

SERVICE MANUAL

STAL
REFRIGERATION

VR Mk I

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1. UNIT DESCRIPTION

7827-C-50E	Heat pump unit series VR
7827-C-60E	Liquid chiller unit series VR
7827-C-70E	Liquid chiller unit series VR

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HEAT PUMP UNIT SERIES VR
Functional description

VRP

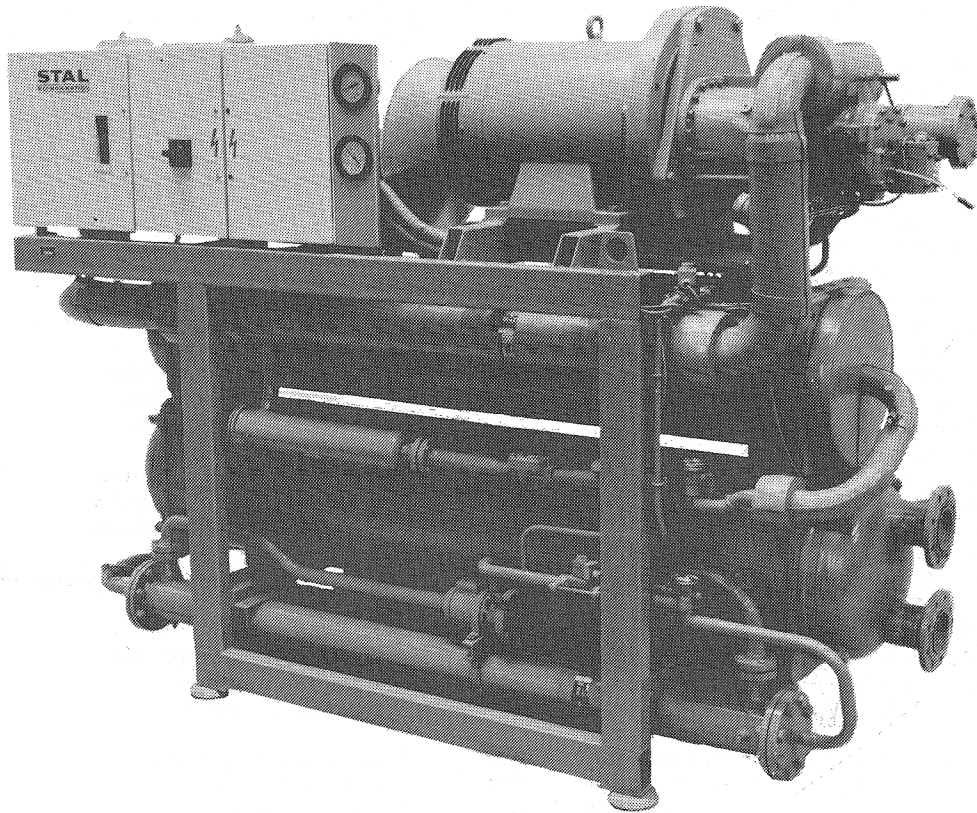


Fig. 1. Heat pump unit VRP

Applications

Heat pump units of type VRP are intended for systems that use water as a heated medium (and are thus equipped with fresh-water-cooled condensers). These units are equipped with evaporators used to chill water, glycol, etc., and they are used in indirect systems where the source of heat can consist of air, rock, soil, a lake etc. See Fig. 2.

Type VRP heat pump units can use R22 or R12 as a refrigerant, depending upon the desired heated medium temperature.

Design and construction

Type VRP heat pump units are ready for working. All you have to do is connect them to your plant's electric lines, chilled medium lines and heated medium system. The compressor (KS), the electric motor (M), the oil separator (OA) and the electrical equipment enclosure (AS) are mounted on a frame. The condenser/oil-cooler (KD/ OK) are mounted on the bottom beams of this frame.

The evaporator (EV) is mounted on the condenser's tube sheets. Moreover, the economizer (ECO) and the suction gas heat exchanger (VXX) are mounted on the frame.

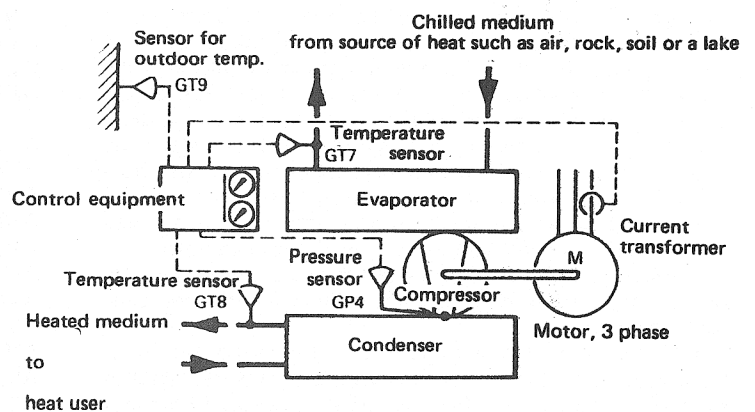


Fig. 2. Schematic diagram of heat pump unit VRP

The compressor is attached to the drive motor flange via a shield. Torque from the electric motor is transferred to the compressor via gearing.

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Operation

Refrigerant and oil circuit (Fig. 3)

When the compressor is started, solenoid valves AV14 and AV12 in the liquid line running to the evaporator and economizer open. The compressor sucks in cold gaseous refrigerant from the evaporator via the suction gas heat exchanger.

In the suction gas heat exchanger, the gaseous refrigerant is superheated by means of heat interchanged with the hot liquid refrigerant. The supply of suction gas to the compressor is regulated by expansion valve SV4 which is upstream from the evaporator. This valve controls (on the basis of the difference between the temperature after the heat exchanger and the refrigerant's saturation temperature) the supply of refrigerant to the evaporator so that at any given instant no more refrigerant is supplied than can be evaporated. Safety valve SAV1 (upstream from the heat exchanger) protects the suction line from excessive pressure.

The cold gaseous refrigerant is mixed in the compressor with atomized oil that is injected for three purposes: lubrication, cooling and control. The gas-oil mixture is sent (under high pressure) via the discharge line to the oil separator. Here, the oil is separated out and collects on the bottom of the separator. The level can be checked via sight glass SG1. Safety valve SAV3 protects the oil separator from excessive pressure.

High-pressure gas is sent on to the condenser via check valve BV2.

In the condenser, energy is transferred from the gaseous refrigerant to the heated medium which is sent (with the assistance of a pump in the heated medium loop) through the condenser. As a result, the refrigerant enters the liquid state. Safety valve SAV2 protects the condenser from excessive pressure.

The hot liquid refrigerant is pressed out of the condenser through stop valve AV15. The main liquid flow then proceeds through the economizer, suction gas heat exchanger and drier filter FT to solenoid valve AV14 and expansion valve SV4 (located upstream from the evaporator). Sight glass SG2 is mounted in the liquid line upstream from the expansion valve. This sight glass can be used to check that the liquid in the line does not contain any gas bubbles. The drier filter removes contaminants and moisture which might otherwise cause the solenoid valves and expansion valves to malfunction. Such contaminants could also damage the compressor. Part of the hot liquid refrigerant downstream from the condenser flows to the economizer via filter SIL7, solenoid valve AV12 and thermostatic expansion valve SV3. The economizer subcools the main flow of liquid refrigerant, thus boosting capacity. SV3 controls the flow of refrigerant to the economizer in the same way as expansion valve SV4 controls flow to the evaporator.

The solenoid valves upstream from the economizer and evaporator are used to close the liquid line when the compressor is stopped.

The refrigerating effect generated in the evaporator, i. e. the lowering of the chilled medium temperature, starts as soon as the compressor has lowered the pressure in the evaporator far enough so that the corresponding evaporating temperature is lower than the chilled medium temperature. The amount of heat generated in the condenser depends upon the refrigerating effect that is generated in the evaporator.

Flap-type check valve BV1 is mounted in the suction line between the suction gas heat exchanger and the compressor.

Its purpose is to prevent rapid flow from the high-pressure side of the compressor unit to the low-pressure side via the compressor when it is stopped.

Parts list for heat pump unit VRP

KS	Compressor
M	Electric motor
OA	Oil separator
KD	Condenser
EV	Evaporator
OK	Oil cooler
ECO	Economizer
VVX	Suction gas heat exchanger
FT	Drier filter
VO	Oil heater
SG1	Sight glass, oil separator
SG2	Sight glass, liquid line
AS	Electrical equipment enclosure
SIL1	Suction filter
SIL3	Oil filter
SIL4	Liquid filter
SIL7	Liquid filter
SV1	Throttle valve, liquid injection
SV3	Expansion valve, economizer
SV4	Expansion valve, evaporator
SV15	Solenoid valve, capacity control
SV16	Solenoid valve, capacity control
SV17	Solenoid valve, capacity control
MP1	Pressure gauge, high-pressure/oil-pressure
MP2	Pressure gauge, low pressure
SAV1	Safety-valve, low-pressure side
SAV2	Safety valve, condenser
SAV3	Safety valve, oil separator
GT2	Motor temperature cut-out
GP1	Low-pressure cut-out
GP3	High-pressure cut-out
GP6	Oil filter cut-out
GT11	Discharge line temperature cut-out
GT15	Oil temperature cut-out
GT16	Oil thermostat
GT13	Thermostat, liquid injection
GN1	Oil level switch
GT7	Temperature sensor, chilled medium
GT8	Temperature sensor, heated medium
GF1	Flow switch
AV3	Stop valve, pressure gauge
AV4	Stop valve, pressure gauge
AV5	Stop valve, pressure gauge
AV6	Stop valve, pressure gauge
AV7	Stop valve, oil-filling and draining
AV8	Stop valve, refrigerant draining
AV9	Stop valve, refrigerant filling
AV10	Solenoid valve, liquid injection
AV12	Solenoid valve, economizer inlet
AV14	Solenoid valve, liquid line
AV15	Stop valve, condenser outlet
AV16	Stop valve, oil filling
AV17	Stop valve, refrigerant draining
BV1	Flap-type check valve, compressor inlet
BV2	Check valve, condenser inlet
BV3	Check valve, economizer outlet

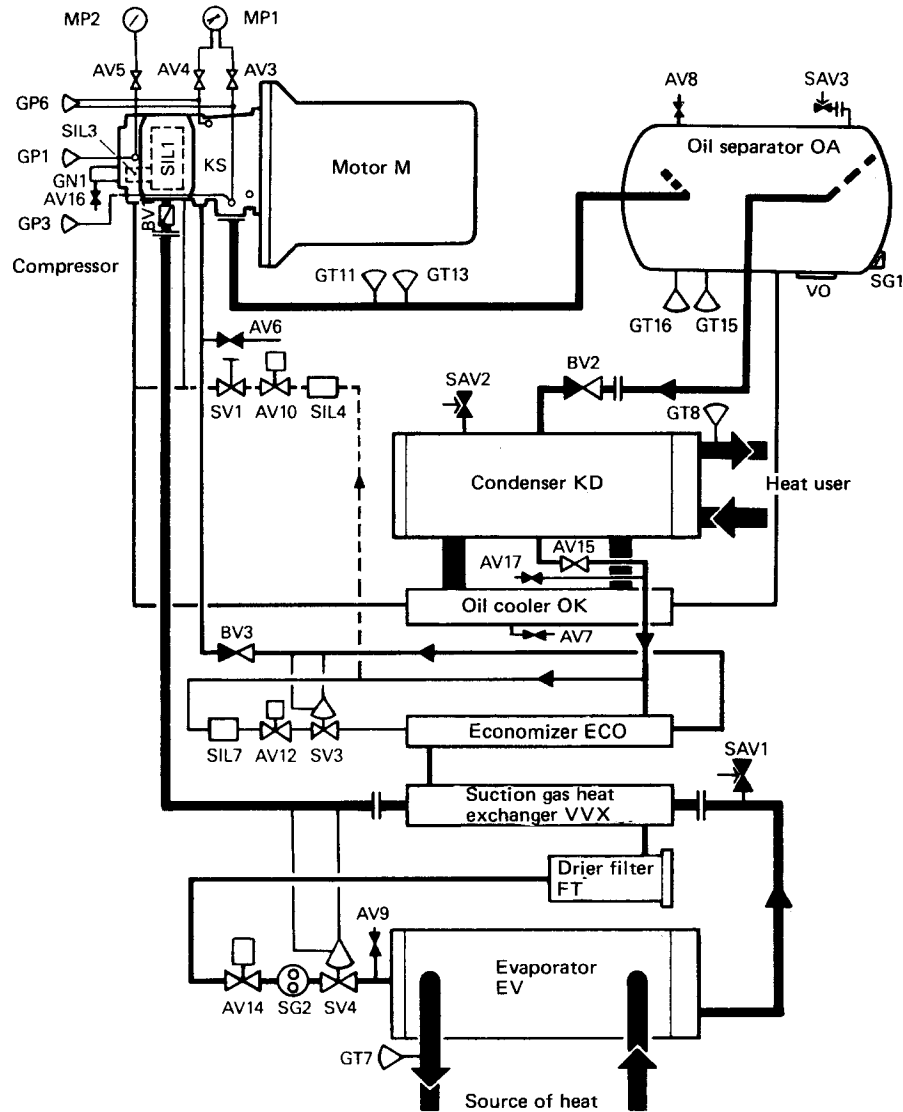


Fig. 3. Flow diagram of heat pump unit VRP

To lower the pressure in the compressor and oil separator when the compressor is stopped, there is a small hole in the flap-type check valve.

Filter SIL1, located on the suction side of the compressor (down-stream from BV1), prevents the compressor from being damaged by contaminants that can follow along with gas entering from the system.

The suction gas leaving the economizer is sent via check valve BV3 to the compressor's economizer connection.

Oil that is collected in the oil separator is returned to the compressor by means of the difference between the pressure at the oil separator and an intermediate pressure in the compressor.

The oil passes an oil cooler that is connected to the bottom of the condenser. In this cooler, the oil is cooled by the refrigerant condensate before it is returned to the compressor. Filter SIL3, located at the compressor oil inlet, prevents contaminants from entering the compressors's lubrication system. The return oil is distributed to points in the compressor where it is used (for example) to lubricate bearings and shaft seals and to operate the capacity control equipment.

The compressor is provided with a number of service valves (AV5, AV3 and AV4) to which pressure gauges (MP2 and MP1) for low pressure, high pressure and differential pressure across the oil filter are connected. A pressure gauge

for the economizer suction pressure can be connected to service valve AV6.

Service valves used for filling refrigerant, draining refrigerant and filling oil are also included. These are designated AV9, AV8, AV7 and AV17.

For special operating situations in which the regular oil cooler does not suffice, equipment is available that will provide liquid injection directly into the compressor's compression chamber.

This equipment consists of filter SIL4, solenoid valve AV10 and throttle valve SV1.

Starting and monitoring

The compressor and the unit operating states are monitored by different cut-outs and control devices. These are connected to an electronic logic unit.

This logic unit controls the compressor's starting equipment and other control devices and it presents on a signal panel any faults that occur. Operating-state information appears on the signal panel.

An operational time meter and an ammeter are built into the logic unit.

The unit can be started only after the max-level circuit breaker and the line fuse switch in the starting and power supply enclosure have been closed.

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Moreover, the interlocking circuit must be closed, the plant must request heat and the ON/OFF switch on the logic unit must be at the ON position.

Starting takes place when the time delay that prevents too frequent starting has expired and on condition that none of the cut-outs is triggered. Cut-out alarms are indicated by red light-emitting diodes on the front of the logic unit.

If you wish to start the unit without any time delay, you can press down the START switch. To reset an alarm, you must also press down this switch.

Cut-out functions

- GP3 High-pressure cut-out, stops the compressor if excessive pressure develops on the discharge side.
- GP1 Low-pressure cut-out, stops the compressor if the pressure drops too low on the suction side.
- GP6 Differential pressure cut-out, stops the compressor if the differential pressure across oil filter SIL3 rises too high.
- GT15 Oil temperature cut-out, stops the compressor if the temperature in the oil separator drops too low.
- GN1 Oil level switch, stops the compressor if the level of oil in the oil filter housing drops too low.
- GT2 Motor temperature cut-out, stops (if included in the system) the compressor if the motor temperature rises too high.
- GF1 Flow switch, stops (if included in the system) the compressor if flow through the evaporator drops too low.
- GT11 Discharge line temperature cut-out, stops the compressor if the discharge line temperature rises too high.
- E1 Overcurrent protector, stops the compressor if the motor current becomes too high.

All faults are indicated on the alarm panel on the logic unit, and are simultaneously incorporated into a collective alarm. An external collective alarm indication can be supplemented by an alarm board that provides individual alarms. Fault resetting and restarting of the compressor are both carried out manually. While the unit is idle, oil heater VO is turned on automatically to prevent the refrigerant in the oil from condensing. The oil heater is controlled via thermostat GT16. If liquid injection is being used, solenoid valve AV10 is controlled by thermostat GT13.

Temperature regulation

The purpose of the compressor unit's temperature regulation equipment is to keep the leaving (from the condenser) heated medium temperature at a constant value. Usually, this value is dependent on the outdoor temperature, although it can also be a constant value.

A limitation function that prevents the chilled medium temperature from dropping too low is also included.

Temperature control incorporates both fine and coarse control.

Fine regulation is handled by the capacity control equipment. Its mechanical parts are built into the compressor. Internal capacity control is implemented by means of pressurized oil obtained from the compressor's lubrication system.

The flow of pressurized oil is controlled by solenoid valves. Solenoid valve SV15 is used to increase capacity, and solenoid valves SV16 and SV17 are used to decrease capacity. These solenoid valves are, in turn, controlled by modular electronic control equipment. To insure easy starting, the compressor is set to its minimum capacity automatically before starting (called unloaded starting).

Coarse control is provided by having the control equipment start and stop the compressor. A timing function prevents too frequent starts.

The accuracy of control during steady-state operation is better than $\pm 0.5^{\circ}\text{C}$. In connection with the starting and stopping of the compressor however, greater variation can be encountered.

The electrical and control functions are described in greater detail on separate manual sheets.

LIQUID CHILLER UNIT SERIES VR
Functional description

VRV, VRM

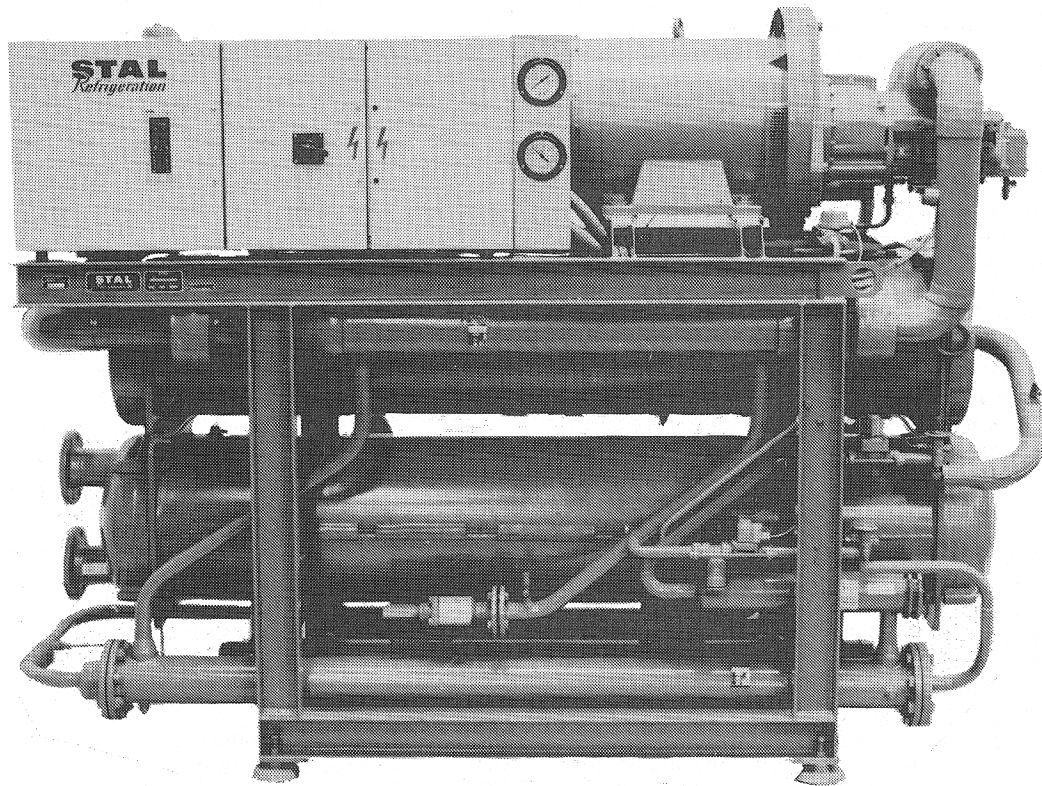


Fig. 1. Liquid chiller unit VRV

Applications

Liquid chiller units of type VRV and VRM are intended for air conditioning and process cooling. VRV units are equipped with fresh-water-cooled condensers. VRM units are equipped with saltwater-cooled condensers. The chilled medium can be water, glycol etc. The refrigerant is usually R22, but R12 can also be used.

Design and construction

Type VRV, VRM liquid chiller units are ready for working. All you have to do is connect them to your plant's electric lines, chilled medium lines and cooling medium system. The compressor (KS), the electric motor (M), the oil separator (OA) and the electrical equipment enclosure (AS) are mounted on a frame. The condenser/oil-cooler (KD/OK) are mounted on the bottom beams of this frame. The evaporator (EV) is mounted on the condenser's tube sheets. Moreover, the economizer (ECO) and the suction gas heat exchanger (VVX) are mounted on the frame.

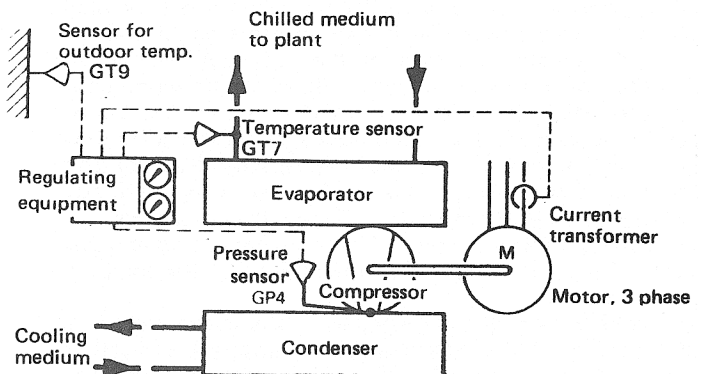


Fig. 2. Schematic diagram of VRV unit.

The compressor is attached to the drive motor flange via a shield. Torque from the electric motor is transferred to the compressor via gearing.

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Operation

Refrigerant and oil circuit (Fig. 3)

When the compressor is started, solenoid valves AV14 and AV12 in the liquid line running to the evaporator and economizer open. The compressor sucks in cold gaseous refrigerant from the evaporator via the suction gas heat exchanger.

In the suction gas heat exchanger, the gaseous refrigerant is superheated by means of heat interchanged with the hot liquid refrigerant. The supply of suction gas to the compressor is regulated by expansion valve SV4 which is upstream from the evaporator. This valve controls (on the basis of the difference between the temperature after the heat exchanger and the refrigerant's saturation temperature) the supply of refrigerant to the evaporator so that at any given instant no more refrigerant is supplied than can be evaporated. Safety valve SAV1 (upstream from the heat exchanger) protects the suction line from excessive pressure.

The cold gaseous refrigerant is mixed in the compressor with atomized oil that is injected for three purposes: lubrication, cooling and control. The gas-oil mixture is sent (under high pressure) via a pressurized line to the oil separator. Here, the oil is separated out and collects on the bottom of the separator. The level can be checked via sight glass SG1. Safety valve SAV3 protects the oil separator from excessive pressure.

High-pressure gas is sent on to the condenser via check valve BV2.

In the condenser, energy is transferred from the gaseous refrigerant to the coolant which is sent (with the assistance of a pump in the coolant loop) through the condenser. As a result, the refrigerant enters the liquid state. Safety valve SAV2 protects the condenser from excessive pressure.

The hot liquid refrigerant is pressed out of the condenser through stop valve AV15. The main liquid flow then proceeds through the economizer, suction gas heat exchanger and drier filter FT to solenoid valve AV14 and expansion valve SV4 (located upstream from the evaporator). Sight glass SG2 is mounted in the liquid line upstream from the expansion valve. This sight glass can be used to check that the liquid in the line does not contain any gas bubbles. The drier filter removes contaminants and moisture which might otherwise cause the solenoid valves and expansion valves to malfunction. Such contaminants could also damage the compressor. Part of the hot liquid refrigerant downstream from the condenser flows to the economizer via filter SIL7, solenoid valve AV12 and thermostatic expansion valve SV3. The economizer subcools the main flow of liquid refrigerant, thus boosting capacity. SV3 controls the flow of refrigerant to the economizer in the same way as expansion valve SV4 controls flow to the evaporator.

The solenoid valves upstream from the economizer and evaporator are used to close the liquid line when the compressor is stopped.

The refrigerating effect generated in the evaporator, i. e. the lowering of the chilled medium temperature, starts as soon as the compressor has lowered the pressure in the evaporator far enough so that the corresponding evaporating temperature is lower than the chilled medium temperature. The amount of heat generated in the condenser depends upon the refrigerating effect that is generated in the evaporator.

Flap-type check valve BV1 is mounted in the suction line between the suction gas heat exchanger and the compressor.

Its purpose is to prevent rapid flow from the high-pressure side of the compressor unit to the low-pressure side via the compressor when it is stopped.

Parts list for liquid chiller units VRV and VRM

KS	Compressor
M	Electric motor
OA	Oil separator
KD	Condenser
EV	Evaporator
OK	Oil cooler
ECO	Economizer
VVX	Suction gas heat exchanger
FT	Drier filter
VO	Oil heater
SG1	Sight glass, oil separator
SG2	Sight glass, liquid line
AS	Electrical equipment enclosure
SIL1	Suction filter
SIL3	Oil filter
SIL4	Liquid filter
SIL7	Liquid filter
SV1	Throttle valve, liquid injection
SV3	Expansion valve, economizer
SV4	Expansion valve, evaporator
SV15	Solenoid valve, capacity control
SV16	Solenoid valve, capacity control
SV17	Solenoid valve, capacity control
MP1	Pressure gauge, high-pressure/oil-pressure
MP2	Pressure gauge, low pressure
SAV1	Safety-valve, low-pressure side
SAV2	Safety valve, condenser
SAV3	Safety valve, oil separator
GT2	Motor temperature cut-out
GP1	Low-pressure cut-out
GP3	High-pressure cut-out
GP6	Oil filter cut-out
GT11	Discharge line temperature cut-out
GT15	Oil temperature cut-out
GT16	Oil thermostat
GT13	Thermostat, liquid injection
GN1	Oil level switch
GT7	Temperature sensor, chilled medium
GF1	Flow switch
AV3	Stop valve, pressure gauge
AV4	Stop valve, pressure gauge
AV5	Stop valve, pressure gauge
AV6	Stop valve, pressure gauge
AV7	Stop valve, oil-filling and draining
AV8	Stop valve, refrigerant draining
AV9	Stop valve, refrigerant filling
AV10	Solenoid valve, liquid injection
AV12	Solenoid valve, economizer inlet
AV14	Solenoid valve, liquid line
AV15	Stop valve, condenser outlet
AV16	Stop valve, oil filling
AV17	Stop valve, refrigerant draining
BV1	Flap-type check valve, compressor inlet
BV2	Check valve, condenser inlet
BV3	Check valve, economizer outlet

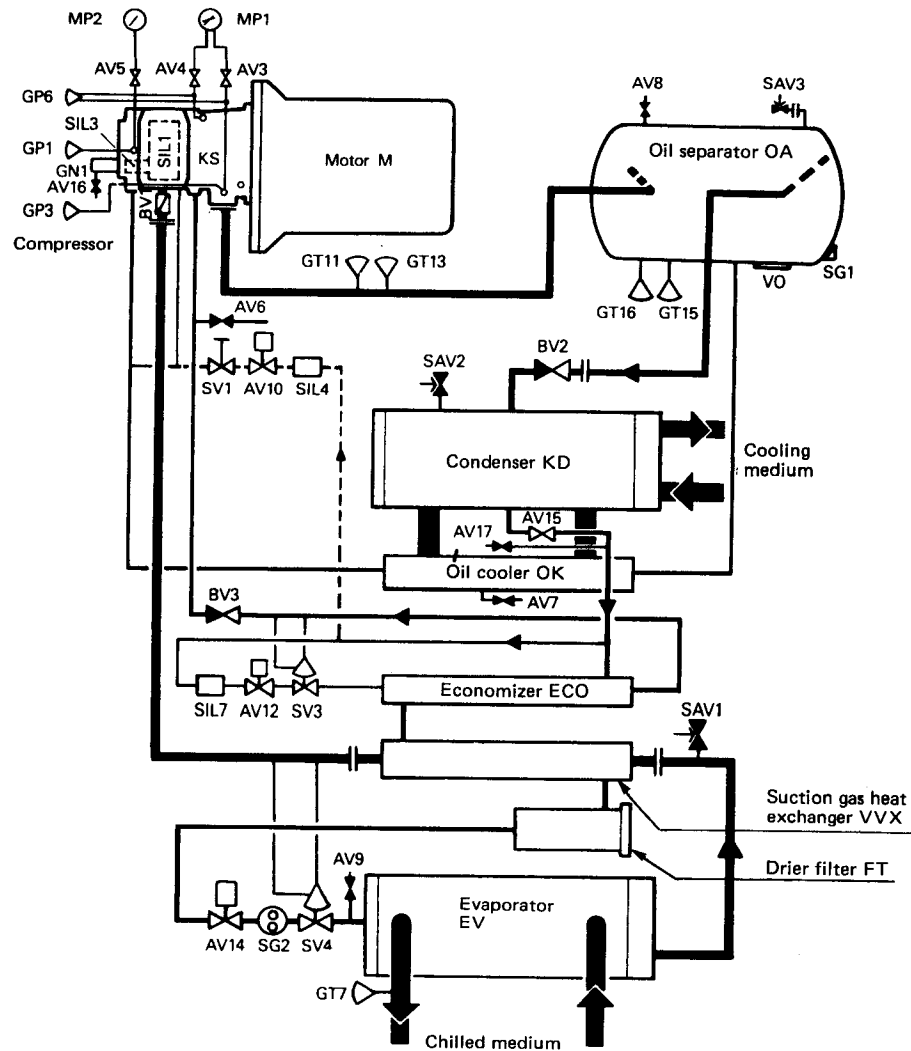


Fig. 3. Flow diagram of liquid chiller units VRV and VRM

To lower the pressure in the compressor and oil separator when the compressor is stopped, there is a small hole in the flap-type check valve.

Filter SIL1, located on the suction side of the compressor (down-stream from BV1), prevents the compressor from being damaged by contaminants that can follow along with gas entering from the system.

The suction gas leaving the economizer is sent via check valve BV3 to the compressor's economizer connection.

Oil that is collected in the oil separator is returned to the compressor by means of the difference between the pressure at the oil separator and an intermediate pressure in the compressor.

The oil passes an oil cooler that is connected to the bottom of the condenser. In this cooler, the oil is cooled by the refrigerant condensate before it is returned to the compressor. Filter SIL3, located at the compressor oil inlet, prevents contaminants from entering the compressors's lubrication system. The return oil is distributed to points in the compressor where it is used (for example) to lubricate bearings and shaft seals and to operate the capacity control equipment.

The compressor is provided with a number of service valves (AV5, AV3 and AV4) to which pressure gauges (MP2 and MP1) for low pressure, high pressure and differential pressure across the oil filter are connected. A pressure gauge

for the economizer suction pressure can be connected to service valve AV6.

Service valves used for filling refrigerant, draining refrigerant and filling oil are also included. These are designated AV9, AV8, AV7 and AV17.

For special operating situations in which the regular oil cooler does not suffice, equipment is available that will provide liquid injection directly into the compressor's compression chamber.

This equipment consists of filter SIL4, solenoid valve AV10 and throttle valve SV1.

Starting and monitoring

The compressor and the unit operating states are monitored by different cut-outs and control devices. These are connected to an electronic logic unit.

This logic unit controls the compressor's starting equipment and other control devices and it presents on a signal panel any faults that occur. Operating-state information appears on the signal panel.

An operational time meter and an ammeter are built into the logic unit.

The unit can be started only after the max-level circuit breaker and the line fuse switch in the starting and power supply enclosure have been closed.

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Moreover, the interlocking circuit must be closed, the plant must require cooling and the ON/OFF switch on the logic unit must be at the ON position.

Starting takes place when the time delay that prevents too frequent starting has expired and on condition that none of the cut-outs is triggered. Cut-out alarms are indicated by red light-emitting diodes on the front of the logic unit.

If you wish to start the unit without any time delay, you can press down the START switch. To reset an alarm, you must also press down this switch.

Cut-out functions

- GP3 High-pressure cut-out, stops the compressor if excessive pressure develops on the discharge side.
- GP1 Low-pressure cut-out, stops the compressor if the pressure drops too low on the suction side.
- GP6 Differential pressure cut-out, stops the compressor if the differential pressure across oil filter SIL3 rises too high.
- GT15 Oil temperature cut-out, stops the compressor if the temperature in the oil separator drops too low.
- GN1 Oil level switch, stops the compressor if the level of oil in the oil filter housing drops too low.
- GT2 Motor temperature cut-out, stops (if included in the system) the compressor if the motor temperature rises too high.
- GF1 Flow switch, stops (if included in the system) the compressor if flow through the evaporator drops too low.
- GT11 Discharge line temperature cut-out, stops the compressor if the discharge line temperature rises too high.
- E1 Overcurrent protector, stops the compressor if the motor current becomes too high.

All faults are indicated on the alarm panel on the logic unit, and are simultaneously incorporated into a collective alarm. An external collective alarm indication can be supplemented by an alarm board that provides individual alarms. Fault resetting and restarting of the compressor are both carried out manually. While the unit is idle, oil heater VO is turned on automatically to prevent the refrigerant in the oil from condensing. The oil heater is controlled via thermostat GT16. If liquid injection is being used, solenoid valve AV10 is controlled by thermostat GT13.

Temperature regulation

The purpose of the compressor unit's temperature regulation equipment is to keep the leaving (from the evaporator) chilled medium temperature at a constant value.

Temperature regulation incorporates both fine and coarse regulation.

Fine regulation is handled by the capacity control equipment. Its mechanical parts are built into the compressor. Internal capacity control is implemented by means of pressurized oil obtained from the compressor's lubrication system.

The flow of pressurized oil is controlled by solenoid valves. Solenoid valve SV15 is used to increase capacity, and solenoid valves SV16 and SV17 are used to decrease capacity. These solenoid valves are, in turn, controlled by modular electronic control equipment. To insure easy starting, the compressor is set to its minimum capacity automatically before starting (called unloaded starting).

Coarse control is provided by having the control equipment start and stop the compressor. A timing function prevents too frequent starts.

The accuracy of control during steady-state operation is better than $\pm 0.5^{\circ}\text{C}$. In connection with the starting and stopping of the compressor however, greater variation can be encountered.

The electrical and control functions are described in greater detail on separate manual sheets.

LIQUID CHILLER UNIT SERIES VR
with double bundle condenser
Functional description

VRW

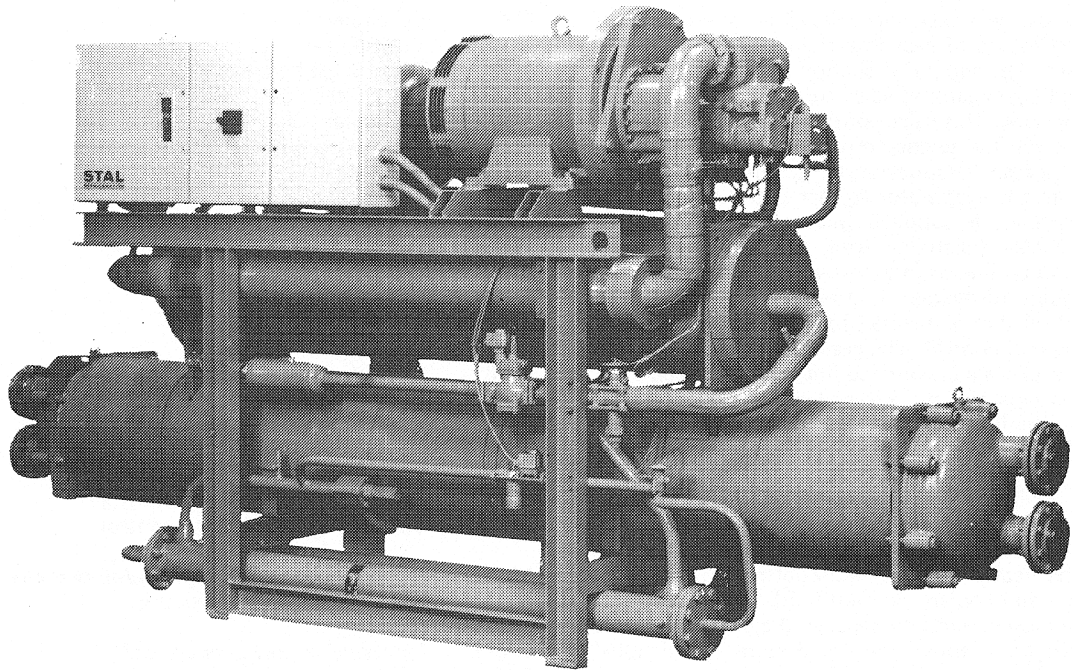


Fig. 1. Liquid chiller unit VRW

Applications

Liquid chiller units of type VRW are intended for air conditioning and process cooling. These units are equipped with a double bundle condenser that is fresh-water cooled. This arrangement permits a cooling circuit and a heat recovery circuit to be connected. The chilled medium can be water, glycol etc. The refrigerant can be R22 or R12.

Design and construction

Type VRW liquid chiller units are ready for working. All you have to do is connect them to your plant's electric lines, chilled medium lines, cooling medium system and heated medium system. The compressor (KS), the electric motor (M), the oil separator (OA) and the electrical equipment enclosure (AS) are mounted on a frame. The condenser/oil-cooler (KD/OK) are mounted on the bottom beams of this frame.

The evaporator (EV) is mounted on the condenser's tube sheets. Moreover, the economizer (ECO) and the suction gas heat exchanger (VVX) are mounted on the frame.

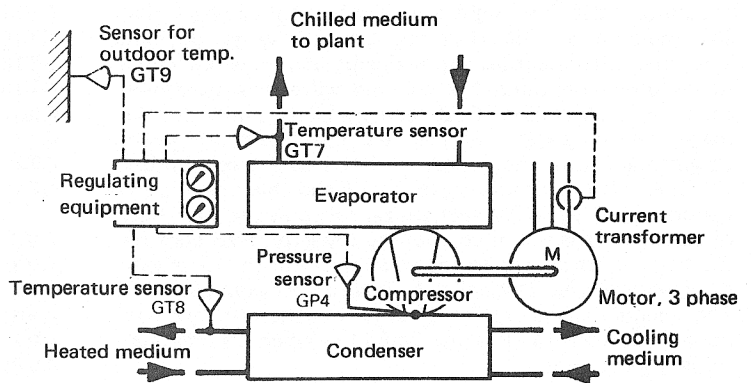


Fig. 2. Schematic diagram of liquid chiller unit VRW

The compressor is attached to the drive motor flange via a shield. Torque from the electric motor is transferred to the compressor via gearing.

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Operation

Refrigerant and oil circuit (Fig. 3)

When the compressor is started, solenoid valves AV14 and AV12 in the liquid line running to the evaporator and economizer open. The compressor sucks in cold gaseous refrigerant from the evaporator via the suction gas heat exchanger.

In the suction gas heat exchanger, the gaseous refrigerant is superheated by means of heat interchanged with the hot liquid refrigerant. The supply of suction gas to the compressor is regulated by expansion valve SV4 which is upstream from the evaporator. This valve controls (on the basis of the difference between the temperature after the heat exchanger and the refrigerant's saturation temperature) the supply of refrigerant to the evaporator so that at any given instant no more refrigerant is supplied than can be evaporated. Safety valve SAV1 (upstream from the heat exchanger) protects the suction line from excessive pressure.

The cold gaseous refrigerant is mixed in the compressor with atomized oil that is injected for three purposes: lubrication, cooling and control. The gas-oil mixture is sent (under high pressure) via a pressurized line to the oil separator. Here, the oil is separated out and collects on the bottom of the separator. The level can be checked via sight glass SG1. Safety valve SAV3 protects the oil separator from excessive pressure.

High-pressure gas is sent on to the condenser via check valve BV2.

In the condenser, energy is transferred from the gaseous refrigerant to the heated medium the coolant or both. The heated medium and coolant are sent (with the assistance of a pump in the loop in question through the condenser. As a result, the refrigerant enters the liquid state. Safety valve SAV2 protects the condenser from excessive pressure.

The hot liquid refrigerant is pressed out of the condenser through stop valve AV15. The main liquid flow then proceeds through the economizer, suction gas heat exchanger and drier filter FT to solenoid valve AV14 and expansion valve SV4 (located upstream from the evaporator). Sight glass SG2 is mounted in the liquid line upstream from the expansion valve. This sight glass can be used to check that the liquid in the line does not contain any gas bubbles. The drier filter removes contaminants and moisture which might otherwise cause the solenoid valves and expansion valves to malfunction. Such contaminants could also damage the compressor. Part of the hot liquid refrigerant downstream from the condenser flows to the economizer via filter SIL7, solenoid valve AV12 and thermostatic expansion valve SV3. The economizer subcools the main flow of liquid refrigerant, thus boosting capacity. SV3 controls the flow of refrigerant to the economizer in the same way as expansion valve SV4 controls flow to the evaporator.

The solenoid valves upstream from the economizer and evaporator are used to close the liquid line when the compressor is stopped.

The refrigerating effect generated in the evaporator, i. e. the lowering of the chilled medium temperature, starts as soon as the compressor has lowered the pressure in the evaporator far enough so that the corresponding evaporating temperature is lower than the chilled medium temperature. The amount of heat generated in the condenser depends upon the refrigerating effect that is generated in the evaporator.

Flap-type check valve BV1 is mounted in the suction line between the suction gas heat exchanger and the compressor.

Its purpose is to prevent rapid flow from the high-pressure side of the compressor unit to the low-pressure side via the compressor when it is stopped.

Parts list for liquid chiller unit VRW

KS	Compressor
M	Electric motor
OA	Oil separator
KD	Condenser
EV	Evaporator
OK	Oil cooler
ECO	Economizer
VVX	Suction gas heat exchanger
FT	Drier filter
VO	Oil heater
SG1	Sight glass, oil separator
SG2	Sight glass, liquid line
AS	Electrical equipment enclosure
SIL1	Suction filter
SIL3	Oil filter
SIL4	Liquid filter
SIL7	Liquid filter
SV1	Throttle valve, liquid injection
SV3	Expansion valve, economizer
SV4	Expansion valve, evaporator
SV15	Solenoid valve, capacity control
SV16	Solenoid valve, capacity control
SV17	Solenoid valve, capacity control
MP1	Pressure gauge, high-pressure/oil-pressure
MP2	Pressure gauge, low pressure
SAV1	Safety-valve, low-pressure side
SAV2	Safety valve, condenser
SAV3	Safety valve, oil separator
GT2	Motor temperature cut-out
GP1	Low-pressure cut-out
GP3	High-pressure cut-out
GP6	Oil filter cut-out
GT11	Discharge line temperature cut-out
GT15	Oil temperature cut-out
GT16	Oil thermostat
GT13	Thermostat, liquid injection
GN1	Oil level switch
GT7	Temperature sensor, chilled medium
GT8	Temperature sensor, heated medium
GF1	Flow switch
AV3	Stop valve, pressure gauge
AV4	Stop valve, pressure gauge
AV5	Stop valve, pressure gauge
AV6	Stop valve, pressure gauge
AV7	Stop valve, oil-filling and draining
AV8	Stop valve, refrigerant draining
AV9	Stop valve, refrigerant filling
AV10	Solenoid valve, liquid injection
AV12	Solenoid valve, economizer inlet
AV14	Solenoid valve, liquid line
AV15	Stop valve, condenser outlet
AV16	Stop valve, oil filling
AV17	Stop valve, refrigerant draining
BV1	Flap-type check valve, compressor inlet
BV2	Check valve, condenser inlet
BV3	Check valve, economizer outlet

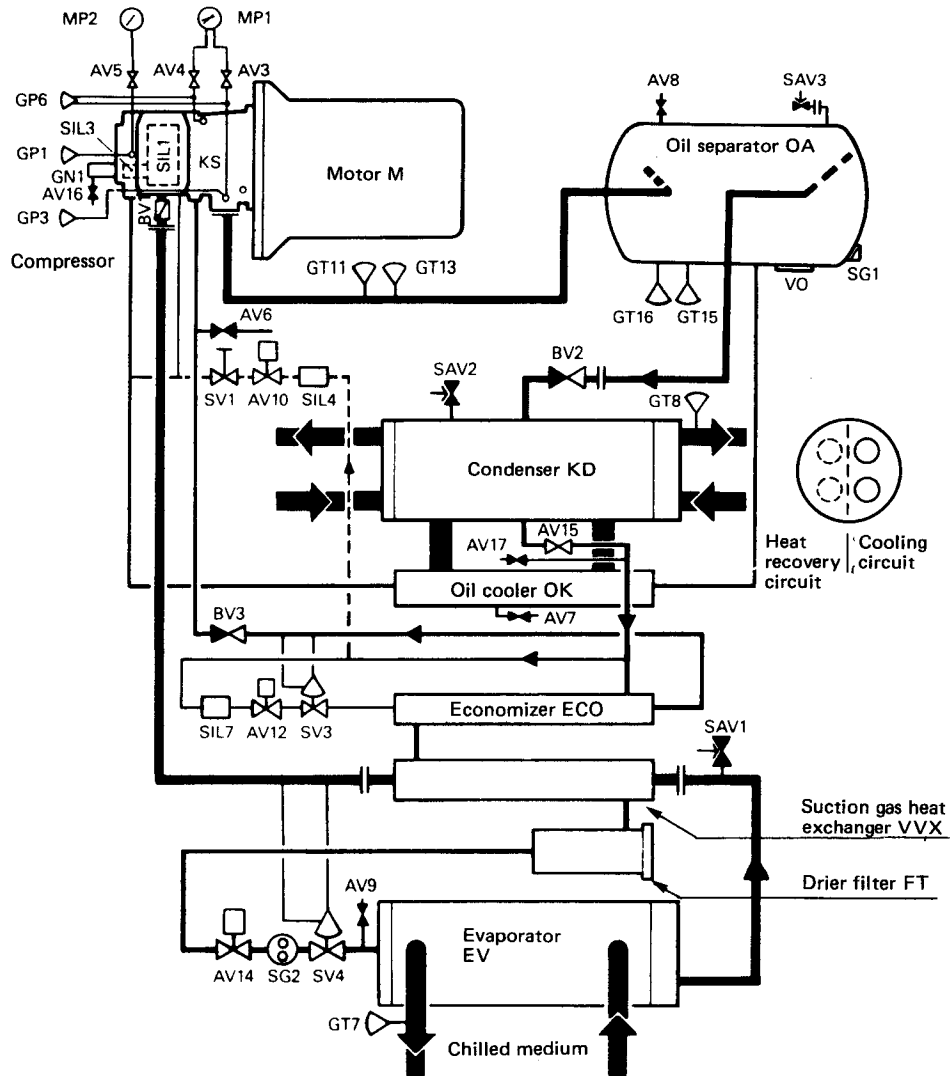


Fig. 3. Flow diagram of liquid chiller unit VRW

To lower the pressure in the compressor and oil separator when the compressor is stopped, there is a small hole in the flap-type check valve.

Filter SIL1, located on the suction side of the compressor (down-stream from BV1), prevents the compressor from being damaged by contaminants that can follow along with gas entering from the system.

The suction gas leaving the economizer is sent via check valve BV3 to the compressor's economizer connection.

Oil that is collected in the oil separator is returned to the compressor by means of the difference between the pressure at the oil separator and an intermediate pressure in the compressor.

The oil passes an oil cooler that is connected to the bottom of the condenser. In this cooler, the oil is cooled by the refrigerant condensate before it is returned to the compressor. Filter SIL3, located at the compressor oil inlet, prevents contaminants from entering the compressor's lubrication system. The return oil is distributed to points in the compressor where it is used (for example) to lubricate bearings and shaft seals and to operate the capacity control equipment.

The compressor is provided with a number of service valves (AV5, AV3 and AV4) to which pressure gauges (MP2 and MP1) for low pressure, high pressure and differential pressure across the oil filter are connected. A pressure gauge

for the economizer suction pressure can be connected to service valve AV6.

Service valves used for filling refrigerant, draining refrigerant and filling oil are also included. These are designated AV9, AV8, AV7 and AV17.

For special operating situations in which the regular oil cooler does not suffice, equipment is available that will provide liquid injection directly into the compressor's compression chamber.

This equipment consists of filter SIL4, solenoid valve AV10 and throttle valve SV1.

Starting and monitoring

The compressor and the unit operating states are monitored by different cut-outs and control devices. These are connected to an electronic logic unit.

This logic unit controls the compressor's starting equipment and other control devices and it presents on a signal panel any faults that occur. Operating-state information appears on the signal panel.

An operational time meter and an ammeter are built into the logic unit.

The unit can be started only after the max-level circuit breaker and the line fuse switch in the starting and power supply enclosure have been closed.

Moreover, the interlocking circuit must be closed, the plant must request heat and the ON/OFF switch on the logic unit must be at the ON position.

Starting takes place when the time delay that prevents too frequent starting has expired and on condition that none of the cut-outs is triggered. Cut-out alarms are indicated by red light-emitting diodes on the front of the logic unit.

If you wish to start the unit without any time delay, you can press down the START switch. To reset an alarm, you must also press down this switch.

Cut-out functions

- GP3 High-pressure cut-out, stops the compressor if excessive pressure develops on the discharge side.
- GP1 Low-pressure cut-out, stops the compressor if the pressure drops too low on the suction side.
- GP6 Differential pressure cut-out, stops the compressor if the differential pressure across oil filter SIL3 rises too high.
- GT15 Oil temperature cut-out, stops the compressor if the temperature in the oil separator drops too low.
- GN1 Oil level switch, stops the compressor if the level of oil in the oil filter housing drops too low.
- GT2 Motor temperature cut-out, stops (if included in the system) the compressor if the motor temperature rises too high.
- GF1 Flow switch, stops (if included in the system) the compressor if flow through the evaporator drops too low.
- GT11 Discharge line temperature cut-out, stops the compressor if the discharge line temperature rises too high.
- E1 Overcurrent protector, stops the compressor if the motor current becomes too high.

All faults are indicated on the alarm panel on the logic unit, and are simultaneously incorporated into a collective alarm. An external collective alarm indication can be supplemented by an alarm board that provides individual alarms. Fault resetting and restarting of the compressor are both carried out manually. While the unit is idle, oil heater VO is turned on automatically to prevent the refrigerant in the oil from condensing. The oil heater is controlled via thermostat GT16. If liquid injection is being used, solenoid valve AV10 is controlled by thermostat GT13.

Temperature regulation

The purpose of the compressor unit's temperature regulation equipment is to keep the leaving (from the evaporator) chilled medium temperature at a constant value.

Temperature regulation incorporates both fine and coarse regulation.

Fine regulation is handled by the capacity control equipment. Its mechanical parts are built into the compressor. Internal capacity control is implemented by means of pressurized oil obtained from the compressor's lubrication system.

The flow of pressurized oil is controlled by solenoid valves. Solenoid valve SV15 is used to increase capacity, and solenoid valves SV16 and SV17 are used to decrease capacity. These solenoid valves are, in turn, controlled by modular electronic control equipment. To insure easy starting, the compressor is set to its minimum capacity automatically before starting (called unloaded starting).

Coarse control is provided by having the control equipment start and stop the compressor. A timing function prevents too frequent starts.

The accuracy of control during steady-state operation is better than $\pm 0.5^{\circ}\text{C}$. In connection with the starting and stopping of the compressor however, greater variation can be encountered.

The electrical and control functions are described in greater detail on separate manual sheets.

2. INSTALLATION AND OPERATION

7827-N-80E

Silencer hood for series VR liquid
chiller and heat pump units

7827-N-60E

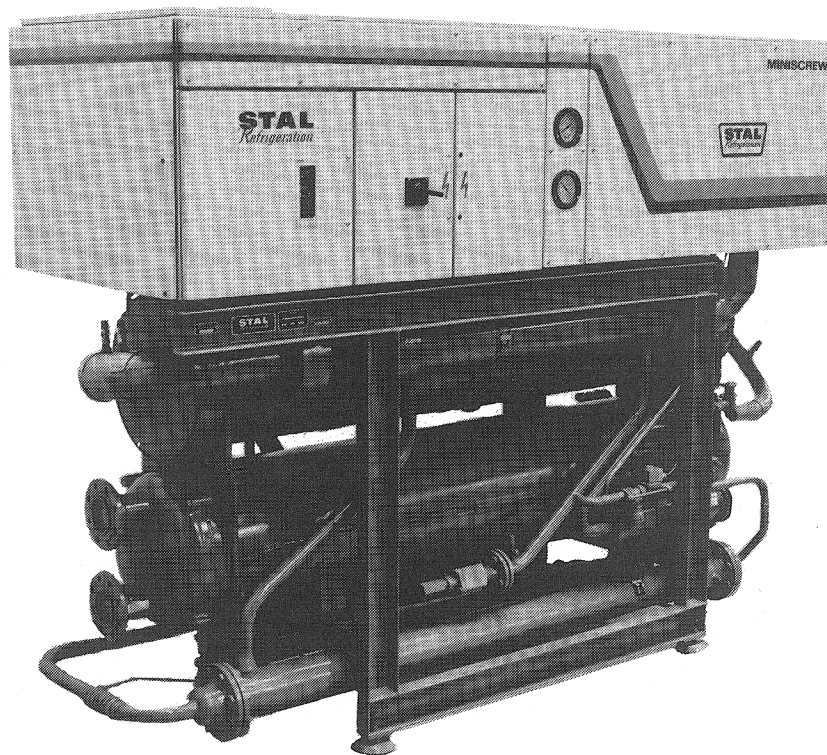
Liquid chiller and heat pump units series
VR

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**SILENCER HOOD FOR SERIES VR LIQUID CHILLER
AND HEAT PUMP UNITS**



VR units can be provided with an optional silencer hood. It fits over the top of the unit as illustrated above, but it is not mounted at the factory. Instead, it is delivered with a mounting kit so that you can assemble and mount it on site.

A mounting kit contains assembly fittings consisting of corners, bars and retainer strips of the correct lengths plus the insulated panels that make up the ceiling and walls.

The bars, retainer strips and other assembly fittings are screwed together to form a framework that is mounted on the compressor unit frame. The electrical equipment enclosure is included as part of this framework. Six additional vibration isolators (ordering No. 3921 9772 572) are fitted between the silencer hood framework and compressor unit frame in addition to those on which the electrical equipment enclosure rests. The vibration isolators on the rear of the electrical equipment enclosure are to be removed. The panels that make up the ceiling, front and rear of the silencer hood are then screwed firmly onto the framework.

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STAL-MINI screw compressor

The ends (doors) shall now be mounted. The extractor line shall be run through the ventilation opening in the ceiling. The pressure gauges shall be mounted in the panel to the right of the electrical equipment enclosure.

To facilitate daily inspection (checking the oil level in the oil separator for example), the ends (doors) can be easily opened.

The framework surrounding the compressor can be removed to provide unobstructed access to the compressor whenever necessary.

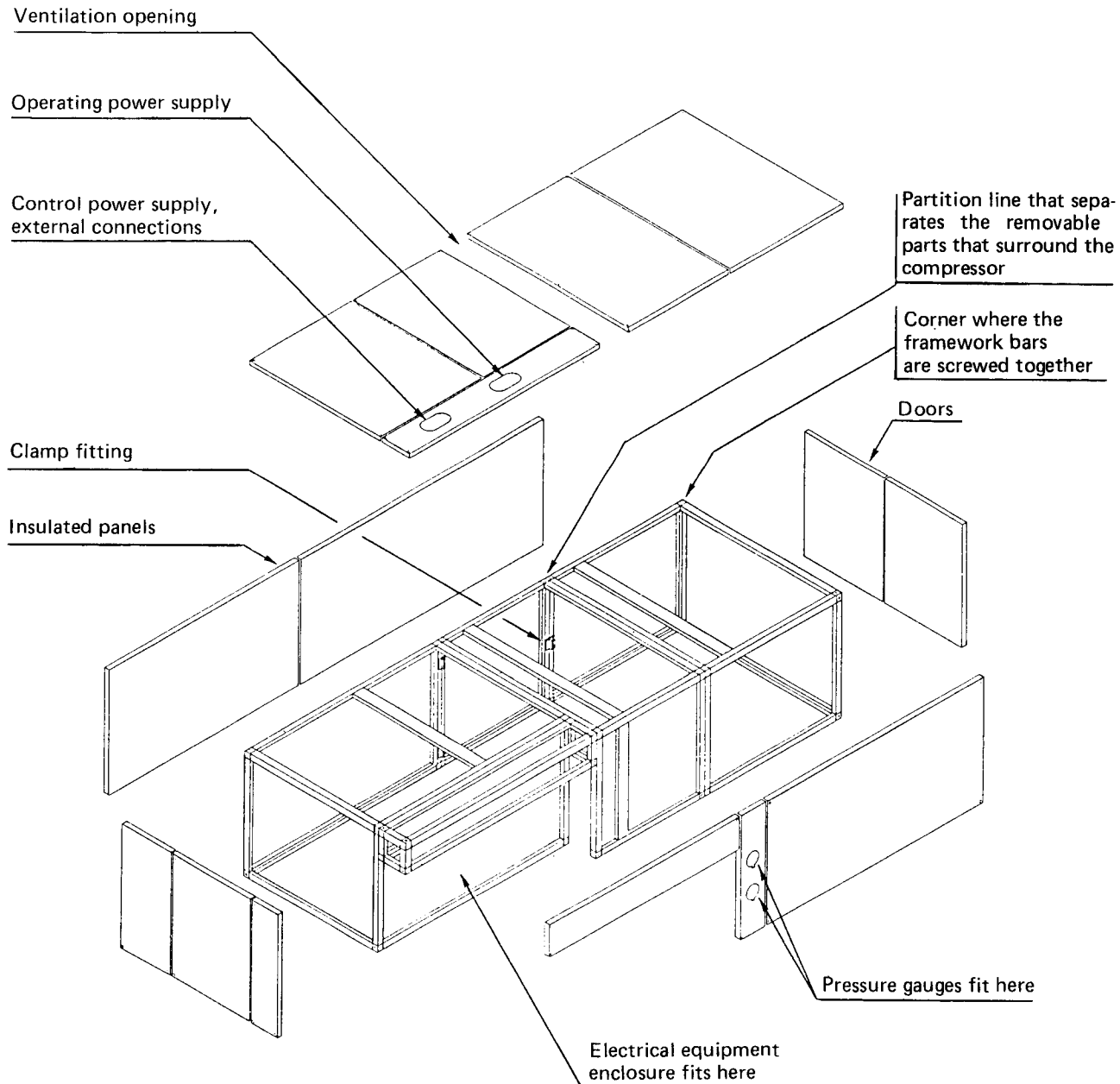


Fig. 1 Exploded view of silencer hood 1904 719-A

The size of the silencer hood depends on the sizes of the compressor unit and the compressor motor. Three versions are available.

Version 1: 1904 719-A. For units with IEC 200M-250M IP23 and IEC 225M-250M IP54 motors. See Figs. 1 and 2.

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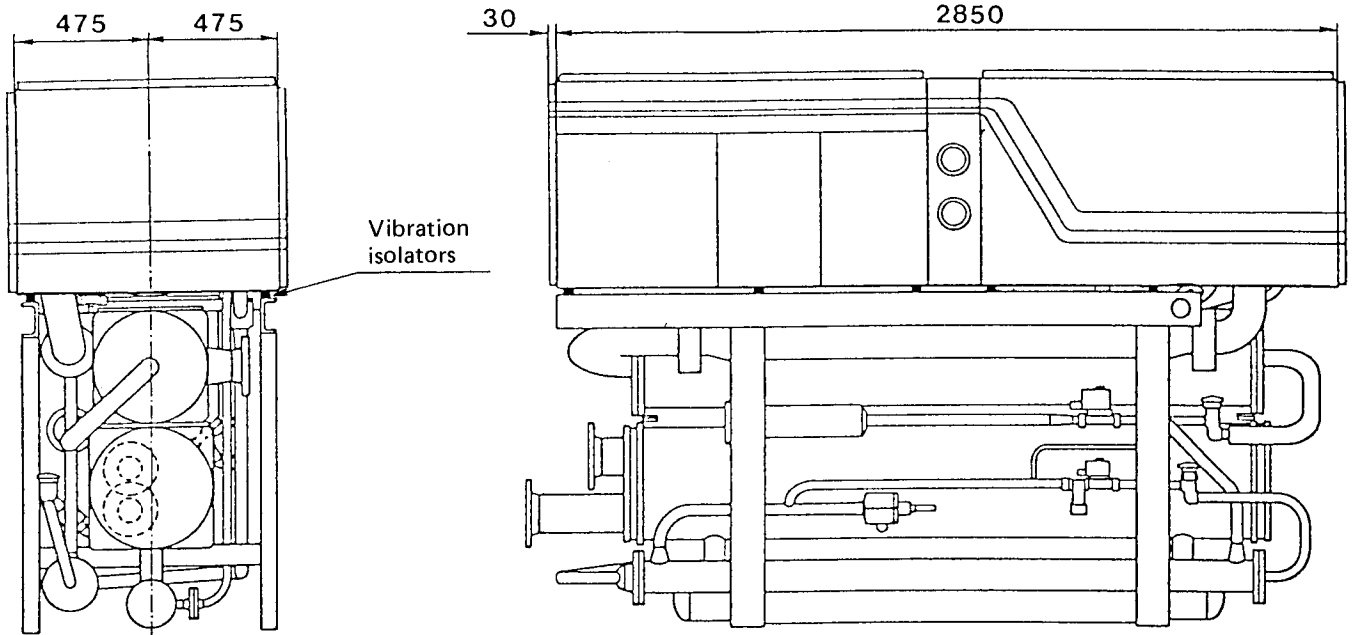


Fig. 2 Compressor unit with silencer hood 1904 719-A

Version 2: 1904 719-B.
For compressor units with IEC 280S-315S IP54 motors.

When this hood is used, four brackets must be welded onto the rear of the compressor unit frame. Use bracket 1904 720-1 for VR compressor units 53-55. Use bracket 1904 720-2 for VR compressor units 57-59. See Figs. 3 and 5.

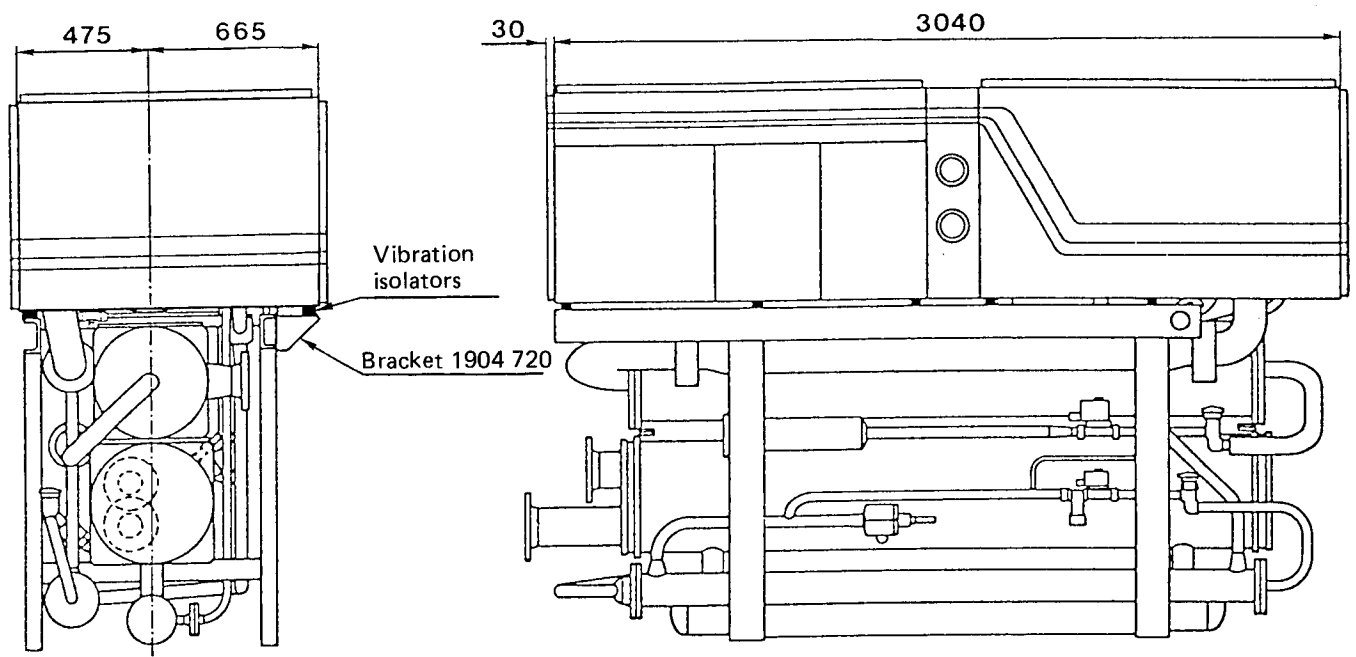


Fig.3 Compressor unit with silencer hood 1904 719-B

Version 3: 1904 719-C.
For units with IEC 280M IP23 and 315M IP54 motors.
When this hood is used, four brackets must be welded onto
the rear of the compressor unit frame.

Use bracket 1904 720-1 for VR compressor units 53-55 and
bracket 1904 720-2 for VR compressor units 57-59. Ver-
sion 3 of the silencer hood has no spacer module above the
electrical equipment enclosure. See Figs. 4 and 5.

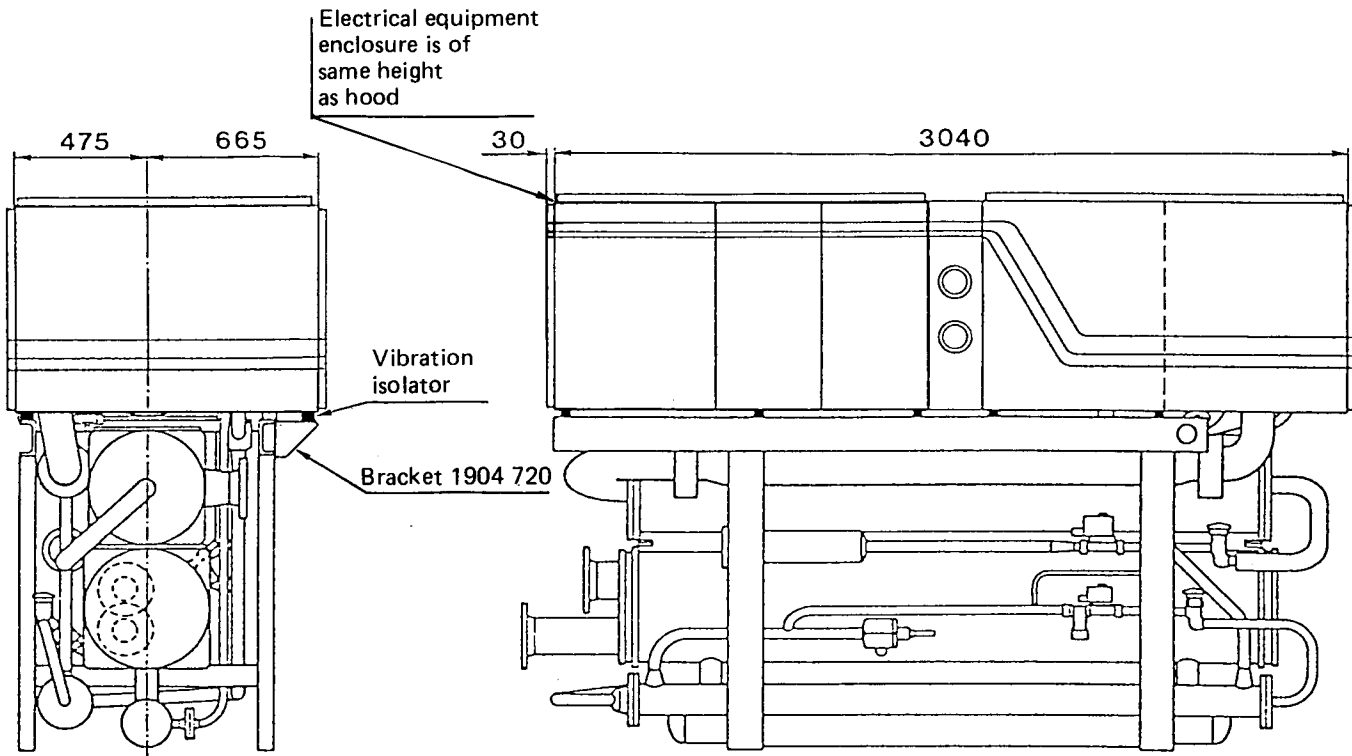


Fig. 4 Compressor unit with silencer hood 1904 719-C

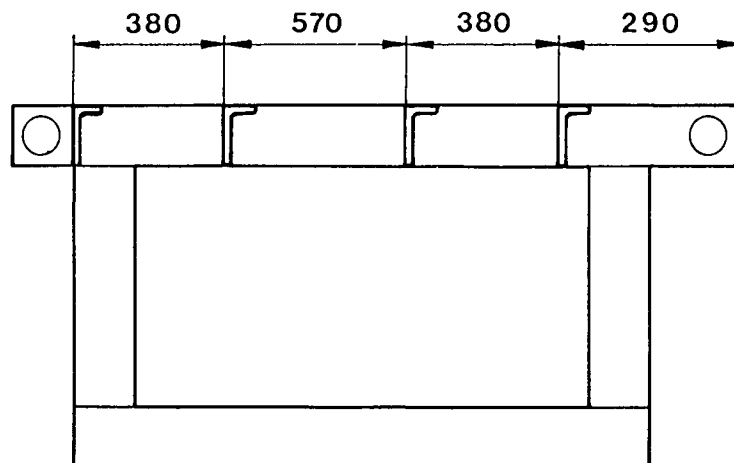
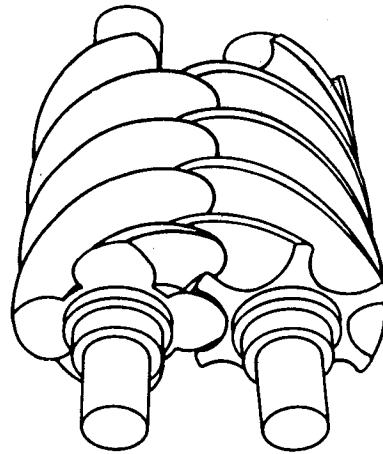


Fig. 5 Locations of brackets 1904 720

LIQUID CHILLER AND HEAT PUMP UNITS
SERIES VR Operating Instructions



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Dieser Text ist eine Kopie der englischen Originalversion der Betriebsanleitung für die Serie VR. Das Recht an den Texten liegt bei STAL.

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TKA 1987-08

STAL-MINI screw compressor

STAL
REFRIGERATION

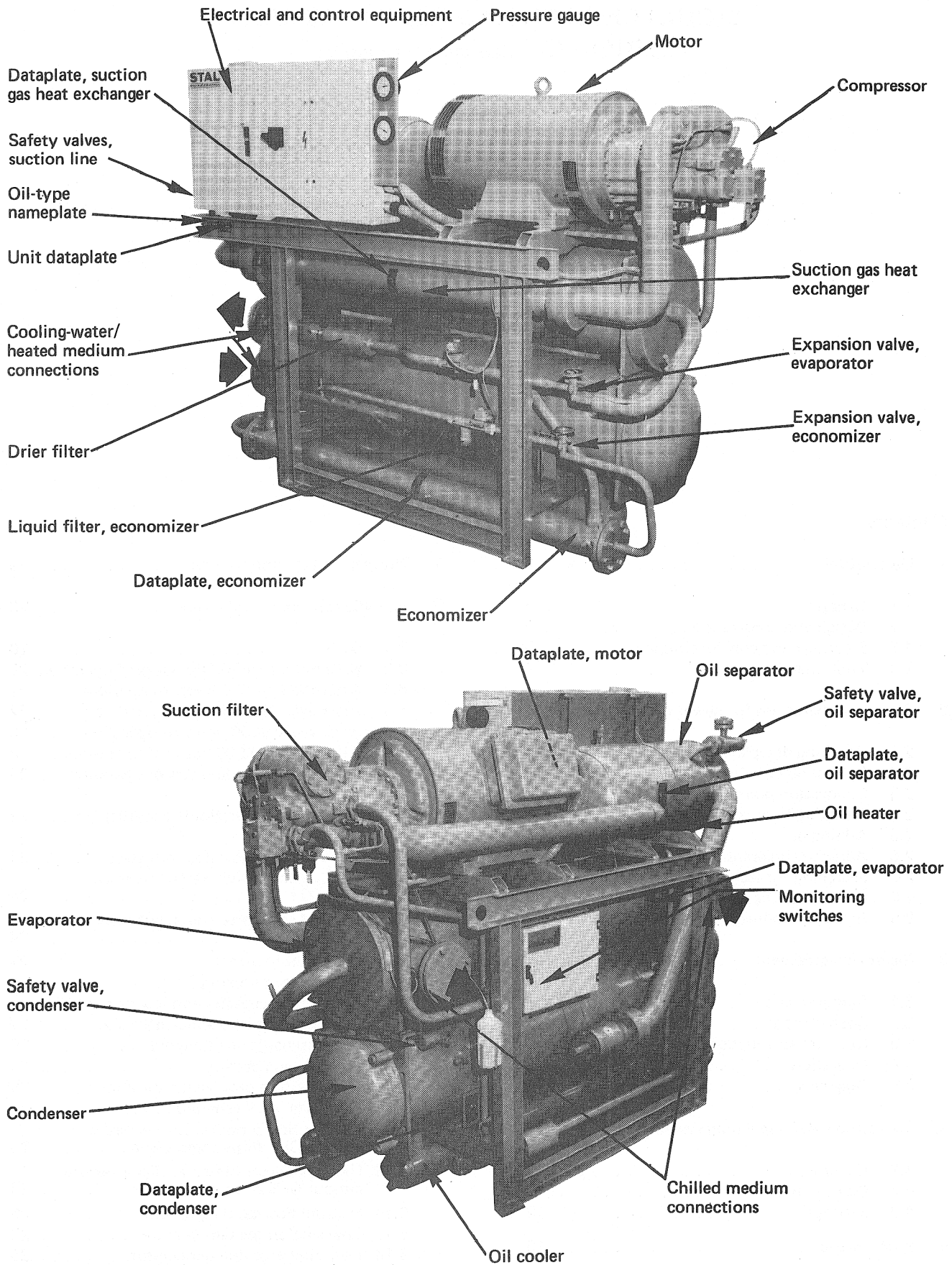


Fig. 1 STAL-MINI screw compressor unit – important components and nameplates

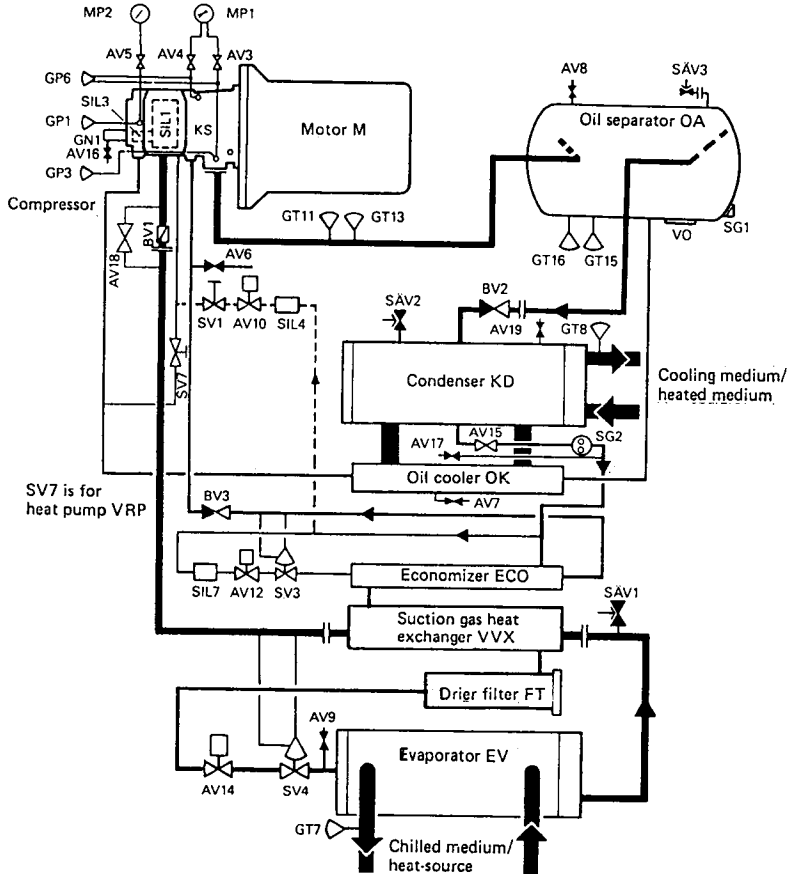


Fig. 2 Schematic system diagram, STAL-MINI VRV, VRP and VRM units

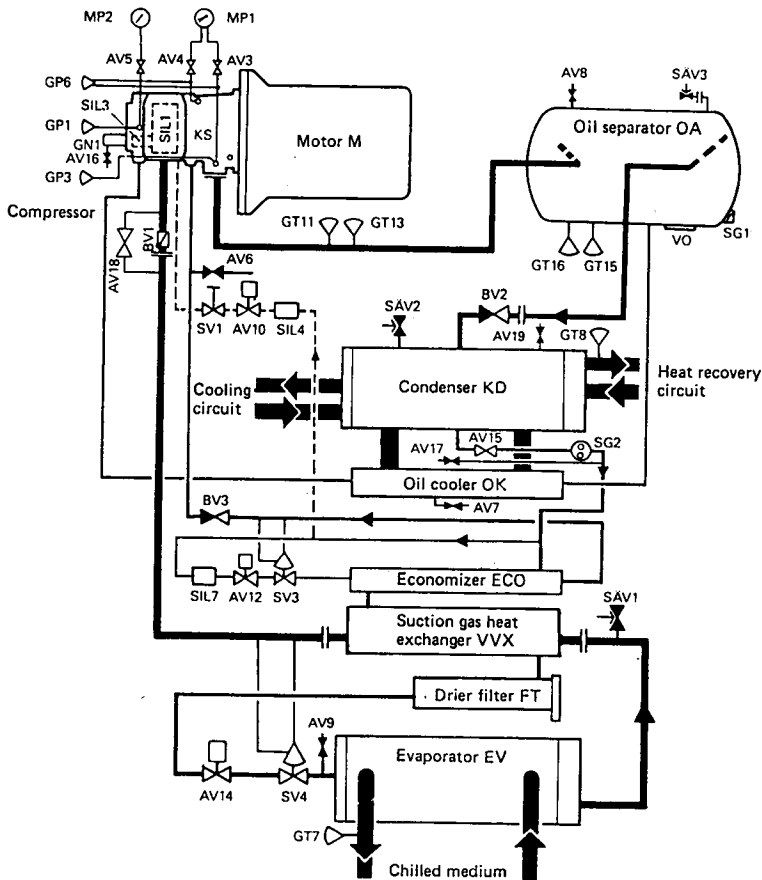


Fig. 3 Schematic system diagram, STAL-MINI VRW unit

1.4 Trial runs

The trial runs, which are carried out in a test rig, simulate the actual operating conditions. These trial runs include the following:

- o Evacuation of the unit
- o Connection to test rig
- o Adding oil and refrigerant
- o Tests that include:
 - Starting up
 - Setting and checking the automatic capacity control system
 - Setting and checking the control and monitor functions.
 - Operational checks (including pressure and temperature levels).
- o Automatic operation
- o Capacity tests
- o Cleaning and replacing filters
- o Disconnection from test rig, emptying water and sealing the connections

2 Start preparations for newly installed units

2.1 Checking dataplates versus order data

Check that the data on the unit's dataplates and nameplates (see Fig. 1) is the same as the data set forth in the order.

2.2 Firm contact with foundation

Check that all of the unit's footplates contact the foundation firmly. If not, insert one or more shims beneath the "high" footplate(s) to prevent the frame from being deformed when the foundation bolts are tightened. See Fig. 4.

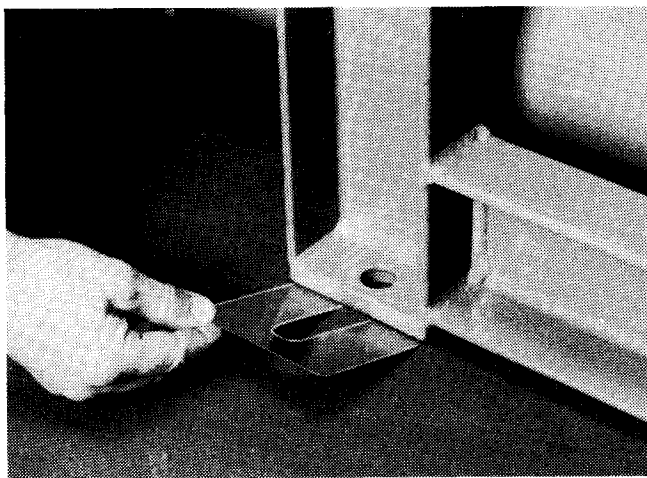


Fig. 4 Inserting a shim beneath a footplate

Units that rest on anti-vibration mountings must be adjusted so that they stand horizontally. Each anti-vibration mounting can be adjusted vertically through 8 mm. The loads carried by each of the anti-vibration mountings must be as equal as possible. See Fig. 5.

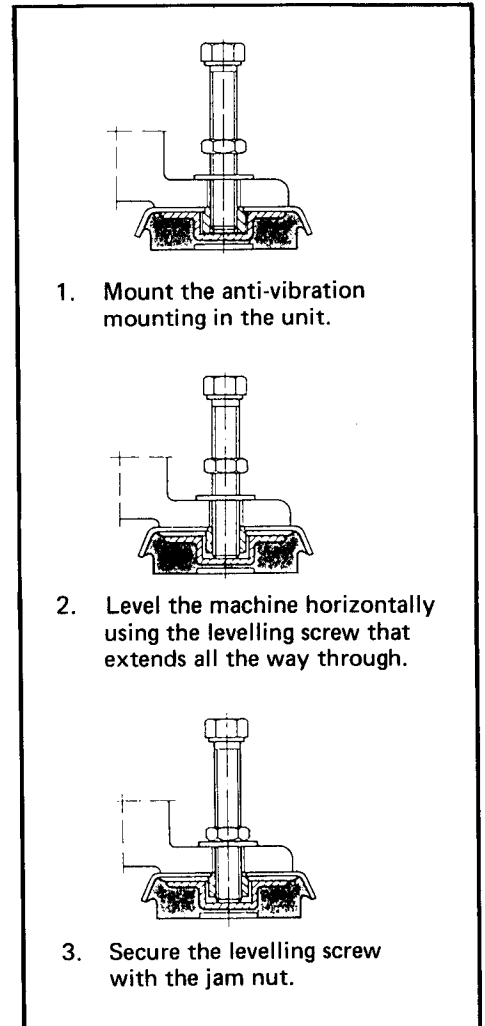


Fig. 5. Adjusting an anti-vibration mountings

2.3 Connection points

The chilled medium lines and the cooling medium /heated medium lines that are to be connected to the unit's evaporator and condenser must be run accurately to their connection points on the unit. There must be no tension in the lines after they have been connected. If in doubt, loosen the connection and check for tension.

If the unit is provided with anti-vibration mountings, check to see that the pipes are provided with flexible rubber connections that prevent vibration propagation. These flexible connections must have longitudinal limiters so that the reaction forces encountered do not affect the unit.

2.4 Checking flow rates

Check the chilled medium system and cooling/heated-medium system to see that the media flow is in the right directions. See Fig. 1.

Start the chilled medium and the cooling/heated-medium pumps and check to see that the specified rates of flow are obtained. To check a flow rate, measure the pressure across the associated pump. Then compare the measured pressure with the values shown on the pump's flow characteristic.

You can also measure the pressure drop across the evaporator. Diagram 1 presents the flow rates and pressure drops permitted when using water as a chilled medium. Glycol and alcohol solutions can also be used as chilled media. The same flow rate limits apply for these. However, the pressure drops for chilled media other than water rise about 3% for each °C that the chilled medium temperature is beneath 5°C.

A suitable corrosion inhibitor should always be added to the chilled medium. This helps prevent corrosion and fouling, thus contributing to maximum efficiency.

Further information is available on request.

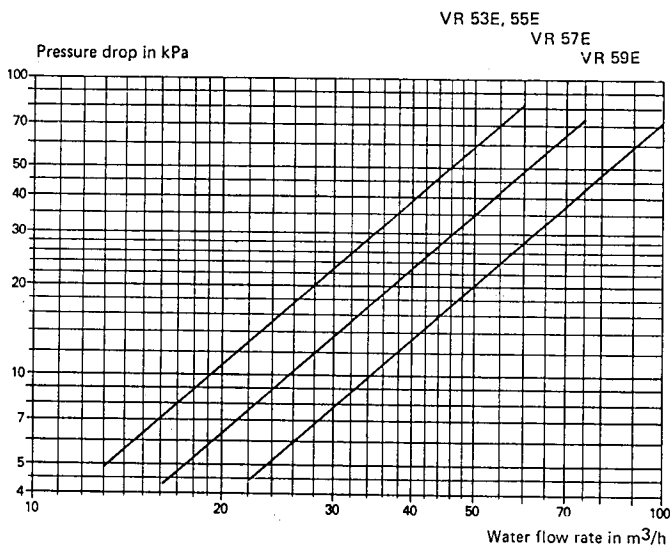


Diagram 1 Chilled medium flow rates and pressure drops for water

The rates of flow and pressure drops permitted when using water as a cooling/heated-medium are presented in diagrams 2, 3 and 4 which follow. For cooling/heated-media other than water, the same flow limits apply. However, the pressure drops can be as much as 20% higher.

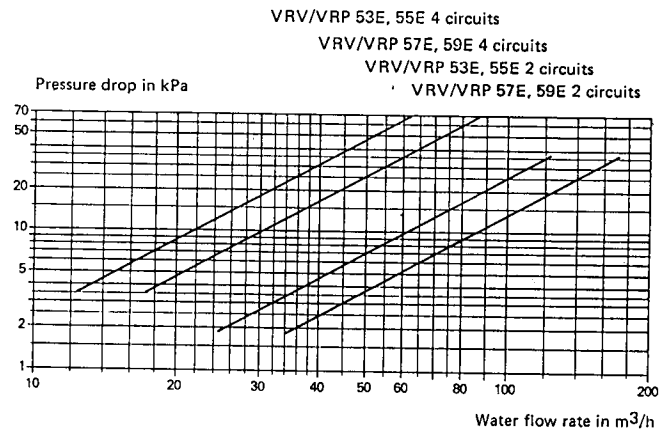


Diagram 2 Cooling/heated-medium flow rates and pressure drops for water (VRV and VRP units)

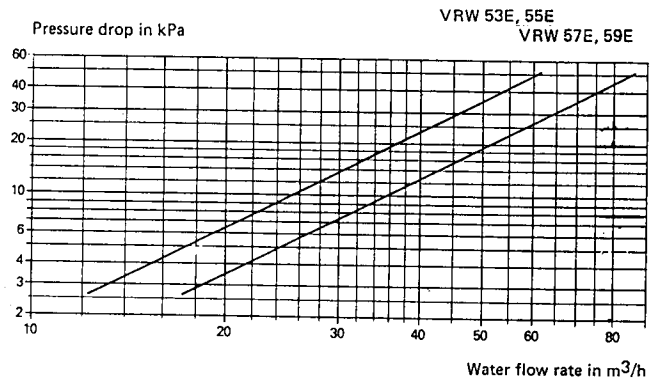


Diagram 3 Cooling/heated-medium flow rates and pressure drops for water (VRW units)

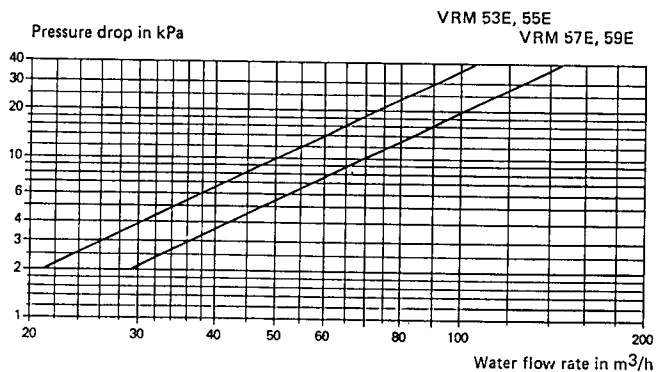


Diagram 4 Cooling/heated-medium flow rates and pressure drops for water (VRM units)

2.5 Adding oil

Use the oil filling pump to add 0.5 litres of oil of the same type as set forth on the unit's dataplate (see Fig. 1). Add the oil to the compressor oil filter housing via valve AV16 (see Fig. 6). A basic oil charge has been added at the factory prior to delivery.

If you need more information about lubricating oils for screw compressors, see manual sheet 7827-N-50.

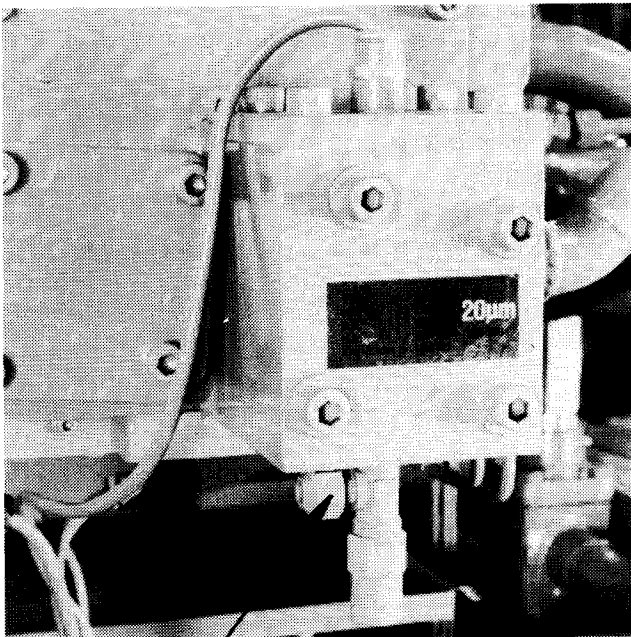


Fig. 6 Valve AV16

2.6 Adding refrigerant

The unit can be delivered with or without a refrigerant charge.

If it was delivered without refrigerant, the refrigerant specified for the unit must be added. See the unit's dataplate (see Fig. 1).

Remember that freezing can cause trouble here. See to it that the cooling water is disconnected or make certain that it is kept in circulation. Follow the instructions set forth below.

Add refrigerant in gaseous form up to a gauge pressure of 0.2 MPa. Then make an initial search for leaks using a detector suitable for the refrigerant being added.

Seal any leaks that are found.

Normally, you can now start to add refrigerant in liquid form. If, however, the condenser is water-cooled and the water is connected, gaseous refrigerant must be added until its pressure corresponds to the saturation pressure at 0°C. Add the refrigerant via valve AV17 (see Fig. 7). Add as much refrigerant as possible up to the limits set forth in Table 1 which follows. The refrigerant charge can be topped up when the unit is put into operation.

	50 Hz	60 Hz	R12 (kg)	R22 (kg)
VRV/M/P	53E	51E	135	120
	55E	53E	135	120
	57E	55E	185	165
	59E	57E	190	170
VRW	53E	51E	185	165
	55E	53E	185	165
	57E	55E	250	225
	59E	57E	255	230

Table 1 Refrigerant charges

2.7 Searching for leaks

The final search for leaks shall be made using a detector suitable for the refrigerant in question. Eliminate any leaks that are found by tightening couplings etc.

2.8 Positioning the valves

Position all valves in the system at their operating positions. See Fig. 7.

Liquid injection valve SV1 (optional) and regulator valve SV7 (included in VRP units) must be closed.

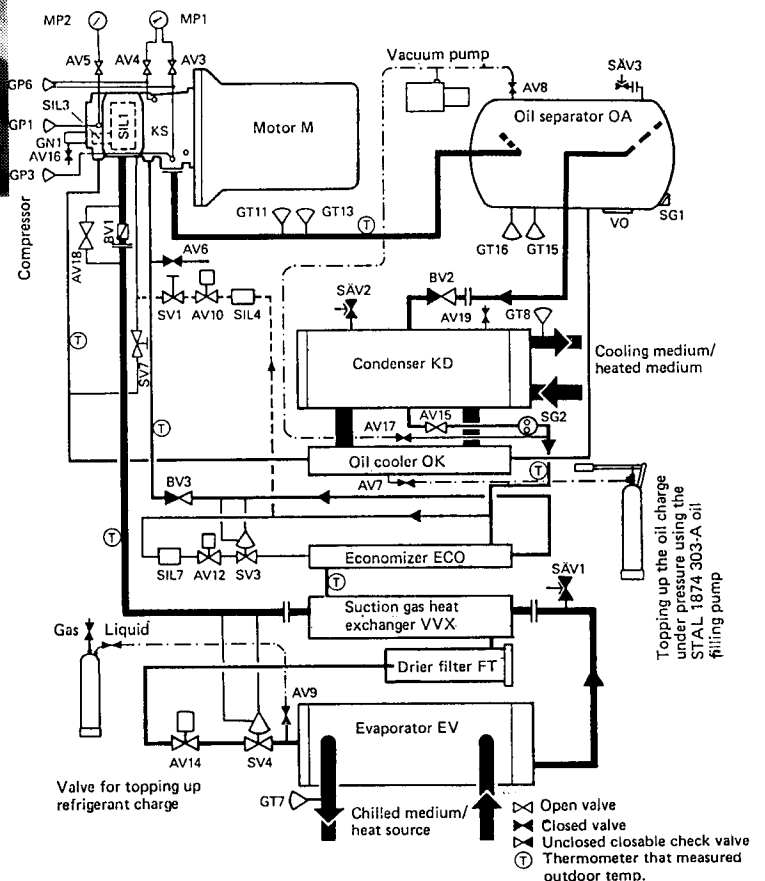


Fig. 7 Operating positions and settings for valves, temperature measurement points, evacuation, adding oil and adding refrigerant

2.9 Electrical connections

Check to see that power is being supplied to the max-level breaker in the specified manner. Check also to see that separate control power is being supplied to the terminal board as specified.

Check to see that all specified devices such as a flow switch or outdoor sensor are properly connected and that all specified interlocks have been properly implemented.

These checks should be based on the electric circuit diagrams and the description of the electrical and control equipment presented in the next section.

3. Electrical equipment

3.1 Requirements

Electric power is needed for the compressor motor. Moreover, the logic unit and the capacity control section must be supplied with power.

The chilled medium must flow at the rate set forth in the specifications for a unit of the size in question.

The heated medium must flow through the condenser when the unit is started.

3.2 Subfunctions

Monitoring switches: Monitoring switches are provided for motor temperature, chilled medium flow rate (if applicable), high pressure, differential pressure across oil filter, low pressure, oil temperature, oil level, motor current and discharge line temperature.

Control: Control functions are provided for the regulation equipment actuation unit, the oil thermostat in oil separator and the thermostat used to control the liquid injection solenoid valve (if applicable).

Temperature regulator: A signal is sent from the temperature regulator to the solenoid valves calling for an INCREASE or DECREASE in capacity.

Operation: Operational functions are provided for the oil heater, the solenoid valve in liquid line, the motor heater (if applicable) and the solenoid valves used for the economizer and for liquid injection. Functions that support unloaded starting and (if applicable) delayed capacity increase are also provided.

Interlocking: Chilled medium pump or heated medium pump.

Internal indicators: Red light-emitting diode (LED) for each monitoring switch set forth above. Green LEDs to indicate operation and closed interlocking circuits. Yellow LEDs to indicate that delay interval is running and power failure has occurred (signal indications) from the regulation equipment are not visible until the enclosure has been opened.

External signals: Zero-potential, make-and-break (transfer) contact for the collective alarm (max 48 V, connected to terminal board). Individual alarm contacts (optional).

External control: Contact connected to terminal board. Used to start the condenser pump or condenser fans.

Delay functions:	Start delay (long)	10 min
	Oil filter	30 s
	Flow switch	30 s
	Oil level	30 s
	Low pressure	60 s
	Start delay (short)	60 s
	Delayed capacity increase	3 min
	Y/D start	7 s

3.3 Operational functions

The system power supply unit (RE5) comprises a circuit board. See Fig. 8. It is connected to the mains via miniature circuit breaker F1.

The transformer provides 24 V, 50/60 Hz that is used to operate the relays and solenoid valves. The 24 V supply and 12 V supply (also obtained from the transformer) are rectified in the power supply unit to 30 V DC and 16 V DC.

These are used for the logic unit in the operating system.

Fuses F01-F07, which are used for the low-voltage side, are mounted on the power supply unit circuit board.

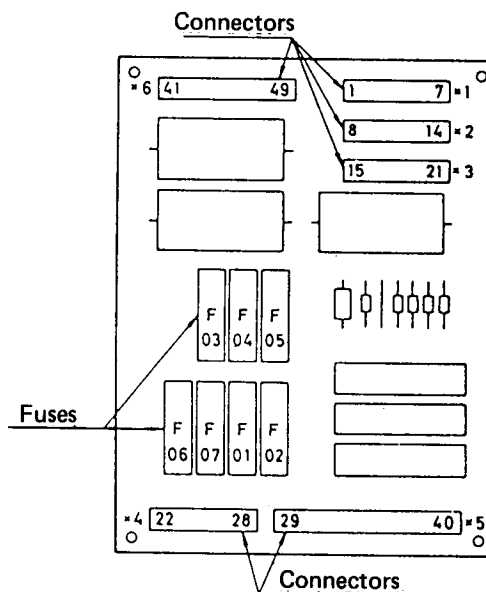


Fig. 8 Power supply unit RE5

Fuses

Item	Amperage/ action	Voltage	Connected equipment
F01	3.15 A	16 V	Internal power supply
F02	3.15 A		Logic unit
F03	6.3 A/slo-blo	24 V	Capacity-control solenoid valves, operating time meter and auxiliary relays
F04	6.3 A/slo/blo		Unused
F05	6.3 A/slo-blo		Unused
F06	6.3 A/slo-blo	24 V	Solenoid valves used for liquid line, liquid injection and economizer
F07	6.3 A/slo-blo	24 V	Regulation equipment
		30 V	Monitoring switches

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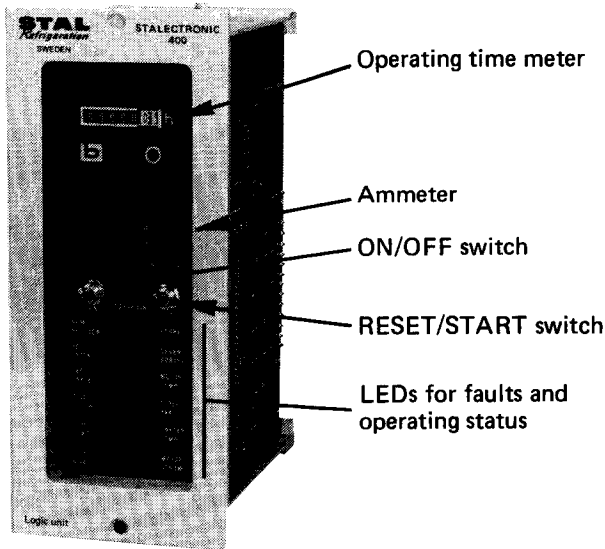


Fig. 9 Logic unit RE1

The following are connected immediately after miniature circuit breaker F1 and before the transformer in the power supply unit:

- Oil heater
- Contactors
- Motor heater (optional)

Oil heater VO is turned on when the compressor is shut down. Oil thermostat GT16 turns off this heater if the temperature rises too high, and turns it on again when the temperature drops. Oil thermostat GT16:

Opens at 50°C
Closes at 47°C

The contactors are controlled from logic unit RE1 via auxiliary relays R1-R3 for Y/D starting. C2, C3, R2 and R3 are not needed when across-the-line starting is used.

Motor heater VM is always kept turned on while the compressor is idle.

Solenoid valves AV10, AV12 and AV14 are supplied with 24 V AC from the power supply unit.

Solenoid valve AV14 opens when the compressor enters the normal operating state.

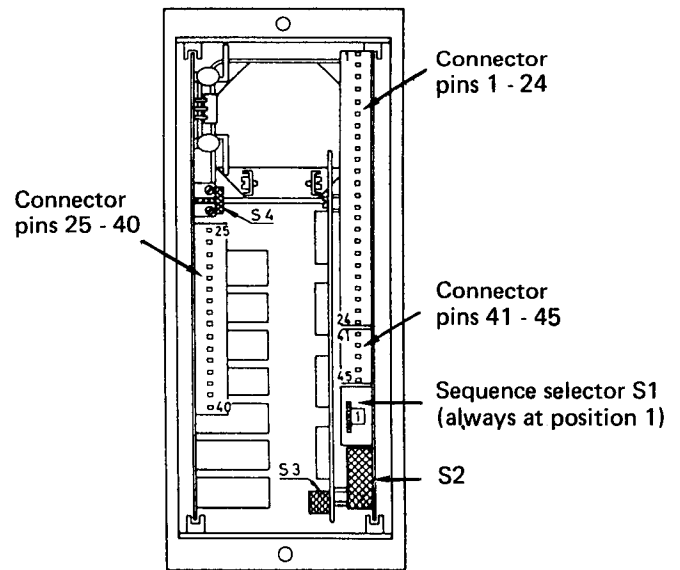
Solenoid valve AV12 is used for the economizer, and it can be provided with control equipment.

Solenoid valve AV10 is used for liquid injection (if applicable), and it opens when the discharge temperature rises too high (due to the fact that thermostat GT13 closes). This thermostat:

Opens at 110°C
Closes at 117°C

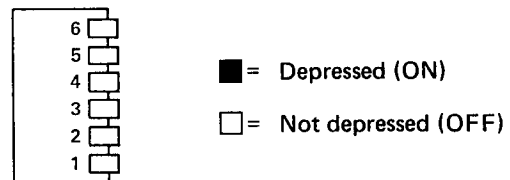
The solenoid valves are permitted to open when the compressor is running, although not during execution of a pump-out function.

Most of the control functions needed to operate the unit are implemented in the logic unit. See Fig. 9. Inside the logic unit there are two function switches designated S2



and S3 (used for different operating situations), a switch designated S1 and a selector switch designated S4. This latter is used to select the current measurement range. See Figs. 10, 11 and 12. Switch S1 must always be at position 1 for STAL-MINI units.

Switch S2 must be set for the current operating situation by depressing the desired actuators. On switches S3 and S4, you must slide the actuators. The proper setting for switch S4 (current range of 100, 200 or 300 A) depends on which current transformer is being used.



- 1 ■ Automatic restart after low suction pressure
□ Manual restart required after low suction pressure
- 2 ■ Automatic restart after low oil temperature
□ Manual restart required after low oil temperature
- 3 Not used for screw compressor units
- 4 ■ Start-to-start delay
□ Stop-to-start delay
- 5 ■ Manual restart required after power failure
□ Automatic restart after power failure
- 6 ■ Flow switch stops unit unconditionally if flow drops
□ Flow switch does not issue fault signal if chilled medium pump stops (interlocking circuit opened)

Fig. 10 Function switch S2

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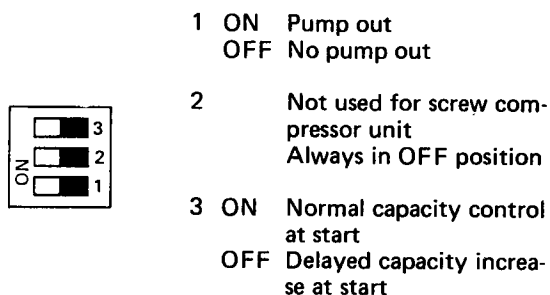


Fig. 11 Function switch S3

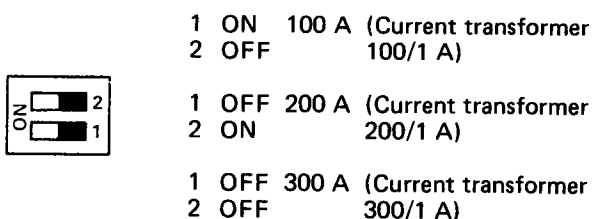


Fig. 12 Current range selector switch S4

3.4 Operation

When the left-hand switch on the front of the logic unit is set to the ON position, a yellow LED lights up to indicate that starting cannot take place until a 10-minute delay interval has elapsed. This delay prevents too frequent starting. However, this delay can be bypassed to permit sooner starting by pressing down the right-hand switch on the front of the logic unit. In such case, the delay interval becomes 60 seconds after the previous stop.

When this 60-second interval has elapsed (or when the 10-minute delay interval has elapsed), the compressor starts if certain conditions are met. There must be no fault signal from any of the monitoring switches. The remote-control interlocking circuit must be closed. And the regulation equipment must have requested a compressor start.

When the green LED on the logic unit is lighted, it indicates that the compressor is running (and also indicates that the interlocking circuit is closed).

When a start takes place (start equipment in Y state), the compressor is unloaded, i.e. the DECREASE solenoid valves are energized.

When changeover to the D state takes place, the capacity control equipment is permitted to establish the capacity requested by the regulation equipment. However, function switch S3 can be used to keep the compressor running at low capacity for an additional 180 seconds.

The compressor is stopped when the control power fails and when one or more of the monitoring switches is tripped (sends out a fault signal). In addition, the compressor is stopped when the start signal being received from the regulation equipment is interrupted or the interlocking circuit is opened and also when the left-hand switch on the front of the logic unit is set to the OFF position.

Switch S3 permits you to select (or deselect) automatic pump-out when the compressor is stopped. If pump-out is selected, the compressor continues to run until the pump-out operation is completed, i.e. until the low-pressure cut-out is tripped.

When the left-hand switch on the front of the logic unit is at the OFF position, the compressor's DECREASE solenoid valves are energized. You can select either automatic or manual restoration of normal operation (restarting) after a power failure. A yellow LED lights up to indicate that the power has failed.

In the event of a fault, the unit is stopped when the following situations arise:

(Normal settings are given below, even though other settings can be used for different operating situations).

- Condensing pressure too high.
Stop occurs immediately when the value preset on cut-out GP3 is exceeded, GP3 is tripped (opens) at a gauge pressure of 2.3 MPa and closes at a gauge pressure of 1.8 MPa.
- Suction pressure too low.
Stop occurs when the pressure drops below the value preset on cut-out GP1 for a period longer than 60 s. GP1 is tripped (opens) and closes as set forth in Table 2 below (figures in MPa of gauge pressure).

	Refrigerant			
	R22		R12	
	Opens (MPa)	Closes (MPa)	Opens (MPa)	Closes (MPa)
Normal suction pressure during operation				
Above -2°C	0.22	0.31	0.10	0.19
between -2 and -10°C	0.10	0.19	0.05	0.14
below -10°C	0.05	0.14	0	0.09

Table 2

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- o Differential pressure across oil filter too high.
Stop occurs when the pressure preset on cut-out GP6 is exceeded for longer than 30 s.
GP6 opens at 0.1 MPa and closes at 0.07 MPa.
- o Temperature of oil in oil separator too low.
Stop occurs immediately when the temperature drops below the value preset on thermostat GT15.
GT15 is tripped (opens) at 20°C and closes at 23°C.
- o Oil level too low.
Stop occurs when the level of the oil in the compressor's oil filter housing drops too low for a period longer than 30 s.
- o Motor temperature too high.
Stop occurs immediately when the max permissible winding temperature is exceeded.
- o Chilled medium flow rate too low.
Stop occurs when the chilled medium flow drops too low for the plant in question due to the fact that the evaporator remains saturated for a period longer than 30 s.
- o Discharge line temperature too high.
Stop occurs immediately when the value preset on cut-out GT11 is exceeded.
GT11 is tripped (opens) at 120°C and closes at 113°C.

- o Motor current too high.
Stop occurs immediately when the current preset on the motor overload cut-out is exceeded.

Faults are indicated by red LEDs.

Normally, manual resetting is required after a fault. However the oil temperature cut-out and low-pressure cut-out can be set for automatic resetting by means of switch S2.

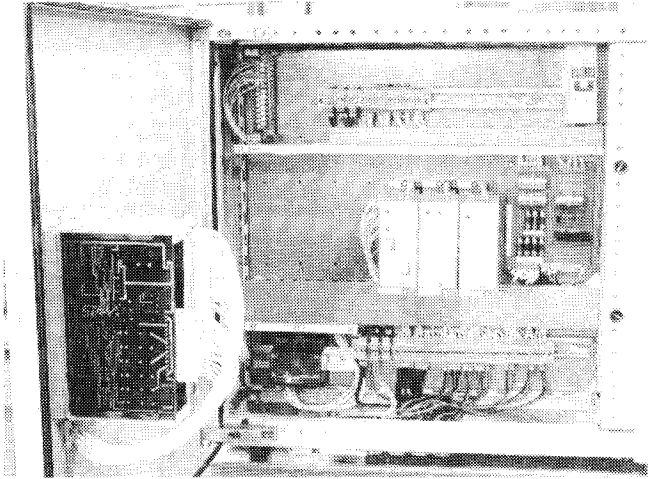


Fig. 13 Control and regulating equipment

List of components

Item	Name	Supplier	Ordering No.	Remarks
F1	Control circuit fuse	AEG	E22L 10A	
TR1	Control circuit transformer	Tramo	A120.90.003	Control power
TR2	Current transformer	LK-NES	HF3A---/1A	220 V, 50 Hz
MST1	Max-level circuit breaker	} These vary, depending on which type of electric motor is selected and also on the mains voltage. See circuit diagram for your system.		
C1	Contacteur H			
C2	Contacteur D			
C3	Contacteur Y			
E1	Motor overload cutout			
RE5	Power supply unit	STAL	3968 1190 410	
RE4	Alarm unit	STAL	3968 1190 600	
RE1	Logic unit	STAL	3968 1190 140	
R1	Auxiliary relay	Sprecher & Schuh	CS3-31E	} Operating coil that is selected will depend on frequency used in power supply unit.
R2	Auxiliary relay	Sprecher & Schuh	CS3-31E	
R3	Auxiliary relay	Sprecher & Schuh	CS3-31E	
R4	Auxiliary relay	Sprecher & Schuh	CS3-31E	
VO	Oil heater	STAL	1903 876-1	220 V, 50/60 Hz
AV14	Solenoid valve coil, liquid line	STAL	3963 1120 803	24 V, 50 Hz
AV14	Pilot solenoid valve, liquid line	STAL	3963 1171 933	24 V, 50 Hz
AV14	Solenoid valve coil, liquid line	STAL	3963 1120 813	24 V, 60 Hz
AV14	Pilot solenoid valve, liquid line	STAL	3963 1171 983	24 V, 60 Hz
AV12	Solenoid valve coil, economizer	STAL	3963 1120 803	24 V, 50 Hz
AV12	Solenoid valve coil, economizer	STAL	3963 1120 813	24 V, 60 Hz
AV10	Solenoid valve coil, liquid injection	STAL	3963 1120 803	24 V, 50 Hz
AV10	Solenoid valve coil, liquid injection	STAL	3963 1120 813	24 V, 60 Hz
SV15	Solenoid valve coil, capacity control	STAL	3963 1151 864	24 V, 50/60 Hz
SV16	Solenoid valve coil, capacity control	STAL	3963 1151 864	24 V, 50/60 Hz
SV17	Solenoid valve coil, capacity control	STAL	3963 1151 864	24 V, 50/60 Hz
GN1	Oil level switch	STAL	3966 4052 655	

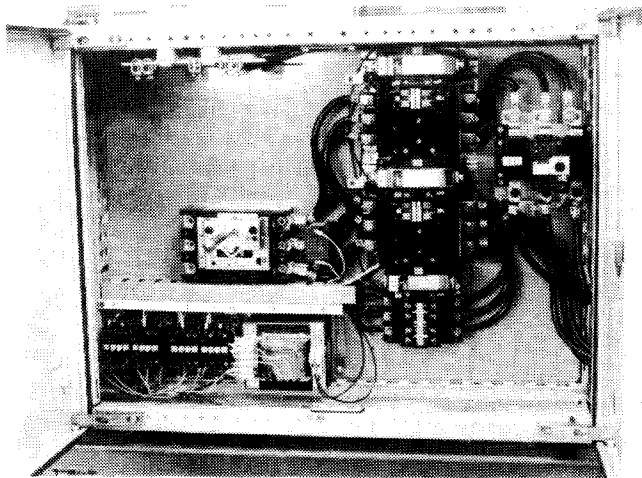


Fig. 14 Starting and power supply equipment

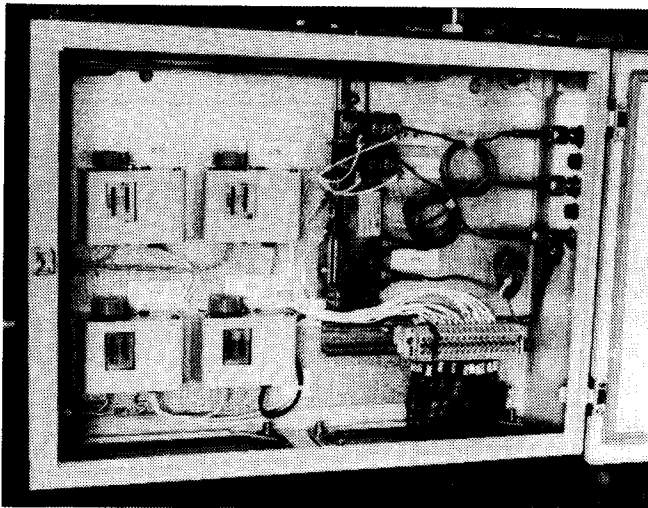


Fig. 15 Pressure and temperature cut-outs

Manual resetting after a fault is carried out using the right-hand switch on the front of the logic unit.

A collective alarm relay changes state when a monitoring switch that requires manually resetting is tripped.

3.5 Diagrams

Somewhat simplified circuit diagrams of the most frequently used variants appear in manual sheet 7827-J-40.

4. Stalelectronic 400 regulating system

4.1 General

Regulating equipment that can control compressor capacity is needed to make certain that a VR unit maintains the specified temperature in the plant. This regulating equipment consists of a number of regulating modules mounted in the electrical equipment enclosure. See Fig. 13.

In a liquid chiller unit, the capacity control section always consists of at least three modules.

1. Temperature regulator
2. START/STOP voltage relay
3. Positioning relay used for capacity control

In addition, there is a sensor located where it can measure the temperature of the leaving chilled medium from the evaporator.

In a heat pump unit, the capacity control section always consists of at least four modules:

1. Temperature regulator (dual regulator)
2. Signal selector
3. START/STOP voltage relay
4. Positioning relay used for capacity control

Here, the regulating equipment also contains a sensor located where it can measure the temperature of the leaving chilled medium or heated medium.

This equipment can be supplemented with additional regulating modules and transducers that provide functions such as desired value displacement based on the outdoor temperature, limitation of condenser pressure and motor current limitation. See Fig. 16.

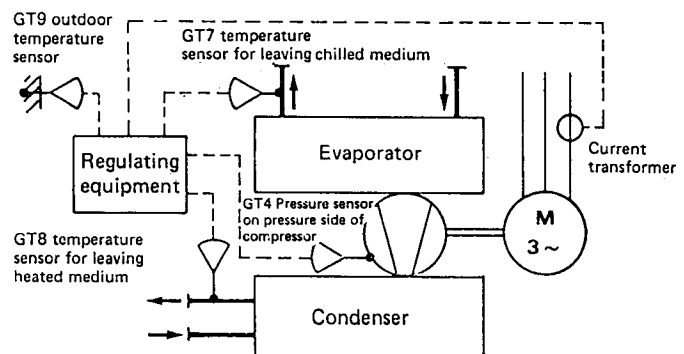


Fig. 16 Supplementary regulating equipment

In addition to the above, there are one or two sockets for special modules. These modules present the current values and the desired values for the regulating equipment on a display. Printers can also be connected to print out readings that are of interest.

4.2 Operation

The temperature regulator or regulators operate as proportional regulators (P regulators).

This means that the signal sent out from a regulator is always proportional to the deviation between the preset desired value and the current value.

This output signal can range from 0 to 20 V (phase-cut signal). When the current value matches the preset desired value, the output signal is 10 V.

The regulator output signal is used to control a voltage relay and a positioning relay. For a heat pump unit, a signal selector is used to select the lowest signal received from the chilled medium and heated medium regulators. The selected signal is used as a control signal for a voltage relay and positioning relay.

The voltage relay processes the signal used to start and stop the compressor, while the positioning relay processes the signals used for the capacity control solenoid valves.

The voltage relay sends a start signal to the logic unit when the regulator's output/control signal reaches a certain pre-settable level.

From the logic unit, the start signal is then sent to the starting devices. If the regulator output/control signal drops beneath the preset difference from the "running" level the start signal is interrupted, thus causing the compressor to stop.

The positioning relay converts the output signal from the regulator/signal-selector to a pulsed 3-state signal. The positioning relay does not send out any output signal when the output signal from the regulator/signal-selector is 10 V.

If the regulator output/control signal increases, an output relay inside the positioning relay pulls in intermittently and sends a pulsed signal that causes an increase in compressor capacity. The higher the voltage of the regulator output/control signal, the longer the INCREASE pulses will be.

Similarly, a second output relay pulls in if the regulator output/control signal drops beneath 10 V. This second output relay sends out a signal that causes a decrease in compressor capacity. These signals control, via the logic unit, the compressor solenoid valves used for capacity control.

The proportional regulator provides (in combination with a positioning relay of the type used here to control the capacity-control solenoid valves) a function that resembles PID (proportional, integrating and differentiating).

Consequently, there is no steady-state regulation deviation while the compressor is running.

A regulator that functions on the same principles as the temperature regulator can be connected to limit the condenser pressure. A signal selector is used to select the lowest signal sent out from the temperature and pressure regulators. This signal is used as a control signal for the voltage relay and positioning relay.

The regulating equipment can also be supplemented with a regulator that limits the motor current. Here too, a signal selector is used to select the lowest signal, which is then sent to the positioning relay.

Moreover, it is possible to supplement the system with an interference unit that displaces the desired value used for the chilled medium/heated-medium regulator. This displacement is based on the outdoor temperature.

The circuit diagrams for the different regulation variants appear in manual sheet 7827-J-50 for liquid chiller units and manual sheet 7827-J-60 for heat pump units.

4.3 Settings

The regulating equipment for each unit is set on the basis of the conditions that prevail in the plant in question.

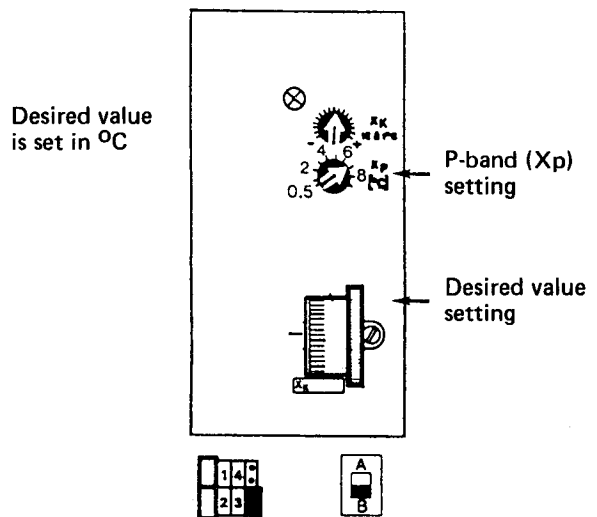
However, the basic settings of the regulating modules are all the same. Only the desired value and the desired value displacement vary.

Different modules are used as main regulator RC1, depending on whether a liquid chiller unit or heat pump unit is being used and also depending on whether or not desired-value displacement is implemented.

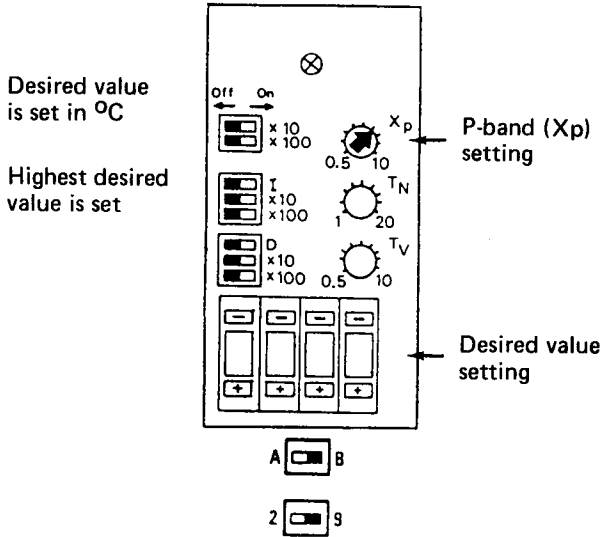
The following regulating modules and basic settings are used.

Temperature regulator RC1

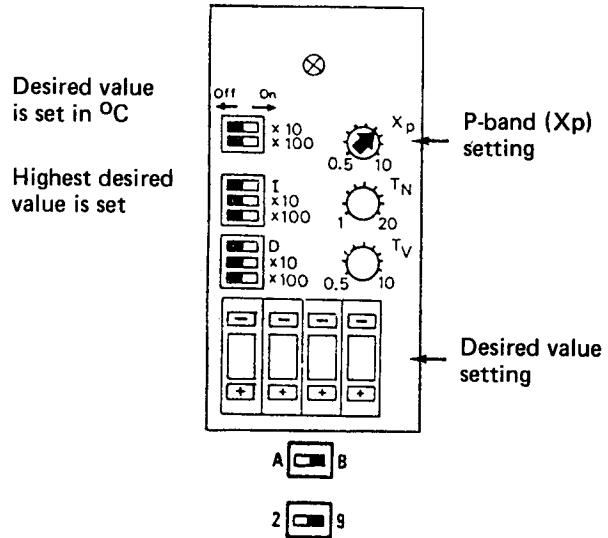
Liquid chiller unit without desired-value displacement



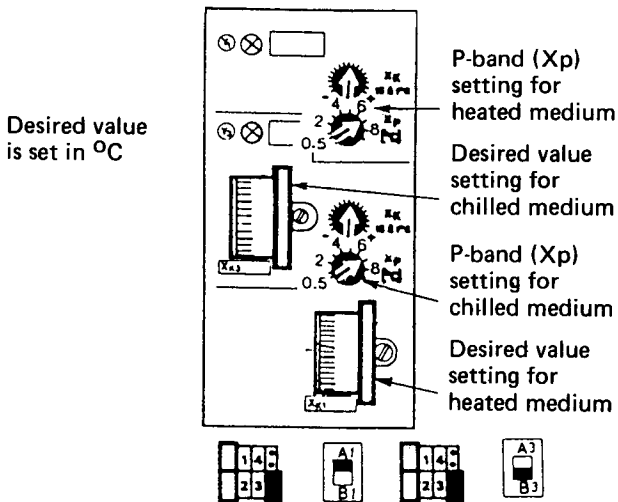
Liquid chiller unit with desired-value displacement



Heat pump unit with desired-value displacement

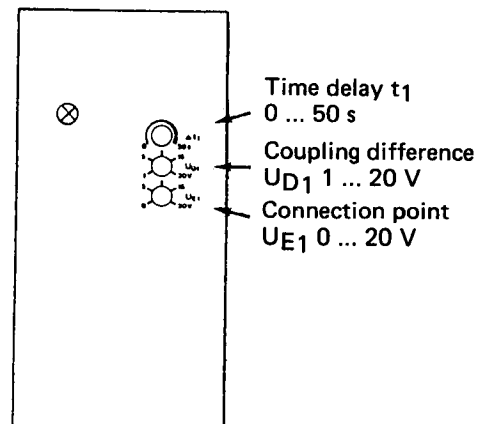
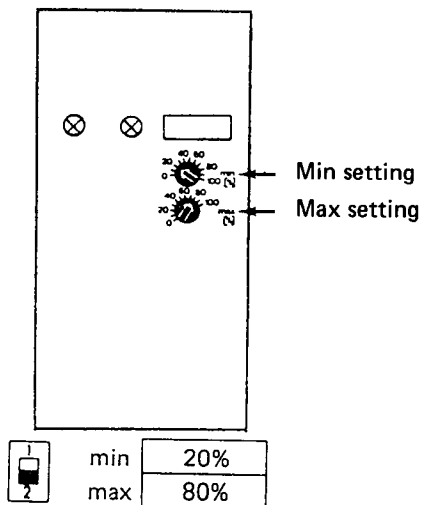


Heat pump unit without desired-value displacement



Common equipment used for all devices:

Positioning relay RE7 and voltage relay are always included



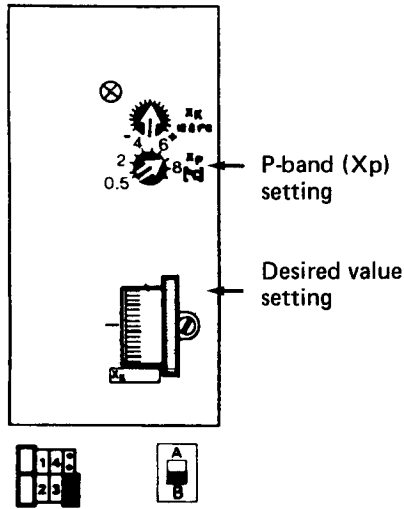
Δt_1	50 S
UD1	6 V
UE1	13 V

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Limiting regulator RC3

Chilled medium limitation on heat pump unit with desired value displacement. This is included in RC1 for heat pump units without desired-value displacement.

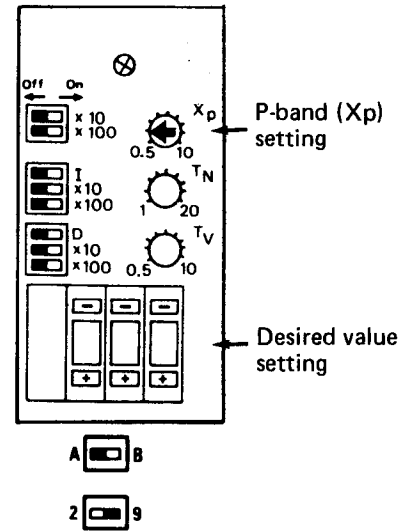
Desired value is set in °C



Limiting regulator RC6

Motor current limitation (optional equipment)

Desired value is set as % of current transformer measurement range.

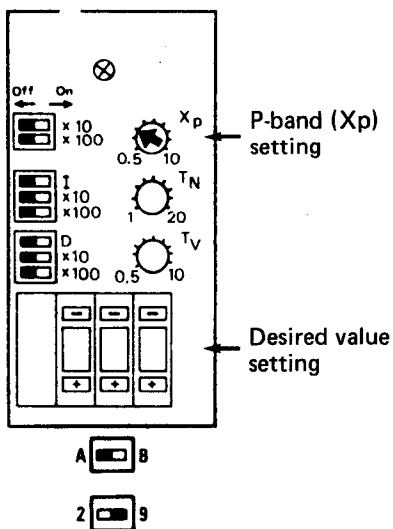


Example: 200/1 current transformer is used. Limitation is desired at 180A. Setting shall be 90%.

Limiting regulator RC4

Condenser pressure limitation (optional equipment)

Desired value is set as % of sensor measurement range in bar



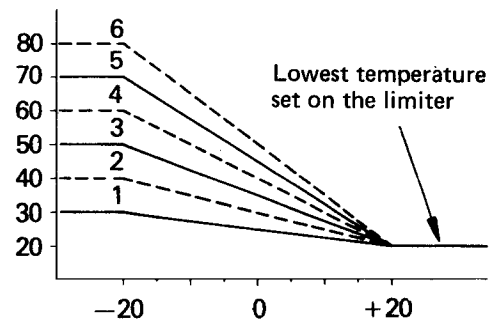
Desired-value displacement

Interference unit RC2 (which displaces the desired value) is used for this function. It is provided with a sensor in the outdoor air or in whatever other medium is to determine the amount of displacement. This interference unit contains measurement amplifier YM-WU and limiter YM-BU.

The principles on which these units are set are presented in a separate manual sheet. Several examples are presented below:

Heat pump unit

Leaving heated medium temperature is same as the regulator setting



Example: Sensor has a range of 0 - 25 bar. Limitation is desired at 20 bar. Setting shall be 80%.

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Setting the measurement amplifier (YM-WU)

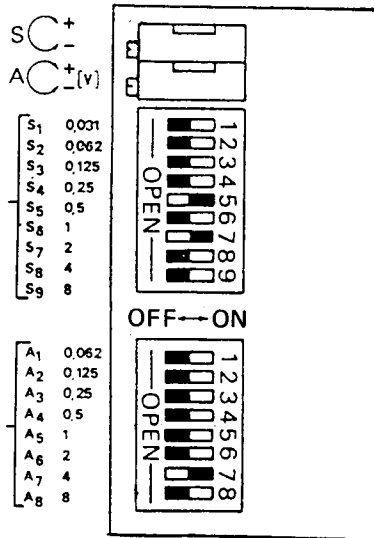
Switch ON

- Curve 1 S5
2 S6
3 S5 + S6
4 S7
5 S5 + S7
6 S6 + S7

Zero point -20°C
provides a setting
of A7 for

Slope
(curve 5 for
example)

Zero point
(-20°C)



If the regulator's desired value setting is changed, the curve is displaced to the corresponding temperature and limitation value.

If no desired-value displacement is required, all switches on the measurement amplifier shall be set to the OFF position, and switch S5 on the limiter shall be set to the OFF position.

Desired-value displacement is used very seldom for liquid chiller units. If it is to be used, see manual sheets 7827-J-50 and 7827-J-60.

5. First startup

5.1 Check to see that the capacity control system has been set for minimum capacity. There are three solenoid valves, and the two at left (see Fig. 17) must be energized. The easiest way to check this is by feeling them to see if they are warm.

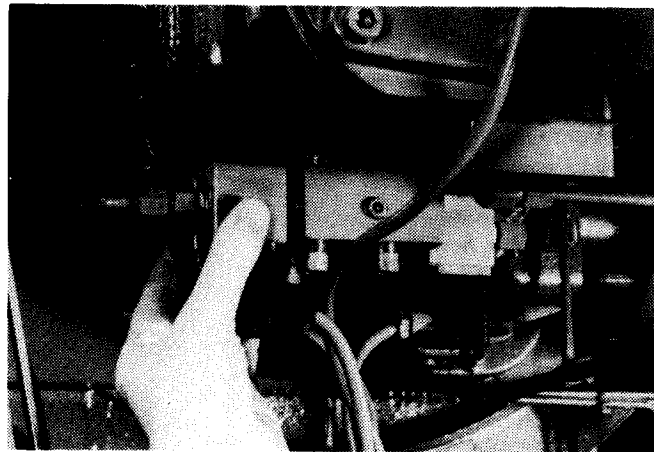


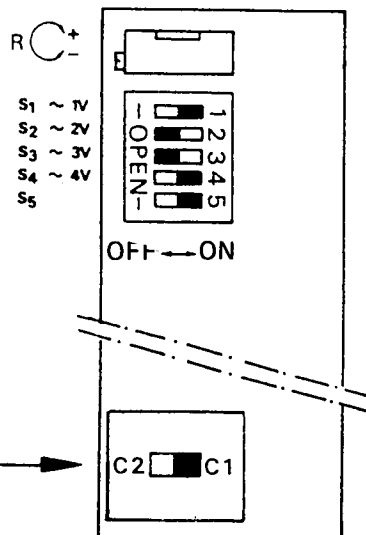
Fig. 17 Capacity control system with solenoid valves

Setting the limiter (YM-BU)

Switch ON

- Curve 1 S1
2 S2
3 S3
4 S4
5 S1 + S4
6 S2 + S4

If limitation
is in effect,
S5 must always
be ON



5.2 Start the motor and then turn it off again right away. Check to see that it rotates clockwise when viewed looking towards the exposed shaft end. If the motor rotates the wrong way, it may damage the compressor. Use a lamp to check the direction of motor rotation by observing the fan impeller inside one of the vents as illustrated in Fig. 18. The impeller should turn in the same direction as that shown by the arrow on the compressor bearing housing.

If the motor rotates in the wrong direction, it is connected up improperly. Check as shown in Fig. 19, or see the motor supplier's phase-sequence instructions etc, and have a qualified electrician make the correction.

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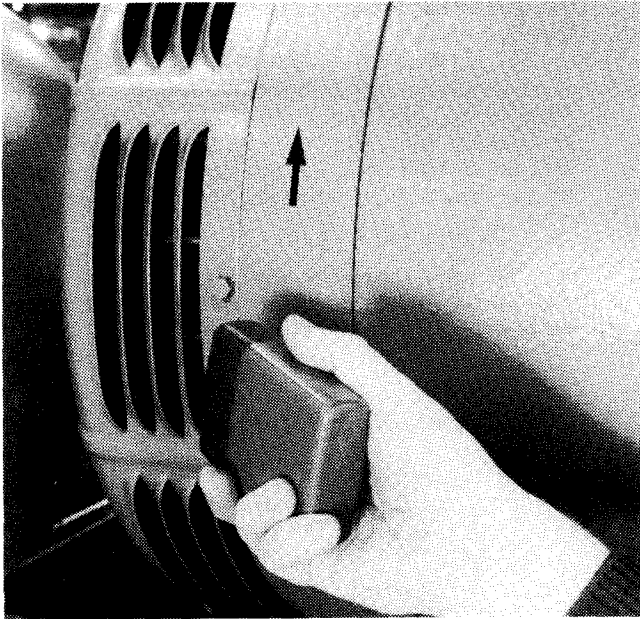


Fig. 18 Checking the direction of motor rotation

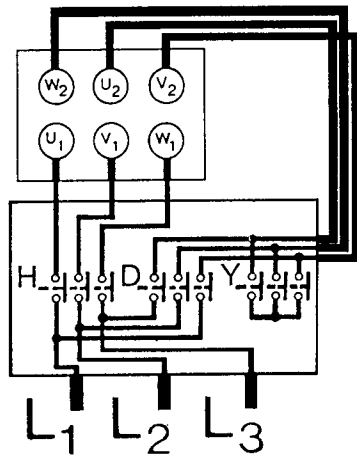


Fig. 19 Motor connections

5.3 Start the unit.

5.4 Check that the settings of the temperature or pressure regulating equipment used to control capacity match the data specified for the system. See also the trial run report.

5.5 Check that the temperatures shown by the pointers on pressure gauges MP1 and MP2 (see Fig. 20) lie with the range specified in the diagram for the compressor in question. See Figs. 21 and 22. Check also to see that these temperatures match the data specified for the system.

5.6 Top up the refrigerant charge. Add refrigerant in liquid form either downstream from the system's expansion valve AV9 (see Figs. 23 and 7) or in liquid line AV17 downstream from the condenser. In the latter case, it may be necessary to lower the pressure in the line. In such case, throttle valve AV 15 (located downstream from the condenser).

Using a surface-temperature thermometer (see Fig. 7), check to see that the temperature of the liquid leaving the condenser is 5-8°C lower than the condensing temperature (subcooling).

Sight glass SG2 in the liquid line (see Figs. 24 and 7) must not reveal any gas bubbles.

5.7 Check to see that the evaporator expansion valve (SV4) is functioning properly. This valve is set during the trial run conducted at the factory.

Use a surface-temperature thermometer (see Fig. 7) to measure the suction gas temperature on the suction line upstream from the compressor. Remove the insulation to expose a small area before measuring.

The difference between the suction gas temperature and the evaporating temperature represents the amount of suction gas superheating. This must be at least 7°C, but it can range up to about 15°C.

The evaporator expansion valve can be adjusted if necessary. See Fig. 25. Turning it clockwise provides more superheating, and each turn corresponds to a change of about 0.25°C.

MP1

Black pointer shows the condensing pressure/temperature. Red pointer shows the pressure after the oil filter.

MP2

Shows the evaporating pressure/temperature.

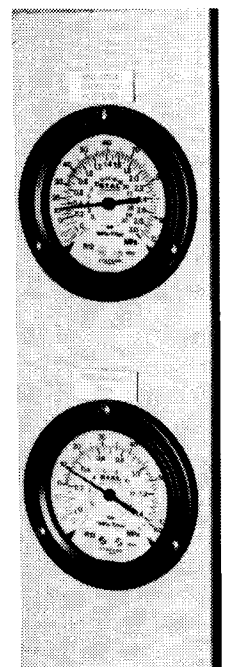


Fig. 20 Pressure gauges

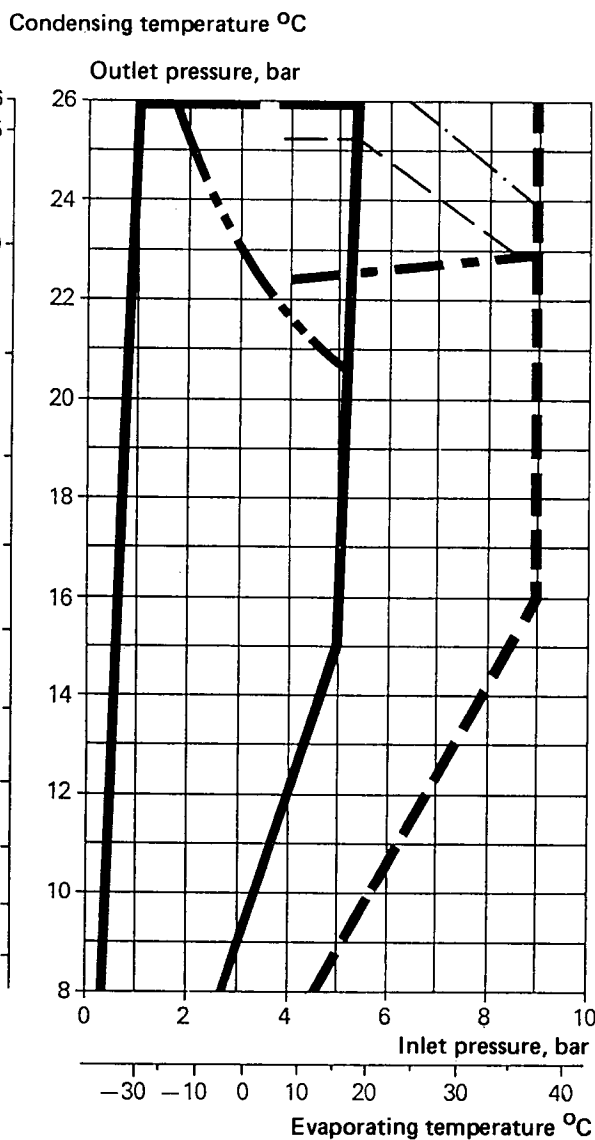
5.8 Check to see that the economizer expansion valve (SV3) is functioning properly. This valve is set during the trial run conducted at the factory. Measure the economizer suction gas temperature using a surface-temperature thermometer. See Fig. 7. Also measure the economizer suction pressure using a service pressure gauge connected to valve AV6. See Fig. 26.

The difference between the economizer suction gas temperature and the economizer suction pressure, converted to the saturation temperature of the refrigerant being used represents the amount of superheating. This must be at least 7°C, but can range up to about 15°C.

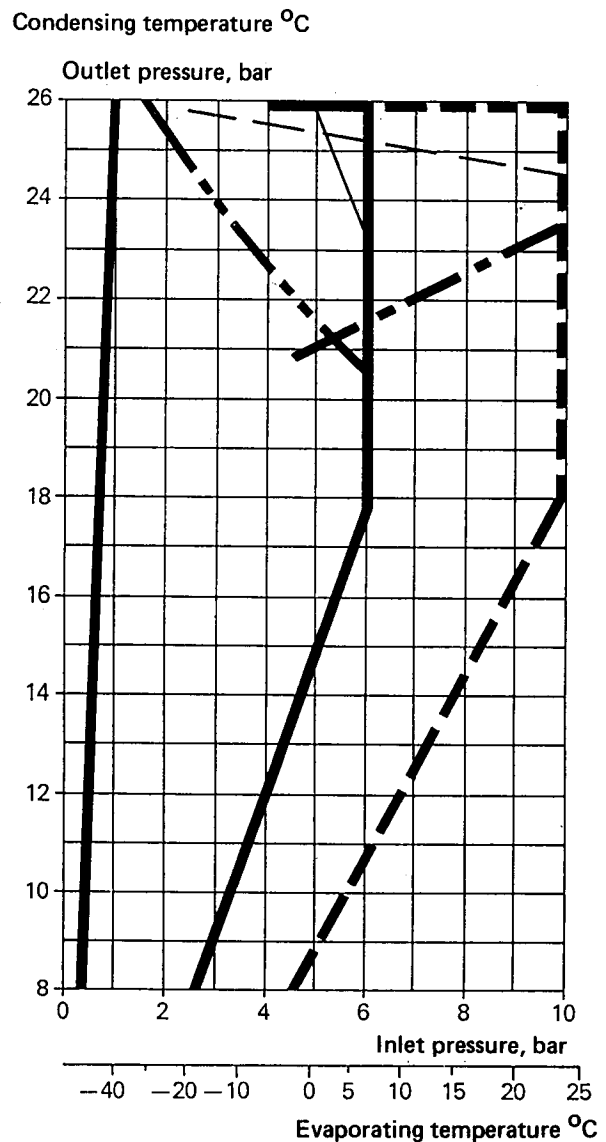
See section 5.7 for an explanation of how to adjust the expansion valve.

5.9 Use a surface-temperature thermometer (see Fig. 7) to measure the liquid temperature downstream from the economizer. This liquid temperature must be about 5°C above the economizer suction pressure, converted to the saturation temperature of the refrigerant being used.

If the liquid is not sufficiently subcooled, it may be because not enough refrigerant has been added to the system.



- R 53-40, 55-40, 57-40 and 59-40
- R 53-25, 55-25, 57-25 and 59-25
- R 59-40
- R 59-25
- R 57-25
- R 59-25 without economizer



- R 53-40, 55-40, 57-40 och 59-40
- R 53-25, 55-25, 57-25 and 59-25
- R 59-40
- R 59-25
- R 59-40 without economizer
- R 59-25 without economizer

Fig. 21 Working range of compressor (R12 refrigerant)

Fig. 22 Working range of compressor (R22 refrigerant)

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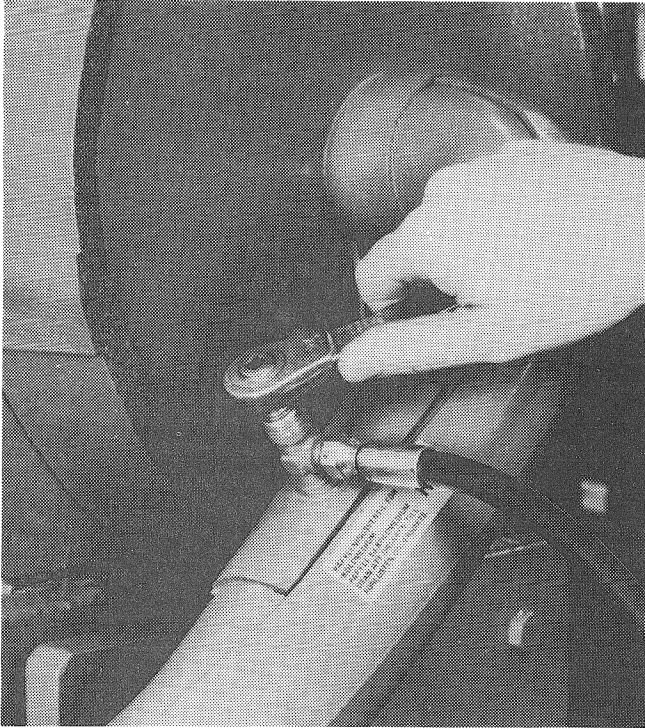


Fig. 23 Valve used to add refrigerant

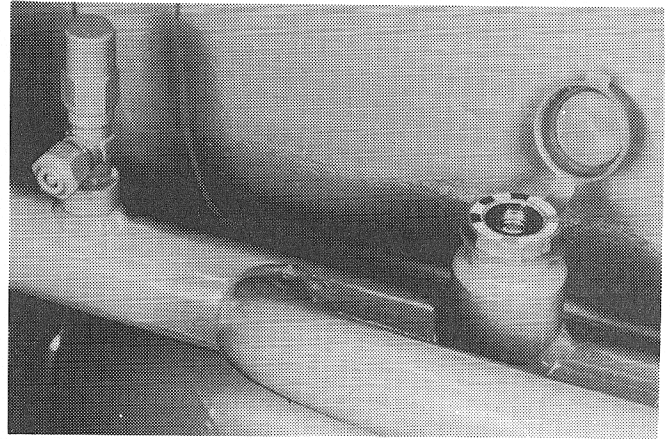


Fig. 24 Sight glass SG2

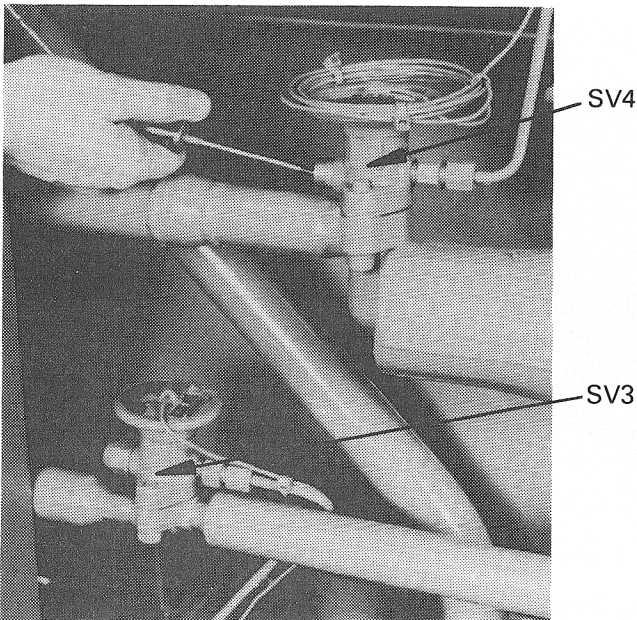


Fig. 25 Evaporator expansion valve SV4 and economizer expansion valve SV3

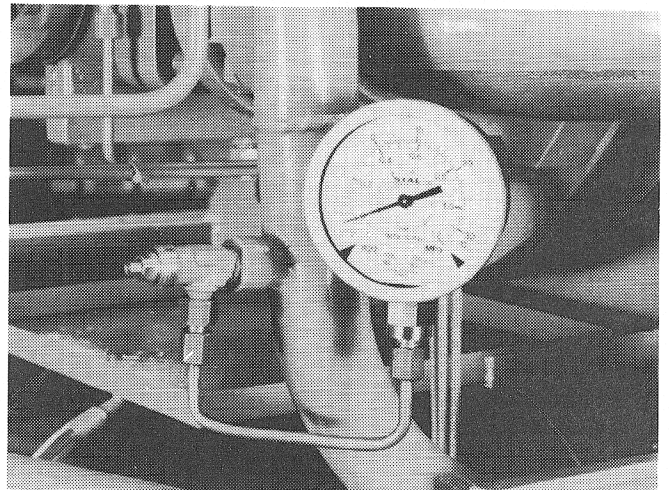


Fig. 26 Service pressure gauge connected to valve AV6

- 5.10 Using a surface-temperature thermometer (see Fig. 7), check the oil temperature in the line running from the oil cooler immediately upstream from the compressor. This temperature shall normally be up to about 5°C above the condensing temperature.

At partial load and under high pressure (VRV chilled medium units and also VRP units), it may be necessary to supplement the oil cooling by:

- o Increasing the oil flow by opening regulating valve SV7 (only for VRP units)
- o Injecting liquid (requires optional equipment)

- 5.11 Use a surface-temperature thermometer (see Fig. 7) to check the temperature in the discharge line between the compressor and the oil separator. This temperature must be at least 20°C higher than the refrigerant condensing temperature and it must not exceed +120°C.

Note that in this temperature range, the measurement error can amount to about 10°C due to the fact that the surface of the pipe has a temperature that is lower than that of the gaseous refrigerant in the pipe.

If the discharge line temperature is too low, it may be because the suction gas temperature (and the economizer suction gas temperature) is too low. See sections 5.7 and 5.8. If the discharge line temperature is too high, it may be because there is insufficient cooling. This normal occurs only at partial load and high pressure. (See section 5.10) and also when the suction gas temperature (and the economizer suction gas temperature) is too high. See sections 5.7 and 5.8.

- 5.12 Check the level in the oil separator. See Fig. 27. Note that this must always be carried out while the unit is running. Normally, the oil level shall lie within the sight glass. If the level drops beneath the sight glass and does not rise back after 10 minutes of operation, top up the oil in the system. See Fig. 7.

Due to the fact that the oil circulates in the refrigerant system, external leaks are the only possible cause of a reduction in the total amount of oil.

If oil is added, it may be necessary to drain a part of it off after the unit has been operating for a while.

- 5.13 Check the unit's low pressure (evaporating pressure). Measured on the °C-graded scale, it shall be about 3-5°C beneath the temperature of the chilled medium that leaves the evaporator at full capacity.

If the difference is higher, it may be because not enough refrigerant has been added to the system or because the chilled medium flow rate is too low.

- 5.14 Listen for any abnormal knocks or other sounds that may be caused by (for example) poorly-clamped or self-oscillating pipes or by knocking valves or the like. Fix any faults that are found, or notify your supervisor.

- 5.15 Check the settings of pressure cut-outs GP1 and GP3 by throttling valves AV15 and BV2 respectively (see Fig. 7) until the cut-outs trip.

Note that the unit does not stop until 60 seconds after low-pressure cut-out GP1 is tripped.

- 5.16 Differential pressure cut-out GP6, which indicates that the oil filter is clogged, can only be checked by opening the electric circuit.

Note that the unit does not stop until 30 seconds after the electric circuit is opened.

- 5.17 Check flow switch GF by reducing the chilled medium flow until the switch trips.

Note that the unit does not stop until 30 seconds after the electric circuit is opened.

- 5.18 Check discharge line thermostat GT11 by lowering its limit value until it trips.

Remember to reset the thermostat to +120°C.

- 5.19 The only way to check oil level switch GN1, which indicates a low oil level, is to open the electric circuit.

Note that the unit does not stop until 30 seconds after the electric circuit is opened.

- 5.20 Search again for any leaks using a leak detector suitable for the refrigerant in question before the system goes back into normal operation.

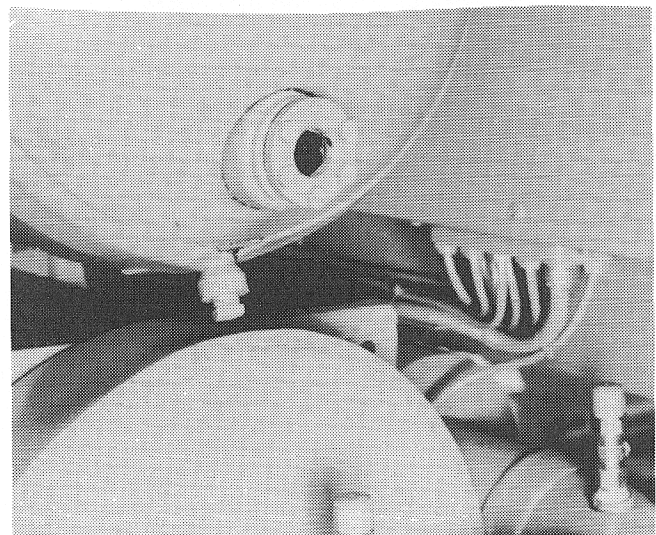


Fig. 27 Sight glass on oil separator.

6. Normal start routine

- 6.1 Turn on the oil heater (if it was not already turned on). Wait until the oil temperature rises so that you can reset the low oil temperature cut-out.
- 6.2 Check to see that all valves are set to their operating positions. See Fig. 7.
- 6.3 Check the level in the oil separator. It must reach at least half way up in the sight glass. See Fig. 27. If necessary, add oil (see Fig. 7) of the same type as that set forth on the unit's dataplate (see Fig. 1).
- 6.4 If the unit has been idle for more than a month, add oil in the filter as set forth in section 2.5.

If oil has been added in the filter a number of times, it may be necessary to drain some of it off. In such case, drain off the oil via valve AV7. See Fig. 7.

- 6.5 Check to see that the compressor capacity control system is set for minimum capacity. See section 5.1.
- 6.6 Start the compressor as set forth in section 3.4. Check the pressure gauges as per section 5.5 and check the oil level as per section 5.12.
- 6.7 Listen for any abnormal sound as set forth in section 5.14.

7. Normal manual stop routine

- 7.1 The compressor can be stopped at any capacity setting. For a brief stop, turn off the ON/OFF switch. Leave all valves at their operating positions (see Fig. 7) if you do not intend to work on the compressor while it is idle.
- 7.2 For long idle periods and also when you wish to work on the unit, turn off the ON/OFF switch and also open the max-level circuit breaker and the control-power miniature circuit breaker.

When the unit is to be run again, close the max-level circuit breaker and reset the control-power miniature circuit breaker (ON position), whereupon power to the oil heater will be turned on.

The unit cannot be started before the oil temperature in the oil separator has risen so that the low oil temperature cut-out can be reset.

If the unit is exposed to vibrations emanating from the environment (from another compressor unit for example), the compressor bearings can be damaged during long idle periods.

To prevent such damage you should start the unit every other week and then stop it again.

- 7.3 While the unit is idle, the pressure in the compressor and in the oil separator drops to the suction pressure via valve AV18. See Fig. 28.

8. Periodic care and maintenance

8.1 Daily

- 8.1.1 Inspect the unit and check to see that there are no abnormal sounds or vibrations.
- 8.1.2 Check that pressure gauges MP1 and MP2 indicate operational values that are within the specified ranges. See section 5.5. Enter the readings in your log.
- 8.1.3 Check that the chilled medium temperature and heated medium temperature match the desired values preset on the control equipment.
- 8.1.4 Check the level in the oil separator. It must lie within the sight glass. If necessary, add oil as instructed in section 5.12.
- 8.1.5 If the oil in the oil separator has an abnormal appearance or if there is some other reason to suspect that its quality has deteriorated significantly, we recommend that you take an oil sample via valve AV7 for analysis. See Fig. 7.
- 8.1.6 Take the sample during operation. Throw out the first decilitre that you drain off. Then drain the sample into a bottle.

Note: Permit the sample bottle to remain open for a few hours after taking the sample so that the refrigerant in the oil can evaporate. Otherwise there is risk that the bottle may burst.

- 8.1.7 Preferably, you should permit the sample to stand for a week in the sealed bottle before carrying out the simplified analysis described below, or send the sample (after the refrigerant has evaporated) to the STAL Experiment Department for more detailed analysis.

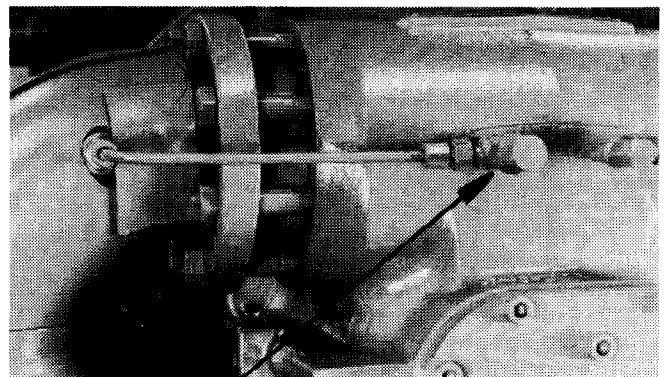


Fig. 28 Valve AV18

STAL-MINI screw compressor

8.1.8 To conduct a simplified analysis, check the oil's colour, odour and viscosity (by comparing it with fresh oil). In addition, the oil's acid number must be checked.

- o Colour. Oil becomes darker with use, but it must not become cloudy or too dark.
- o Odour. At elevated temperatures, oils — particularly mineral oils — disintegrate and acids form. The oil from the compressor must not have an acid odour. Compare with fresh oil.
- o Viscosity. The viscosity of the oil may drop somewhat with use. Permit a small amount of oil to run out through a capillary tube having an approximately 1 mm bore. Measure the time required and then make a corresponding test with fresh oil. The time required by the used oil must not be shorter than 85% of the time required by the fresh oil.
- o Acid number. The acid number expresses the amount of KOH needed to neutralize the acids in one gram of oil. The acid number must be lower than 0.06 mg KOH/g of oil to ensure good lubrication and reliable operation.

Wholesalers of refrigerating equipment can provide you with a test kit suitable for determining the acid number in Freon plants. The result of this test consists of a colour indication. Conduct the test using one of these kits, or assign the task to the closest chemical laboratory. Alternatively, the STAL Experiment Department can carry out a more precise determination.

8.1.9 Change, via valve AV7 (see Fig. 7), the oil in the oil separator and oil cooler if any result of the above analysis indicates that it should be changed.

Note: Turn off the control power before changing the oil.

8.2 Within the first 50-100 hours of operation

8.2.1 Close valve AV15 (see Fig. 7) which is located downstream from the compressor. Run the compressor to lower the pressure in the part of the system downstream from the condenser to a value that is just above atmospheric pressure. Wait five minutes and then repeat this procedure a second time.

If the compressor is being run at partial load, low-pressure cut-out GP1 may have to be provided with a jumper (between terminals 101-102 in the monitoring switch enclosure, Fig. 13).
 Close valve BV2.

Filter No.	Part	Spare part No.	Remarks
SIL 1	Suction filter	1901 450-A	Clean
	Sealing ring	3921 5211 810	Replace
SIL 3	Oil filter	1902 208-A	Replace
	O-ring	3921 5282 422	Replace
	Gasket	1902 209-1	Replace
SIL 4	Filter insert	3963 1119 138	Clean
	Cover gasket	3963 1119 608	Replace
SIL 7	Filter insert	3963 1119 139	Clean
	Cover gasket	3963 1119 622	Replace
FT	Desiccator element incl gaskets	3952 8018 901	Replace

Table 3. Cleaning and replacement of filters and gaskets

8.2.2 Clean, as set forth below, all filters and suction strainers in the unit (see Fig. 7 and Table 3) and also in the rest of the system. Filter SIL3 must be replaced.

Proceed as follows:

- a. Stop the compressor and open the max-level circuit breaker and the miniature circuit breaker in the control power system.
- b. Connect service valve AV8 (see Fig. 7) via a service compressor to a refrigerant cylinder. Open the valve and transfer all remaining refrigerant to the cylinder.
- c. Replace the insert in SIL 3. See Fig. 29. Also replace the O-ring beneath the filter flange in SIL 3 and the cover gasket.
- d. Remove the cover so that SIL 1 can be cleaned. See Fig. 30. Pull out the filter carefully, seeing to it that none of the contaminants come loose and fall into the compressor. Wash the filter insert in POLYCLEANS or an equivalent degreasant and flush it clean with hot water. Blow the filter clean and completely dry with air. Hold it up against a bright light and check that the filter meshes are clean. If not, repeat the above procedure. Mount the filter again. Note that the tapered sleeve must be turned inward. See Fig. 30. Fit the cover using a new sealing ring.

- e. Remove the cover so that SIL 7 can be cleaned (and also SIL 4 if it is included in your unit). See Fig. 31. Clean as set forth above for SIL 1 and mount again using a new gasket.

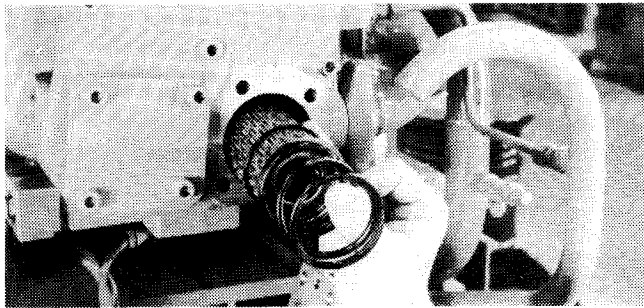
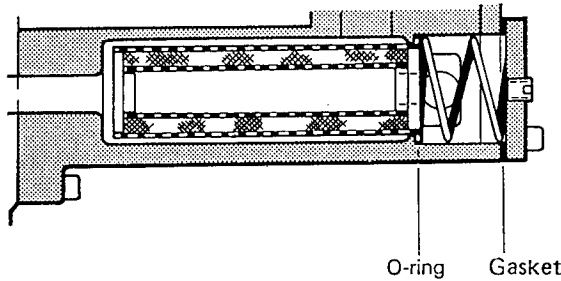


Fig. 29 Filter SIL 3

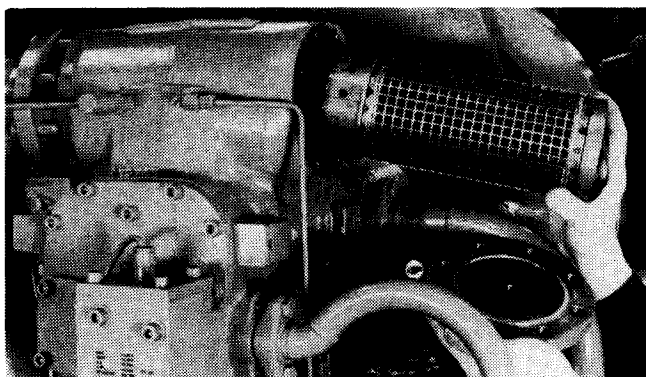
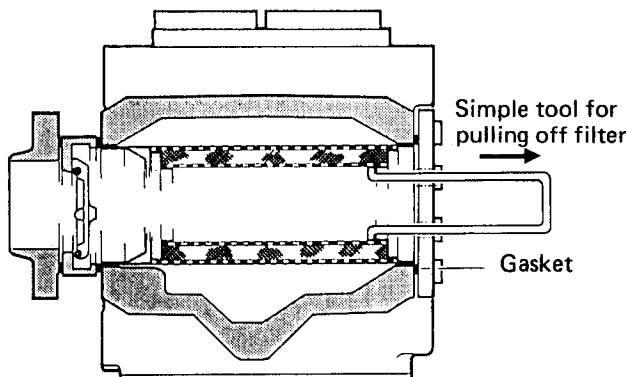


Fig. 30 Filter SIL 1

- f. Open drier filter FT. See Fig. 32. Replace the inserts. Also replace the filter gaskets between the inserts and in the bottom. The flange gasket must also be replaced.
- g. Do not leave the system open any longer than absolutely necessary when replacing filters.
- h. Evacuate the opened parts of the unit using a vacuum pump. This should be done at a temperature no higher than +10°C. You should preferably connect the vacuum pump to both the high-pressure and low-pressure sides, i. e. to valves AV8 and AV17 in Fig. 7. For a 2.5 m³/h pump, you should use at least 1/4" lines. For a 6 m³/h pump use at least 3/8" lines, and for a 12 m³/h pump use at least 1/2" lines. This will ensure full utilization of pump capacity.

See to it that valve AV18 (see Fig. 28) is open. Valves that interface with the environment such as drainage and filling valves must be closed of course.

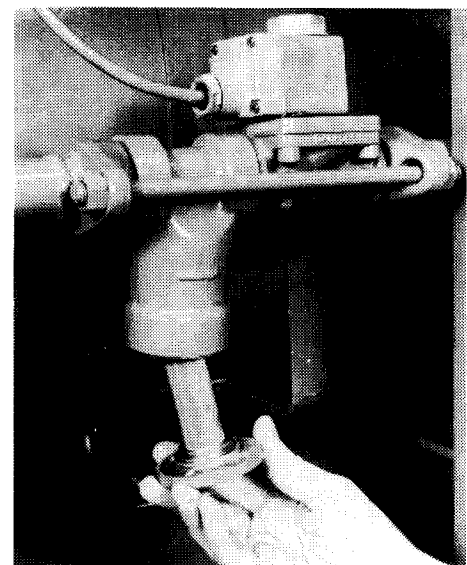
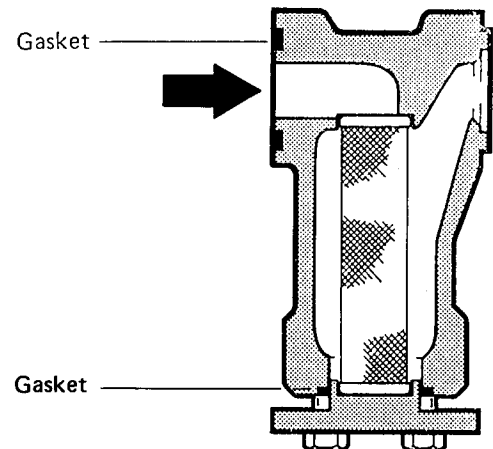


Fig. 31 Filter SIL 7 (SIL 4 is optional)

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First check with a vacuum meter on the suction side of the pump to see that the final pressure is under 133 Pa absolute (1 mm Hg).

Evacuate the unit to maximum pressure of 133 Pa absolute (1 mm Hg).

Check to see that it is dry by closing the line between the vacuum pump and the unit. After five minutes, the pressure in the unit must not have risen to more than 266 Pa absolute (2 mm Hg). If it rises above this pressure, repeat the procedure and keep repeating it until the pressure remains beneath 266 Pa absolute.

If you encounter difficulty in bringing down the pressure, it is either because water has collected somewhere in the unit or because there is a leak somewhere in the system.

- i. Open valves BV2 and AV15. Also open the other valves in the system that were closed.

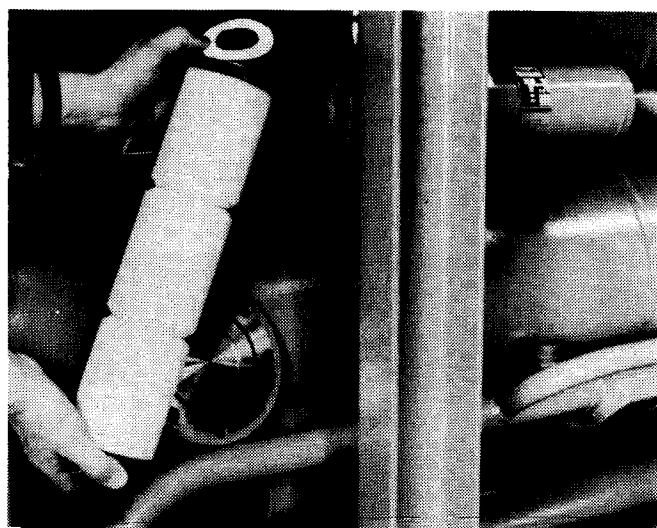
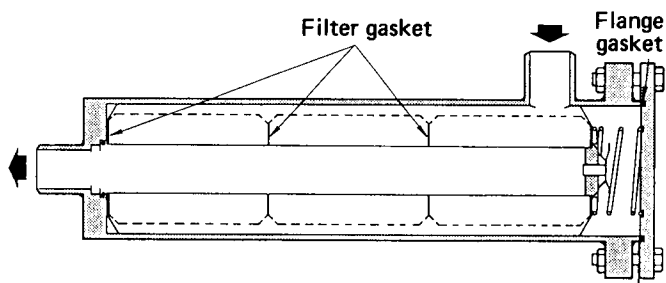


Fig. 32 Drier filter FT

- 8.2.3 Lubricate the motor bearings. This must be done while the unit is running. Make certain that the lube nipples (see Fig. 33) are clean. Add fresh grease using a clean grease gun.

- 8.2.4 Retighten the threaded joints on the compressor and the unit. Certain threaded joints may be located beneath the insulation. If, however, the check conducted using a leak-detector torch at normal refrigerant pressure did not reveal any tendency towards leakage, you do not have to remove the insulation to retighten the joints (applies to the ends of the evaporator and the flanged joint between the evaporator and heat exchanger).

- 8.2.5 Retighten all accessible cable connections (devote special care to the heavy cables). To do this properly, you must be familiar with the electric power systems.

Note that external control power may be present in the equipment. In such case, it must also be turned off.

- 8.2.6 Close the max-level circuit breaker and the miniature circuit breaker in the control power circuit.

- 8.2.7 Search through the unit for leaks.

8.3 After first 500 hours of operation

- 8.3.1 Search through the unit for leaks.

8.4 After every 2500 hours of operation

Note that the motor may require earlier lubrication. See the motor nameplate.

- 8.4.1 Replace filter SIL 3 and clean filters SIL 1, SIL 4 and SIL 7 as set forth in section 8.2.1 and part i. of section 8.2.2.

- 8.4.2 Lubricate the motor bearings if the motor frame number is higher than IEC 225 M. This must be done while the unit is running. See to it that the lube nipples (see Fig. 33) are clean. Add fresh grease using a clean grease gun.

A specified amount of grease must always be pressed into each bearing. See Table 4 and also the motor data plate. While the unit is running, pump in grease on 3-4 separate occasions with 2-3 minute pauses between them.

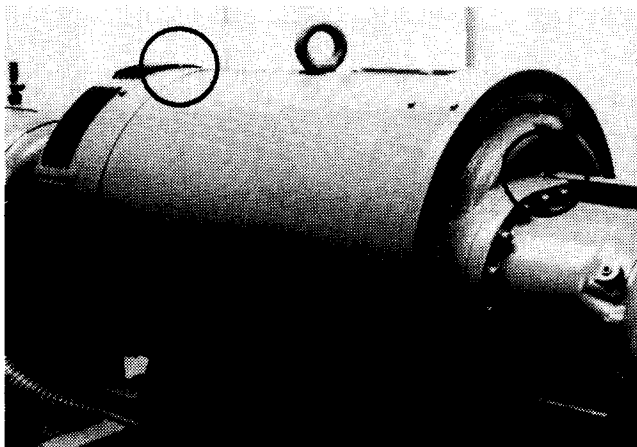


Fig. 33 Lube nipples for motor bearings

Use only one of the EP greases listed below

Supplier	Designation
SKF	SKF Grease LGEP2
BP	BP Grease XRB2-EP
Castrol	Spheerol APS2
Chevron	Dura-lith Grease EP2
A. Christiernsson	Alexol HMP 1 EP Alexol HMP 2 EP
Esso	Beacon EP1 Beacon EP2
Fina	Marson HFF 2 EP
Gulf	Synthetic Grease Gulflex MP
Mobiloil	Mobilux EP2
Nynäs Petroleum	L 62 EP
OK	Oktosol Grease EP2
Shell	Shell Alvania EP2
Texaco	Multifak EP2 Novatex Grease EP2

Alternatively, you can use one of the following greases to which MOS₂ has been added. They have been processed in the same way as EP greases, although no information is presently available about the effects of MOS₂ on service life:

Supplier	Designation
A. Christiernsson	Alexol HMO 1 EP Alexol HMO 2 EP
Gleitmolybdän	Gleitmo 500
Klüber Lubr.	Klüber Unimoly GL 82
Mobil Oil	Mobilplex Special
Molub-Alloy	Molub-Alloy 848 Molub-Alloy 807
Nynäs Petroleum	L 62M
Shell	Shell Retinax AM
Texaco	Texaco Molytex EP 2

- 8.4.3 Search through the unit for leaks.
- 8.4.4 Start the unit again for normal operation.

8.5 After every 5000 hours of operation

Note that in heat pump systems you must take an oil sample and analyze it as set forth in sections 8.1.5 – 8.1.8. Make sure that the results are satisfactory before proceeding with service.

- 8.5.1 Replace drier filter FT as set forth in part f of section 8.2.2.
- 8.5.2 Replace the oil in the oil separator and oil cooler in units used in heat pump systems if the analysis results indicate that this should be done.
- 8.5.3 Lubricate the motor bearings (all sizes). See Fig. 33 and Table 4.

Frame number IEC	Number of poles	Amount of grease Grams
160	2	10
180	2	12
200	2	15
225	2	15
250	2	15
280	2	20
315	2	35

Table 4. Amounts of grease for electric motor bearings

- 8.5.4 Retighten the threaded joints on the compressor and on the unit
- 8.6 After every 20 000 hours of operation**
 - 8.6.1 Change the oil in the oil separator and the oil cooler.
 - 8.6.2 Repack the bearings with grease in motors having frame numbers lower than IEC 250.
- 8.7 After every 40 000 hours of operation**
 - 8.7.1 Replace the bearings in motors having frame numbers higher than IEC 225 M.
 - 8.7.2 Disassemble the compressor for a complete overhaul. See manual sheet 4815-N-10 or contact your closest representative.

9. Fault tracing after operational disturbances

Cause	Remedy	Cause	Remedy
9.1 Compressor motor does not start		9.2 Compressor motor starts, but stops after 30 seconds	
a. Max-level circuit breaker is tripped	Reset circuit breaker	a. Oil level too low	See section 9.11 below
b. Miniature circuit breaker in control power circuit is tripped	Reset miniature circuit breaker	b. Oil filter SIL 3 clogged	Replace oil filter
c. ON/OFF switch is off	Turn ON/OFF switch on	9.3 Compressor motor starts, but stops after 60 seconds	
d. No start signal received from regulating equipment	Wait for cooling or heating request. Reset regulating equipment if compressor still does not start	a. Suction pressure too low	See section 9.12 below
e. Time-delay that prevents too frequent starting	Wait until time-delay has expired	9.4 High motor current	
f. Interlocking circuit is open	Check all connected functions	a. Operating outside specified ranges	Adjust to provide correct operation
g. Motor fuses are tripped or blown	Reset or replace fuses	b. Motor fault	Check electric circuits. Dismount and repair motor, if necessary
h. Fuses in control power circuit are tripped or blown	Reset or replace fuses	9.5. High motor temperature	
i. Fuses in power supply unit are blown	Replace fuses	a. Cooling air supply is blocked so that cooling becomes insufficient	Check cooling air supply and remove any obstruction
j. Fault in control power circuit	Check and remedy the fault	b. Compressor operates outside specified ranges, see Figs. 20 and 21	Adjust to provide correct operation
k. Fault in regulating system	Check and remedy the fault	c. One phase is not being supplied to motor	Check and remedy
l. One or more monitoring switches are tripped	Check the settings. Reset or check and remedy the fault	9.6 Compressor capacity too low or high	
1. Low oil temperature GT15		a. Regulating equipment is malfunctioning because:	
2. Low suction pressure GP1		1. A solenoid valve is clogged or faulty	Clean solenoid valve or replace it
3. High condensing pressure GP3		2. Regulating equipment is faulty	Check and repair regulating equipment
4. High pressure drop across oil filters GP6		3. Capacity control piston in compressor has jammed	Dismount and remedy – see instructions in manual sheet 4815-N-10.
5. Low level in oil separator GN		9.7. Compressor makes abnormal sound	
6. High discharge line temperature GT11		a. Damaged bearing	Stop the compressor immediately and call a service technician to investigate. See also the instructions in manual sheet 4815-N-10
7. High motor current		b. Binding	
8. High motor temperature		c. Liquid in compressor suction line	
9. Low chilled medium flow rate GF			

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Cause	Remedy	Cause	Remedy
9.8 High discharge line temperature			
a. Insufficient oil cooling	Check liquid injection equipment or check valve SV7 on VRP units (extra oil injection. Check the oil filter	h. Chilled medium flow rate too low	Check pump, strainers and valves
b. Refrigerant level too low	Check for leaks and add refrigerant	i. Low-pressure cut-out GP1 is set too high	Reset cut-out
c. Excessive suction gas superheating	Readjust expansion valve	9.13 High condenser pressure. High-pressure cut-out GP3 stops compressor	
9.9 Low oil temperature		a. Insufficient condenser cooling	Increase cooling
a. Faulty oil heater	Replace oil heater	b. Cooling water filter clogged	Clean filter
b. Oil heater thermostat GT15 set incorrectly or is faulty	Reset thermostat or replace it	c. Refrigerant level too high	Drain off refrigerant
9.10 High pressure drop across oil filters		d. Air or non-condensable gases in system	Bleed off gases
a. Oil filter SIL3 in compressor is clogged	Replace filter	e. High-pressure cut-out GP3 set to trip at too low a pressure	Reset high-pressure cut-out
9.11 Low level in oil separator		f. Condenser surfaces are coated	Clean condenser tubes
a. Oil heater is faulty	Repair or replace oil heater	9.14 High suction gas temperature	
b. Oil heater thermostat GT15 is set incorrectly or faulty	Reset thermostat or replace it	a. Compressor capacity too low	Reset control equipment
c. Discharge line temperature too low, with liquid carryover	Adjust expansion valve	b. Expansion valve temperature sensor is at wrong location or poorly clamped	Relocate or reclamp sensor
d. Ambient temperature too low	Insulate oil separator	c. Refrigerant level too low	Add refrigerant and check for leaks
9.12 Low suction pressure. Low-pressure cut-out GP1 stops compressor		9.15 Low suction gas temperature	
a. Compressor capacity too high	Change desired value for capacity control system	a. Liquid in suction line	Reset expansion valve
b. Filter in liquid line clogged	Replace filter	b. Expansion valve set incorrectly or faulty	Reset or replace expansion valve
c. Excessive suction gas superheating	Change expansion valve setting	c. Liquid injection equipment (if used) is incorrectly adjusted or faulty	Adjust or replace equipment
d. Expansion valve is set incorrectly or is faulty	Change setting or replace valve	9.16 Low discharge line temperature	
e. Faulty solenoid valve in liquid line	Replace coil and clean valve	a. Liquid injection equipment or extra oil injection equipment (for VRP) set incorrectly	Reset or replace equipment
f. Refrigerant level too low	Add refrigerant and check for leaks	b. Liquid in suction line	Reset expansion valve
g. Chilled medium side of evaporator is dirty	Clean evaporator	c. Liquid in economizer line	Reset economizer expansion valve

3. COMPRESSOR

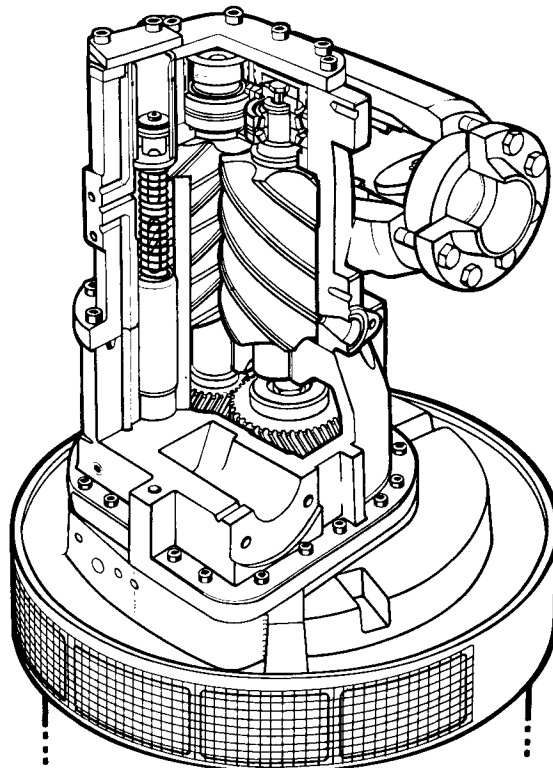
4815-C-6E	Screw compressor type R5
4815-C-11E	Screw compressor type R5
4815-E-111E	Working range for screw compressor type R5
4815-E-116E	Working range for screw compressor type R5
4815-N-45E	Rotor bearings in screw compressor type R5
4815-N-20E	Capacity control
4815-R-9E	Screw compressor type R5

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TYPE R5 SCREW COMPRESSORS
Generations E and F



Generations E and F of the type R5 STAL-MINI screw compressors represent a new step forward in the evolution of the R5 compressor towards a broader operating range, improved reliability and further simplification/standardization.

BUILT-ON MOTOR

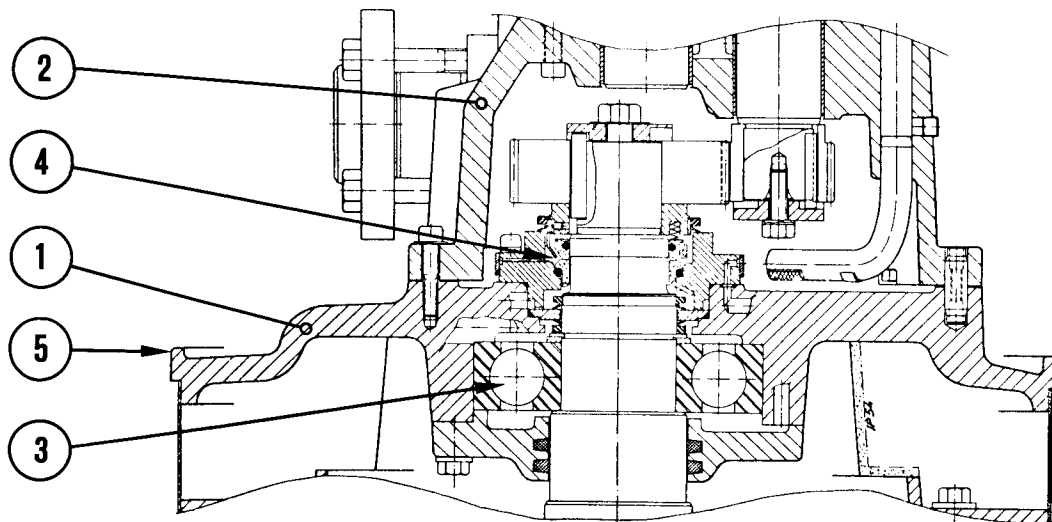
All compressors in these new generations have built-on motors. Each of the new built-on motors has a flange (1) designed especially for direct connection to the rotor unit (2). This flange supports the bearings (3) and the shaft seal (4) as well as the grease and oil seals. Moreover, each built-on motor contains the requisite lubrication and oil ducts, and serves as a part of the bearing housing. The outer edge (5) of the flange is turned up so that, for vertical mounting, it will collect any oil, grease and/or condensed water that gathers there.

DIFFERENT MOTORS, SAME PARTS

Just as before, different variants of the motor are available. However, the motor shaft, the shaft seal, the motor bearing and the flange interface with the compressor are identical on all variants of the motor.

HIGHER APPLIED POWER, BROADER OPERATING RANGE

Thanks to the new motor design, more power can be applied than for the previous motors. See the technical data on manual sheet 4815-C-11. This, in turn, provides a broader operating range.

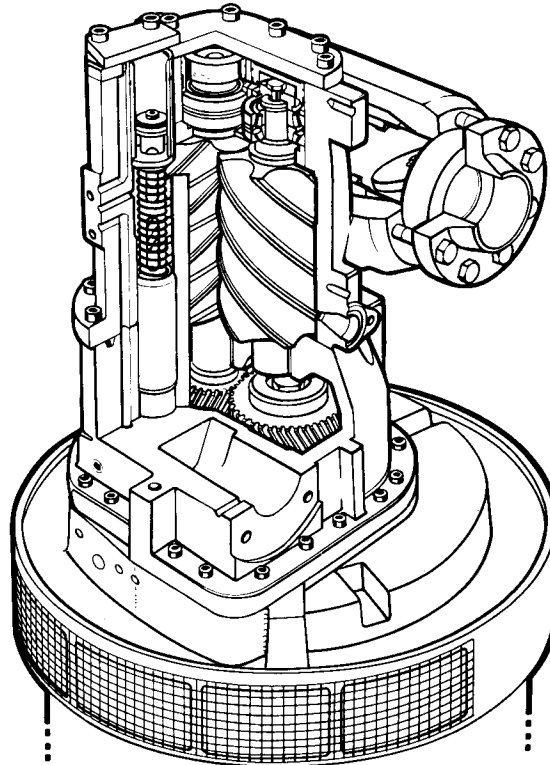


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Type R5 SCREW COMPRESSORS Technical data Generation E and later generations



		R51	R53	R55	R57	R59
50 Hz	Swept volume, m ³ /h	—	245	288	345	412
	Permissible maximum applied power, kW	—	92	108	130	130
60Hz	Swept volume, m ³ /h	245	288	345	412	—
	Permissible maximum applied power, kW	92	108	130	130	—

Motor rotation direction:	Clockwise viewed facing the shaft end (arrow on bearing housing)
Max permissible inlet pressure:	10 bar absolute
Max permissible discharge pressure:	26 bar absolute
Min pressure ratio at $V_i = 2.5$	1.8
Min pressure ratio at $V_i = 4.0$	3.0

See appropriate manual sheet 4815-E-xxx for information about the permissible operating range for your compressor and refrigerant.

NOTE: The applied power figures tabulated above are for the following built-on motors: 3931 3224, 3931 3229, 3931 3234, 3931 3239

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**WORKING RANGE FOR SCREW COMPRESSOR Type R5
Generation E, F**

Refrigerant: R12

The working range of compressor type R5 is limited by:

- o Max permissible torque applied to drive shaft.
- o Max permissible discharge pressure.
- o Max permissible suction pressure.
- o Min permissible pressure ratio.
- o Recommended min rated bearing life.
- o Min permissible oil viscosity (> 7 cSt)

Service life is maximized and life cycle cost is minimized under operating conditions within the specified working range (if the compressor is installed correctly in other respects).

Always consult the STAL Refrigeration before using a compressor under operating conditions outside the specified working range.

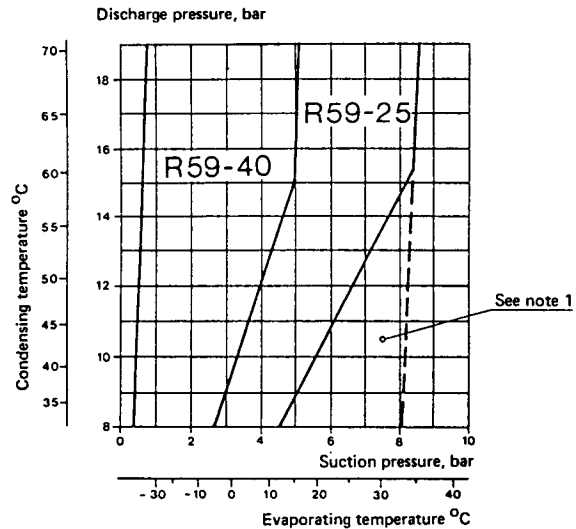
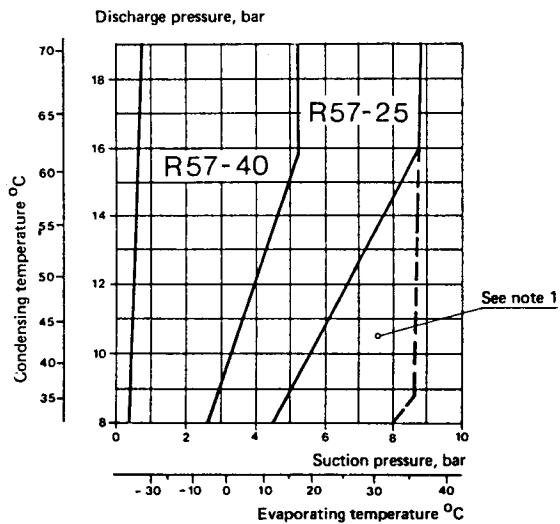
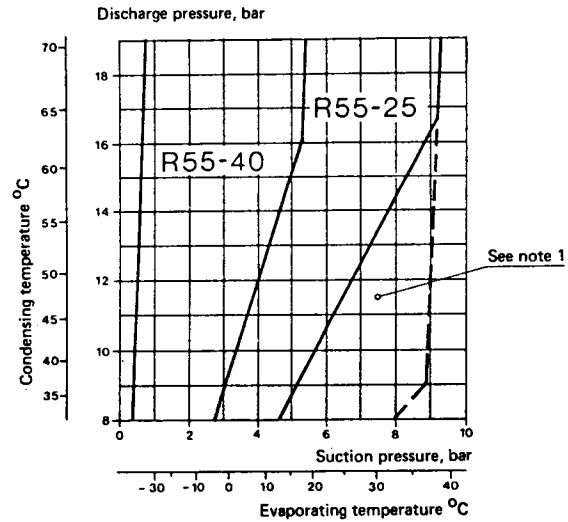
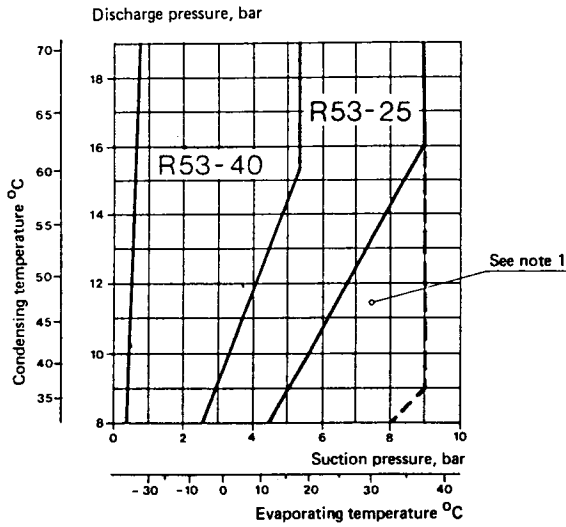
The following diagrams are for a mains frequency of 50 Hz.

For 60 Hz :

Read the R53 diagram for the R51 compressor
Read the R55 diagram for the R53 compressor
Read the R57 diagram for the R55 compressor
Read the R59 diagram for the R57 compressor.

IMPORTANT! The R59 compressor must not be operated on 60 Hz.

Working range for compressor
 Refrigerant: R12



Note 1 Operation with lower pressure ratio than 1.8 and 3.0 resp. for compressor R5X-25 and R5X-40 resp. during more than 30 sec. is not permitted. In cases when this cannot be avoided use a differential pressure controller according to special manual sheet.

WORKING RANGE FOR SCREW COMPRESSOR Type R5 As from generation E

Refrigerant: R22

The working range of compressor type R5 is limited by:

- o Max permissible torque applied to drive shaft.
- o Max permissible discharge pressure.
- o Max permissible suction pressure.
- o Min permissible pressure ratio.
- o Recommended min rated bearing life.
- o Min permissible oil viscosity (> 7 cSt)

Service life is maximized and life cycle cost is minimized under operating conditions within the specified working range (if the compressor is installed correctly in other respects).

Note that the use of an economizer increases both capacity and power consumption but reduces specific power consumption.

Always consult the STAL Refrigeration before using a compressor under operating conditions outside the specified working range.

The following diagrams are for a mains frequency of 50 Hz.

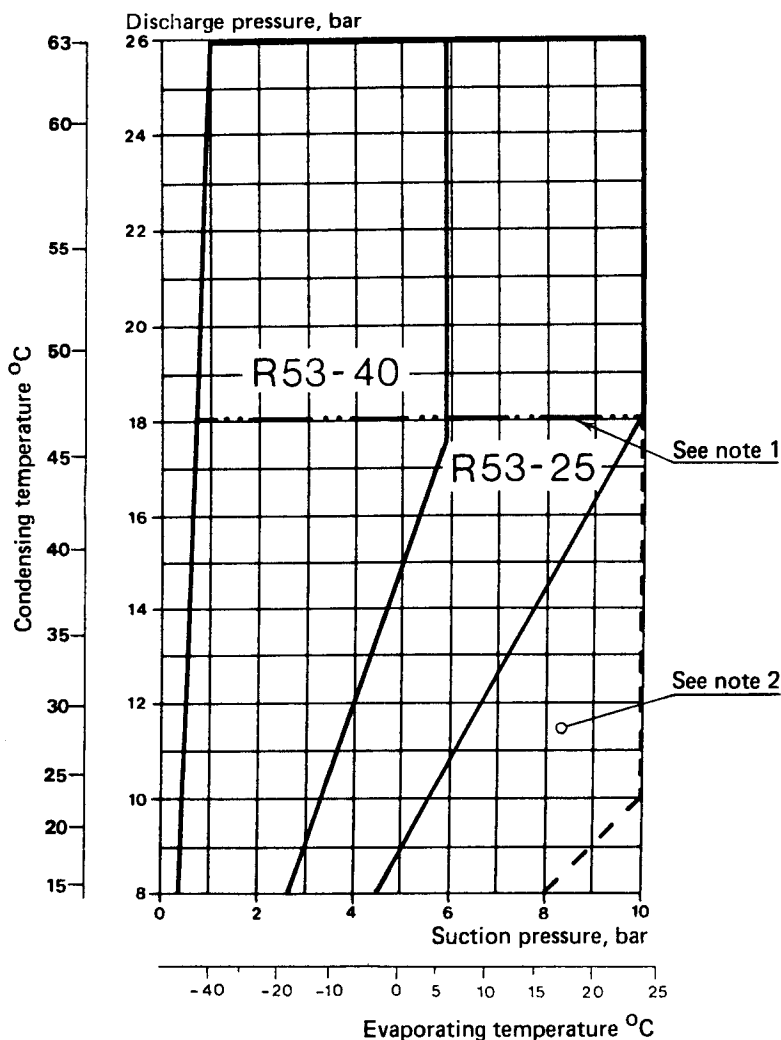
For 60 Hz :

- Read the R53 diagram for the R51 compressor
- Read the R55 diagram for the R53 compressor
- Read the R57 diagram for the R55 compressor
- Read the R59 diagram for the R57 compressor.

IMPORTANT! The R59 compressor must not be operated on 60 Hz.

Working range for compressor

Refrigerant: R22



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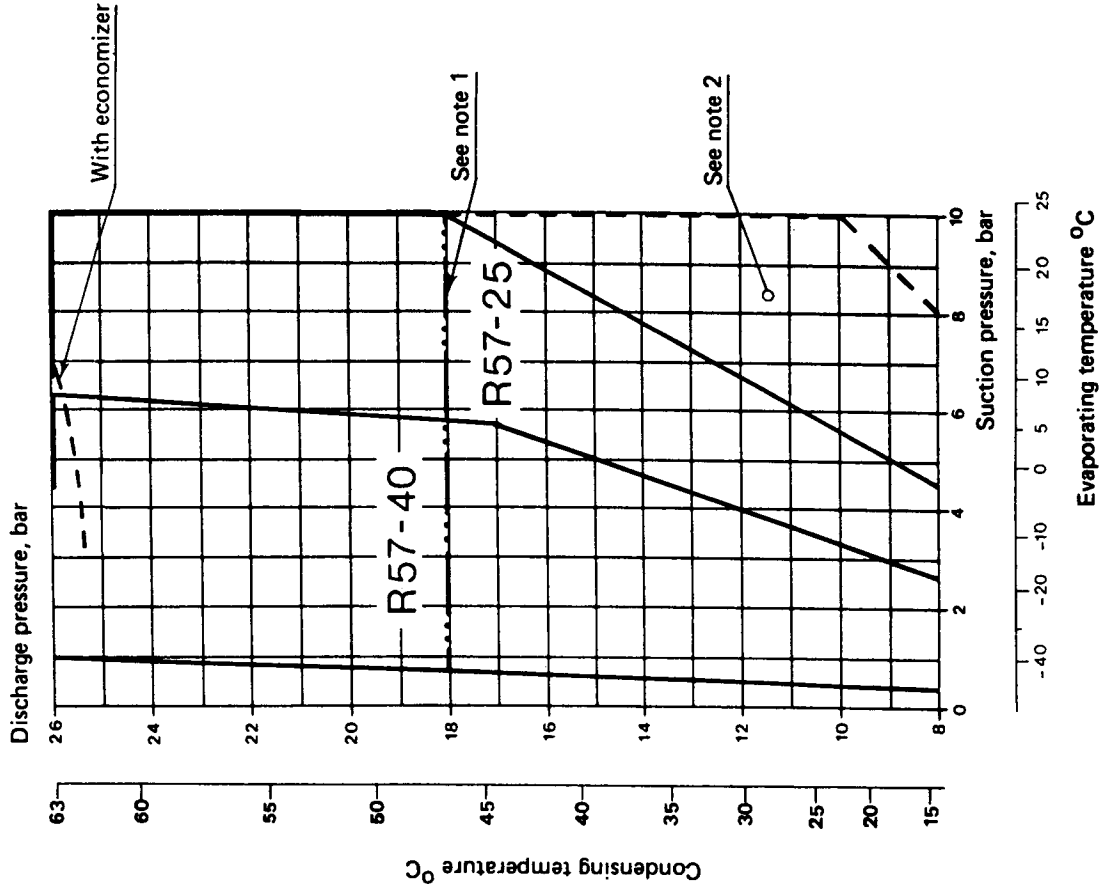
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STAL-MINI screw compressor

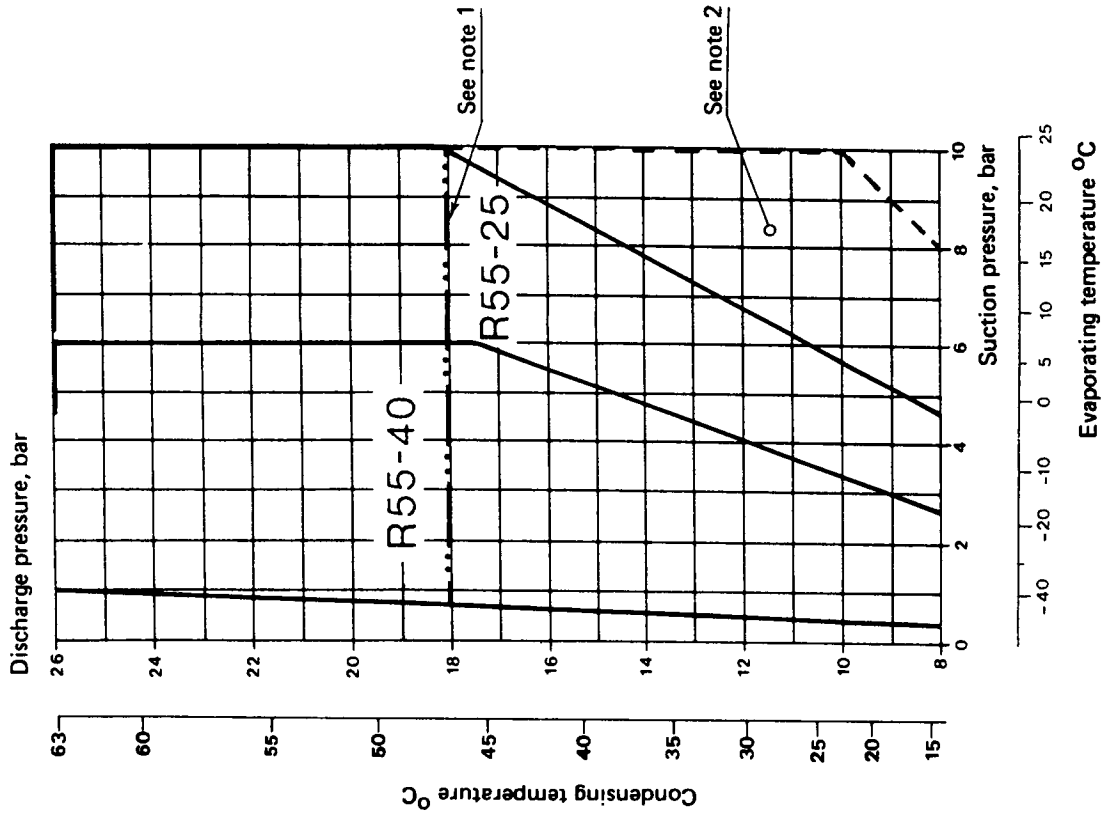
Working range for compressor

Refrigerant: R22



Working range for compressor

Refrigerant: R22



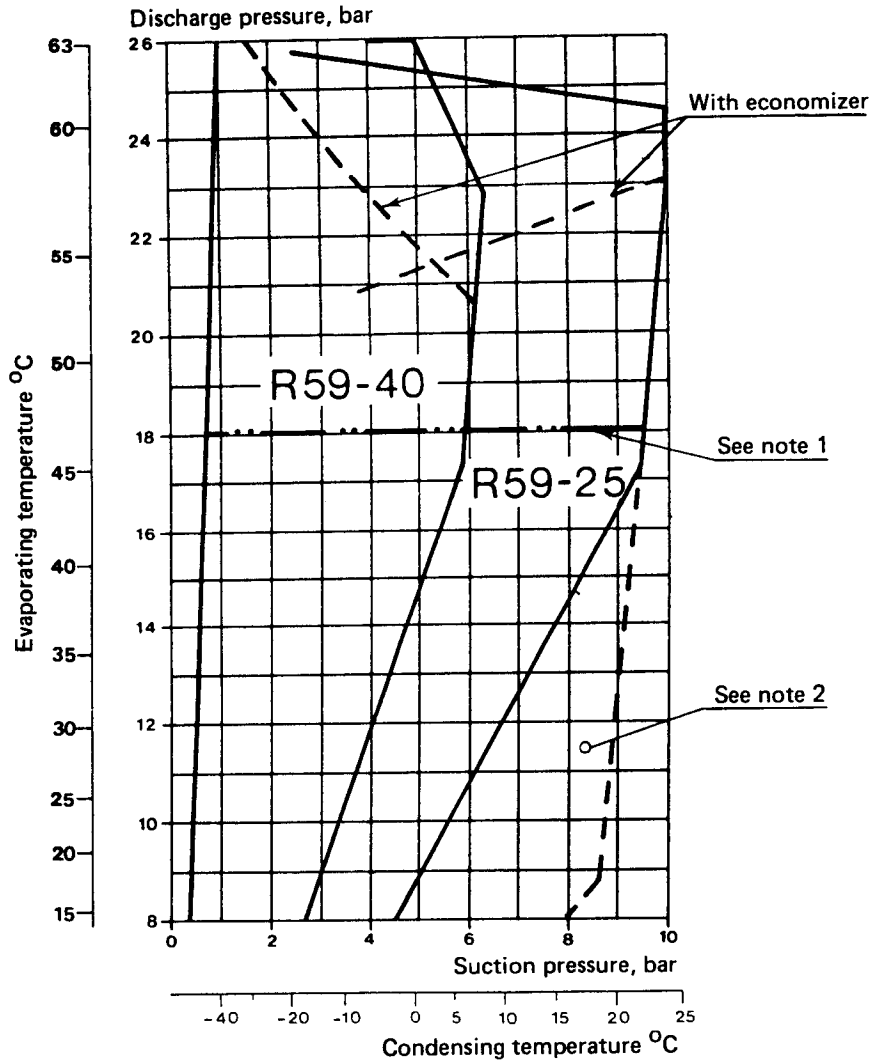
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Working range for compressor

Refrigerant: R22



Note 1 Limit for operation with R22 and Mobil Arctic Oil 300 under the following conditions:

- o Oil temperature in oil separator
condensing temperature $\geq t_1 + 30^{\circ}\text{C}$
- o Oil temperature to compressor $\leq +45^{\circ}\text{C}$

Note 2 Operation with lower pressure ratio than 1.8 and 3.0 resp. for compressor R5X-25 and R5X-40 resp. during more than 30 sec. is not permitted. In cases when this cannot be avoided use a differential pressure controller according to special manual sheet.

ROTOR BEARINGS IN SCREW COMPRESSOR Type R5

Each of the rotors in the R5 compressor is carried in an inlet bearing and outlet bearing.

The inlet bearing is built up of dual taper roller bearings, and it absorbs both radial and thrust forces that act on the rotors.

The outlet bearing (located at the drive end) is a slide bearing, and it absorbs only radial forces.

INLET BEARING

The inlet bearing in R series compressors is a combined thrust and radial bearing. It consists of a package (1) of dual taper roller bearings and spacers arranged in an X configuration.

The parts included in this package such as the bearing rings (2), rollers (3) and spacers (4) are paired so that the internal bearing play after mounting will lie within a range of 0.01 - 0.04 mm. This means that one must never replace or change the positions of the individual parts included in the bearing package (the entire package must be replaced). Moreover, one outer ring and one inner ring are marked on the same sides, and these sides must be mounted facing the associated rotor body. See separate manual sheet.

The bearing inner rings are mounted on the ends of the rotor shafts. Balancing piston (5) holds the bearing inner ring on the male rotor, and cup (6) holds the bearing inner ring on the female rotor. The bearing outer rings are located at the bearing seats in the rotor casing, and they are held in place by sleeves (7) and (8) and also by the disc springs (9) that are located beneath top cover (10).

OUTLET BEARING

The outlet bearings (11, 12) are pure radial bearings, and they are made of white metal fitted to steel. They are designed either as bearing bushings or bearing halves, and they are mounted in a bearing housing. These bearings are provided with amply dimensioned oil pockets and they are positioned by means of lugs (13) and mating recesses in the bearing housing.

The bearing on the male rotor has a larger bearing surface than that on the female rotor due to the fact that, in addition to forces emanating from the gas and the meshing of the rotors, the bearing on the male rotor must absorb forces emanating from the drive gearing.

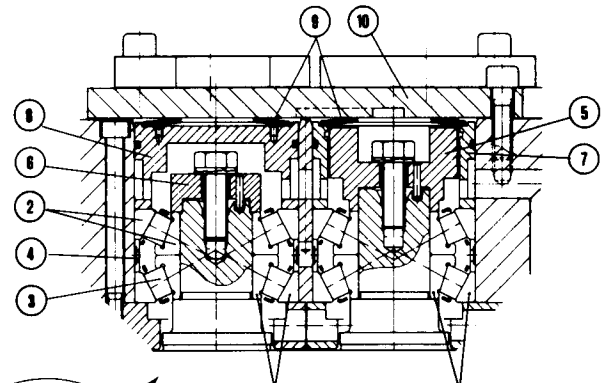
COUNTERBALANCING THE BEARING FORCES

Forces emanating from the gas, the meshing of the rotors and the drive gearing impose radial and thrust loads on the bearings. To ensure maximum bearing service life, the thrust load on the male rotor inlet bearing is reduced by means of a balancing piston (5) and helical gear wheels (14, 15). The thrust forces on the female rotor inlet bearing are (due to the fact that drive is provided by the male rotor) so small that separate counterbalancing is not needed.

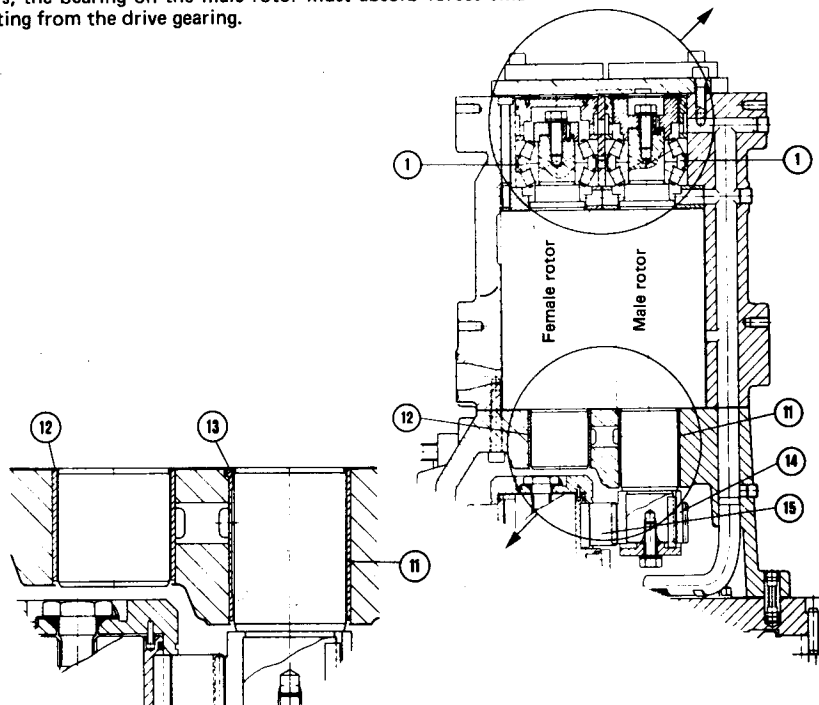
Moreover, the points at which the gears mesh have been arranged to help reduce the radial load on the male rotor inlet bearing.

SPARE PARTS

See the part list in manual 4815-R-10 and the spare part sets in manual sheet 4815-R-12.



Bearing rings with markings on same side



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CAPACITY CONTROL

R5

GENERAL

Screw compressor capacity is controlled by means of a piston located beside the male rotor bore. The bore in which this piston runs in the rotor casing is provided with oblong slits that lead into the compression chamber. These slits are designed to match the male rotor pitch.

When the axially moveable piston is inserted all the way into the rotor casing, it covers all of the slits, and the compressor operates at maximum capacity. When the piston is moved towards the discharge side, the slits are opened one by one so that gas flowing through them will return to the inlet (via a separate passage in the rotor casing) without being compressed.

Capacity control is stepless between 100% and 30%, depending upon the operating conditions.

OPERATION

The capacity control piston moves axially in response to the difference between the compressor oil pressure and suction pressure.

The capacity control piston is permanently joined to an auxiliary piston via a spring guide. The auxiliary piston runs in its own removeable cylinder.

In addition to the aforesaid difference in pressure the capacity control piston is actuated by a spring mounted between a spring stop and the piston itself.

The position of the capacity control piston is determined by two counteracting, regulating oil pressures. One acts on the piston itself to counteract the INCREASE-Capacity command. The other acts on the auxiliary piston to counteract the DECREASE-Capacity command.

When the capacity control piston moves (thus moving the auxiliary piston as well), high-pressure oil enters one of cylindrical spaces (see illustration on next page), while oil is drained from the other cylindrical space to suction pressure.

Oil is supplied and drained via three solenoid valves designated SV15, SV16 and SV17.

A valve plate is mounted on the rotor casing. Passages drilled internally in the rotor casing lead to this valve plate from the oil filter housing (oil pressure), the inlet (suction pressure), the DECREASE cylindrical space and the INCREASE cylindrical space.

CONTROL FUNCTION

The control function sends voltage pulses to the solenoid valves as follows (the control equipment is described in a separate manual sheet):

Increase capacity

Solenoid valves SV16 and SV17 de-energized. Solenoid valve SV15 energized by voltage pulses.

High-pressure oil flows via solenoid valve SV17 to the INCREASE cylindrical space.

Simultaneously, oil is drained from the DECREASE cylindrical space via solenoid valve SV15 to the inlet.

Decrease capacity

Solenoid valve SV15 is de-energized.

Solenoid valves SV16 and SV17 are energized by voltage pulses.

High pressure oil flows via SV17 to the DECREASE cylindrical space. Simultaneously, oil is drained from the INCREASE cylindrical space to the inlet via solenoid valve SV16.

Steady-state capacity

All solenoid valves are de-energized.

The INCREASE cylindrical space is exposed to oil pressure via solenoid valve SV17.

The DECREASE cylindrical space is closed.

Unloaded starting (compressor unit idle)

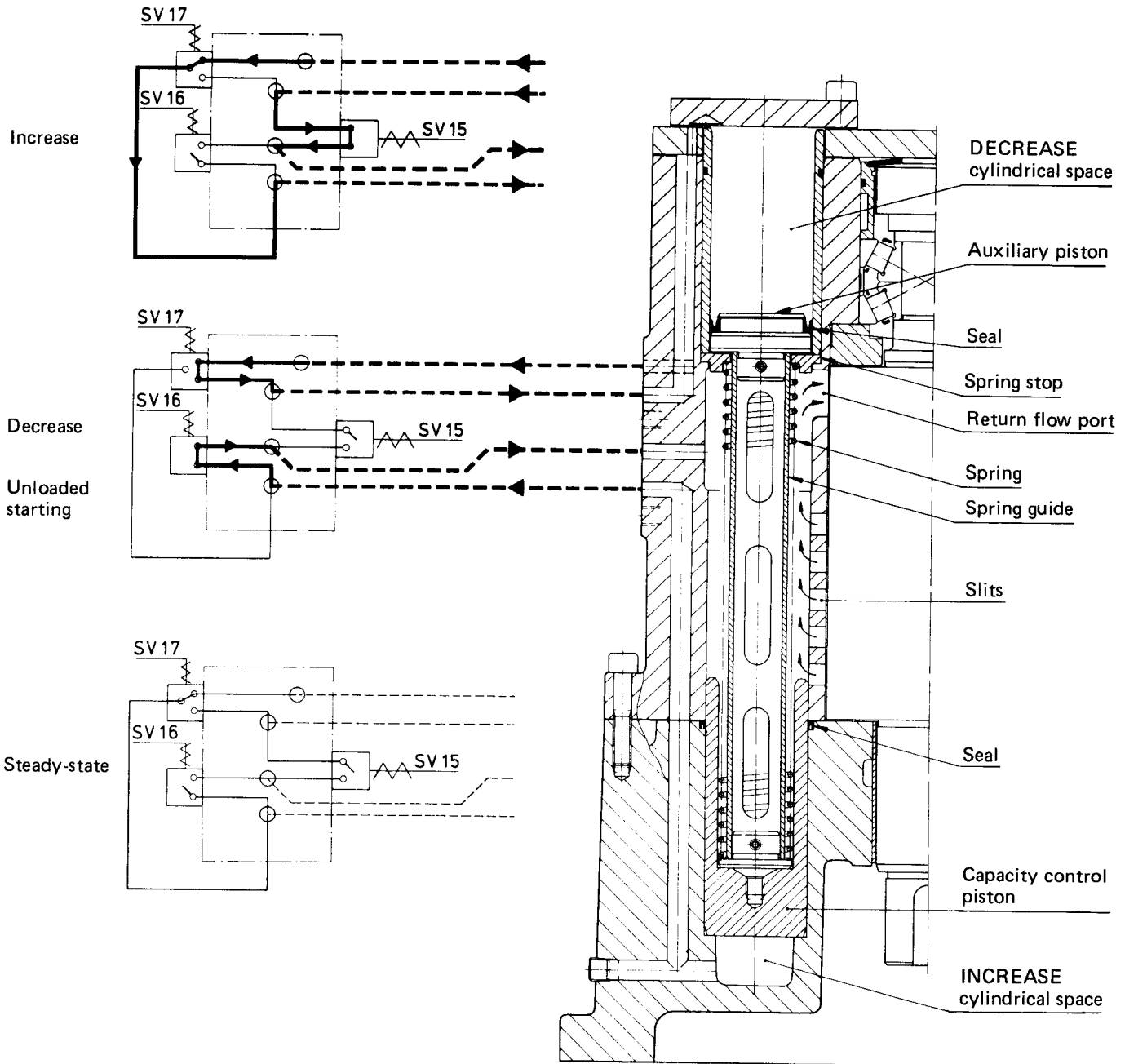
When the compressor unit is idle, there is no difference between the oil pressure and suction pressure. Consequently, it is impossible to move the capacity control piston as described above.

However, when the compressor unit is idle, the spring moves the capacity control piston and auxiliary piston to their minimum capacity position, thus providing unloaded starting. Simultaneously, SV16 and SV17 are energized to drain the INCREASE cylindrical space and fill the DECREASE cylindrical space.

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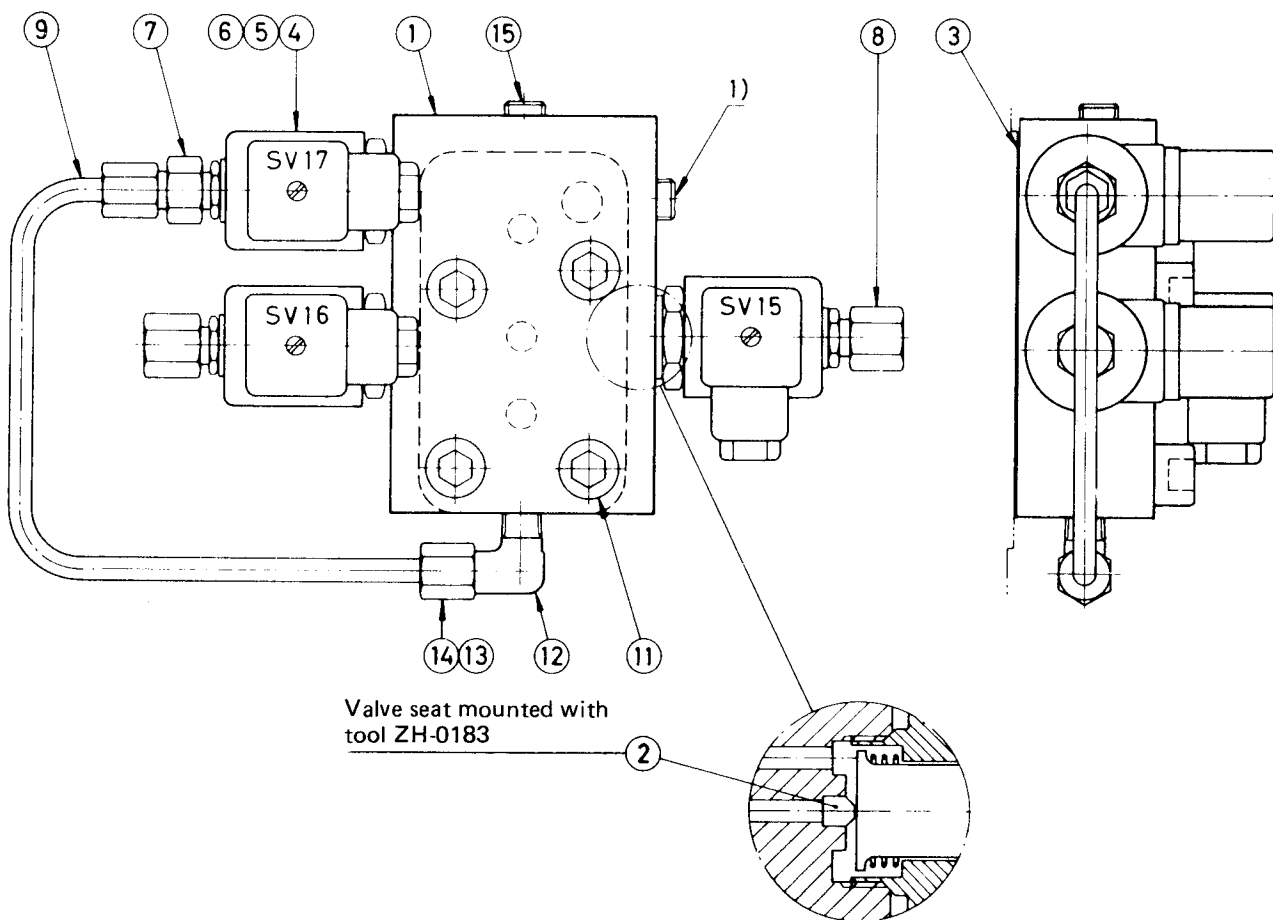
For list of parts, see manual sheet 4815-R-10.

LIST OF PARTS

Item	Voltage – Frequency			Article number	Designation
	220 V 50/60 Hz	110 V 50/60 Hz	24V 50/60 Hz		
1	1	1	1	1903 732-1	Valve plate
2	3	3	3	3963 1151 855	Valve seat
3	1	1	1	1903 737-1	Gasket
4	3			3963 1151 861	Solenoid valve
5		3		3963 1151 862	Solenoid valve
6			3	3963 1151 864	Solenoid valve
7	1	1	1	1894 018-2	Adapter nipple
8	2	2	2	1895 108-2	Blind plug
9	1	1	1	1903 738-1	Pipe
11	4	4	4	3921 2171 501	Screw
12	1	1	1	3951 3050 801	Elbow nipple
13	2	2	2	3951 3092 806	Nut
14	2	2	2	3951 3081 806	Ferrule
15	2	2	2	3951 3156 801	Plug

Spare coils for solenoid valves

Voltage – Frequency	Article number of coil
220 V, 50/60 Hz	3963 1151 911
110 V, 50/60 Hz	3963 1151 912
24 V, 50/60 Hz	3963 1151 914



- 1) Older compressors are provided with an external pipe for oil pressure at 1).
The new arrangement shown here was introduced during 1984

SCREW COMPRESSOR TYPE R5
Generation E and F
List of parts

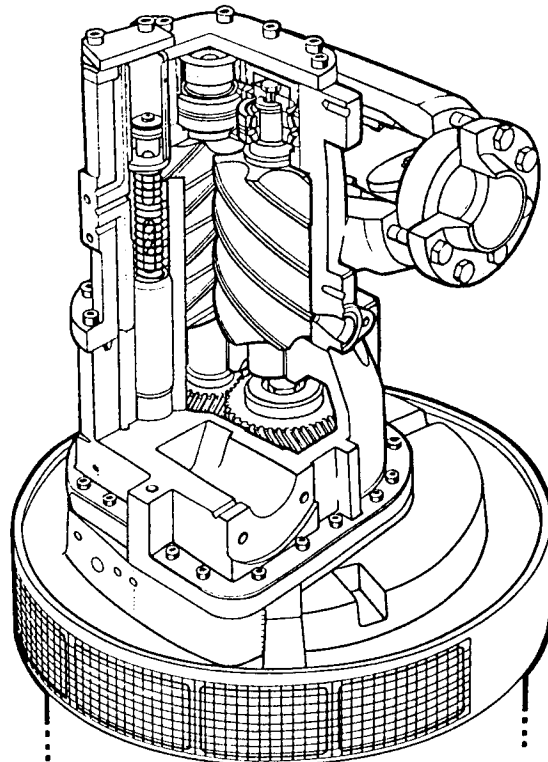



Fig 1 Screw compressor typ R5


The R5 family of screw compressors is based on a rotor unit combined with different gearings in order to obtain the desired swept volume, motor size, etc.

The combinations appear in manual sheet 4815-C-17.

The design principles are such that numerous parts are identical for the different sizes of compressors.

List of parts 1 Includes parts that are identical for compressors R51-R59.

List of parts 2 Includes other parts that are identical for compressors R51-R59 but differ for the classified and unclassified types and also differ for the 2.5 and 4.0 built-in volume ratios. The numbers of these parts are encircled  in figure 2.

List of parts 3 Includes the different gear wheels for compressors R51-R59. The numbers of these parts are enclosed in boxes  in figure 2.

Note: The compressor designation system is explained in manual sheet 4815-C-17.

In a screw compressor, the rotor unit is mounted on a base. The rotor unit consists of a main rotor and a smaller gear rotor. The rotor unit is mounted on a base which is connected to the motor. The rotor unit is mounted on a base which is connected to the motor. The rotor unit is mounted on a base which is connected to the motor.

List of parts 1. Identical parts for compressors

R51, R53, R55
R57, R59

No.	Qty.	Designation	Article number
2	1	Plate	1902 998-1
3	1	Plate	1902 999-1
7	2	Double conic roller bearing	1902 096-1
8	1	Bushing	1903 658-1 1)
9	1	Bushing	1903 659-1 2)
12	2	Disc spring	3921 9512 236
13	1	Cup	1903 076-1
14	1	Sleeve	1902 212-1
15	1	Cover	1903 005-1
16	1	Cover	1902 220-1
17	1	Cover	1903 007-1
18	1	Oil filter	1902 208-A
19	1	Spring	1901 393-1
20	1	Cylinder	1902 996-1
21	1	Sealing ring	3921 5263 255
22	1	Piston	1902 995-1
23	1	Washer	1902 997-1
24	1	Pipe	1903 003-1
25	1	Spring	1903 004-1
26	1	Plug	1902 994-1
27	1	Suction filter	1901 450-A
28	1	Flange	1901 451-1
29	1	Flap valve	1911 650-C
30	1	Welding flange	3951 3318 808
31	1	Piston	1903 002-1
32	1	Intermediate piece	1902 219-1
33	1	Welding flange	3951 3318 806
34	1	Draining pipe	1902 599-A
35	1	Key	1901 815-2
37	1	Washer	1903 079-1
38	4	Dowel pin	1878 645-1
39	1	Ring	1904 461-1
40	1	Ring	1904 791-1
41	1	Nipple	3951 3041 802
42	1	Joint ring	3951 3081 806
43	1	Nut	3951 3091 806
44	1	Injection tube	1904 961-A
45	1	Seat holder	1904 460-1
48	1	V-ring holder	1904 039-3
49	2	V-ring	3922 1633 075
51	1	Washer	1904 469-1
52	1	Washer	1901 449-3
54	1	Gasket	1902 223-1
55	1	Cover gasket	1903 011-1
56	1	Gasket	1902 209-1
57	1	Gasket	1903 009-1
58	1	Gasket set	1903 118-A
59	1	Orifice plug	1899 551-A 3)
60	1	Sealing ring	3921 5262 455
61	6	Compression spring	3921 9227 843

No.	Qty.	Designation	Article number
62	1	Ring	1903 812-3
63	1	Rotating ring	1904 464-1
64	1	Driver	1904 463-1
65	1	Stationary seat	1904 465-1
66	1	Spring housing	1904 462-1
67	1	Hose socket	1904 971-1
68	1	Stop valve	1885 411-D
70	1	O-ring	3921 5282 422
71	2	O-ring	3921 5282 426
72	1	O-ring	3921 5282 420
73	1	O-ring	3921 5282 207
74	1	O-ring	3921 5282 436
75	1	O-ring	3921 5282 435
76	1	O-ring	1904 249-16
77	1	O-ring	1904 249-4
80	3	Sealing ring	3921 5211 810
81	2	Sealing ring	3921 5211 806
85	7	Plug	3951 3156 803
86	7	Plug	3951 3156 802
88	4	Screw	3921 2179 457
89	2	Screw	3921 2174 321
90	3	Screw	3921 2121 538
91	6	Screw	3921 2179 497
92	8	Screw	3921 2179 501
93	8	Screw	3921 2179 471
94	8	Screw	3921 2121 638
95	8	Screw	3921 2121 630
96	21	Screw	3921 2179 501
97	1	Screw	3921 2121 489
98	4	Screw	3921 2121 638
100	1	Screw	3921 2121 630
101	7	Screw	3921 2179 501
102	9	Screw	3921 2179 503
108	8	Lock washer	3921 5415 165
109	2	Spring washer	3921 5401 146
110	6	Lock washer	3921 5415 179
111	24	Washer	3921 5121 173
119	1	Tension pin	3921 1112 205
120	2	Tension pin	3921 1112 252
121	2	Tension pin	3921 1112 345
122	1	Tension pin	3921 1112 206
124	2	Tension pin	4)
130	1	Sign	1870 759-1
131	1	Number sign	1894 123-1
132	1	Patent number sign	1894 263-1
133	8	Screw	3921 2411 169

- 1) Can be superseded by two 1903 656-1
- 2) Can be superseded by two 1903 657-1
- 3) For freons. For NH₃ 1902 739-1 is used
- 4) See manual sheet 4815-N-15

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List of parts 2. Compressor R51, R53, R55, R57, R59
 Unclassified and classified parts for 2.5 and 4.0 built-in volume ratio



No.	Qty.	Designation	Article number			
			R5XC-25Y	R5XC-40Y	R5XD-25Y	R5XD-40Y
1	1	Rotor housing	1902 963-1	1902 963-2	1902 963-3	1902 963-4
4	1	Bearing housing	1902 964-1		1902 964-2	
5	1	Pair of rotors	1903 086-B		1903 086-A	
6						
10	1	Balancing piston	1903 077-1	1903 078-1	1903 077-1	1903 078-1
11	1	Sleeve	1902 210-1	1902 211-1	1902 210-1	1902 211-1

List of parts 3. Gear wheels to compressor R5



No.	Qty.	Designation	Article number				
			R51	R53	R55	R57	R59
36	1	Pinion	1902 235-1	1902 237-3	1902 237-5	1902 237-7	1902 237-9
50	1	Gear wheel	1904 470-1	1904 470-3	1904 470-5	1904 470-7	1904 470-9

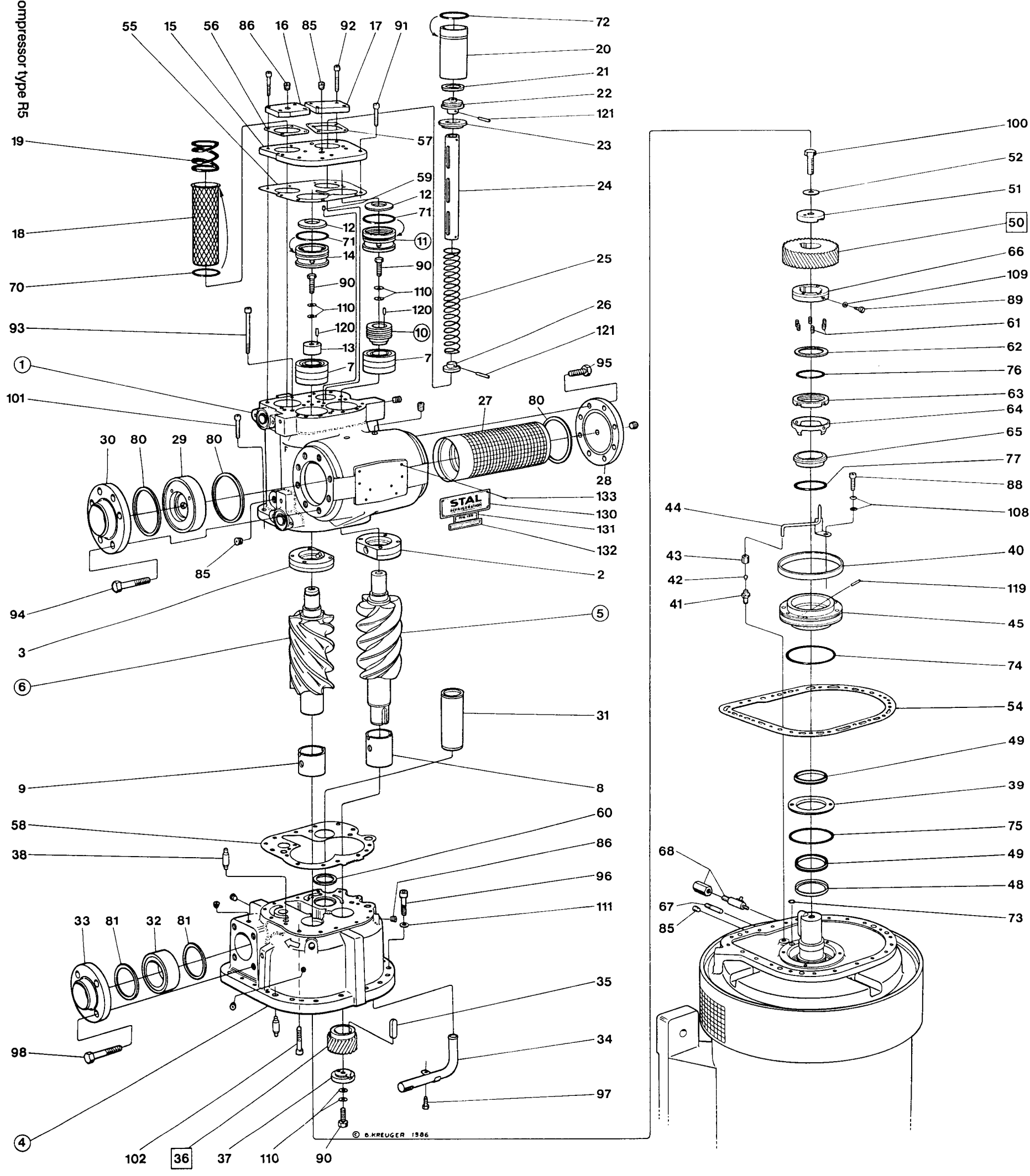
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 REFRIGERATION

Fig 2 Parts Included in screw compressor type R5



STAL-MINI screw compressor

4815-R-9aE
 5/5
 TKK 1989-08

4. COMPRESSOR MOTOR

4815-N-8E

Care and maintenance of 2-pole electric
motors used with type R screw compressors

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CARE AND MAINTENANCE OF 2-POLE ELECTRIC MOTORS USED WITH TYPE R SCREW COMPRESSORS

A. GENERAL

Screw compressors of type R are driven by 2-pole asynchronous motors at 3000 r/min or 3600 r/min synchronously.

For high-speed electric motors having outputs of the magnitude in question here, it is vital that the motor supplier's maintenance instructions be followed closely.

This manual sheet makes no attempt to provide a complete set of maintenance instructions for the electric motor you are using. Instead, it is limited to the following:

- Bearing lubrication for motors with rolling bearings.
- Idle motors that are exposed to external vibrations.
- Y/D starting
- Insulation resistance

B. ELECTRIC MOTORS WITH ROLLING BEARINGS: grease lubrication

For high-speed 2-pole motors, it is vital that the bearings be lubricated in the right way and with a suitable type of grease

Only EP greases are to be used for the electric motors that drive type R compressors. Suitable EP greases are tabulated below:

EP grease

Supplier	Designation
SKF	SKF Grease LGEP 2
BP	BP Grease XRB2-EP
CASTROL	Spheerol APS 2
CHEVRON	Dura-lith Grease EP2
A CHRISTIERNSSON	Alexol HMP 1 EP Alexol HMP 2 EP
ESSO	Beacon EP1 Beacon EP2
FINA	Marson HFF 2 EP
GULF	Synthetic Grease Gulflex MP
MOBIL OIL	Mobilux EP2
NYNÄS PETROLEUM	L 62 EP
OK	Oktozol Grease EP2
SHELL	Shell Alvania EP2
TEXACO	Multifak EP2 Novatex Grease EP2

The following greases contain (among other things) MoS₂. However, their basic oil viscosity is such that they can be represented in diagrams in the same way as the regular EP greases.

At present, information is lacking about how MoS₂ may affect life expectancy as the various parameters are varied.

A CHRISTIERNSSON	Alexol HMO 1 EP Alexol HMO 2 EP
GLEITMOLYBDÄN	Gleitmo 500
KLÜBER LUBR.	Klüber Unimoly GL82
MOBIL OIL	Mobilplex Special
MOLLUB-ALLOY	Molub-Alloy 848 Molub-Alloy 807
NYNÄS PETROLEUM	L 62 M
SHELL	Shell Retinax AM
TEXACO	Texaco Molytex EP2

To lubricate, proceed as follows:

1. See to it that clean grease is put into a clean grease gun, and make certain that the lube nipples are clean.
2. Add from 10 to 70 grams of grease for each bearing each time you lubricate.
See the applicable OPERATING INSTRUCTIONS for the unit in question.
From 10 to 70 grams of grease must be pressed into each bearing under all conditions.
3. Add the specified amount of grease to each bearing by means of 3 or 4 pumping operations separated by intervals of 2 or 3 minutes.

The motor bearings must be lubricated when the motor is first put into operation, after about 50 hours of operation, and thereafter at the following intervals:

Lube intervals			
Continuous operation (24 hours/day)		Intermittent operation (about 6-12 hours/day)	
Main frequency 50 Hz 3000 r/min	Main frequency 60 Hz 3600 r/min	Main frequency 50 Hz 3000 r/min	Main frequency 60 Hz 3600 r/min
4 months	2 months	12 months	6 months

If the above time intervals are exceeded, there is serious risk that the life expectancy of the motor will be shortened.

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C. EXTERNAL VIBRATIONS THAT AFFECT IDLE MOTORS

In plants containing more than one compressor unit where the units are installed adjacent to each other, and in plants where other machines (vibration sources) are installed close to the compressor unit or units, there is always risk that vibrations will damage idle bearings.

To prevent such damage, compressor units that are idle for longer than one week shall have their shafts rotated to a new resting position. This means that the shafts must be rotated to a new resting position every seven days throughout the period during which the compressor unit is idle.

D. Y/D STARTING

For Y/D starting, the changeover from Y to D starting must not take place before the motor has reached its operating speed, i.e. about 2950 r/min at 50 Hz and 3550 r/min at 60 Hz.

Starting times vary from plant to plant, depending upon the operating conditions and on the motor's excess torque relative to the compressor's. Starting times between 4 and 15 seconds are to be considered normal.

Before starting up a compressor plant, the built-in timing relay in the Y/D starter shall be preset to about 15 seconds. Then start the compressor unit at the maximum feasible condensing pressure for the plant in question. Measure the starting time, i.e. the time that elapses until operating speed is reached (indicated when the ammeter pointer drops momentarily).

Finally, set the timing relay to a time that is equal to the starting time you measured plus three seconds.

It is also vital that all contacts in the Y/D starter function satisfactorily. They must close and open simultaneously and distinctly in all three phases.

E. INSULATION RESISTANCE

Before an electric motor is put into operation in a new plant, its insulation resistance must be measured with a Megger or the like.

Information about the minimum permissible resistance (the insulation resistance) shall be obtained from the motor manufacturer. The insulation resistance must also be checked before starting up after a long idle period. If the measured values are lower than the permissible values, the motor must be dried in accordance with instructions provided by the motor supplier.

Installing a built-in heating device in the motor is always recommended.

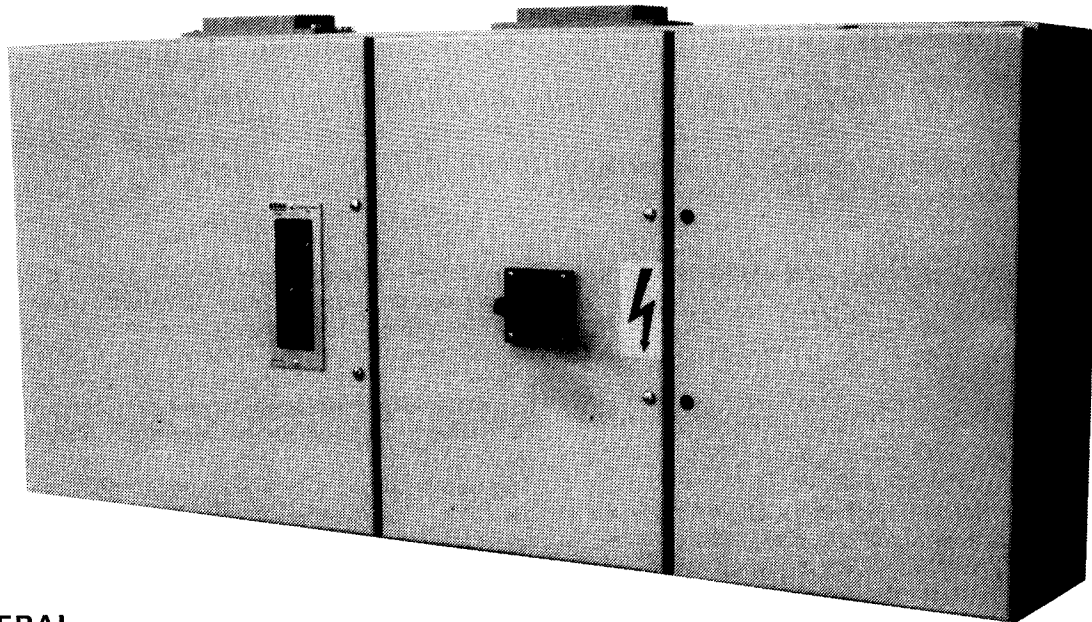
5. ELECTRICAL- AND REGULATING EQUIPMENT

7827-J-40E	Liquid chiller and heat pump units, series VR
7827-J-50E	Liquid chiller unit, series VR
7827-J-60E	Heat pump unit, series VR
4815/7827-N-120E	Operating system
4815/7827-N-130E	STALELECTRONIC 400

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LIQUID CHILLER AND HEAT PUMP UNITS, SERIES VR
Electrical equipment**GENERAL**

The unit's electrical equipment is housed in a sheet steel enclosure whose maximum tightness complies with the requirements set forth in IP54. The electrical equipment has four main sections, all of which are always included:

1. Power supply and starting section
2. Logic unit used for control and monitoring functions
3. Capacity control section
4. Separate enclosure that contains pressure cut-outs, temperature cut-outs and thermostats

The power supply and starting section contains the max-level circuit breaker (main circuit breaker that is tripped both thermally and magnetically), the automatic fuses used for the control circuits, the neutral terminal and the earth bus and the starter (Y/D starting) with thermal motor overload cutout. However, if the mains voltage is 660 V, 50 Hz, an across-the-line starter is used. This section also includes the current transformer used for the ammeter as well as the transformer and power supply unit used for the logic-unit section and capacity control section.

The logic unit (designed especially for the unit) contains electronic circuitry provided with inputs from the capacity control section, the cut-outs, the current transformer, and the interlocking circuit connected via the pump. It also contains outputs to the solenoid valves used for capacity control and the relays used to control the following:

- The starting equipment
- The oil heater and optional motor heater
- The solenoid valves

Outputs are also provided for fault signals and the collective alarm.

(An operational time meter and ammeter are included in the logic unit.)

The capacity control section differs from application to application, and it is described in a separate manual sheet. The unit is provided with a separate enclosure for the pressure cut-outs, temperature cut-outs and thermostats. In addition, there are solenoid valves, an oil heater, a motor temperature cut-out and sensors that send signals to the capacity control section. External devices are connected to the rest of the equipment via terminals.

The starter is connected to the compressor motor.

The equipment includes cables on which the different conductors are - to the extent required - marked using the 0-number system.

The equipment complies with Swedish standards, but on request it can be adapted to other standards.

ELECTRICAL DATA

Normally a main voltage of 380 V, 50 Hz is supplied to the unit's max-level circuit breaker. However, it is also possible to use the following mains voltages: 415, 500 and 660 V, 50 Hz as well as 380 and 440 V, 60 Hz.

Normally the control voltage is 220 V, 50 or 60 Hz. But when the mains voltage is 415 V, 50 Hz a control voltage of 240 V is used.

OPTIONAL EQUIPMENT

Zero-potential make-and-break (transfer) contacts connected to the terminals used for each individual alarm.

A pump-out cut-out and flow switch are also available (see code-letter information in manual sheet entitled Ordering Procedure).

Other deviations from the standard equipment can be made on special request. These include special cables, key-actuated locks and compliance with the tightness requirements set forth in IP54.

DESCRIPTION

- 1. Operation
- 2. Diagrams
- 3. Connections to the plant

1. OPERATION

REQUIREMENTS

Electric power for the compressor motor and voltage supplies for the logic-unit section and capacity control section.

Chilled medium flow as specified for the size of unit in question.

Heated medium flow through the condenser when the unit is started.

SUBFUNCTIONS

- Cut-outs:** Motor temperature, chilled medium flow (optional), high pressure, differential pressure across oil filter, low pressure, oil temperature, oil level, motor current and discharge line temperature.
- Control:** Unit that turns on the regulating equipment, oil thermostat in the oil separator, thermostat (optional) that controls the solenoid valve used for liquid injection.
- Temperature regulation:** Signal sent from the regulator to the solenoid valves used to INCREASE and DECREASE capacity.
- Operation:** Oil heater, solenoid valve in liquid line, motor heater (optional), solenoid valves used for economizer and (optional) liquid injection.
Provisions for unloaded starting and (optional) delayed capacity increase.
- Interlocking circuit:** Chilled medium pump or heated medium pump.
- Internal signals:** Red light-emitting diode for each cut-out (as listed above)
Green light-emitting diode which indicates that the compressor is running and that the interlocking circuit is closed. Yellow light-emitting diodes which indicate that the start-delay time is running and that there has been a power failure (signals from the regulating equipment can be observed only when the enclosure is open).
- External signals:** Zero-potential make-and-break (transfer) contacts for the collective alarm. These are connected to the terminals (max 48 V). Individual alarm contacts (optional).

External control: Contacts that are connected to the terminals and used to start the condenser pump or condenser fans.

Delay functions:	Start delay (long)	10 min
	Oil filter	30 s
	Flow switch	30 s
	Oil level	30 s
	Low pressure	60 s
	Start delay (short)	60 s
	Delayed capacity increase	3 min
	Y/D start	7 s

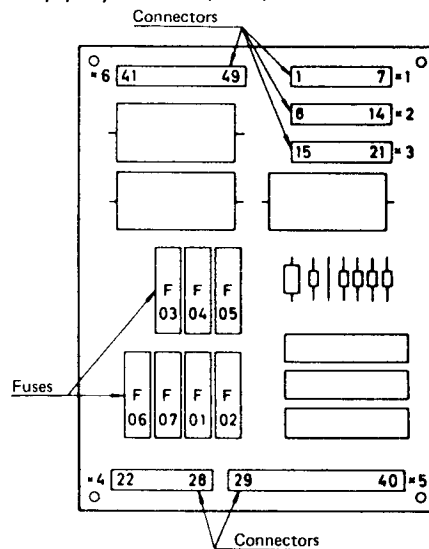
OPERATIONAL FUNCTIONS

Power supply

The system's power supply unit – RE5 – is mounted on a circuit board. It is connected to the mains via an automatic fuse designated F1. The transformer provides 24 V, 50/60 Hz for the relays and solenoid valves. The transformer also provides 24 V and 12 V voltages that are rectified to 30 V DC and 16 V DC respectively in the power supply unit. These DC voltages are used for the logic unit in the operating system.

The power supply unit circuit board also contains the fuses used for the low-voltage side. These fuses are designated F01-F07.

Power supply unit (RE5)



Item	Amperage	Voltage	Connected device
F01	3.15A	16 V	Internal power supply in logic unit
F02	3.15A		
F03	6.3AT	24V	Solenoid valves used for capacity control, operational time meter and auxiliary relays
F04	6.3AT		Reserve
F05	6.3AT		Reserve
F06	6.3AT	24V	Solenoid valves used in liquid line, for liquid injection and for the economizer
F07	6.3AT	24V	Regulating equipment
		30V	Cut-outs

The following are connected immediately after automatic fuse F1 and before the power supply unit's transformer:

- oil heater
- contactors
- motor heater (optional)

The oil heater – designated VO – is turned on while the compressor is stopped. Oil thermostat GT16 turns off the heater if the temperature rises too high and turns it on again when the temperature drops.

Opens at 50°C
Closes at 47°C

The contactors, which are used for Y/D starting, are controlled from the logic unit (RE1) via auxiliary relays R1-R3. When across-the-line starting is used, C2, C3, R2 and R3 are not needed.

The motor heater – designated VM – is always turned on while the compressor is idle.

Solenoid valves AV10, AV12 and AV14 are supplied with 24V AC from the power supply unit.

Solenoid valve – AV14 – is open when the compressor is running normally.

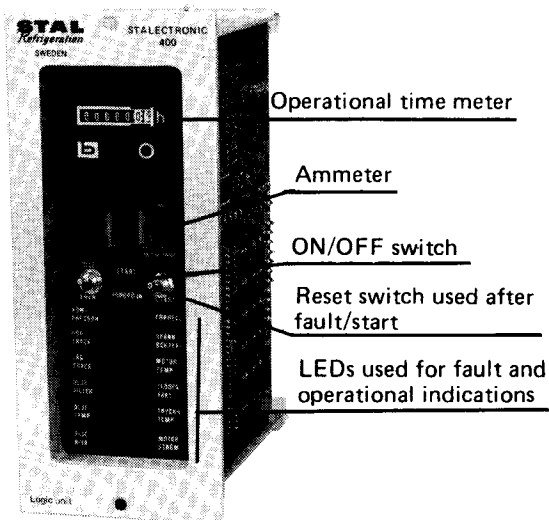
Solenoid valve – AV12 – is used for economizer, and it can be provided with control equipment.

Solenoid valve – AV10 – is used for optional liquid injection. When the discharge line temperature rises too high, thus causing thermostat GT13 to close, solenoid valve AV14 opens.

Opens at 110°C
Closes at 117°C

These valves are permitted to open while the compressor is running, but not during pump-out.

Logic unit (RE1)

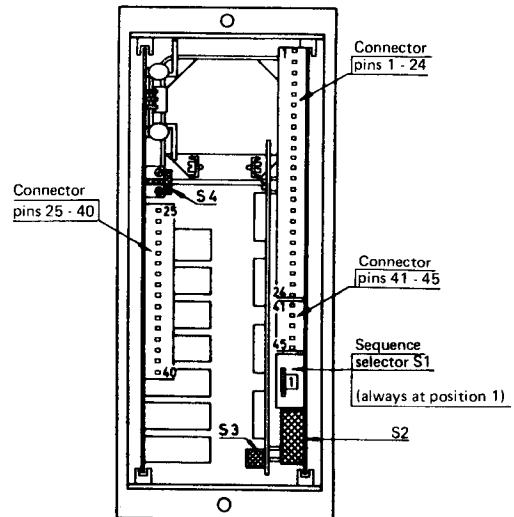


Most of the control functions needed to operate the unit are found in the logic unit.

Inside the logic unit there are two function switches designated S2 and S3. These are used for different operating situations. The logic unit also contains a switch designated S1. It must always be set to 1 in a STAL-MINI compressor unit.

There is also a switch designated S4, and it is used to select the current measurement range.

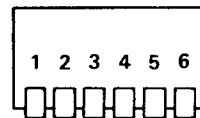
Switch S2 must be set for the operating situation in question by depressing the appropriate buttons. Switches S3 and S4 are set by moving the switch actuators. S4 can be set for a current measurement range of 100, 200 or 300A, depending on which current transformer is being used.



Function switch S2:

- = depressed (ON)
- = not depressed (OFF)

- 1 Automatic restart after low suction pressure
 Manual restart required after low suction pressure
- 2 Automatic restart after low oil temperature
 Manual restart required after low oil temperature
- 3 Not used for screw compressor unit
- 4 Start-to-start starting delay
 Stop-to-start starting delay
- 5 Manual restart after power failure
 Automatic restart after power failure
- 6 Flow switch stops unit unconditionally for loss of flow
 Flow switch does not issue fault signal if chilled medium pump is stopped (interlocking circuit is opened)

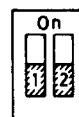


Function switch S3:



- 1 ON Pump out
OFF No pump out
- 2 Not used for screw compressor unit
Always at OFF position
- 3 ON Normal capacity control after start
OFF Delayed capacity increase after start

Current measurement selector S4:



- 1 ON 100 A (100/1 A current transformer)
- 2 OFF 200 A (200/1 A current transformer)
- 1 OFF 300 A (300/1 A current transformer)
- 2 OFF 300 A (300/1 A current transformer)

OPERATION

When the left-hand switch on the front of the logic unit is set to the ON position, a yellow light-emitting diode lights up to indicate that starting cannot take place until after a 10-minute delay. This delay prevents the equipment from being started too frequently. However, you can bypass this delay by pressing down the right-hand switch on the front of the logic unit. In such case, the delay time is 60 seconds (measured from the previous stop).

When the delay time has expired, the compressor starts if certain conditions are met. A fault signal must not have been issued by any of the cut-outs. The interlocking circuit used for remote control must be closed, and the regulating equipment must have requested a compressor start. A green light-emitting diode on the logic unit is lighted to indicate that the compressor is running. Another green LED indicates that the interlocking circuit is closed.

The compressor is unloaded (DECREASE solenoid valves are energized) when it is started (starting equipment in the Y state).

When changeover to the D state takes place, the capacity control system is permitted to change to the capacity requested by the regulating equipment. However, you can use function switch S3 to set the system so that the compressor will be run for an additional 180 seconds at low capacities.

The compressor is stopped when the control power is interrupted and also when any of the cut-outs is tripped. The compressor is also stopped when the start signal from the regulating equipment or the interlocking circuit is interrupted and also when the left-hand switch on the front of the logic unit is set to OFF.

Switch S3 permits you to provide a pump-out function when the compressor is stopped. In such case, the compressor continues to run until the pump-out/low-pressure cut-out is tripped.

When the left-hand switch on the front of the logic unit is at the OFF position, DECREASE signals are sent to the compressor's solenoid valves.

For restarting after a power failure, you can select automatic or manual restoration of normal operation. A yellow light-emitting diode lights up to inform you that there has been a power failure.

In the event of a fault, the unit cut-outs are tripped as follows (normal settings are presented, although it should be noted that other settings can be encountered, depending upon the operating situation in question):

Condensing pressure too high

Trip occurs immediately when the value set on cut-out GP3 is exceeded.

Opens at 2.3 MPa gauge pressure
Closes at 1.8 MPa gauge pressure

Suction pressure too low.

Trip occurs when the pressure has been lower than the setting of cut-out GP1 for longer than 60 seconds.

Opens at 0.10 MPa gauge pressure
Closes at 0.19 MPa gauge pressure

Differential pressure across the oil filter too high.

Trip occurs when the value set on cut-out GP6 has been exceeded for longer than 30 seconds.

Opens at 0.1 MPa
Closes at 0.07 MPa

Oil temperature in the oil separator too low.

Trip occurs immediately when the temperature drops below the value set on thermostat GT15.

Opens at 20 °C
Closes at 23 °C

Oil level too low

Trip occurs when the oil level in the compressor's oil filter housing has been too low for longer than 30 seconds.

Motor temperature too high

Trip occurs immediately when the winding temperature has exceeded the permissible value.

Chilled medium flow rate too low.

Trip occurs when a rate of chilled medium flow through the evaporator that is too low for the plant in question has been measured for longer than 30 seconds.

Discharge line temperature too high.

Trip occurs immediately when the value set on cut-out GT11 has been exceeded.

Opens at 120 °C
Closes at 113 °C

Motor current too high

Trip occurs immediately when the current at the motor overload cutout has exceeded the preset value

Red LEDs indicate faults

Normally, manual resetting is required after a fault. However, switch S2 can be set to provide automatic resetting of the oil temperature cut-out and low-pressure cut-out.

Manual resetting after a fault is carried out by means of the right-hand switch on the front of the logic unit.

A collective alarm relay changes state when a cut-out that requires manual resetting is tripped.

2. DIAGRAMS

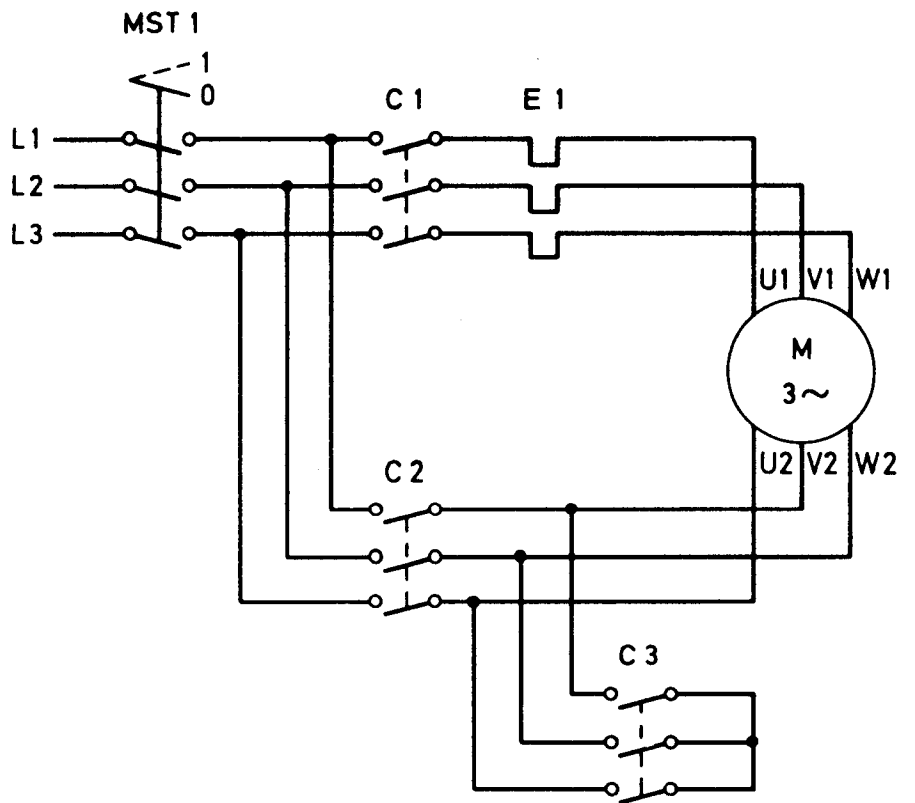
Only simple circuit diagrams of the most commonly encountered versions of the equipment are presented in this manual sheet.

A complete circuit diagram of your unit accompanies it on delivery.

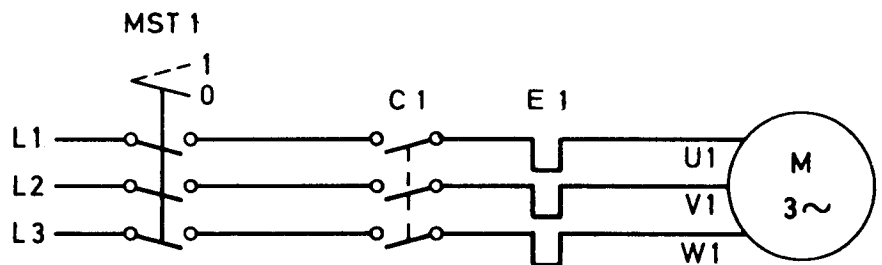
Additional copies of the complete circuit diagram of your unit can be obtained from the supplier of the electrical equipment.

STARTERS

Y/D STARTING

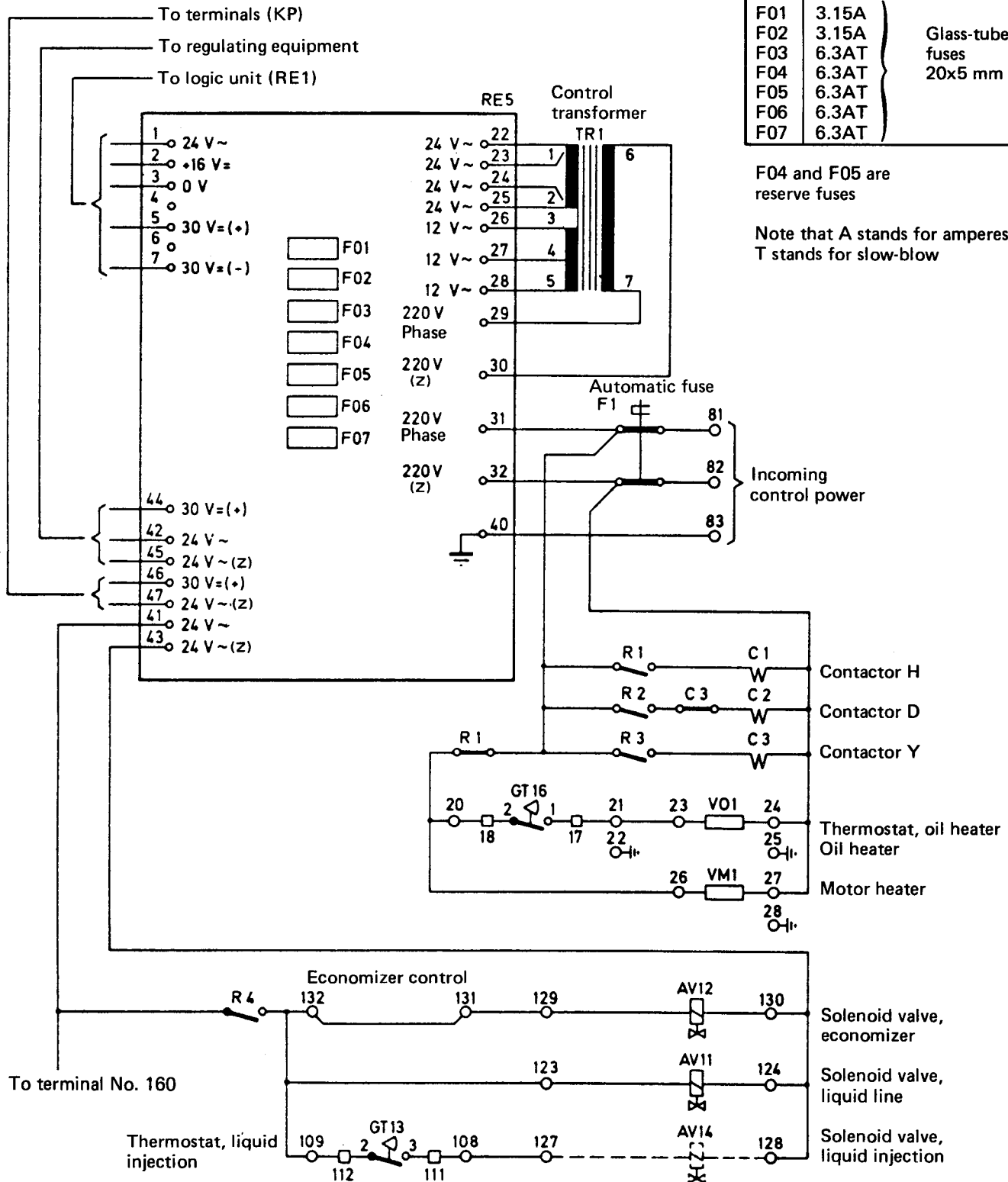


ACROSS-THE-LINE STARTING

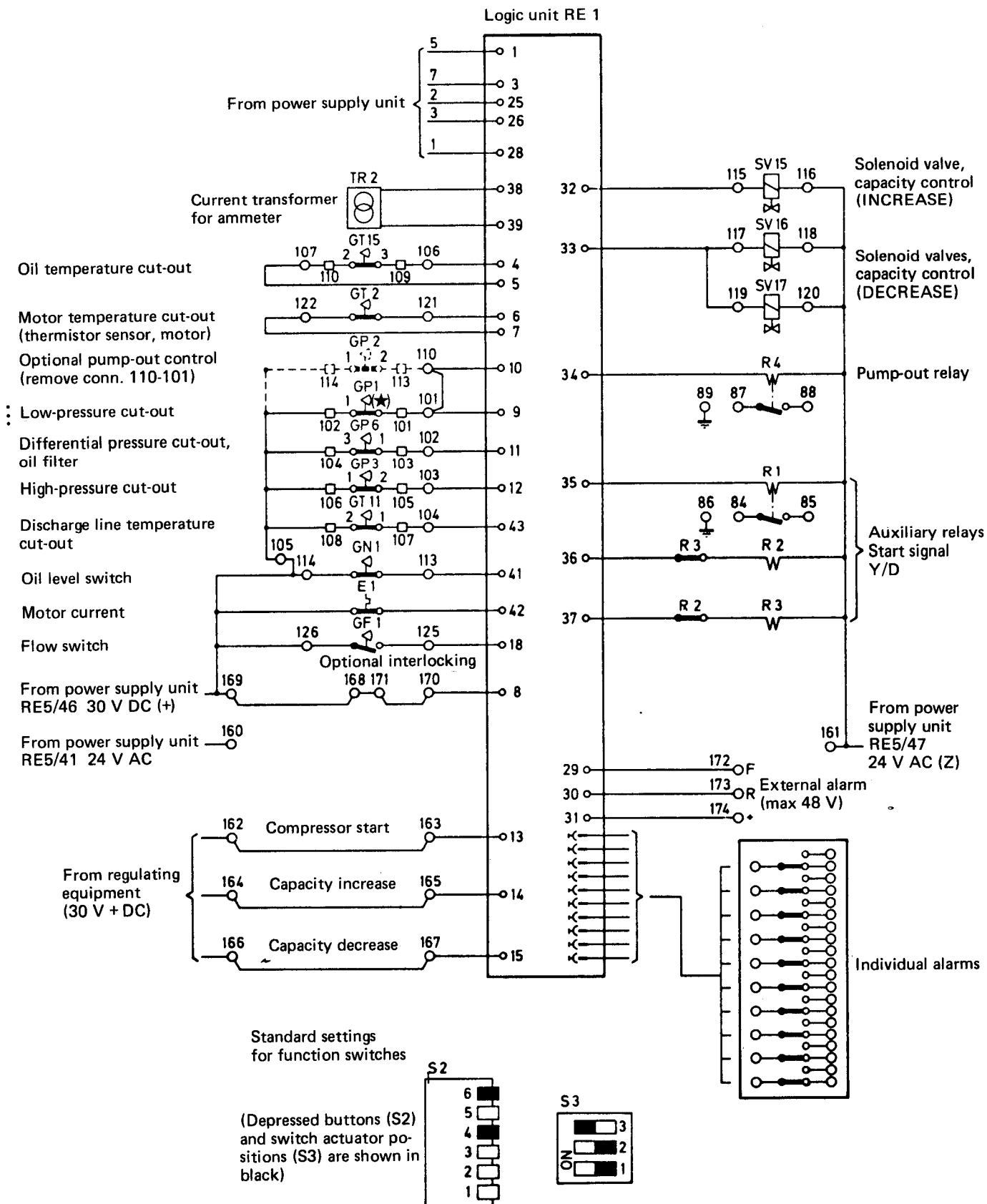


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**POWER SUPPLY UNIT
TRANSFORMER
FUSES
CONTROL DEVICES**



OPERATING SYSTEM

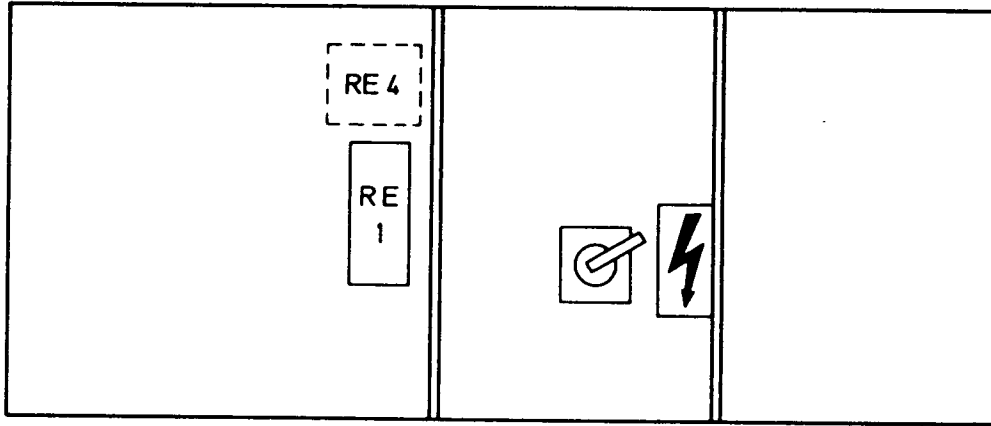


(★) Can be connected between 1 and 2 or between 1 and 3, depending on which cut-out is used. See page 10a/12.

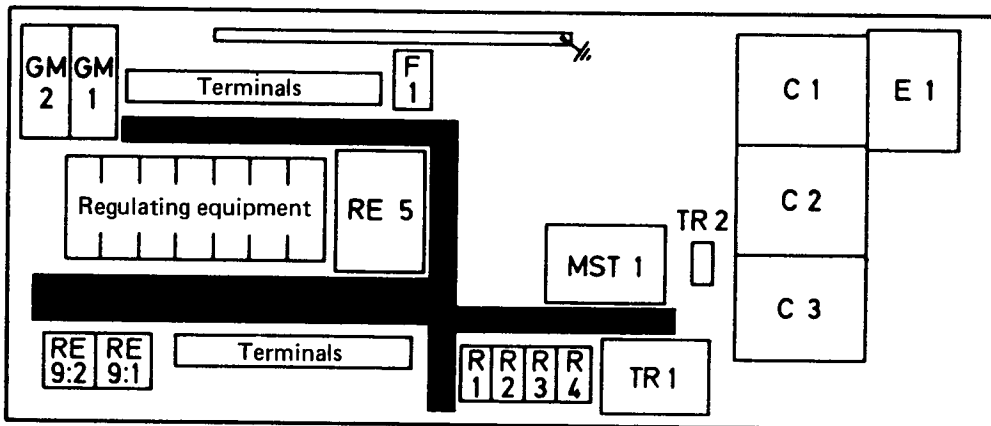
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STAL-MINI screw compressor

STAL
REFRIGERATION



External view of electrical equipment enclosure



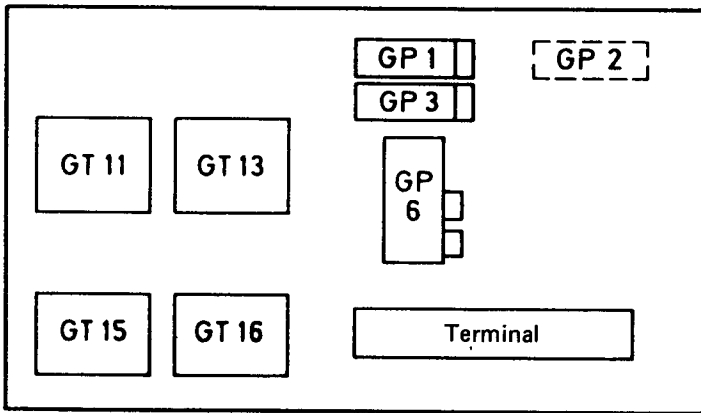
Component locations in electrical equipment enclosure

LIST OF COMPONENTS

Item	Name	Supplier	Designation	Remarks
F1 TR1 TR2	Automatic fuse Control transformer Current transformer	AEG Tramo LK-NES	E22L10A A120.90.003 HF3A---/1A	Control voltage 220V, 50 Hz
MST1 C1 C2 C3 E1	Max-level circuit breaker Contactor H Contactor D Contactor Y Motor overload cutout	Varies, depending on the electric motor and mains voltage. See the electric circuit diagram for your equipment.		
RE5 RE4 RE1	Power supply unit Alarm unit Logic unit	STAL STAL STAL	3968 1190 410 3968 1190 600 3968 1190 140	
R1 R2 R3 R4	Auxiliary relay Auxiliary relay Auxiliary relay Auxiliary relay	Sprecher and Schuh Sprecher and Schuh Sprecher and Schuh Sprecher and Schuh	CS3-31E CS3-31E CS3-31E CS3-31E	The coil that is selected will depend on the supply voltage and frequency
VO1 AV14 AV14 AV14 AV14 AV12 AV12 AV10 AV10	Oil heater Solenoid valve coil, liquid line Solenoid pilot valve, liquid line Solenoid valve coil, liquid line Solenoid pilot valve, liquid line Solenoid valve coil, economizer Solenoid valve coil, economizer Solenoid valve coil, liquid injection Solenoid valve coil, liquid injection	STAL STAL STAL STAL STAL STAL STAL STAL	1903 876-1 3963 1120 803 3963 1171 933 3963 1120 813 3963 1171 983 3963 1120 803 3963 1120 813 3963 1120 803 3963 1120 813	220V, 50/60 Hz 24V, 50 Hz 24V, 50 Hz 24V, 60 Hz 24V, 60 Hz 24V, 50 Hz 24V, 60 Hz 24V, 50 Hz 24V, 60 Hz 24V, 60 Hz
SV15 SV16 SV17	Solenoid valve, capacity control Solenoid valve, capacity control Solenoid valve, capacity control	STAL STAL STAL	3963 1151 864 3963 1151 864 3963 1151 864	24V, 50/60 Hz 24V, 50/60 Hz 24V, 50/60 Hz
GN1	Oil level switch	STAL	3966 4052 655	

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SEPARATE ENCLOSURE FOR PRESSURE AND TEMPERATURE CUT-OUTS

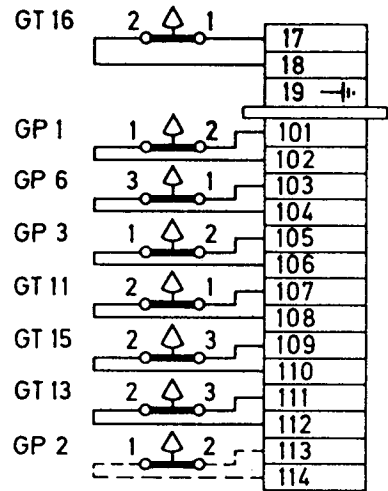


Locations of components in electrical equipment enclosure

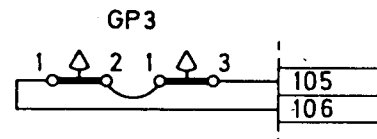
LIST OF COMPONENTS

Item	Name	Article No.	Remarks
GT11	Discharge line temperature cut-out	3966 2181 880	
GT13	Thermostat for liquid injection	3966 2181 880	
GT15	Oil temperature cut-out	3966 2181 877	
GT16	Thermostat for oil heater	3966 2181 877	
GP 3	High-pressure cut-out	3966 1214 833	
GP 3	High-pressure cut-out	3966 1232 812	TÜV
GP 6	Differential pressure cut-out, oil filter	3966 1414 801	
GP 1	Low-pressure cut-out	3966 1114 810	Evaporating temp $\geq -10^{\circ}\text{C}$
GP 1	Low-pressure cut-out	3966 1125 802	Evaporating temp $< -10^{\circ}\text{C}$
GP 2	Optional pump-out cut-out	3966 1114 810	

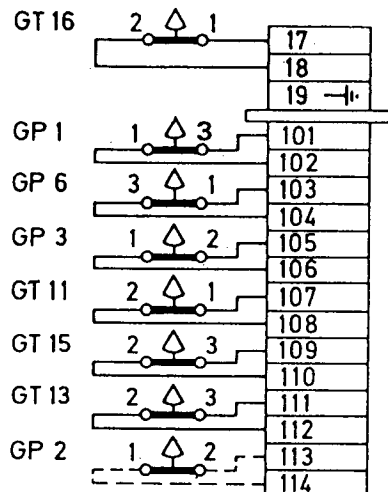
Connecting up cut-outs
Evaporating temp. $\geq -10^{\circ}\text{C}$



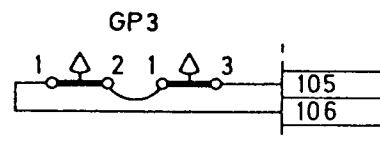
TÜV-approved high-pressure cut-out



Connecting up cut-outs
Evaporating temp. $< -10^{\circ}\text{C}$



TÜV-approved high-pressure cut-out



3. CONNECTIONS TO THE PLANT

OPERATING POWER AND CONTROL POWER

The operating power and control power supplied to the unit must comply with governmental regulations. The incoming operating power line must be connected to the threaded terminals on the max-level circuit breaker.

The incoming control power line must be connected via a separate cable to a terminal in the operating system.

DATA ON FUSES, CIRCUIT BREAKERS AND ELECTRIC MOTOR

The max-level circuit breaker (MST) provides protection between the operating power mains and the unit.

Automatic fuse F1 provides protection between the control power mains and the unit.

The compressor can be equipped with an electric motor having an output ranging from 45 to 132 kW.

The following data is for standard motors:

Motor kW	Rated current A 380/50	Start current A Y/D 380/50	Start current A Across-the-line 380/50	Max-level circuit breaker A	Line fuse A
45	88	158	598	100	10
55	104	187	707	125	10
75	140	252	952	150	10
90	168	302	1008	175	10
110	200	360	1300	225	10
132	240	432	1560	250	10

To protect the supply line properly, values lower than those tabulated below must not be used.

The equipment is designed for a 50 kA short-circuit current if cartridge fuse-links are used.

In such case, the prefuses and circuit breaker must not be dimensioned for values higher than those tabulated below.

Max-level breaker A	Prefuses A	Max conductor area in mm ² 1)
100	125	50
125	125	50
150	200	120
175	200	120
225	250	120
250	250	150

The above table is for 380V, 50 Hz and Y/D starting.

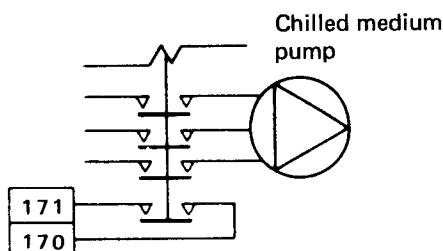
- 1) Copper conductors having areas equal to or smaller than those tabulated above can be mounted on compressor units having standard equipment. However, equipment suitable for conductors having larger areas or aluminium cables can be supplied on request.

EXTERNAL CONTROL FUNCTIONS

All external control functions must be connected to terminals in the operating system enclosure.

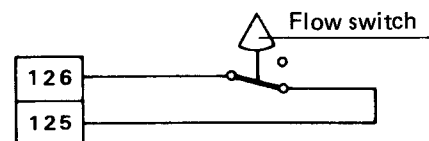
Interlocking via the chilled medium pump (or heated medium pump).

To permit the unit to start, certain terminals must be joined to each other via external devices. The interlocking circuit connected via the chilled medium pump proceeds via a terminal.



Interlocking via a flow switch

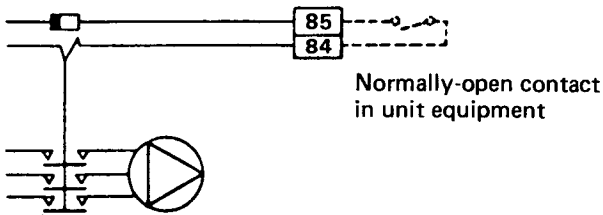
To supplement the interlocking circuit that proceeds via the chilled medium pump, we recommend that a flow switch be connected into the chilled medium line.



A lamp indicator that lights up when the rate of flow is outside the preset limit is included on the unit. After this function has been tripped, it must be reset manually.

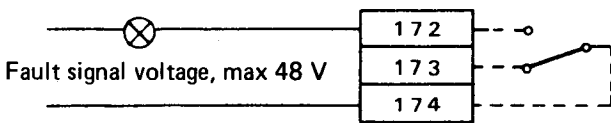
OPERATION OF CONDENSER PUMP (VRV, VRM)

The condenser pump is connected so that it will start when the unit starts.



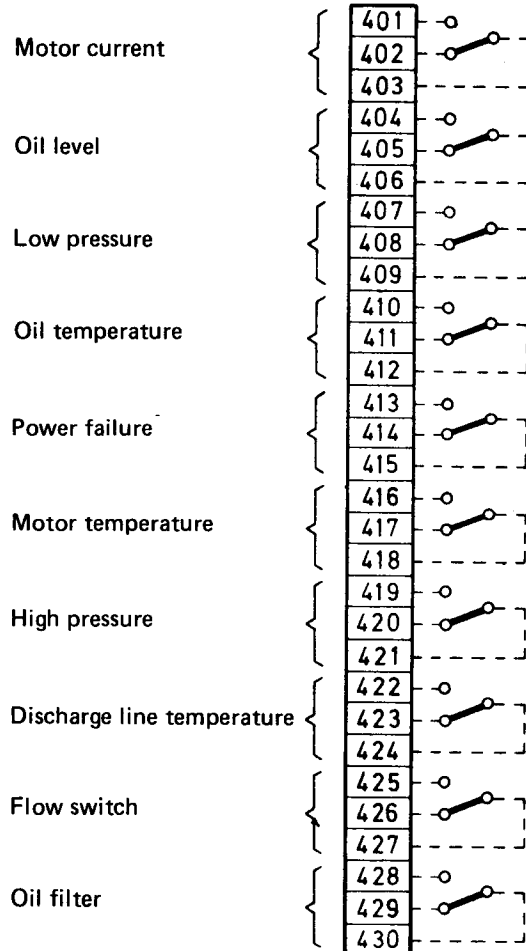
EXTERNAL COLLECTIVE ALARM

External fault signal Contact for alarm: 174-172



External voltage source and lamp

EXTERNAL INDIVIDUAL ALARMS (RE4)



Fault signal voltage, max 48 V
 Fault signal current, max 1.25A

Transfer contact in unit

The contacts shown above are at the no-alarm position

LIQUID CHILLER UNIT, SERIES VR
Regulating Equipment
Stalelectronic 400

GENERAL

Regulating equipment that can control compressor capacity is needed to make certain that a VR unit will be able to maintain the specified temperature in the process. This regulating equipment, which consists of a number of regulator modules, is mounted in an electrical equipment enclosure.

The regulating equipment always includes at least three modules for a liquid chiller unit:

- a) Temperature regulator
- b) Voltage relay used for starting and stopping
- c) Positioning relay used for capacity control

In addition, there is a temperature sensor that senses the temperature of the chilled medium that leaves the evaporator.

This equipment can be supplemented with additional regulator modules and sensors to implement the functions needed for set point displacement based on outdoor temperature, condenser pressure limitation and motor current limitation (see Fig. 1).

In addition to the above, one or two sockets are included for special modules used to present the regulating equipment's current values and set values on a display. A printer can also be connected to these sockets so that measured values can be printed out.

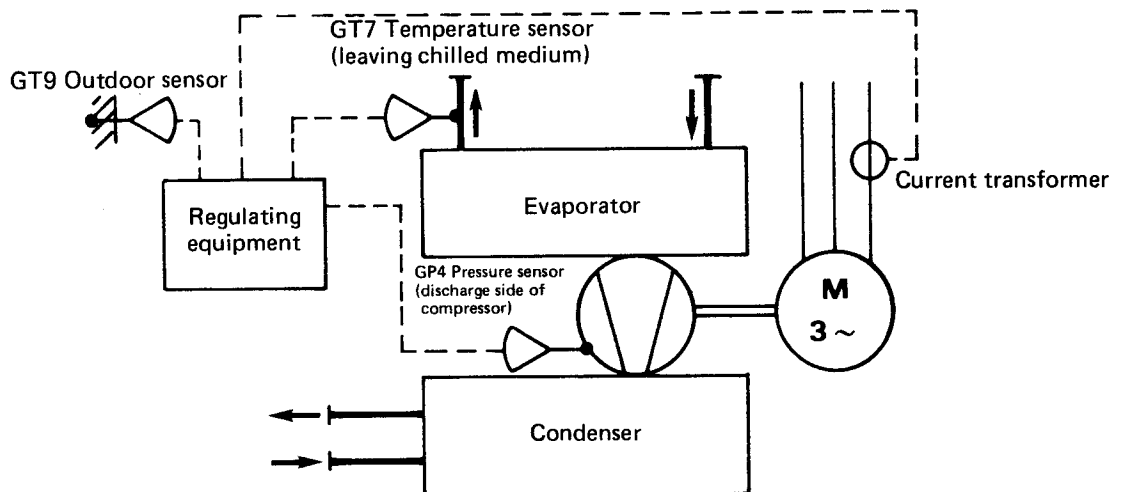


Fig. 1

OPERATION

The temperature regulator functions as a purely proportional regulator (P-regulator). This means that the output signal from the regulator is proportional to the deviation between the preset set point and the actual current value.

The output signal has a working range of 0 to 20 V (phase cut signal). When the current value is the same as the preset set point, the output signal is 10 V.

The output signal from the regulator is used to control a voltage relay and a positioning relay. The voltage relay handles the signal used for starting and stopping the compressor, while the positioning relay handles the signals sent to the solenoid valves used for capacity control.

The voltage relay sends a start signal to the logic unit when the regulator's output signal reaches a certain presettable level.

From the logic unit, a start signal is sent to the starting devices. If the regulator's output signal drops beneath a preset difference from the turn-on level, the start signal is interrupted, thus causing the compressor to stop.

The positioning relay converts the regulator's output signal to a pulsed 3-state signal. When the output signal from the regulator is 10 V, the positioning relay does not send out any output signal.

If the regulator signal increases, an output relay in the positioning relay pulls in intermittently and sends out a pulsed signal that causes the compressor capacity to increase. As the voltage of the regulator signal increases, the ON pulses become longer. Similarly, a second output relay pulls in if the regulator signal drops beneath 10 V. This output relay sends out a signal that causes the compressor capacity to decrease. These signals control, via the logic unit, the solenoid valves in the compressor that are used for capacity control.

The proportional regulator provides in combination with a positioning relay (of the type used here to control the capacity control system solenoid valves), a function similar to PID (Proportional, Integrating and Differentiating). Consequently, no stationary regulating deviation is obtained while the compressor is running. A regulator that functions, in principle, in the same way as the temperature regulator can be connected to the system to limit condenser pressure. In such case, a signal selector is used to select the lowest signal from the temperature and pressure regulators. This signal is then used as a control signal for the voltage relay and positioning relay.

The regulating equipment can also be supplemented with a regulator that limits the motor current. Here too, a signal selector is used to select the lowest signal. This signal is then sent to the positioning relay.

Moreover, the system can be supplemented with an interference unit that displaces the temperature regulator's set point on the basis of the outdoor temperature.

Connection diagrams for the different regulating system variants appear in Figs. 5 - 12.

SETTINGS

The set point and P-band (X_p) can be set as desired on the front of each regulator.

For a temperature regulator, the desired temperature is set on the set point potentiometer. For a pressure or current regulator, the set point potentiometer is graduated from 0 to 100. Consequently, its setting corresponds to a percentage of the full range of the pressure sensor or current transformer. If, for example, a pressure sensor having a measurement range of 0 - 40 bar is being used and the set point is set to 65, it corresponds to 65% of 40 bar, i. e. 26 bar.

This also applies to a current regulator. Usually, a current transformer has a full measurement range of 200 A. If the set point is set to 80, it will thus correspond to 80% of 200 A, i.e. 160 A.

The P-band setting will depend in large part on the time constants that are characteristic of the process, and these can vary from application to application. Moreover, the P-band setting will depend on the user's preferences with regard to the size of the control deviation, the starting/stopping frequency, etc.

It is thus impossible to set forth any general setting values. After the initial settings have been made, they should be trimmed (fine adjustment) for the application at hand. These initial settings can be made as shown in Fig. 4, which also presents the setting values for the voltage and positioning relays and the settings of the function switches in the regulator modules. With the possible exception of the voltage relay setting, these settings are never to be changed.

The turn-on level (U_E) and its difference (U_D) from the turn-off level can be set on the voltage relay. The turn-on delay Δt can also be set on the voltage relay.

Interference unit (Fig. 2)

To displace the set point of the temperature regulator on the basis of outdoor temperature, you can use an interference unit which contains a measured-value (temperature-to-voltage) converter (3968 1110 801), a measured-value amplifier (3968 1110 852) and a limiter (3968 1110 851).

An outdoor temperature indication can be provided if the interference unit is equipped with a digital indicator module.

The measured-value (temperature-to-voltage) converter converts the temperature signal received from a -100°C to $+100^{\circ}\text{C}$ sensor to a voltage signal (0 V to 10 V). This signal is then amplified suitable in the measured-value amplifier module. The signal sent to the regulator can then be limited to the desired level in the limiter module. The output signal from the interference unit is added to the chilled medium temperature current-value signal after the measured-value converter in the regulator.

Since the regulating system tries to keep the current value and the set point equal to each other, the actual current value (at any given set point) will drop as the output from the interference unit rises. This occurs because the current value which the regulator senses is the sum of the actual current value and the output signal from the interference unit. The resultant function is thus equivalent to a reduction of the set point in response to a rise in the output signal from the interference unit.

Examples showing how settings can be made (Fig. 3)

Let's assume that, for a liquid chiller, you wish to change the temperature of the leaving chilled medium as follows:

At an outdoor temperature of 0°C the chilled medium temperature is +10°C and when the outdoor temperature drops lower the chilled medium temperature does not rise. At an outdoor temperature of +20°C the chilled medium temperature is +5°C, and when the outdoor temperature rises higher the chilled medium temperature does not drop.

This means that the chilled medium temperature is to be displaced 5°C when the outdoor temperature varies from 0°C to +20°C. The temperature regulator's set point must be set to the desired chilled medium temperature at the lower outdoor temperature (in this case 10°C).

The zero-point (A) and the slope (S) are set on the measured-value amplifier module.

The zero-point (A) is set (using code switches A1 – A8) to the voltage that corresponds to the lower outdoor temperature. Since the measured-value converter module in the interference unit provides an output signal that ranges from 0 V to 10 V for a temperature range of –100°C to +100°C a temperature of 0°C corresponds to a voltage of 5.0 V. To provide this, you must set the zero-point (A) to 5.0 V, and this is accomplished by setting A7 and A5 to their ON positions and all other code switches to their OFF positions. If fine adjustment is necessary, use the potentiometer.

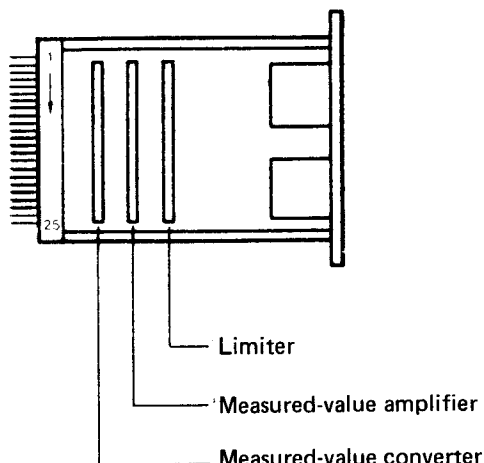
The slope (S) must be set using code switches S1 – S9.

$$S = \frac{\Delta U_{out}}{\Delta U_{in}}$$

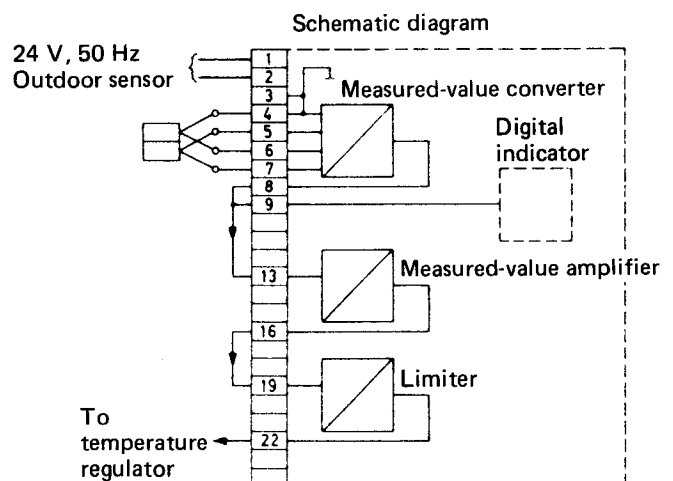
ΔU_{in} is the voltage that corresponds to the difference between the highest and the lowest outdoor temperature. In this case, we obtain:

$$6\text{ V } (+20^\circ\text{C}) - 5\text{ V } (0^\circ\text{C}) = 1\text{ V}$$

Locations of modules



INTERFERENCE UNIT



ΔU_{out} is the maximum deviation voltage sent to the regulator. In this example, the set point is to be displaced a maximum of 5°C, and if the regulator contains measured-value converter module 3968 1110 802 (provides an output signal of 0 V – 10 V for a measurement range of 0°C – 100°C), a change of 5°C corresponds to a 0.5 V voltage change.

In this case $S = \frac{0.5}{1} = 0.5$, i. e. S5 must be at the ON position, and the other code switches must be at their OFF positions.

Here too, fine adjustment can be carried out using the potentiometer if necessary.

The limitation voltage U_B must then be set on the limitation module (3968 1110 851) to the same value as U_{out} . This setting is made using code switches S1 – S4. In this example, $U_B = 0.5\text{ V}$, but since the lowest voltage that can be set on the code switches (as indicated above) is 1 V, this setting must be made using the potentiometer (see below). However, code switch S5 must always be at the ON position, and the switch marked C1-C2 must always be at position C1.

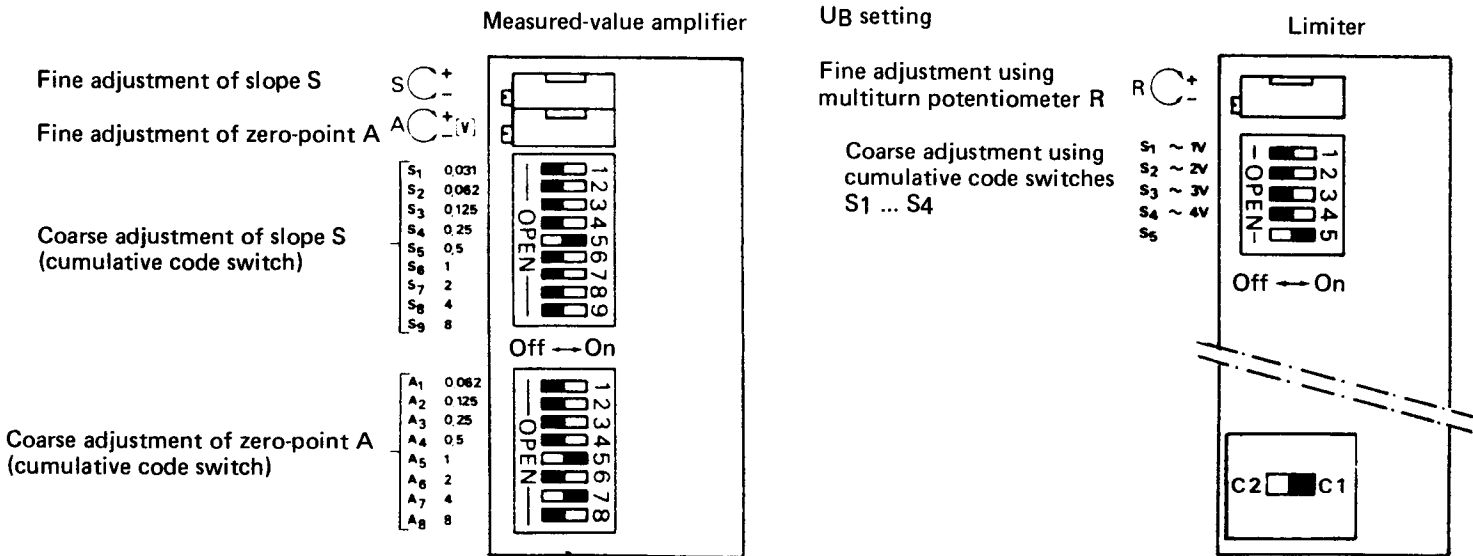
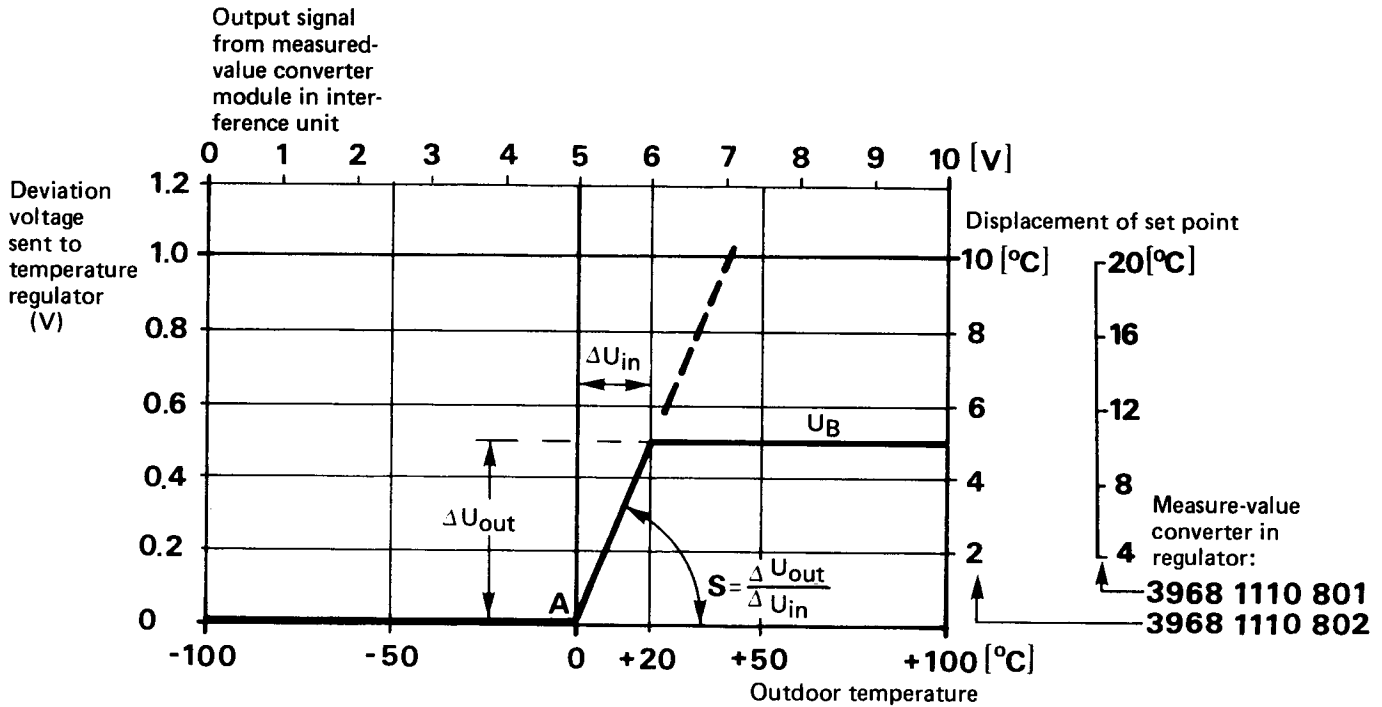
The zero-point (A) and the slope (S) can be adjusted through $\pm 0.18\text{ V}$ and $\pm 0.18\text{ V/V}$ respectively by means of the potentiometers used for fine adjustment. If the situation is such that you do not want these potentiometers to have any effect, they should be set to their mid-points. You can set them to their approximate mid-points as follows:

Turn the adjustment screw in either direction until you hear a ratcheting sound (indicates that the potentiometer is at its end position). Then turn the adjustment screw 16 turns in the opposite direction.

The potentiometer used for the limitation voltage (U_B) has a working range of 0 to 1 V. When the adjustment screw is turned anti-clockwise to its end position (where you will hear a ratcheting sound as mentioned above), it is at the 0 V position. The entire working range of 1 V corresponds to 32 turns clockwise from this zero-position.

Fig. 2

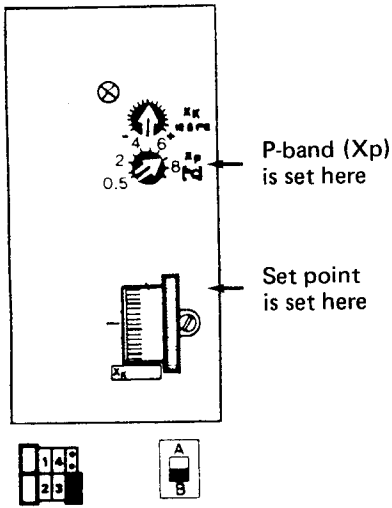
EXAMPLES SHOWING HOW SETTINGS CAN BE MADE



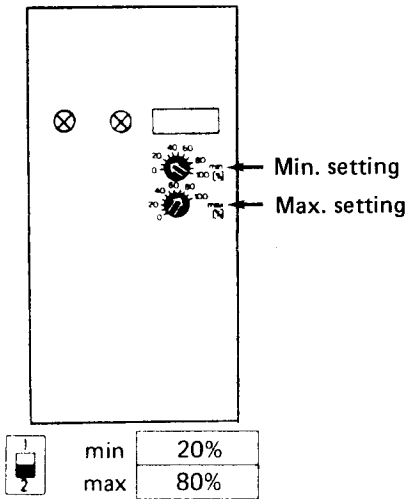
(Black indicates depressed switch actuator)

Fig. 3

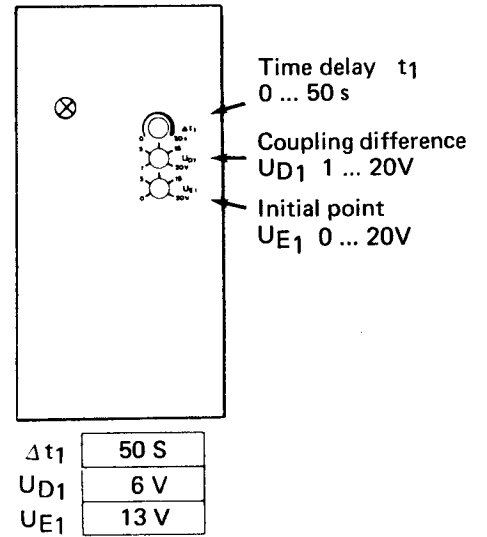
RC1 Temperature regulator in regulating equipment without set point displacement



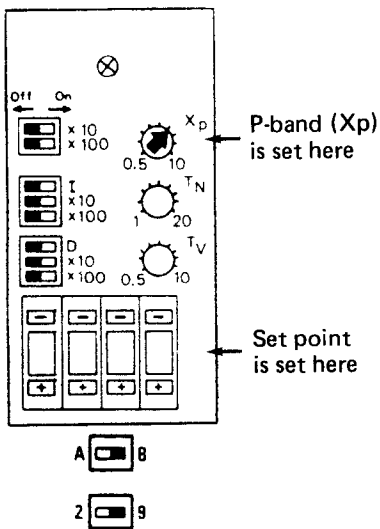
RE7 Positioning relay



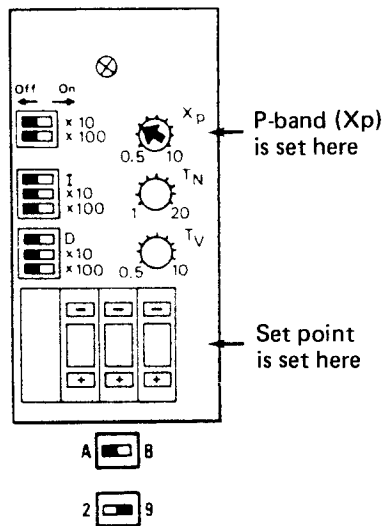
RE8 Voltage relay



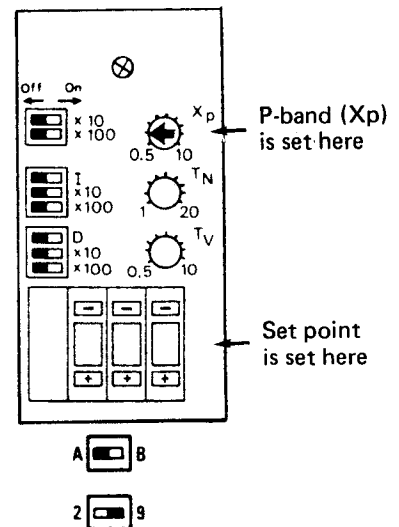
RC1 Temperature regulator in regulating equipment without set point displacement



RC4 Pressure regulator



RC6 Current regulator



Examples of settings. For pushbutton switches, black indicates a depressed actuator. For movable-actuator switches, black indicates the actuator position.

Fig. 4

Liquid chiller regulation
 (standard arrangement)

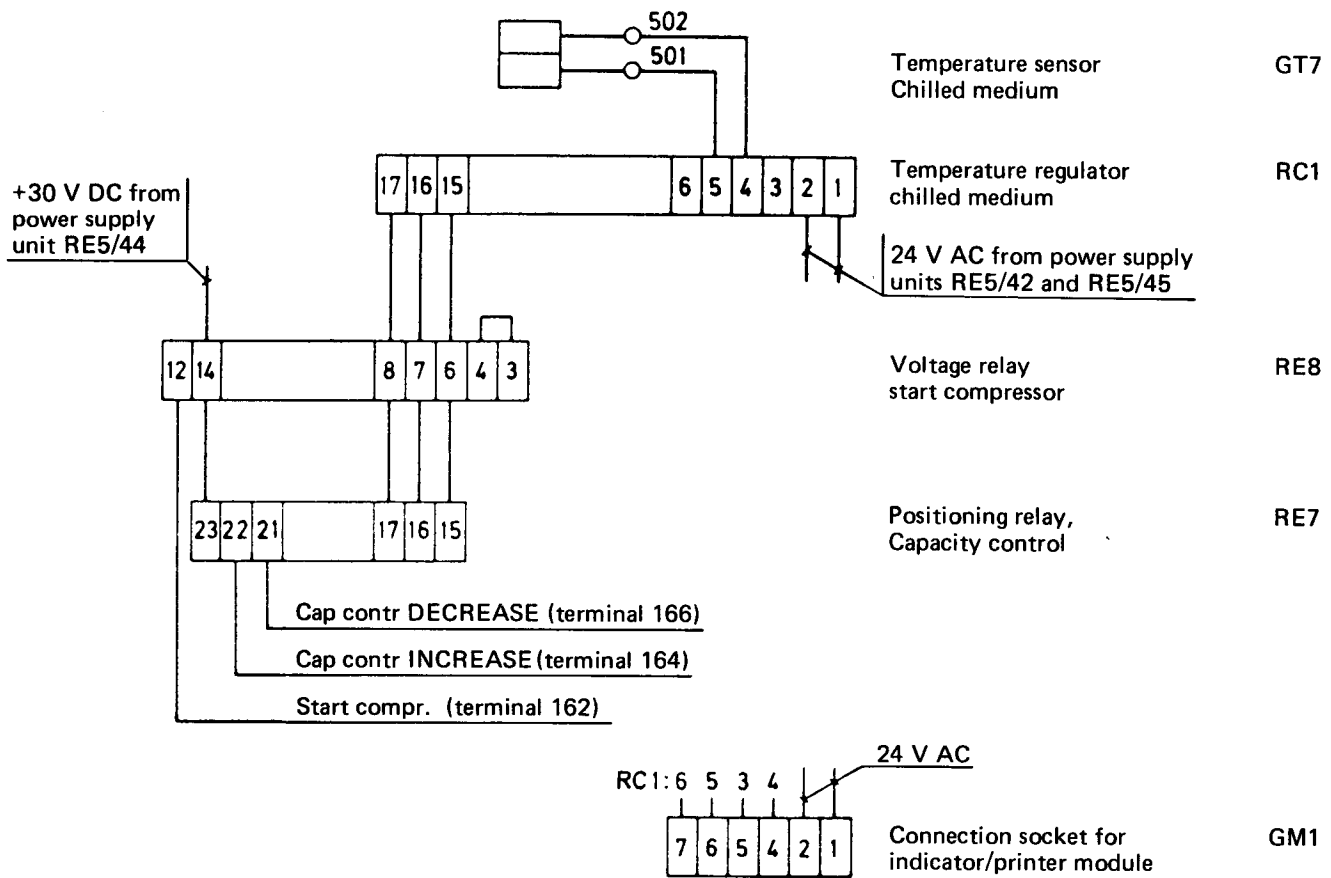


Fig. 5

Liquid chiller regulation
Supplement:
Set point displacement (outdoor temp.)

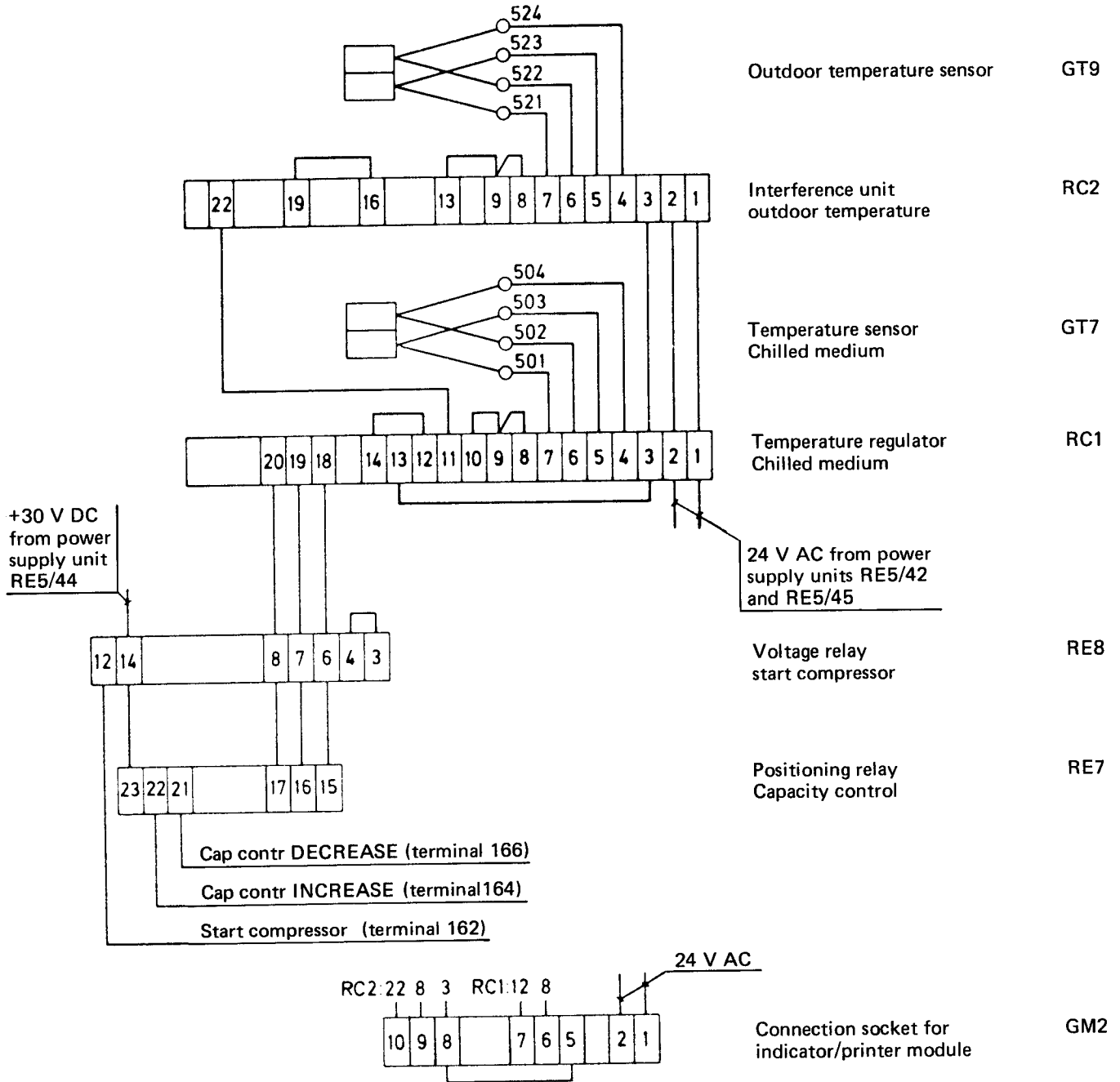


Fig. 6

Demno... för... givande... eljest... är utan...

Liquid chiller regulation
 Supplement:
 Condenser pressure limitation

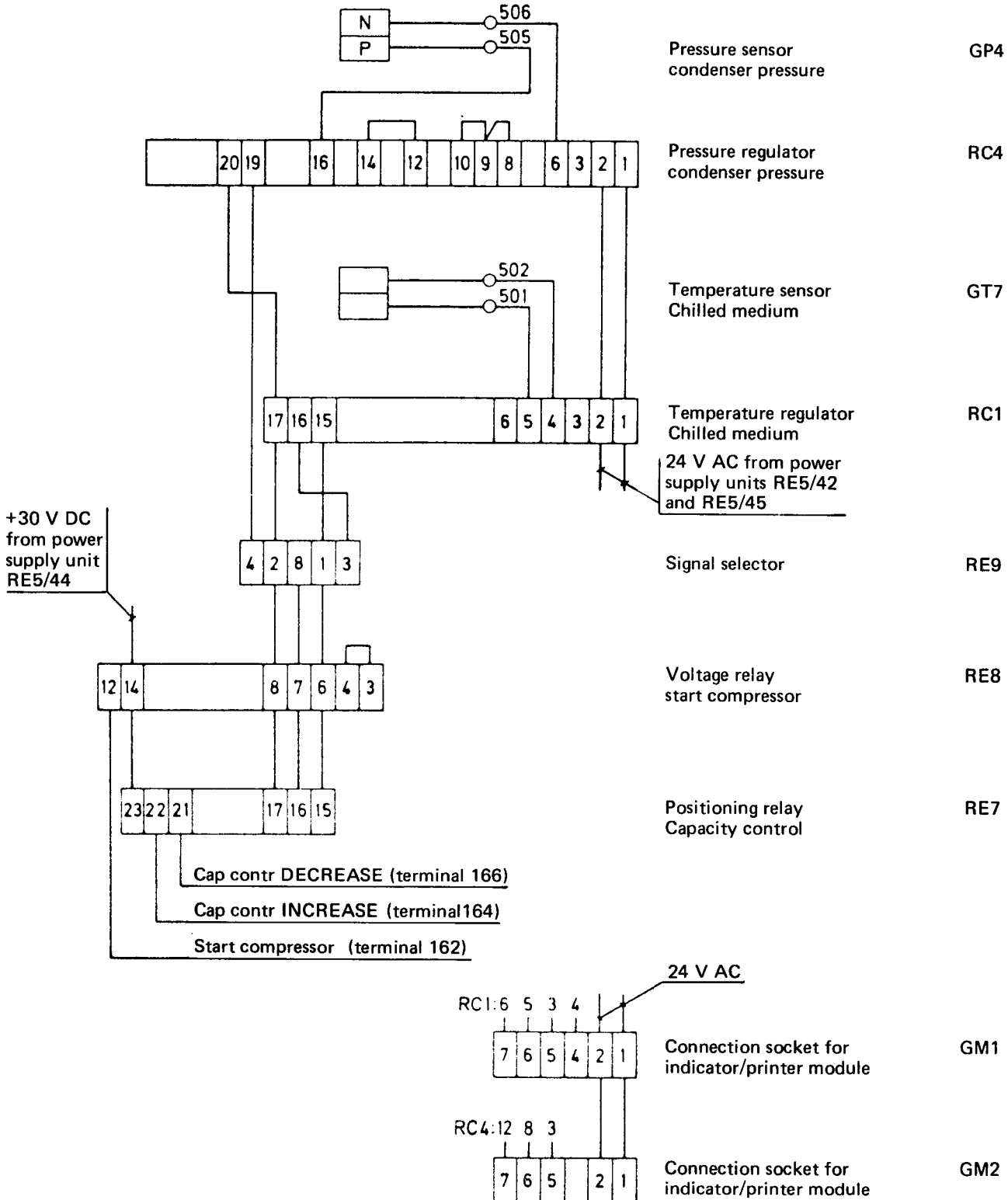


Fig. 7

Bild 8 zeigt die elektrische Schaltung des Kompressors. Die Anschlüsse sind wie folgt beschriftet: 502, 501, +30 V DC, 17, 16, 15, 6, 5, 4, 3, 2, 1, 12, 14, 8, 7, 6, 4, 3, From logic unit RE1/40, From Transf TR1 terminal 4, 20, 19, 18, 14, 12, 10, 9, 4, 3, 2, 1, 24 V AC, 3, 2, 8, 1, 4, 23, 22, 21, 17, 16, 15, Cap contr DECREASE (terminal 166), Cap contr INCREASE (terminal 164), Start compressor (terminal 162), RC1: 6, 5, 3, 4, 7, 6, 5, 4, 2, 1, 24 V AC, RC6: 12, 9, 3, 7, 6, 5, 2, 1.

Liquid chiller[†] regulation
Supplement:
Motor current limitation

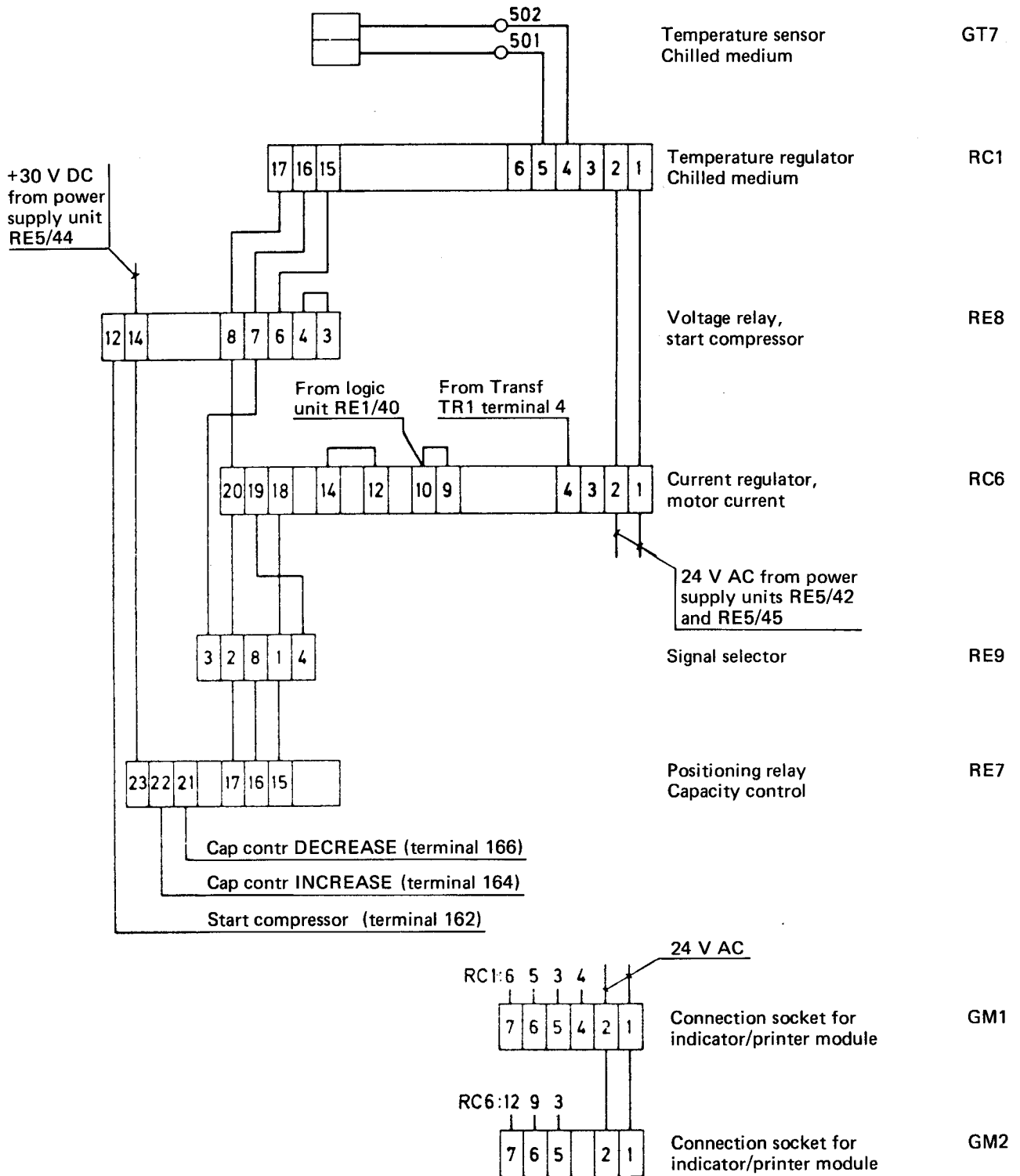


Fig. 8

7827 - J - 50E
 10/14
 TKA 1986-05

STAL-MINI screw compressor



Liquid chiller regulation
 Supplement:
 Set point displacement (outdoor temp.)
 Condenser pressure limitation

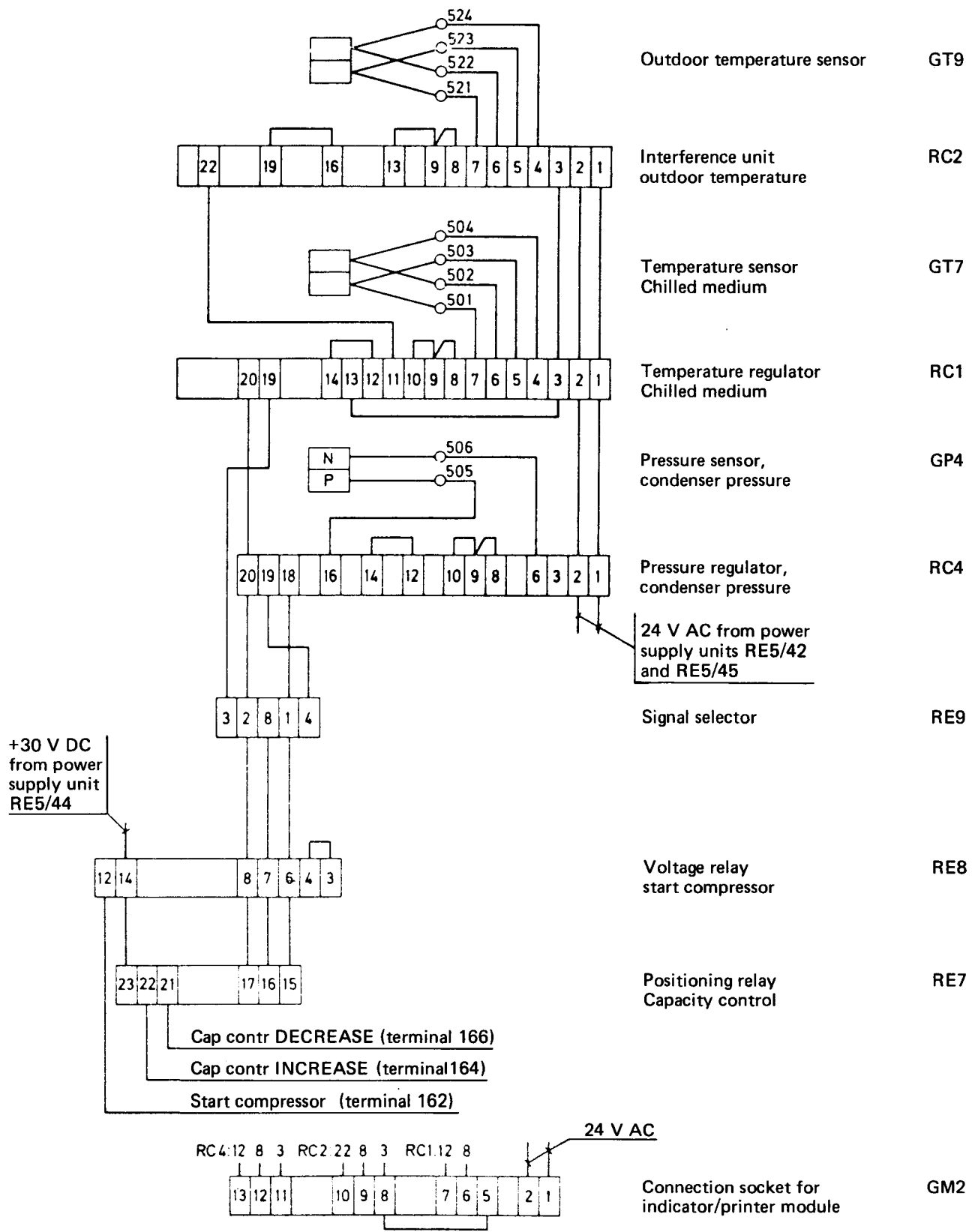


Fig. 9

Liquid chiller regulation
 Supplement:
 Condenser pressure limitation
 Motor current limitation

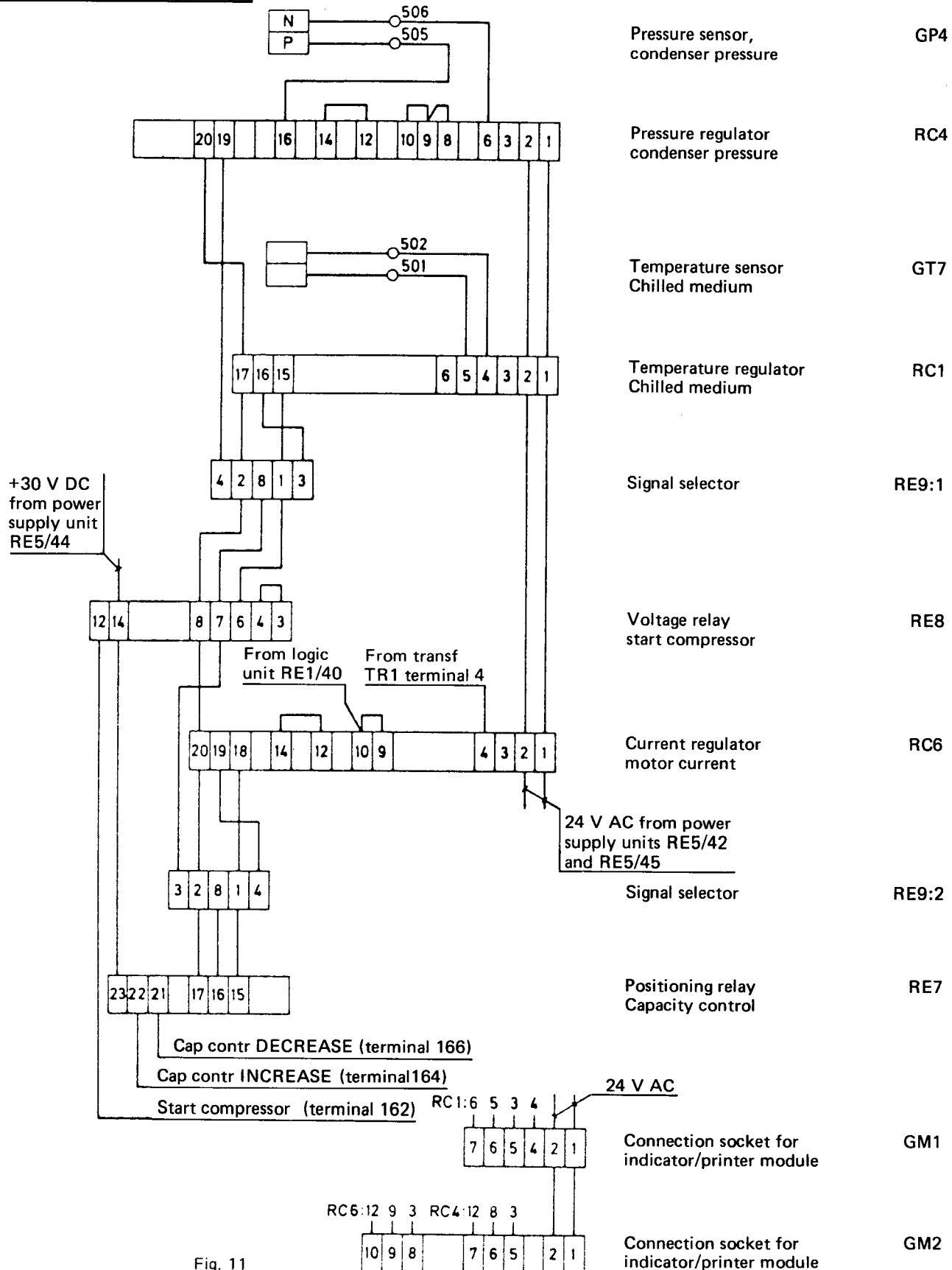


Fig. 11

LIST OF COMPONENTS

Item	Name	Designation	Remarks
RC1	Temperature regulator	3968 1105 801	No set point displacement
RC1	Temperature regulator complete with plug-in modules	3968 1108 801 3968 1110 502 3968 1110 802	Set point displacement range of 0°C to +100°C
RC1	Temperature regulator complete with plug-in modules	3968 1108 801 3968 1110 501 3968 1110 801	Set point displacement range of -100°C to +100°C
RC2	Interference unit complete with plug-in modules	3968 1109 801 3968 1110 801 3968 1110 852 3968 1110 851	
RC4	Pressure regulator complete with plug-in modules	3968 1108 801 3968 1110 502 3968 1110 826	
RC6	Current regulator complete with plug-in modules	3968 1108 801 3968 1110 502	
RE7	Positioning relay	3968 1102 801	
RE8	Voltage relay	3968 1101 801	
RE9	Signal selector	3968 1103 801	
GT7	Temperature sensor chilled medium	3966 2982 030	No set point displacement, range of 0°C to +30°C
GT7	Temperature sensor chilled medium	3966 2982 038	No set point displacement, range of -32°C to +40°C
GT7	Temperature sensor chilled medium	3967 2514 100	Set point displacement
GT9	Temperature sensor outdoor temperature	3967 2513 066	
GP4	Pressure sensor	3966 1830 807	Range of 0 to 25 bar (gauge pressure)
GP4	Pressure sensor	3966 1830 808	Range of 0 to 40 bar (gauge pressure)

HEAT PUMP UNIT, SERIES VR
Regulating Equipment
Stalelectronic 400

GENERAL

Regulating equipment that can control compressor capacity is needed to make certain that a VR unit will be able to maintain the specified temperature in the process. This regulating equipment, which consists of a number of regulator modules, is mounted in an electrical equipment enclosure.

The regulating equipment always includes at least four modules for a heat pump unit:

- a) Temperature regulator (double)
- b) Signal selector
- c) Voltage relay used for starting and stopping
- d) Positioning relay used for capacity control

In addition, there is a temperature sensor that senses the temperature of the leaving chilled and heated medium.

This equipment can be supplemented with additional regulator modules and sensors to implement the functions needed for heated medium temperature displacement based on outdoor temperature, condenser pressure limitation and motor current limitation (see Fig. 1).

In addition to the above, one or two sockets are included for special modules used to present the regulating equipment's current values and set values on a display. A printer can also be connected to these sockets so that measured values can be printed out.

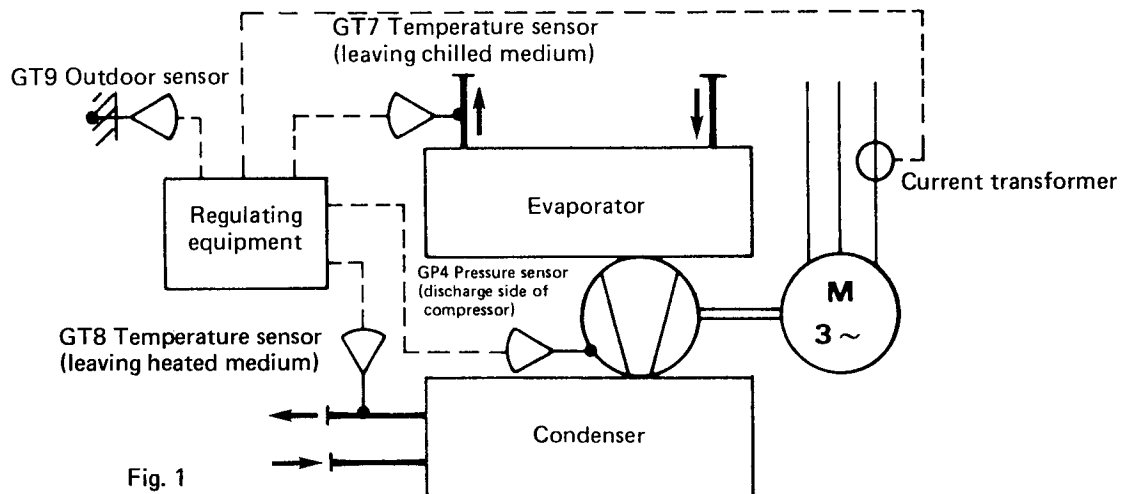
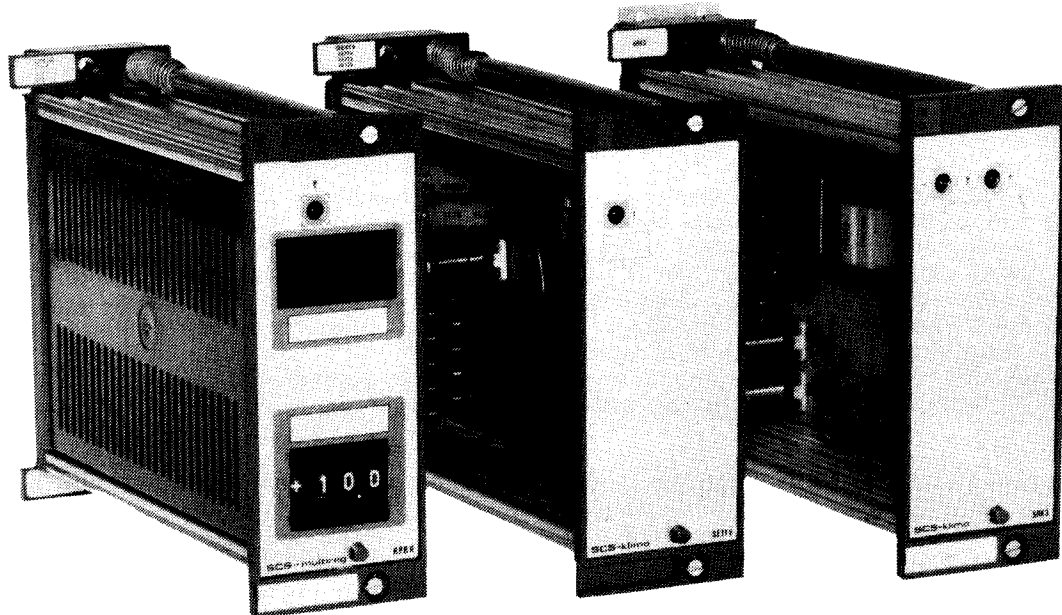


Fig. 1

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OPERATION

The temperature regulator functions as a purely proportional regulator (P-regulator). This means that the output signal from the regulator is proportional to the deviation between the preset set point and the actual current value.

The output signal has a working range of 0 to 20 V (phase cut signal). When the current value is the same as the preset set point, the output signal is 10 V.

By means of a signal selector the lowest signal from chilled and heated medium regulators is selected as a control signal.

This control signal is used to control a voltage relay and a positioning relay. The voltage relay handles the signal used for starting and stopping the compressor, while the positioning relay handles the signals sent to the solenoid valves used for capacity control.

The voltage relay sends a start signal to the logic unit when the control signal reaches a certain presettable level.

From the logic unit, a start signal is sent to the starting devices. If the control signal drops beneath a preset difference from the turn-on level, the start signal is interrupted, thus causing the compressor to stop.

The positioning relay converts the signal selector's signal to a pulsed 3-state signal. When the control signal from the signal selector is 10 V, the positioning relay does not send out any output signal.

If the control signal increases, an output relay in the positioning relay pulls in intermittently and sends out a pulsed signal that causes the compressor capacity to increase. As the voltage of the control signal increases, the ON pulses become longer. Similarly, a second output relay pulls in if the control signal drops beneath 10 V. This output relay sends out a signal that causes the compressor capacity to decrease. These signals control, via the logic unit, the solenoid valves in the compressor that are used for capacity control.

The proportional regulator provides in combination with a positioning relay (of the type used here to control the capacity control system solenoid valves), a function similar to PID (Proportional, Integrating and Differentiating). Consequently, no stationary regulating deviation is obtained while the compressor is running.

A regulator that functions, in principle, in the same way as the temperature regulator can be connected to the system to limit condenser pressure. In such case, a signal selector is used to select the lowest signal from the temperature and pressure regulators. This signal is then used as a control signal for the voltage relay and positioning relay.

The regulating equipment can also be supplemented with a regulator that limits the motor current. Here too, a signal selector is used to select the lowest signal. This signal is then sent to the positioning relay.

Moreover, the system can be supplemented with an interference unit that displaces the heated medium regulators set point on the basis of the outdoor temperature.

Connection diagrams for the different regulating system variants appear in Figs. 4 - 11.

SETTINGS

The set point and P-band (Xp) can be set as desired on the front of each regulator.

For a temperature regulator, the desired temperature is set on the set point potentiometer. For a pressure or current regulator, the set point potentiometer is graduated from 0 to 100. Consequently, its setting corresponds to a percentage of the full range of the pressure sensor or current transformer. If, for example, a pressure sensor having a measurement range of 0 - 40 bar is being used and the set point is set to 65, it corresponds to 65% of 40 bar, i. e. 26 bar.

This also applies to a current regulator. Usually, a current transformer has a full measurement range of 200 A. If the set point is set to 80, it will thus correspond to 80% of 200 A, i.e. 160 A.

The P-band setting will depend in large part on the time constants that are characteristic of the process, and these can vary from application to application. Moreover, the P-band setting will depend on the user's preferences with regard to the size of the control deviation, the starting/stopping frequency, etc.

It is thus impossible to set forth any general setting values. After the initial settings have been made, they should be trimmed (fine adjustment) for the application at hand. These initial settings can be made as shown in Fig. 3, which also presents the setting values for the voltage and positioning relays and the settings of the function switches in the regulator modules. With the possible exception of the voltage relay setting, these settings are never to be changed.

The turn-on level (UE) and its difference (UD) from the turn-off level can be set on the voltage relay. The turn-on delay Δt can also be set on the voltage relay.

Interference unit (Fig. 2)

To displace the set point of the heated medium regulator on the basis of outdoor temperature, you can use an interference unit which contains a measured-value (temperature-to-voltage) converter (3968 1110 801), a measured-value amplifier (3968 1110 852) and a limiter (3968 1110 851).

An outdoor temperature indication can be provided if the interference unit is equipped with a digital indicator module.

The measured-value (temperature-to-voltage) converter converts the temperature signal received from a -100°C to +100°C sensor to a voltage signal (0 V to 10 V). This signal is then amplified suitable in the measured-value amplifier module. The signal sent to the regulator can then be limited to the desired level in the limiter module. The output signal from the interference unit is added to the heated medium temperature current-value signal after the measured-value converter in the regulator.

Since the regulating system tries to keep the current value and the set point equal to each other, the actual current value (at any given set point) will drop as the output from the interference unit rises. This occurs because the current value which the regulator senses is the sum of the actual current value and the output signal from the interference unit. The resultant function is thus equivalent to a reduction of the set point in response to a rise in the output signal from the interference unit.

Examples showing how settings can be made (Fig. 3)

Let's assume that, for a heat pump, you wish to change the temperature of the leaving heated medium as follows:

At an outdoor temperature of -20°C the heated medium temperature is +70°C and when the outdoor temperature drops lower the chilled medium temperature does not rise. At an outdoor temperature of +20°C the heated medium temperature is +20°C, and when the outdoor temperature rises higher the heated medium temperature does not drop.

This means that the heated medium temperature is to be displaced 50°C when the outdoor temperature varies from -20°C to +20°C. The temperature regulator's set point must be set to the desired heated medium temperature at the lower outdoor temperature (in this case +70°C).

The zero-point (A) and the slope (S) are set on the measured-value amplifier module.

The zero-point (A) is set (using code switches A1 - A8) to the voltage that corresponds to the lower outdoor temperature. Since the measured-value converter module in the interference unit provides an output signal that ranges from 0 V to 10 V for a temperature range of -100°C to +100°C a temperature of -20°C corresponds to a voltage of 4.0 V. To provide this, you must set the zero-point (A) to 4.0 V, and this is accomplished by setting A7 to its ON position and all other code switches to their OFF positions. If fine adjustment is necessary, use the potentiometer.

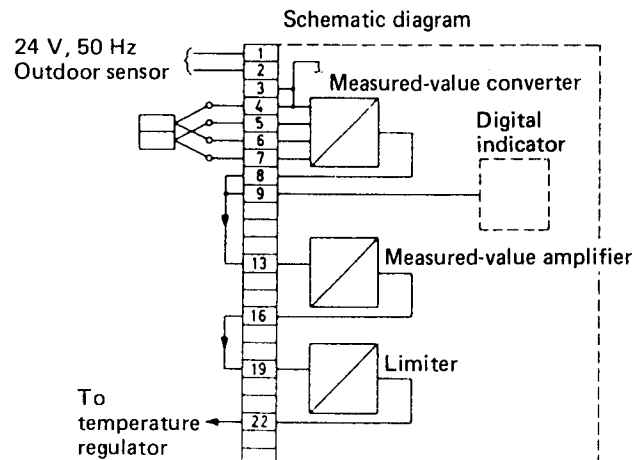
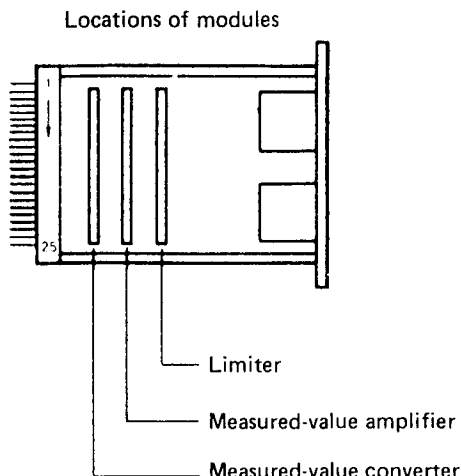
The slope (S) must be set using code switches S1 - S9.

$$S = \frac{\Delta U_{out}}{\Delta U_{in}}$$

ΔU_{in} is the voltage that corresponds to the difference between the highest and the lowest outdoor temperature. In this case, we obtain:

$$6 \text{ V } (+20^\circ\text{C}) - 4 \text{ V } (-20^\circ\text{C}) = 2 \text{ V}$$

INTERFERENCE UNIT



ΔU_{out} is the maximum deviation voltage sent to the regulator. In this example, the set point is to be displaced a maximum of 50°C, and if the regulator contains measured-value converter module (provides an output signal of 0 V - 10 V for a measurement range of 0°C - 100°C), a change of 50°C corresponds to a 0.5 V voltage change.

In this case $S = \frac{5.0}{2} = 2.5$, i. e. S7 and S5 must be at the ON position, and the other code switches must be at their OFF positions.

Here too, fine adjustment can be carried out using the potentiometer if necessary.

The limitation voltage U_B must then be set on the limitation module (3968 1110 851) to the same value as ΔU_{out} . This setting is made using code switches S1 - S4. In this example, $U_B = 5.0 \text{ V}$, S4 and S1 is set in the "ON" position and S2 and S3 in the "OFF" position. The potentiometer must be at its zero position (see below).

However, code switch S5 must always be at the ON position, and the switch marked C1-C2 must always be at position C1.

The zero-point (A) and the slope (S) can be adjusted through $\pm 0.18 \text{ V}$ and $\pm 0.18 \text{ V/V}$ respectively by means of the potentiometers used for fine adjustment. If the situation is such that you do not want these potentiometers to have any effect, they should be set to their mid-points. You can set them to their approximate mid-points as follows:

Turn the adjustment screw in either direction until you hear a ratcheting sound (indicates that the potentiometer is at its end position). Then turn the adjustment screw 16 turns in the opposite direction.

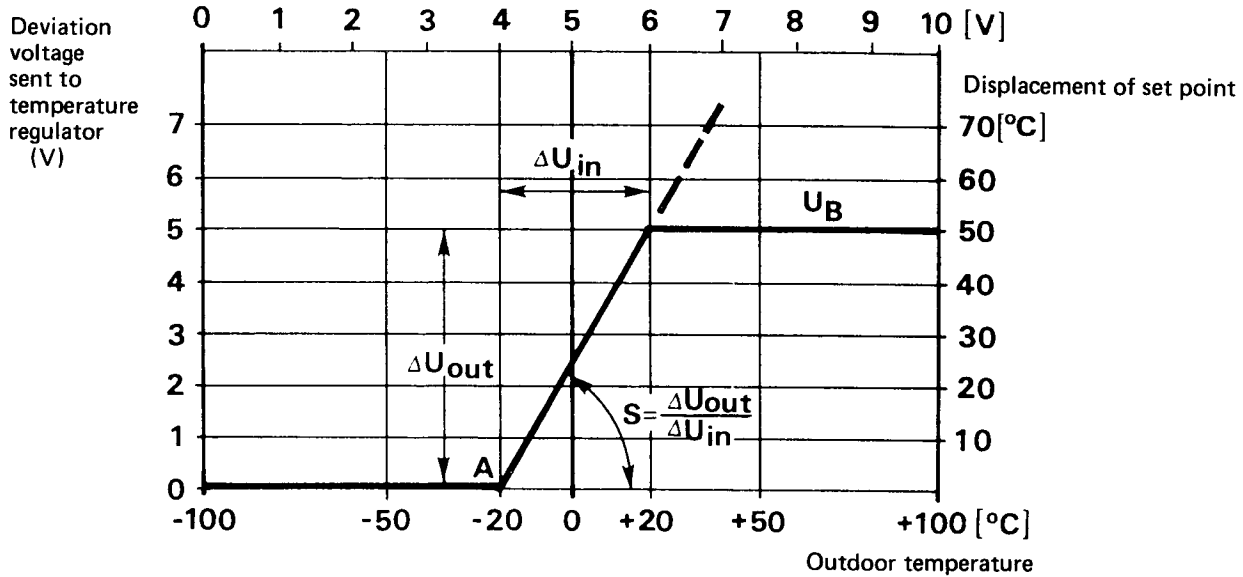
The potentiometer used for the limitation voltage (U_B) has a working range of 0 to 1 V. When the adjustment screw is turned anti-clockwise to its end position (where you will hear a ratcheting sound as mentioned above), it is at the 0 V position. The entire working range of 1 V corresponds to 32 turns clockwise from this zero-position.

Fig. 2

STAL-MINI screw compressor

EXAMPLES SHOWING HOW SETTINGS CAN BE MADE

Output signal from measured-value converter module in interference unit

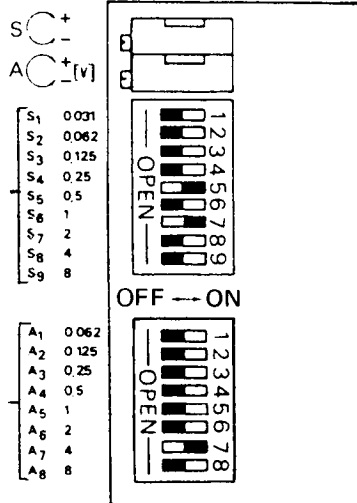


Fine adjustment of slope S
Fine adjustment of zero-point A

Coarse adjustment of slope S (cumulative code switch)

Coarse adjustment of zero-point A (cumulative code switch)

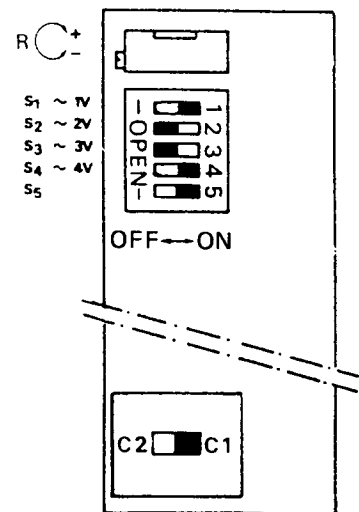
Measured-value amplifier



UB setting

Fine adjustment using multiturn potentiometer R
Coarse adjustment using cumulative code switches S1 ... S4

Limiter



(Black indicates depressed switch actuator)

Fig. 3

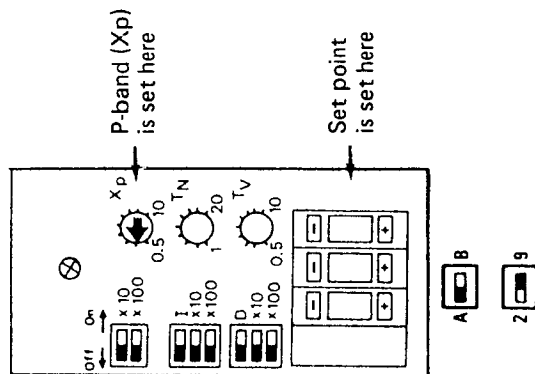
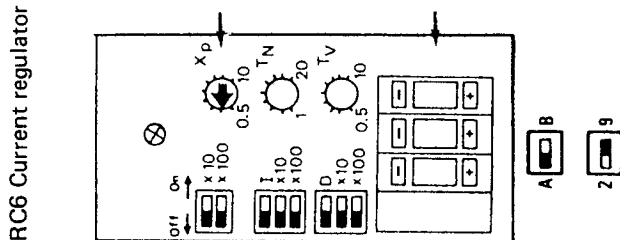
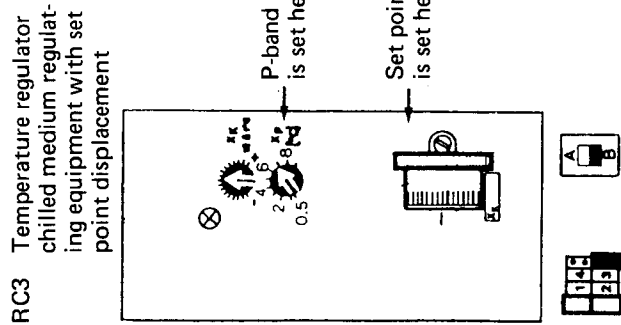
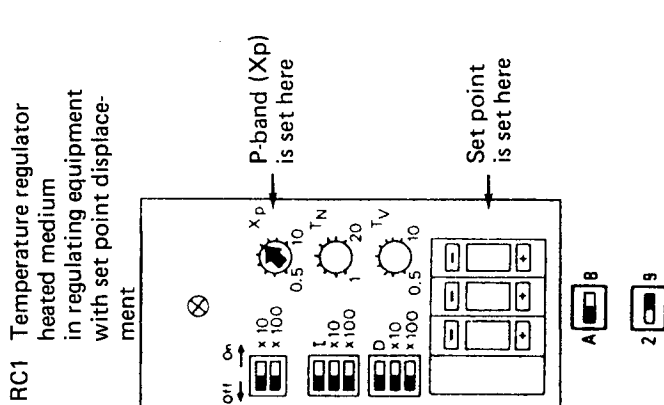
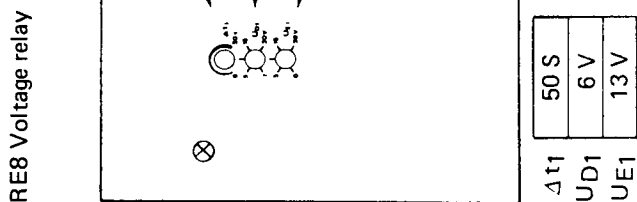
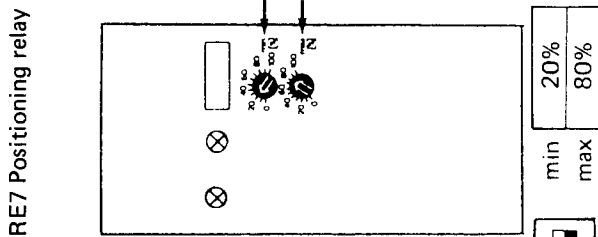
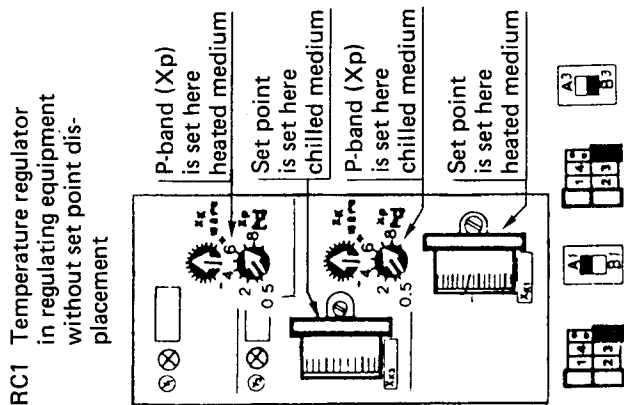


Fig. 4 Examples of settings. For pushbutton switches, black indicates a depressed actuator.

Heat pump regulation with limitation
 against low chilled medium temperature
 (standard arrangement)

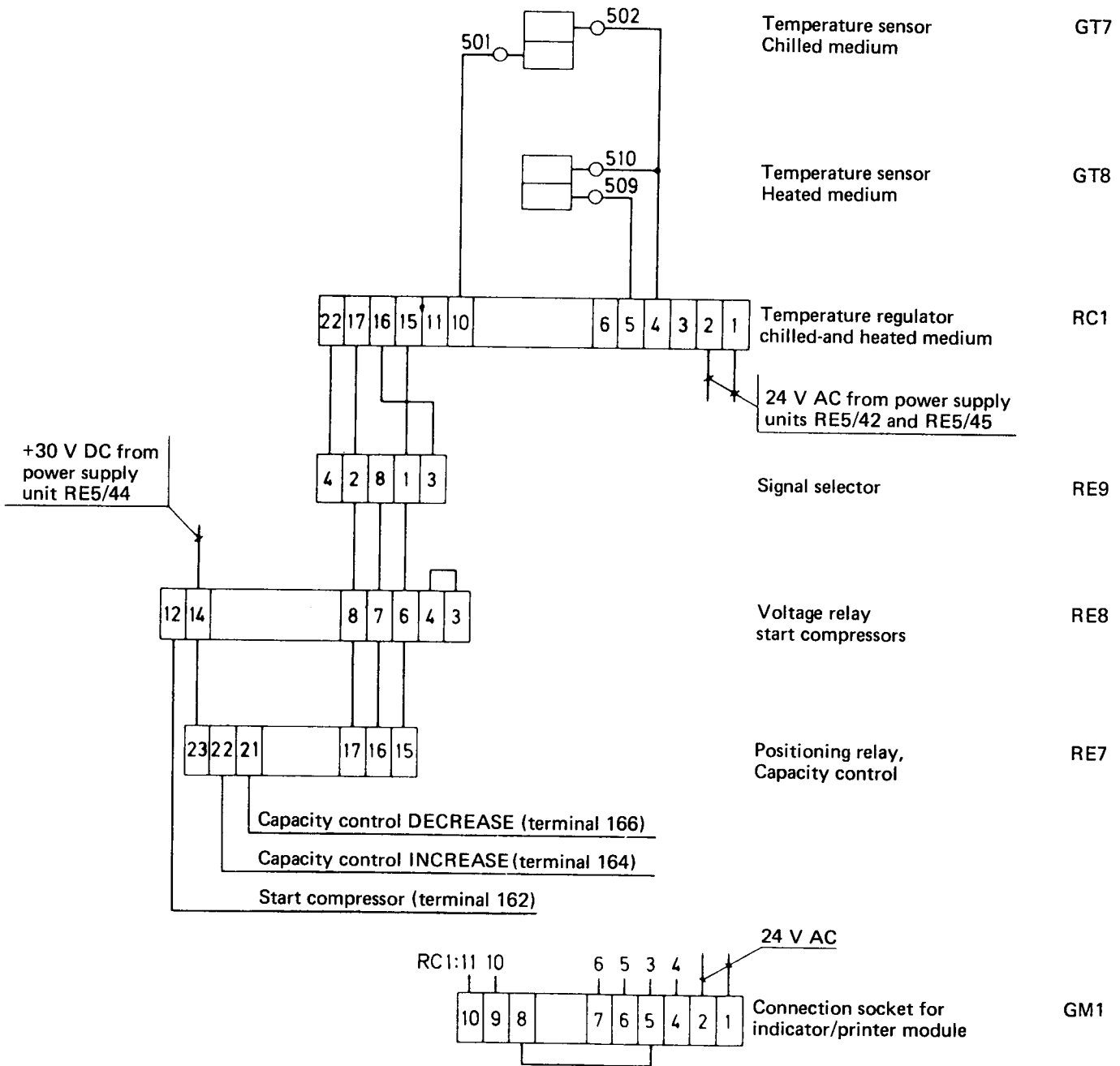


Fig. 5

Heat pump regulation with limitation against low chilled medium temperature
Supplement:
Set point displacement (outdoor temp.)

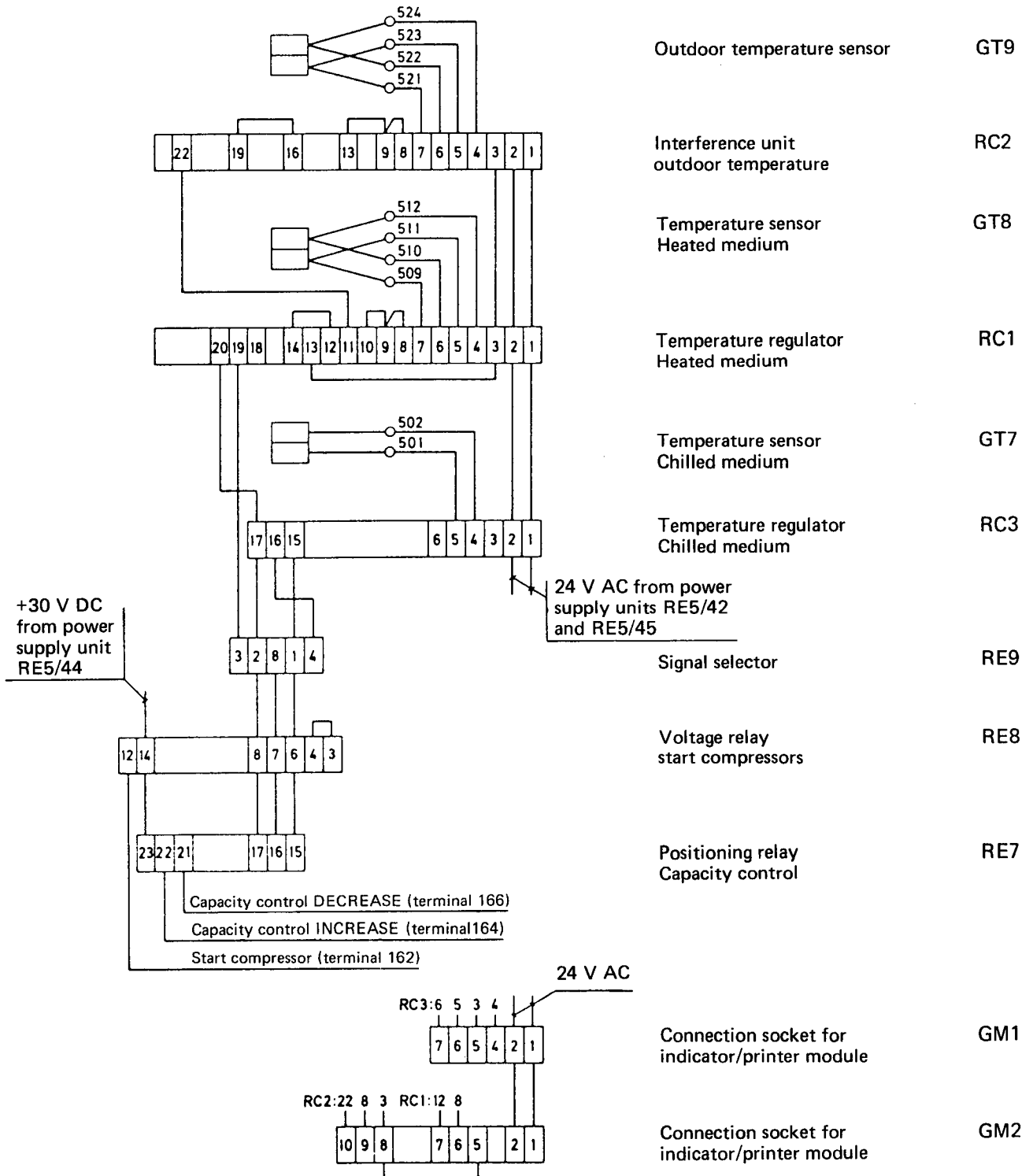


Fig. 6

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Heat pump regulation with limitation
 against low chilled medium temperature
 Supplement:
 Condenser pressure limitation

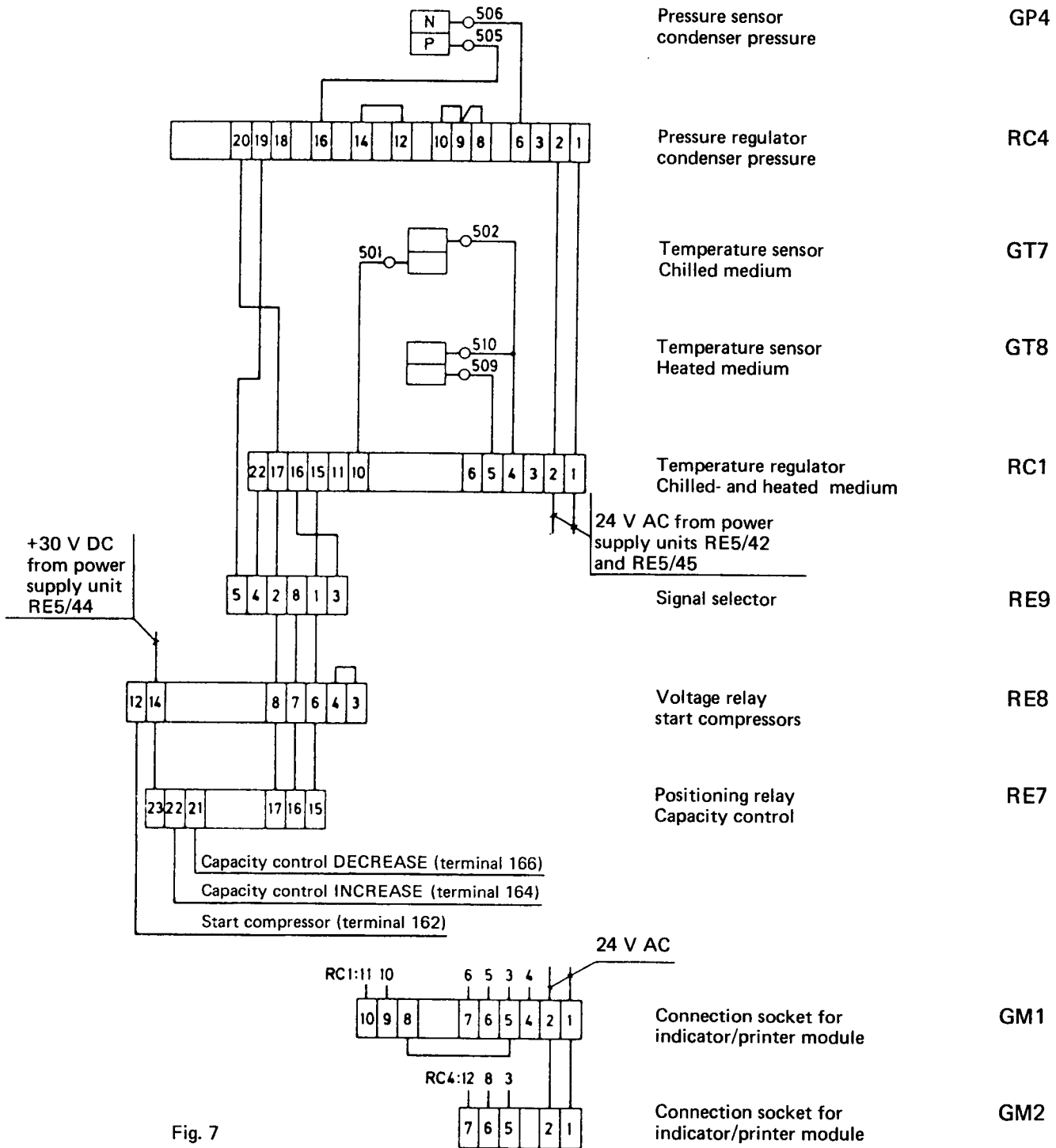


Fig. 7

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Heat pump regulation with limitation against low chilled medium temperature
Supplement:
Motor current limitation

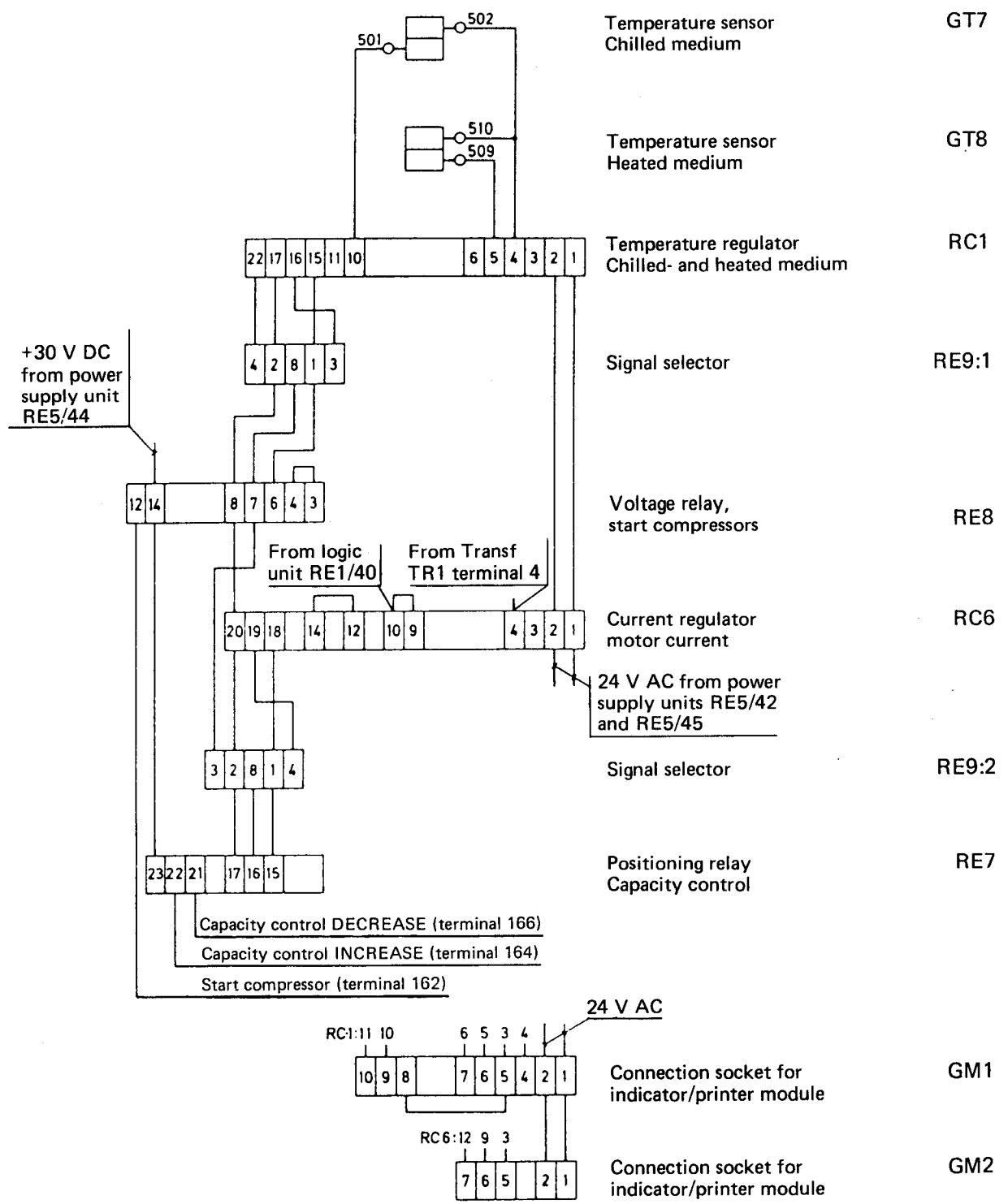


Fig. 8

Heat pump regulation with limitation
 against low chilled medium temperature
 Supplement:
 Set point displacement (outdoor temp.)
 Condenser pressure limitation

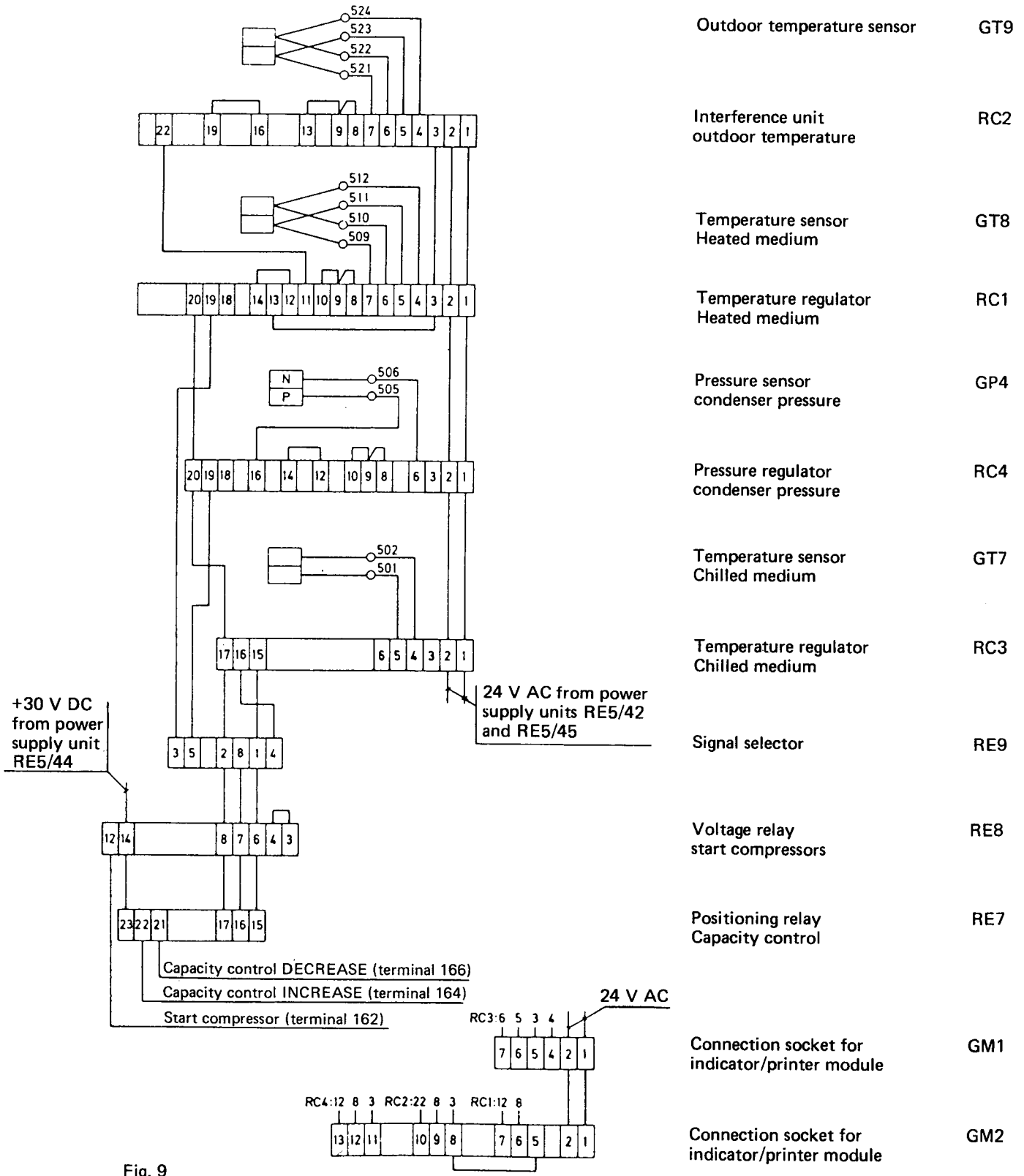


Fig. 9

Heat pump regulation with limitation against low chilled medium temperature
Supplement:
Set point displacement (outdoor temp.)
Motor current limitation

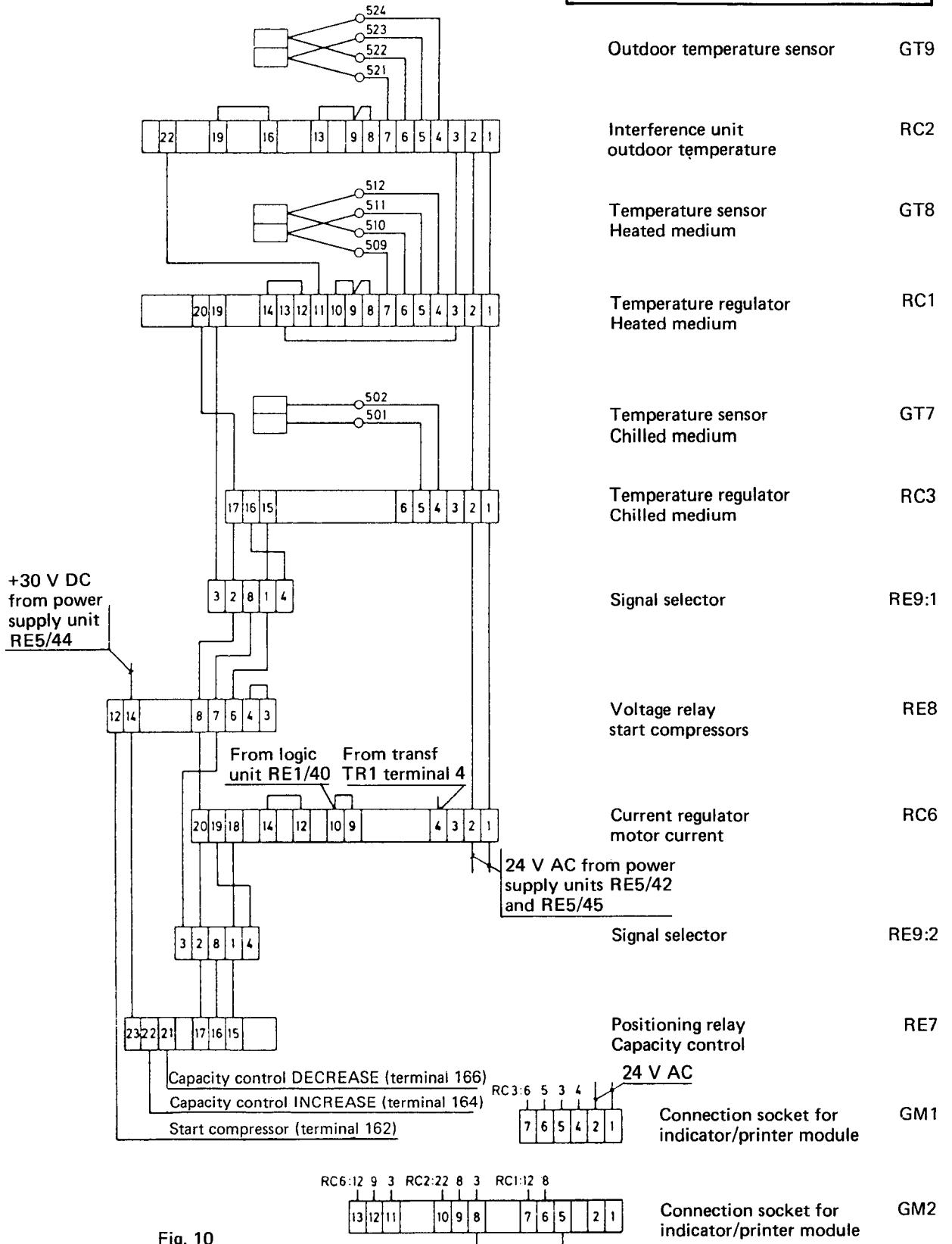


Fig. 10

Heat pump regulation with limitation
 against low chilled medium temperature
 Supplement:
 Condenser pressure limitation
 Motor current limitation

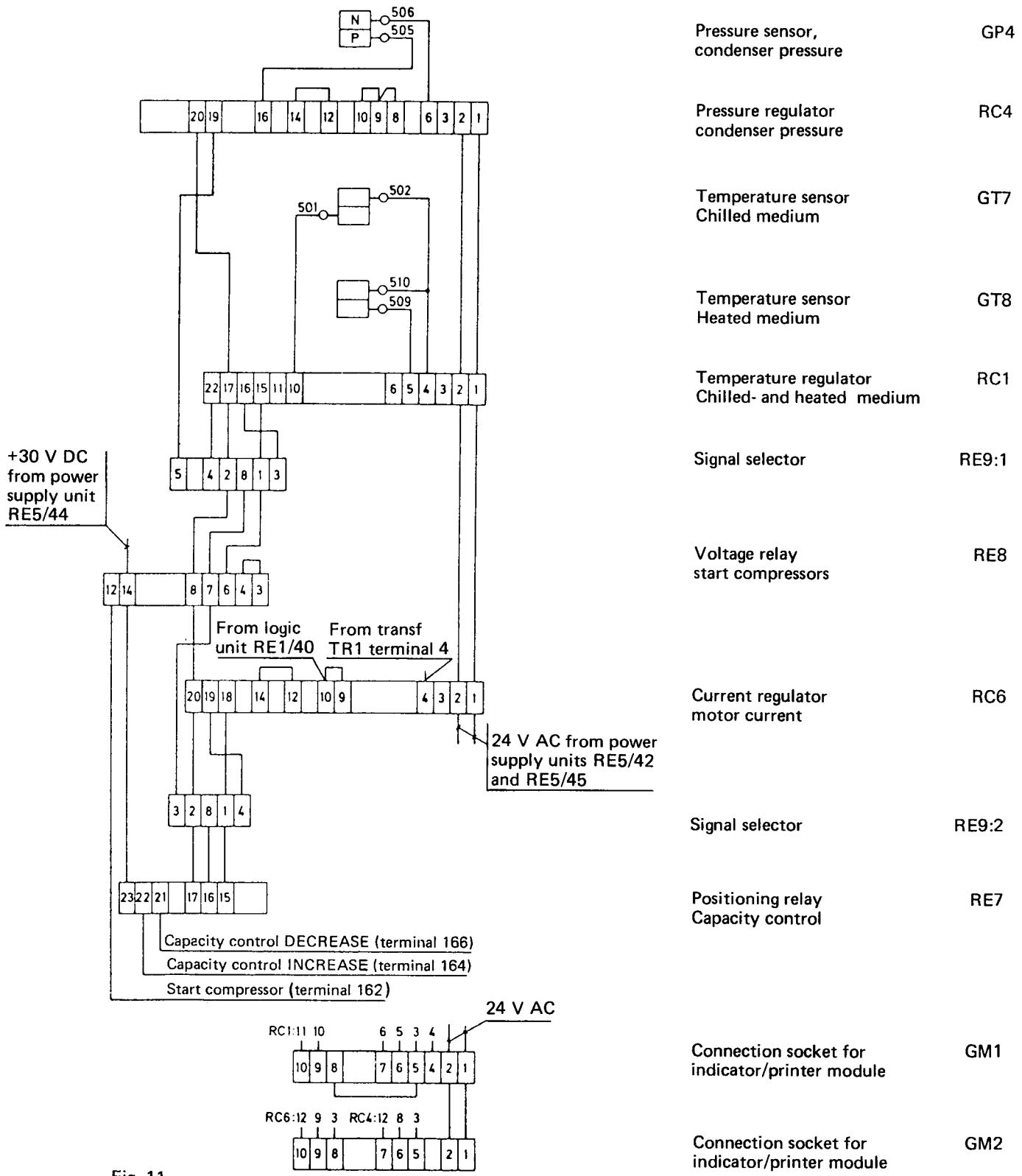


Fig. 11

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Heat pump regulation with limitation against low chilled medium temperature
 Supplement:
 Set point displacement (outdoor temp)
 Condenser pressure limitation
 Motor current limitation

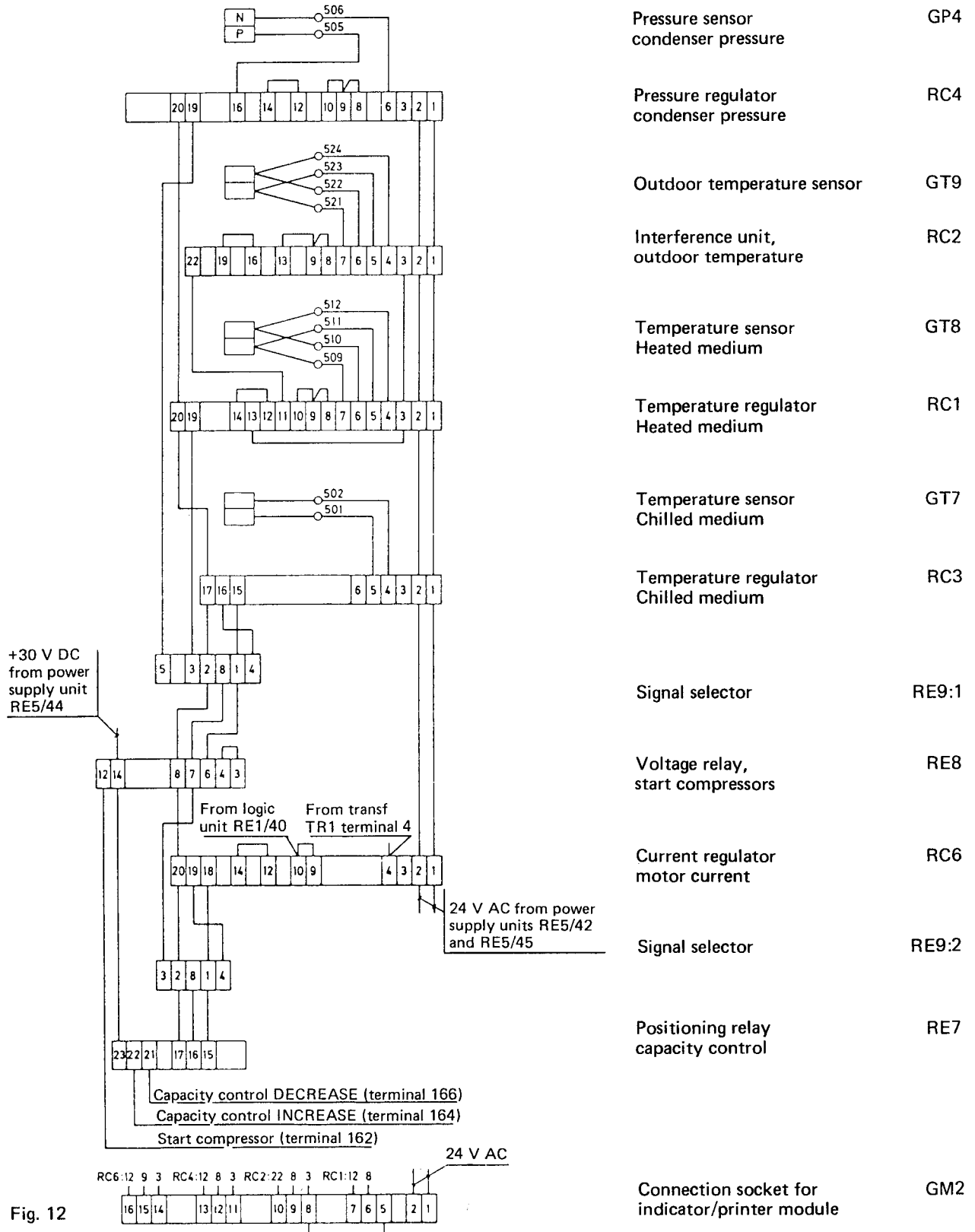


Fig. 12

LIST OF COMPONENTS

Item	Name	Designation	Remarks
RC1	Temperature regulator	3968 1106 801	No set point displacement
RC1	Temperature regulator heated medium complete with plug-in modules	3968 1108 801 3968 1110 502 3968 1110 802	Set point displacement of heated medium displacement
RC2	Interference unit complete with plug-in modules	3968 1109 801 3968 1110 801 3968 1110 852 3968 1110 851	
RC3	Temperature regulator chilled medium	3968 1105 801	Set point displacement of heated medium temperature
RC4	Pressure regulator complete with plug-in modules	3968 1108 801 3968 1110 502 3968 1110 826	
RC6	Current regulator complete with plug-in modules	3968 1108 801 3968 1110 502	
RE7	Positioning relay	3968 1102 801	
RE8	Voltage relay	3968 1101 801	
RE9	Signal selector	3968 1103 801	
GT7	Temperature sensor chilled medium	3966 2982 030	range of 0°C to +30°C
GT7	Temperature sensor chilled medium	3966 2982 038	range of -32°C to +40°C
GT8	Temperature sensor heated medium	3966 2982 105	No set point displacement
GT8	Temperature sensor heated medium	3967 2514 100	Set point displacement of heated medium temperature
GT9	Temperature sensor outdoor temperature	3967 2513 066	
GP4	Pressure sensor	3966 1830 807	range of 0 to 25 bar (gauge pressure)
GP4	Pressure sensor	3966 1830 808	range of 0 to 40 bar (gauge pressure)

OPERATING SYSTEM STALELECTRONIC 400 Component description

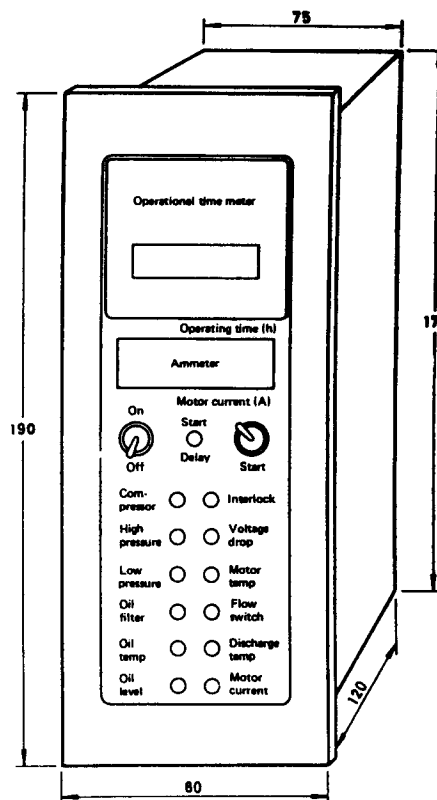
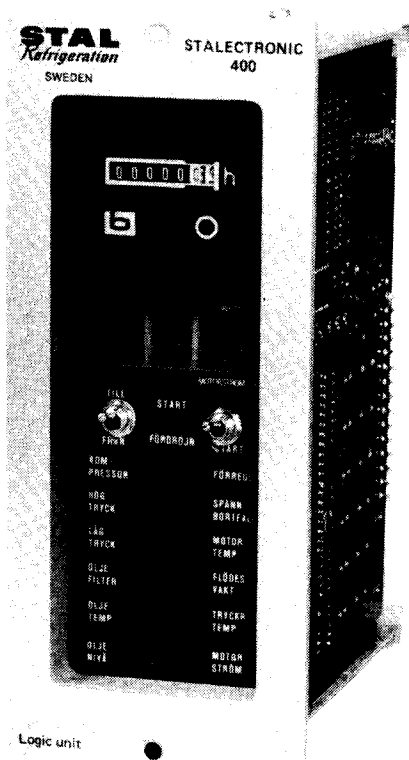
This manual sheet presents a general description of the functions of all of the components included in the STALELECTRONIC 400 operating system.

A separate manual sheet tells how these components are connected to, each other, to the regulating equipment and to the external devices.

Design and construction

The logic unit contains four circuit boards and an operational time meter, all of which are mounted in an aluminium frame which, in turn, is mounted in the cabinet door. Wires are connected via terminals mounted on strips on the rear of the logic unit. The circuit boards are mounted in slots, so that they can easily be removed if replacement becomes necessary.

LOGIC UNIT



3968 1190 1..

General

The electronic logic unit handles compressor operation. It also contains a motor current indicator and a operational time indicator. Light-emitting diodes on the front indicate triggered safety monitoring switches, certain start conditions and compressor running/idle. The front panel also contains an ON/OFF switch and a switch used to reset the monitoring functions.

Power supply unit

The logic unit is supplied with power from power supply unit 3968 1190 410. The internal electronics as supplied with 16 V DC which, via voltage regulators in the logic unit, is converted to stabilized 12 V DC and 5 V DC.

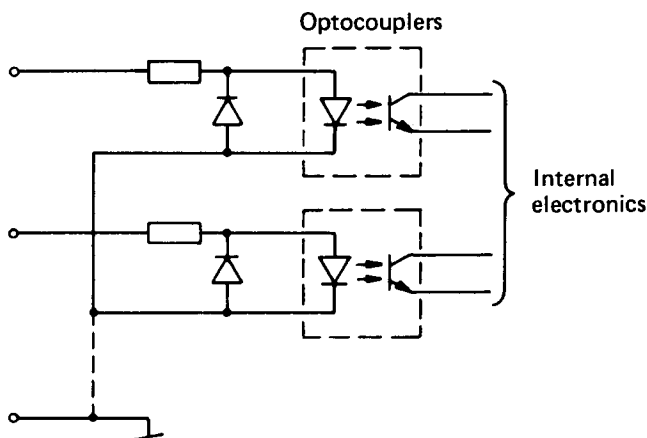
30 V DC is used for the monitoring functions and incoming control signals. The output voltage for the starting equipment, the solenoid valves and the operational time meter is 24 V AC.

Inputs

- Oil temperature cut-out
- Motor temperature cut-out
- Low-pressure cut-out
- High-pressure cut-out
- Oil level switch
- Discharge temperature cut-out
- Oil pressure cut-out (differential pressure)
- Motor current cut-out
- Flow switch/starter
- Pump-out function
- Interlock circuit
- Start compressor
- INCREASE capacity
- DECREASE capacity

The following monitoring-function inputs are galvanically isolated from the internal electronics via optocouplers: interlock, pump-out function, start signal and capacity control signals.

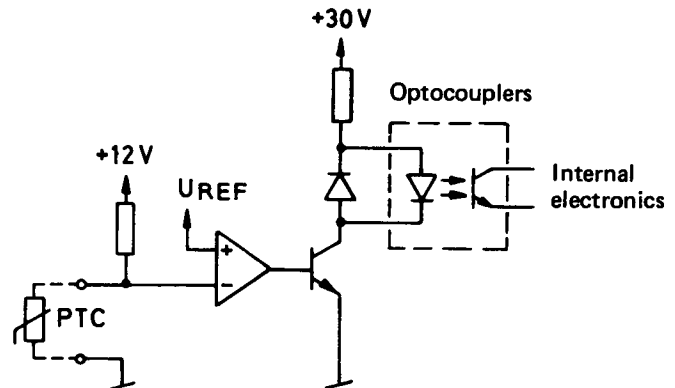
Schematic diagram



The inputs are supplied with +30 V DC via monitor and control devices (thermostats, pressostats and other regulating equipment). An open circuit indicates a triggered monitoring function, thereby stopping the compressor. This arrangement prevents an open circuit in an external wire or cable (for example) from disabling any of the monitoring switches.

The monitor inputs used for motor temperature and oil temperature differ from those described above; they are designed for PTC thermistors.

Schematic diagram

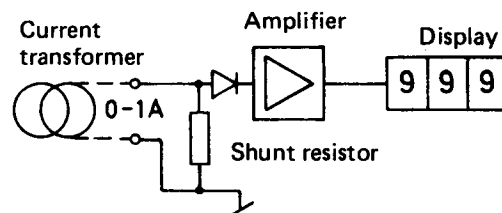


The thermistor (in series with a fixed resistor) is supplied with +12 V. The voltage drop, which varies depending on the thermistor's resistance, is compared with a reference voltage. If the voltage drop is high (high resistance), the monitoring function is triggered. These monitor inputs are also galvanically isolated from the internal electronics via optocouplers. The monitoring function for the oil temperature is triggered at 1.2 kohms and restored at 330 ohms. The monitoring function for a motor temperature is triggered at 1.7 kohms and restored at 950 ohms.

A zero-potential contact function can also be connected to these monitor inputs. In such case, they perform the same functions as the other monitor inputs.

A current transformer with a secondary current of 1A can be connected to the logic unit. This current causes a voltage drop across a resistor. This voltage drop is amplified and sent to a 3-digit display which indicates motor current.

Schematic diagram

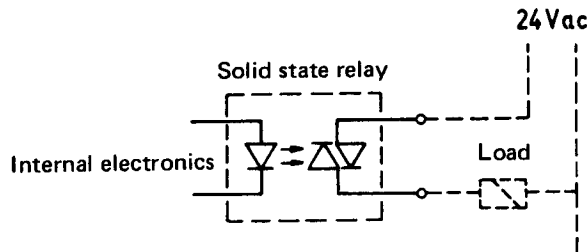


Outputs

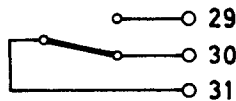
- H } Control of start equipment
- D }
- Y }
- INCREASE solenoid valve
- DECREASE solenoid valve
- Liquid-line solenoid valve
- Collective alarm
- Alarm unit for individual alarms
- DC signal (motor current)

The outputs used to control the start equipment and solenoid valves are galvanically isolated from the internal electronics via a solid state relay that operates on 24 V AC.

Schematic diagram



These is a built-in relay for the collective alarm. Its zero-potential transfer contact can be used to send out fault indications. A maximum of 48 V (max 5 A) can be connected.



Terminals 29 to 31 are connected together for an alarm. If an outgoing signal is desired for each individual alarm (rather than a collective alarm), it is possible to connect an individual alarm unit via a flat cable.

A 0 - 10V DC signal that is proportional to the motor current sensed by the current transformer is available. It is intended for regulating equipment provided with motor current limitation. The 0 - 10 V DC corresponds to 0 - 100% of the current transformer's measurement range (ordinarily 200 A).

Operation

Start

The following condition must be present for the logic unit to permit the compressor to start:

- Switch on front panel at ON position.
- and
- No monitoring function triggered
- and
- Start delay time has expired
- and
- Interlock circuit closed
- and
- Start signal (from control equipment) is present

If no monitoring function has been triggered, the light-emitting diodes associated with the monitoring functions will all be extinguished. If the interlock circuit is closed, the green light-emitting diode on the front panel will be lighted. While the start delay is in effect, a yellow-emitting diode on the front panel is lighted. The start delay time is 10 minutes, and it can be implemented in one of two ways: start-start or stop-start. The start delay time can be bypassed by pressing the spring-return switch labeled START. Pressing this switch reduces the start-delay time to one minute (measured from the previous stop).

When the compressor is started, outputs H and Y (to starter) and the outputs for the liquid-line solenoid valve are all energized. The green light-emitting diode marked COMPRESSOR lights up. After about 7 s, the Y output is de-energized and the D output is energized. Simultaneously, the capacity control system is released, i. e. the statuses of the inputs determine which solenoid valve is to be energized. (Previously during the starting cycle, the output for the DECREASE solenoid valve was energized, regardless of the statuses of the inputs). When the compressor is started, it is possible for you to select delayed capacity increase. In such case, the output used for the DECREASE solenoid valve is energized (output used for the INCREASE solenoid valve is de-energized) for three minutes after start-up prior to the release of the capacity control system.

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4815/7827 - N - 120E
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Kp 1985-09

STAL-MINI screw compressor

STAL
REFRIGERATION

Stop

A stop command is issued when:

- The switch on the front panel is set to the OFF position
- or
- One of the monitoring functions has been triggered
- or
- The interlock circuit is broken
- or
- The start signal is interrupted

When the compressor is stopped, the following outputs are de-energized: H, D, (Y), liquid-line solenoid valve and INCREASE solenoid valve. Moreover, the DECREASE solenoid valve output is energized.

A function switch permits you to enable the pump-out function. If the interlock circuit or start signal circuit is broken — and the pump-out function is enabled — only the liquid line solenoid valve output is de-energized at first. Consequently, the compressor stops later, when the pump-out is de-energized.

Monitoring functions

An immediate stop occurs if any of the following monitor inputs is de-energized: high-pressure, discharge temperature, motor current, motor temperature or oil temperature. A red light-emitting diode on the front panel lights to indicate which monitoring function is triggered.

If any of the following inputs is de-energized, the stop command is delayed 30 s: flow-switch/starter, oil filter or oil level. If the following input is de-energized, the stop command is delayed 60 s: low-pressure cut-out.

For the above 30-s and 60-s delay inputs, a red light-emitting on the front panel also lights to indicate which monitoring function has been triggered. These delayed monitoring functions do not cause a fault signal to be issued when the individual inputs are de-energized as long as the logic unit does not issue a signal to the starter (i. e. compressor is in operation).

Triggered monitoring functions are reset by means of the spring-return switch marked START on the front panel. However, you can select automatic restarting for the low-pressure and oil temperature cut-out functions. As a result, it is not necessary to carry out a reset operation by means of the START switch; instead, the compressor is started automatically when (and if) the monitor input is energized again (if the other start conditions are met).

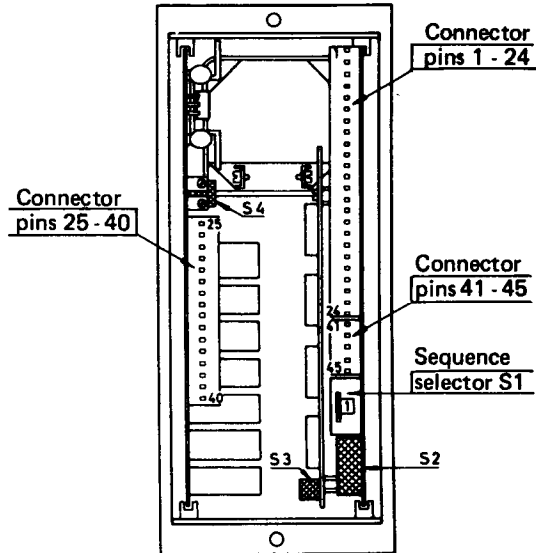
The relay contact that is used for the collective alarm changes state when a monitoring function is triggered. Note, however, that this does not take place if a monitoring function for which automatic restarting has been selected is triggered.

Voltage drop

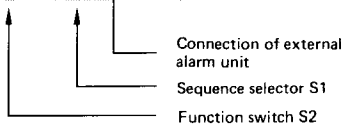
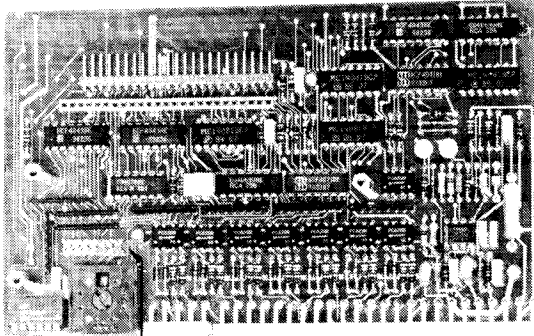
Naturally, the compressor is stopped immediately if the power supply is interrupted for any reason. Here too, you can select either manual or automatic restarting. If the incoming power has been out and is then restored, the yellow light-emitting diode on the front panel marked VOLTAGE DROP lights up. This condition can be reset (light-emitting diode extinguished) by means of the START switch.

Settings

There are a number of switches (S1-S4) on the circuit boards. These are used to select different operational functions.

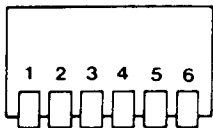


Sequence selector S1 must always be set to 1 if a single screw compressor unit is being controlled.



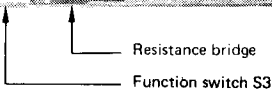
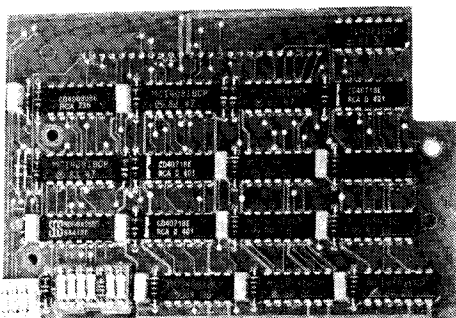
Function switch S2:

■ = depressed

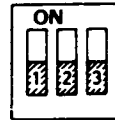


- 1 Automatic restart after low suction pressure
- 1 Manual restart required after low suction press.
- 2 Automatic restart after low oil temperature
- 2 Manual restart required after low oil temperature
- 3 Not used for screw compressor unit.
- 4 Start delay between starts (start-start);
- 4 Start delay between stop and start (stop-start).
- 5 Manual restart after voltage drop
- 5 Automatic restart after voltage drop.
- 6 Flow switch stops the compressor unit unconditionally in the event that flow is interrupted
- 6 Flow switch does not send a fault signal if the chilled medium pump is stopped (interlock circuit is broken).

Switch 6 is always depressed for a compressor unit of the RV type

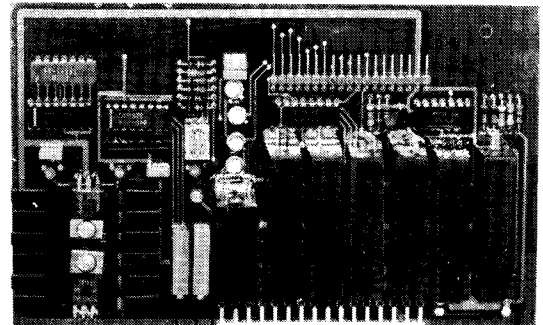
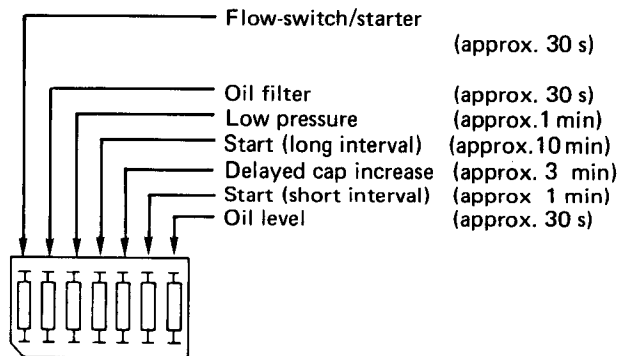


Function switch S3:

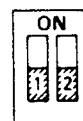


- 1 ON Pump out
OFF No pump out
- 2 Not used for screw compressor unit (must always be at the OFF position).
- 3 ON Normal capacity control after startup.
OFF Delayed capacity increase after startup.

The delay times that are built into the logic unit are determined by RC links. The resistors used in these links are mounted on a resistance bridge connected via an IC socket. The delay is about 0.6 – 0.9 s/kohm.



Current range selector S4
Potentiometer P2
Potentiometer P1



- 1 OFF } 200 A (current transformer 200/1A)
- 2 ON }
- 1 OFF } 300 A (current transformer 300/1A)
- 2 OFF }

Potentiometers P1 and P2 are used to adjust the ammeter. P1 is used to set the 0-point, and P2 is used to set the gain (slope).

Product numbers

Complete logic unit,
RV version: 3968 1190 15 ..

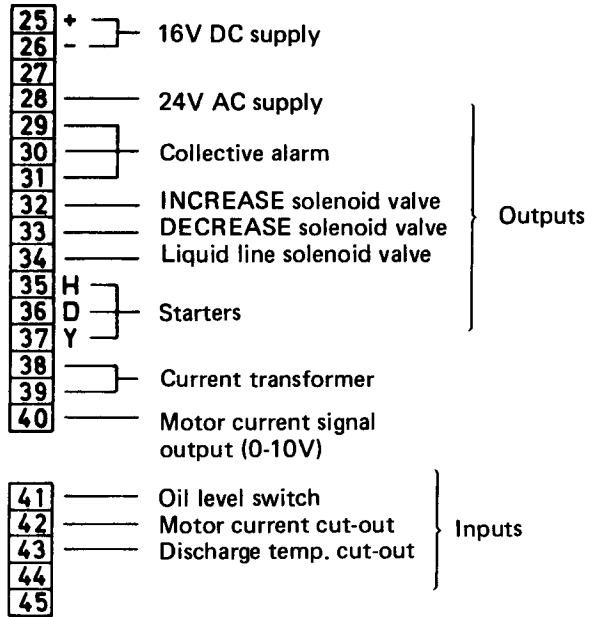
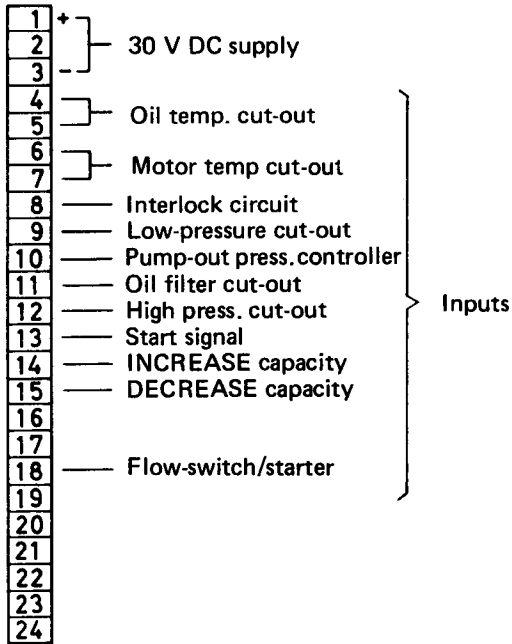
Complete logic unit,
VR version: 3968 1190 14 ..

Swedish legends = 0
English legends = 5
German legends = 6

The RV version and VR version differ only with regard to one of the legends on the front panel. The RV version has the word **STARTER** beside one of the light-emitting diodes, while the VR version has the words **FLOW SWITCH** beside this same light-emitting diode.

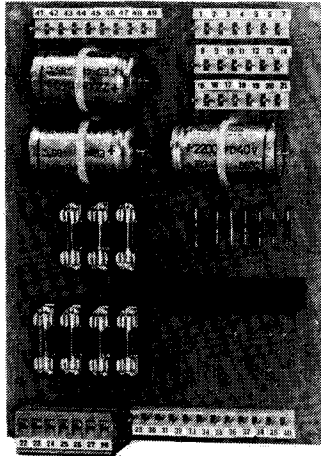
Connector

Pin assignments



Unused pins are intended for certain special functions that are implemented for reciprocating compressor units.

POWER SUPPLY UNIT



3968 1190 410

General

Power supply unit 3968 1190 410 is used for the regulating equipment plus up to three logic units 3968 1190 1...

Operation

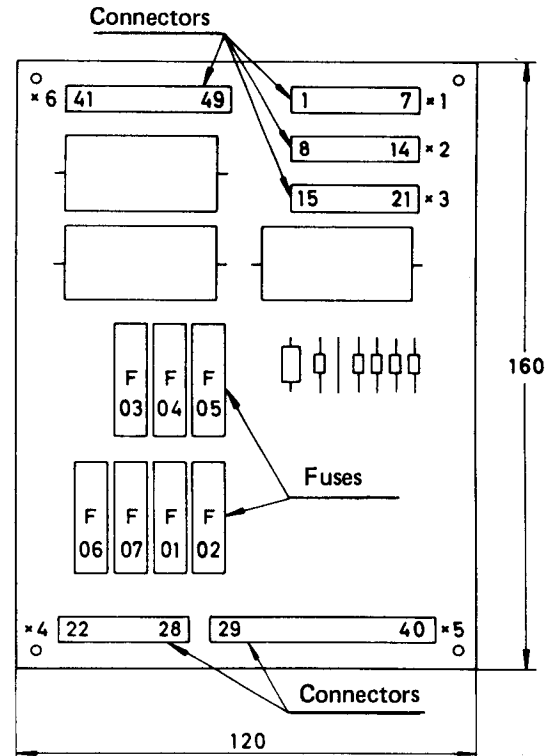
A transformer provides the power supply unit with 24V AC, 2V AC and 12V AC. These voltages are rectified and smoothed to 30 V DC and 16 V DC. The necessary fuses (glass-tube fuses measuring 5 x 20 mm) are mounted in the power supply unit.

Fuses

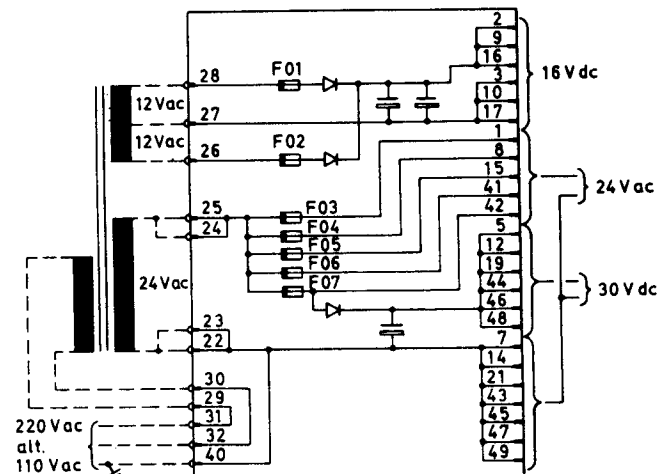
Position	Rating	Voltage	Connected equipment
F01	3.15A	16V DC	Internal power supply for logic units
F02	3.15A		
F03	6.3A Slow-blow	24V AC	Solenoid valves, operational time meter and starters for compressor 1
F04	6.3A Slow-blow	24V AC	Solenoid valves, operational time meter and starters for compressor 2
F05	6.3A Slow-blow	24V AC	Solenoid valves, operational time meter and starters for compressor 3
F06	6.3A Slow-blow	24V AC	Equipment to be added in the future
F07	6.3A Slow-blow	24V AC	Regulating equipment
		30V DC	Monitoring switches and operational fault panel

Connections

Incoming and outgoing cables are connected via connectors. As a result, the power supply unit can be easily disconnected if replacement should become necessary.



Schematic diagram

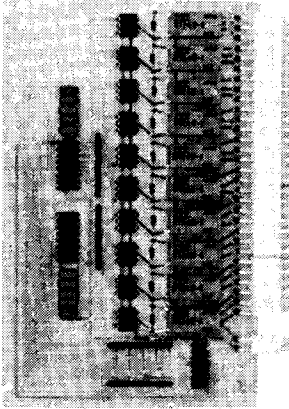


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ALARM UNIT

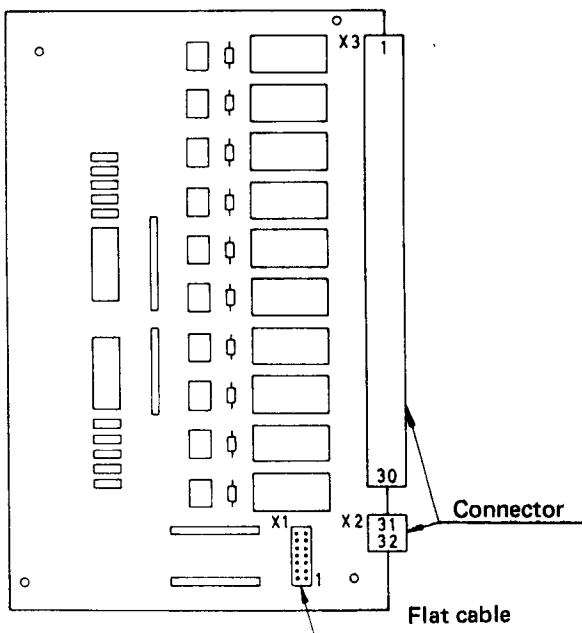


General

The alarm unit is designed for connection to logic unit 3968 1190 --, in situations where individual outgoing fault indications are desired for each individual alarm (as opposed to a collective alarm).

Operation

The alarm unit receives a signal from the logic unit when a monitoring function is triggered. This signal pulls in a relay via an optocoupler. The optocoupler provides galvanic isolation from the logic unit. The relay coil is supplied with 30 V DC. Each relay (one for each individual alarm) has a zero-potential transfer contact that is used for external fault indication.

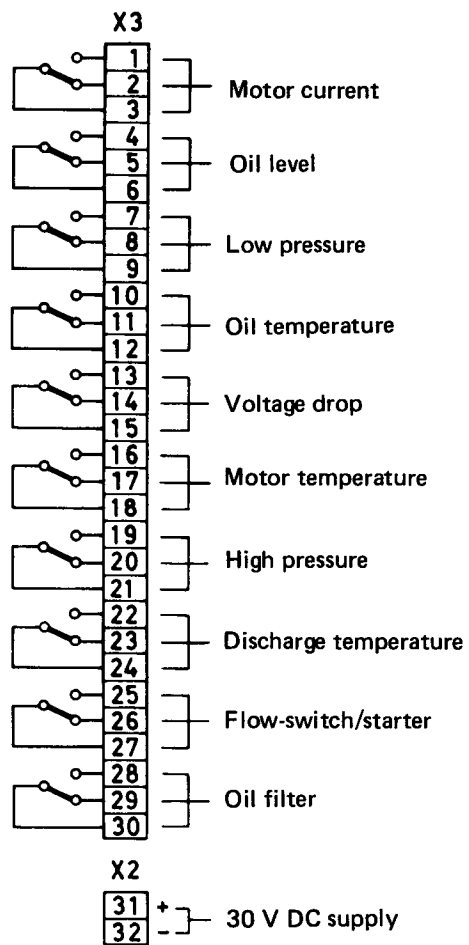


Connections

The logic unit is connected to the alarm unit via a flat cable. Two connectors (terminal strips) are provided for connection of the relay contacts and the supply voltage. As a result, the alarm unit can be easily disconnected in the event that replacement becomes necessary. The relay contacts can be connected to a maximum of 48 V (max 1.25 A).

Terminal strips (connectors)

Pin assignments



STALELECTRONIC 400
Regulating Equipment
Component description

GENERAL

The regulating equipment used for the RV series and VR series comprises different components. These components can be grouped as follows:

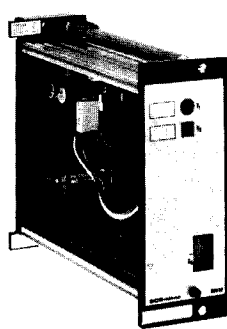
1. Regulators
2. Measuring transducer
3. Actuators
4. Sensors

This manual sheet presents a general description of these components, including technical data, operation etc.

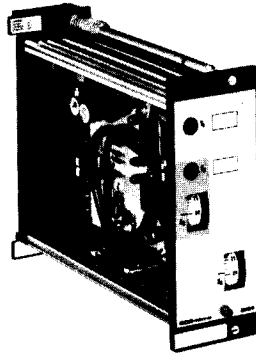
The overall architecture of the regulating system and the ways in which the components interact are described in separate manual sheets.

1. REGULATORS

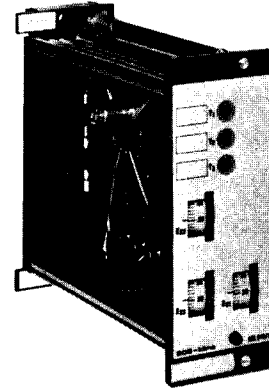
P-regulators



3968 1105 801



3968 1106 801



3968 1107 801

P-regulators

These are used in control circuits where a narrow P-band can be accepted for stable operation since a remaining control deviation is utilized.

- 3968 1105 801: Regulator with P-function and one continuous output, 0...20V DC.
 3968 1106 801: Two regulators of the above type.
 3968 1107 801: Three regulators of the above type

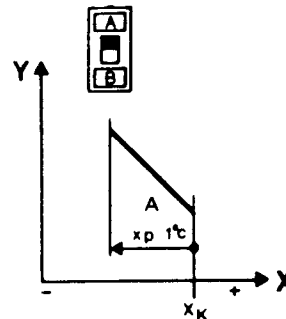
OPERATION

This electronic regulator is a complete unit that includes a rectifier, measurement bridge and amplifier. The incoming sensor signal is compared with the preset setpoint, and any deviation is sent to the final amplifier which provides a continuous 0...20V DC output signal (designated 9).

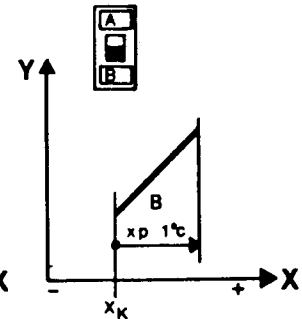
An indicator lamp at each output indicates the strength of the output signal.

Mounted on the regulator circuit board is an internal switch used to select the operating mode. This board also contains a resistor socket that accommodates plug-in resistors, whose resistance will differ, depending upon the application at hand.

Information about the states of the switch and the mounting of the plug-in resistors is presented in the manual sheets that describe the different types of control situations.



Function selector at position A. Signal decreases as temperature rises.

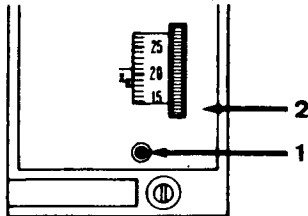


Function selector at position B. Signal increases as temperature rises.

ADJUSTMENT, SETTINGS AND CHECKS

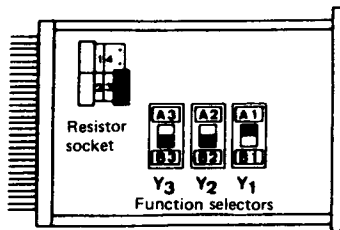
The following information about adjustment, settings and checks applies to all regulators.

Removing the front panel:



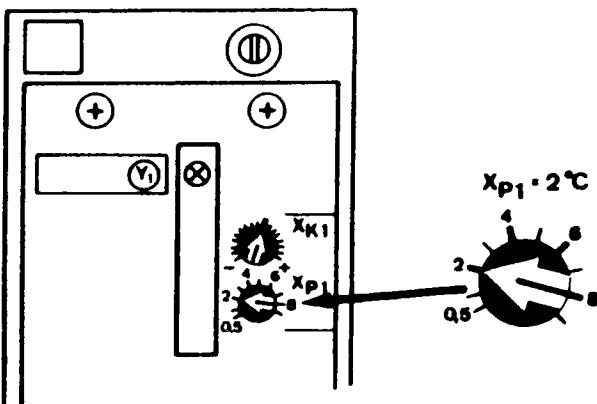
1. Press the red button
2. Lift the front panel a little and pull it down

Setting the operating mode.



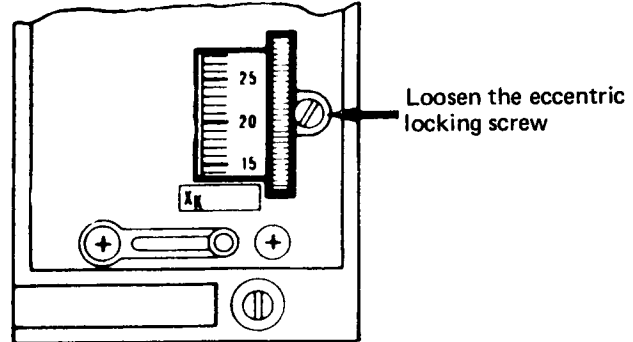
The resistor socket is configured as illustrated above for all of the situations described in the manual sheets.

Adjustment of P-band



The setting of potentiometer X_{K1} is not to be changed in any of the control situations described in the manual sheets (arrow should point to red index mark).
The setting of potentiometer X_{P1} (P-band) is determined when the system is started up, giving due regard to the stability of the control system in the application at hand.

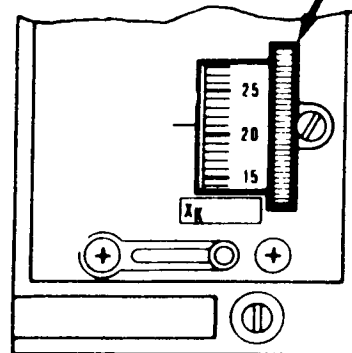
Setting the set point:



A thermometer is used to measure the temperature (actual value) at the sensor. This reading is then set on the regulator's setpoint potentiometer X_K . You can check the setting by turning setpoint potentiometer X_K . If the setpoint moves up or down, the regulator lamp will so indicate.

Check that the correct scale is mounted on the setpoint potentiometer (X_K) knob

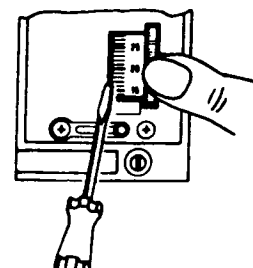
Set the desired setpoint (21°C for example) by turning the setpoint potentiometer (X_K) knob.



Readjusting the setpoint:

If the measured temperature (actual value of 20°C for example) does not match the value preset on the regulator (setpoint of 21°C for example) readjustment will be necessary.

- a. Grasp the setpoint potentiometer on its right-hand side. Now, using a screwdriver, turn the drum on which the setpoint scale is mounted until the setpoint is the same as the actual value (20°C in our example).



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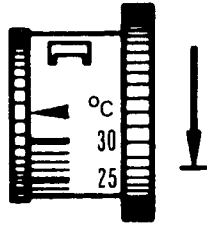
Ändring av denna skrift eller utgiva av den utan tillstånd av STAL är straffbart. STAL behåller sig förbehåll för ändring av denna meddelande förbehålles. STAL

- b. Change the setpoint from 20°C to 21°C.
- c. Permanently set the setpoint (X_K) by means of the eccentric screws (should not be carried out by unauthorized personnel).
- d. Replace the front panel.

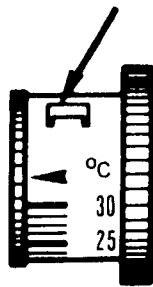
Changing scales:

Remove the front panel.

- Use your thumb to depress the red button at the bottom of the front panel.
- Carefully lift away the front panel by pulling it down.
- Turn the right-hand knurled potentiometer drum until it stops.

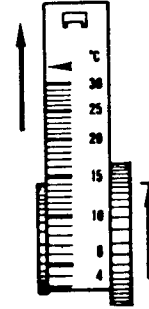


- Lift the end of the scale strip using a small screwdriver or other suitable tool, i.e. loosen the end of the scale strip from the first cam. You must be careful to see that the scale ring, i.e. the lefthand knurled drum on the potentiometer (right-hand drum) is not displaced (turned forward or back).
- Keep a firm grip on the end of the scale strip. You must not drop it under any circumstances !

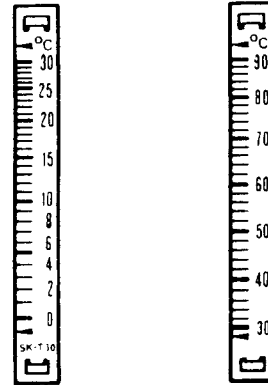


- Pull the scale strip slightly upward with your left hand.
- Keep your right hand on the knurled potentiometer drum.
- Turn carefully upward until you reach the end limit.
- Pull out the scale strip at the other cam, making certain that the two drums are not displaced relative to each other.

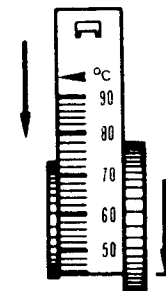
- Permit the potentiometer drum to remain at its end position.



- Turn the scale strip over or replace it.



- Press the strip over the cam at the lower part of the scale.
- Turn the potentiometer drum down carefully using your right thumb until it reaches its end limit.
- Guide the end of the scale with your left hand.
- Be careful not to let the end of the scale slip!

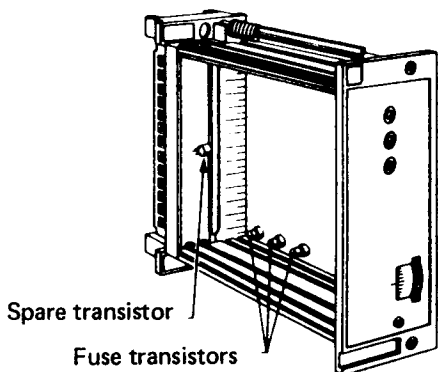


- Press the end of the scale onto the potentiometer drum.
- Press the end of the scale over the cam using a small screwdriver or some other suitable tool.
- Check the end markers (◀) at the two end positions.
- If they are not properly positioned, readjustment will be necessary.
- Insert the front panel in the slots at top and press the upper part over the red button.

Items to check if the control system does not function.

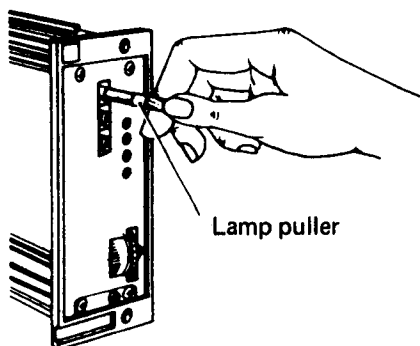
1. Check to see that the system is wired properly as per the system wiring diagram.
2. Measure the supply voltage (24V, 50 Hz) between terminals 1 and 2.
3. Check the way in which the resistor is mounted in the socket.
4. Check that the function selector on the regulator is set properly.
5. Measure the sensor resistor at the regulator input.
6. Check the load resistance to see that there is no short circuit or open circuit:
 - Y₁ = between terminals 15 and 16
 - Y₂ = between terminals 18 and 19
 - Y₃ = between terminals 21 and 22
 - The resistance between each of the above must be at least 10 ohms.

If you find a short circuit, you must first remedy it and then immediately replace the fuse transistor on the regulator.



7. Measure the regulator's output voltage (should be 0...20V DC)
 - If this voltage is present and the indicator lamps are not lighted, replace the indicator lamps.

Replacing faulty indicator lamps:

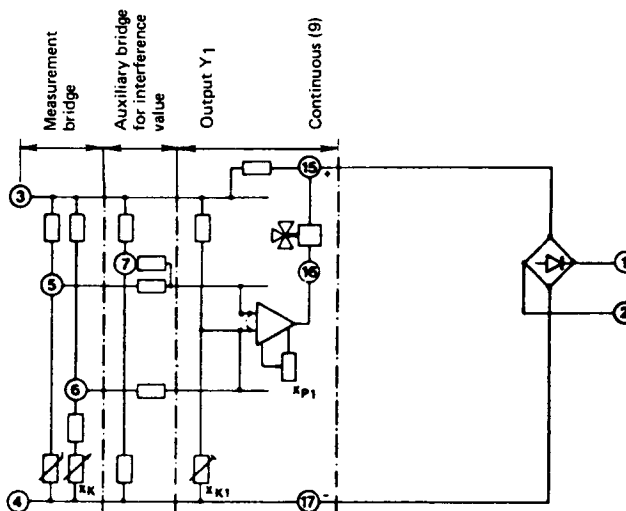


Technical data

Voltage supply	24V +15% 50 -60 Hz - 10	
Output signal	Continuous (designated 9) Y ₁ , Y ₂ , Y ₃ : each 0 -20V DC phase interface is indicated by means of a signal lamp	
Power output	Max 40 W at 20V DC (total for all outputs)	
Sensor	Thermistor-type temperature sensor	
Temperature ranges	Temperature	Sensor
	0 to +30°C	3966 2982 030
	-32 to +40°C	3966 2982 038
	+20 to +105°C	3966 2982 105
Ambient temperature	0 to +50°C	

Schematic diagram

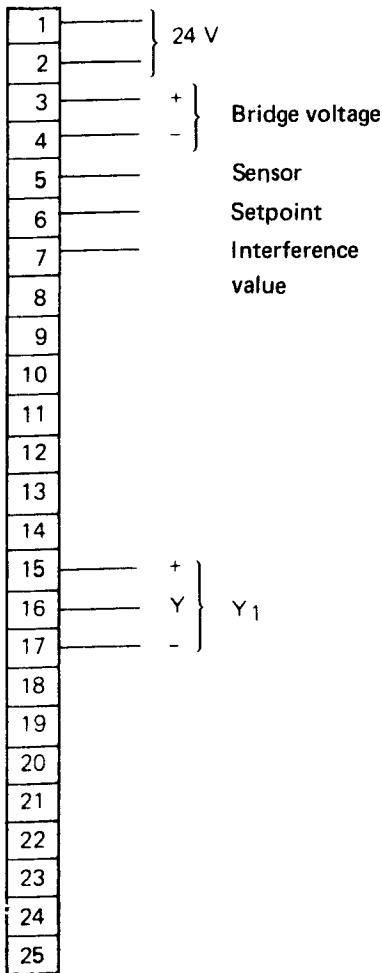
(Example: Regulator 3968 1105 801)



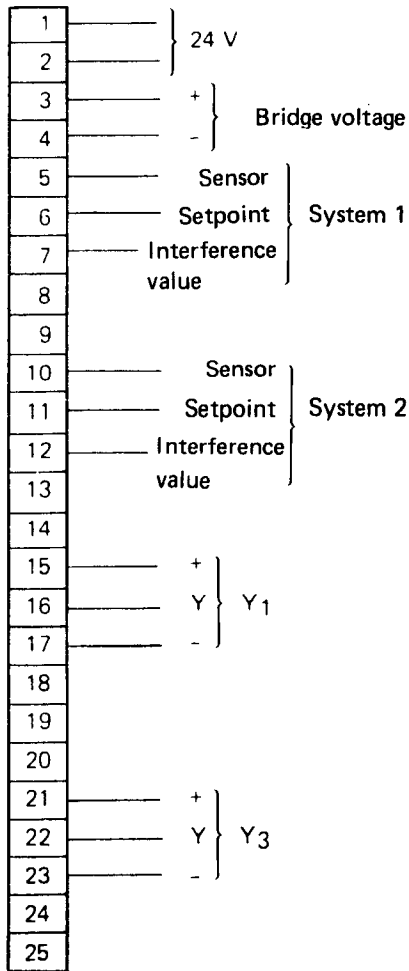
Connection diagram

Pin assignments

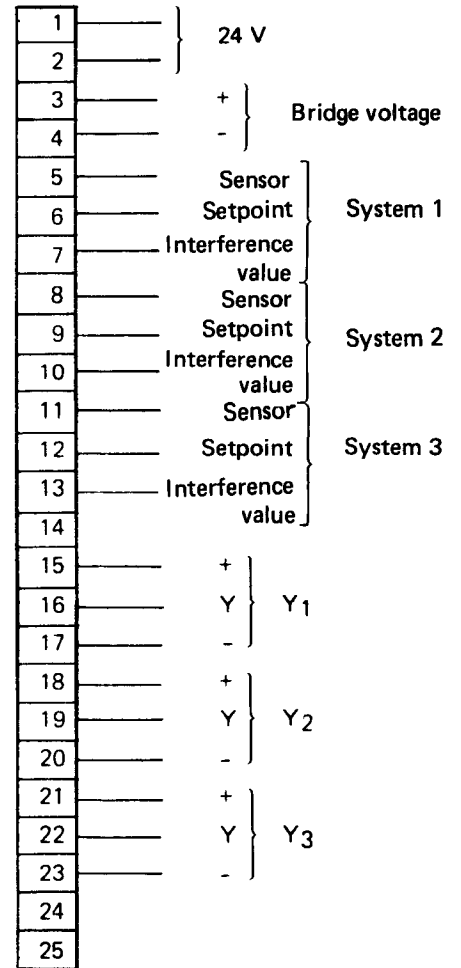
3968 1105 801



3968 1106 801



3968 1107 801

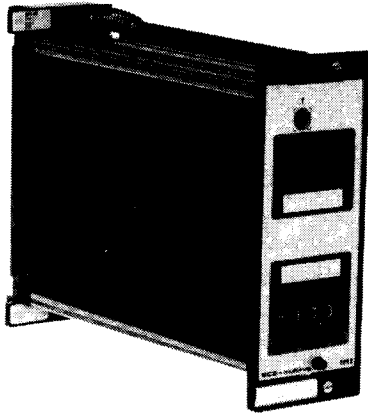


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PDPI-regulators



3968 1108 801 och 3968 1108 802

GENERAL

These electronic regulators (class 0.5) have plug-in measuring transducers, digital setpoint modules and digital indicator modules.

- Can be changed over for P-, PD-, PI-, and PDPI-functions.
- Output signal, continuous, 0 - 20V DC
- One or two outputs
- Can be changed to provide 2-state function.
- Modules with units signal of 0 - 10V DC
- External setpoint sensor can be connected.

Regulator 3968 1108 801 has one output.
Regulator 3968 1108 802 has two outputs.

OPERATION

The signal received from the measurement sensor is converted in the measuring transducer module to a units signal of 0 - 10V DC. The setpoint sensor's output signal also has a range of 0 - 10V DC. These two signals are sent to terminals and also to a comparator. This comparator also has two additive inputs, one for control value x (actual value) and one for the reference value w (setpoint). This arrangement supports special functions such as displacement of the setpoint.

The resulting control deviation (received from the comparator) is then processed in the control amplifier using the preset proportionality band and the time values (P, PD, PI and PDPI). The proportionality band X_p , the D time T_v and the I time T_n can all be adjusted as desired.

Saturation of the integrator is prevented by means of an ARW link. The D function is implemented before the I function. Taken together, these two functions thus optimize the startup conditions.

Output amplifier signal Y' is modulated linearly between 0 and 20V. The proportionality band is related to $\Delta Y' = 5V$.

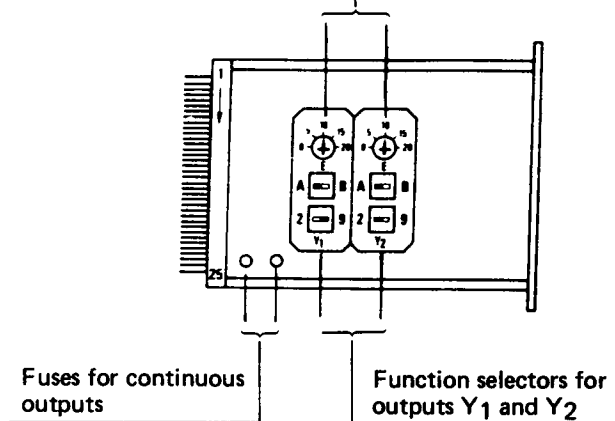
The power amplifiers in the regulator permit direct connection of positioners such as control valves, stepping couplers, electric power controllers etc. An indicator lamp is provided for each regulator output.

An internal switch can be used to vary the amplification function from continuous (0 . . . 20V position 9) to a 2-state function (20V = ON, 0V = OFF, position 2).

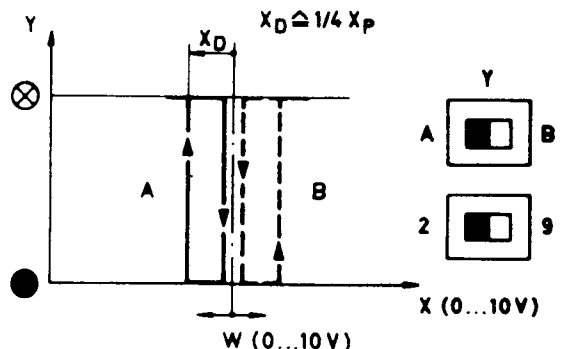
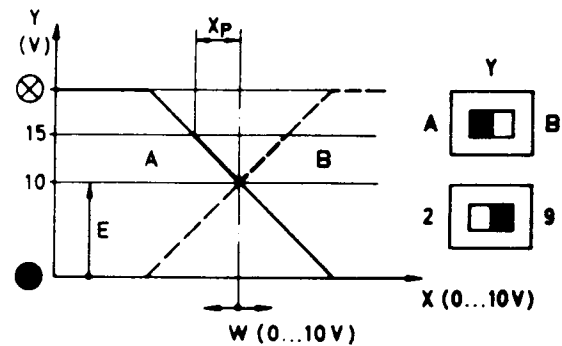
The circuit board contains function selectors that can be used to change the operating mode.

Regulator 3968 1108 802 can control its outputs in sequence, thanks to the fact that it is possible to displace intervention points E.

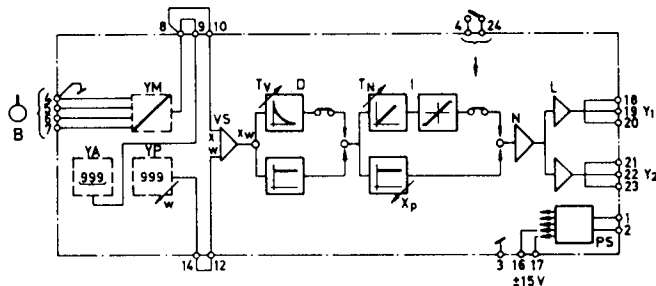
Displacement of intervention point E



Function diagram (P operation)



Schematic diagram



- | | |
|----------------------------|--|
| B: Measurement sensor | YM: Measuring transducer |
| YA: Digital indicator | YP: Setpoint sensor |
| VS: Comparator | I: Integrator with ARW (Limiter hookup) |
| D: Differentiator | N: Output amplifier |
| PS: Power supply | Y1: Output signal 0 - 20 V |
| Y1: Output signal 0 - 20 V | Y2: Output signal 0 - 20 V (3968 1108 802) |

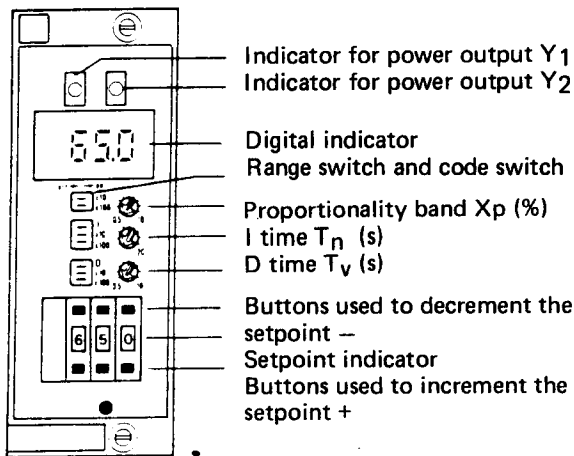
Adjustment provisions

The front panel can be removed by pressing lightly on the red button. Potentiometers that can be used to adjust the following are located beneath the front panel:

- Proportionality band X_p
- Integration time (I-time) T_n
- Differentiation time (D-time) T_v

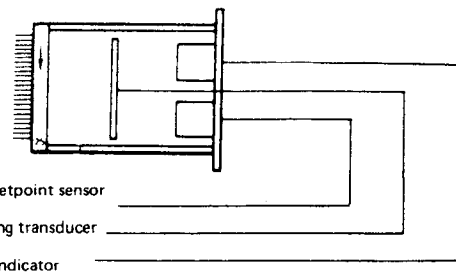
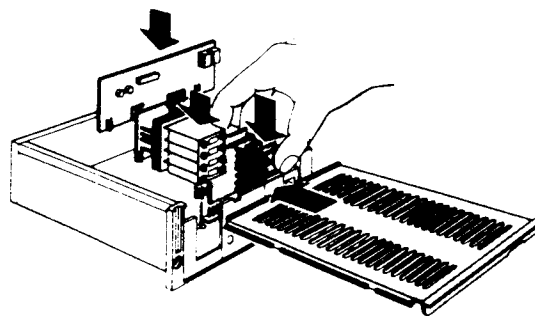
There are also decadic range switches for X_p , T_n and T_v , and code switches that can be used to turn the D and I functions on and off.

The I function can also be turned off by connecting a jumper between terminals 24 and 4.



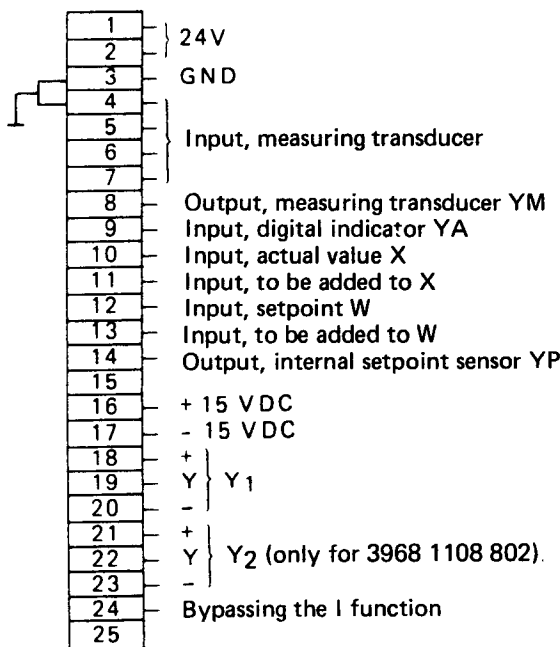
MOUNTING PLUG-IN MODULES

After the side cover has been removed, you can insert plug-in modules. To prevent mistakes, the connectors and guide pins are keyed. You must not insert modules while the power is turned on.



Connection diagram

Pin assignments



4815/7827 - N - 130E
8/22
Kp 1985-08

STAL-MINI screw compressor

STAL
REFRIGERATION

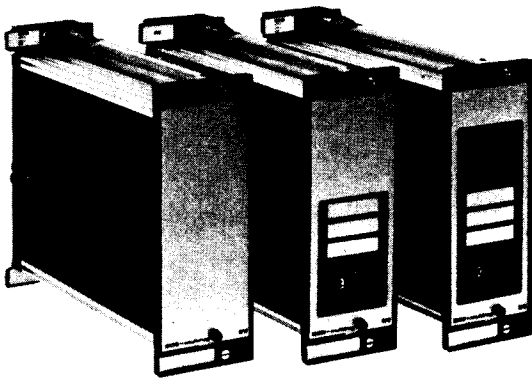
TECHNICAL DATA

Supply voltage	24VAC $\begin{matrix} +15 \\ -10 \end{matrix}$ % 50 ...60 Hz or 24V DC $\begin{matrix} +35 \\ -15 \end{matrix}$ % battery
Power consumption	Max 5 VA (unloaded)
Ambient temperature	0 to +50°C during operation -25 to +85°C in storage
Outputs, reconnectable	Y ₁ , Y ₂ , continuous (designation 9): each 0 -20 V DC 2-state (designation 2): outputs are provided with indicator lamps
Output power	Max 40 VA at 20V DC (total for the two Y outputs)
Reference unit (setpoint)	2 inputs each 0 -10V DC (additive)
Controlled entity (actual value)	2 inputs each 0 -10V DC (additive)
Resistance per input	> 100 kohms
Input filters	One on each input Frequency limit (-3dB) 5 Hz Attenuation of 40 dB per decade

Accuracy	≤ 0.5% of measurement range at 20°C, 24V, 50 Hz
Effect of temperature	±0.005%/K, typical deviation between setpoint and actual value
Control function	P, PD, PI or PDPI (selectable)
Proportional range	X _p = 0.5 to 10% (steplessly adjustable) 5 to 100% (x10) 50 to 1000% (x100)
I time	T _n = 1 to 20 s (steplessly adjustable) 10 to 200 s (x10) 100 to 2000 s (x100)
D time	T _v = 0.5 to 10 s (steplessly adjustable) 5 to 100 s (x10) 50 to 1000 s (x100)
Sensor	See section on measuring transducer plug-in module

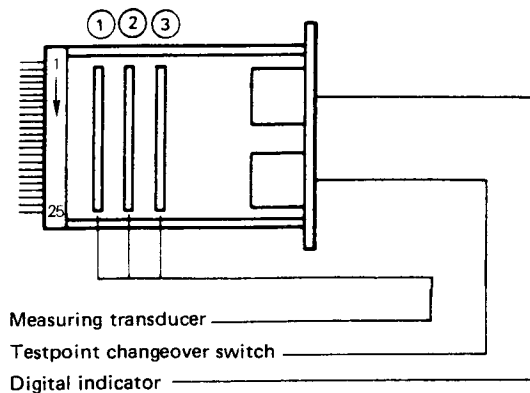
2. MEASURING TRANSDUCER

Measuring transducer with digital indicators



3968 1109 801

Alternatively, up to three incoming 0 -10V DC signals can be connected via the testpoint changeover switch so that they can be presented on an indicator.



GENERAL

This electronic transducer (class 0.5), incorporates plug-in measuring transducers, changeover modules and digital indicator modules. Features include

- Up to three measuring transducer channels
- Plug-in measuring transducer
- Different mounting provisions
- Adaptability to different standard signals

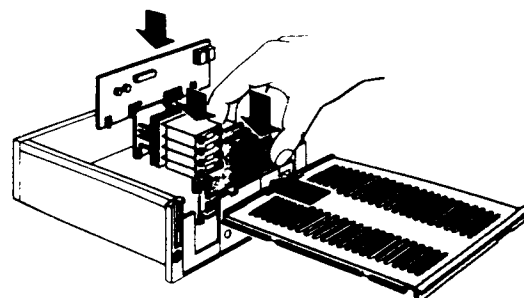
OPERATION

The signal received from the measurement sensor is converted to a units signal (0 -10V DC in the measuring transducer module).

This signal is sent, via the testpoint changeover switch to the digital indicator. It is also possible to connect the measuring transducer signal to a regulator or to an external indicator. Plug-in modules used for signal selection, limitation and amplification can also be mounted in the measuring transducer board slots.

MOUNTING PLUG-IN MODULES

After the side cover has been removed, you can insert plug-in modules. To prevent mistakes, the connectors and guide pins are keyed. You must not insert modules while the power is turned on.

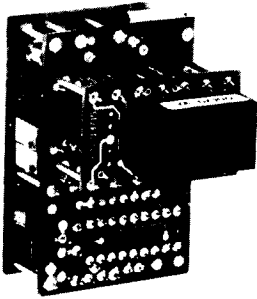


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STAL-MINI screw compressor

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Digital indicators



3968 1110 601, 3968 1110 602

PURPOSE

The digital indicator module can be mounted in regulators 3968 1108 801 and 3968 1108 802 to indicate the actual value. It can also be mounted in control centre 3968 1109 801 to indicate any desired measured entity (in response to the 0 - 10V DC units signal). The indication ranges match the measurement ranges and setpoint ranges of the other modules.

OVERVIEW

Ordering No	Indication range	Input
3968 1110 601	-99.9 to +99.9	+0.005 to +9.995 V DC
3968 1110 602	0 to +99.9	0 to +9.990 V DC

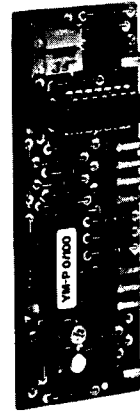
TECHNICAL DATA

Power supply	Via control centre
Accuracy	≤ 0.15% at 20°C with 24V, 50 Hz, supplied to the control centre
Ambient temperature	In operation 0 to +50°C In storage -25 to +85°C
Indication	3-digit, 7-segment red LED indicator
Input	0 - 10V DC
Input resistance	> 1 megohm
Input filter	Frequency limit (-3dB) at 5 Hz Attenuation of 40 dB per decade
Effect of temperature	±0.005%/K, typical

Correction of starting point and slope:

The starting point and the slope can be adjusted by means of two potentiometers located on the side. The upper is for slope and the lower is for the starting point.

Measuring transducers for resistance thermometer Pt 100 DIN



3968 1110 801, 3968 1110 802

PURPOSE

This measuring transducer module can be mounted in regulators 3968 1108 801 and 3968 1108 802. It can also be mounted in control centre 3968 1109 801, where it converts the measurement sensor signal to a voltage signal of 0 - 10V DC.

OVERVIEW

Ordering No.	Measurement range	Output
3968 1110 801	-100 to +100°C	0 to +10V DC
3968 1110 802	0 to +100°C	0 to +10V DC

TECHNICAL DATA

Power supply	Via control centre
Accuracy	≤ 0.15% at 20°C with 24V, 50 Hz, supplied to the control centre
Ambient temperature	In operation 0 to +50°C In storage -25 to +85°C
Type of sensor	Resistance thermometer Pt 100 DIN
Sensor cable	4-conductor
Sensor current	< 3.5 mA
Line compensation	Not needed
Permissible line resistance	Max 400 ohms
Output	0 - 10V DC, varies linearly with temperature
Load	≥ 2 kohms

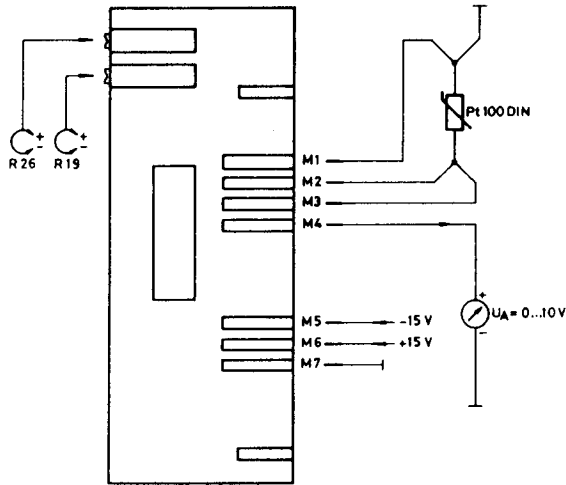
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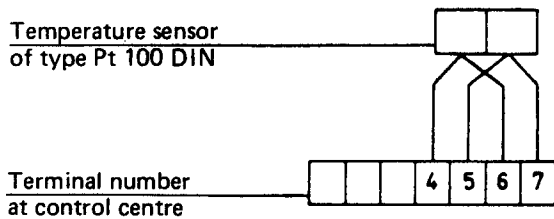
Input filter	40 dB (50 - 60 Hz)
Effect of temperature	3968 1110 801 $\pm 0.005\%/K$, typical 3968 1110 802 $\pm 0.01\%/K$, typical
Effect of line resistance	3968 1110 801 0.0005%/ohm, typical 3968 1110 802 0.001%/ohm, typical

Balancing provisions

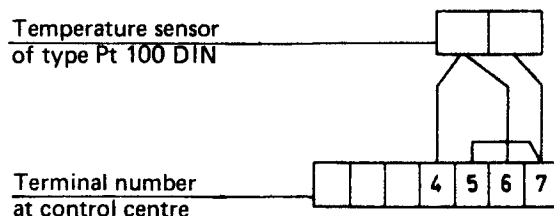


- 1 Range starting point: U_A balanced to 0V by means of R19 (parallel displacement)
- 2 Range end point: U_A balanced to 10V by means of R26 (change in slope)

Wiring diagram



4-conductor link compensates entirely for conductor resistances (max 400 ohms).



3-conductor link does not compensate fully for conductor resistances and should thus only be used across short distances.

Current/voltage/measuring transducer



3968 1110 826

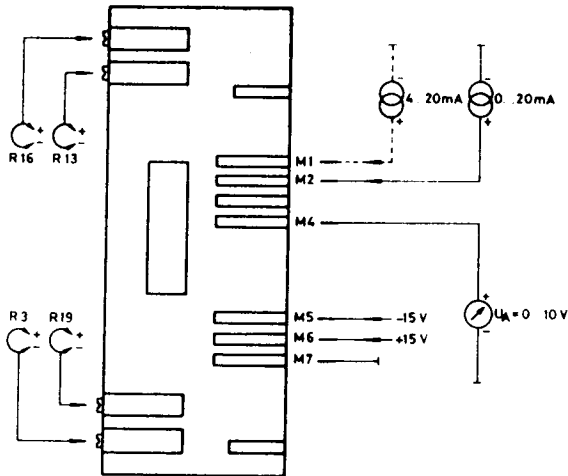
PURPOSE

This measuring transducer module can be mounted in regulators 3968 1108 801 and 3968 1108 802. It can also be mounted in control centre 3968 1109 801 where it converts a 0 - 20mA or 4 - 20mA current signal to a 0 - 10V DC voltage signal.

TECHNICAL DATA

Power supply	Via control centre
Accuracy	$\leq 0.15\%$ at 20°C with 24V, 50 Hz, supplied to the control centre.
Ambient temperature	In operation 0 to +50°C In storage -25 to +85°C
Input	Standard current signal, 0 - 20mA or 4 - 20mA
Input resistances	51 ohms (for 0 - 20mA) 62 ohms (for 4 - 20mA)
Input filter	Frequency limit (-3dB) 5 Hz Attenuation 20 dB per decade
Output	0 - 10V DC varies linearly with the input current
Load	≥ 2 kohms
Effect of temperature	$\pm 0.005\%/K$, typical

Balancing provisions



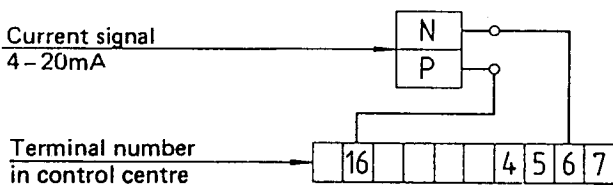
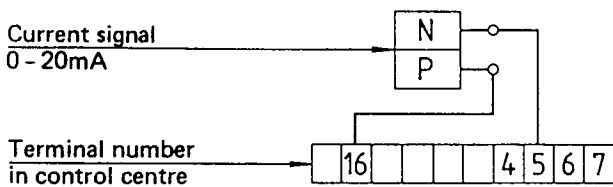
Input 0 - 20mA

- 1 Range starting point:
 U_A is balanced to 0V by means of R3 (parallel displacement).
- 2 Range end point:
 U_A is balanced to 10V by means of R19 (change in slope)

Input, 4 - 20mA

- 1 Range starting point:
 U_A is balanced to 0V by means of R13 (parallel displacement)
- 2 Range end point:
 U_A is balanced to 10V by means of R16 (change in slope)

Wiring diagram



When a pressure transducer is used, the regulator shall be set as follows:

1. The pressure transducer's operating range (selected giving due regard so type of control system being used is, for example, 0 - 6 bar (gauge pressure).
 For refrigerants NH₃ and R22 the following temp/pressure ratios are thus obtained from the table (absolute pressure reduced by 1 bar to obtain gauge pressure).

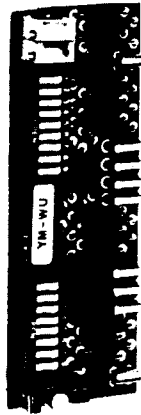
°C	NH ₃	R22
-50	0.4085	0.6439 bar
-45	0.5450	0.8271
-40	0.7171	1.049
-35	0.9312	1.317
-30	1.195	1.635
-25	1.515	2.010
-20	1.901	2.448
-15	2.362	2.957
-10	2.908	3.543
- 5	3.548	4.213
0	4.294	4.976
+ 5	5.158	5.838
+10	6.150	6.807
+15	7.285	7.891
+20	8.574	9.099
+25	10.031	10.439
+30	11.669	11.919
+35	13.504	13.548
+40	15.549	15.535
+45	17.820	17.290
+50	20.331	19.923

2. The desired value shall be set on the regulator as a percentage of the transducer's operating range. For example
 Transducer operating range = 0-6 bar (gauge pressure)
 Desired regulation point = -10°C
 Refrigerant = NH₃

$$\frac{x \cdot 6}{100} = 1.908$$

$$x = 31.8\%$$

Measurement amplifier



3968 1110 852

PURPOSE

Used for scale conversion and scale displacement when a dot matrix printer is being used. Used to convert the 0-20 V DC regulator output signal or 0-1 V DC or 0-5 V DC signal voltages to smoothed 0-10 V DC. Also used as an interference value device. The measurement amplifier module can be mounted in regulators 3968 1108 801 and 3968 1108 802. It can also be mounted in control centre 3968 1109 801.

OPERATION

The input voltage is filtered and amplified. Origin A and slope S are steplessly adjustable.

Function diagram



ADJUSTMENT PROVISIONS

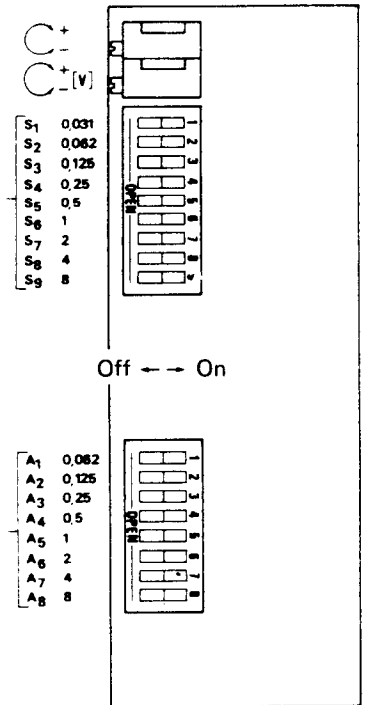
Origin A and slope S can be set roughly by means of their code switches (located on the circuit board). The values set forth in the table are added. Fine adjustment is carried out by means of the multiturn potentiometers provided for origin A and slope S.

Fine adjustment, slope S

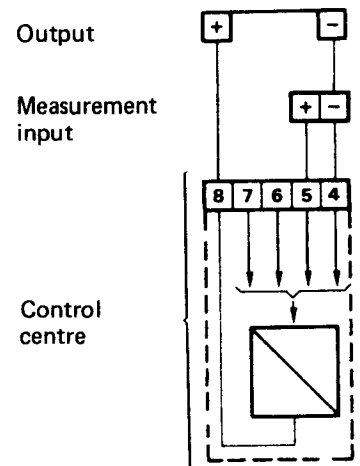
Fine adjustment, origin A

Coarse adjustment, slope S

Coarse adjustment, origin A



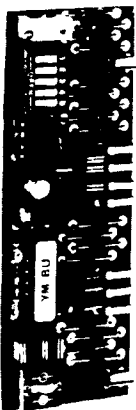
Connection diagram



TECHNICAL DATA

Power supply	Via control centre
Input voltage	≤ 20 V DC
Input filter	Frequency limit (-3 dB) 3 Hz Attenuation 60 dB per decade
Input resistance	100 kohms
Output voltage	0 - 10V DC
Load	> 2 kohms
Amplification, slope S	0.1 - 16, steplessly adjustable
Origin A	0 - 16 V DC, steplessly adjustable
Adjustment accuracy	≤ 0.15%
Effect of temperature	±0.01%/K, typical
Ambient temperature	In operation 0 - +50°C In storage -25 - +85°C

Signal selector/limiter



3968 1110 851

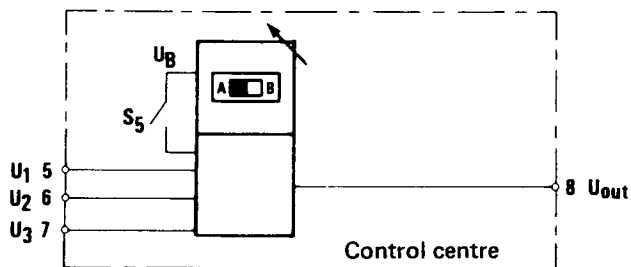
PURPOSE

The signal selector/limiter module can be mounted in regulators 3968 1108 801 and 3968 1108 802. It can also be mounted in control centre 3968 1109 801 where it is used to limit DC signals. This module can also be used as a signal selector with adjustable limitation provisions.

OPERATION

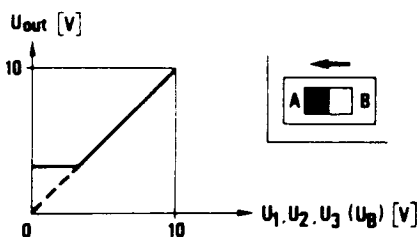
This module selects one of four 0 - 10V DC input voltages. Three external voltages designated U_1 , U_2 and U_3 are sent to the module. The fourth voltage, designated U_B , can be adjusted steplessly by means of the code switch. Switch S_5 can be used to inhibit the effect of U_B . This module functions as a maximum or minimum signal selector, depending upon the mode in which it is set. In mode A, it selects the highest signal. In mode B, it selects the lowest signal. The selected signal is sent to the output. This module can be used as both a signal selector and signal limiter. Inputs that are not used remain floating.

Schematic diagram

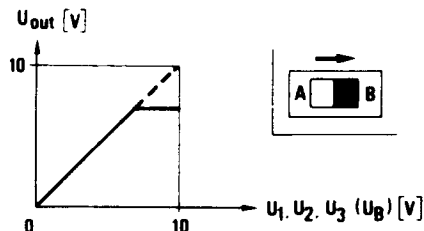


Adjustment provisions

- Selection of highest signal $U_{out} = \max(U_1, U_2, U_3, U_B)$. Here, the minimum limiting function can be obtained.



Selection of lowest signal $U_{out} = \min(U_1, U_2, U_3, U_B)$. Here, the maximum limiting function can be obtained.

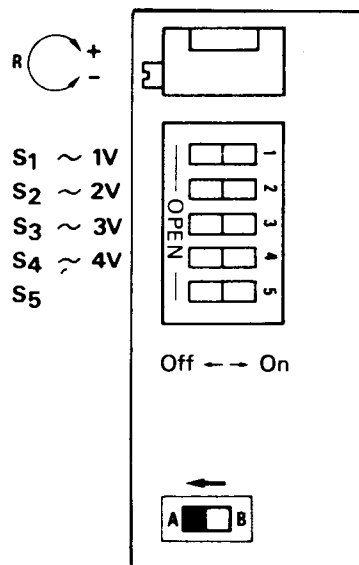


Adjustment of U_B

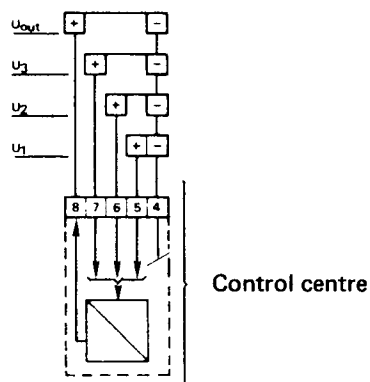
Fine adjustment by means of multiturn potentiometer R

Coarse adjustment by means of additive code switches $S_1 - S_4$

Inhibition of U_B by means of S_5



Wiring diagram



TECHNICAL DATA

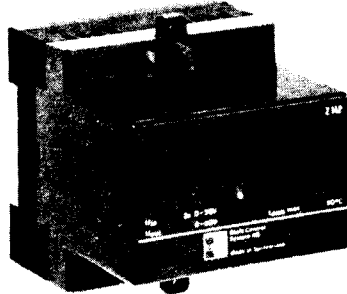
Power supply
Inputs U_1 , U_2 and U_3
Input resistance
Internal limitation
voltage U_B

Via the control centre
0 - 10V DC each
100 kohms per input
0 - 10V DC, steplessly adjustable

Output U_{out}
Load
Effect of temperature
Adjustment accuracy
Ambient temperature

0 - 10V DC
 ≥ 2 kohms
 $\pm 0.005\%/K$, typical
 $\leq 0.15\%$
In operation 0 - $+50^\circ C$
In storage - 25 - $+85^\circ C$

Minimum signal selector/ Inverter for phase interface signal



3968 1103 801

PURPOSE

This module is used either as a minimum signal selector or as an inverter. If the lowest of two or three regulator signals must be selected so that it can be sent to an actuator, this module functions as a minimum signal selector. If a phase interface signal of 0 - 20 V DC must be converted to a phase interface signal of 20 - 0 V DC, this module is used as an inverter.

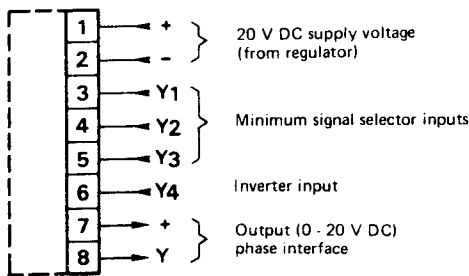
This module cannot be used as a minimum signal selector and inverter simultaneously.

OPERATION

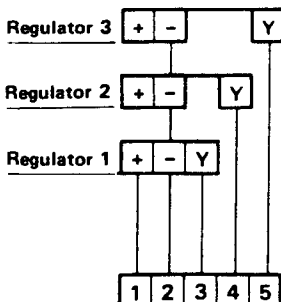
When this module is used as a minimum signal selector, up to three Y signals can be connected. The signal having the lowest voltage is sent on as an output signal to the actuator. Inputs Y₁ and Y₂ must always be connected; otherwise, output Y will be blocked. Input Y₃ need not be connected. Input Y₄ is the inverter input. An ascending signal 0-20V DC provides a descending output signal 20-0V DC at output Y.

Wiring diagram

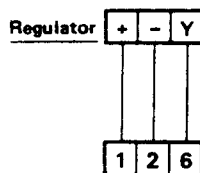
Pin assignments



Minimum signal selector hookup



Inverter hookup



TECHNICAL DATA

Supply voltage	20 V DC from regulator
Input voltages Y ₁ - Y ₄	0 - 20 V DC, phase interface
Power consumption	
Y ₁ , Y ₂ and Y ₃	60 mW per input
Y ₄	300 mW
Output signal	0 - 20 V DC, phase interface
Output power	Max 40 W
Ambient temperature	0 - +50°C

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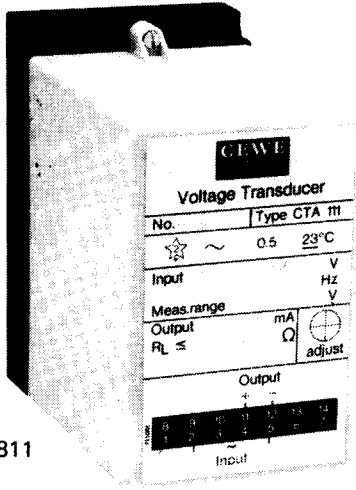
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STAL-MINI screw compressor

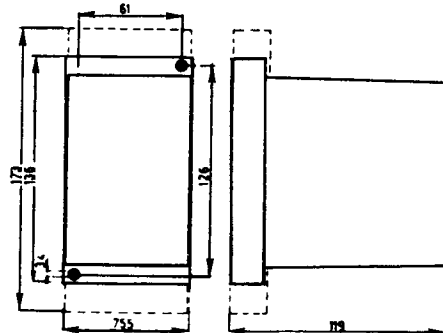
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Measurement value transducer for AC



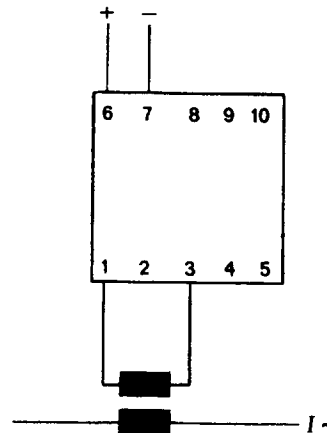
3968 1112 811

Dimensions (mm)



Wiring diagram

Output signal

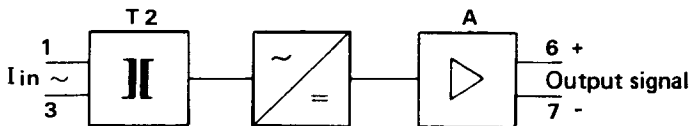


GENERAL

Measurement value converter 3968 1112 811 converts sinusoidal AC (0–1A) to a proportional load-independent DC signal (0–20mA). The input current can be connected to an instrument transformer.

OPERATION

The input current (I_{in}) is transformed to a suitable signal level in current transformer T2. This transformer also provides galvanic isolation between the input and output sides. In the rectifier circuit, which is based on operational amplifiers, the signal is rectified and smoothed. It is then converted to a load-independent DC signal in amplifier A.



TECHNICAL DATA

General data

Working temperature range	-20°C to +55°C
Storage temperature range	-65°C to +80°C
Test voltage	2 kV, 50 Hz
Permissible overload	2 x I_{in} continuous 10 x I_{in} for 10s 40 x I_{in} for 1s
Casing colour	Blue
Casing material	Polycarbonate, self-extinguishing
Weight	0.7 kg

Input data

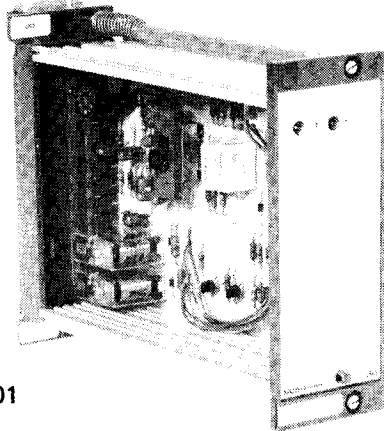
Input current (I_{in})	1A
Power consumption	0.7 – 2.2 VA
Frequency	45 – 65 Hz

Output data

Output signal	0 – 20 mA
Load resistance	0 – 750 ohms
Accuracy class	0.5
Ripple	1% (peak-to-peak)
Linearity error	< 0.2%
Load error	< 0.05%
Setting time	< 300 ms
Temperature-dependency	< 0.1%/10°C
Max voltage at open output	20V

3. ACTUATORS

Positioning relay



3968 1102 801

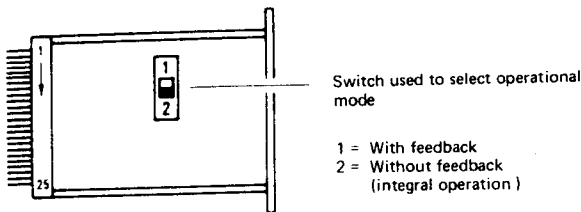
OPERATION

This electronic positioning relay converts the regulator's continuous output voltage to a 3-state signal, thus permitting two solenoid valves to control compressor capacity (INCREASE or DECREASE).

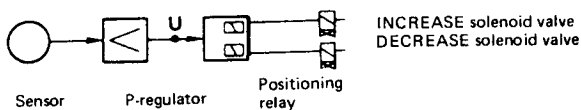
Two indicator lamps are used to indicate the operating status.

Voltage is supplied via the regulator to terminals 15 and 17 on the positioning relay.

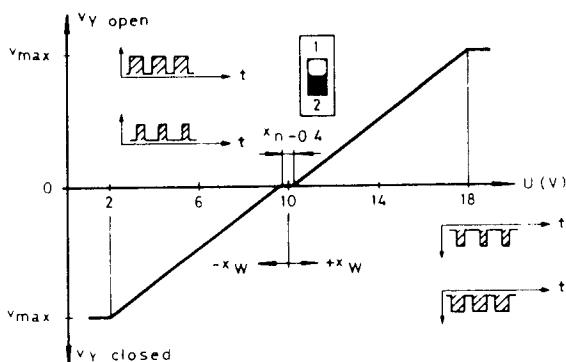
In the event that the supply voltage is interrupted, the positioning relay input is de-energized, whereupon output terminals 21 and 23 are connected together and the actuator closes.



Integral operation



The solenoid valves are controlled by pulses. The intervals between these pulses become shorter as the regulator deviation decreases. This provides a positioning speed that depends upon the amount of deviation.



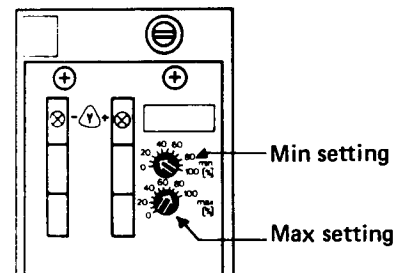
For this type of operation, the positioning relay is connected to a P-regulator. This arrangement provides a PID function. A D time of 50 seconds is set permanently in the positioning relay. Even for high-speed regulation applications where severe difficulties are encountered, this provides stable regulation.

Settings

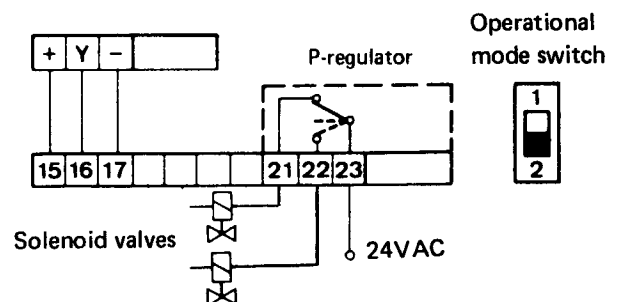
- Set operational mode switch at position 2
- Set proportionally band xp on P regulator
- Set operational mode (A or B) on P regulator
- In the steady state, the voltage is 10 V
- After removing the front panel, the maximum closing speed can be set (0 to < 50%) by means of the potentiometer.
 - >50% provides opening signal
 - 0% provides shortest pulse duration
 - Up to 50% provides up to max pulse duration

The max potentiometer can be used to set the max opening speed (> 50 to 100%)

- < 50% provides closing signal
- 50% provides shortest pulse duration
- Up to 100% provides up to max pulse duration



Wiring diagram



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STAL-MINI screw compressor

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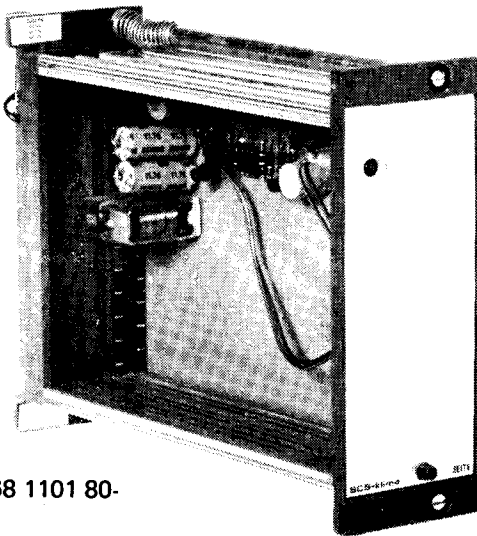
TECHNICAL DATA

Supply voltage 20V DC (from regulator)
Power consumption 4 VA
Output
– Zero-potential relay contacts in transfer configuration
– Operational mode is indicated by 2 lamps
Contact loading 220V AC, 2 A inductive, 5A resistive
Interruption of supply voltage Terminals 21 and 23 are connected together (equivalent to an input voltage of 0 V)
Neutral zone xN 0.4 V, permanently set
Ambient temp. 0 to + 50°C
Selection of operational mode By means of internal switch

Integral operation

– Working range 2- 10 and 10 - 18V
– Proportional amplification xp
– Shortest positioning pulse 250 ms
– Max. limitation speed Adjustable
– Lead time T_v 50 s (permanently set)

Step switch (voltage relay module)



3968 1101 80-

This step switch (voltage relay module) is used primarily for starting and stopping compressors. It is also used for sequence control.

OPERATION

The voltage relays in this step switch are energized as the voltage rises. They are energized in a sequence that corresponds to the preset cut-in points and preset time-delays. After the first stage has been cut in, the timing of the second stage's delay period commences immediately, and when this period has expired stage 2 is cut in (on condition that the input voltage has reached the threshold value that has been established for stage 2). These statements also apply to the third and fourth stages. On the other hand, the first stage's delay period starts when its threshold value has been reached.

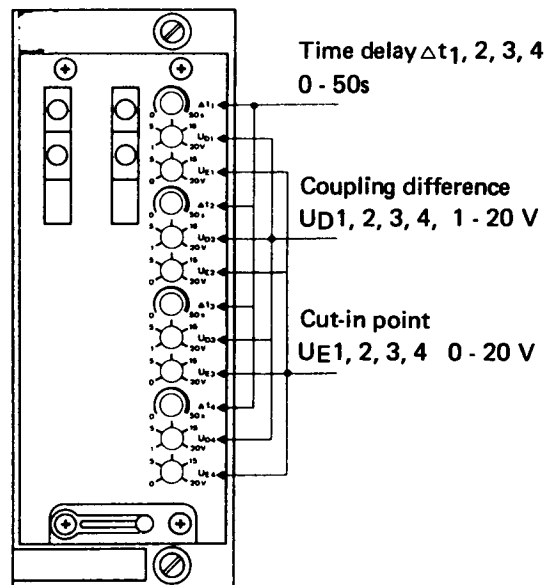
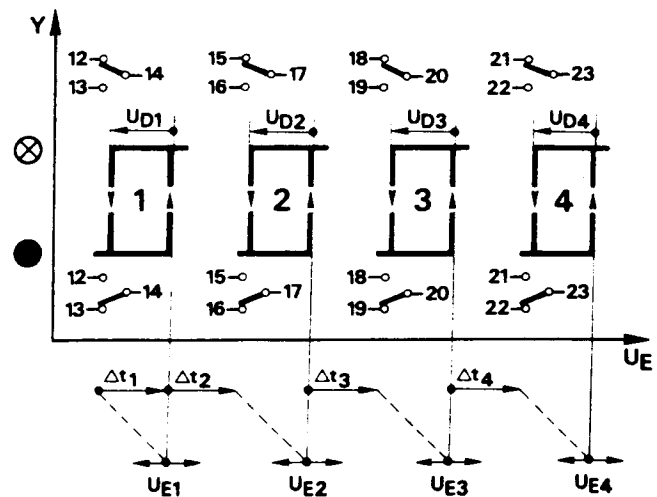
When the input voltage decreases, the voltage relays immediately re-assume their initial states, with a displacement that corresponds to the coupling difference.

Indicator lamps on the front panel display the current connection state.

Adjustment provisions

U_E , U_D and Δt can be set individually after the front panel has been removed.

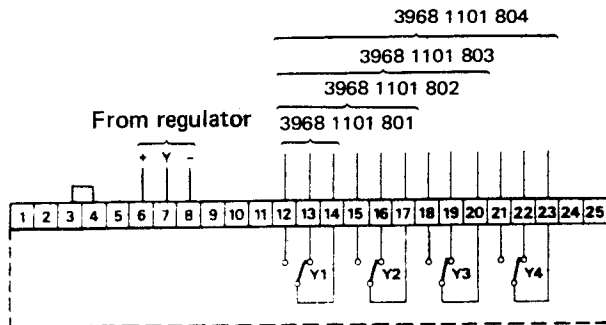
Cut-in point U_E 1, 2, 3, 4 0 - 20V
Coupling difference U_D 1, 2, 3, 4 1 - 20V
Time delay Δt 1, 2, 3, 4 0 - 50s



Types

3968 1101 801: 1 voltage relay or connection stage
3968 1101 802: 2 voltage relays or connection stages
3968 1101 803: 3 voltage relays or connection stages
3968 1101 804: 4 voltage relays or connection stages

Wiring diagram



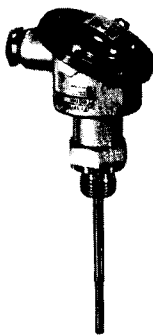
Technical data

Supply voltage	24V DC from regulator
Power consumption	2 VA per stage
Control voltage U_E	0- 20 V DC phase interface
Operating procedure	As the control voltage rises, the relays pull in
Output	Zero potential transfer contacts
Contact data	1.2 A inductive 3A resistive per stage, 220 V AC
Ambient temperature	0- 50°C
Cut-in-point $U_{E1,2,3,4}$	0- 20 V
Coupling difference U_D	1- 20 V
Delay time $t_{1, 2, 3, 4}$	0- 50s

4. SENSORS

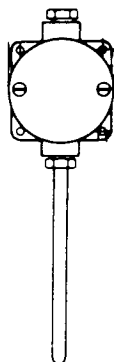
Temperature sensor, type Pt 100

Submersible sensor



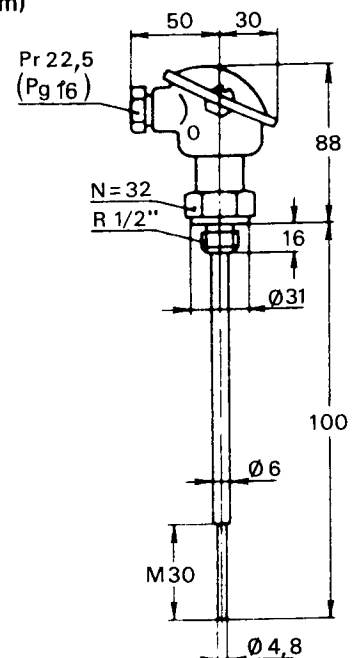
3967 2514 100

Outdoor sensor



3967 2513 066

Dimensions (mm)



PURPOSE

Submersible sensor 3967 2514 100 is used to measure liquid temperatures.

Outdoor sensor 3967 2513 066 is used to measure air temperature outdoors or in moist premises.

OPERATION

The resistance of a platinum element changes in response to temperature changes (resistance rises as the temperature rises).

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4815/7827 - N - 130E
20/22
Kp 1985-08

STAL-MINI screw compressor

STAL
REFRIGERATION

Temperature sensor with platinum element
(100 ohms 0°C)

°C	ohms	°C	ohms
-45	82.23	30	111.67
-40	84.21	35	113.61
-35	86.19	40	115.54
-30	88.17	45	117.47
-25	90.15	50	119.40
-20	92.13	55	121.32
-15	94.10	60	123.24
-10	96.07	65	125.16
-5	98.01	70	127.07
0	100.00	75	128.98
5	101.95	80	130.89
10	103.90	85	132.80
15	105.85	90	134.70
20	107.79	95	136.60
25	109.73	100	138.50

3967 2513 066:

Materials: Terminal box: Aluminium casting
Conduit: Stainless and acid-resistant steel
Platinum element

Temperature range: -60°C to +120°C

Max ambient temp. for terminal box: +120°C

Working medium: Air

Standards: Platinum element: Pt-100 as per DIN 43760

Protection class: IP 67

Time constant: 5 min in stationary air

Tolerances: At 0°C, ±0.3°C
At 100°C, ±0.6°C } as per DIN 43760

TECHNICAL DATA

3967 2514 100:

Materials: Terminal box: aluminium casting
Conduit: Material - No. 1.4435 (equivalent to Swedish Standard steel) (SS-steel 2353)
Platinum element

Temperature range: -100°C to +450°C

Max ambient temp. for terminal box: +120°C

Working medium: Gaseous or liquid

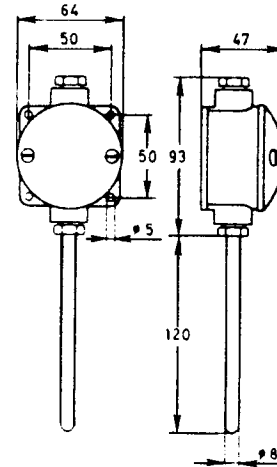
Standards: Platinum element: Pt 100, as per DIN 43760
Terminal box: form B, as per DIN 43729
Conduit: Pressure class PN40

Protection class: IP 54

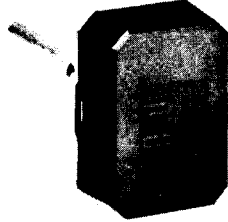
Terminals: 2.5 mm²

Response time: 9/10
- In air moving from about 2 m/s: < 150s
- In water moving from about 0.2 m/s: < 10s

Dimensions (mm)



Thermistor-type temperature sensors (submersible sensor)



3966 2982 030, 3966 2982 038 and 3966 2982 105

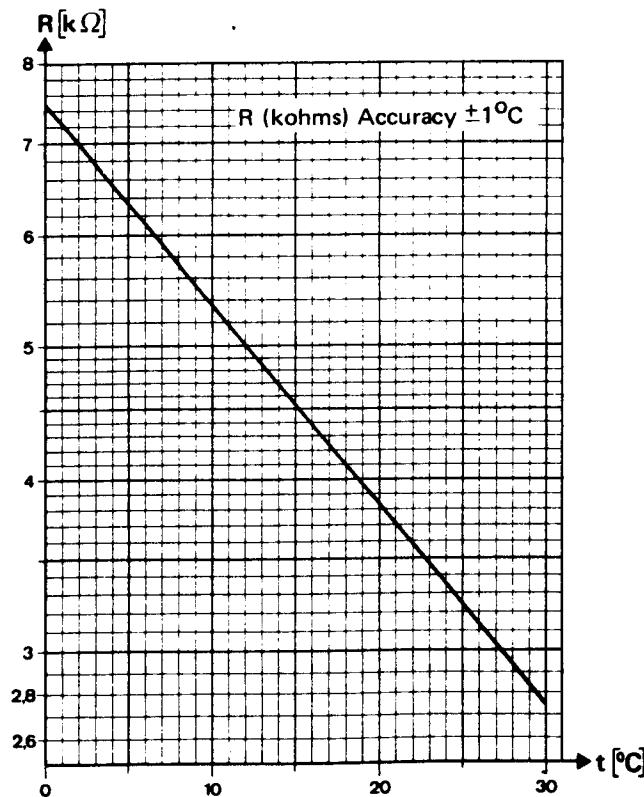
PURPOSE

Submersible sensors 3966 2982 030, 3966 2982 038 and 3966 2982 105 are used to measure and regulate liquid temperatures together with P-regulators 3968 1105 801, 3968 1106 801 and 3968 1107 801.

OPERATION

The resistance of an NTC element changes in response to temperature changes (the resistance drops as the temperature rises). The varying value of the resistance (the actual value) is compared with the value preset in the regulator.

Resistance diagram for sensor 3966 2982 030



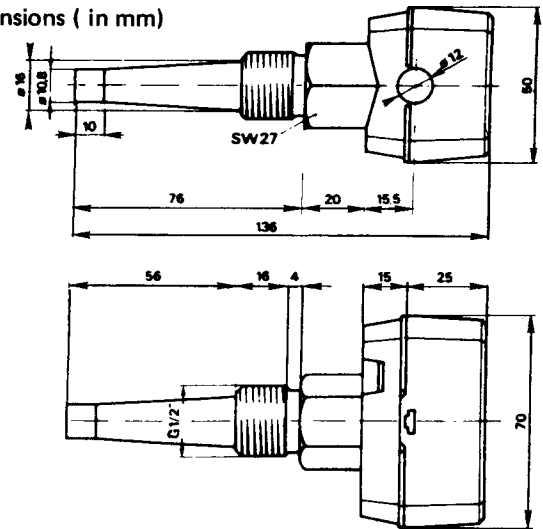
TECHNICAL DATA

Element:	NTC
Range:	0 to +30°C
Sensor wire colours:	Green/white (or black/blue)
Nominal pressure:	4 MPa (40 bar)
Time constant:	20s
Damage limits:	-30/+70°C

DESIGN AND CONSTRUCTION

This sensor consists of a submersible tube with 1/2" threads. An NTC element is built into the tube and provided with a casing. The submersible tube and casing are designed as an integral unit. The NTC element can be replaced without dismantling the submersible tube. This means that you will only need one submersible tube.

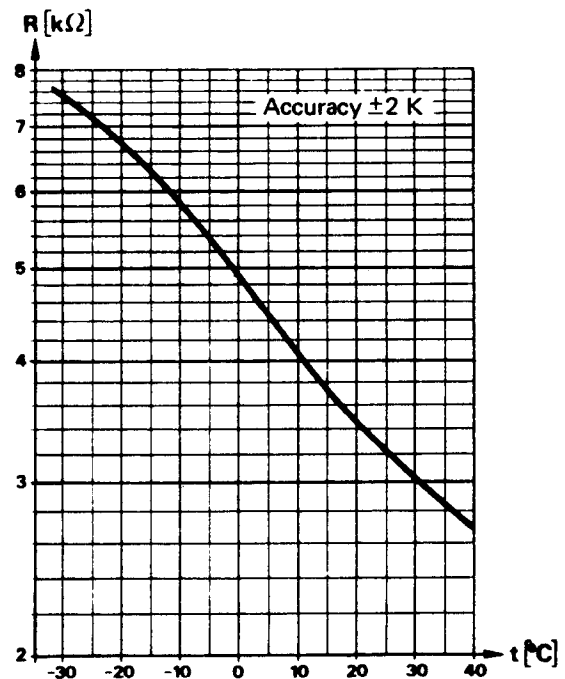
Dimensions (in mm)



INSTALLATION

The submersible sensor must be mounted (if possible) in a pipe bend in such a way that the submersible tube faces the flowing water. Mounting in turbulent flow is preferable.

Resistance diagram for sensor 3966 2982 038



TECHNICAL DATA

Element:	NTC
Range:	-32°C to +40°C
Sensor wire colour:	White
Nominal pressure:	4 MPa (40 bar)
Damage limits:	-50/+70°C

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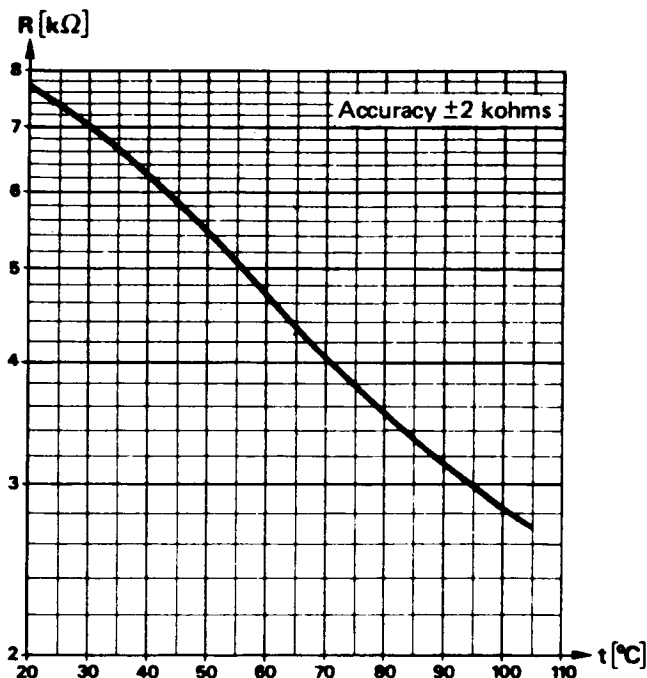
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4815/7827 - N - 130E
 22a/22
 TKA 1986-07

STAL-MINI screw compressor

STAL
 REFRIGERATION

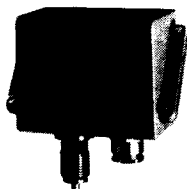
Resistance diagram for sensor 3966 2982 105



TECHNICAL DATA

Element: NTC
 Range: 20 - 105°C
 Sensor wire colour: Grey
 Nominal pressure: 4 MPa (40 bar)
 Damage limit: -50/+150°C

Pressure sensor



3966 1830 ...

OPERATION

This pressure sensor converts the pressure of the medium to a pressure-proportional DC signal.

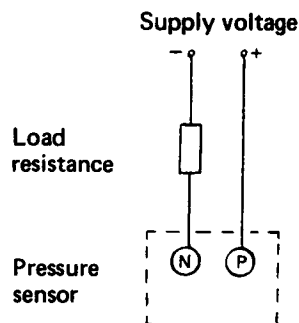
TECHNICAL DATA

Measurement principle: Inductive
 Output signal: 4 - 20 mA
 Linearity error: ±1% F. S. O.
 Temp. coefficient: 0.06% F. S. O.
 Supply voltage: 13.5 to 36 V DC

Load resistance: Max 410 ohms at 24 V DC
 Working media: Lubricating oil, ammonia, freon refrigerants, etc.
 Medium temperature: -40 to +100°C
 Ambient temperature: -10 to +70°C
 Pressure connector: BSP 1/2"
 Electrical connector: Pr 20.4
 Protection class: IP 67

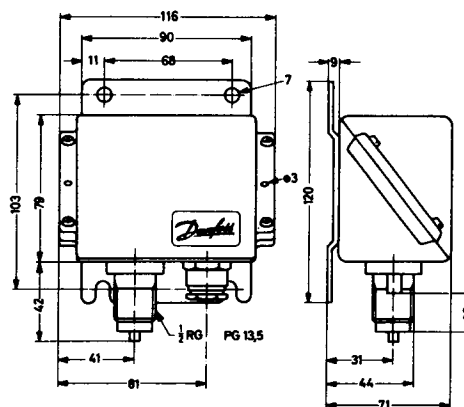
Article number	Pressure range MPa (gauge)	Test pressure MPa (gauge)	Bursting pressure MPa (gauge)
3966 1830 801	0 - 0.16	0.32	10
802	0 - 0.25	0.5	10
803	0 - 0.4	0.8	10
804	0 - 0.6	1.2	20
805	0 - 1.0	2.0	20
806	0 - 1.6	3.2	40
807	0 - 2.5	5.0	40
808	0 - 4.0	8.0	40

WIRING DIAGRAM



If the pressure sensor is used together with regulator 3968 1108 ... the load resistance is included in the regulator.

Dimensions (mm)



6. OIL SYSTEM

481/4832-C-25E Oil system

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OIL SYSTEM

OIL SYSTEM PURPOSES

The oil system in the compressor serves as a part of the refrigerant system. The oil has a number of purposes: lubrication, sealing and capacity control. Moreover, it frequently dissipates the heat of compression. Since these purposes are all linked to the compressor, the system has been designed so that oil recovered from the refrigerant system remains in the compressor.

SYSTEM DESIGN

In principle, the system comprises an oil separator, a cooler and an oil filter. See Fig. 1.

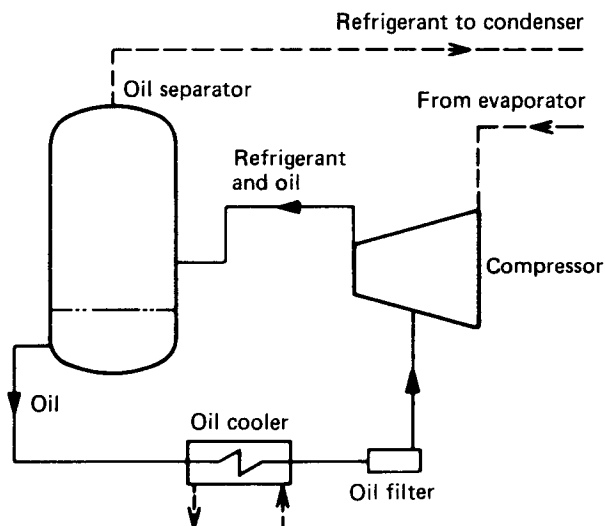


Fig. 1 Oil system, schematic diagram

System details can differ widely from compressor to compressor, depending upon the requirements imposed by the customer, whether a vertical or a horizontal oil separator is provided, etc. The system shown in Fig. 2 has a vertical oil separator.

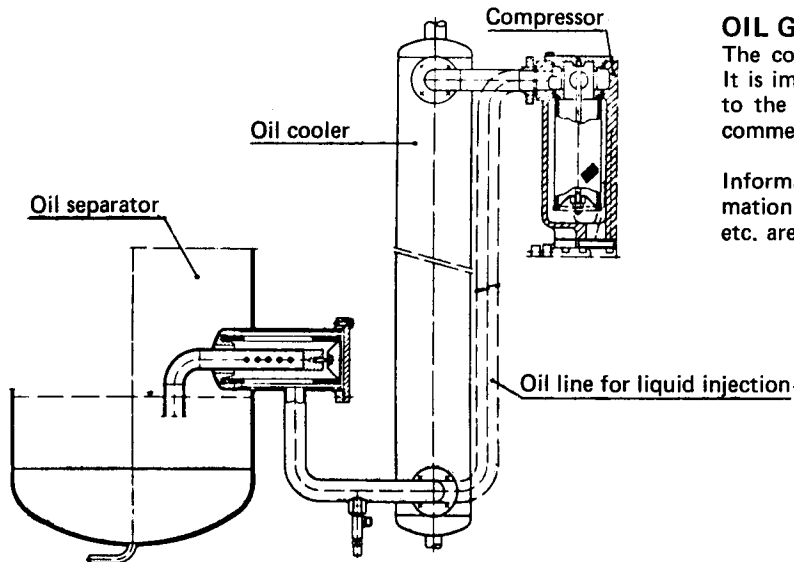


Fig. 2 Oil system for S24 screw compressor

OIL CIRCULATION

Normally, the compressor has no oil pump. Instead, oil circulates in response to the difference in pressure between the oil separator (compressor discharge pressure) and an intermediate pressure in the compressor compression chamber (to which the oil is returned). Under certain operating conditions where pressure differentials are small (booster systems, for example), an external oil pump is connected to the system to ensure a sufficiently high rate of oil flow.

In systems where the desired pressure difference ($P_1 - P_2$) does not build up quickly after startup, a differential pressure valve is needed.

To prevent damage to the compressor if the oil flow should be interrupted, a monitor is included in the oil system.

In the compressor, the oil first passes through a fine filter before being distributed to the different tube and sealing points located at the radial and thrust bearings, shaft seal, balancing pistons and gear wheels (in type R compressors). The oil is then injected into the compression chamber where it is pressed into the sealing gaps while simultaneously absorbing heat from the refrigerant. Finally, after it has become finely dispersed in the refrigerant, it is pressed out through the discharge port and sent to the oil separator where it is recovered for further use.

COOLING

As a rule, the heat of compression is carried away by having the oil cooled in a heat exchanger before it passes through the compressor. The heat exchanger can be water-cooled or condensate-cooled. Whenever feasible the heat is used in a heat pump or heat recovery system. In certain cases, the heat of compression is dissipated by injecting liquid refrigerant directly into the compression chamber. This does not require any oil cooler, but it reduces efficiency somewhat.

HYDRAULIC SYSTEM FOR CAPACITY CONTROL

High-pressure oil is also used in the hydraulic system that governs the capacity control piston. The oil is sent to a valve block that is governed by an external control system. It is distributed/drained to/from the hydraulic system in response to control system signals.

OIL GRADES

The compressors are designed to use different refrigerants. It is important to see that the oil grade is properly matched to the refrigerant and operating conditions as per the recommendations issued by STAL.

Information about how to select an oil and detailed information about the oil separator, cooler and return system, etc. are presented in a special section of the STAL manual.

Denna förklaringsblad är ett avsnitt ur STAL-manualen för kylsystem. Den är avsedd för tekniska personer som arbetar med kylsystem. Den innehåller tekniska detaljer som inte är avsedda för allmänheten. För ytterligare information kontakta STAL.

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7. ECONOMIZER, DRIER FILTER

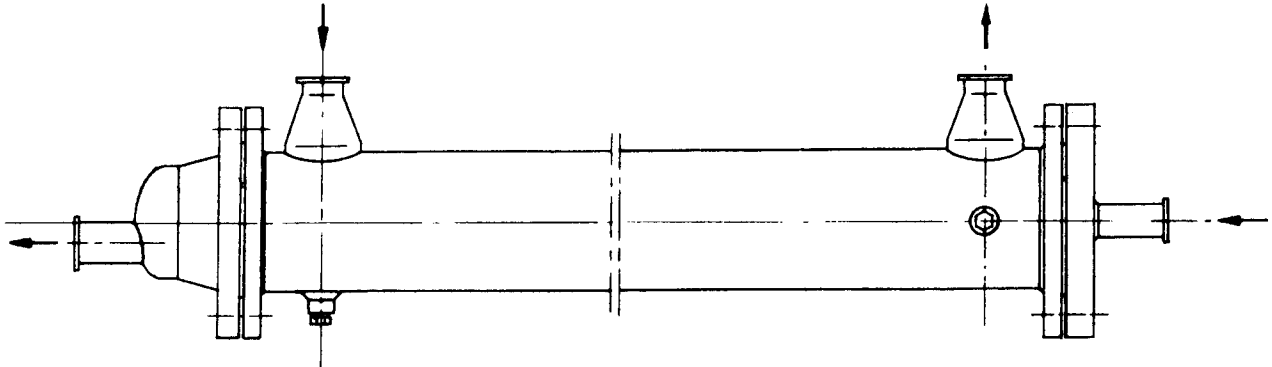
7547/7827-N-110E The EXB Economizers

528-N-6E Drier filter 1913 560

Denne manual er kun til brug for tekniske medarbejdere og tekniske skoleelever. Den må ikke udlånes eller gøres tilgængelig for andre personer. For yderligere oplysninger om dette dokument, kontakt venligst STAL.

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THE EXB ECONOMIZERS**1. GENERAL**

Economizers of type EXB are intended for use in RTK/RTM and VRV/VRM/VRW/VRP units that use refrigerants R12, R22 and R500. The design pressure is 3.0 MPa, and the EXB economizers fulfil applicable sections of Swedish standards.

2. DESCRIPTION

The EXB economizer is a heat exchanger of the shell-and-tube type. It consists of a tube bundle surrounded by a shell as well as tube sheets, a distribution head and an outlet head.

The tubes are made of copper with internal and external fins. The tubes are rolled into the tube sheets which, in turn, are welded to the shell.

The liquid refrigerant on the shell side is guided by a number of baffles. The seal between each head and the shell consists of a flat gasket.

The refrigerant evaporates inside the tubes and the liquid refrigerant that flows outside the tubes in the shell chamber is thus supercooled. The refrigerant is distributed equally among the tubes by means of a distributor mounted in the distribution head.

3. CARE AND MAINTENANCE**3.1 LEAKS**

If refrigerant consumption is such that there is reason to suspect a leak, the economizer should also be checked for leaks. Leak detection at the external connections should be carried out in the usual way. However, if a tube attachment is leaking, it will not cause any loss of refrigerant since the leak is purely internal. An abnormally low discharge line temperature sometimes indicates an internal leak.

If there is reason to suspect that a tube attachment is leaking, you can dismount the economizer heads and search for leaks with a leak-detector lamp, soap solution or the like. The condenser pressure should be kept high (equivalent to a temperature of about 45°C) while you are searching for leaks with soap solution. Make certain that any water used during leak detection is completely removed before closing up the equipment.

To check the internal tightness of the tubes, blow air through them, plug them and let them stand for two hours. Then, remove the plugs from one tube at a time and search for leaks using a leak-detector lamp.

NOTE: You must not wash with TRI (trichloroethylene) before searching for leaks using a leak-detector lamp, since TRI provides the same indication as freon refrigerants.

If a tube attachment leaks, you can try to fix it by rolling. For marine systems, it is advisable to keep a suitable rolling tool available. It should be of the adjustable type with a nominal diameter of 16.0 - 18.0 mm. If it proves impossible to roll the tube attachment in such a way as to eliminate the leak, and if the leakage is so serious that it jeopardizes the functioning of the economizer and thus of compressor safety ("wet" operation), the tube must be replaced or plugged. Plugging instructions are presented in manual sheet 547-N-15.

Up to 10% of the tubes can be plugged without having any significant effect on the functioning of the economizer. In the event of major damage, the damaged tubes or the economizer must be replaced.

3.1.1 REPLACING A TUBE

- Drill both ends of the tube using a 19.5 mm diameter drill. Make certain that the drilling operation does not damage the tube bore.
- After drilling, insert a mandrel or the like in one end of the tube. Then tap the tube out using light hammer blows.
- Tube remnants sometimes remain in the tube sheet since the drill diameter is smaller than the outside diameter of the tube. Remove these remnants. The holes in the tube sheets must have a diameter of 20 (+0.25/+0.1) mm.
- Polish the ends of the new tube to remove all dirt and oxide. Make certain that the tube bore and the outside of the tube are thoroughly degreased and free of scratches. The ends of the tube must be soft-annealed.

3.2 DISTRIBUTION HEAD

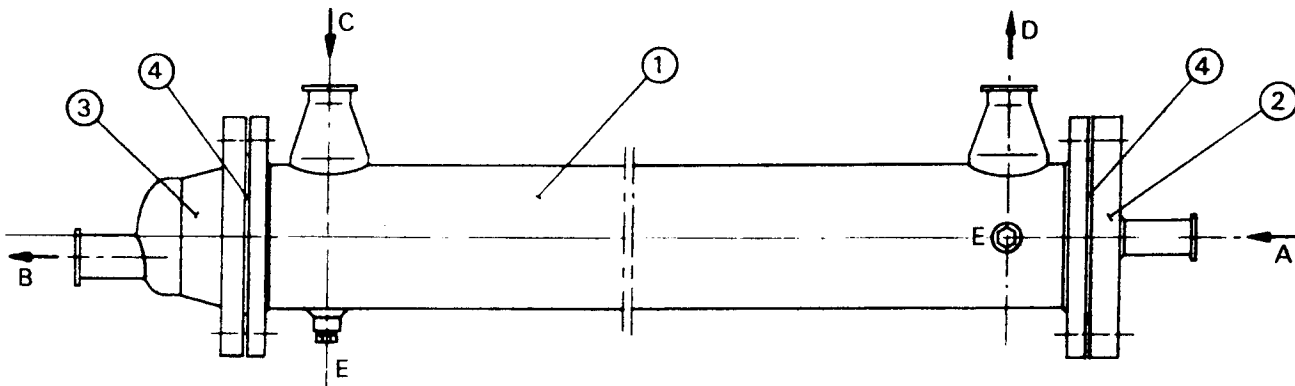
The refrigerant is distributed equally among the tubes by means of a distributor mounted in the distribution head. Any dirt that gets in when the refrigerant side is opened can, if it sticks in the distributor, cause serious overheating (relative to the intermediate pressure). This can be remedied by cleaning the distributor.

3.3 EVACUATION

If the refrigerant side of the economizer has been opened, the economizer must be evacuated before being put back into operation.

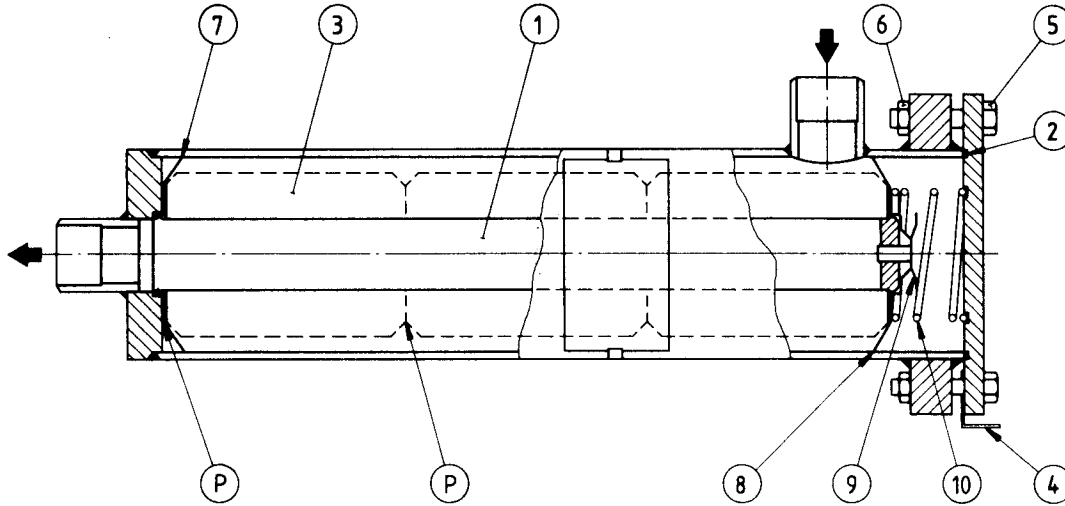
4. LIST OF PARTS, ECONOMIZER

Type	Ordering number	Tube	Gasket for inlet head	Gasket for outlet head	Attachments for distribution head and outlet head
EXB 43-1	1913 520-A	1910 909-1	1913 526-1 one 1913 526-2 one	3921 5206 100 one	M6S M20 - 70 8.8 3921 2121 678 sixteen
EXB 59-1	1913 530-A	1910 909-1	1913 536-1 one 1913 536-2 one	3921 5206 125 one	M6S M24 - 80 8.8 3921 2121 724 sixteen



Item	Name
1	Set of tubes
2	Distribution head
3	Outlet head
4	Gasket
Connections	
A	Intermediate-pressure liquid from expansion valve
B	Intermediate-pressure gas to compressor
C	High-pressure liquid from condenser or liquid receiver
D	Subcooled high-pressure liquid to heat exchanger or evaporator
E	Drainage

DRIER FILTER 1913 560
Maintenance instructions



LIST OF PARTS

Part No.	Name	Quantity and designation					
		1913 560-A		1913 560-B		1913 560-C	
1	Insert	1	1913 561-A	1	1913 561-B	1	1913 561-C
2	Gasket	1	Danfoss 633 L 9228	1	Danfoss 633 L 9228		Danfoss 633 L 9228
3	Desiccant element	2	3952 8018 901	3	3952 8018 901	4	3952 8018 901
4	Name plate	1	—	1	—	1	—
5	Screw	8	3921 2121 546 M6S 12 x 70 8.8	8	3921 2121 546 M6S 12 x 70 8.8	8	3921 2121 546 M6S 12 x 70 8.8
6	Nut	8	3921 2601 122 M6M 12 8	8	3921 2601 122 M6M 12 8		3921 2601 122 M6M 12 8

included in
3952 8018
901

3952 8018 901 is available as a spare part in an air-tight package that also contains gasket (2) and nameplate (4).

LIST OF PARTS

Part No.	Name	Quantity and designation					
		1913 561-A		1913 561-B		1913 561-C	
7	Block holder	1	Danfoss 023U 1141	1	Danfoss 023U 1142	1	Danfoss 023U 1143
8	Clamping plate	1	Danfoss 023U 1334				
9	Screw	1	Danfoss 023U 1147				
10	Spring	1	Danfoss 663X 1718				
2	Gasket	1	Danfoss 633 L 9228				

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HOW TO REPLACE DESICCANT ELEMENTS

When a new plant is being started up, the desiccant elements should normally be replaced after a maximum of 24 hours of operation. Moreover, they should be replaced again after about 72 hours of operation. Thereafter, the desiccant elements can remain in place for a long time if the rules set forth for avoiding moisture in the system are followed.

If a moisture detector is present, the desiccant elements must be changed when the indicator becomes yellow. In addition, the desiccant elements should be changed after major servicing jobs etc. (opening the compressor for example). And they should also be changed each time the system is topped up with 10-15% or more of the total refrigerant charge.

REMOVING AND INSERTING THE INSERT

The valve immediately upstream from the drier filter must be closed (while the system is operating) before removing the insert to clean it or to replace the desiccant elements. When the drier has been sucked empty, the valve immediately downstream from the drier must also be closed. Loosen the screws that hold the cover, but make certain the drier is not under any pressure before fully loosening and removing the screws and then removing the cover.

The insert can now be removed. The desiccant elements can be removed by removing screw (9) and then removing clamping plate (8). The gasket (P) between the desiccant inserts and (if present) the gasket beneath the block holder must be replaced. Clean all parts thoroughly.

Open the packages that contain the desiccant elements and mount the elements immediately. Fit a new flange gasket (2). Mount the nameplate that reads "CHARGED" on one of the screws.

STOP VALVES Type AVA 5 - 20

GENERAL

The design of these valves is based on many year's experience, the aim being to provide an economical valve which could take the place of the earlier types S-500:A7-15 and S-500:B7-15. Besides the valves have been provided with a flare bonnet. By utilizing modern manufacturing methods, a uniform, high quality is obtained at a low price. The valves are made for connection to steel tubes. They are made of steel and the valve body is surface-treated. The valve stem seal is made of teflon.

SOME DISTINGUISHING FEATURES

Robust construction

Valve stem of stainless steel

The stem sealing is so designed, that the sliding surface of the stem is always protected against external damage. On the bigger valves, which are intended for welding in, the gasket is not assembled. The gasket is delivered with the valve threaded on the stem under the valve cover.

Cover for the valve stem is delivered as standard. The threads of the valve stem are protected as far as possible from dirt and impurities from the pipe system.

The stem threads have a very fine pitch, facilitating flow adjustment. The bigger valves are also provided with a regulating cone.

A handwheel and disassembly tools are obtainable as attachments.

APPLICATIONS

The valves are designed for working pressures of up to 3.5 MPa and for temperatures between +150 and -70°C. They are suitable for all of the currently known refrigerants.

At high pressures and moderate temperatures, they are also suitable for other mediums, that do not attack the valve material, such as air, water, light hydraulic oils, certain vegetable oils, ethylene, etc.

The valves will not be mounted with the stem downwards.

INTERCHANGEABILITY AND ORDER PROCEDURE

The AVA-valves are fully interchangeable for the earlier valves S-500:A and S-500:B concerning installation dimensions and connections.

When ordering a valve with a handwheel, state the order number, e.g. Valve 1885 411-E, Handwheel 3921 8822 801.

WELDING

When AVA 15-2 and AVA 20-2 are welded into the installation site, the teflon gasket must be removed. In fitting, the steel washer must be placed under the teflon gasket.

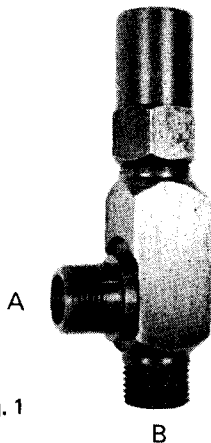


Fig. 1

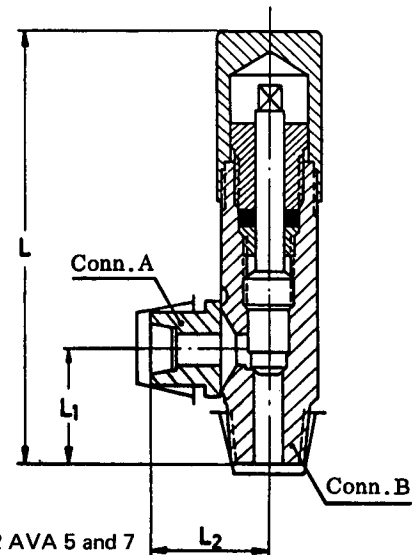


Fig. 2 AVA 5 and 7

TECHNICAL DATA Table 1

Type AVA	Order number	Flow diameter mm	Intended for pipe D ₀ /D ₁	Type of connection		Friction factor 1)	Replaces valve type	Corresponds older valve type	L	L ₁	L ₂	Hand-wheel	Connection parts (not included in the valve)			
				A	B								Connection A		Connection B	
													Joint ring	Nut	Joint ring	Nut
7-1	1885 411 -A	6.8	10.2/6.2	Joint ring coupling	3/8 NPTF	4.2	S-500:A7	S-500:H6	103	27.5	27.5	3921 8822 801	3951 3081 810	3951 3091 810	—	—
7-2	-B	6.8	10.2/6.2		Joint ring	4.2	S-500:B7	S-500:G6	103	27.5	27.5		3951 3081 810	3951 3091 810	3951 3081 810	3951 3091 810
7-3	-C	6.8	10.2/6.2		1/4 NPTF	4.2			103	27.5	27.5		3951 3081 810	3951 3091 810	—	—
5-1	-D	5	6/4		1/4 NPTF				103	27.5	24		3951 3081 806	3951 3091 806	—	—
5-2	-E	5	6/4		Joint ring				103	27.5	24		3951 3081 806	3951 3091 806	3951 3081 806	3951 3091 806
15-1	1886 620 -E	15	21.3/17.3	Joint ring coupling		8.5/6.0	1886 620-A	S-500:G13	147	40	40	1885 887-A	3951 3081 821	3951 3091 810	3951 3081 821	3951 3091 821
15-2	1886 620 -F	15	17.2/13.2 21.3/17.3	Weld		3.0/2.0 8.5/6.0	1886 620-B		147	40	40		Welding connection to pipes			
15-3	1886 620 -G	15	21.3/17.3	2) 3/4 NPTF		8.5/6.0	—	—	147	40	42	1885 887-A	3951 3081 821	3951 3091 810	—	—
20-2	1887 170 -F	20	21.3/17.3 26.9/22.3 33.7/28.5	Weld		2.7/2.0 7.4/5.6	1887 170-B		174	45	45	1885 887-B	Welding connection to pipes			

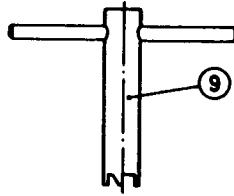
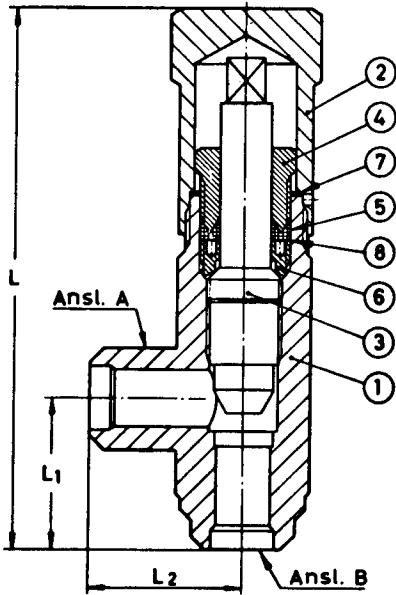
1) Refers to flow in different directions for valves 15-1 and 15-2, for the remaining valves the friction factor for both flow directions is valid.
2) Joint ring coupling

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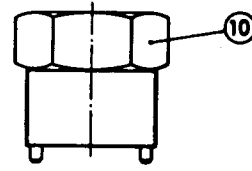
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Stop valves



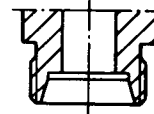
Tool for disassembling gasket



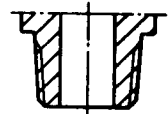
Tool for back seal

The valve can both be electric welded and gas welded

When welding in of the valve, the gland (4) and the gasket (5) are to be disassembled and the valve stem should be opened completely



AVA 15-1 conn. A and B



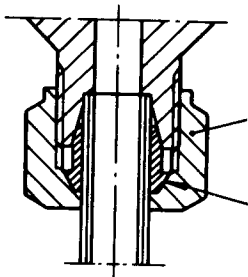
AVA 15-3 conn. B

Fig. 3
AVA 15-2 and 20-2

Table 2

Valve type AVA	Parts									
	Valve housing 1	Cover 2	Stem 3	Gland 4	Gasket 5	Back seal 6	Gasket ring 7	Washer 8	Assembly tool 9	Tool 10
5, 7		1885 419-1		1885 418-1			3921 5213 828			
15 - 1	1886 621-E	1886 626-1	1886 627-3	1889 320-1 1)	1886 630-11 1)	1883 814-1	3921 5213 848	1887 930-1	1889 349-D	1888 316-A
15 - 2	1886 621-F	1886 626-1	1886 627-3	1889 320-1 1)	1886 630-11 1)	1883 814-1	3921 5213 848	1887 930-1	1889 349-D	1888 316-A
20 - 2	1887 171-F	1887 176-1	1887 177-3	1887 178-1 2)	1886 630-12 2)	1887 179-1	3921 5213 856	1887 930-2	1889 349-B	1888 316-B
5 and 7		1885 419-1		1885 418-1	1885 422-1		3921 5213 828			

- 1) Spare parts for the old valve 1886 620-A and B, see standard sheet 3951 4314
- 2) Spare parts for the old valve 1887 170-B, see standard sheet 3951 4314



Joint ring coupling
Fig. 4

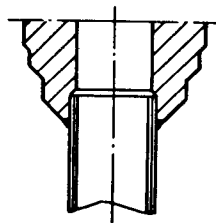
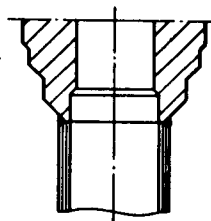


Fig. 5



Welding connection for AVA 15-2 and 20-2
Fig. 6

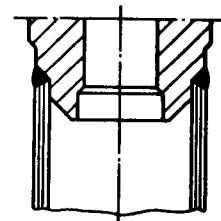


Fig. 7

MAINTENANCE

Directions for disassembling of AVA 15 and 20

If the stem seal leaks, it will normally suffice to tighten the gland (4). If this measure proves inadequate, the gasket (5) should be changed. If the valve can be left open while this is being done, open it fully so that the stem (3) seals against the back seal (6). Otherwise, the pressure in the valve must be lowered to atmospheric before the gland is screwed off. The gasket can then be screwed out with the disassembly tool. The latter can be struck into the gasket to secure a good grip.

Always use carefulness when dismantling a gasket. The washer may be missing (because of improper mounting) or positioned on the wrong side of the gasket. If such is the case, the back seal can come loose, and this will result in refrigerant leakage. If this occurs, you must stop screwing out the gasket immediately. Knock it off the stem using a suitable screw-driver and remove the pieces with a suitable implement.

AVA 5 and 7

These valves are not to be disassembled. The complete valve must be changed.

STOP VALVE TYPE ASB

DN 40

GENERAL

This stop valve is designed for use in refrigerating plants and intended for welding to steel pipes. The valve is distinguished by its low weight and compact installation dimensions.

The valve can be delivered classified in Lloyd's Register of Shipping, Det Norske Veritas, Bureau Veritas and Germanischer Lloyd.

DESCRIPTION

The valve has a low flow resistance. The valve body (1) is made of steel, a material chosen in view of the fact that the valves are normally welded into the piping system on the installation site. The disk (3) has a replaceable sealing ring (7) of teflon. The disk which runs in a guide on the valve body cover is connected to the stem (4) by a simple coupling without screwed joints, etc. This guide protects the threads of the valve stem against impurities. The stem is made of stainless steel with a highly polished surface. The stem seal (5) is of a modern O-ring design which makes the valve easy to operate and eliminates any need of subsequent tightening. The valve is provided with a so-called back seal (18) which serves to afford sealing between the stem and the cover of the valve body, enabling the stem seal (5) to be removed for overhauling and replacement, if necessary, of the O-rings. The connection pipe stubs are arranged for direct welding to pipes with an outside diameter of 48.3 mm. A valve cover, stem extension, regulating cone and low-temperature stuffing box for the stem seal are available as optional accessories.

PRESSURE DROP

The resistance factor for the valve is 5.2 in the case of flow against the disk and 6.5 in the case of flow with the disk (from A to B, see Fig. 2). The resistance factor is valid for an inside diameter of 43.1 mm on connecting pipes. The flow resistance of the valve is calculated on the basis of the following formula

$$\Delta p = \xi \times \frac{w^2 \times \rho}{2}$$

where

Δp = Pressure drop in N/m²

w = Velocity in pipe m/s

ρ = Density of medium kg/m³

ξ = Resistance factor of valve

APPLICATION

The valve is pressure tested to 4.5 MPa. Permissible temperature ranges:

-40°C to +150°C with standard version of stem seal

-60°C to +150°C with refrigerants and with low-temperature stuffing box.

The valve complies with the requirements according to AD-Merkblatt W10.

It may be used for refrigerants NH₃, R12, R22, R502 and R13B1, as well as for air, oils and other media which do not attack aluminium, steel, teflon, Klinger Oilit and nitrile rubber.

FITTING INSTRUCTIONS

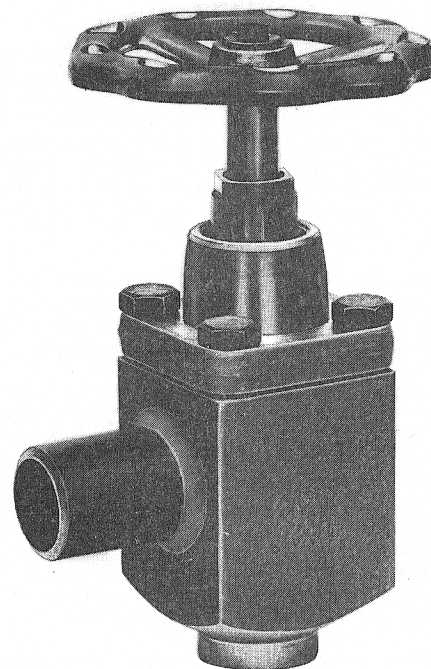


Fig. 1

STOCKAGE AND FORMS OF DELIVERY

The valve is intended to be welded into the piping system on the installation site and while this is being done the insert will have to be removed in order not to get damaged. For this reason, the valve will be delivered in two sections.

The valve body is delivered separately, ready to be welded into the piping system on the installation site. The screws for fitting of the insert are delivered screwed into the valve body. For this reason, the insert is delivered without these screws but is otherwise complete with its seal and is packed in a waxed corrugated-board case marked with the type reference, size designation and drawing number.

ORDERING PROCEDURE

When ordering the valve, refer to Table 1 below, which lists the order numbers for valve bodies and inserts. These order numbers must always be quoted. The table also lists accessories which must be ordered separately.

Table 1 Order No.

Classification society	Valve body	Insert
LR and NV	1910 360-A	1885 100-B
Unclassified	1910 360-B	
BV	1910 360-D	
GL	1910 360-E	
Accessories		
	1910 360-F	

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**CHECK VALVE TYPE ABB
DN 40**

GENERAL

This check valve is used in piping to prevent return flowing. It can be closed by hand against the direction of flow but cannot, on the other hand, be opened by force. All parts of the valve, with the exception of the valve disk, are identical with those in the stop valve of type ASB, with which it is completely interchangeable.

The valve can be delivered classified in Lloyd's Register of Shipping, Det Norske Veritas, Bureau Veritas and Germanischer Lloyd.

DESCRIPTION

The valve has a full flow area corresponding to the diameter of the connections.

The valve body (1) is made of steel, which has been chosen in view of the fact that this valve is usually welded into the piping system on the installation site. The disk (3) has a replaceable sealing ring (7) of teflon. The disk, which is loaded by the spring (9), runs in a guide in the valve body cover. This guide protects the threads of the valve stem (4) against impurities. The valve stem is made of stainless steel with a highly polished surface. The disk is completely free of the stem and consequently cannot be opened, but can be closed, by force.

The valve stem seal (5) is of a modern O-ring design, making the valve easy to operate by hand and eliminating the need for subsequent tightening of the seal. The valve is provided with a so-called back seal (19) between the stem and the valve body cover, allowing the stem seal (5) to be removed for overhauling and replacement, if necessary, of O-rings. The handwheel is provided with a sign plate (10) indicating the direction of flow of the valve.

The connections are arranged for direct welding to pipes with an outside diameter of 48.3 mm.

PRESSURE DROP

The requisite pressure difference in order for the valve to open is 4.4 kPa with the stem vertical and the handwheel upwards and 0.7 kPa with the stem vertical and the handwheel downwards.

APPLICATION

The valve is pressure tested to 4.5 MPa. Permissible temperature ranges:

-40°C to +150°C with standard version of stem seal

- 60°C to +150°C with refrigerants and with low-temperature stuffing box.

The valve complies with the requirements according to AD-Merkblatt W10.

It may be used for refrigerants NH₃, R12, R22, R502 and R13B1, as well as for air, oils and other media which do not attack aluminium, steel, teflon, Klinger Oilit and nitrile rubber.

FITTING INSTRUCTIONS

The check valve should be fitted with the stem vertical, and in this context it should be borne in mind that the flow resistance will be smaller with the handwheel downwards.

When the valve is being welded to a pipe, flange, etc., the insert must be removed, as otherwise the sealing rings may get damaged. The insert must be kept protected against dirt and other foreign matter. Take particular care with the valve stem, which is sensitive to scratching, scoring, etc.

When the valve body has been fitted (welded or flanged) and it has been ensured that welding slag, dirt etc., has been removed both from the valve body itself and in the lines leading to and from it, the insert may be fitted. Make sure that the stem is set for a fully open valve. Position the sealing ring in the cover and tighten the screws alternately. Never paint the valve stem.

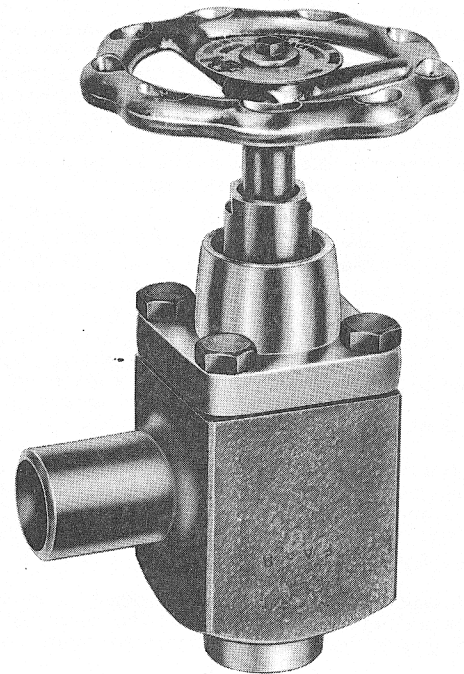


Fig. 1

STOCKAGE AND FORMS OF DELIVERY

The valve is intended to be welded into the piping system on the installation site and while this is being done the insert will have to be removed in order not to get damaged. For this reason, the valve will be delivered in two sections.

The valve body is delivered separately, ready to be welded into the piping system on the installation site. The screws for fitting of the insert are delivered screwed into the valve body. For this reason, the insert is delivered without these screws but is otherwise complete with its seal and is packed in a waxed corrugated-board case marked with the type reference, size designation and drawing number.

ORDERING PROCEDURE

When ordering the valve, refer to Table 1 below, which lists the order numbers for valve bodies and inserts. These order numbers must always be quoted. The table also lists accessories which must be ordered separately.

Table 1 Order No.

Classification society	Valve body	Insert
LR and NV	1910 360-A	1885 101-B
Unclassified	1910 360-B	
BV	1910 360-D	
GL	1910 360-E	
Accessories		
Valve cover	1885 187-B	
Stem extension	1885 009-B	
Low-temperature stuffing box for stem seal	1886 144-B	

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MAINTENANCE

Directions for dismantling and re-assembly in the event of leakage

If the stem seal leaks, the O-rings (14) will have to be replaced. If the valve can be left open while this is being done, open it fully so that the stem sealing cone seals against the seat in the valve cover. Otherwise, the pressure over the disk will have to be lowered to atmospheric before the stuffing box (5) is screwed off. The rings can then easily be removed and new ones fitted. Make sure that the stem is free of scratches, scorings, etc. There must on no account be any sharp edges or burrs on the stem.

When fitting the sealing rings, make sure that they are flawless and take care not to damage them. Lubricate the rings with refrigerating machinery oil. The stuffing box with rings should be easy to pass onto the stem and slide smoothly on it.

A complete stuffing box should be kept handy for insertion. When the valve is opened, a tiny quantity of refrigerant dissolved in the oil on the stem may escape. A leak-detecting torch or similar testing device will, however, give only a transient indication of leakage.

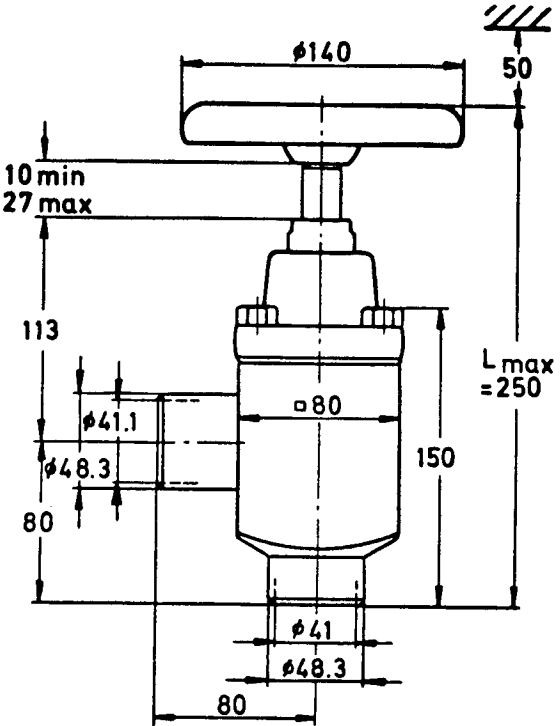
Satisfactory functioning of the stuffing box is conditional on having rubber rings of the right quality and proper size. It is recommended that a few spare rings be kept for each valve size, as only original rings of special synthetic rubber may be used.

If the sealing ring on the disk is damaged, it can either be reversed or replaced by a new one. The valve must then be completely relieved of pressure before the insert is removed.

A slightly damaged seat can be improved by rubbing with a piece of emery cloth attached to a flat-ended cylindrical block. Never treat the stem carelessly. Never paint the stem.

Table 2. List of parts

Item No.	Description	Quant.	Order No.
1	Valve body	1	1910 360-A/E
2	Valve body cover	1	1885 226-1
3	Valve disk	1	1910 814-1
4	Valve stem	1	1885 114-1
5	Stuffing box	1	1885 071-1
6	Retainer	1	1910 816-1
7	Sealing ring	1	1885 117-2
8	Washer	1	1885 018-1
9	Spring	1	1885 154-1
10	Sign-plate	1	1820 729-3
11	Handwheel	1	3921 8821 805
12	Gasket	1	3921 5213 880
13	Gasket	1	3921 5216 820
14	O-ring	2	3921 5284 724
15	Disc spring	2	3921 9512 806
16	Screw	4	3921 2120 538
17	Screw	1	3921 2150 109
18	Screw	1	3921 2121 364



Weight 5.9 kg

Fig. 2

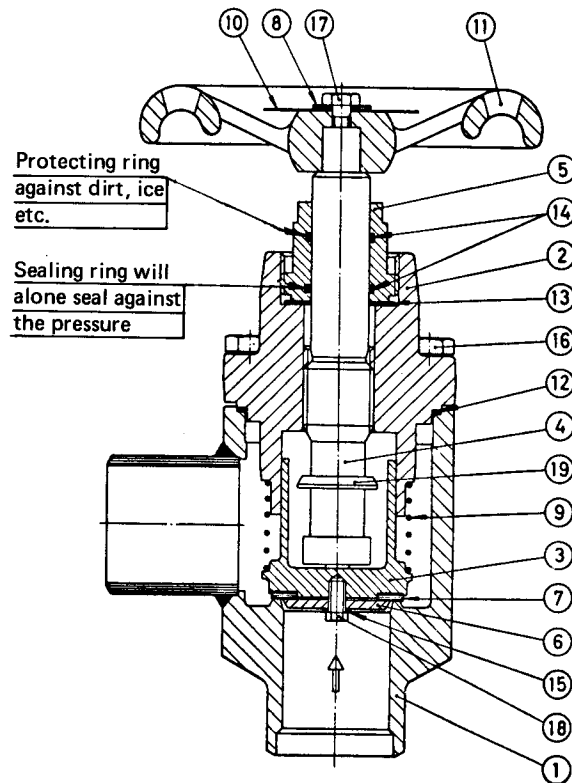


Fig. 3

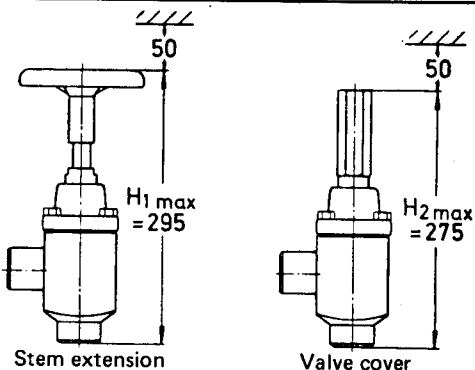


Fig. 4

**CHECK VALVE TYPE ABB
DN 65**

GENERAL

This check valve is used in piping to prevent return flowing. It can be closed by hand against the direction of flow but cannot, on the other hand, be opened by force. All parts of the valve, with the exception of the valve disk, are identical with those in the stop valve of type ASB, with which it is completely interchangeable.

The valve can be delivered classified in Lloyd's Register of Shipping, Det Norske Veritas, Bureau Veritas and Germanischer Lloyd.

DESCRIPTION

The valve has a slightly reduced flow area in relation to the diameter of the connections.

The valve body (1) is made of steel, which has been chosen in view of the fact that this valve is usually welded into the piping system on the installation site. The disk (3) has a replaceable sealing ring (7) of teflon. The disk, which is loaded by the spring (9), runs in a guide in the valve body cover. This guide protects the threads of the valve stem (4) against impurities. The valve stem is made of stainless steel with a highly polished surface. The disk is completely free of the stem and consequently cannot be opened, but can be closed, by force.

The valve stem seal (5) is of a modern O-ring design, making the valve easy to operate by hand and eliminating the need for subsequent tightening of the seal. The valve is provided with a so-called back seal (19) between the stem and the valve body cover, allowing the stem seal to be removed for overhauling and replacement, if necessary, of O-rings. The handwheel is provided with a sign plate (10) indicating the direction of flow of the valve.

The connections are arranged for direct welding to pipes with an outside diameter of 76.1 mm.

PRESSURE DROP

The requisite pressure difference in order for the valve to open is 3.4 kPa with the stem vertical and the handwheel upwards and 0.2 kPa with the stem vertical and the handwheel downwards.

APPLICATION

The valve is pressure tested to 4.5 MPa. Permissible temperature ranges:

-40°C to +150°C with standard version of stem seal

-60°C to +150°C with refrigerants and with low-temperature stuffing box.

The valve complies with the requirements according to AD-Merkblatt W10.

It may be used for refrigerants NH₃, R12, R22, R502 and R13B1, as well as for air, oils and other media which do not attack aluminium, steel, teflon, Klinger Oilit and nitrile rubber.

FITTING INSTRUCTIONS

The check valve should be fitted with the stem vertical, and in this context it should be borne in mind that the flow resistance will be smaller with the handwheel downwards.

When the valve is being welded to a pipe, flange, etc., the insert must be removed, as otherwise the sealing rings may get damaged. The insert must be kept protected against dirt and other foreign matter. Take particular care with the valve stem, which is sensitive to scratching, scoring, etc.

When the valve body has been fitted (welded or flanged) and it has been ensured that welding slag, dirt etc., has been removed both from the valve body itself and in the lines leading to and from it, the insert may be fitted. Make sure that the stem is set for a fully open valve. Position the sealing ring in the cover and tighten the screws alternately. Never paint the valve stem.

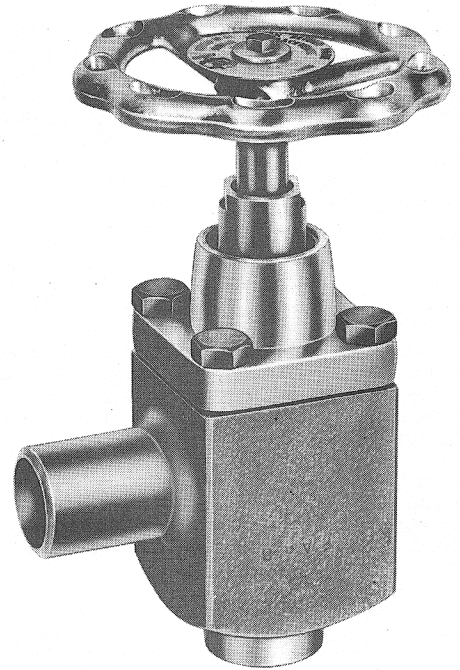


Fig. 1

STOCKAGE AND FORMS OF DELIVERY

The valve is intended to be welded into the piping system on the installation site and while this is being done the insert will have to be removed in order not to get damaged. For this reason, the valve will be delivered in two sections.

The valve body is delivered separately, ready to be welded into the piping system on the installation site. The screws for fitting of the insert are delivered screwed into the valve body. For this reason, the insert is delivered without these screws but is otherwise complete with its seal and is packed in a waxed corrugated-board case marked with the type reference, size designation and drawing number.

ORDERING PROCEDURE

When ordering the valve, refer to Table 1 below, which lists the order numbers for valve bodies and inserts. These order numbers must always be quoted. The table also lists accessories which must be ordered separately.

Table 1 Order No.

Classification society	Valve body	Insert
LR and NV	1910 362-A	1885 101-C
Unclassified	1910 362-B	
BV	1910 362-D	
GL	1910 362-E	
Accessories		
Valve cover	1885 187-B	
Stem extension	1885 009-B	
Low-temperature stuffing box for stem seal	1886 144-B	

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MAINTENANCE

Directions for dismantling and re-assembly in the event of leakage

If the stem seal leaks, the O-rings (14) will have to be replaced. If the valve can be left open while this is being done, open it fully so that the stem sealing cone seals against the seat in the valve cover. Otherwise, the pressure over the disk will have to be lowered to atmospheric before the stuffing box (5) is screwed off. The rings can then easily be removed and new ones fitted. Make sure that the stem is free of scratches, scorings, etc. There must on no account be any sharp edges or burrs on the stem.

When fitting the sealing rings, make sure that they are flawless and take care not to damage them. Lubricate the rings with refrigerating machinery oil. The stuffing box with rings should be easy to pass onto the stem and slide smoothly on it.

A complete stuffing box should be kept handy for insertion. When the valve is opened, a tiny quantity of refrigerant dissolved in the oil on the stem may escape. A leak-detecting torch or similar testing device will, however, give only a transient indication of leakage.

Satisfactory functioning of the stuffing box is conditional on having rubber rings of the right quality and proper size. It is recommended that a few spare rings be kept for each valve size, as only original rings of special synthetic rubber may be used.

If the sealing ring on the disk is damaged, it can either be reversed or replaced by a new one. The valve must then be completely relieved of pressure before the insert is removed.

A slightly damaged seat can be improved by rubbing with a piece of emery cloth attached to a flat-ended cylindrical block. Never treat the stem carelessly. Never paint the stem.

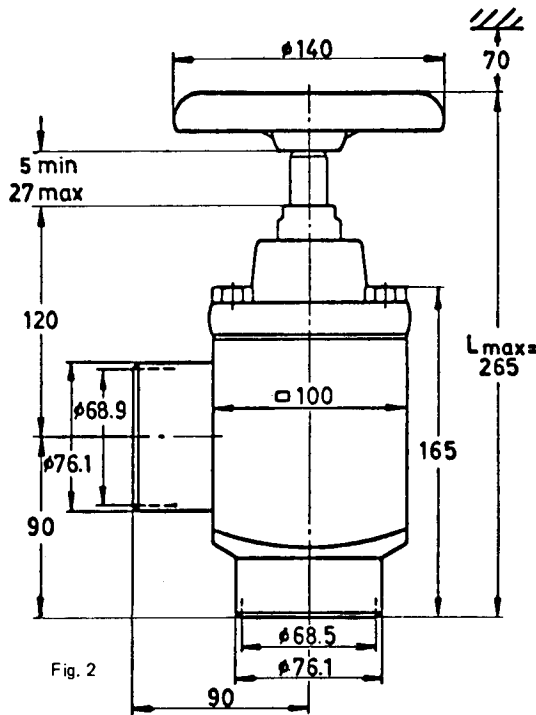


Fig. 2

Weight 11 kg

Table 2. List of parts

Item No.	Description	Quant.	Order No.
1	Valve body	1	1910 362-A/E
2	Valve body cover	1	1885 173-1
3	Valve disk	1	1910 813-1 1)
4	Valve stem	1	1885 114-1
5	Stuffing box	1	1885 071-1
6	Retainer	1	1910 816-2
7	Sealing ring	1	1885 117-3
8	Washer	1	1885 018-1
9	Spring	1	1910 815-1 1)
10	Sign-plate	1	1820 957-3
11	Handwheel	1	3921 8821 805
12	Gasket	1	3921 5213 882
13	Gasket	1	3921 5216 820
14	O-ring	2	3921 5284 724
15	Disc spring	2	3921 9512 806
16	Screw	4	3921 2120 538
17	Screw	1	3921 2150 109
18	Screw	1	3921 2121 367

1) Disk (3) and spring (9) must be changed at the same time.

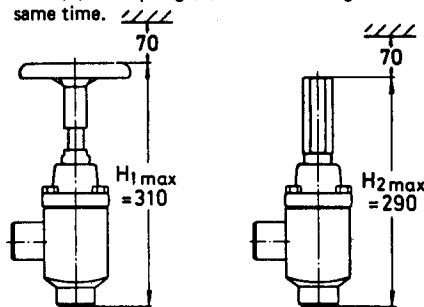


Fig. 4 Stem extension

Valve cover

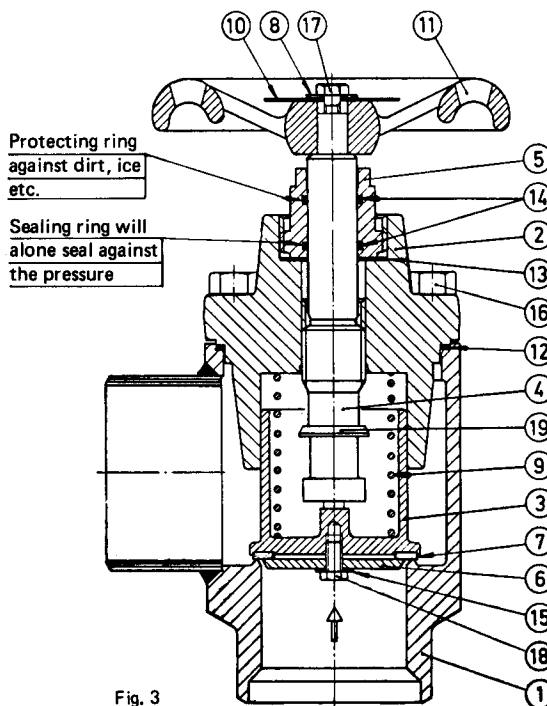


Fig. 3

CHECK VALVE TYPE ABB DN 80

GENERAL

This check valve is used in piping to prevent return flowing. It can be closed by hand against the direction of flow but cannot, on the other hand, be opened by force. In order to get the smallest possible flow resistance, the stem must be set for a fully open valve. The valve features a built-in damper to eliminate hammering in response to with small flows or violent turbulence in the pipe system.

It has a low weight and compact installation dimensions.

The check valve has the same body as stop valve ASB 80, and also has the same gland and stem seal as this.

The valve can be delivered classified in Lloyd's Register of Shipping, Det Norske Veritas, Bureau Veritas and Germanischer Lloyd.

DESCRIPTION

The valve has a full flow area corresponding to the diameter of the connection.

The valve body (1) is made of fully drawn steel tube, a material chosen in view of the fact that the valve is normally welded into the piping system on the installation site. The valve disk (3) has a sealing ring (4) of teflon. The disk, which is loaded by the spring (7), is tightened to the damping piston (9) by means of a lock nut (20). The piston runs through the damping cover (6) which, in turn, is screwed to a sleeve (5). This sleeve is secured to the cover (2) by means of three locking screws. The sleeve has a lug for the spring and can be turned in order to increase the spring force on the disk. This slightly increases the pressure drop. The stem (8) is made of stainless steel with a highly polished surface. The stem seal (13) is of "Rulon LD" (a type of reinforced teflon) which permits subsequent tightening. The valve is provided with a so-called back seal (11) of teflon.

The back seal serves to afford sealing between the stem and the cover (2), enabling the stem seal to be removed for replacement. The handwheel carries a sign plate indicating the flow direction of the valve. The connection pipe stubs are arranged for direct welding to pipes with outside diameters of 88.9 mm. A valve cover, a stem extension and seal dismantling tool are available as optional accessories.

APPLICATION

The valve is pressure tested to 4.5 MPa.

Permissible temperature range is - 60 to + 150°C when using refrigerant.

The valve complies with the requirements according to AD-Merkblatt W10.

The valve may be used for refrigerants NH₃, R12, R22, R502 and R13B1, as well as for air, oils and other media which do not attack steel, teflon and Klinger Oilit.

FITTING INSTRUCTIONS

The check valve should be fitted with the stem vertical, and in this context it should be borne in mind that the flow resistance will be smaller with the handwheel downwards. When the valve is being welded to a pipe, flange etc., the insert must be removed. The insert must be kept protected against dirt and other foreign matter. Take particular care with the valve stem, which is sensitive to scratching, scoring, etc.

When the valve body has been fitted (welded or flanged) and it has been ensured that welding slag, dirt etc., has been removed both from the valve body itself and in the lines leading to and from it, the insert may be fitted. Make sure that the stem is set for a fully open valve. Position the sealing ring in the cover and tighten the screws alternately. Never paint the valve stem.

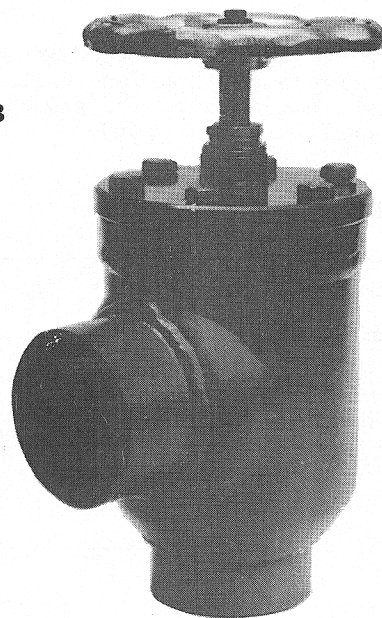


Fig. 1

STOCKAGE AND FORMS OF DELIVERY

The valve is intended to be welded into the piping system on the installation site and while this is being done the insert will have to be removed in order not to get damaged. For this reason, the valve will be delivered in two sections.

The valve body is delivered separately, ready to be welded into the piping system on the installation site. The valve insert, complete with its seal and screws, is delivered packed in a waxed corrugated-board case marked with the type reference, size designation and drawing number.

PRESSURE DROP

The resistance factor relates to the inside diameter 82.5 mm of the connecting pipes and is found from diagram 1 as a function of ρw^2 .

The flow resistance of the valve is calculated from the following formula:

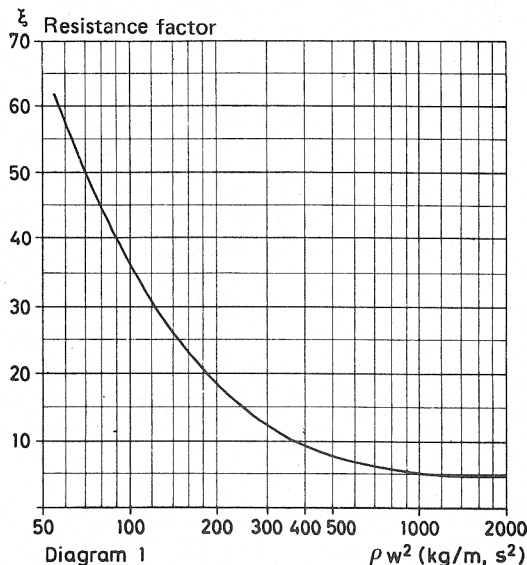
$$\Delta p = \xi \times \frac{w^2 \times \rho}{2}$$

$$\Delta p = \text{Pressure drop in N/m}^2$$

$$w = \text{Velocity in pipe m/s}$$

$$\rho = \text{Density of medium kg/m}^3$$

$$\xi = \text{Resistance factor of valve}$$



ORDERING PROCEDURE

When ordering the valve, refer to Table 1 below, which lists the order numbers for valve bodies and inserts. These order numbers must always be quoted. The table also lists accessories which must be ordered separately.

Table 1 Order No.

Classification society	Valve body	Insert
LR and NV	1886 568-A	1888 850-B
Unclassified	1886 568-B	
BV	1886 568-D	
GL	1886 568-E	
Accessories		
Valve cover	1885 187-G	
Dismantling tool for stem sealing	1889 349-D	
Stem extension	1885 009-E	

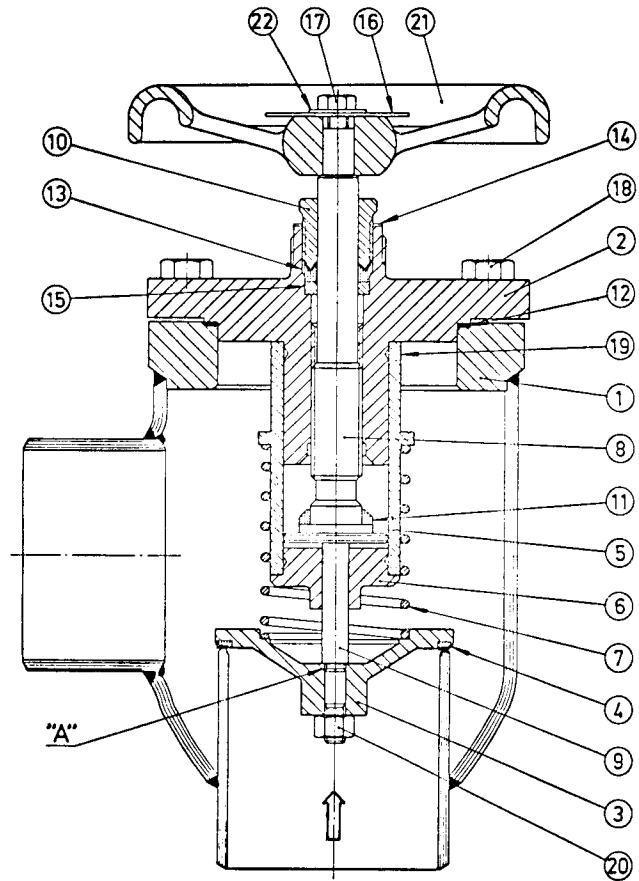


Fig. 3

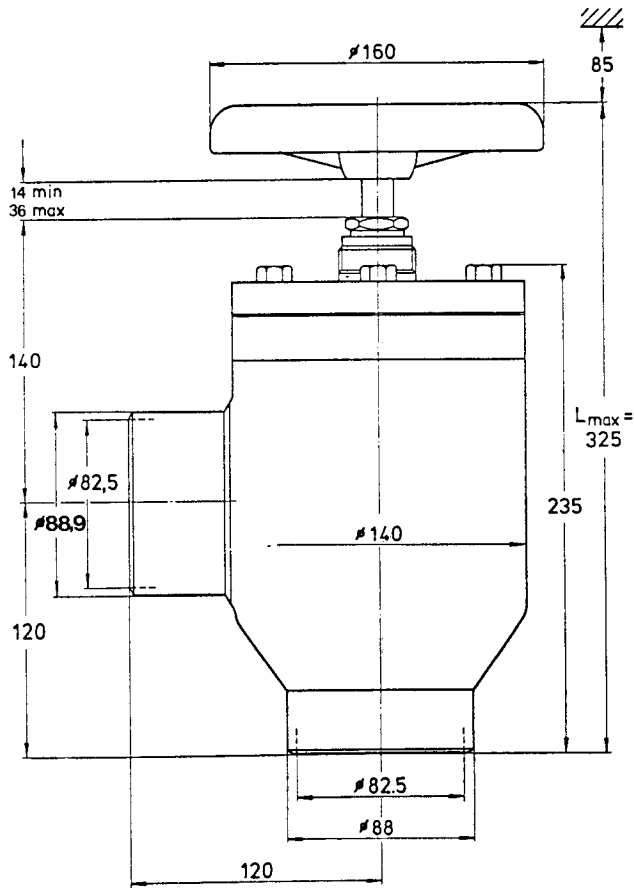


Fig. 2

Weight 10 kg

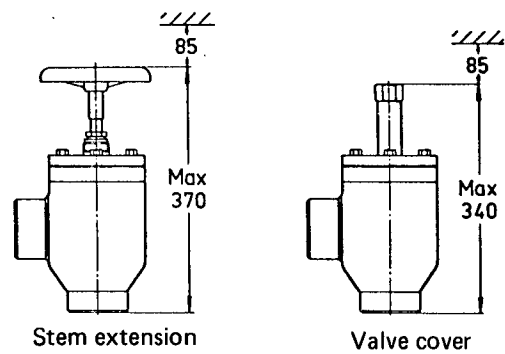


Fig. 4

MAINTENANCE**Directions for dismantling and re-assembly in the event of leakage**

If the stem seal leaks, it will normally suffice to tighten the gland (10). If this measure proves inadequate, the gasket (13) should be replaced. If the valve can be left open while this is being done, open it fully so that the back seal (11) seals between the cover and the stem (8). Otherwise, the pressure over the disk (3) must be lowered to atmospheric before the gland is screwed off. The gasket can then be screwed out with the aid of the dismantling tool. The latter should be struck into the gasket to provide a good grip.

Make sure that there are no scratches, scorings or the like on the valve stem. There must on no account be any sharp edges or burrs on it.

When fitting the gasket, make sure that it is not scratched or scored on the inner, cylindrical part. Lubricate the gasket with refrigerating machinery oil.

When the valve is opened, a tiny quantity of refrigerant dissolved in the oil on the stem may escape. A leak-detecting torch or similar testing device will, however, give only a transient indication of leakage.

If the sealing ring on the disk (3) is damaged, the disk must be replaced by a new one, since the sealing ring is roller expanded onto it. While this is being done, the valve must be completely relieved of pressure. To remove the disk, proceed as follows: slacken the stop screws in the lower part of the sleeve carefully and lift the disk out, together with the damping piston and cover. Secure the damping piston carefully in a vice with soft jaws and then back off the nut (20). Detach the disk from the damping piston and replace it by a new one with an undamaged sealing ring. Wind two turns of teflon tape around the guide pin of the damping piston at "A" and then push the new disk on and secure it. Tighten the nut with a torque of approx. 10 Nm. Then fit the parts in the sleeve (5).

A slightly damaged seat can be improved by rubbing with a piece of emery cloth attached to a flat-ended cylindrical block.

Table 2. List of parts

Item No.	Description	Quant.	Order No.
1	Valve body	1	1886 568-A/E
2	Cover	1	1889 361-1
3	Disk (with sealing ring)	1	1888 864-A
4	Sealing ring	1	1821 107-23
5	Sleeve	1	1887 632-1
6	Cover	1	1888 862-1
7	Spring	1	1910 339-1
8	Stem	1	1888 858-1
9	Piston	1	1888 860-1
10	Gland	1	1888 785-1
11	Back seal	1	1887 207-5
12	Gasket	1	1886 347-1
13	Gasket	1	1886 630-9
14	Gasket ring	1	3921 5213 851
15	Ring	1	1887 205-5
16	Sign-plate	1	1820 957-3
17	Screw	1	3921 2120 370
18	Screw	6	3921 2120 495
19	Stop screw	6	3921 2241 321
20	Nut	1	3921 2627 118
21	Handwheel	1	3921 8821 906
22	Disc spring	2	3921 9512 806

**SCREW COMPRESSOR Type R5
CHECK VALVE
SUCTION FILTER**

GENERAL

The purpose of the check valve is to prevent gas from flowing rapidly through the compressor from the high-pressure to the low-pressure side when it is stopped. The check valve (1), see Fig. 1, is of the flap type, and it is mounted between the suction line and the compressor suction filter housing. When the compressor is stopped, the check valve closes so that the pressure in the compressor is equalized, thus preventing the compressor from rotating backwards.

The suction filter (6) prevents impurities from the plant from being sucked into the compressor where they could cause damage. The suction filter housing is a part of the compressor rotor casing.

The filter cartridge comprises a folded strainer cloth provided with two support grids (one on each side) that extend between the two end sleeves. This grid supports the filter and provides a tight seal against the filter housing. The filter filters out particles larger than 60 µm. The filter can be dismantled without disturbing the rest of the pipe system.

The running-in filter (9) provides fine filtering of the suction gas. Its purpose is to remove the contaminants often encountered in a new plant system. The suction strainer is provided with a running-in filter prior to delivery. The running-in filter must be removed or replaced after about 20 hours of operation.

See also the instructions on the nameplate (10) that accompanies the delivery.

To remove the running-in filter, first remove the cover (7). If a new running-in filter is to be mounted, pull out the suction filter (6) and press the running-in filter into place from the inlet end of the suction filter. Then remount. Follow the service instructions set forth below.

Final adjustment and setting of valves, cut-outs etc. must wait until the system is clean and the running-in filter has been removed.

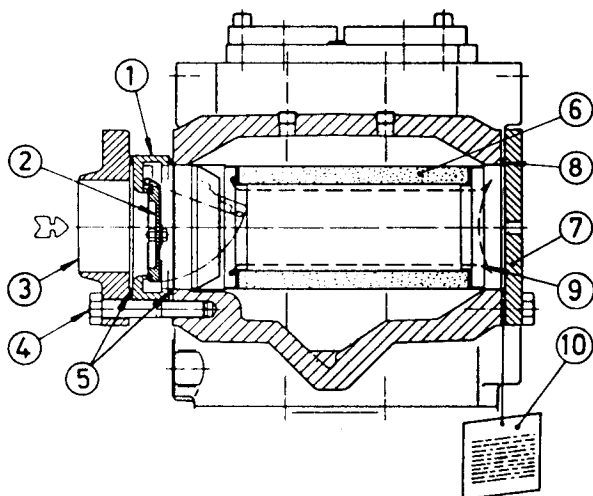


Fig. 1 Inlet to R5 compressor

SERVICE INSTRUCTIONS

If, when it is stopped, the compressor rotates backwards, the check valve is not closing properly. This can occur if flap (2) sticks at its open position for some reason. It can also occur if there is an insufficient seal attributable to a faulty flap suspension device or sealing ring/seat.

The check valve shall be dismantled and mounted as follows:

1. Close the valves upstream and downstream from the compressor unit and equalize the pressure to the low-pressure side via the service valve. Then close this valve and drain off all of the remaining refrigerant.
2. Loosen screws (4) which secure the suction pipe axially. This permits sealing rings (5) to disengage the positioner edge. You can then pull out check valve (1) radially.
3. Repair or replace check valve (1). Replace sealing rings (5).
4. Insert check valve (1) and sealing rings (5).
5. Check that the TOP markings on the check valve are at the top and that the arrow (→) points toward the compressor.
6. Check that sealing rings (5) are positioned properly before tightening screws (4).
7. Evacuate air from the system and then open the valves.
8. Check for leaks.

If the suction pressure drops below the specified operating value (without any reduction in the amount of refrigerant in the system and without any throttling on the suction side), filter (6) may be clogged. This filter can be cleaned as follows:

1. Close the valves upstream and downstream from the compressor unit and equalize the pressure to the low-pressure side via the service valve. The close the service valve and drain off all of the remaining refrigerant.
2. Remove the cover (7) and pull out the filter. Use the tool that is provided for this purpose. Make certain that any contaminants in the filter do not fall out of the filter (6) and into the compressor.
3. Clean the filter cartridge by washing it in a water-soluble degreasant and then flush it clean with hot water. Next, apply compressed air until the cartridge is completely dry and clean. We recommend the degreasant made by POLYCLEANS. Outlets where it can be purchased in different countries appear in Table 1 (overleaf).

Hold the filter cartridge up to the light and check to see that the support grids are completely clean. If not, repeat the above procedure until they are.

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4. Fit the suction filter and check to see that it is turned the right way relative to the check valve. See Fig. 1.
5. Fit cover (7) using a new sealing ring (8).
6. Evacuate air from the system and then open the valves.
7. Check for leaks.

SPARE PARTS

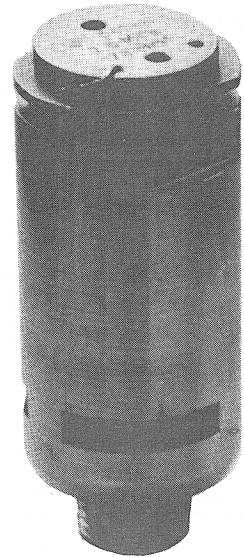
See the list of parts in manual sheet 4815-R-10 and the spare part sets in the manual sheet 4815-R-12.

9. 1904 652-A Running-in filter
10. 1898 126-1 Instructions

Table 1. Outlets where the POLYCLEANS degreasant can be purchased

- | | | | |
|--|--|---|---|
| 1. Sweden (Scandinavia)
Bertil Liljeholm AB
Frejagatan 12
MALMÖ 13
Tel.: 040/86 955 | 3. Netherlands (Holland)
Cadix Nederland BV
Postbu 10
FIJNAART (N.B.)
TX 54697 Cadixned | 5. Germany
Molto GmbH
6293 LOHNBERG/LAHN
Tel.: 6471/8041 | 7. France
C.C.M.M.
23 Bld des Capucines
PARIS 2
TX 23755 |
| 2. Belgium
Mourik Belgium NV
Quay 503
2040 ANTWERP
TX 33483 Acster
General Agency | 4. Luxemburg
Antony Steinbach SA
2/4 Rue du Chemin de Fer
LUXEMBOURG GARE
Tel.: 352/487048 | 6. Great Britain
M.A. Stanbrough Ltd.
Cadix House
BROWNFIELDS
Welvyn Garden City AL7 1AN
HERTS - U.K.
TX 23950 - Polycell | 8. Spain
Canary Islands
Disa
P.O.B. 363
SANTA CRUZ DE TENERIFE
TX 92299 |
| | | 9. Canada
Niagara Brand Chemicals
Division of FMC
1274 Plain Road E
Burlington
ONTARIO
Tel.: 634/2355 | 10. Australia
Polycell Products Ltd.
P.O.B 100
West Footseray
VICTORIA 3021 |

SAFETY VALVE
Type AZB 15



GENERAL

This safety valve is of a simple and reliable design. The standard opening pressures are in accordance with the requirements of the Swedish Refrigeration Code and the Swedish Pressure Vessel Code. See also manual sheet 517-N-1.

DESCRIPTION

The valve is of the so-called high-lifting type. This implies that the valve disk is fitted with a secondary pressure surface, so that full opening is attained as soon as the preset pressure is reached. The valve is set for opening at the pressures stipulated in Table 1. It is leak-proof at pressures below the sealing pressures indicated in Table 1.

The valve is of stainless steel, except for the springs which are made of galvanized spring steel. It is free-blowing and must be fitted in a special housing when a blow-off line is required. See manual sheet 517-N-1.

The minimum throughput area is 176 mm².

APPLICATIONS

Applications are evident from Tables 2 and 3. Temperature range - 60 to +120°C. It can be used for all media that do not attack galvanized steel or PTFE. Note! The valve is not suitable for use as a relief valve.

FITTING INSTRUCTIONS (see manual sheet 517-N-1)

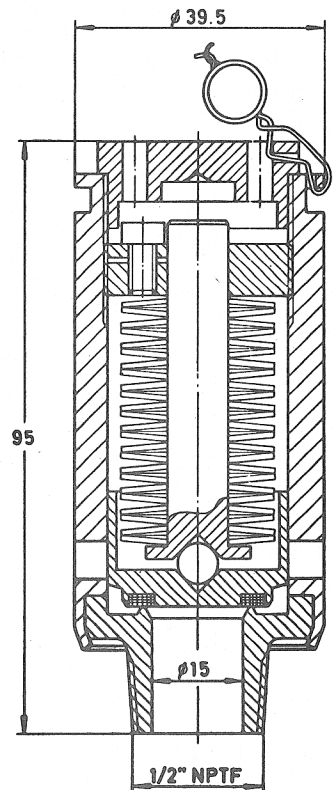
A special valve casing is available for this valve. The casing can be welded to the pressure connection and has a threaded connection for the blow-off line. The valve casing has drawing number 1821 486-A. For fitting of two valves, a special valve rack (1888 981-A) is available for welding into the pressure connection. The safety valve must be connected above the liquid level in the vessel. The valve seal must not be broken. When fitting the valve max 10 kpm is to be used.

STOCKAGE AND FORM OF DELIVERY

The valve is delivered adjusted and sealed, ready to be screwed into the valve casing. The valve is packed in anti-corrosive paper and a plastic bag. It weighs 0.6 kg. When ordering, quote the numbers indicated below.

Table 1

Article number (drawing number)	Type AZB	Marking on cover	Sealing pressure MPa	Opening pressure MPa
1911 540-A	1505	1911 540-A 0.5 MPa 176 mm ²	0.4	0.5
1911 540-B	1507	1911 540-B 0.75 MPa 176 mm ²	0.68	0.75
1911 540-C	1513	1911 540-C 1.3 MPa 176 mm ²	1.17	1.3
1911 540-D	1518	1911 540-D 1.8 MPa 176 mm ²	1.62	1.80
1911 540-E	1522	1911 540-E 2.2 MPa 176 mm ²	2.00	2.20
1911 540-F	1525	1911 540-F 2.5 MPa 176 mm ²	2.25	2.50
1911 540-G	1531	1911 540-G 3.1 MPa 176 mm ²	2.80	3.10
1911 540-H 1)	1525 B	1911 540-H 2.5 MPa 176 mm ²	2.25	2.50
1911 540-K	1530	1911 540-K 3.0 MPa 176 mm ²	2.70	3.00
1911 540-L 1)	1522 B	1911 540-L 2.2 MPa 176 mm ²	2.0	2.20



1) -H and -L without lead seal

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Table 2. Valve applications based on the minimum test pressure for pressure vessels in accordance with the requirements of the Swedish Refrigeration Code.

Valve	Pressure setting Pe MPa	Refrigerant						
		R12	R22	NH ₃	R13B1	R114	R500	R502
1911 540-B	0.75	LT Stationary						
1911 540-C	1.3	HT Stationary HT, LT Marine	LT	LT				LT
1911 540-D	1.8		LT 1)	LT 1)				LT 1)
1911 540-E	2.2		HT	HT	LT	HT	HT	HT
1911 540-F	2.5	HT 1)	HT 1)	HT 1)		HT 1)	HT 1)	HT 1)
1911 540-G	3.1				HT			
1911 540-H	2.5	HT 2)	HT 2)	HT 2)		HT 2)	HT 2)	HT 2)
1911 540-K	3.0	HT 1)	HT 1)			HT 1)		
1911 540-L	2.2	HT 2)	HT 2)	HT 2)		HT 2)	HT 2)	HT 2)

- 1) For pressure vessels with a higher test pressure than the minimum required according to the Swedish Refr. Code
E. g. vessels in ice-rink installations, air-conditioning plants or heat pump installations.
- 2) Intended as blow-off valve in reciprocating compressors.

Table 3. Highest permissible external pressure vessel area, Y m² per valve, according to the Swedish Refr. Code.

Valve	Max permissible operating press. of press. vessel Pe MPa	Min test pressure of pressure vessel Pe MPa	Refrigerant in premises without combustibile material						
			R12	R22	NH ₃	R13B1	R114	R500	R502
1911 540-B	0.75	1.0	1.8						
1911 540-C	1.3	1.7	2.9	3.4	7.7				
1911 540-C	1.3	1.8							3.2
1911 540-D	1.8	2.4		4.7	10.7				4.2
1911 540-E	2.2	2.9		5.7	12.8	2.2	4.0	5.2	5.0
1911 540-F	2.5	3.3	5.4	6.4	14.5		4.6	5.9	5.6
1911 540-G	3.1	4.1				3.0			
1911 540-K	3.0	3.9	6.4	7.5			5.4		
Valve			Refrigerant in premises without combustibile material						
1911 540-B	0.75	1.0	10.5						
1911 540-C	1.3	1.7	17.3	20.4	46				
1911 540-C	1.3	1.8							19
1911 540-D	1.8	2.4		28.4	64				25
1911 540-E	2.2	2.9		34.0	76	13	24	31.7	30
1911 540-F	2.5	3.3	32.7	38.6	87		27.5	35.5	34
1911 540-G	3.1	4.1				18			
1911 540-K	3.0	3.9	38.4	45.4			32.3		

Pe = gauge

1 MPa = 10 kp/cm²

In view of the oscillations and pressure pulsations occurring in most pump systems, the maximum operating pressure should not exceed 80 - 85% of the opening pressure.

SAFETY VALVE Type AZB 25

GENERAL

This safety valve is of a simple and reliable design. The standard opening pressures are in accordance with the requirements of the Swedish Refrigeration Code and the Swedish Pressure Vessel Code. See also manual sheet 517-N-1E.

DESCRIPTION

The valve is of the so-called high-lifting type, implying that the valve disk is fitted with a secondary pressure surface, so that full opening is attained as soon as the preset opening pressure is reached. The valve is set to open at the pressures specified in Table 1. The valve is completely leakproof at pressures specified in Table 1 under sealing pressure.

The valve is totally enclosed and is provided with a connection for a blow-off line.

All parts are of galvanized steel, except for the valve disk and stem which are made of stainless steel. The valve seal is made of reinforced PTFE.

The minimum throughput area is 5.7 cm².

The valve supersedes 1886 321 and 1884 130.

APPLICATIONS

The valve applications are evident from Tables 2 and 3. Temperature range -60 to +120°C.

The valve can be used for all media which do not attack galvanized steel or PTFE.

FITTING INSTRUCTIONS

Connections A and B fit against welding flange 3951 3318 802.

For fitting of two valves, special valve racks are available for welding into the pressure connection. See manual sheet 517-N-1E. The safety valve must be connected above the liquid level in the vessel. The valve seal must not be broken.

FORM OF DELIVERY

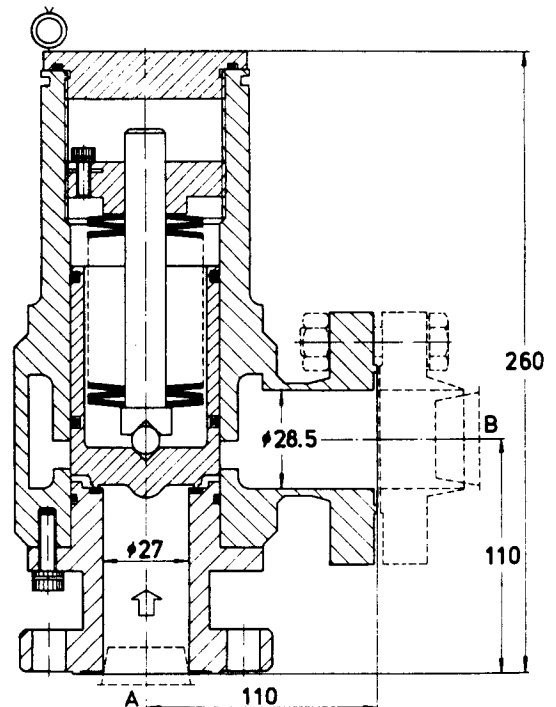
The valve is delivered adjusted and sealed. Connection B is fitted with a counter flange.

ORDERING PROCEDURE Table 1

Order No.	Type AZB	Marking 1)	Sealing pressure P _e MPa 2)	Opening pressure
1911 000-A	2507	Order No. 0.75 MPa 5.7 cm ²	0.68	0.75
1911 000-B	2513	Order No. 1.3 MPa 5.7 cm ²	1.17	1.30
1911 000-C	2518	Order No. 1.8 MPa 5.7 cm ²	1.62	1.80
1911 000-D	2522	Order No. 2.2 MPa 5.7 cm ²	2.00	2.20
1911 000-E	2525	Order No. 2.5 MPa 5.7 cm ²	2.25	2.50
1911 000-F	2531	Order No. 3.1 MPa 5.7 cm ²	2.80	3.10
1911 000-G	2530	Order No. 3.0 MPa 5.7 cm ²	2.70	3.00

1) The marking is punched into the valve cover

2) The sealing pressure must not be exceeded in normal operating conditions



Weight: 9 kg
P_e = gauge
1 MPa 10 kp/cm²

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Table 2. Valve applications, based on the minimum test pressures for pressure vessels as prescribed in the Swedish Refrigeration Code.

Valve	P _e MPa	Refrigerant						
		R12	R22	NH ₃	R13B1	R114	R500	R502
1911 000-A	0.75	LP Stationary						
1911 000-B	1.3	HP Stationary HP, LP Marine	LP	LP				LP
1911 000-C	1.8		LP 1)	LP 1)				LP 1)
1911 000-D	2.2		HP	HP	LP	HP	HP	HP
1911 000-E	2.5	HP 1)	HP 1)	HP 1)		HP 1)	HP 1)	HP 1)
1911 000-F	3.1				HP			
1911 000-G	3.0	HP 1)						

LP = Low pressure side

HP = High pressure side

1) For pressure vessels with higher test pressures than the minimum required by the code.
E.g. vessels in ice rinks, air-conditioning plants or heat pump plants.

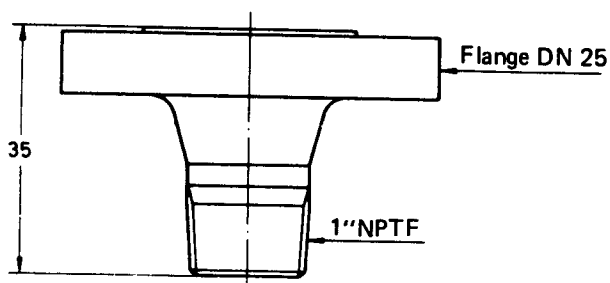
Table 3. Maximum permissible, external pressure vessel area, Y m², per valve, according to the Swedish Refrigeration Code.

Valve	Max. permissible operating pressure of vessel P _e MPa	Min. test pressure of vessel P _e MPa	In premises with combustible material						
			R12	R22	NH ₃	R13B1	R114	R500	R502
1911 000-A	0.75	1.0	5.7						
1911 000-B	1.3	1.7	9.3	11.0	24.8				
1911 000-B	1.3	1.8							10.2
1911 000-C	1.8	2.4		15.3	34.5				13.4
1911 000-D	2.2	2.9		18.4	41.4	7.0	13.0	17.2	16.1
1911 000-E	2.5	3.3	17.6	20.8	47.0		14.8	19.4	18.3
1911 000-F	3.1	4.1				9.5			
1911 000-G	3.0	4.0	20.7						
Valve	In premises without combustible material								
1911 000-A	0.75	1.0	34.2						
1911 000-B	1.3	1.7	56	66	149				
1911 000-B	1.3	1.8							61
1911 000-C	1.8	2.4		91	207				81
1911 000-D	2.2	2.9		110	248	42	78	103	97
1911 000-E	2.5	3.3	105	125	282		89	116	110
1911 000-F	3.1	4.1				58			
1911 000-G	3.0	4.0	124						

P_e = gauge

1 MPa 10 kp/cm²

1895 769-A



Intermediate piece intended for conn. of AZB 25 on valve rack or welding boss with thread where safety valve 1884 130 has previously been screwed in.

SYNGLAS SIGHT GLASS 3951 6021 SCHAUGLAS

INSVETSNING

Vid insvetsning av stosen ska glas och packningar vara demonterade. Efter insvetsningen kontrolleras planheten hos glasets anliggningsplan i stosen. Är planheten sämre än 0.17 mm måste anliggningsplanet planfräses till det angivna måttet

MONTERING AV GLAS

Vid montering eller utbyte av glas ska nya inoljade packningar användas. Se till att ansatserna på stosen och locket samt packningar och glas är fria från föroreningar.

Skruvarna dras växelvis diagonalt varvid åtdragningsmomentet höjs successivt till i tabell nedan angivet.

WELDING

When welding in the body, the glass and gaskets must be removed. After welding, check the flatness of the glass contact surface in the body. If the flatness is poorer than 0.17 mm the contact surface must be milled to the stipulated dimension.

FITTING THE GLASS

Always use new gaskets which have been smeared with oil when fitting or replacing the glass. Make sure that there is no foreign matter on the lugs on the body and cover, or on the gaskets and glass.

Tighten the screws alternately and diagonally, successively increasing the tightening torque to the stipulated in the table below.

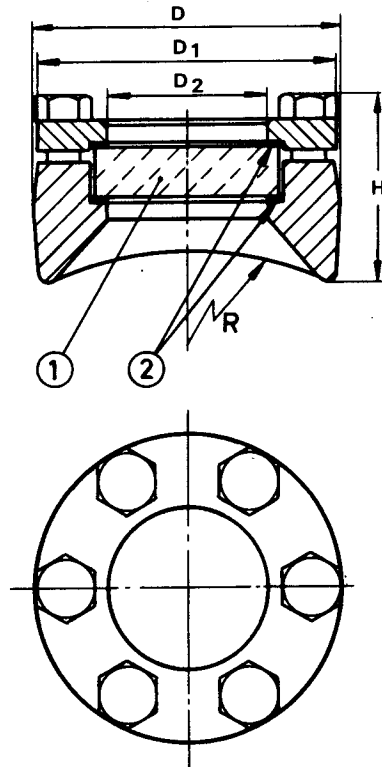
EINSCHWEISSEN

Beim Einschweißen des Gehäuses müssen Glas und Dichtungen demontiert sein. Nach dem Einschweißen wird die Ebenheit der Glasauflagefläche am Gehäuse kontrolliert. Ist die Ebenheit schlechter als 0.17 mm, so muß die Auflagefläche auf das angegebene Maß plangefräst werden.

EINBAU DES GLASES

Bei Einbau oder Austausch eines Glases müssen neue, eingölte Dichtungen verwendet werden.

Darauf achten daß die Ansätze von Gehäuse und Deckel, sowie Dichtungen und Glas frei von Verunreinigungen sind. Die Schrauben werden wechselweise diagonal angezogen, wobei das Anzugsmoment allmählich bis auf die in der Tabelle unten angegebenen Werte erhöht wird.



	Synglas – Sight glass – Schauglas	
	3951 6021 840	3951 6021 856
D	68	92
D1	67	88
D2	30	48
H	50	56
R	55	90
Åtdragningsmoment Tightening torque Anzugsmoment	8 Nm	14 Nm

Reservdelar – Spare parts – Ersatzteile

Synglas Sight glass Schauglas	No	Antal Quant. Anzahl	Artikelnummer Article number Artikelnummer	Benämning Name of part	Benennung	
3951 6021 840	1	1	3951 6021 954	Glas	Glass	Glas
	2	2	3951 6021 955	Packning	Gasket	Dichtung
3951 6021 856	1	1	3951 6021 956	Glas	Glass	Glas
	2	2	3951 6021 957	Packning	Gasket	Dichtung

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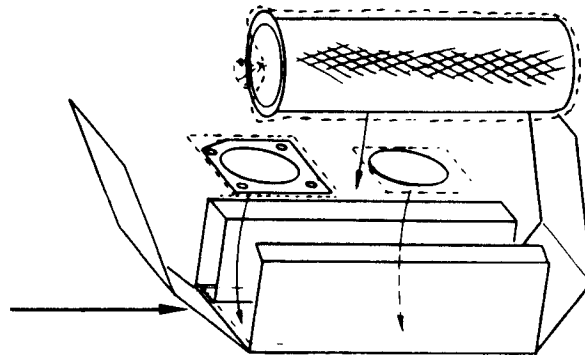
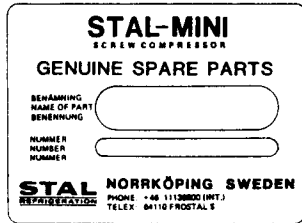
9. SPARE PARTS AND TOOLS

4815-R-12E	Screw compressors, type R5
4815-R-15E	Set of tools 1903 365-A
4815-R-16E	Set of tools 1903 364-A
4815-R-17E	Set of tools 1903 36-B

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**SKRUVKOMPRESSORER Typ R5
SCREW COMPRESSORS, Type R5
SCHRAUBENVERDICHTER Type R5****RESERVDLSSATSER FÖR KOMPRESSOR
SPARE PART SETS FOR COMPRESSOR
ERSATZTEILSÄTZE FÜR VERDICHTER**

Reservdelssatserna består av ett antal reservdelssatser anpassade för olika servicearbeten på kompressorn, se tabell och 2.

eparata satser finns för byte av oljefilter, sugfilter, axeltätning och lager. atserna innehåller den specifika utbytsdetaljen samt packningar, tätningar dyl som berörs av åtgärder, med rdantag av lagersatsen, som måste ombineras med packningsatts.

ör översyn av kompressor omfattande an nämnda åtgärder finns komplett servdelssats.

tabell 3 omfattar reservdelar för kapacitetsregleringens magnetventiler.

etaljer som inte innefattas i reservdelssatserna t ex kughjul, rotorerna m m ställs separat vid behov, se kompressorns delförteckning.

These spare part sets are intended for different types of service work on a compressor. See Table 1 and 2.

Separate sets are available for changing the following: oil filter, suction filter, shaft seal and bearing. The sets contain the replacement parts that are needed as well as the gaskets, seals and the like that are affected by the measures taken except for bearing set, which must be combined with the set of gaskets.

Complete spare sets are available for compressor overhauls that include the aforesaid types of service.

Table 3 presents the spare parts needed for the solenoid valves used in the capacity control system.

Parts not included in the spare part sets such as gear wheels, rotors etc. must be ordered separately as required. See the list of parts for the compressor in question.

Die Ersatzteilsätze bestehen aus einer Anzahl Sätze, die für verschiedene Servicearbeiten am Verdichter angepaßt sind, siehe Tabelle 1 und 2.

Für Austausch von Ölfilter, Ansaugfilter, Wellendichtung und Lager gibt es separate Sätze. Die Sätze beinhalten das gewünschte Austauscheteil samt die zum Austausch benötigten Dichtungen.

Nur der Lagersatz muß mit dem Dichtungssatz ergänzt werden.

Für Überholung des Verdichters, die die oben genannten Maßnahmen umfaßt, gibt es komplette Ersatzteilsätze.

Tabelle 3 beinhaltet Ersatzteile für die Magnetventile der Leistungsregelung.

Teile die nicht in den Ersatzteilsätzen eingehen, z.B. Zahnräder, Rotoren u. s. w. werden bei Bedarf separat bestellt. Siehe dazu das Teilverzeichnis des Verdichters.

Tabell 1 Serviceåtgärder och reservdelssatser. Kompressorgeneration A - D (dvs Y = A, B, C eller D)

Table 1 Service jobs and spare part sets. Compressor generation A - D (i.e. Y = A, B, C or D)

Tabelle 1 Servicemaßnahmen und Ersatzteilsätze. Verdichtergeneration A - D (d. h. Y = A, B, C oder D)

Åtgärd Service job Maßnahme	Kompressorbeteckning Compressor designation Verdichterbezeichnung enligt/as per/gemäß hb-blad/manual sheet HB-Blatt 4815-C-16	Reservdelssats Spare part set Ersatzteilsatz	Vikt Weight Gewicht kg
Byte av oljefilter Change oil filter Ölfilteraustausch	Samtliga All Sämtliche	1903 850-A	0.4
Byte av axeltätning Se även not 1. Change shaft seal See also note 1. Austausch der Wellendichtung Siehe auch Anm. 1	R5XY-XX A B C D E R51Y-XX A B C	1904 372-A	2.0
Byte av axeltätning Se även not 1. Change shaft seal See also note 1. Austausch der Wellendichtung Siehe auch Anm. 1	R5XY-XX F G R51Y-XX D E	1904 372-B	2.0
Byte av sugfilter Change suction filter Austausch des Ansaugfilters	Samtliga All Sämtliche	1904 371-A	1.3
Byte av lager Change bearing Lageraustausch	Samtliga All Sämtliche	1904 373-A	3
Packningssats Set of gaskets Dichtungssatz	Samtliga All Sämtliche	1904 374-A	2
Översyn Overhaul Überholung	R5XY-XX A B C D E R51Y-XX A B C	1903 851-A	10
Översyn Overhaul Überholung	R5XY-XX F G R51Y-XX D E	1903 851-B	10

Not 1. Axeltätningar för kompressorer av generation A och B (R5XA/B-XXX) modifieras enligt handboksblad 4815-V-1

Note 1. Shaft seals for compressors of generations A and B (R5XA/B-XXX) must be modified as set forth in manual sheet 4815-V-1

Anm. 1 Bei den Verdichtern der Generation A und B (R5XA/B-XXX) werden die Wellendichtungen gemäß Handbuchblatt 4815-V-1 modifiziert.

Tabell 2 Serviceåtgärder och reservdelssatser.

Table 2 Service jobs and spare part sets.

R5X E/F - XX

Tabelle 2 Servicemaßnahmen und Ersatzteilsätze.

Åtgärd Service job Maßnahme	Reservdelssats Spare part set Ersatzteilsatz	Vikt Weight Gewicht kg
Byte av oljefilter Change oil filter Ölfilteraustausch	1903 850-A	0.4
Byte av axeltätning Se även not 1. Change shaft seal See also note 1. Austausch der Wellendichtung Siehe auch Anm. 1	1904 974-A	2.5
Byte av sugfilter Change suction filter Austausch des Ansaugfilters	1904 371-A	1.1
Byte av lager Change bearing Lageraustausch	1904 373-A	3
Packningssats Set of gaskets Dichtungssatz	1904 975-A	2
Översyn Overhaul Überholung	1904 976-A	10

Tabell 3. Reservdelsförteckning, magnetventil för kapacitetsreglering

Table 3. List of spare parts for solenoid valves used in capacity control system

Tabelle 3. Ersatzteilverzeichnis, Magnetventil der Leistungsregelung

	Utförande Power requirements Ausführung	Artikelnummer Article number Artikelnummer
Komplett magnetventil Complete solenoid valve Komplettes Magnetventil	220 V, 50-60 Hz	3963 1151 861
	110 V, 50-60 Hz	862
	24 V, 50-60 Hz	864
Spole/Coil/Spule	220 V, 50-60 Hz	3963 1151 911
	110 V, 50-60 Hz	912
	24 V, 50-60 Hz	914
Hirschmannkontakt Hirschmann contact Hirschmannkontakt		3963 1151 915
Ankare + fjäder Armature plus spring Kern + Feder	Rubintätning Rubin seal Rubinendichtung	3963 1151 916

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VERKTYGSSATS
SET OF TOOLS
WERKZEUGSATZ

1903 365-A

R5, RZ, RV, RT

Förteckning över standardverktyg i verktygssats

List of standard tools in the set of tools

1903 365-A

Verzeichnis über Standardwerkzeuge im Werkzeugsatz

No.	Antal Quant. Anzahl	Delbeteckning Part number Bezeichnung	Benämning	Name of part	Benennung
1	1	1903 365-1	Momentnyckel	Torque wrench	Drehmomentschlüssel
2	1	1903 365-2	Spärnyckel	Ratchet wrench	Sperrschlüssel
3	1	1903 365-3	Sexkantnyckel	Hexagon key	Sechskantschlüssel
4	1	1903 365-4	Sexkantnyckel	Hexagon key	Sechskantschlüssel
5	1	1903 365-5	Sexkantnyckel	Hexagon key	Sechskantschlüssel
6	1	1903 365-6	Sexkantnyckel	Hexagon key	Sechskantschlüssel
7	2	1903 365-7	Förlängning	Extension	Verlängerung
8	1	1903 365-8	Hylsa	Sleeve	Hülse
9	1	1903 365-9	Hylsa	Sleeve	Hülse
10	1	1903 365-10	Hylsa	Sleeve	Hülse
11	1	1903 365-11	Insexhylsa	Socket head sleeve	Innensechskanthülse
12	1	1903 365-12	Insexhylsa	Socket head sleeve	Innensechskanthülse
13	1	1903 365-13	Insexhylsa	Socket head sleeve	Innensechskanthülse
14	1	1903 365-14	Insexhylsa	Socket head sleeve	Innensechskanthülse
15	1	1903 365-15	Skruvmejsel	Screw driver	Schraubenzieher
16	1	1903 365-16	Skruvmejsel	Screw driver	Schraubenzieher
17	2	1903 365-17	Skiftnyckel	Adjustable spanner	Schraubenschlüssel
19	1	1903 365-19	Hammare	Hammer	Hammer
20	1	1903 365-20	Dorn	Drift	Dorn
21	2	1903 365-21	T-handtag	T-handle	T-Handgriff
22	1	1903 365-22	Sexkantnyckel	Hexagon key	Sechskantschlüssel
23	1	1903 365-23	Hylsa	Sleeve	Hülse
24	1	1903 365-24	Hylsa	Sleeve	Hülse
25	1	1903 365-25	Ringnyckel	Ring key	Ringschlüssel
26	1	1903 365-26	Ringnyckel	Ring key	Ringschlüssel
50	1	1903 365-50	Kartong	Carton	Karton

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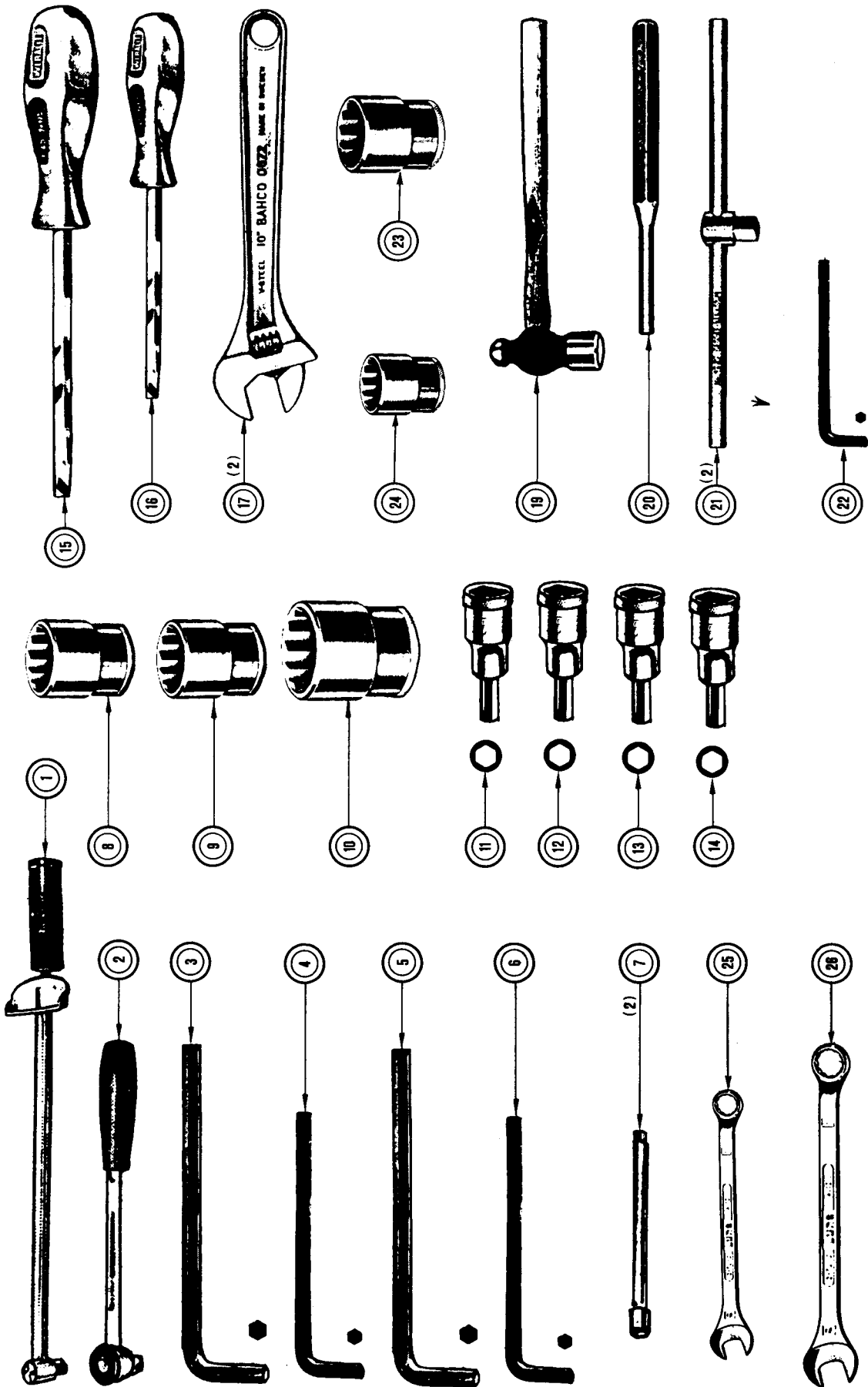
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4815 - R - 15bSET
2/2
Kp 1985-08

skruvkompressor
STAL-MINI screw compressor
Schraubenverdichter

STAL
REFRIGERATION



VERKTYGSSATS
SET OF TOOLS
WERKZEUGSATZ

1903 364-A

R5

Förteckning över specialverktyg i verktygssats
List of special tools in the set of tools
Verzeichnis über Sonderwerkzeuge im Werkzeugsatz

1903 364-A

Vikt, Weight, Gewicht 51 kg

No.	Antal Quant. Anzahl	Delbeteckning Part number Bezeichnung	Benämning	Name of part	Benennung
1	1	1903 364-1	Skruv	Screw	Schraube
2	1	1878 746-1	Distanshylsa	Distance sleeve	Distanzhülse
3	1	1903 364-3	Mutter	Nut	Mutter
4	1	1903 249-A	Ok	Yoke	Haltebügel
5	1	1903 323-A	Oljepump	Oil pump	Ölpumpe
6	1	1903 324-1	Cylinder	Cylinder	Zylinder
7	1	1904 657-1	Avdragare	Puller	Abzieher
8	1	1903 329-1	Ring	Ring	Ring
9	1	1903 339-1	Fästplatta	Fixing plate	Befestigungsplatte
10	1	1903 340-1	Mutter	Nut	Mutter
11	1	1903 331-1	Kopp	Cup	Schale
12	2	1903 326-1	Mellanstycke	Intermediate piece	Zwischenstück
13	1	1903 364-13	Bricka	Washer	Scheibe
14	1	1902 241-A	Avdragare	Puller	Abzieher
15	1	1903 333-1	Platta	Plate	Platte
16	1	1901 523-1	Mellanstycke	Intermediate piece	Zwischenstück
17	1	1901 864-1	Kopp	Cup	Schale
18	1	1903 335-1	Kolv	Piston	Kolben
19	1	1903 334-1	Kolv	Piston	Kolben
20	1	1903 329-2	Ring	Ring	Ring
21	1	3921 5455 156	Spärring	Retaining ring	Sicherungsring
22	1	3921 5455 158	Spärring	Retaining ring	Sicherungsring
23	1	1903 336-A	Mothåll	Lever arm	Hebelarm
24	1	1903 338-1	Skruv	Screw	Schraube
25	1	1903 337-1	Mutter	Nut	Mutter
26	1	1901 528-2	Skruv	Screw	Schraube
27	1	1901 525-3	Platta	Plate	Platte
28	1	1901 525-4	Platta	Plate	Platte
29	2	1901 530-1	Bricka	Washer	Scheibe
30	1	1901 526-2	Platta	Plate	Platte
31	1	1901 527-2	Platta	Plate	Platte
32	2	1901 531-1	Bricka	Washer	Scheibe
33	1	1901 586-2	Plastnos	Guide	Steuerung
34	1	1901 584-1	Plastnos	Guide	Steuerung
35	1	1902 242-A	Bock	Jack	Bock
36	1	1903 374-A	Indikeringsverktyg	Indicating tool	Anzeigewerkzeug
37	1	1903 341-1	Stång	Bar	Stange
38	1	1903 342-1	Tryckstång	Push rod	Druckstange
39	2	3921 2120 372	Skruv	Screw	Schraube
40	2	3921 2231 459	Stoppskruv	Grub screw	Gewindestift
41	1	3921 2179 536	Skruv	Screw	Schraube
42	4	1903 848-1	Skruv	Screw	Schraube
43	2	3921 2101 370	Skruv	Screw	Schraube
44	2	3921 2101 295	Skruv	Screw	Schraube
45	2	3921 2120 469	Skruv	Screw	Schraube
47	1	1903 330-2	Stång	Bar	Stange
48	1	1903 330-1	Stång	Bar	Stange
49	1	1903 332-1	Stång	Bar	Stange
50	1	1901 522-1	Tryckstång	Push rod	Druckstange
51	2	3921 2600 124	Mutter	Nut	Mutter
52	4	3921 5121 186	Bricka	Washer	Scheibe
53	6	3921 5121 178	Bricka	Washer	Scheibe
54	2	3921 8333 492	Lyftögla	Eye bolt	Hebeöse
55	1	3921 8333 670	Lyftögla	Eye bolt	Hebeöse
56	1	1903 326-2	Mellanstycke	Intermediate piece	Zwischenstück
57	1	1903 364-57	Spärringstång	Retaining ring pliers	Sicherungsringzange
59	1	1904 313-1	Utdragare	Extractor	Auszieher
60	1	1905 088-1	Platta	Plate	Platte
98	1	4815-R-16	Handboksblad	Manual sheet	Handbuchblatt
99	1	1903 497-1	Hänglås	Padlock	Vorhängeschloß
100	1	1903 373-1	Verktygslåda	Tool box	Werkzeugkasten

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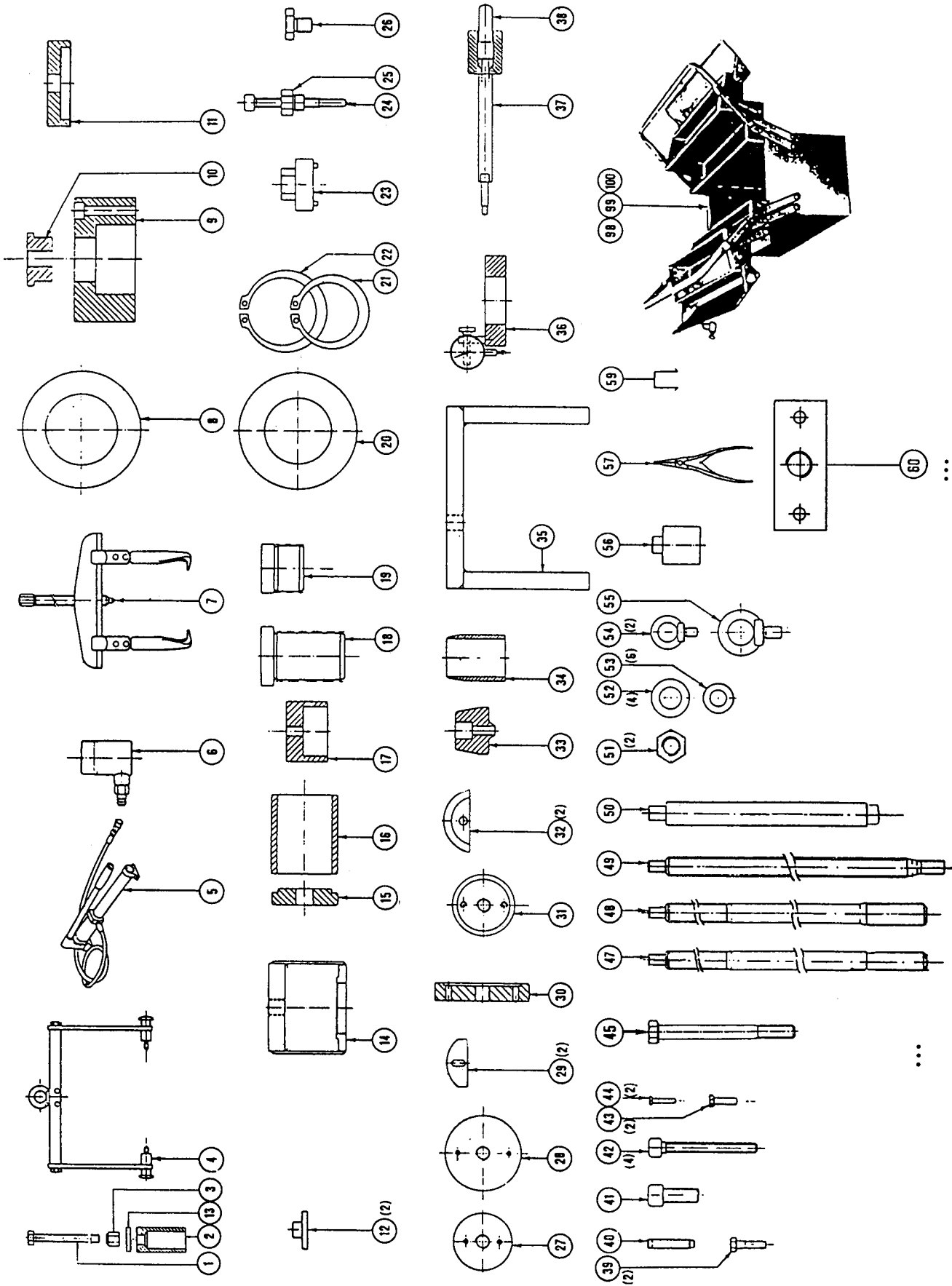
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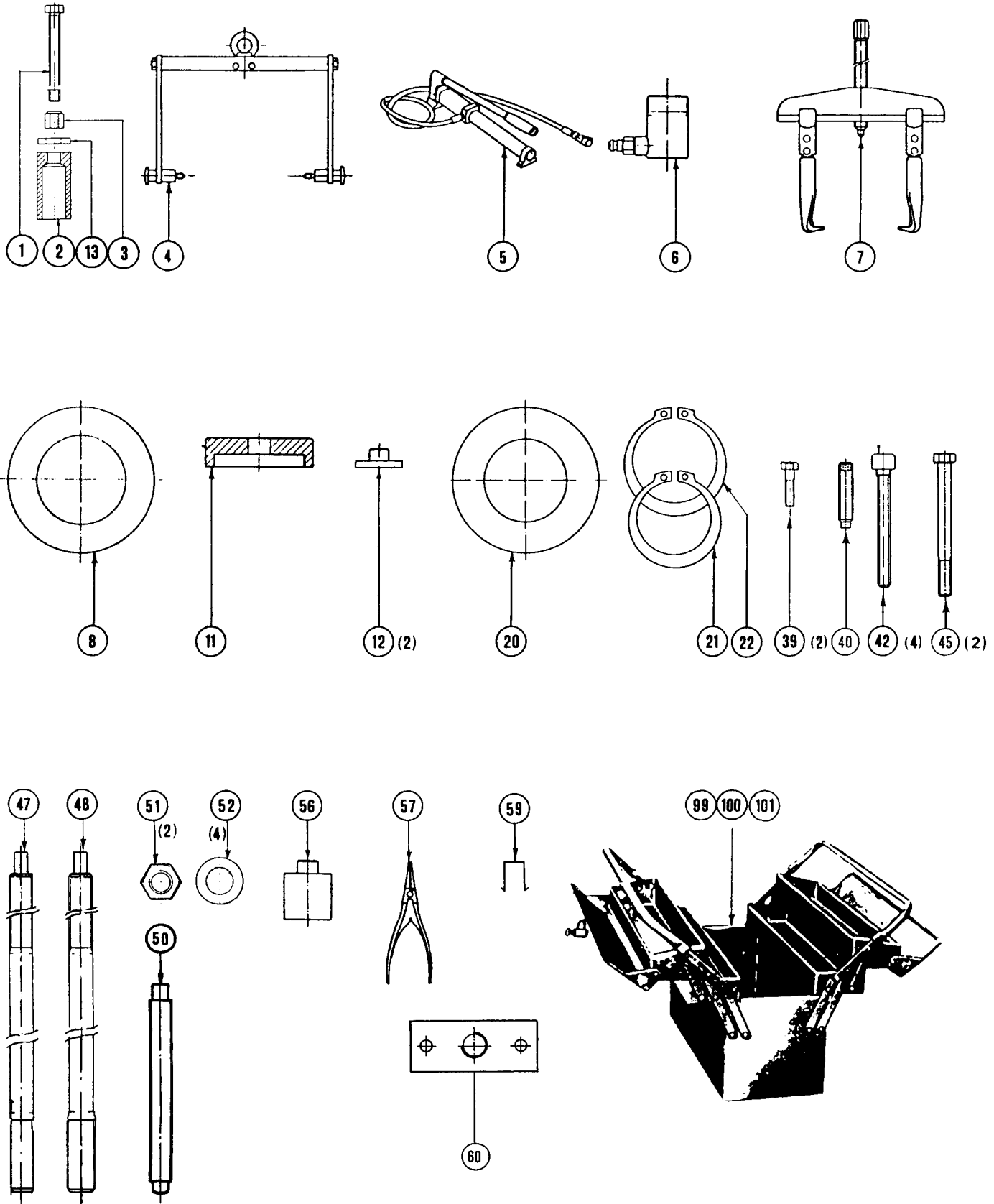
STAL
 REFRIGERATION



4815 - R - 17cSET
2/2
TKK 1989-05

skruvkompressor
STAL-MINI screw compressor
Schraubenverdichter

STAL
REFRIGERATION



10. GENERAL INSTRUCTIONS

- 691-N-5E Testing for leaks, leak detection
- 707-N-1E Safe handling of chlorofluorocarbon refrigerants
- 7151-A-1E Moisture in cooling systems
- 7181-N-5E Drying of large cooling plants

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TESTING FOR LEAKS AND LEAK DETECTION

Refrigerant : R12, R22

A refrigeration plant must be absolutely leakproof. When completely assembled, the plant must be tested for leaks, pressure-tested and dried.

Pressure-testing and drying are dealt with in separate sheets of the refrigeration manual.

The procedure when testing for leaks differs to some extent with plants of different sizes and types.

1. LARGE PLANTS

Testing for leaks may be carried out according to either method a or method b below.

Method a, in contrast to method b, involves no loss of refrigerant, but on the other hand it may take longer than method b for plants with numerous joints (e.g. ice rinks with direct evaporation).

The choice of one method or the other must be made from case to case by considering the cost of the lost refrigerant in relation to the time saving.

Method a

- a 1. Fill the entire system with dry nitrogen gas or air from a cylinder to a pressure of about 2-3 kg/cm² and then carry out a rough test.
- a 2. Subject the system to a pressure test with dry nitrogen gas or air from a cylinder. (See separate sheet of refrigeration manual.)
- a 3. Now reduce the pressure to about 2 kg/cm² below the test pressure. Test all joints and connections for leaks with soap solution or alcohol sulphonate. The soap solution used should be strong and produce a good lather. The lather will keep longer if a few drops of glycerine are added to the soap solution. Brush the solution around all joints. Use a mirror to examine points that are difficult of access. It may take up to a minute or so for the bubbles to become visible from tiny leaks.
- a 4. Reduce the pressure to atmospheric and then dry the system by evacuation. See instructions on separate sheet of the refrigeration manual.
- a 5. Charge the system with the requisite amount of refrigerant and then check for leaks with a leak detector.
- a 6. The user of the refrigeration plant ought to check for leaks regularly during the first running period.

Method b

- b 1. Fill the entire system with dry nitrogen gas or air from a cylinder to a pressure of about 2-3 kg/cm² and then carry out a rough test.
- b 2. Raise the pressure, if possible, to approx. 5 kg/cm² by pouring in refrigerant. Before connecting the refrigerant cylinder, make sure that its pressure is higher than the pressure in the system.
- b 3. Raise the pressure to the test pressure (see separate sheet of the refrigeration manual) with dry nitrogen gas or air from a cylinder. Then check for leaks with a leak detector.
- b 4. Reduce the pressure to atmospheric and then dry the system by evacuation. See instructions on separate sheet of the refrigeration manual.

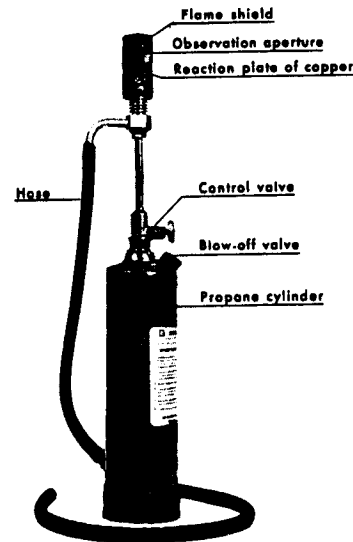
b 5. Charge the system with the requisite amount of refrigerant, and then check for leaks once again, also with a leak detector.

b 6. The user of the refrigeration plant ought to check for leaks regularly during the first running period.

2. SMALL PLANTS

After drying, fill the plant with refrigerant to a pressure of about 3 kg/cm². Next, raise the pressure with dry nitrogen gas to the prescribed test pressure. Check for leaks with a leak detector and then remove the pressure-testing medium by double evacuation.

3. LEAK DETECTOR



The leak detector is used to localize leaks in refrigeration plants. It reacts to such refrigerants as methyl chloride, R12, R22, etc., the principle being that the colour of a flame in which there is a piece of glowing copper will change if the combustion air contains refrigerant. It must not be used for leak detection when inflammable gases are involved. There are various designs of leak detector, e.g. using acetylene or propane as fuel. Since the working principle is the same, this description is confined to a leak detector which uses propane as fuel.

Ignition and extinguishing

Propane is admitted to the burner by opening the control valve enough to release a small trickle of gas. Ignite the gas, and then adjust the flame size so that the copper plate becomes cherry red to slightly light red in colour.

N.B. Do not screw the flame up so much that the copper plate adopts a yellow colour.

It is important for the copper plate to be thoroughly cleaned, so that all traces of oxide and other impurities are removed, before the flame is ignited. An oxidized plate may cause the flame to turn green despite the absence of leakage. Re-cleaning may also be necessary in course of the test. To extinguish the flame, close the control valve.

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Mode of operation

Adjust the flame so that it is visible in the observation aperture. The flame should not protrude beyond the flame shield. A small flame is more sensitive than a large one. The flame heats a reaction plate which is made of copper. The suction tube, consisting of a length of rubber hose, is used to explore the area where a leak is suspected. Air is drawn through the suction tube by the ejector effect of the propane gas flowing through the burner. Any refrigerant present will be decomposed in the burner and react with the red-hot copper plate (forming compounds of copper and halogen), causing the flame to change its colour. A tinge of green indicates a small concentration of refrigerant. The flame will be coloured more intensely the stronger the concentration of refrigerant is. In the presence of large quantities of refrigerant the flame becomes a vivid violet or purple, and may even be stifled by a lack of oxygen. Normally, the flame is colourless or pale blue. To ensure good results, attention should be paid to the following points:

1. The copper plate must not be burnt away and must be in position.
2. If the flame is coloured yellow, the suction hose is choked to a greater or lesser degree. Remove the obstruction and check now and then that air is being drawn through the hose by holding the free end thereof to the ear.
3. Test the leak detector in air known to contain R12 or R22.
4. Hold the hose about a millimeter away from the joint being tested.
5. Move the end of the hose slowly right round each joint. It takes a certain amount of time for the air to pass through the hose and reach the copper plate. Leak testing cannot be hurried.
6. If a green tinge in the flame is ever noticed, explore the surrounding area thoroughly until the leak is discovered.
7. Note that the detector will also react to trichloroethylene (C_2HCl_3) and should, therefore, not be used near machine parts that have recently been cleaned with this agent.

8. Do not use the detector more than necessary in air known to contain large amounts of refrigerant, as the reaction plate is gradually consumed.
9. Avoid direct inhalation of the combustion products of the leak detector in the vicinity of a refrigerant leak. These products are poisonous.
10. Always work to a definite plan in leak detection, to ensure that no joint or other suspect point is skipped. Always remember that not even the tiniest leak can be disregarded. However small a leak may be, the refrigerant charge may escape through it. The system must never be recharged until all leaks have been located and sealed. If one leak is discovered, it cannot be assumed that it is the only one - the entire system must be thoroughly checked.

4. FINAL INSPECTION

Before the plant is handed over to the customer, it should be tested for leaks once more, with a leak detector, at as high a pressure as the operating conditions allow. During this final check, particular attention should be paid to the stuffing box.

In this connection, attention is called to the importance of checking the tightness of the cylinder-head bolts with the compressor warm.

All the components incorporated in a refrigeration plant are carefully tested for leaks in accordance with the prescribed regulations. Despite this, experience shows that leakage from certain components after assembly is unavoidable. This, however, does not necessarily imply that the leakage test before delivery was carelessly carried out. Damage in packing and transport, corrosion, vibration, etc., may lead to the subsequent appearance of leaks.

The person responsible for the installation must not fail to ensure that all conceivable points of leakage that can be reached with reasonable effort are checked for leaks before the plant is handed over.

**SAFE HANDLING OF CHLOROFLUOROCARBON REFRIGERANTS
(CFC - REFRIGERANTS)****GENERAL**

The following instructions have been written on the basis of experience gained by the Technical Committee of the Swedish Refrigeration Society. These instructions are intended to supplement the regulations, laws and directives that are in force at the site of your plant.

1. INTRODUCTION

The instructions that are presented here apply to the following refrigerants:

R11	(CCl ₃ F)
R12	(CCl ₂ F ₂)
R13	(CClF ₃)
R14	
R12B1	
R13B1	(CBrF ₃)
R22	(CHClF ₂)
R23	
R113	(CCl ₂ F · CClF ₂)
R114	(CClF ₂ · CClF ₂)
R115	(CClF ₂ · CF ₃)
R116	
R500	(Azeotropic mixture of R12 and R152)
R502	(Azeotropic mixture of R22 and R115)
R503	

Instructions for handling CFC refrigerants other than those listed above must be provided by the producer.

The following examples of other CFC refrigerants are flammable:

R152a (CH₃ · CHF₂ is a component of R500, which is nonflammable)

R142b
R141B

Different producers give their CFC refrigerants different names. The following names are being used at the present time (1984) in Europe.

Arcton
Algofrene
Freon
Frigen
Flugene
Forane
Isceon
Kaltron

It is thus evident that producers are calling R22 (for example) by the following names: Arcton 22, Algofrene 22, Freon 22, etc. These names should not be used when referring to the different types of refrigerants in general text. Instead, the following should be used: R12, R13 etc.

Chlorofluorocarbon (CFC) refrigerants have been in use for more than 50 years. They were introduced to replace older refrigerants that were highly flammable, toxic or both. All CFC refrigerants now in general use are:

- Nonflammable and non-explosive
- Of low toxicity
- Non-corrosive under normal conditions

Refrigerants now in general use display the above properties under normal, correct conditions of use. However, you should be familiar with the properties of CFC refrigerants, and you must comply with the handling instructions presented below.

2. PROPERTIES**2.1 Pressure**

CFC refrigerants cover a wide range of boiling points and vapour pressures. Normally, refrigerants are delivered in liquid form and under pressure in cylinders except for the following:

- R14, which is transported as a gas under high pressure.
- R11 and R113, which are in liquid form at normal temperatures and atmospheric pressure and are delivered in metal drums that are not pressurized or only slightly pressurized.

The cylinders used to transport CFC refrigerants must comply with national pressure vessel regulations and also the applicable international regulations. The cylinders must be marked with the name of the government agency that has granted approval and also with the date on which they were inspected and tested.

Refrigerating systems must also be designed and constructed to withstand the maximum pressures that can be encountered, giving due regard to the pressures that can build up when the system is being shut down. Always check carefully to see that the system has been approved for a pressure that corresponds to the pressure that can be developed by the refrigerant in use.

2.2 Odour

CFC refrigerants have a faint "trichloroethylene" odour. However, this is discernible only for high concentrations in air, 1000 to 2000 ppm (equivalent to 0.1 to 0.2% since ppm means parts per million).

2.3 Heavy gases

The gases given off by CFC refrigerants are heavier than air and thus tend to collect at floor level or ground level, in drains, in basements, in pits, in ditches and in other lowlying places.

2.4 Thermal decomposition

If CFC gases are exposed to an open flame or a surface hotter than about 300°C, thermal decomposition takes place. When this happens, gases form that are both acidic and toxic. These gases irritate (among other things) the eye.

3. HANDLING INSTRUCTIONS

3.1 High concentrations of gases

Inhaling very high concentrations of CFC gases, even throughout only a brief interval, must be avoided since they can be hazardous. This can cause unconsciousness, and in extreme cases it can be fatal.

Since CFC vapours are heavier than air, they can remain for a long time in poorly ventilated areas. Care must thus be taken whenever there is reason to suspect the presence of high concentrations of such gases. Fully satisfactory ventilation that includes provisions (exhausting equipment or the like) for removing gases from low-lying parts of the hazardous area or provisions for powerful and thorough air-mixing in these low areas are needed to prevent high concentrations from building up. In doubtful situations, a respirator of the face-mask type should be worn.

Moreover, if a high CFC content is suspected or indicated by a leak detector, personnel should not be permitted to enter the space in question without having a colleague standing by outside who can check at short intervals the well-being of the person or persons who have gone inside. All personnel who wear respirators must be thoroughly familiar with their use. If there is the least doubt about how to use a respirator properly and how it functions, the personnel in question must not enter the area where the presence of a high CFC content is suspected or has been indicated. In such a situation, the fire brigade or the supplier of the refrigerating system should be called in.

Workplaces must be ventilated in such a way that the maximum permissible concentration of hazardous substances (the hygienic limit) is not exceeded.

Hygienic limits: 8-hour duration of exposure to 500 ppm
15-minute duration of exposure to 750 ppm

The regulations that specify the above limits took effect in May of 1985.

"Refrigerating standards" set forth specifications for the minimum outdoor air flow permitted when ventilating areas that have suffered a catastrophe.

Sites at which CFC refrigerants can be released into the outdoor air (through discharge devices for example), must be carefully selected in such a way as to minimize the risks thereby entailed.

3.2 Presence of decomposition products

CFC gases can decompose at high temperatures (above about 300°C). If the presence of decomposition gases is suspected, personnel must leave the area in question, and it must be thoroughly flushed clean with fresh air before anyone not wearing a respirator is permitted to enter. And as mentioned above in section 3.1, personnel who wear respirators must be thoroughly familiar with their use.

Never weld or braze in locations where CFC gases can be present. Never place an open gas heater or an electric heater in locations where CFC vapours can be present. And never smoke in such locations.

Filter-type masks and gas masks alone do not provide complete protection, and their use is thus not recommended.

3.3 Contact with skin

CFC refrigerants having low boiling points can cause frostbite and freezing if the liquid comes into contact with the skin. Refrigerant-tight gloves must thus be worn in situations where there is risk that liquid CFC will be released. Naturally, other unprotected parts of the body must also be covered so that they do not come into direct contact with CFC. See section 3.4.

R11 and R113 do not cause frostbite and freezing, but they do remove the natural fat from the skin (in the same way as other fat solvents). As a result, the skin becomes vulnerable to infection. Here too, refrigerant-tight gloves provide good protection.

3.4 Contact with eyes

Safety goggles must be worn to protect the eyes from liquid splatter.

3.5 Heating refrigerant cylinders

Refrigerant cylinders must never be heated to temperatures higher than 50°C since this entails risk that they will become completely full as the liquid inside expands. And this, in turn, can cause the cylinder to explode as the result of pressure exerted by the liquid. If it is necessary to heat a cylinder, use hot water or indirect heat limited to a temperature no higher than 45°C. This can be done (for example) in a heating cabinet that has a thermostatic control and also a reliable safety device that interrupts heating in the event that the thermostat malfunctions. Direct heating with a welding flame, stream or water hotter than 45°C must never be carried out.

3.6 Overfilling of refrigerant cylinders

Refrigerant cylinders must be check-weighed after being filled in order to detect overfilling. If a cylinder is filled with more refrigerant than the maximum amount specified on the cylinder, it can become completely full of liquid when the temperature rises slightly above the temperature that prevailed during filling. In such case, any further heating can create a liquid pressure that will cause the cylinder to explode.

3.7 Handling cylinders

Cylinders must be kept in a cool place where there is no risk of fire. They must be kept firmly in a stable position while in storage and also during use. They must be moved carefully to the site where they are to be used with suitable materials handling equipment. An abrupt impact can damage a cylinder, causing it to explode. Cylinders must never be used as rollers or temporary supports.

Never try to repair a cylinder or a valve that appears to be damaged. Instead, consult your supplier who will be able to suggest suitable measures.

3.8 Contaminated oil

Oil that has been in a refrigerating system must be handled carefully. It can contain acids, particularly if a short circuit has occurred in the hermetically sealed motor that drives the compressor. When handling such oil, you should wear protective clothing and safety glasses.

3.9 Welding and brazing

3.9.1 Before and after welding or brazing any part of a system that uses a CFC refrigerant, the system must be blown out using dry nitrogen gas (N₂) to remove all remnants of the CFC refrigerant and traces of air. This will prevent the formation of acidic decomposition products and metal oxides in the system. Note that since the pressure in a nitrogen cylinder is usually higher than the maximum permissible pressure in the CFC refrigerant system, the supplier's instructions must be followed faithfully.

3.9.2 Before welding or brazing, pressure must be relieved from the refrigerant system. Otherwise, the rise in temperature caused by welding or brazing could cause an explosion.

3.9.3 Oxygen or air, together with the lubricating oil used in refrigeration compressors, can form an explosive mixture. This is why you must not use oxygen or air to blow a refrigerant system clean.

3.10 Leak detection

Personnel who operate and install refrigerating systems must be given clear instructions in the use and maintenance of leak detection equipment. A sign must be posted at the place where the leak detection equipment is normally kept. This sign shall state the following:

- How to use and maintain the equipment.
- How to check the functioning of the equipment.
- The address and telephone number of the company that services the equipment.

4. FIRST AID

4.1 Inhalation

A person who has inhaled high concentrations of CFC gases must be taken out into the fresh air immediately. A person who has been seriously affected by CFC gases must be kept warm and at rest. If the situation so requires, use artificial respiration. Oxygen can be administered, preferably under the supervision of a medically skilled person. Heart stimulants, adrenalin and the like must never be given.

4.2 Frostbite and freezing

Parts of the skin that have been frostbitten or frozen should be rinsed with lukewarm water to warm them up again. Frostbite or freezing should be treated in the same way as a burn. Clothes that have absorbed any of the refrigerant must be removed immediately, but if they are frozen fast to the skin they must first be thawed out and then carefully removed. If the refrigerant has come into contact with a person's eye, the eye must be washed out continuously with a 2% salt solution for 10 minutes. Then contact a doctor who can provide further treatment.

4.3 Thermal decomposition

Acidic decomposition products from CFC refrigerants irritate the eye, throat and respiratory organs. Normally, these effects give ample warning of the presence of decomposition products, but anyone who has been overexposed to these products must be taken out into the fresh air and, in severe cases, kept at rest under medical supervision.

Moisture as a consequence of insufficient drying can cause very serious disturbances in a cooling plant. Moisture appears in several states:

1. Free water (in liquid, solid, or gaseous state)
2. Dissolved water (in refrigerants and oil)
3. Adsorbed water (on the surface of the material or in the drier)
4. Chemically bound water (e.g. in electrical insulation materials)

SOURCES OF MOISTURE

Air

Ordinary air contains moisture that can be precipitated on the surface of the material through adsorption due to reduction of steam pressure in pores.

If the temperature of the material is lower than the dew point of the air, condensation occurs as well.

Air comes in contact with the components while being manufactured and also during the installation. Pressure testing with air can leave behind moisture in considerable quantities, unless the air is dried.

Water

Hydraulic pressure testing with water is prescribed for a great many components of cooling plants.

Components that are pressure tested with air are often immersed into water at which procedure drops of water can force their way in during the handling.

Welding touch

The products of combustion generated when welding are largely composed of water vapour.

Refrigerating-machine oil

Oil is **hygroscopic** and when it comes in contact with air, moisture is absorbed which can afterwards evaporate because of the higher temperature in the compressor.

Refrigerant

Refrigerants contain water. Suppliers of refrigerants R12 and R22 usually guarantee a water content of 10 mg/kg at the most.

EFFECTS OF MOISTURE IN COOLING SYSTEMS

Clogging of expansion valves

The various liquid refrigerants can dissolve a larger or smaller quantity of water. The solubility is generally stated in mg water per kg of refrigerant which is actually the equivalent of ppm = parts per million, the unit as used in English literature. The solubility depends on the temperature. Compare the diagram below which includes most of the ordinary refrigerants. Water is limitlessly soluble in ammonia.

If the refrigerant contains more water before the expansion valve than corresponds to the solubility at the temperature after the expansion, water freezes to ice if the temperature is lower than 0 °C. This causes clogging at the point of throttling and the valve spindle gets frozen fast.

At temperatures lower than +10 and +18 °C respectively, R12 and R22 form solid hydrates which can also cause clogging.

Corrosion

If the quantity of water in a cooling plant exceeds certain limits, the result may involve most serious damages due to corrosion.

The risk of corrosion depends on:

- a. Quantity of water
- b. Type of refrigerant
- c. Temperature
- d. Material exposed to attack

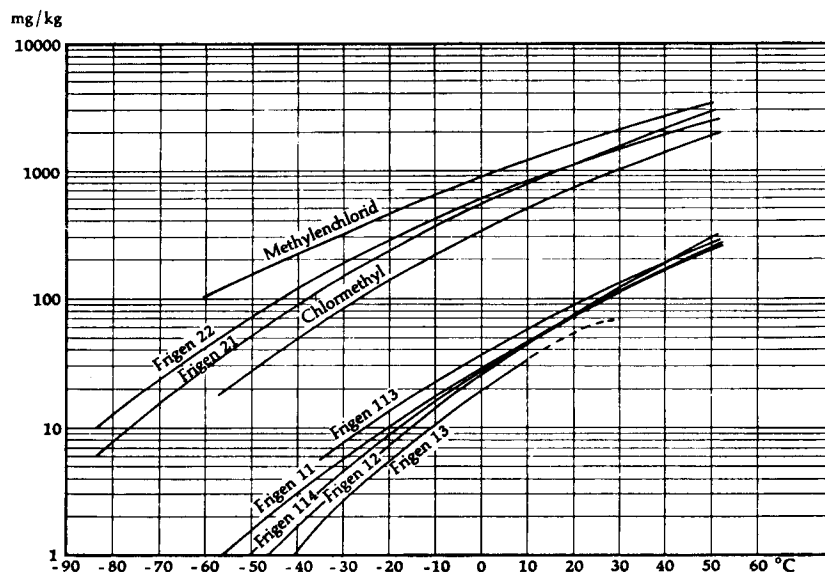
Water reacts with R12 and R22 forming a lot of disintegrated products, among other things hydrochloric acid which in turn reacts with steel, copper, and aluminium by producing salts. The sludges formed may cause clogging of expansion valves, poor sealing of compressor valves, sticking pistons, bearings, etc.

Hydrochloric acid can also cause breaking down of electrical insulation in hermetic compressor units.

Water in ammonia plants may also be the reason of corrosion.

Copper-plating

Under certain conditions, copper can dissolve in refrigerating-machine oil, forming an organic combination with the oil. Copper will then again be precipitated on steel surfaces, preferably on hot surfaces like bearings, cylinders, and valves. Water takes an active part in copper-plating and particularly at precipitation on steel surfaces.



FEUCHTIGKEIT IM KÄLTEKREISLAUF

Feuchtigkeit als Folge unzureichender Trocknung kann zu sehr ernsthaften Störungen in einer Kälteanlage führen. Die Feuchtigkeit tritt in verschiedenen Formen auf:

1. Freies Wasser (in flüssigem, festem oder dampfförmigem Zustand)
2. Gelöstes Wasser (im Kältemittel und Schmieröl)
3. Angelagertes Wasser (an Werkstoffflächen und in Trocknern)
4. Chemisch gebundenes Wasser (z.B. in elektrischen Isolierstoffen)

FEUCHTIGKEITSQUELLEN

Luft

Gewöhnliche Luft enthält Feuchtigkeit, die durch Adsorption auf Werkstoffflächen infolge Dampfdrucksenkung in den Poren niedergeschlagen werden kann. Ist die Temperatur der Fläche niedriger als der Taupunkt der Luft, so entsteht ebenfalls Kondensation.

Luft kommt mit den Anlagenkomponenten während der Herstellung und Montage in Berührung. Druckprüfung mit Luft kann, wenn diese nicht getrocknet wird, bedeutende Feuchtigkeitsmengen zurücklassen.

Wasser

Hydraulische Druckprüfung mit Wasser wird für eine grosse Anzahl Kälteanlagenteile vorgeschrieben.

Gegenstände, die mit Luft abgedrückt werden, werden oft in Wasser getaucht, wobei Wassertropfen während der Arbeit eindringen können.

Schweissflamme

Die bei Schweissarbeiten gebildeten Verbrennungsprodukte bestehen zu einem grossen Teil aus Wasserdampf.

Kältemaschinenöl

Schmieröl ist hygroskopisch und bindet, wenn es mit Luft in Berührung kommt, Feuchtigkeit, die später bei höherer Temperatur im Kompressor verdampfen kann.

Kältemittel

Kältemittel enthalten Wasser. Die Lieferanten der Kältemittel R12 und R22 gewährleisten gewöhnlich einen maximalen Wassergehalt von 10 mg/kg.

FOLGEN DER FEUCHTIGKEIT IM KÄLTEKREISLAUF

Verstopfung der Expansionsventile

Die verschiedenen Kältemittelflüssigkeiten können eine grössere oder kleinere Wassermenge lösen. Die Löslichkeit wird zweckmässig in mg Wasser pro kg Kältemittel angegeben, was direkt der in der englischen Literatur verwendeten Einheit ppm = parts per million entspricht. Die Löslichkeit ist von der Temperatur abhängig. Siehe Figur 1, die die meisten üblichen Kältemittel enthält. In Ammoniak ist Wasser unbegrenzt löslich.

Wenn das Kältemittel vor dem Expansionsventil mehr Wasser enthält als der Löslichkeit bei der Temperatur nach der Ausdehnung entspricht, so gefriert das Wasser aus, wenn die Temperatur niedriger als 0 °C ist. Dieses führt zur Verstopfung der Drosselstelle und zum Festfrieren der Regelspindel. R12 und R22 können bei Temperaturen unter +10 bzw. +18 °C feste Hydrate bilden, die ebenfalls zu Verstopfungen führen können.

Korrosion

Übersteigt die Wassermenge in einer Kälteanlage bestimmte Grenzen, so kann da Korrosion mit daraus sich ergebenden sehr ernststen Schäden führen.

Die Korrosionsgefahr ist abhängig von:

- a. der Wassermenge
- b. dem Kältemitteltyp
- c. der Temperatur
- d. dem vom Angriff betroffenen Werkstoff

Wasser reagiert mit R12 und R22, wobei eine Menge Zerfallprodukte gebildet werden. Unter anderem kann sich Salzsäure bilden, die ihrerseits mit Stahl, Kupfer und Aluminium unter Bildung von Salzen reagiert. Die gebildeten Verunreinigungen ("sludges") können die Verstopfung der Expansionsventile, schlechte Dichtung der Kompressorventile, Fressen der Kolben und Lager usw. herbeiführen.

Die Salzsäure kann auch die Zerstörung der elektrischen Isolation in hermetischen Kompressoraggregaten zur Folge haben.

In Ammoniakanlagen kann Wasser die Ursache von Korrosionserscheinungen bilden.

Kupfer-Plattierung

Unter gewissen Bedingungen kann sich Kupfer in Kältemaschinenöl lösen und mit diesem eine organische Vereinigung bilden. Aus dieser kann das Kupfer auf Stahlflächen, vorzugsweise auf warmen Flächen, wie Lagern, Zylindern und Ventilen niedergeschlagen werden. Wasser ist wirksam bei der Verkupferung beteiligt, und zwar ganz besonders bei der Verkupferung stählerner Flächen.

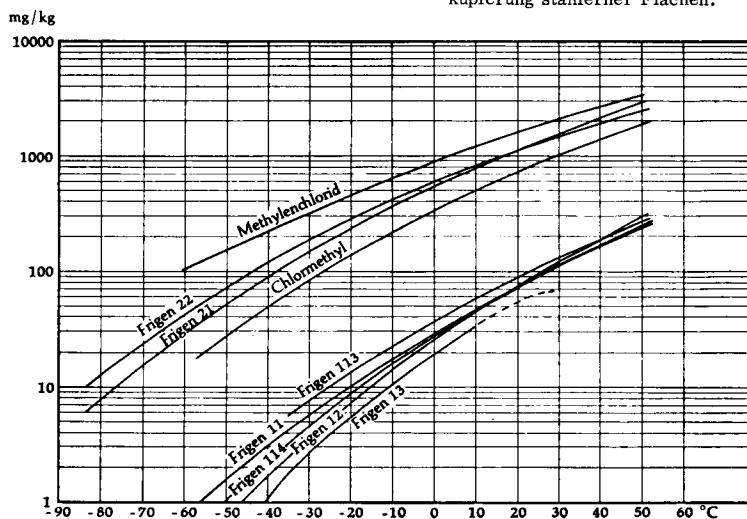


Fig. 1. Löslichkeit des Wassers in flüssigem Kältemittel

(aus Frigen Handbuch)

DRYING OF LARGE COOLING PLANTS

GENERAL

These instructions for drying by evacuation are valid for all large cooling plants using R12, R22 or ammonia as refrigerant. For small installations with hermetic compressors there are special, separate instructions.

POINTS TO BE OBSERVED DURING ASSEMBLY

While the plant is being assembled, every conceivable practical step should be taken to prevent the entry of moisture into the cooling system. The following rules are particularly important and should be followed wherever possible. If practical considerations make it necessary to waive any of the points, then the other measures should be carried out even more thoroughly to give the same final result.

1. Pipes for the plant should be plugged and should be stored indoors whenever possible. If the pipes have to be kept out in the open while the assembly task is going on, they must be moved indoors early enough for any moisture in them to have time to dry out before the pipes are installed in the system.
2. Never leave the system open for longer than is absolutely essential. Seal all openings in the system when work has finished for the day. This can be done by simple means, e.g. by using polythene bags and rubber bands.
3. Before an item of apparatus is connected to the system, make sure that it contains no water. Items with flanged connections or which are otherwise simple to open should be examined immediately upon arrival at the erection site. Upon completion of the check, the apparatus should be resealed until it is time to connect it to the system. Depending on a variety of factors, such as the size of the item involved and the available time, it must be decided from case to case whether an item of apparatus which is found to contain water is to be returned or if it is to be dried in site. As a general rule, apparatus containing water must be dried separately before being connected to the system.

DRYING METHOD

Drying by evacuation is based on the fact that the boiling point of water decreases with falling pressure. In course of evacuation, any water or ice in the plant will evaporate and is carried away by the vacuum pump. The table below shows the pressures which must be reached in order for the water to start boiling at different temperatures.

Temperature, °C	Pressure, mm Hg
-20	0.8
-15	1.2
-10	2
- 5	3
0	4.6
+ 5	6.5
+10	9.2
+15	12.8
+20	17.5
+25	23.4

For every kilogram of water to be vapourized, 600—680 kcal are consumed. In view of the difficulties involved in supplying heat to a completely erected plant, it is extremely important that the assembly and erection instructions be followed implicitly, so that the plant will contain as little water as possible when the drying process commences. As a comparison, we can refer to the long amount of time required to boil off 1 kg water over a gas flame, despite the substantial heat supply involved.

If the plant contains a lot of water right from the start, the aforesaid difficulties in respect of heat supply may very well lead to the obtaining of final pressures that are lower than the evaporating pressure of water at room temperature, although the plant is not dry. When the prescribed final pressure is reached, it should therefore be checked as far as possible that no part of the plant is colder than the ambient temperature. Cold parts in the plant indicate the presence of residual water, which may possibly have frozen to ice.

INSTRUCTIONS

1. Evacuate the plant to a pressure of 1 mm Hg. If possible, carry out the evacuation at temperatures above +10 °C.
2. Close the line between the vacuum pump and the plant. The pressure in the plant may not rise more than to 2 mm Hg within five minutes.
3. Fill to atmospheric pressure with dry nitrogen or with atmospheric air passed through a drier. For small plants, refrigerant can be used for the intermediate filling.
4. Evacuate the plant to a pressure of 1 mm Hg. If refrigerant was used for the intermediate filling, a final pressure of 5 mm Hg will suffice.
5. Fill the plant with refrigerant for leak testing.

PRACTICAL CONSIDERATIONS

Before evacuation of the plant is commenced, the efficiency of the pump should be checked. This is done by connecting the vacuum gauge direct to the suction side of the pump. A pump in good condition gives, with the gas-ballast valve open, a final pressure lower than 1 mm Hg and with a closed gas-ballast valve a final pressure lower than 0.05 mm Hg. Next, open the pump gas-ballast valve so that a final pressure of just under 1 mm Hg is obtained.

If the check reveals that the pump gives a poor final pressure, the reason for this may be that it has previously been used to transport refrigerant, some of which has dissolved in the oil for the vacuum pump. This refrigerant can be ventilated out of the oil by running the pump with the suction side closed and the gas-ballast valve wide open. As a rule, running for 10 minutes will suffice.

The vacuum gauge used must be of good quality and highly accurate. For field-service use, a pointer instrument with a measuring range of 0—20 mm Hg is suitable. It should be noted that an instrument of this kind must not be subjected to overpressure.

If the entire capacity of the vacuum pump is to be fully utilized the connection between the pump and the plant must not be of too narrow a gauge. The following table shows the minimum connection size for some different pump sizes.

Pump capacity, cu. m/h	Connection
2.5	2 x 1/4" or 1 x 3/8"
6	2 x 3/8" or 1 x 1/2"
12	2 x 1/2" or 1 x 5/8"

During the evacuation procedure, make sure that all valves are opened so that the entire system will be evacuated. The most reliable result is obtained by connecting the vacuum pump to both the high-pressure and the low-pressure side. If the construction of the plant is such that large pressure drops in the system may be suspected, the vacuum gauge should be connected at the point where the pressure is highest.

**MEASURES WHEN IT PROVES DIFFICULT TO SATISFY
THE DEMANDS MADE IN THE INSTRUCTIONS**

If the final pressure of 1 mm Hg is not attained within a reasonable time, or if the check after the first evacuation reveals a pressure rise of more than to 2 mm Hg, the reason is:

- a) the plant contains water
- b) the plant leaks
- c) the plant contains water and leaks

The chart below has been prepared, and should be followed, to make it easier to determine which of the above points is applicable in the particular case concerned and to see what steps should be taken. Frequently, a faster result is obtained if the plant is examined in sections.

Before commencing the search, any refrigerant which may be dissolved in the compressor oil must be removed by evacuation of the compressor only, as the presence of refrigerant and oil make judgment more difficult.

