

1

MOUNTING INSTRUCTIONS
FOR DANFOSS COMPRESSORS

C O N T E N T S

M O U N T I N G I N S T R U C T I O N S F O R 2 2 0 - 2 4 0 V A N D 1 1 5 - 1 2 7 V C O M P R E S S O R S

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1. GENERAL

When a compressor has to be installed in new appliances normally sufficient time is available to choose the right compressor type from datasheets and make sufficient testing.

Contrary when a faulty compressor has to be replaced it can in many cases be impossible to get the same compressor type as the original.

In such cases it is necessary to compare relevant compressor catalogue data.

Long lifetime for a compressor can be expected if the

service work is done in the right way and cleanness and dryness of the components are taken into consideration.

The service technician has to observe the following when choosing a compressor.

Type of refrigerant, voltage and frequency, application range, compressor displacement/capacity, starting conditions and cooling conditions.

If possible use the same refrigerant type as in the faulty system.

2. COMPRESSOR

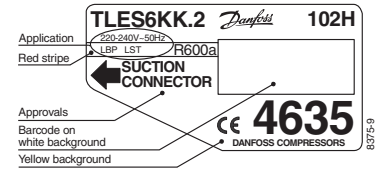
The programme of Danfoss compressors consists of the basic types P, T, N, F, SC and SC Twin.



Danfoss 220 V compressors have a yellow label with information of the type designation, voltage and frequency, application, starting conditions, refrigerant and code number. The 115 V compressors have a green label.

LST/HST mentioned both means that the starting characteristics are depending on the electrical equipment.

If the type label has been destroyed, the compressor type and the code number can be found in the stamping on the side of the compressor. See first pages in collection of datasheets for the compressor.



2.1 DENOMINATION

Example of compressor denomination

Basic design (P, T, N, F, S)

L, R, C = int. motor protection
T, F = ext. motor protection
LV = variable speed

E = energy optimization
Y = High energy optimization

S = semi direct suction

Nominal displacement in cm³

T L E S 4 F K

A	= LBP / (MBP)	R12
AT	= LBP (tropical)	R12
B	= LBP / MBP / HBP	R12
BM	= LBP (240 V)	R22
C	= LBP	R502 / (R22)
CL	= LBP	R404A/ R507
CM	= LBP	R22 / R502
CN	= LBP	R290
D	= HBP	R22
DL	= HBP	R404A/ R507
F	= LBP	R134a
FT	= LBP (tropical)	R134a
G	= LBP/MBP/HBP	R134a
GH	= Heat pumps	R134a
GHH	= Heat pumps (optimized)	R134a
H	= Heat pumps	R12
HH	= Heat pumps (optimized)	R12
K	= LBP/(MBP)	R600a
KT	= LBP (tropical)	R600a
MF	= MBP	R134a
ML	= MBP	R404A/R507

empty = LST / HST
K = Capillary tube (LST)
X = Expansion valve (HST)

The first letter of the denomination (P, T, N, F or S) indicates compressor series whereas the second letter indicates motor protection placing.

E, Y and X mean different energy optimization steps. S means semi direct suction. V means variable speed compressors. On all these mentioned types the indicated suction connector has to be used. Using the wrong connector as suction connector will lead to reduced capacity and efficiency.

A number indicates the displacement in cm³, but for PL compressors the number indicates the nominal capacity. The letter after the displacement indicates which refrigerant must be used as well as the field of application for the compressor. (See example)

LBP (Low Back Pressure) indicates the range of low evaporating temperatures, typically -10°C down to -35°C or even -45°C, for use in freezers and refrigerators with freezer compartments.

MBP (Medium Back Pressure) indicates the range of

medium evaporating temperatures, typically -20°C up to 0°C, such as in cold cabinets, milk coolers, ice machines and water coolers.

HBP (High Back Pressure) indicates high evaporating temperatures, typically -5°C up to +15°C, such as in dehumidifiers and some liquid coolers.

T as extra character indicates a compressor intended for tropical application. This means high ambient temperatures and capability of working with more unstable power supply.

The final letter in the compressor denomination provides information on the starting torque. If, as principal rule, the compressor is intended for LST (Low Starting Torque) and HST (High Starting Torque), the place is left empty.

The starting characteristics are depending on the electrical equipment chosen.

K indicates LST (capillary tube and pressure equalization during standstill) and X indicates HST (expansion valve or no pressure equalization).

2.2
LOW AND HIGH
STARTING TORQUE

Description of the different electrical equipments shown can be found in the datasheets for the compressors. See also section 6.0.
Low starting torque (LST) compressors must only be used in refrigerating systems having capillary tube throttling device where pressure equalization is obtained between suction and discharge sides during each standstill period. A PTC starting device (LST) requires that the standstill time is at least 5 minutes, since this is the time necessary for cooling the PTC.
The HST starting device, which gives the compressor a

high starting torque, must always be used in refrigeration systems with expansion valve, and for capillary tube systems without full pressure equalization before each start.
High starting torque (HST) compressors are normally using a relay and starting capacitor as starting device.
The starting capacitors are designed for short time cut-in. "1.7% ED", which is stamped onto the starting capacitor, means for instance max. 10 cut-ins per hour each with a duration of 6 seconds.

2.3
MOTOR PROTECTOR
AND WINDING
TEMPERATURE

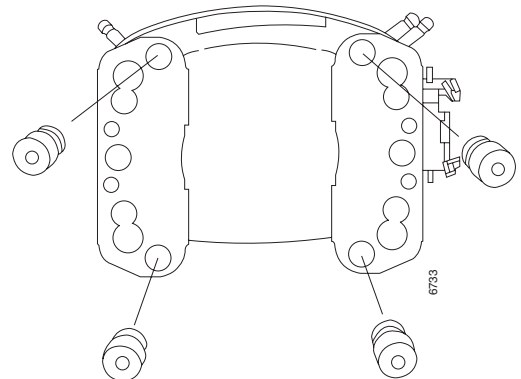
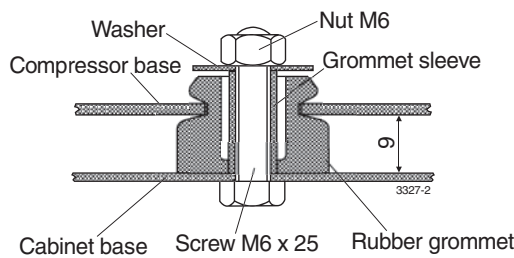
Most of the Danfoss compressors are equipped with a built-in motor protector (winding protector) in the motor windings. See also section 2.1.
At peak load the winding temperature must not exceed

135°C and at stable conditions the winding temperature must not exceed 125°C. Specific information on some special types can be found in the collection of data sheets.

2.4
RUBBER GROMMETS

Stand the compressor on the base plate until it is fitted. This reduces the risk of oil coatings inside the connectors and associated brazing problems. Place the compressor on its side with the connectors pointing upwards and then fit

the rubber grommets and grommet sleeves on the base plate of the compressor.
Do not turn the compressor upside down.
Mount the compressor on the baseplate of the appliance.



2.5
MINIMUM AMBIENT
TEMPERATURE

Allow the compressor to reach a temperature above 10°C before starting the first time to avoid starting problems.

3.0
FAULT FINDING

If the compressor does not operate, it could have many reasons. Before replacing the compressor, it should be made sure, that it is defect.

For easy failure location, a small folder is available with document number CN.71.B

3.1
WINDING PROTECTOR
CUT OUT

If the winding protector cuts out while the compressor is cold, it can take approx 5 minutes for the protector to reset. If the winding protector cuts out while the

compressor is warm (compressor housing above 80°C) the resetting time is increased. Up to approx 45 minutes may pass before reset.

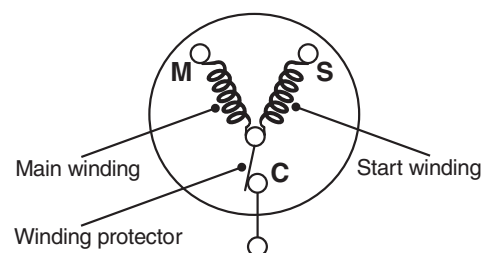
3.2
PTC AND PROTECTOR
INTERACTION

The PTC starting unit requires a cooling time of 5 minutes before it can restart the compressor with full starting torque. Short time power supply cut offs, not long enough to allow the PTC to cool down, can result in start failure for up to 1 hour. The PTC will not be able to provide

full action during the first protector resets, as they typically do not allow pressure equalization also. Thus the protector trips until the reset time is long enough. This mismatch condition can be solved by unplugging the appliance for 5 to 10 minutes typically.

3.3
CHECK OF WINDING
PROTECTOR AND
RESISTANCE

In the event of compressor failure a check is made by means of resistance measurement directly on the current lead-in to see whether the defect is due to motor damage or simply a temporarily cut out of the winding protector. If tests with resistance measurement reveal a connection through the motor windings from point M to S of the current lead-in, but broken circuit between point M and C and S and C this indicates that the winding protector is cut out. Therefore, wait for resetting.



4.0
OPENING THE REFRIGERATING SYSTEM

Never open a refrigerating system before all components for the repair are available. Compressor, drier and other system components must be sealed off until a continuous assembly can occur.
Opening a defect system must be done in different ways depending on the refrigerant used.

Fit a service valve to the system and collect the refrigerant in the right way.
If the refrigerant is flammable it can be released outside in the open air through a hose if the amount is very limited. Then flush the system with dry nitrogen.

4.1
FLAMMABLE REFRIGERANTS

R600a and R290 are hydrocarbons. These refrigerants are flammable and are only allowed for use in appliances which fulfil the requirements laid down in the latest revision of EN/IEC 60335-2-24. (To cover potential risk originated from the use of flammable refrigerants). Consequently, R600a and R290 are only allowed to be

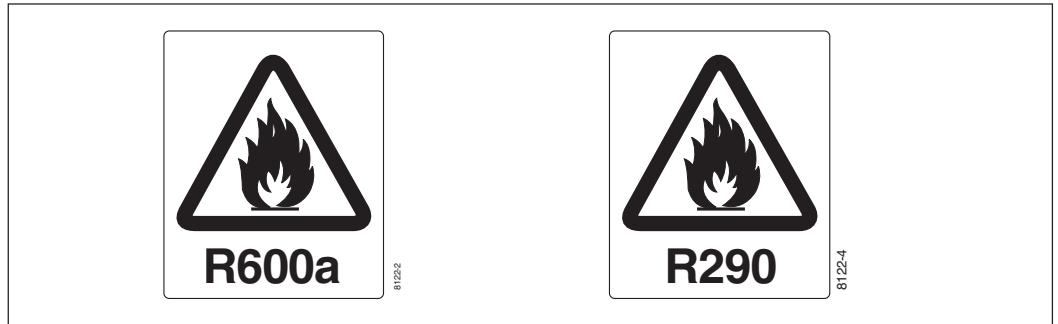
used in household appliances designed for this refrigerant and fulfil the above-mentioned standard. R600a and R290 are heavier than air and the concentration will always be highest at the floor. The flammability limits are approx. as follows,

Refrigerant:	R600a	R290
Lower limit:	1.5% by vol. (38 g/m ³)	2.1% by vol. (39 g/m ³)
Upper limit:	8.5% by vol. (203 g/m ³)	9.5% by vol. (177 g/m ³)
Ignition temperature:	460°C	470°C

In order to carry out service and repair on R600a and R290 systems the service personnel must be properly trained to be able to handle flammable refrigerants. This includes knowledge on tools, transportation of compressor and refrigerant, and the relevant regulations and safety precautions when carrying out service and repair.

Do not use open fire when working with refrigerants R600a and R290!

Danfoss compressors for the flammable refrigerants R600a and R290 are equipped with a yellow warning label as shown.



The smaller R290 compressors, types T and N, are LST types. These often need a timer to ensure sufficient pressure equalization time.

5.0
MOUNTING

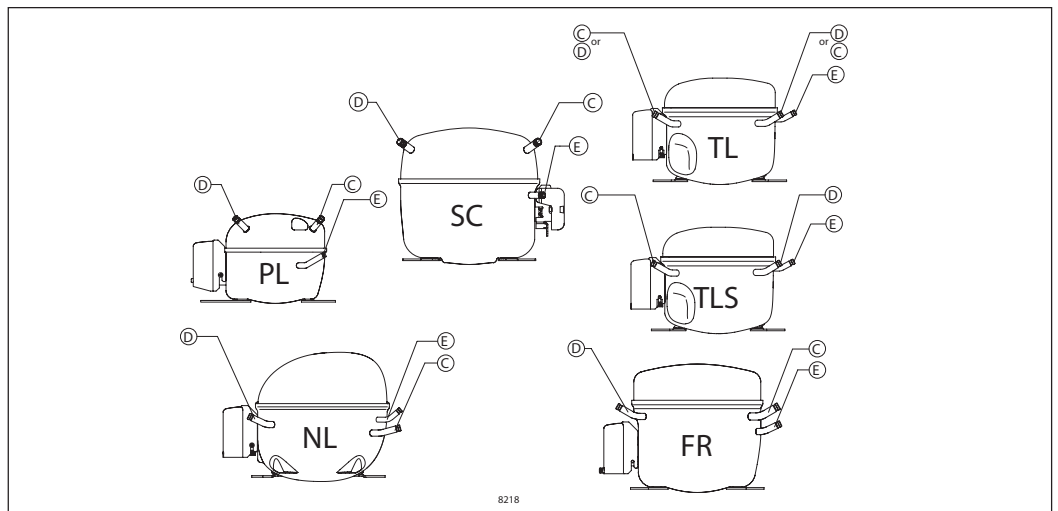
Soldering problems caused by oil in the connectors can be avoided by placing the compressor on its base plate some time before soldering it into the system. The com-

pressor must never be placed upside down. The system should be closed within 15 minutes to avoid moisture and dirt penetration.

5.1
CONNECTORS

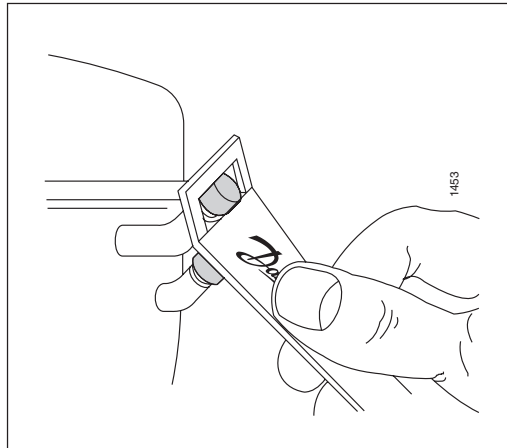
The positions of connectors are found in the sketches. "C" means suction and must always be connected to the suction line. "E" means discharge and must be connected

to the discharge line. "D" means process and is used for processing the system.



Most Danfoss compressors are equipped with tube connectors of thick-walled, copper-plated steel tube which have a solderability which comes up to that of conventional copper connectors. The connectors are welded into the compressor housing and weldings can't be damaged by overheating during soldering.

The connectors have an aluminium cap sealing (Capsolut) which gives a tight sealing. The sealing secures that the compressors have not been opened after leaving Danfoss' production lines. In addition to that, the sealing makes a protecting charge of nitrogen superfluous.

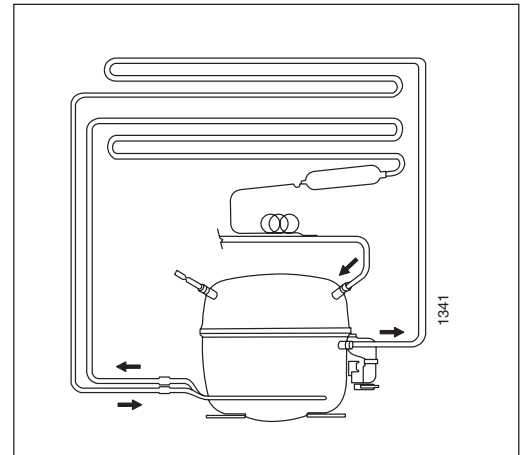


The capsoluts are easily removed with an ordinary pair of pliers or a special tool as shown. The capsolut cannot be remounted.

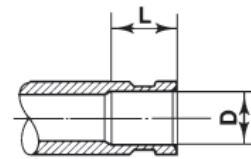
When the seals on the compressor connectors are removed the compressor must be mounted in the system within 15 minutes to avoid moisture and dirt penetration. *Capsolut seals on connectors must never be left in the assembled system.*

Oil coolers, if mounted (compressors from 7 cm³

displacement), are made of copper tube and the tube connectors are sealed with rubber plugs. An oil-cooling coil must be connected in the middle of the condenser circuit.



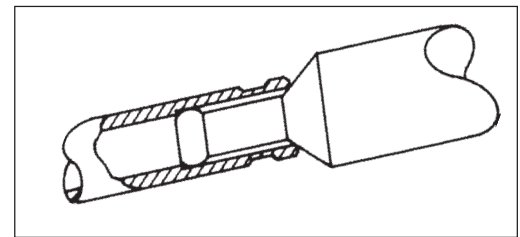
SC Twin compressors must have a non-return valve in the discharge line to compressor no. 2. If a change in the starting sequence between compressor no. 1 and no. 2 is wanted a non-return valve has to be placed in both discharge lines.



In order to have optimum conditions for soldering and to minimize the consumption of soldering material, all tube connectors on Danfoss compressors have shoulders, as shown.

5.2 DRIFTING OUT CONNECTORS

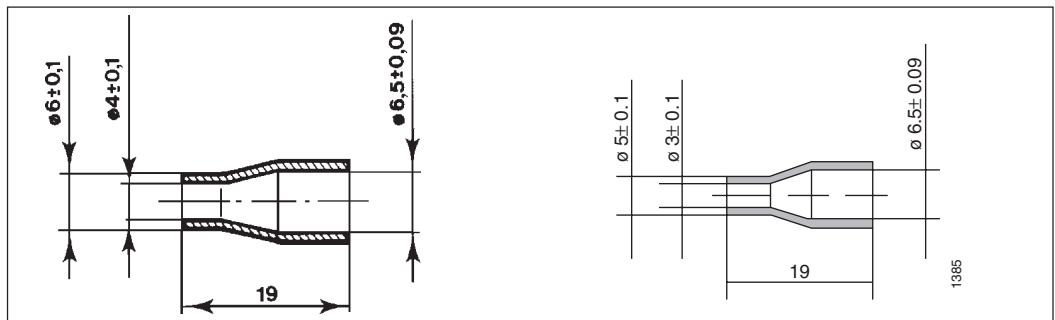
It is possible to drift out the connectors having inside diameters from 6.2 mm to 6.5 mm which suit 1/4" (6.35 mm) tube, but we advise against drifting out the connectors by more than 0.3 mm. During drifting it is necessary to have a suitable counterforce on the connectors so that they don't break off. A different solution to this problem would be to reduce the diameter of the end of the connector tube with special pliers.



5.3 TUBE ADAPTERS

Instead of drifting out the connectors or reducing the diameter of the connection tube, copper adapter tubes can be used for service. A 6/6.5 mm adapter tube can be used where a compressor with millimetre connectors (6.2 mm) is to be

connected to a refrigerating system with 1/4" (6.35 mm) tubes. A 5/6.5 mm adapter tube can be used where a compressor with a 5 mm discharge connector is to be connected to a 1/4" (6.35 mm) tube.



5.4
SOLDERS

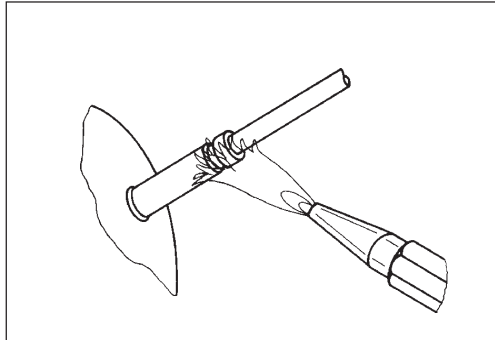
For soldering the connectors and copper tubes solders having a silver content as low as 2% can be used. This means that the so-called phosphor solders can also be used when the connecting tube is made of copper.

If the connecting tube is made of steel, a solder with high silver content which does not contain phosphor and which has a liquidus temperature below 740°C is required. For this also a flux is needed.

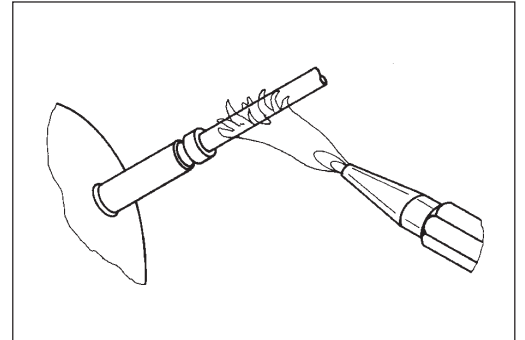
5.5
SOLDERING

The following are guidelines for soldering of steel connectors different from soldering copper connectors. During heating, the temperature should be kept as close

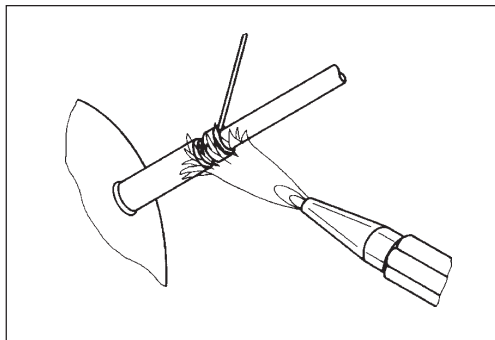
to the melting point of the solder as possible. Overheating will lead to surface damage, so decreasing the chances of good soldering.



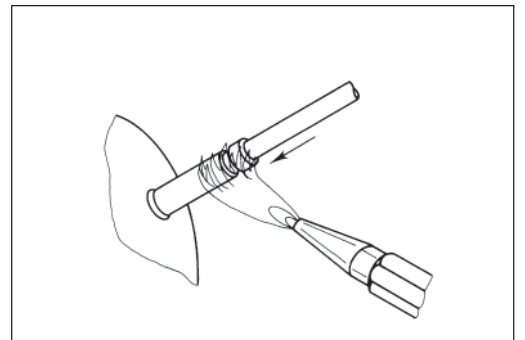
Use the "soft" heat in the torch flame when heating the joint. Distribute the flame so at least 90% of the heat concentrates around the connector and approx. 10% around the connecting tube.



When the connector is cherry-red (approx. 600°C) apply the flame to the connecting tube for a few seconds.



Continue heating the joint with the "soft" flame and apply solder.

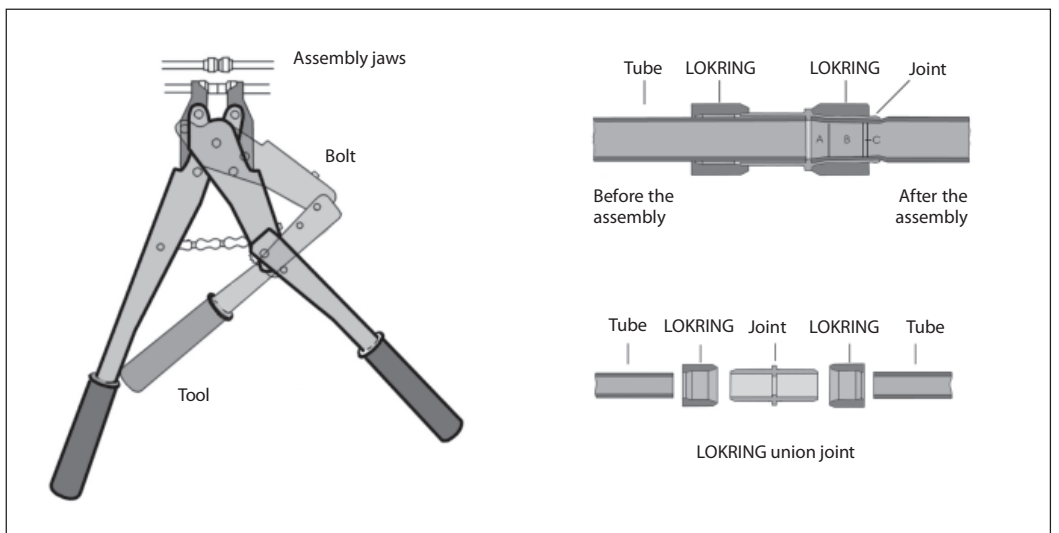


Draw the solder down into the solder gap by slowly moving the flame towards the compressor; then completely remove the flame.

5.6
LOKRING
CONNECTIONS

System containing the flammable refrigerants R600a or R290 must not be soldered. In such cases a Lokring connection as shown can be used. Newly made systems can be soldered as usual, as long as they have not been charged with flammable refrigerant.

Charged systems are newer to be opened by use of the flame. Compressors from systems with flammable refrigerant have to be evacuated to remove the refrigerant residues from the oil.



5.7
DRIERS

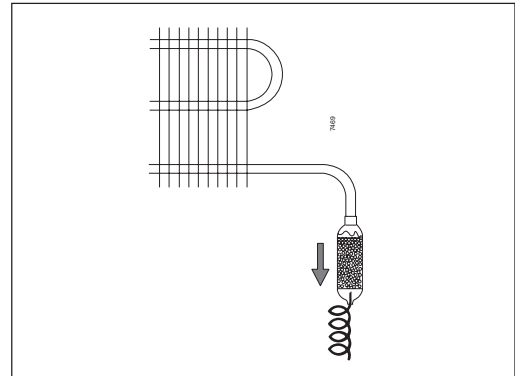
Danfoss compressors are expected used in well-dimensioned refrigerant systems including a drier containing an adequate amount and type of desiccant and with a suitable quality.

The refrigerating systems are expected to have a dryness corresponding to 10 ppm. As a max limit 20 ppm is accepted.

The drier must be placed in a way ensuring that the direction of flow of the refrigerant follows gravitation. Thus the MS beads are prevented from moving among themselves and in this way making dust and possible blockage at the inlet of the capillary tube. At capillary tube systems this also ensures a minimal pressure equalizing time.

Especially pencil driers should be chosen carefully to ensure proper quality. In transportable systems only driers approved for mobile application are to be used.

A new drier must always be installed when a refrigeration system has been opened.



5.8
DRIERS AND
REFRIGERANTS

Water has a molecular size of 2.8 Ångström. Accordingly, Molecular Sieves with a pore size of 3 Ångström will be suitable for normally used refrigerants.

MS with a pore size of 3 Ångström can be supplied by the following,

UOP Molecular Sieve Division (former Union Carbide)
25 East Algonquin Road, Des Plaines
Illinois 60017-5017, USA

	4A-XH6	4A-XH7	4A-XH9
R12, R22, R502	×	×	×
R134a		×	×
HFC/HCFC blends			×
R290, R600a		×	×

Grace Davison Chemical
W.R.Grace & Co, P.O.Box 2117, Baltimore
Maryland 212203 USA

	"574"	"594"
R12, R22, R502	×	×
R134a	×	×
HFC/HCFC blends		×
R290, R600a		×

CECA S.A
La Defense 2, Cedex 54, 92062 Paris-La Defense
France

	NL30R	Siliporite H3R
R12, R22, R502	×	×
R134a	×	×
HFC/HCFC blends		×
R290, R600a		×

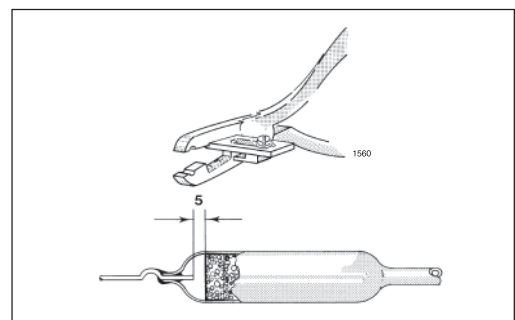
Driers with the following amount of desiccants are recommended.

Compressor	Drier
PL and TL	6 gram or more
FR and NL	10 gram or more
SC	15 gram or more

In commercial systems larger solid core driers are often used. These are to be used for the refrigerants according to the manufacturers instructions. If a burn-out filter is needed in a repair case, please contact the supplier for detail information.

5.9
CAPILLARY TUBE
IN DRIER

Special care should be taken when soldering the capillary tube. When mounting the capillary tube it should not be pushed too far into the drier, thus touching the gaze or filter disc, causing a blockage or restriction. If, on the other hand, the tube is only partly inserted into the drier, blockage could occur during the soldering. This problem can be avoided by making a "stop" on the capillary tube with a pair of special pliers as shown.



6.0
ELECTRICAL EQUIP-
MENT

For information on the right starting devices, please see Datasheets for the compressor.
Never use a starting device of an old compressor, because this may cause a compressor failure.
No attempt must be made to start the compressor

without the complete starting equipment. For safety reasons the compressor must always be earthed or otherwise additionally protected. Keep away inflammable material from the electrical equipment.
The compressor must not be started under vacuum.

6.1
LST STARTING DEVICE

Compressors with internal motor protector.
Fig. 21, 22 and 23 show three types of devices with PTC starters.
Mount the starting device on the current lead-in of the compressor.
Pressure must be applied to the centre of the starting device so that the clips are not deformed.
Mount the cord relief on the bracket under the starting device.

On some energy optimized compressors a run capacitor is connected across the terminals N and S for lower power consumption.
Pressure must be applied to the centre of the starting device when dismantling so that the clips are not deformed.
Place the cover over the starting device and screw it to the bracket.

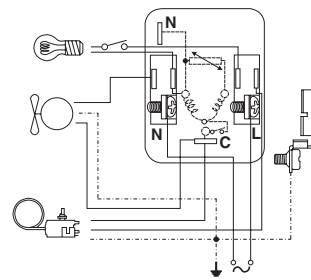
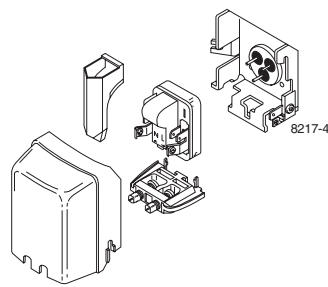


Fig. 21

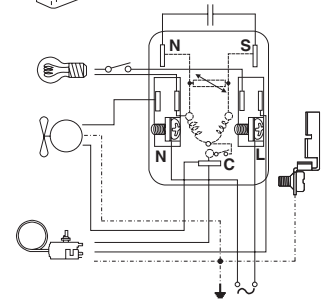
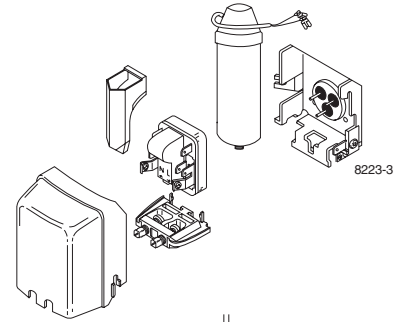


Fig. 22

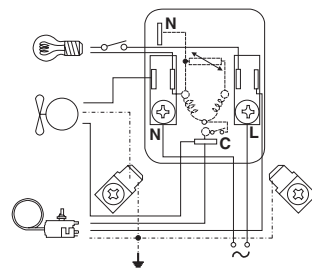
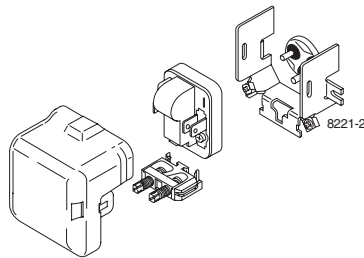


Fig. 23

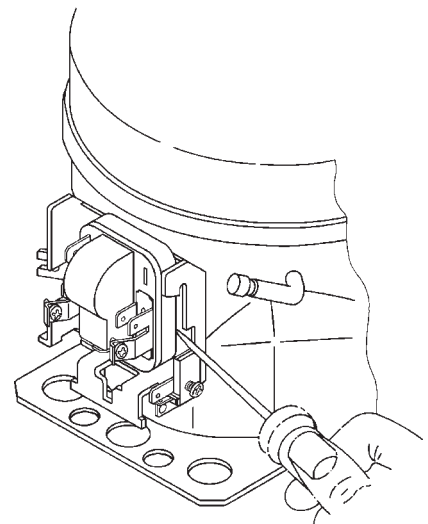
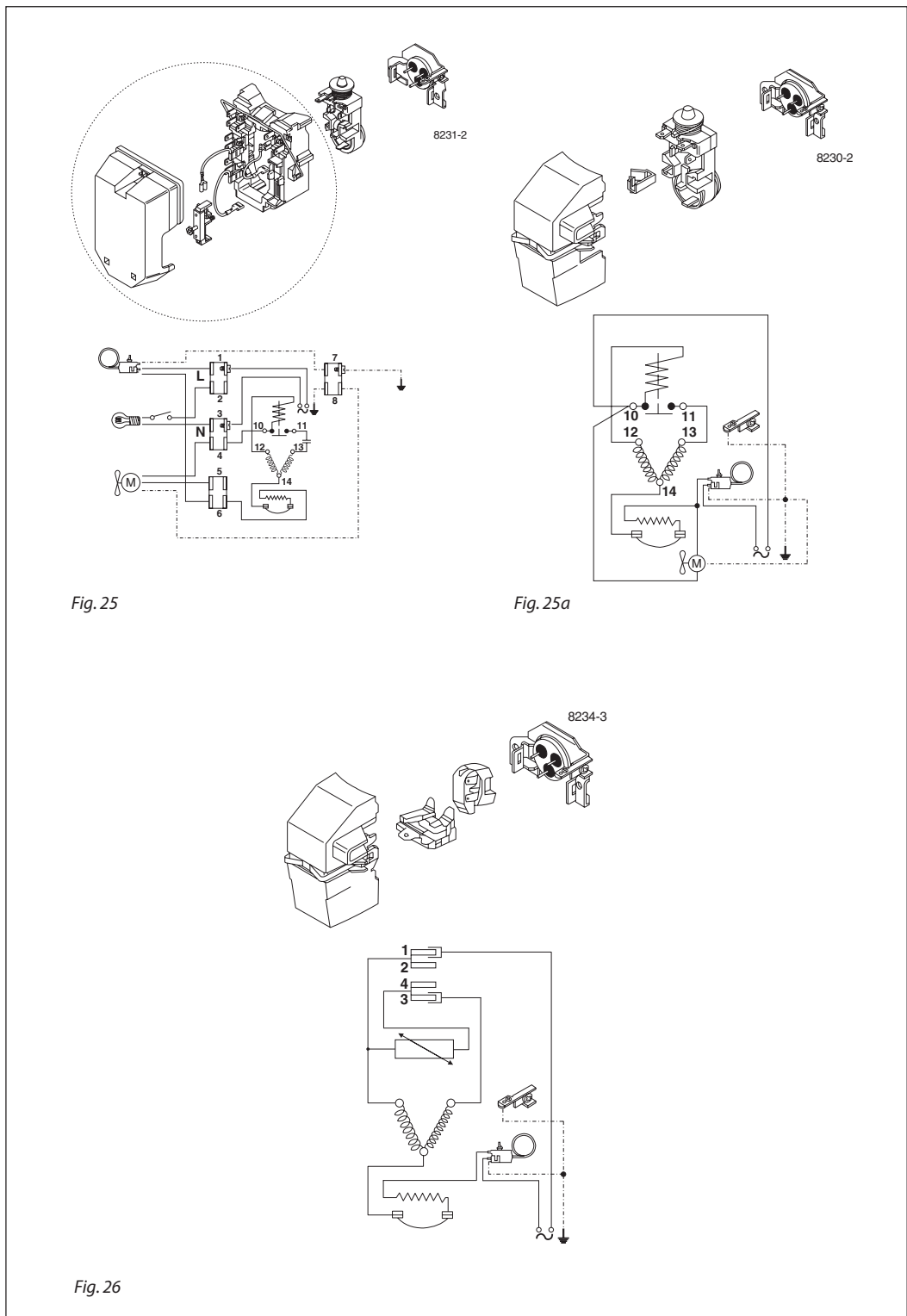


Fig. 24

Compressors with external motor protector.
 Fig. 25 and 25a show equipment with relay and motor protector. Mounting of the relay is also done by applying pressure on the center of the relay. The cover is fixed with a clamp.

Fig. 26 shows equipment with PTC and external protector. The protector is placed on the bottom terminal pin and the PTC on the 2 on the top. The cover is fixed with a clamp. No cord relief is available for this equipment.



6.2
 HST STARTING
 EQUIPMENT

Fig. 27, 28, 29, 30 and 31 show five types of devices with relays and starting capacitor. Mount the starting relay on the current lead-in on the compressor. Apply pressure to the centre of the starting relay to avoid deforming the clips. Fasten the starting capacitor to the bracket on the compressor.

Mount the cord relief in the bracket under the starting relay. (Fig. 27 and 28 only). Place the cover over the starting relay and screw it to the bracket or lock it in position with the locking clamp, or the integrated hooks.

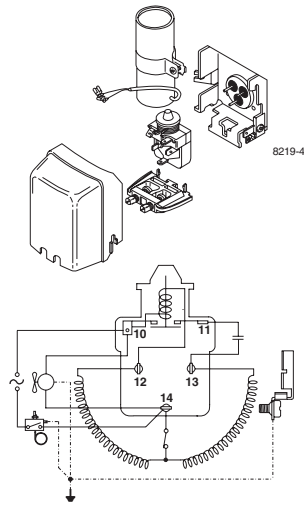


Fig. 27

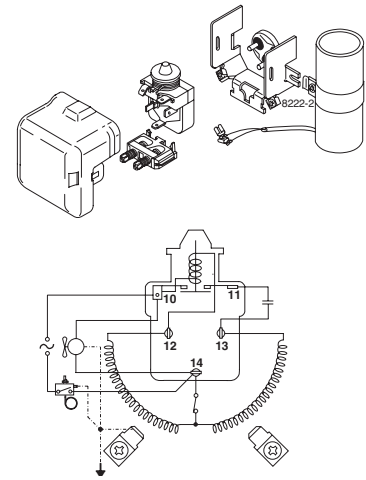


Fig. 28

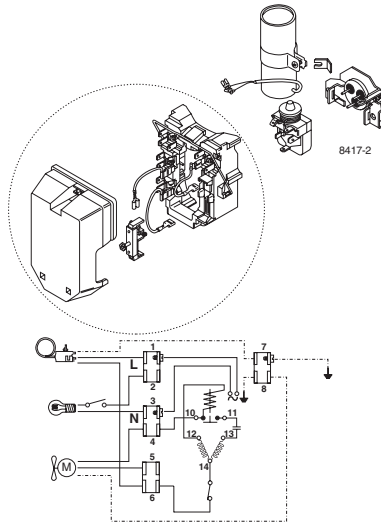


Fig. 29

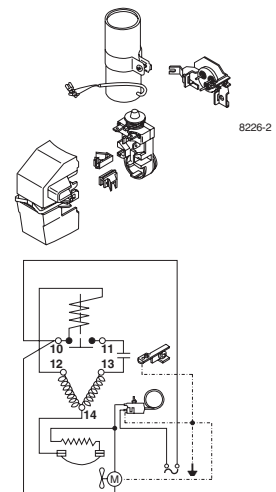


Fig. 30

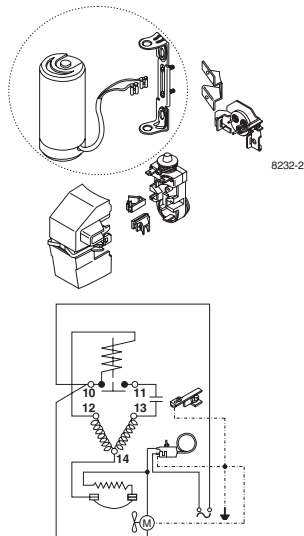


Fig. 31

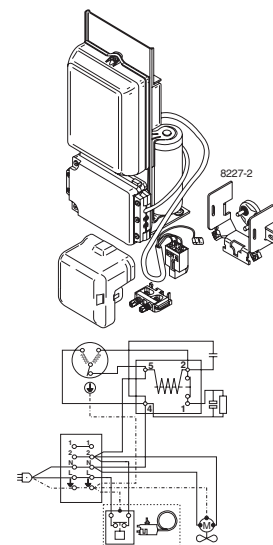


Fig. 32

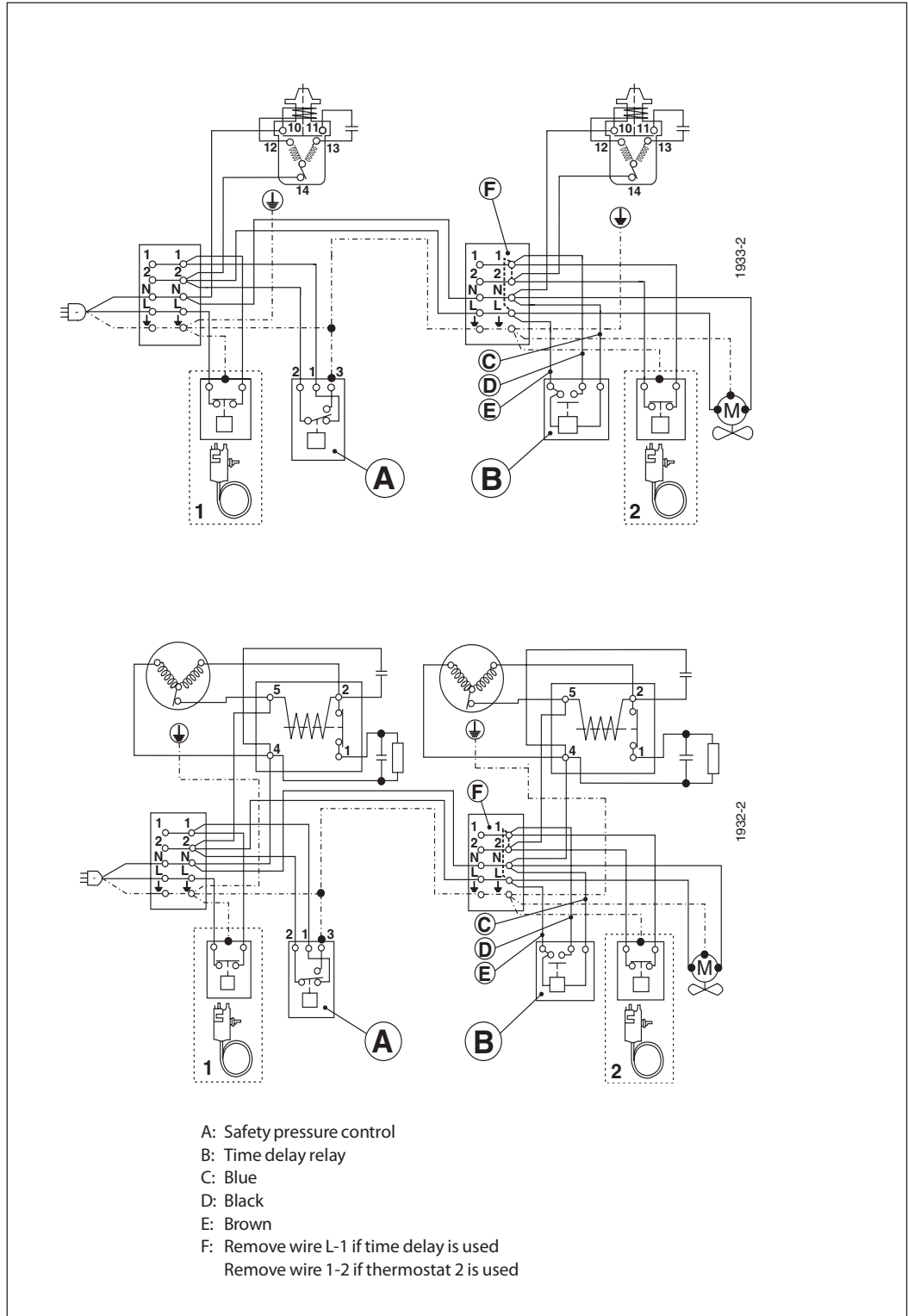
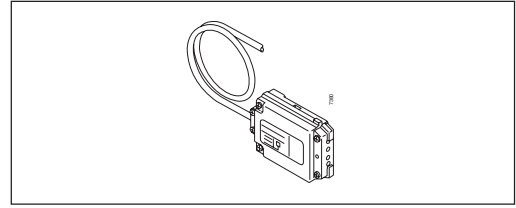
6.3
HST CSR
STARTING EQUIPMENT

Mount the terminal box on the current lead-in. Note that the leads must face upwards. Mount the cord relief in the

bracket under terminal box. Place the cover. (See fig. 32 above).

6.4
EQUIPMENT
FOR SC TWIN COM-
PRESSORS

The use of a time delay (e.g. Danfoss 117N0001) is recommended for starting the second section (15 seconds time delay).
If time delay is used, the connection on the terminal board between L and 1 must be removed from the compressor no. 2 connection box. If thermostat for capacity control is used, the connection on the terminal board between 1 and 2 must be removed.



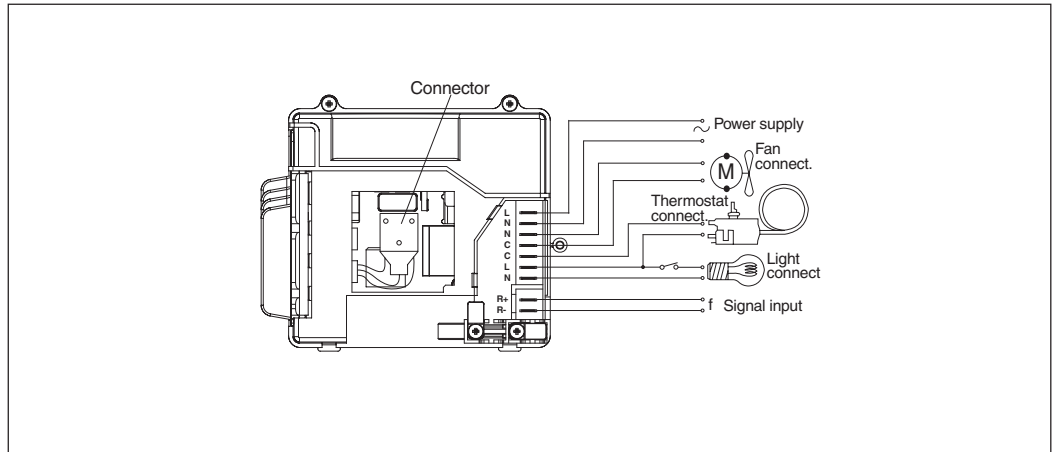
6.5 ELECTRONIC UNIT FOR VARIABLE SPEED COMPRESSORS

The electronic unit provides the TLV and NLV compressors with a high starting torque (HST) which means that a pressure-equalization of the system before each start is not necessary.

The variable speed compressor motor is electronically controlled. The electronic unit has built-in overload protection as well as thermal protection. In case of activation of the protection the electronic unit will protect the compressor motor as well as itself. When the protection has been activated, the electronic unit

automatically will restart the compressor after a certain time.

The compressors are equipped with permanent magnet rotors (PM motor) and 3 identical stator windings. The electronic unit is mounted directly on the compressor and controls the PM motor. Connecting the motor directly to AC mains, by fault, will damage the magnets and lead to drastically reduced efficiency, or even no functioning.



7.0 EVACUATION

After brazing, evacuation of the refrigeration system is started.

When a vacuum below 1 mbar is obtained the system is pressure equalized before the final evacuation and charging of refrigerant.

If a pressure test has been performed directly before evacuation, the evacuation process is to be started smoothly, with low pumping volume, to avoid oil loss from the compressor.

Many opinions exist how evacuation can be carried out in the best way.

Dependent on the volume conditions of the suction and the discharge side in the refrigeration system, it might be necessary to choose one of the following procedures for evacuation.

One-sided evacuation with continuous evacuation until a sufficiently low pressure in the condenser has been obtained. One or more short evacuation cycles with pressure equalization in between is necessary.

Two-sided evacuation with continuous evacuation until a

sufficiently low pressure has been obtained.

These procedures naturally require a good uniform quality (dryness) of the components used.

Fig. 38 shows a typical course of a one-sided evacuation from the process tube of the compressor. It also shows a pressure difference measured in the condenser. This can be remedied by increasing the numbers of pressure equalizations. The dotted line shows a procedure where two sides are evacuated simultaneously.

When the time is limited, the final vacuum to be obtained is only dependent on the capacity of the vacuum pump and the content of non condensable elements or refrigerant residues in the oil charge.

The advantage of a two-sided evacuation is that it is possible to obtain a considerably lower pressure in the system within a reasonable process time. This implies that it will be possible to build a leak check into the process in order to sort out leaks before charging the refrigerant.

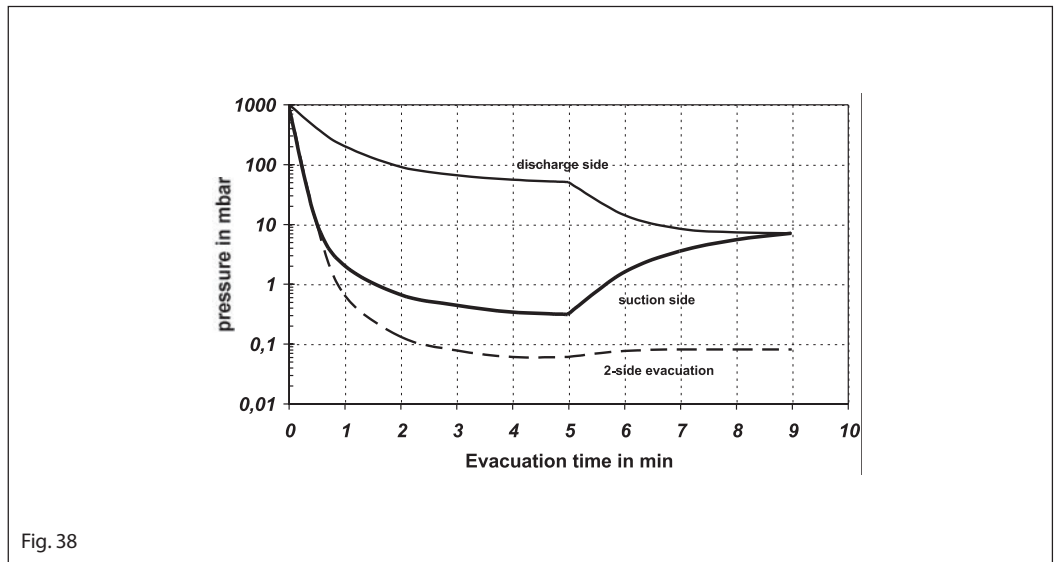


Fig. 38

Fig. 39 is an example of a pre-evacuation process with built-in leak test. The level of vacuum obtained depends on the process chosen. Two-sided evacuation is recommended.

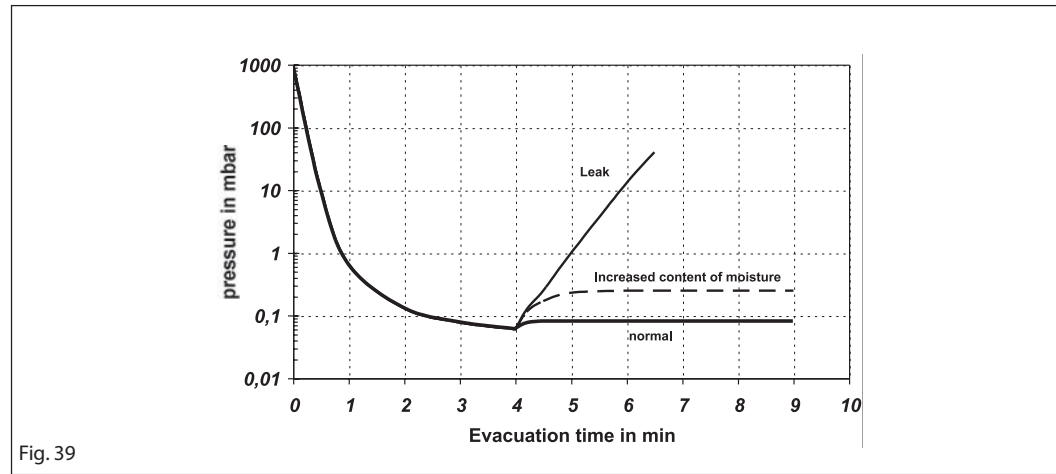


Fig. 39

7.1 VACUUM PUMPS

An explosion-safe vacuum pump must be used for systems with the flammable refrigerants R600a and R290.

The same vacuum pump can be used for all refrigerants if it is charged with Ester oil.

8.0 CHARGING OF REFRIGERANT

Always charge the system with type and amount of refrigerant recommended by the manufacturer. In most cases the refrigerant charge is indicated on the type label of the appliance.

Charging can be done according to volume or by weight. Use a charging glass for charging by volume. Flammable refrigerants must be charged by weight.

8.1 MAXIMUM REFRIGERANT CHARGE

If the max refrigerant charge is exceeded the oil in the compressor may foam after a cold start and the valve system could be damaged.

The refrigerant charge must never be too large to be contained on the condenser side of the refrigeration system. Only the refrigerant amount necessary for the system to function must be charged.

Compressor	Maximum refrigerant charge			
	R134a	R600a	R290	R404A
P	300 g	150 g		
T	400 g*	150 g	150 g	400 g
N	400 g*	150 g	150 g	400 g
F	900 g	150 g		850 g
SC	1300 g		150 g	1300 g
SC-Twin	2200 g			

*) Single types with higher limits available, see data sheets.

8.2 CLOSING THE PROCESS TUBE

For the refrigerants R600a and R290 the closing of the process tube can be done by means of a Lokring connection.

Soldering is not allowed on systems with flammable refrigerants.

9.0 TESTING

Hermetic refrigerating systems must be tight. If a household appliance shall function over a reasonable lifetime, it is necessary to have leak rates below 1 gram per year. So leak test equipment of a high quality is required. All connections must be tested for leaks with a leak testing equipment. This can be done with an electronic leak testing equipment. The discharge side of the system (from discharge

connector to the condenser and to the drier) must be tested with the compressor running. The evaporator, the suction line and the compressor must be tested during standstill and equalized pressure. If refrigerant R600a is used, leak test should be done with other means than the refrigerant, e.g. helium, as the equalizing pressure is low, so often below ambient air pressure. Thus leaks would not be detectable.

9.1 TESTING OF THE APPLIANCE

Before leaving a system it must be checked that cooling down of the evaporator is possible and that the compressor operates satisfactory on the thermostat. For systems with capillary tube as throttling device it is

important to check that the system is able to pressure equalize during standstill periods and that the low starting torque compressor is able to start the system without causing trips on the motor protector.



For further information please visit:

www.danfoss.com/compressors

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