. Another phenomenon is »whistling« in thermostatic expansion valves. Here a check should be made to ensure that the size of the orifice corresponds to the system characteristics and that above all there is sufficient liquid subcooling ahead of the expansion valve [approx. 5 k_v].



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