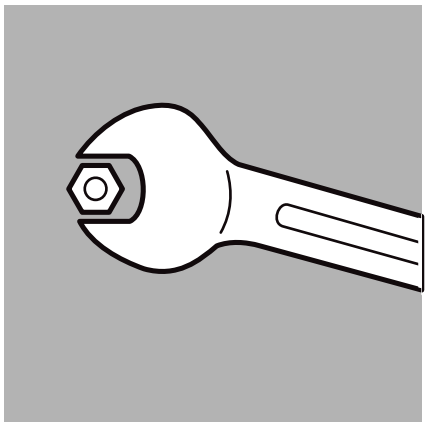
Operation Manual
for the authorized specialist

Oil Burner
EK 6../7../8../9.. S-R

ELCO KLÖCKNER
Heiztechnik



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Important Information

General information

Installation and start-up of the burner are the responsibility of qualified personnel, and they are responsible for correct installation.

Qualified personnel are specialists who are familiar with the erection, installation, setting-up and start-up of the burner.

These specialists

- **have been trained in the handling of fuels (combustible liquids) according to the valid and applicable guidelines and regulations.**
- **are authorized and trained to test and install electric circuits and electrical equipment in accordance with the technical safety standards.**

To ensure safe, environmentally friendly and energy-saving operation the following standards, among others, are to be followed:

DIN 4755
Oil fired furnaces in heating plants

EN 267
Vaporizing oil burners

DIN 4789
Connecting vaporizing oil and gas burners with blowers to heat generators

VDE 01 16 (pr EN 50 156)
Electrical furnace equipment

Installation
The burner must be installed and set up in accordance with the instructions supplied by the manufacturer. The instructions provided by the boiler manufacturer must also be adhered to.

Starting up
The initial start-up of the furnace must be carried out by the erector, manufacturer or other specialist authorized by them.

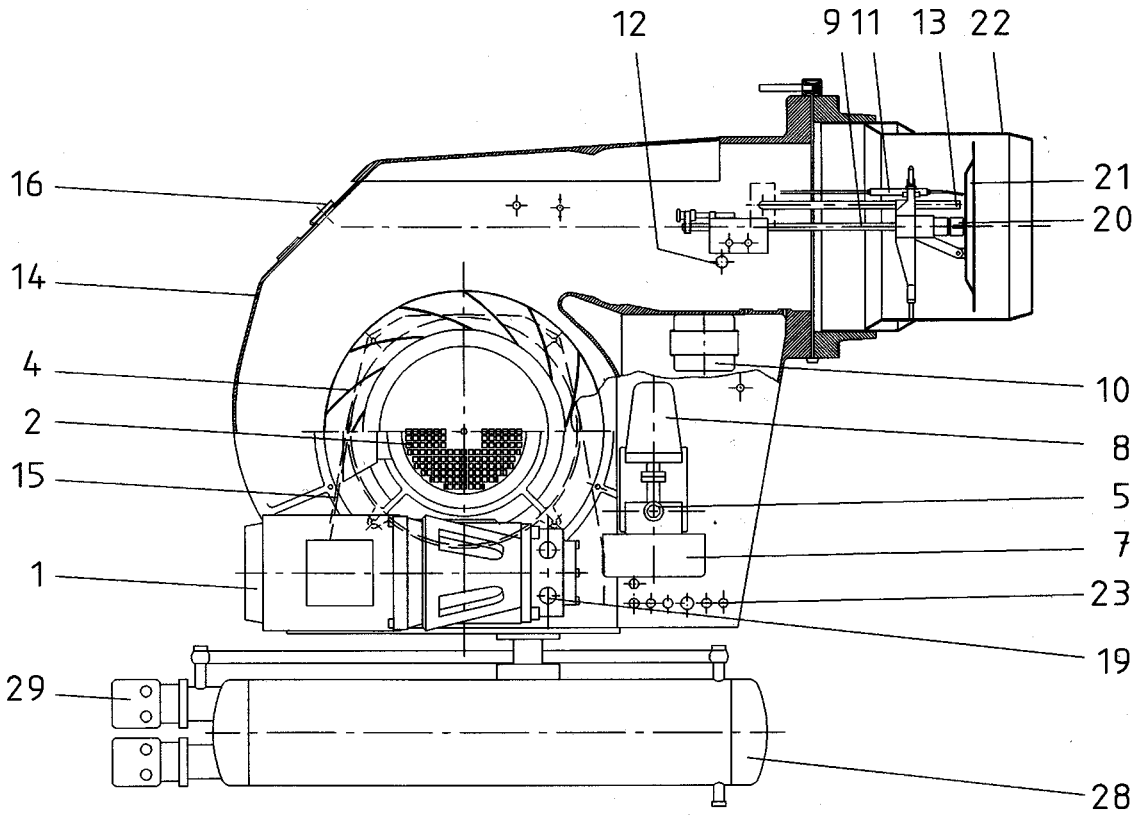
Product description
The burners of types EK 6.../ EK 7.../EK 8.../ EK 9...S-R are oil burners for the combustion of **heavy fuel oil according DIN 51603-3**, all equipped to the EN 267 safety standard.
The burners are equipped with combustion air fan and air pressure switch with test key, oil pressure atomizer with oil high-pressure pump, nozzle rod, return nozzle and hydraulic oil system (valves, pressure switch, piping, etc.), gas ignition burner (option), electrical igniter and mechanical compound control system.

Testing and maintenance
The operator must check or have the plant checked and/or serviced at least once every year. The combustion values must be checked after every maintenance action.

Guarantee
Damages arising from the following are excluded from the guarantee:

- **Improper use or operation**
- **Faulty installation or repair work on the part of the buyer or third parties, including the acquisition of parts not supplied by the manufacturer**
- **Operation of the plant under excess pressure or outside the manufacturer's performance data or inappropriate oil supply**
- **Use of unsuitable fuels**

Sectional Drawing



1 Pump motor
2 Blower motor
4 Fan impeller
5 Output Pressure Control Valve
7 Compound controller
8 Actuator
9 Return nozzle rod
10 Ignition transformer
11 Ignition electrodes
12 Flame sensor
13 Pilot burner
14 Burner housing
15 Air box
16 Inspection glass
19 Oil pump
20 Oil nozzle
21 Baffle plate
22 Flame tube
23 Cable inlets
28 Pre-heater
29 Electrical connection and temperature controller

Key to types

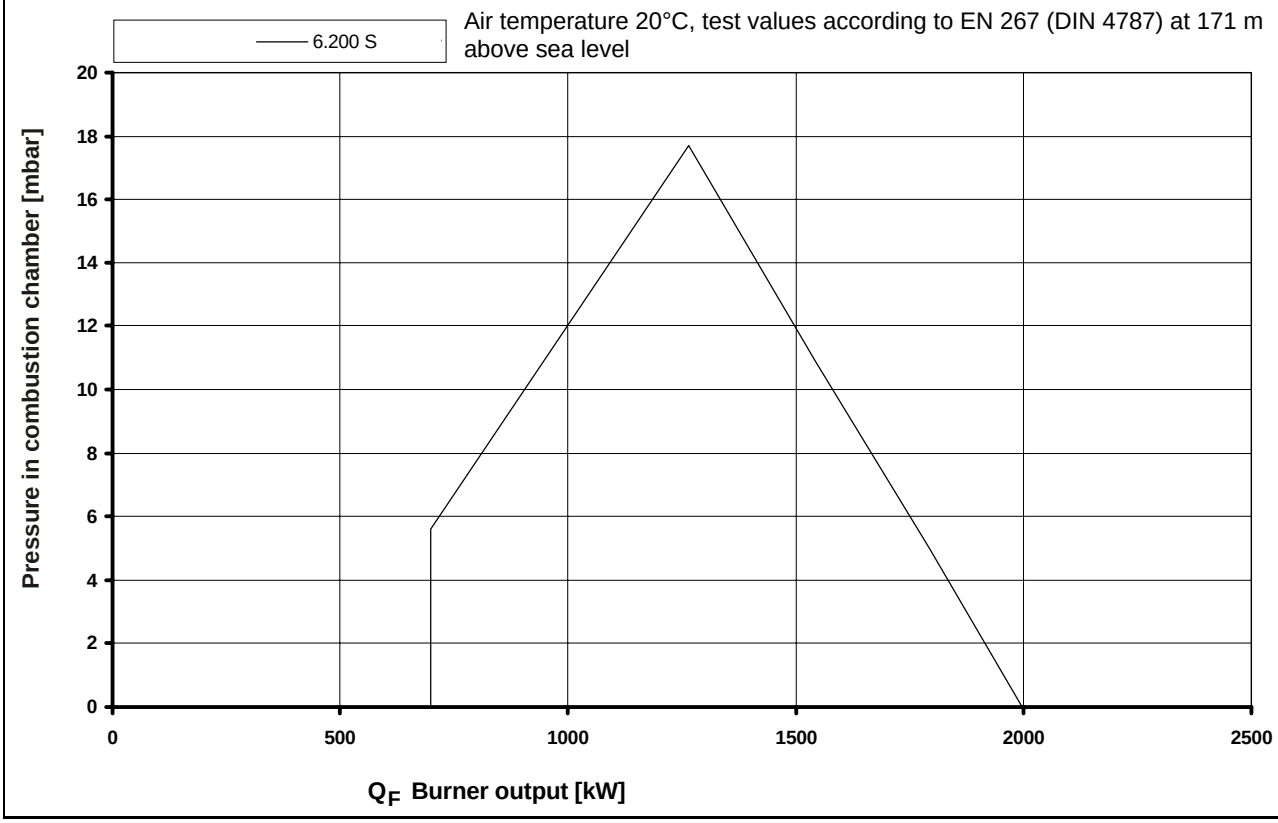
Example: EK 6.300 S-R

EK Elco Klöckner
6. Size
300 Load index (x10 = approx. burner output in kW)
S Heavy oil
R Mechanical compound control

EK 6.200 S-R

Technical Data	6.200 S-R
Burner output	700 - 1999 kW
Fuel flow rate	63 - 180 kg/h
Operating mode	fully modulating
Type of fuel	Heavy fuel oil
Burner control box	LFL 1.3 / LFL 1.6 / LGK 16
Flame sensor	QRA 2 / QRA 2 / QRA 53
Fan motor	400 / 690 V, 50 Hz 3,0 kW, 6,6 A, 2800 min^{-1}
Pump unit	SMG 1527 - 0,75 kW
Gear output	540 l/h
Pressure	30 bar
Pre-heater	3x230/400 V 1x12 kW
Nozzle rod	MAT-DG
Nozzle	MK 27
Oil hoses / External connection	DN 13x1300
Actuator	SQM 10/11
Ignition transformer	ZA20 140 / ZM20-14
Ignition burner	ZB 12
Weight	≈ 220 kg

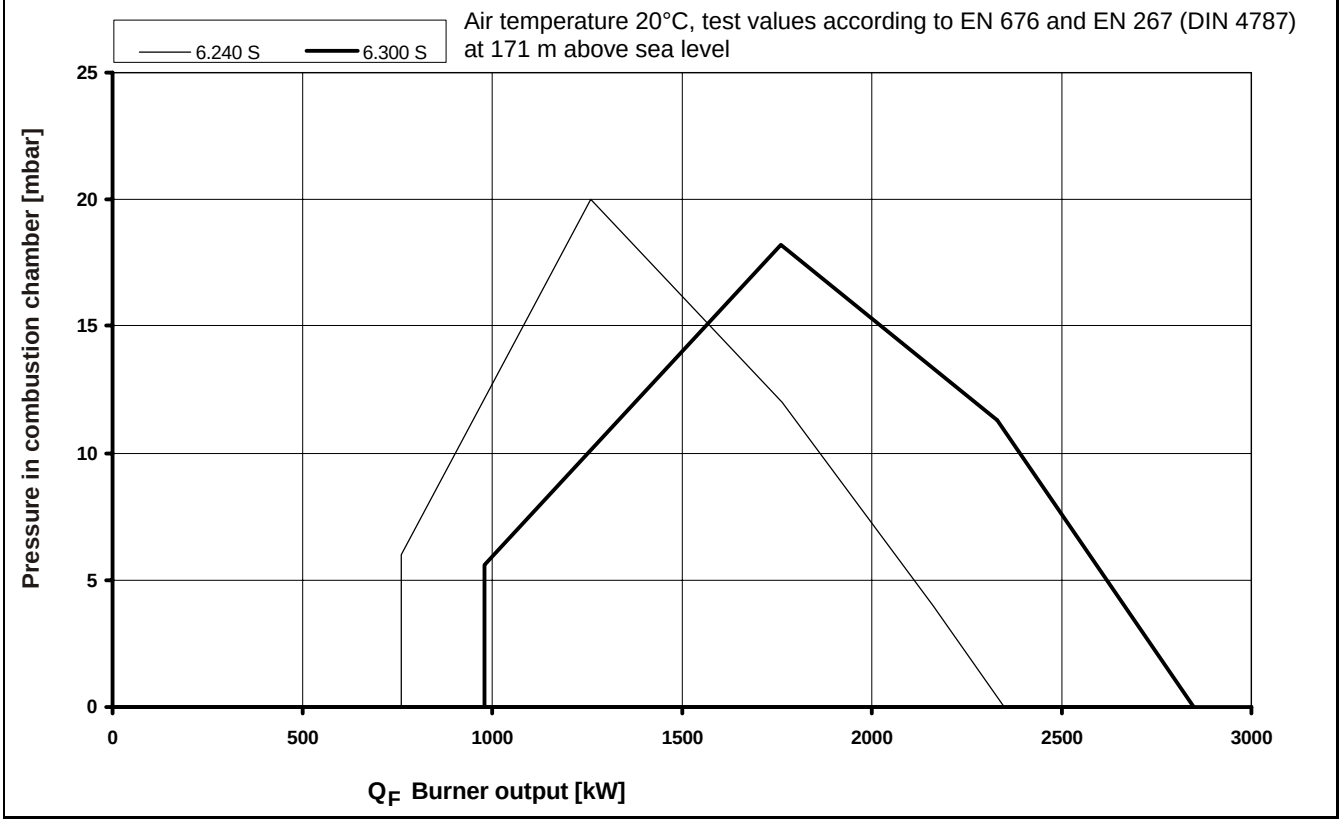
Operating range EK 6.200 S-R



EK 6.240 / 300 S-R

Technical Data	6.240 S-R	6.300 S-R
Burner output	760 - 2350 kW	980 - 2850 kW
Fuel flow rate	68 - 212 kg/h	88 - 257 kg/h
Operating mode	fully modulating	fully modulating
Type of fuel	Heavy fuel oil	Heavy fuel oil
Burner control box	LFL 1.3 / LFL 1.6 / LGK 16	LFL 1.3 / LFL 1.6 / LGK 16
Flame sensor	QRA 2 / QRA 2 / QRA 53	QRA 2 / QRA 2 / QRA 53
Fan motor	400 / 690 V, 50 Hz 4,0 kW, 8,5 A, 2800 min^{-1}	400 / 690 V, 50 Hz 4,0 kW, 8,5 A, 2800 min^{-1}
Pump unit	SMG 1528 - 1,5 kW	SMG 1528 - 1,5 kW
Gear output	700 l/h	700 l/h
Pressure	30 bar	30 bar
Pre-heater	3x230/400 V 1x12 kW	3x230/400 V 1x12 kW
Nozzle rod	MAT-DG	MAT-DG
Nozzle	MK 27	MK 27
Oil hoses / External connection	DN 20x1300 / 3/4"	DN 20x1300 / 3/4"
Actuator	SQM 10/11	SQM 10/11
Ignition transformer	ZA20 140 / ZM20-14	ZA20 140 / ZM20-14
Ignition burner	ZB 12	ZB 12
Weight	≈ 220 kg	≈ 230 kg

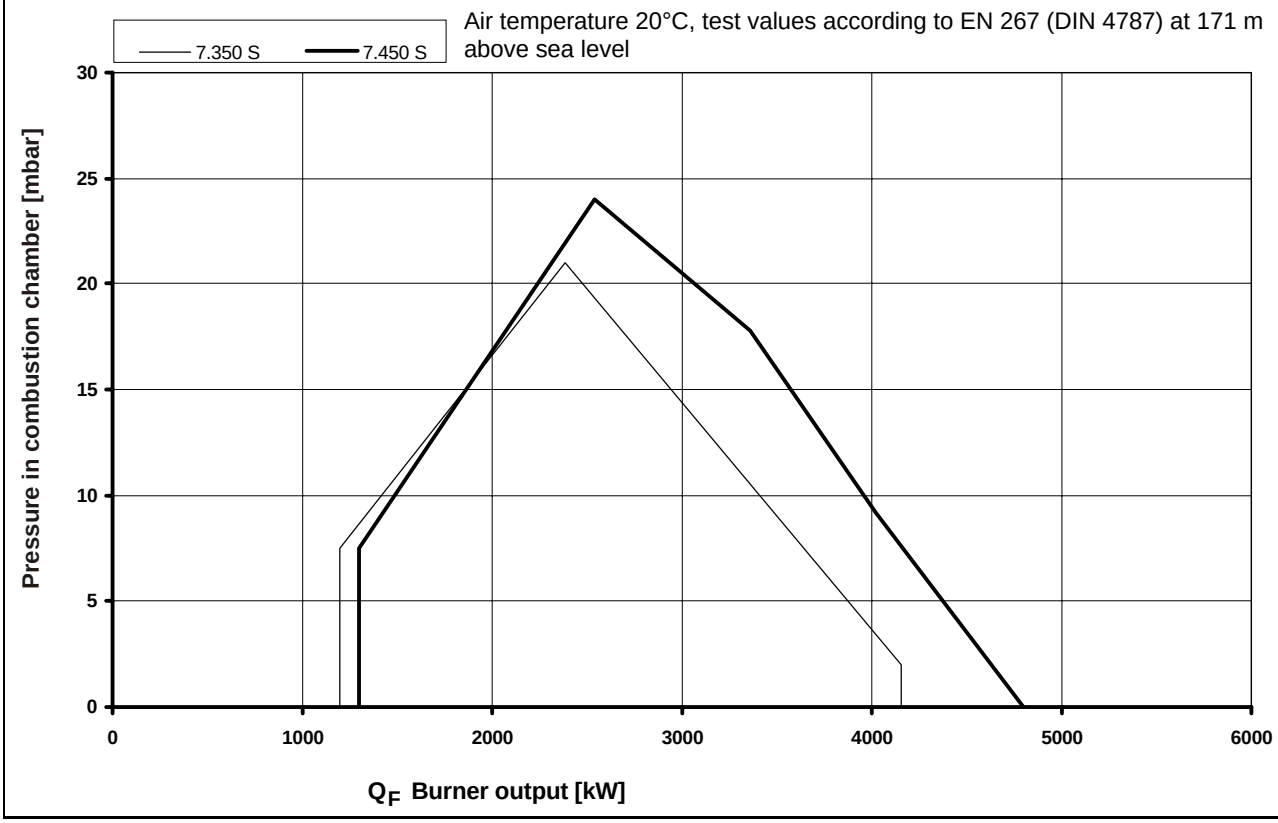
Operating range EK 6.240 / 300 S-R



EK 7... S-R

Technical Data	7.350 S-R	7.450 S-R
Burner output	1200 - 4153 kW	1300 - 4700 kW
Fuel flow rate	107 - 375 kg/h	116 - 424 kg/h
Operating mode	fully modulating	fully modulating
Type of fuel	Heavy fuel oil	Heavy fuel oil
Burner control box	LFL 1.3 / LFL 1.6 / LGK 16	LFL 1.3 / LFL 1.6 / LGK 16
Flame sensor	QRA 2 / QRA 2 / QRA 53	QRA 2 / QRA 2 / QRA 53
Fan motor	400 / 690 V, 50 Hz 5,5 kW, 11,7 A, 2800 min^{-1}	400 / 690 V, 50 Hz 7,5 kW, 15,5 A, 2800 min^{-1}
Pump unit	SMG 1529 - 2,2 kW	SMG 1529 - 2,2 kW
Gear output	1200 l/h	1200 l/h
Pressure	30 bar	30 bar
Pre-heater	3x230/400 V 1x20 kW	3x230/400 V 1x20 kW
Nozzle rod	MAT-DG	MAT-DG
Nozzle	MK 27	MK 27
Oil hoses / External connection	DN 20x1300 / 3/4"	DN 20x1300 / 3/4"
Actuator	SQM 10/11	SQM 10/11
Ignition transformer	ZA20 140 / ZM20-14	ZA20 140 / ZM20-14
Ignition burner	ZB 2	ZB 2
Weight	≈ 350 kg	≈ 350 kg

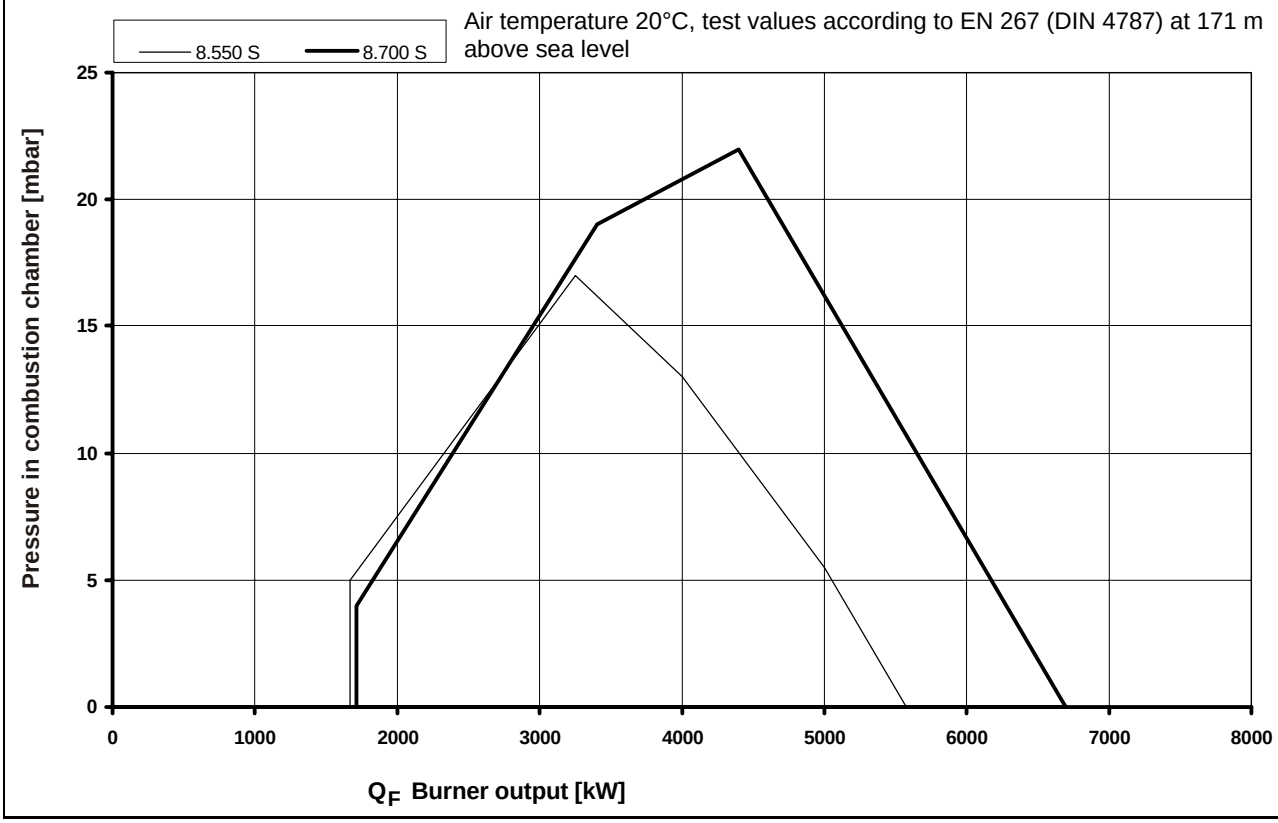
Operating range EK 7... S-R



EK 8... S-R

Technical Data	8.550 S-R	8.700 S-R
Burner output	1647 - 5581 kW	1718 - 6900 kW
Fuel flow rate	150 - 500 kg/h	154 - 600 kg/h
Operating mode	fully modulating	fully modulating
Type of fuel	Heavy fuel oil	Heavy fuel oil
Burner control box	LFL 1.3 / LFL 1.6 / LGK 16	LFL 1.3 / LFL 1.6 / LGK 16
Flame sensor	QRA 2 / QRA 2 / QRA 53	QRA 2 / QRA 2 / QRA 53
Fan motor	400 / 690 V, 50 Hz 11 kW, 22,5 A, 2800 min^{-1}	400 / 690 V, 50 Hz 15 kW, 30,0 A, 2800 min^{-1}
Pump unit	SMG 1530 - 3,0 kW	SMG 1530 - 3,0 kW
Gear output	1700 l/h	1700 l/h
Pressure	30 bar	30 bar
Pre-heater	3x230/400 V 2x12 kW	3x230/400 V 2x12 kW
Nozzle rod	MAT-DG	MAT-DG
Nozzle	MK 27	MK 27
Oil hoses / External connection	DN 25x1300 / 1"	DN 25x1300 / 1"
Actuator	SQM 10/11	SQM 20/21
Ignition transformer	ZA20 140 / ZM20-14	ZA20 140 / ZM20-14
Ignition burner	ZB 2	ZB 2
Weight	≈ 410 kg	≈ 430 kg

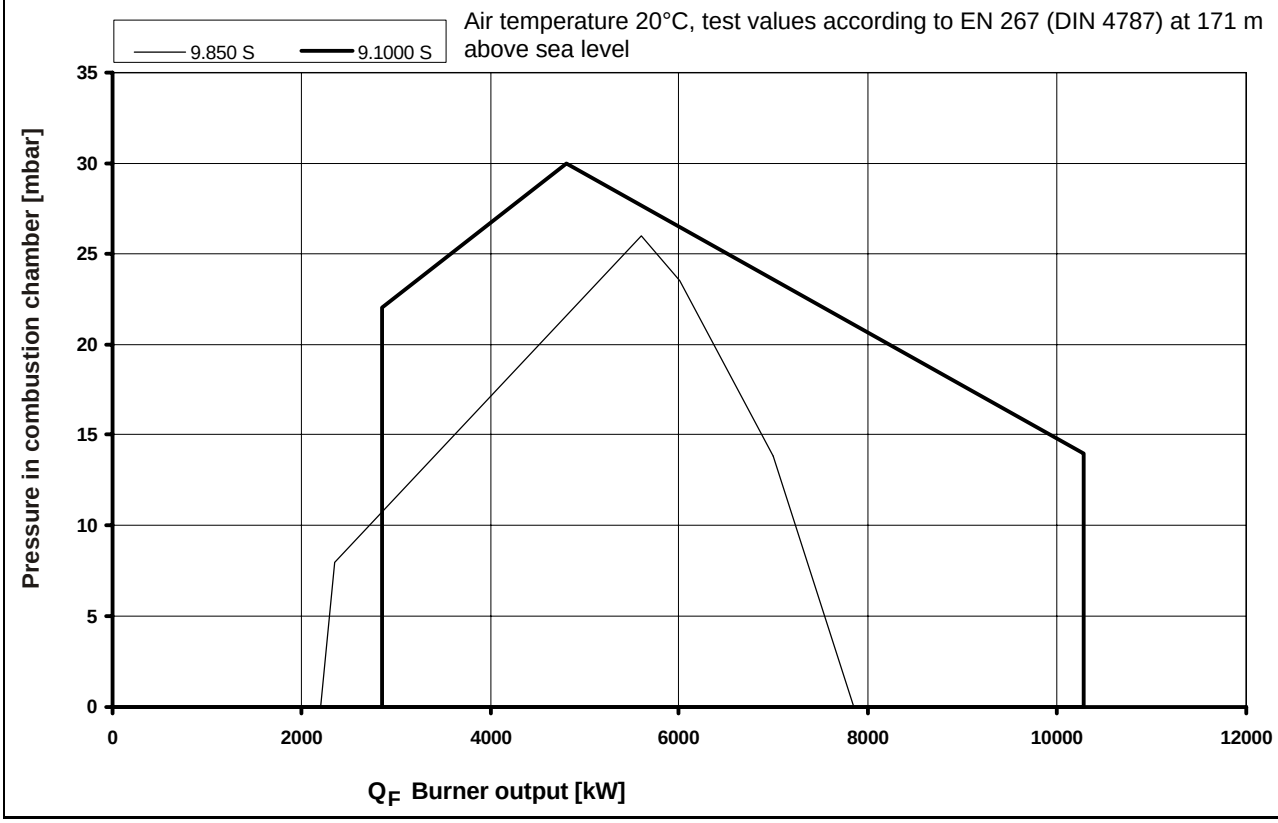
Operating range EK 8... S-R



EK 9... S-R

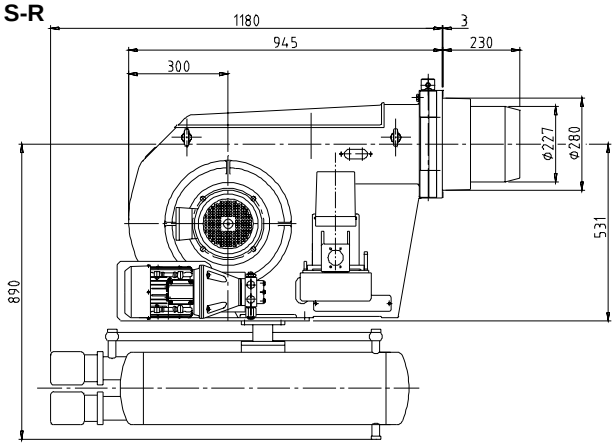
Technical Data	9. 850 S-R	9.1000 S-R
Burner output	2210 - 7845 kW	2850 - 10276 kW
Fuel flow rate	200 - 710 kg/h	238 - 930 kg/h
Operating mode	fully modulating	fully modulating
Type of fuel	Heavy fuel oil	Heavy fuel oil
Burner control box	LFL 1.3 / LFL 1.6 / LGK 16	LFL 1.3 / LFL 1.6 / LGK 16
Flame sensor	QRA 2 / QRA 2 / QRA 53	QRA 2 / QRA 2 / QRA 53
Fan motor	400 / 690 V, 50 Hz 18,5 kW, 35,0 A, 2800 min^{-1}	400 / 690 V, 50 Hz 22 kW, 42,5 A, 2800 min^{-1}
Pump unit	SMG 1531 - 4,0 kW	SMG 1531 - 4,0 kW
Gear output	2700 l/h	2700 l/h
Pressure	30 bar	30 bar
Pre-heater	3x230/400 V 2x20 kW	3x230/400 V 2x20 kW
Nozzle rod	MAT-DG	MAT-DG
Nozzle	MK 27	MK 27
Oil hoses / External connection	DN 25x1300 / 1"	DN 25x1300 / 1"
Actuator	SQM 20/21	SQM 20/21
Ignition transformer	ZA20 140 / ZM20-14	ZA20 140 / ZM20-14
Ignition burner	ZB 2	ZB 2
Weight	≈ 820 kg	≈ 840 kg

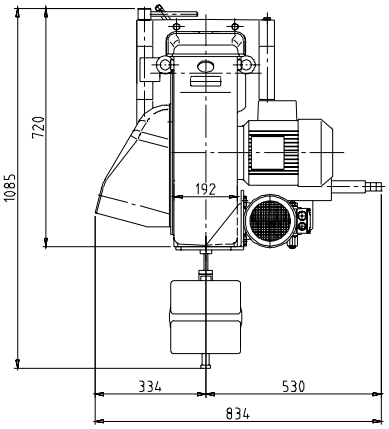
Operating range EK 9... S-R

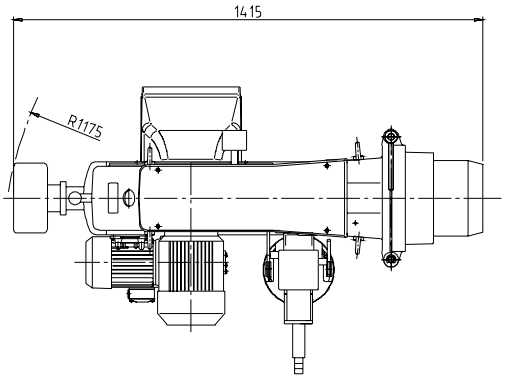


Dimensioned Drawings
EK 6... S-R

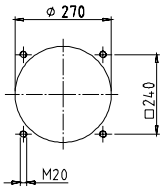
EK 6.200 S-R



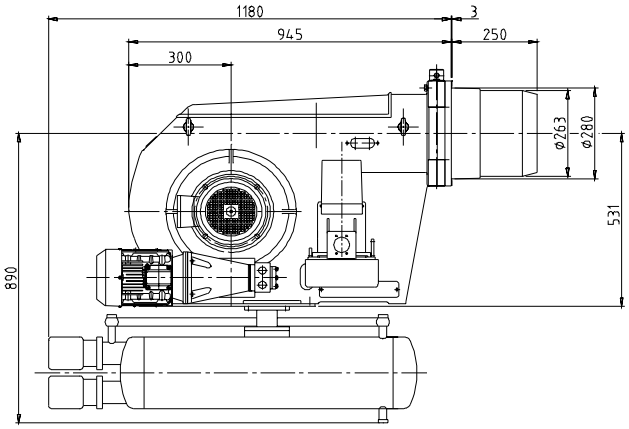


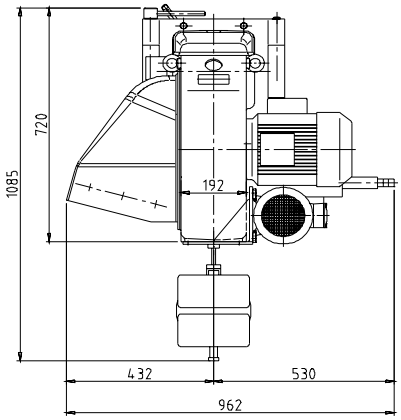


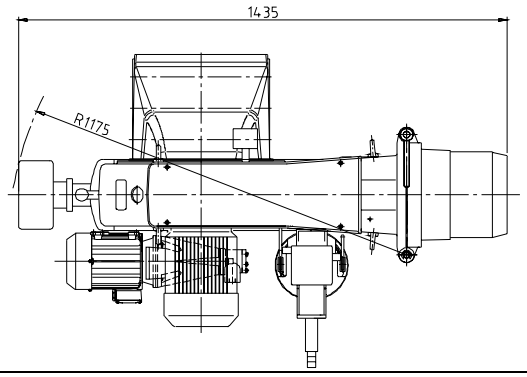
Dimensions in boiler connection plate



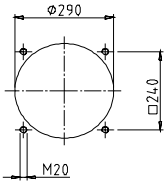
EK 6.240/300 S-R





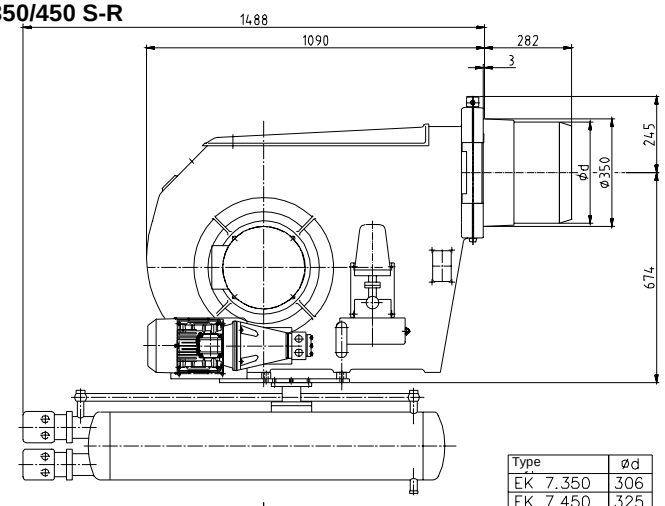


Dimensions in boiler connection plate

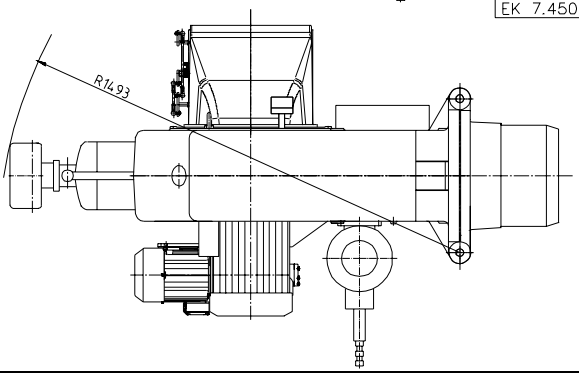


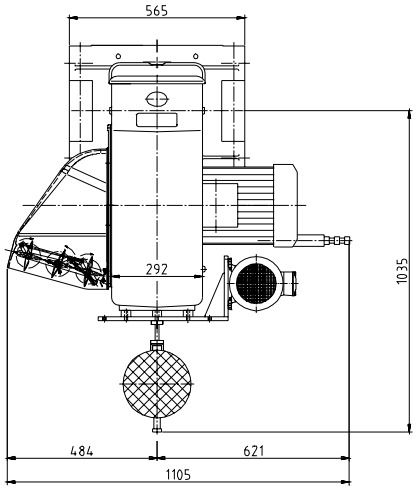
Dimensioned Drawings
EK 7... / 8... S-R

EK 7.350/450 S-R

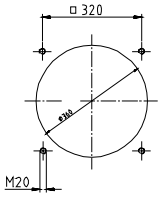


Type	ød
EK 7.350	306
EK 7.450	325

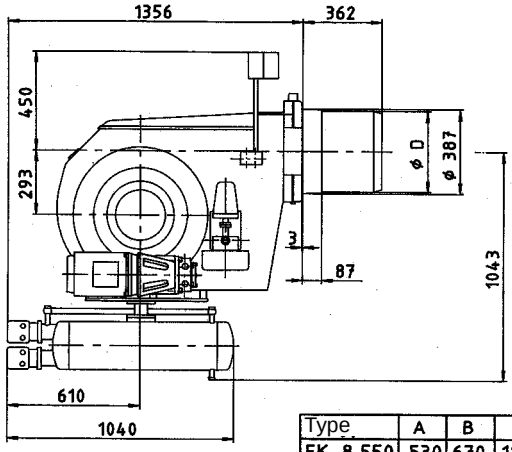




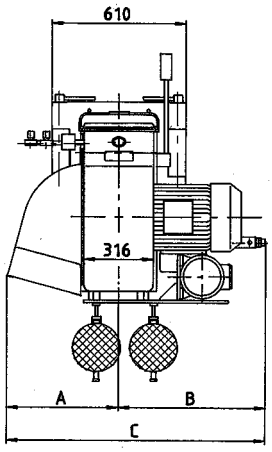
Dimensions in boiler connection plate



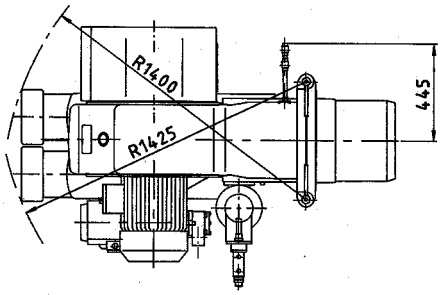
EK 8.550/700 S-R

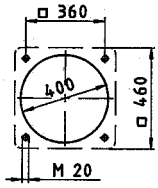


Type	A	B	C	øD
EK 8.550	530	670	1200	346
EK 8.700	511	670	1181	369



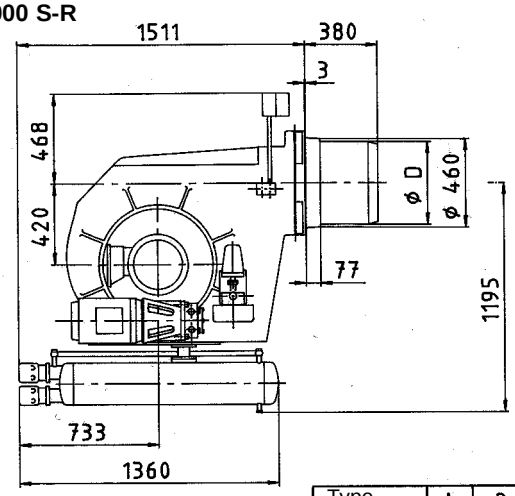
Dimensions in boiler connection plate

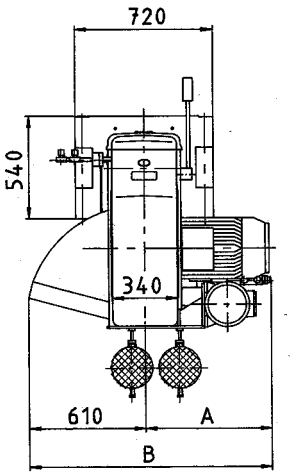




Dimensioned Drawings
EK 9... S-R

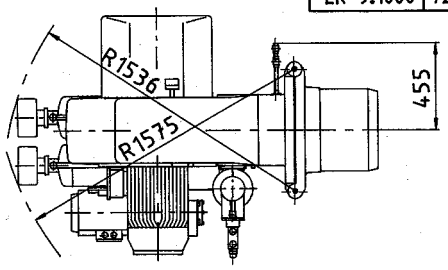
EK 9.850/1000 S-R

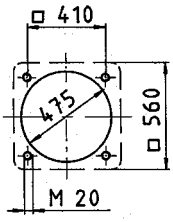




Type	A	B	øD
EK 9.850	657	1267	386
EK 9.1000	720	1330	431

Dimensions in boiler connection plate





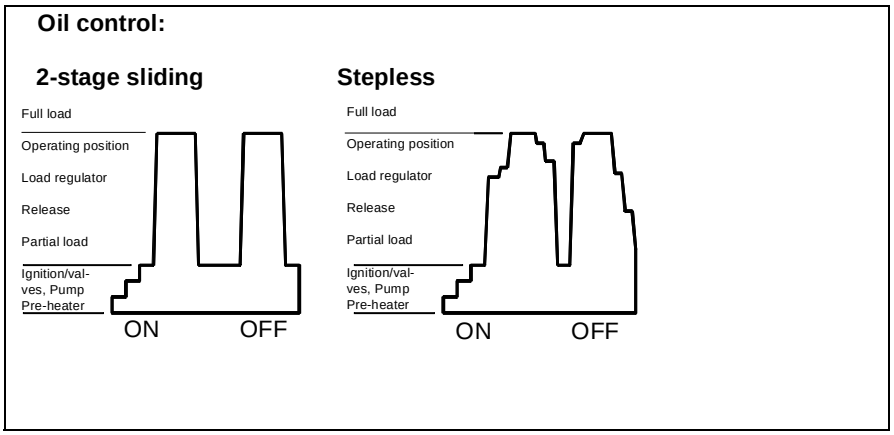
Operation

Start-up Mode
Oil Operating Mode
General Safety Functions

Oil start-up mode
After the heavy-oil burner has been turned on the pre-heater will be started. The heavy oil will be heated to a temperature between 80°C and 140°C depending on viscosity. The electric heat-tracing system and the pump pre-heater will be turned on. After the pre-heating phase the oil is pumped through the oil lines and the flushing valve until the desired temperature has been reached. After the selected oil temperature has been reached the start-up program will be turned on.

The automatic furnace controller will control and monitor the starting process. The electric actuator will open the closed air damper to its full-load position so that the burner will ventilate the furnace and the exhaust hoods with the specified air rate. Shortly after the pre-ventilation process has been started the lack-of-air cut-out must change over to operating position within a certain time, i.e. the minimum air pressure setting must be reached and maintained until the burner is turned off. At the end of the specified pre-ventilation time the air damper will be moved into its partial-load position.
The built in gas pilot burner will be ignited and after the preignition time the ignition of the main flame will take place.
The system may also be designed for ignition by direct electrical igniter.
The solenoid valves will open and thus allow the pressurized oil to flow to the nozzle and to the return line. The oil will be atomized, mixed with the combustion air and ignited. A safety period is provided to allow the flame to develop a proper and steady pattern. On the termination of the safety period a flame signal must have been received by the automatic furnace controller via the flame monitor and remain on until the regular shut-off. The start-up program of the burner has now been completed.

Oil operating mode
After the flame has developed the load regulator will be enabled which brings the burner into its operating position. The load regulator will now control the burner automatically between its partial-load and full-load stages.
Depending on the heat demand, the electric actuator of the mechanical compound control system will be fed with the OPEN or CLOSE signal via the regulator and thus increase or decrease the oil and air flow rates.
This compound control system will vary the positions of the oil control valve and air damper and thus regulate the oil flow rate in conjunction with the air flow rate.
The burner can either be controlled in two-stage sliding mode or, if a respective controller is provided, in stepless control mode.
The stepless control will allow the burner to be operated at any desired stage between its partial-load and full-load positions. The burner will be turned off from its partial-load position. The air damper will be closed when the burner is out of operation and will thus prevent cold air flowing through the burner chamber, heat exchanger and chimney. The interior cooling losses will be greatly minimized.

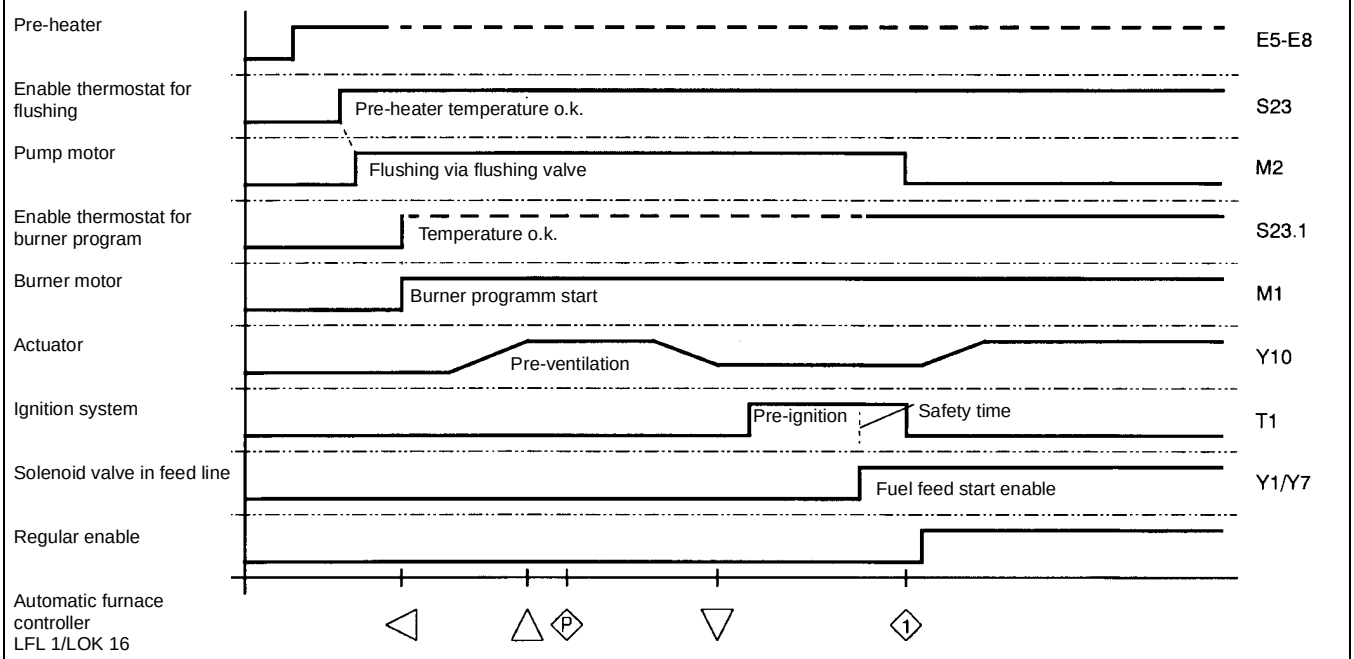


General safety functions
In case a flame does not develop when starting the burner (fuel release) the burner will shut off at the end of the safety period (shut-off on trouble). A shut-off on trouble will also occur in the case of flame failure during operation, air flow failure during the pre-ventilation phase and pressure failure during the whole period of burner operation. Any failure of the flame signal at the end of the safety period and a flame signal during the pre-ventilation phase (external light control) will result in a shut-off on trouble with the automatic furnace controller being locked. The trouble is indicated by the trouble signal lamp lighting up. The automatic furnace controller can be unlocked immediately after a shut-off on trouble by pressing the unlocking key. The program unit will return to its starting position and proceed with the restart of the burner.

A voltage failure will result in a regular shut-off of the burner. Upon voltage recovery there may be an automatic restart unless another interlock is provided, e.g. by the safety system. In any case of trouble the fuel oil supply will be shut off right away. The program unit will stop at the same time causing also the trouble location indicator to stop. The symbols will indicate the kind of trouble.

Flow Diagram

Flow diagram for EK 6-9 S-R



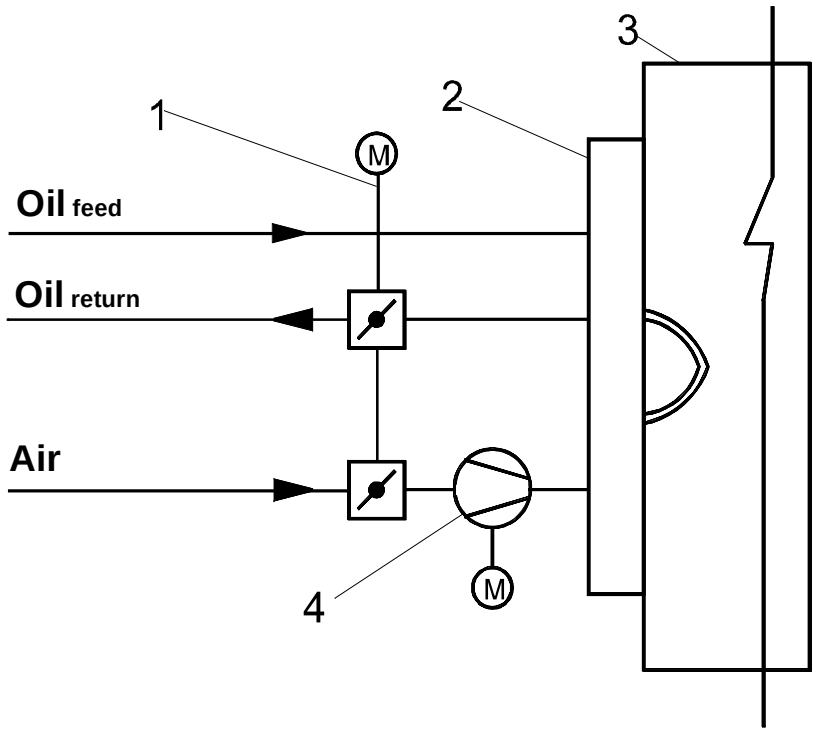
Fuel-air Compound Control Hydraulic Diagram

Fuel-air compound control
This compound control system with precision-adjustment capability has been designed to allow the fuel and air flow rates to be steadily varied in sliding mode for an adjustment of the fuel-air ratio over the whole control range.
In the two-stage sliding control concept the partial-load and full-load positions are within the control range. Depending on the heat demand these two load points will be selected in sliding mode. A larger fuel feed will not be suddenly turned on or off. In the stepless control mode the load will be controlled at any point within the control range depending on the heat demand. The two-stage sliding and the stepless control concepts are different only in the control systems used with the burners. The same mechanical equipment is used for both versions.

Mechanical compound control:
The compound control system will be operated by the steplessly reversible electric drive unit in dependence of the heat requirement.
The air damper and the oil control valve will be controlled by the same system.

In the burner operating mode, a certain quantity of the oil not being burnt in the combustion process is returned from the nozzle via the oil control valve. This return oil is regulated by an oil control valve which is operated in a linked concept with the air flow.
To ensure an optimum air-to-fuel adjustment over the full control range it will be possible to vary the position of the air damper by means of setscrews incorporated in the compound controller.

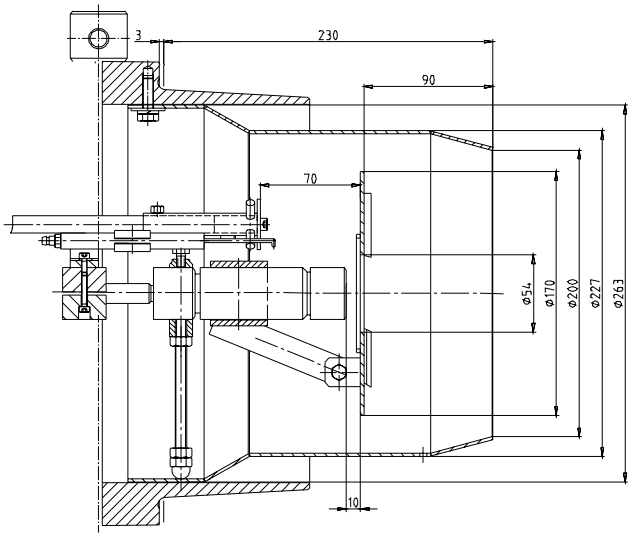
Mechanical compound control



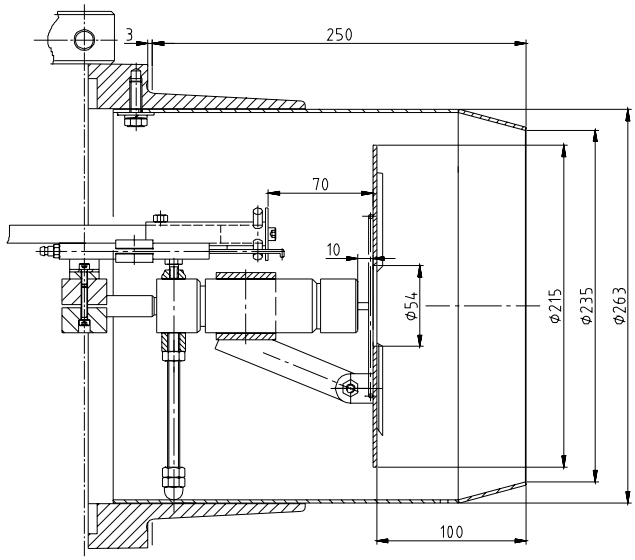
1 Compound controller
2 Burner
3 Boiler
4 Combustion air fan

Burner Head Settings
EK 6... S-R

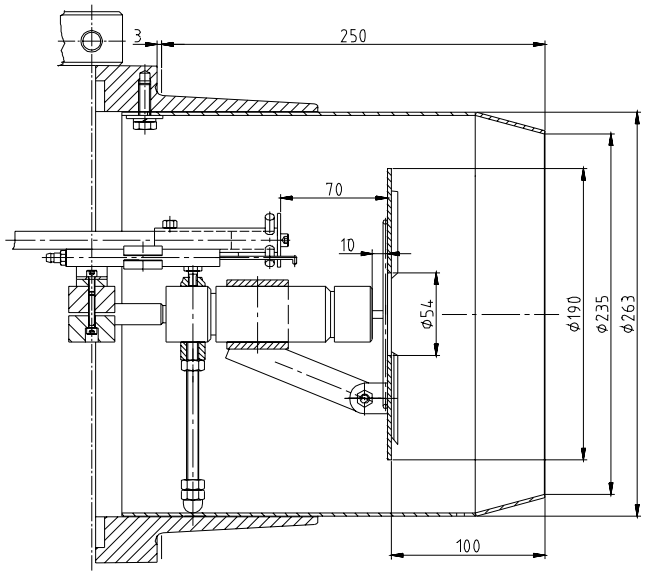
EK 6.200 S-R



EK 6.240 S-R

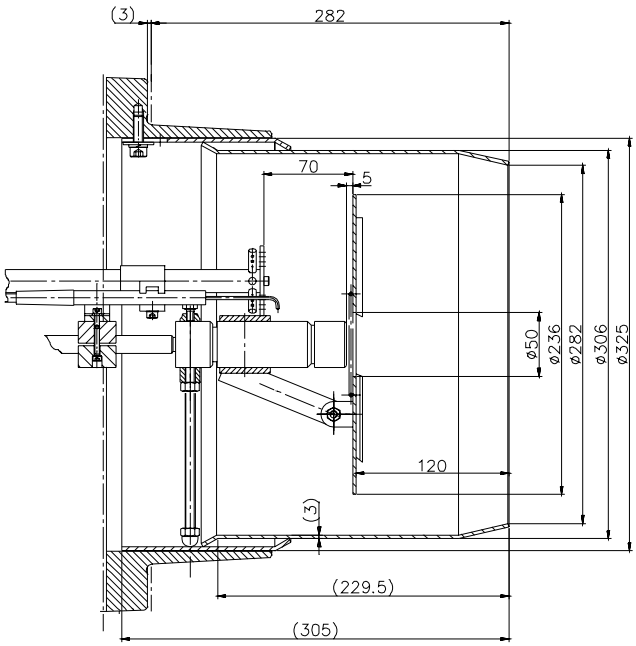


EK 6.300 S-R

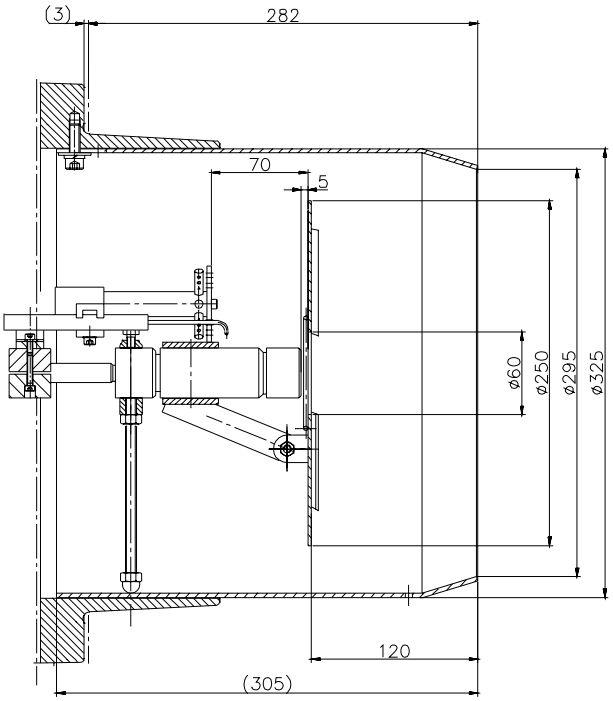


Burner Head Settings
EK 7... / 8... S-R

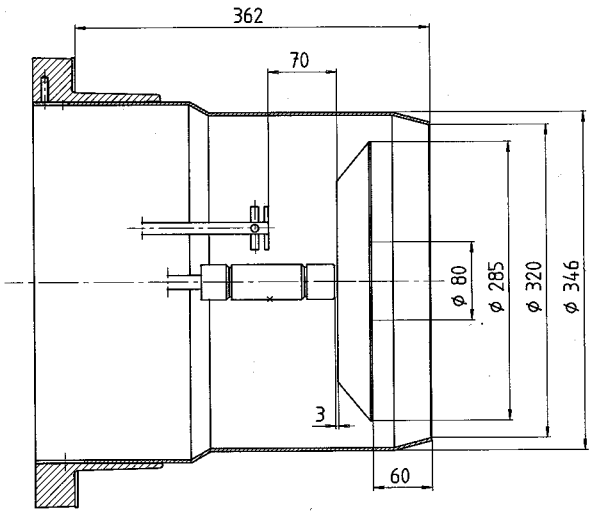
EK 7.350 S-R



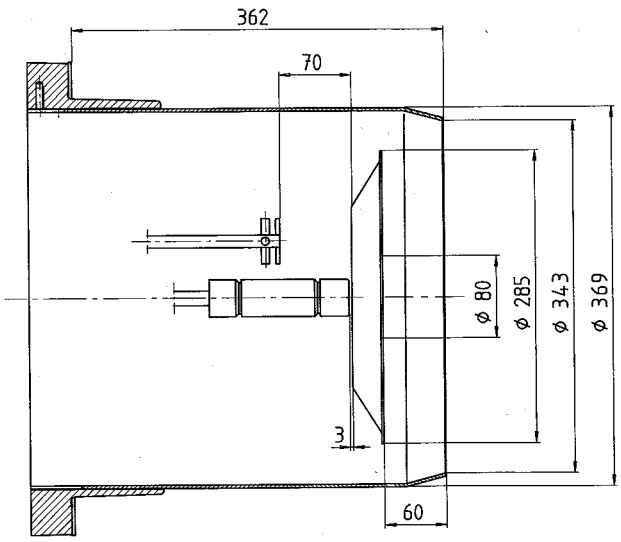
EK 7.450 S-R



EK 8.550 S-R

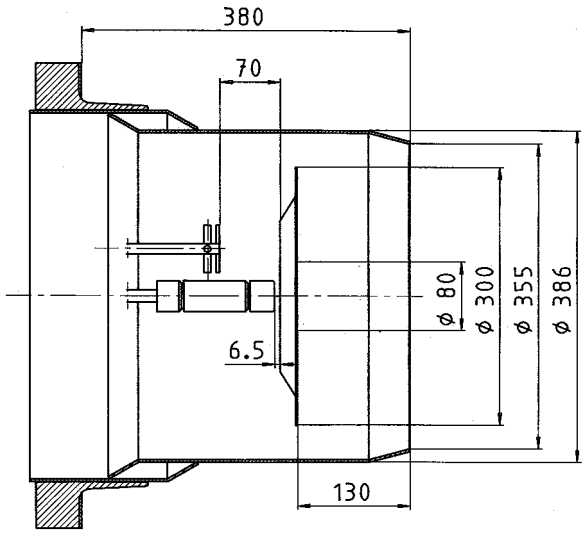


EK 8.700 S-R

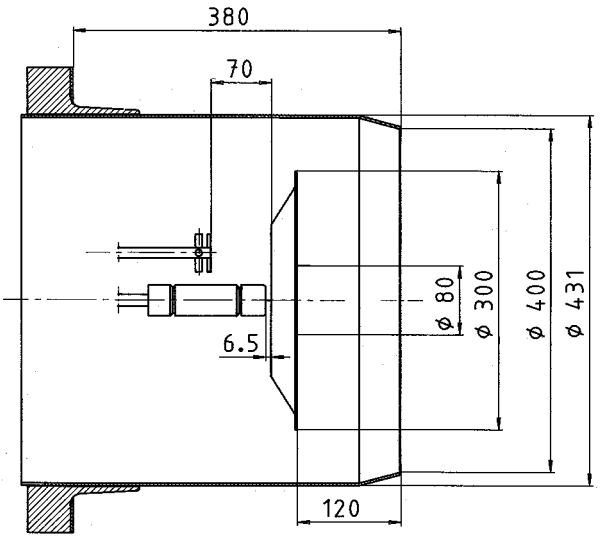


Burner Head Settings
EK 9... S-R

EK 9.850 S-R



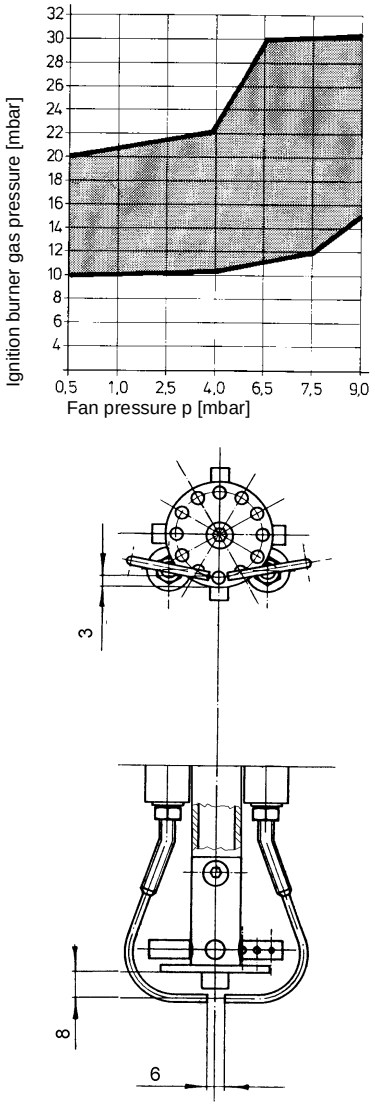
EK 9.1000 S-R



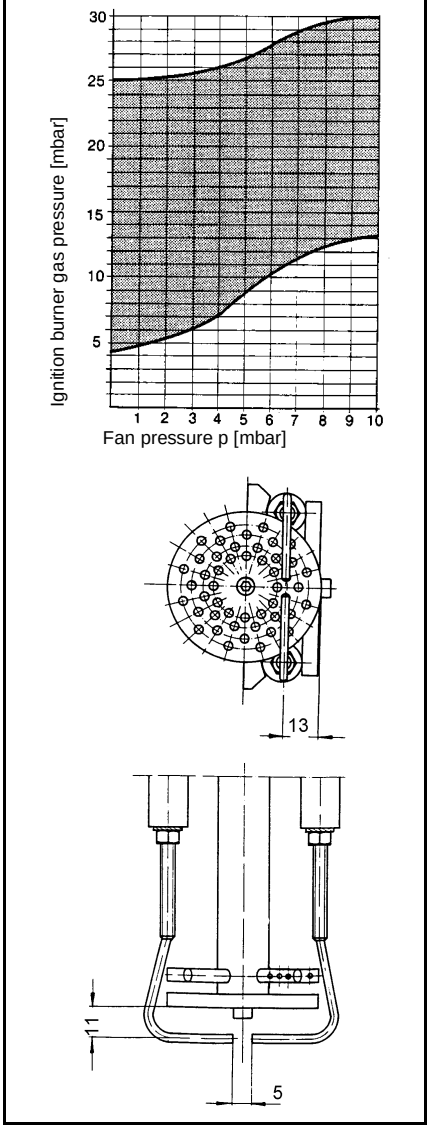
Installation

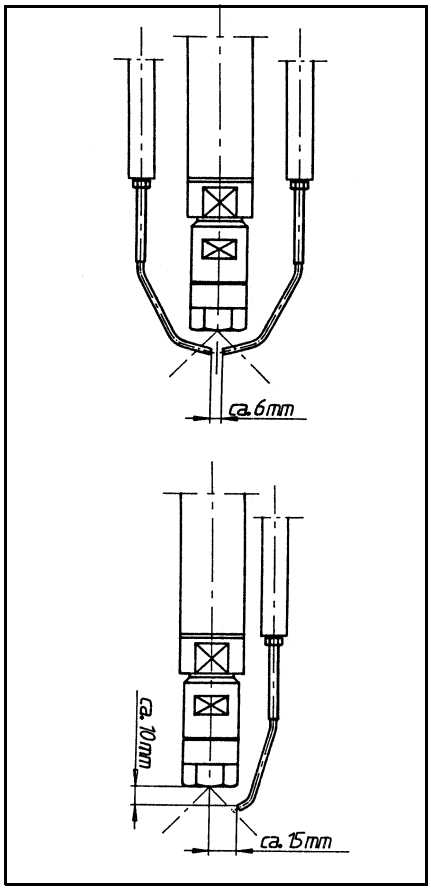
Mounting to Boiler
Electrical Connection
Presetting

Ignition burner ZB 12



Ignition burner ZB 2





Burner mounting
For mounting the burner to the boiler make sure the connection plate has been prepared according to the dimensions given in the technical datasheets.

- Install the stud bolts in the connection plate.
- Put the insulating backing and burner in place and fasten by bolts.

Check before burner installation

1. Select the nozzle according to boiler output and combustion chamber geometry.
2. Set the mixing and ignition unit according to the boiler output. For the standard factory setting refer to the burner head settings.
3. Set the ignition electrodes on the ignition burner or on the nozzle.
4. Check the burner tube installation depth according to the data specified by the burner and boiler manufacturers.

Electrical connection
The electrical connection work comprising all the installation materials, terminals and earth connections must be carried out in accordance with the applicable regulations. For the electrical installation of the burner care must be taken to observe the circuit diagram made out for the furnace system.
The electrical connection of the burner and gas valves and instruments shall be entrusted to authorized specialists only.

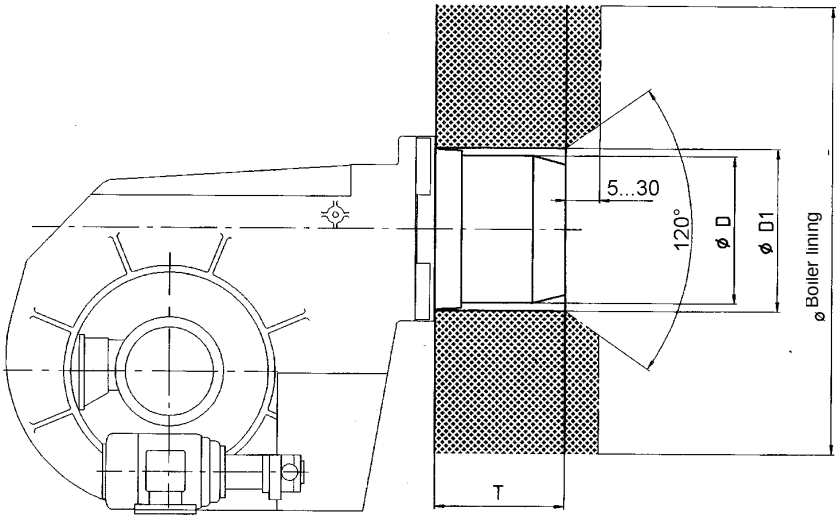
NOTE: For the installation of the connection cables care must be taken to provide cable loops of sufficient length to allow for the swing-out of the boiler door and burner.
Make sure after the completion of the electrical connection work to check the wiring of the electrical system of the burner. This should include a check of the direction of rotation of the burner motor (fan).

Boiler inspection glass cooling
For cooling and cleaning the boiler inspection glass a cooling line (e.g. hose) may be installed from the burner to the inspection glass. The burner is provided with a connection socket for this purpose.

Boiler lining

Boiler lining
The space between the flame tube of the burner ϕD and the boiler lining ϕ D1 must be packed with heat-resistant material, e.g. Cerafelt.

This space is not allowed to be lined with brickwork.



Burner type	Dimension T (Standard)	ϕD	ϕD1
EK 6.200	230	227	290
EK 6.240	250	263	290
EK 6.300	250	263	290
EK 7.350	282	306	360
EK 7.450	282	325	360
EK 8.550	362	346	400
EK 8.700	362	369	400
EK 9.850	380	386	475
EK 9.1000	380	431	475

Oil Supply

Ring line
The oil supply system is an important factor influencing the operational reliability of a burner system. The data needed for dimensioning the pipeline system can be collected from our manual „Burner System Planning“.

Normally, a ring line is used for the oil supply to burner systems.

A ring line for heavy-oil burner systems consists of the following main components in addition to the electric heat-tracing lines:

oil feed pump,
oil filter,
gas-air separator and
pressure control valves.

The electric heat-tracing and the tank heating systems will ensure that the fuel oil is kept in a pumpable condition all the time. An oil filter must be installed in the feed line upstream of each burner to prevent that dirt particles and other impurities originating from pipeline installation can damage the solenoid and pressure control valves.

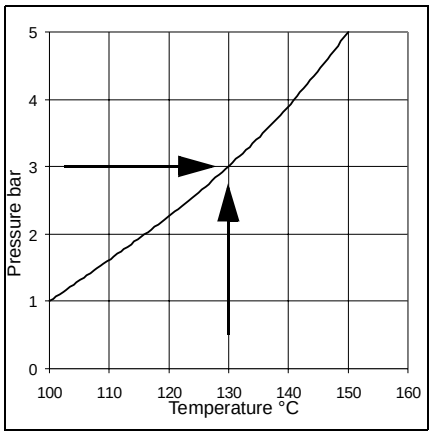
To avoid burner trouble due to air bubbles, the ring line system incorporates a gas-air separator at the highest point of the ring line system and as closely as possible to the burner. Air bubbles will thus be prevented from entering the burner feed line but are returned to the storage tank via the return line of the ring line system.

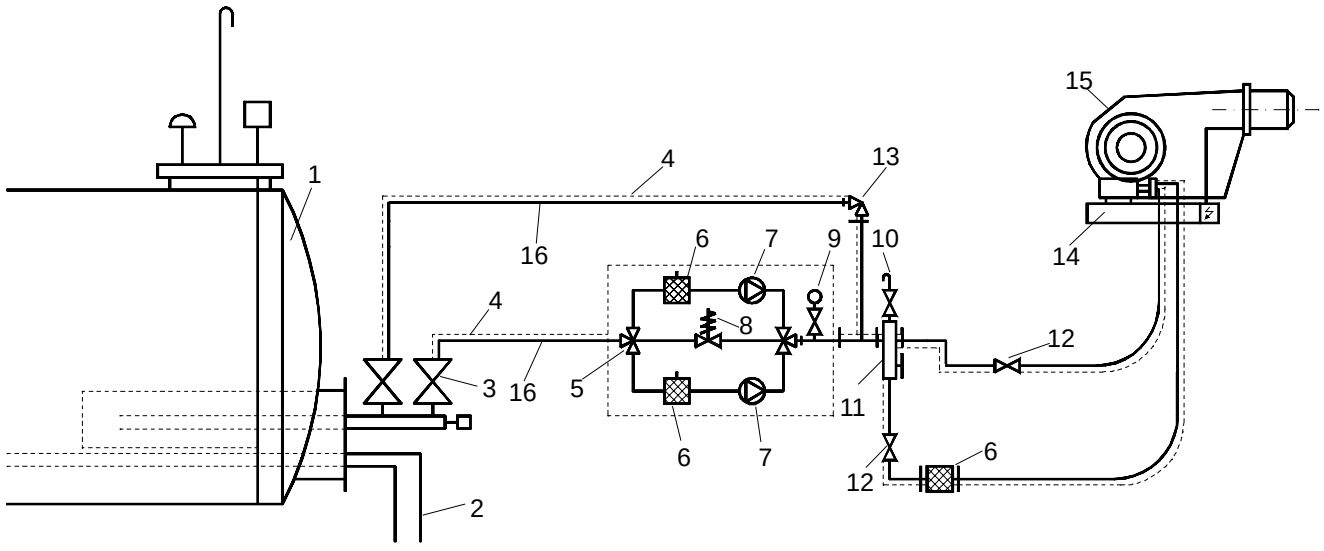
Steam tracing or hot-water tracing systems may be used instead of the electric heat-tracing lines.

The ring line pressure must be selected in dependence of the fuel oil temperature.

As can be seen from the diagram below, the static pressure of the oil must be minimum 3 bar at 130°C, for example.

Oil pressure in dependence of operating temperature





1 Storage tank
2 Tank heating
3 Quick-acting stop valve
4 Electric heat tracing
5 Ball valve
6 Oil filter
7 Oil feed pump
8 Relief valve
9 Pressure gauge
10 Vent valve
11 Gas-air separator
12 Stop valve
13 Pressure control valve (Setting in accordance with diagram)
14 Electric oil pre-heater
15 Burner
16 Ring line

Oil Supply

Oil hoses
The oil hoses used for heavy oil operation are of high-grade steel corrugated design approved according to DIN 4798 Part 1. The hoses are jacketed with a high-grade steel mesh. They are resistant to temperature and chemical reactions of heavy fuel oil according to DIN 51603 Part 2. The mounting instructions given below should be observed.

An oil filter must be installed upstream of each burner to prevent that dirt particles contained in the oil and impurities from pipeline installation can enter the burner.

Technical data of oil hoses

Nominal pressure PN = 16 bar
Test pressure PP = 21 bar
Operating pressure up to 10 bar
Operating temperature up to 150°C

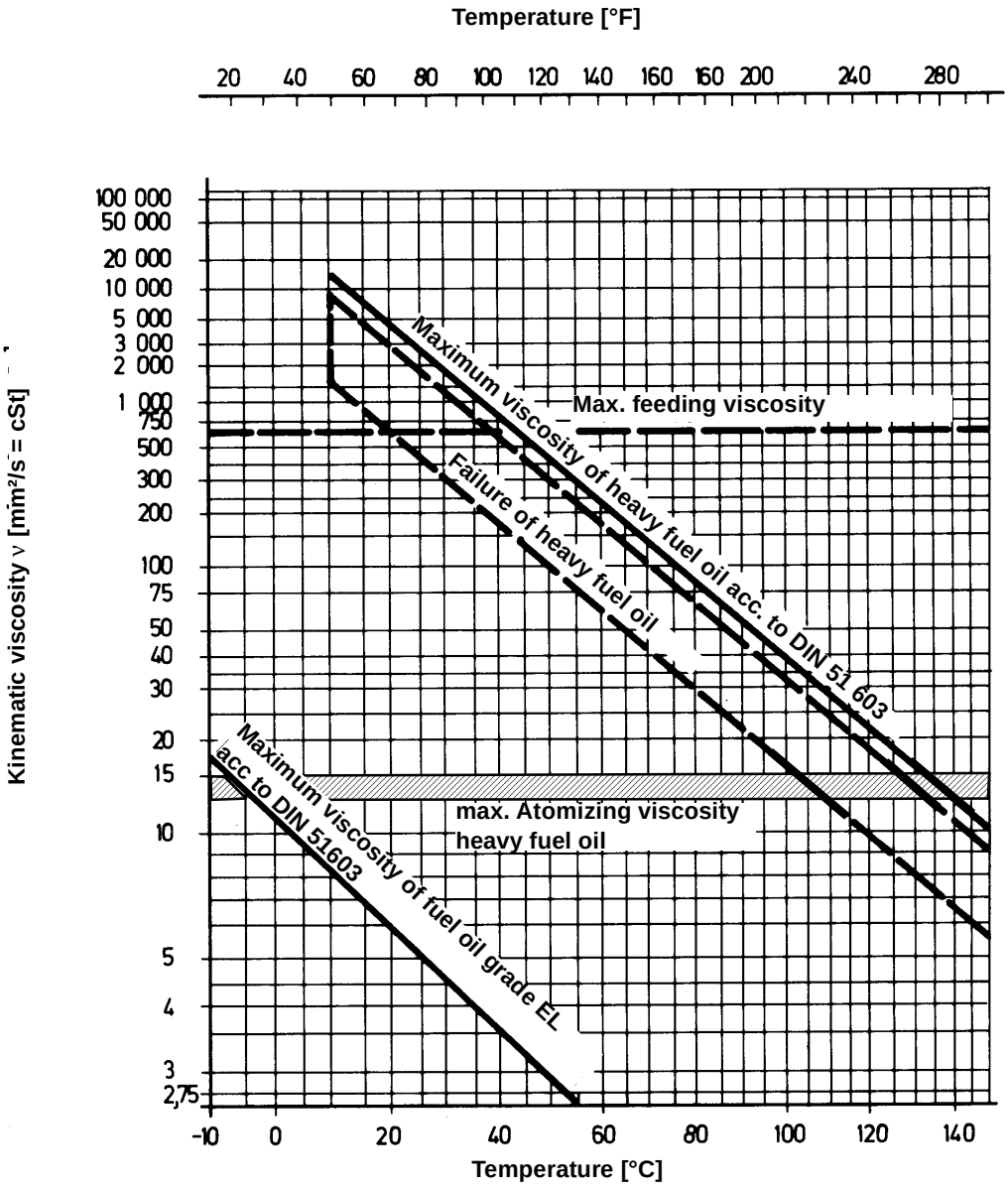
Mounting instructions
When mounting the oil hoses be sure they are free of distortion and relieved of stress.
Take care to observe the minimum bending radius „R“ (see table) and support the oil hoses on the structure.
Make sure the hoses do not make contact with each other and avoid that they can be damaged from outside, e.g. by contact with other parts of the burner or boiler.

If burners are of swinging type make sure to mount the oil lines so that the hoses will not be subject to stress when swinging out the burner (relieving of tension).

Application

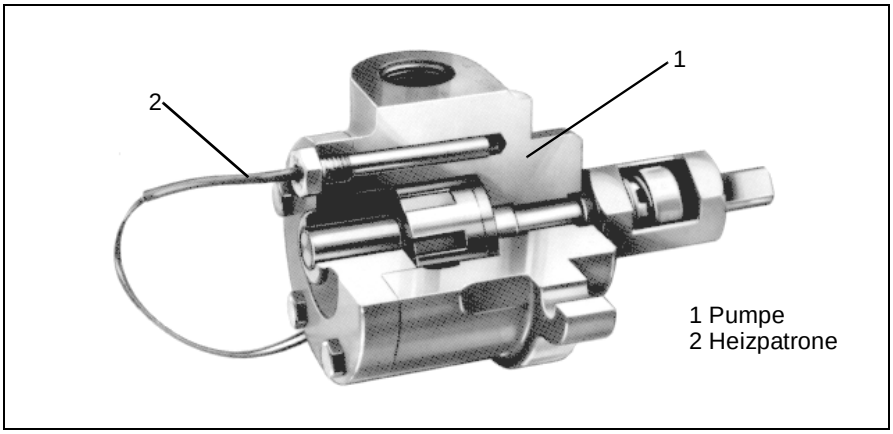
Burner type	DN	Lenght [mm]	Connection, both sides	Minimum bending radius R [mm]
EK 6.170/200	12	1300	R 1/2"	110
EK 6.240/300	20	1300	M 30x1,5	240
EK 7	20	1300	M 30x1,5	240
EK 8/9	25	1300	M 38x1,5	250

Viscosity as a Function of Oil Temperature



usual feeding viscosity: 60 - 100 cSt
usual atomizing viscosity: 10 cSt

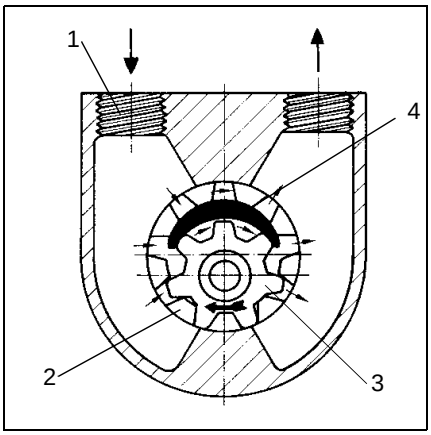
Oil Pump



Type code:

Example for pump
BGG-D-V-H1

BGG Type of pump
D Clockwise direction of rotation
V Viton shaft seal up to 150°)
H1 Electric heating of pump by means of heating cartridge



Operation:
The oil is fed from the inlet port (1) to a rotor (2) with internal toothing which in turn drives an eccentrically positioned gearwheel (3) with external toothing. The rotor is sealed against the gearwheel by means of a crescent-shaped seal (4). The pressure control valve must be fitted separately.

The pumps are designed for the use of commercial heavy oil grades, with the viscosity ranging from 55 cSt/60°C and 11 cSt/120°C.
In the pump diagram the viscosity is at about 22 cSt/100°C.
The pump pressure is 15-30 bar.

Technical Data	**Application:**
Typ BGG - D - 4 - BH1 Output at 30 bar 540 l/h Connection G 1/2" Pump heating 100 Watt	EK 6.170 GS-R EK 6.200 S-R / GS-R
Typ BHP - D - 4 - BH1 Output at 30 bar 700 l/h Connection G 3/4" Pump heating 160 Watt	EK 6.240 GS-R / S-R EK 6.300 S-R / GS-R
Typ BHM - D - 4 - BH1 Output at 30 bar 1200 l/h Connection G 3/4" Pump heating 160 Watt	EK 7.450 / .500 S-R EK 7.350 - .500 GS-R / EK 8.550 GS-R
Typ BHG - D - 4 - BH1 Output at 30 bar 1700 l/h Connection G 3/4" Pump heating 160 Watt	EK 8.550 / .700 S-R EK 8.700 GS-R
Typ B-WL4 -115- D - BH1-So1'' Output at 30 bar 2700 l/h Connection G 1" Pump heating 280 Watt	EK 9.850 / .1000 S-R / GS-R

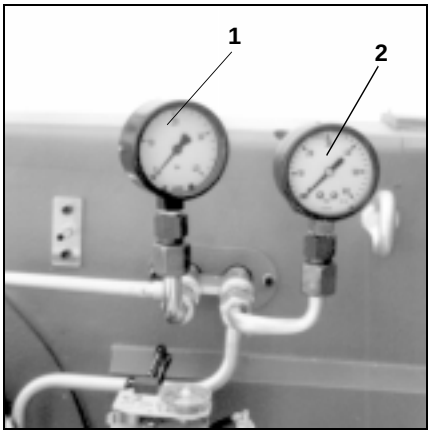
NOTE: The pump pressure must be adjusted in dependence of the selected oil nozzle (see pressure control valve in feed line).

50° - abt. 400 cSt -- max. viscosity
120° - abt. 25 cSt -- max. viscosity

Max. temperature 150 °C

Max. inlet pressure 6 bar
Max. vacuum -0.6 bar

Oil Pump



Filling the oil pump with oil
To avoid seizing of the gearwheel system of the pump the user should fill the pump and the oil supply system with fuel oil or motor oil prior to the initial operation of the burner plant.

Mounting the instruments
Before the adjustment of the burner it will be required to mount pressure gauges for sensing the feed pressure and pump pressure. Alternatively, the pressure gauges installed in the oil pump feed line and pressure control valve return line can be used for this purpose.

NOTE: The pressure gauges must be removed and the connections sealed by suitable means after the burner system has been taken into operation.

If the pressure gauges are not removed from the burner these must be shut off with stop valves.

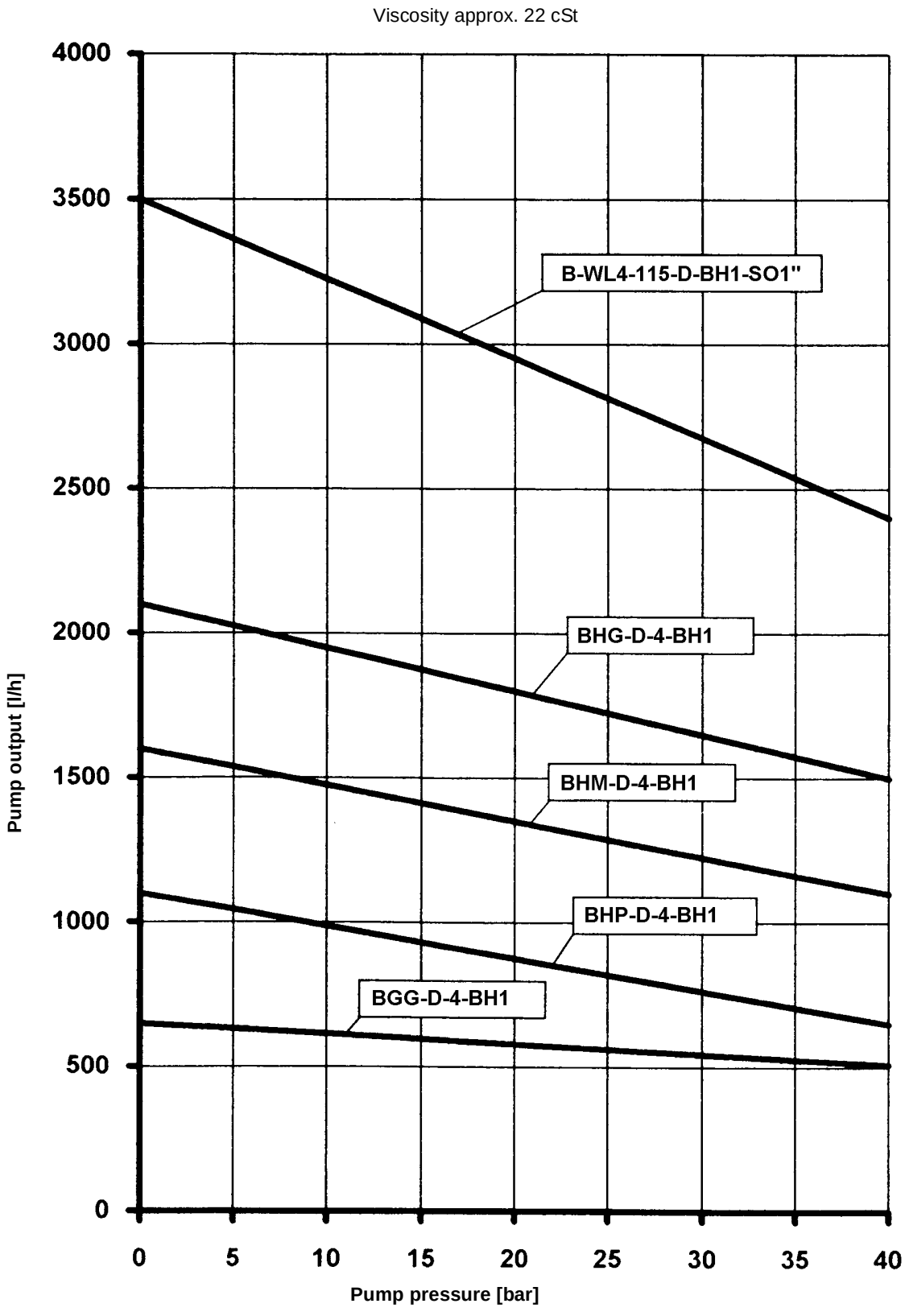
Bleeding
Open the feed and return stop valves and make sure the ring line is in operation, if provided.

Reduce the oil pressure on the pressure control valve as described in the related manual.

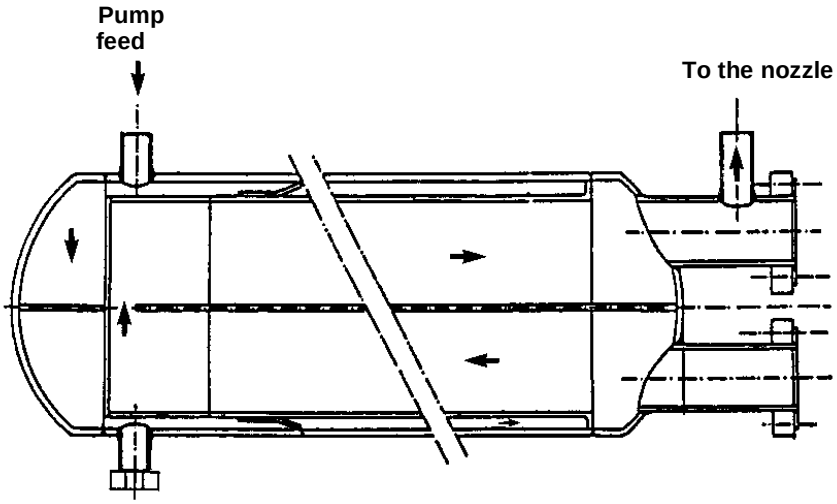
Bleed the hydraulic oil system of the burner with the ring line pressure.

Turn on the pump by pressing the switching contactor. Check for correct direction of rotation, for proper oil delivery and for absence of leaks. Bleed the pump via the pressure gauge connection, for example.

Pump Output Diagram



Electric oil pre-heater



Electric oil pre-heater

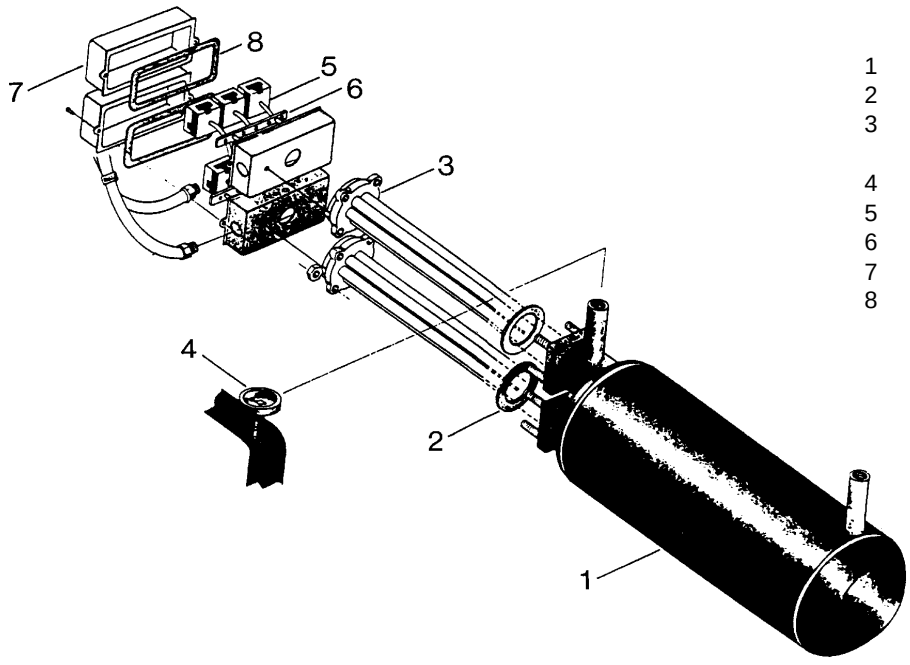
Type NE 622	12 kW
Type NE 1032	20 kW
Operating pressure	max. 40 bar
Regulating thermostat	60-160 °C

Two electric heating elements rated 6 kW and 10 kW each are installed in the pre-heater.

Functional description
The pumpable fuel oil enters the pre-heater at the top, flows through the 2 heating elements from outside to inside or from front to rear and is heated up to the final temperature set at the regulating thermostat.

A temperature limiter set to maximum temperature is fitted as a safety feature.

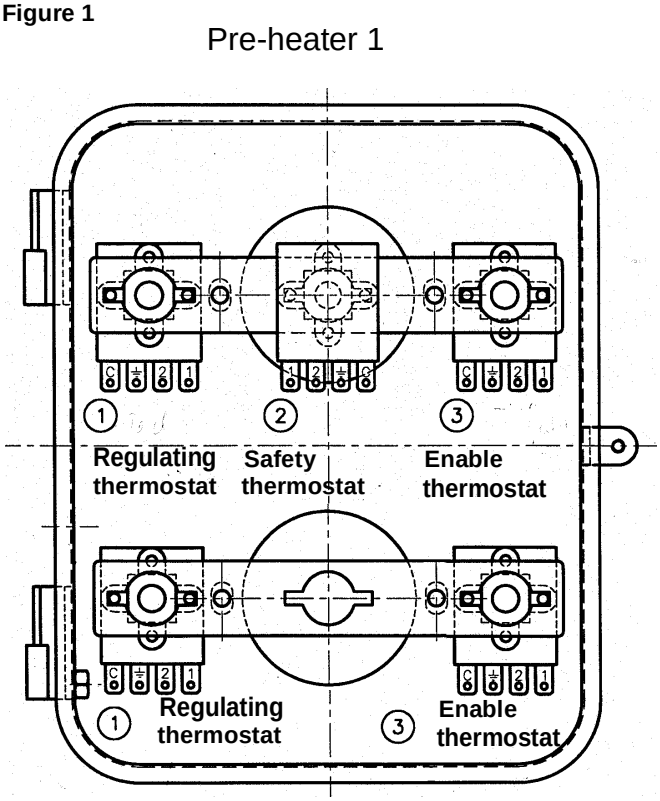
Electric oil pre-heater



1 Pre-heater housing
2 Heating element seal
3 Heating element
2 x 6 kW / 2 x 10 kW
4 Thermostat controller
5 Safety thermostat
6 Mounting element (thermostats)
7 Thermostat housing
8 Thermostat housing seal

Thermostat Setting

Figure 1



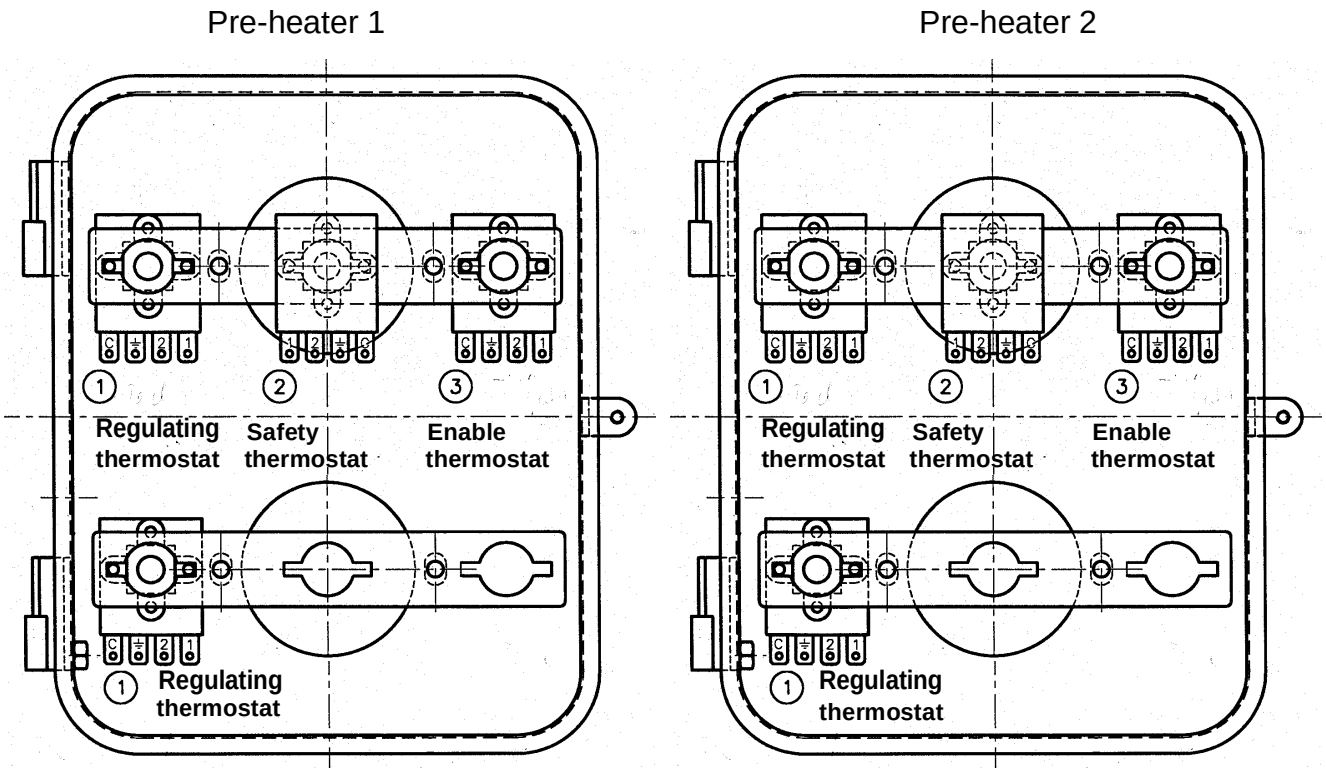
Thermostat setting

Figure 1 shows the factory setting in °C for the thermostats used with **burner types EK 6/EK 7 GS-R / E with one pre-heater.**

Figure 2 shows the factory setting in °C for the thermostats used with **burner types EK 8/EK 9 GS-R / E with two pre-heaters.**

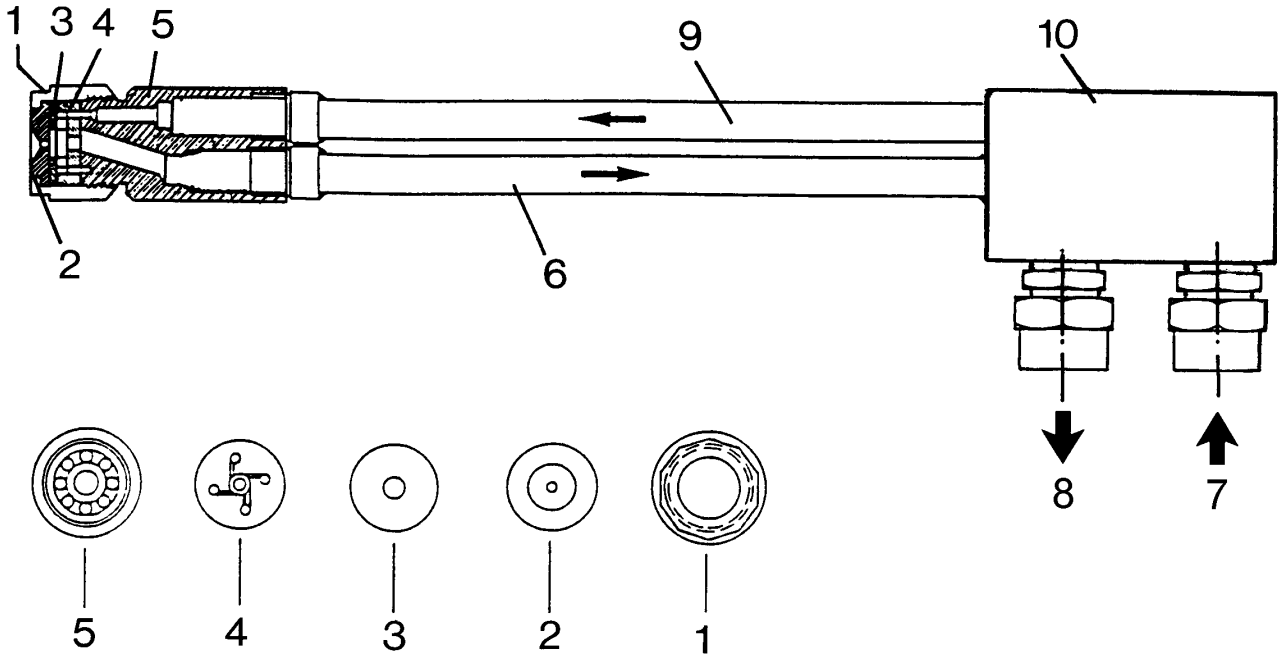
The temperature should be adjusted in accordance with the oil grade used. The viscosity on the oil nozzle should be approx. 15-20 cSt; see Viscosity Diagram.

Figure 2

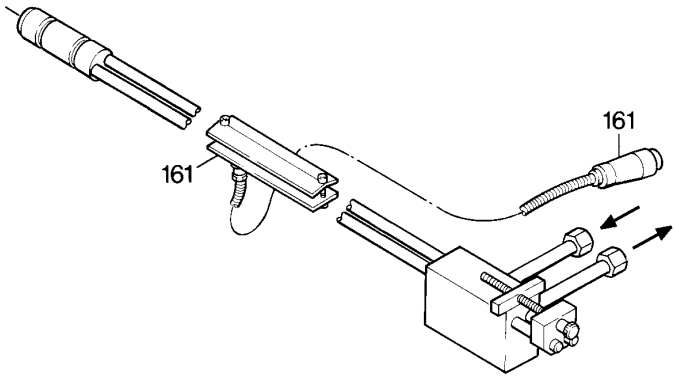


Return Nozzle Rod MAT

Functional description
The oil delivered by the burner pump will enter the feed pipe (9) via the connection block (10).
Then it flows through the feed pipe (9) at the pre-set pressure directly to the return nozzle. Part of the oil delivered will be returned through the return flow pipe (6) via the return flow hole of the nozzle.
The return flow rate is controlled according to the required output using an output pressure control valve.
Approved shut-off valves are installed directly upstream of the inlet to the nozzle rod in the oil feed and oil return lines.



1. Union nut
2. Nozzle plate
3. Intermediate plate
   (is only used for special combination of nozzles)
4. Swirl chamber
5. Nozzle rod
6. Return pipe
7. Feed flow
8. Return flow
9. Feed pipe
10. Connection block



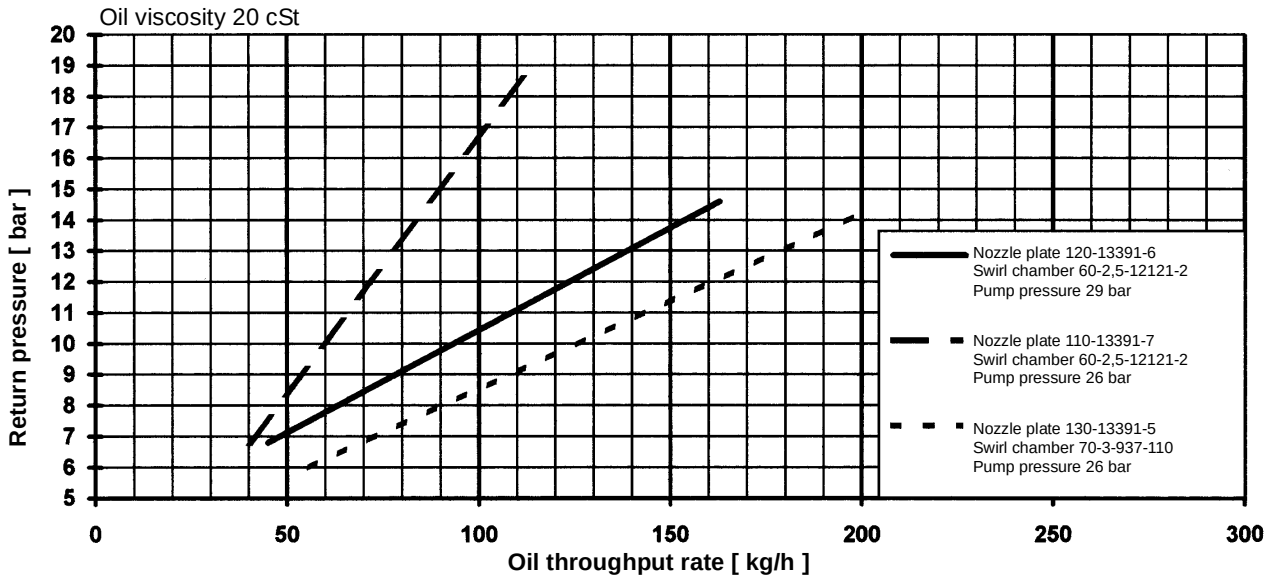
Heat tracing line for nozzle rod
The heat tracing line (Item 161) is mounted on the nozzle rod in a way that the feed pipe and return pipe are constantly heated.

Heat tracing system	Rating
EK 60	100 W
EK 7 - 9	150 W

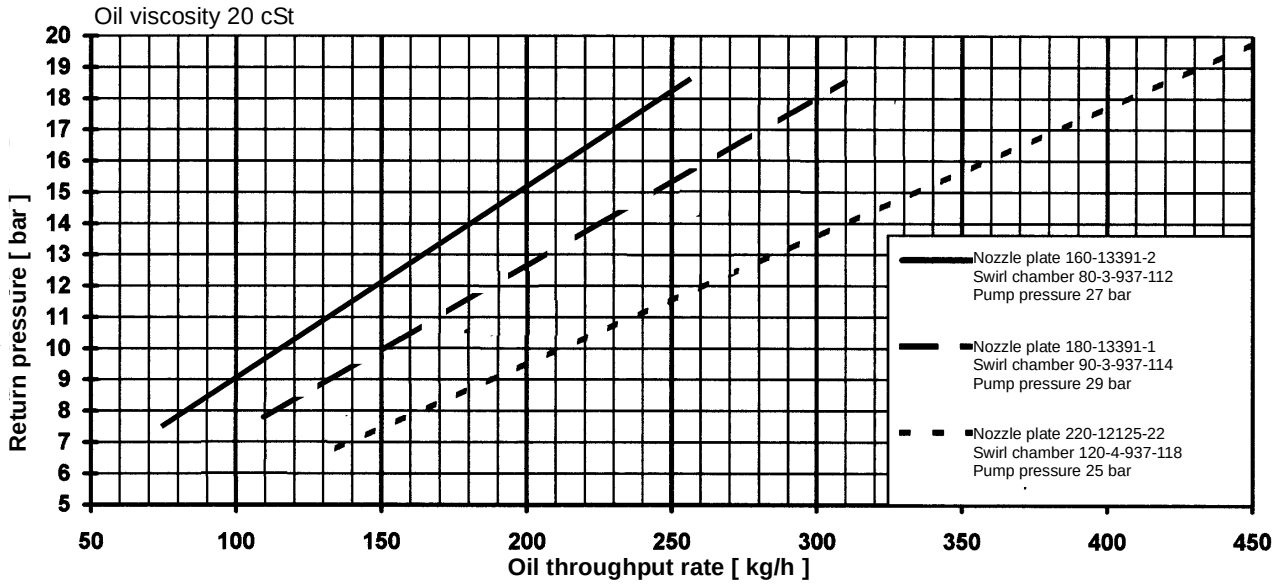
Nozzle Output Curves

EK 6... S-R / GS-R/E
EK 7... S-R / GS-R/E

Nozzle output curves EK 6... S-R / GS-R/E



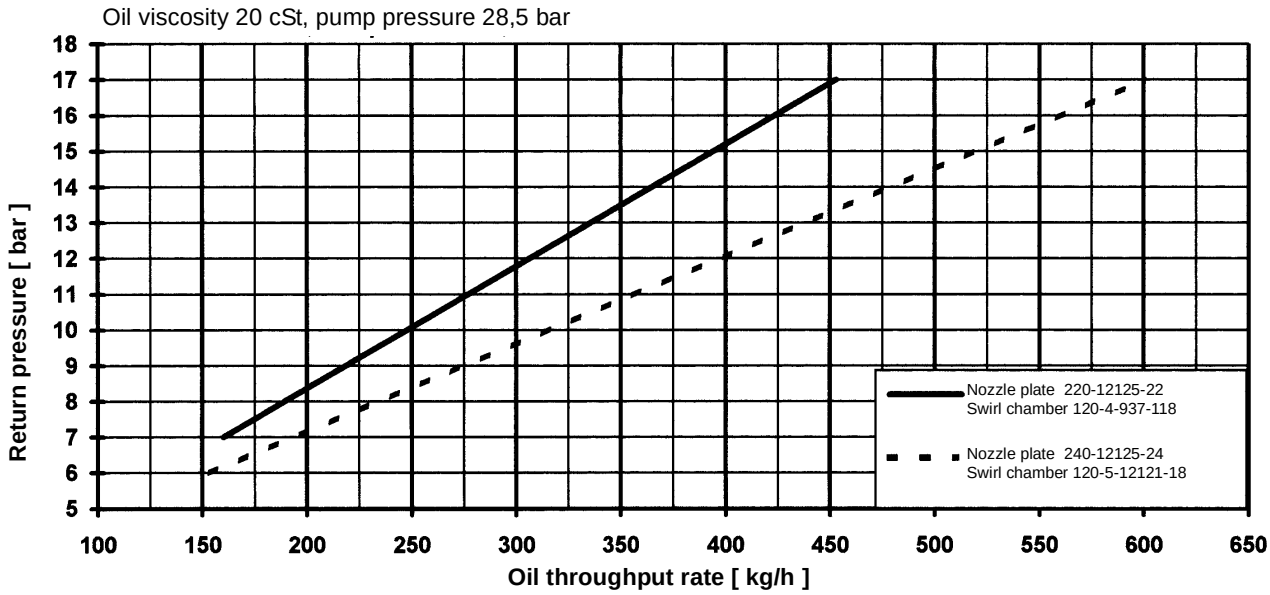
Nozzle output curves EK 7... S-R / GS-R/E



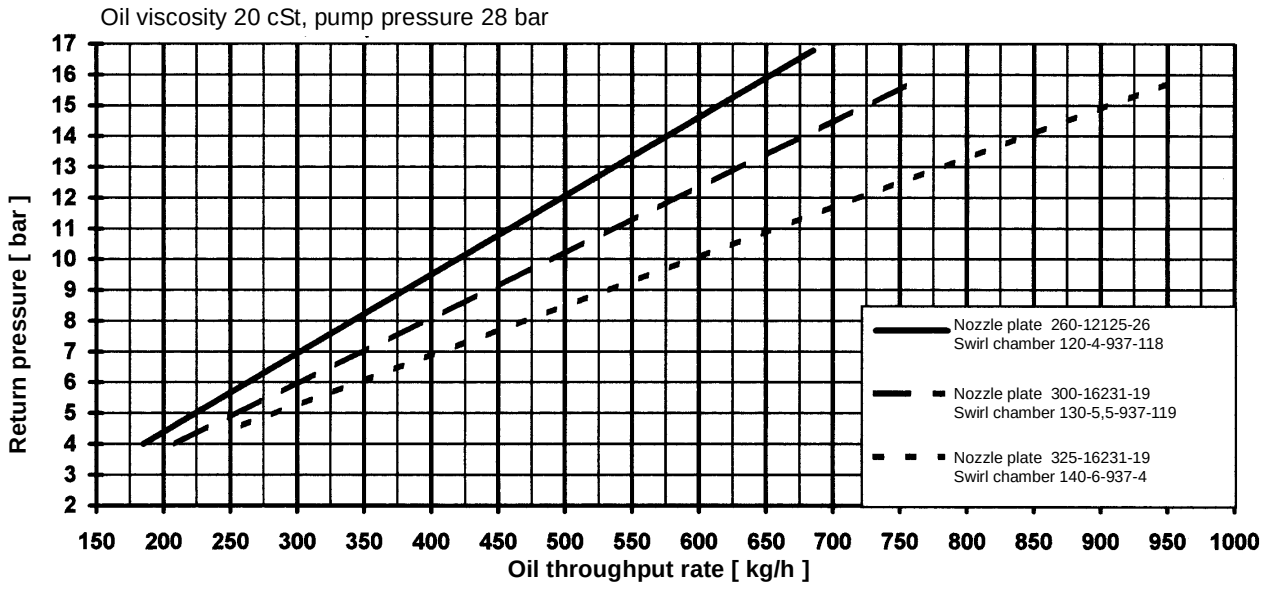
Nozzle Output Curves

EK 8 / 9... S-R / GS-R/E

Nozzle output curves EK 8... S-R / GS-R/E



Nozzle output curves EK 9... S-R / GS-R/E

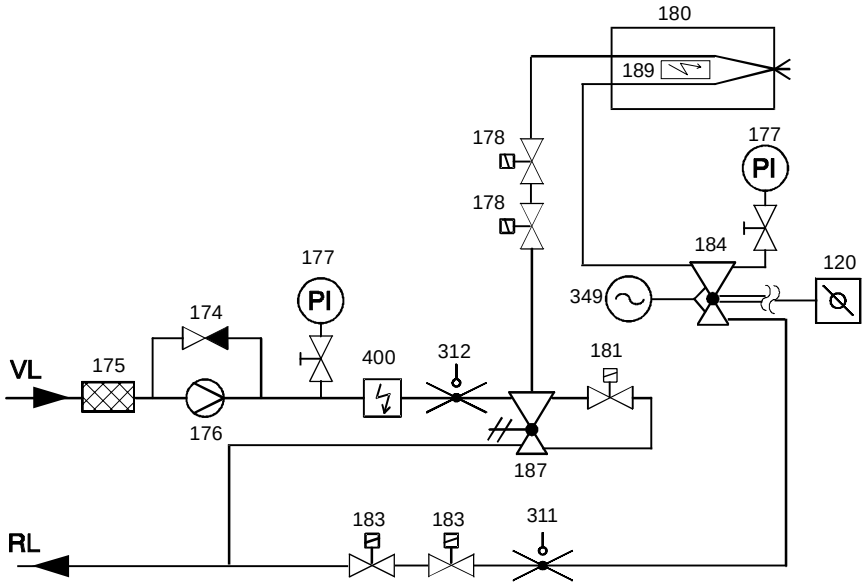


Oil Burner Operation
Hydraulic Diagram

Functioning of the steplessly adjustable heavy oil burner
The pumpable heavy oil is fed to the burner pump by an oil feed pump (Item 176) via the ring line, the gas-air separator and the daily service tank. The burner pump will flush the heavy oil heated up in the pre-heater (Item 400) via the flushing valve (Item 181) and the pressure control valve (Item 187) to ensure a viscosity suitable for combustion. After the preset oil temperature has been reached the flushing valve (Item 181) will be closed. The oil pressure control valve (Item 187) installed downstream of the burner pump will keep the atomizing pressure at a constant level (approx. 25-30 bar) according to the overflow principle.
The pump pressure should be set 2-3 bar higher to compensate for pressure losses in the nozzle rod (Item 180), the pre-heater and the solenoid valves (Item 178). The nozzle rod has a feed and a return connection. The return pipe incorporates 2 solenoid valves (Item 183) and an output pressure control valve.

After the solenoid valves (Item 178) in the feed line to the nozzle rod has opened, the minimum output of the burner is selected by setting the minimum return pressure (3-9 bar) on the output pressure control valve (Item 184) accordingly.
When setting the compound controller to maximum output, the return pressure setting (approx. 13-20 bar) will be increased according to nozzle size. This return pressure will now dictate the maximum output of the return nozzle in accordance with the nozzle output curves and the nominal output of the heat generator. Simultaneously with the oil flow rate control, an air flow rate controller incorporated in the compound controller will adjust the air flow rate required for the combustion of the selected oil quantity.
When using the nozzle rod type DG 75 with shut-off valves in the feed and return lines, the system can be configured without a solenoid valve (Item 178) and a solenoid valve (Item 183) each.

Hydraulic diagram



120 Air damper
175 Filter
176 Pump
177 Pressure gauge with stop valve
178 Feed solenoid valve (115 V)
180 Nozzle rod MAT
181 Flushing valve
183 Return solenoid valve (115 V)
184 Output control valve
187 Pressure regulating valve
189 Electric heating tracer
311 Return oil pressure switch
312 Feed oil pressure switch
349 Actuator, mechanical compound
400 Pre-heater (Option, pre-heater can be installed external)

Always 1x 178 und 1x183 electrical connected in-line

Checking Procedure

Check the following prior to the initial operation of the boiler system:

- Take care to observe the operating instructions supplied by the boiler manufacturer. The boiler must be mounted ready for operation.
- Ensure that the heating system is filled with water to capacity.
- Check the complete system for correct electrical wiring.
- Check the burner motor for correct direction of rotation.
- Check for the proper setting of the temperature and pressure controllers, limiters, safety switches and electrical limit switches.
- Bleed the fuel-carrying lines (make sure they are free of air).
- Check tank, lines and oil pump are filled with oil and correct oil nozzle is fitted.
- Check the oil hydraulic system is free of leaks.
- Check the exhaust gas ports are opened and adequate fresh air intake is ensured.
- With burner in starting position check that air damper is in „CLOSED“ position.
- Check that automatic furnace controller is unlocked and in its original position.

Oil start-up
Open all shut-off valves of oil supply system.

- Fill pump with oil.
- Set fuel selector switch to its „Oil“ position.
- Mount pressure gauge in the feed line and return line.
- Mount the pressure gauge for checking the pump suction pressure.

Bleeding
Shortly start the burner and check for proper direction of rotation. Bleed the oil line and oil pump.

CAUTION: The hydraulic system has been filled with test oil by the manufacturer. This may cause ignition trouble when initially operating the system. To protect the pump, the oil pressure controller is factory-set at zero pressure. When starting the burner take care to increase the oil pressure slowly to the operating level.

Checks before start-up

Check direction of rotation of the burner motor and/or burner pump.

Checking of the direction of rotation of the burner motor (direct on-line starting) is carried out by pressing the contactor.

With Star-Delta connection the mains and the star contactor must be operated simultaneously.

The direction of rotation of the burner motor is correct if the ventilator impeller turns in the direction of the mixing unit.

The correct direction of the oil pump can be determined by the stamped directional arrow.

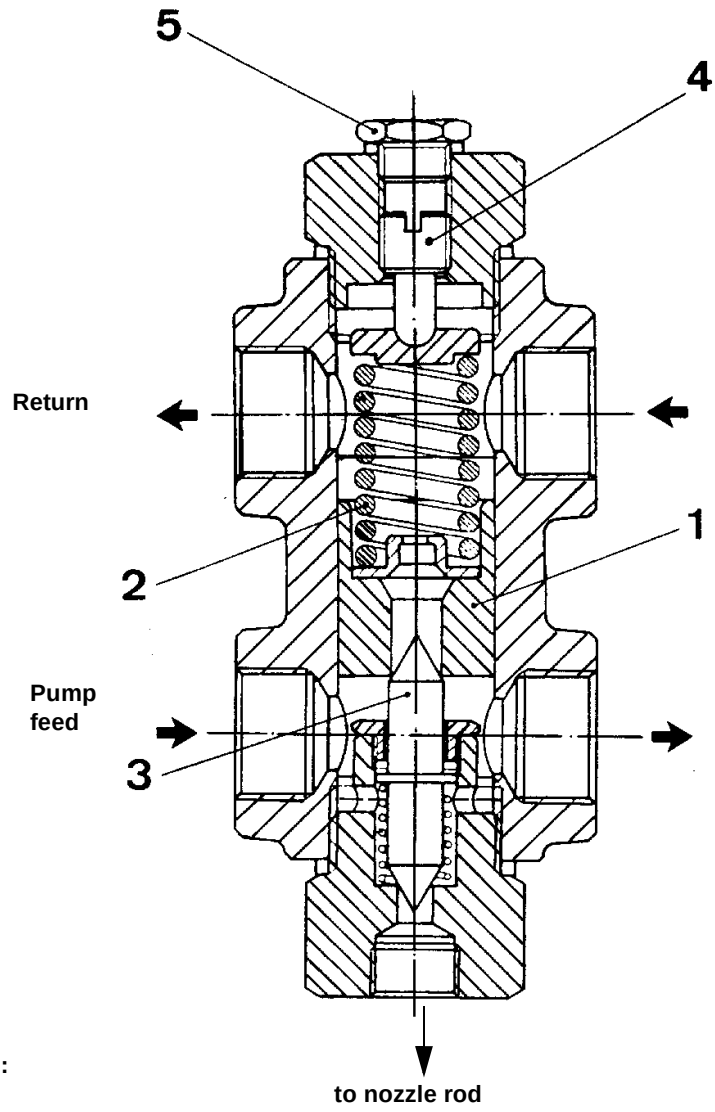
Ensure a functional check of the burner program procedure is carried out before the first fuel flow release.

- Disconnect the oil solenoid valve in the feed line (see electrical circuit diagram).
- Start the burner and check that the program process follows the described sequence for starting up:

1. Blower
2. Air valve, pre-aeration
   Check limit switch setting
3. Air pressure control
4. Air valve to partial output
   Check limit switch setting
5. Ignition
6. Open valves
7. Shut-down on fault at the end of the safety period (see automatic furnace controller)

- Unlock the automatic furnace controller.

Pressure Control Valve in Feed Line



Items:

1 Piston
2 Spring
3 Valve cone
4 Regulating screw
5 Screw cap

Pressure control valve

The pressure control valve has been provided for setting the pump pressure in the feed line.

A piston (1) movably arranged in a cylinder is pressed against the valve cone (3) by a spring (2). As the pressure on the side of the valve cone rises above the spring pressure, the piston will be lifted and the oil caused to flow over to the pressureless side.

For the installation of overflow valves of this type the following general information should be observed:

The spring side (spring can be seen from outside) must in any case be chosen to be the return side, i.e. the pressureless side. Consequently, the direction of overflow is from the pressurized side to the pressureless spring side.

Any counterpressure on the return side must thus be added to the selected spring pressure setting.

It is of no consequence for the operation of this type of valves whether they are mounted in continuous lines or at line ends.

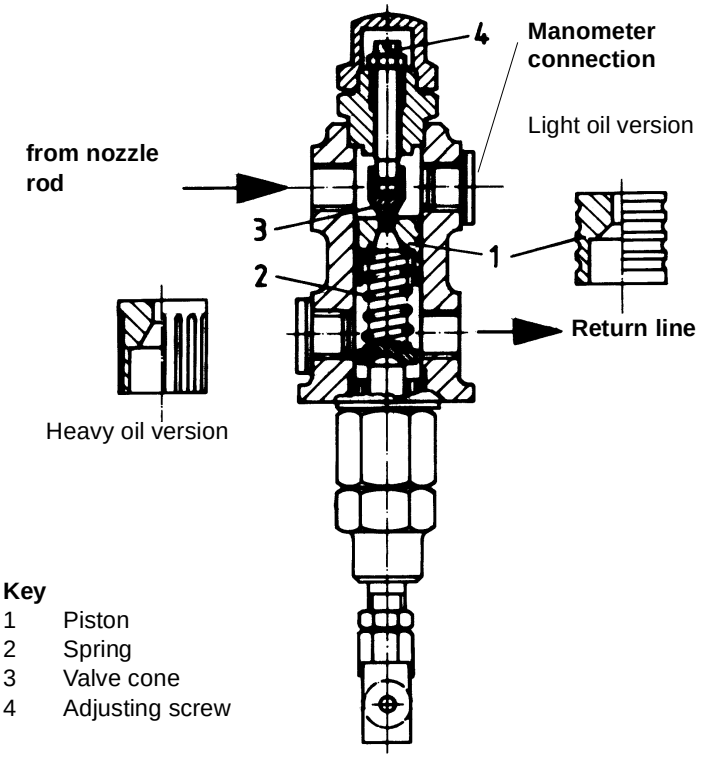
Pressure setting
Proceed with screwing out the screw cap (5) to allow the desired pump pressure to be selected with setscrew (4). Turn the screw clockwise or counterclockwise to increase or reduce the pressure, respectively.

Flushing process (see hydraulic diagram):
During the flushing process the solenoid valve (178) will be in its closed position while the solenoid valve (181) will be open. This causes the heavy fuel oil to flow via the pressure control valve (187) into the return pipe so that a closed-circuit flushing process will be ensured.

Start-up
Mechanical Compound Control

Output Pressure Control Valve in Return Line

Output pressure control valve



Key

1	Piston
2	Spring
3	Valve cone
4	Adjusting screw

The output pressure control valve installed in the return line will set the oil flow rate to the level required for providing the necessary nozzle and burner output.

Pressure setting:
The return oil flows into the pressure chamber of the output pressure control valve (Item 184 in hydraulic diagram), which is situated between the piston (1) and the valve cone (3). Situated on the outlet side is the spring (2). Depending on the burner output, this spring is compressed to a greater or lesser extent by the shaft supported in the guide bush.

A higher pressure on the spring will increase the pressure in the return line and thus result in a higher nozzle output.

The basic setting (see "Setting Instructions") is selected by means of the adjusting screw (4). The screw must be turned clockwise for increasing the pressure and counterclockwise for reducing it.

Start-up
Mechanical Compound Control

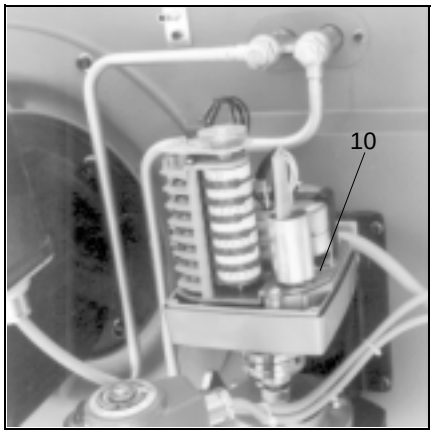
Oil/Air Flow Rate Adjustment

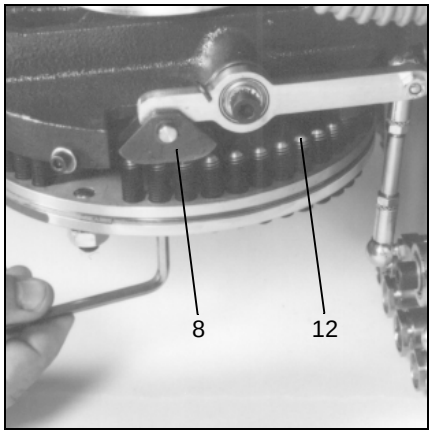
Oil flow rate adjustment

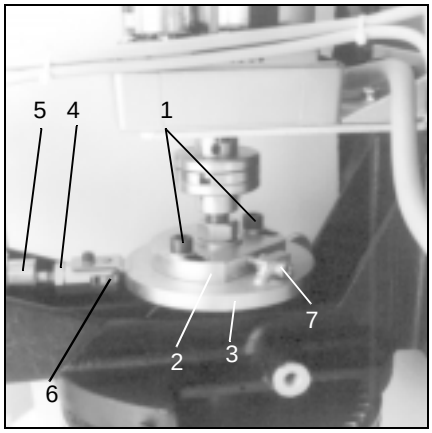
1. Proceed with removing the protective hoods from the SQM actuator and compound controller. Start the burner. Turn off the control system to ensure the compound controller remains in its minimum output position. After the ignition proceed as follows:
   Check the furnace and readjust the air flow rate according to the air flow rate adjusting instructions. Turn clockwise to increase the air flow rate.
   Turn counterclockwise to reduce the air flow rate.
   Loosen the two locking screws (1) of the eccentric disk (3) so that this can be rotated eccentrically relative to the carrier disk (2). Loosen the counter nut (4), adjust the support (5) until the ball bearing (6) of the pressure regulator valve makes contact with the eccentric disk (3). Make sure during the adjustment of the pressure regulator valve and thereafter to observe the combustion process. Care should be taken that the burner is not operated with insufficient air flow rate.

NOTE: Adjust the air pressure switch after the burner has been started (see section entitled „Air Pressure Switch"). If the air pressure switch is set at too high a pressure level this may lead to burner shut-off. Reduce the pressure setting of the air pressure switch if required.

2. **Measuring the low-load oil throughput rate**
   a) either with oil counter or
   b) by way of return pressure and nozzle diagrams
3. **Adjusting the low-load oil throughput rate**
   For this purpose, turn the support (5). If the pressure is too high, turn the support into the shaft to reduce the length of shaft and support. Proceed in reverse order if the pressure is found to be low. While doing this, observe the combustion process and readjust the air flow rate as required.
4. **Increasing to maximum load in steps**
   Increase the burner output to maximum load in small steps while observing the combustion process at the same time. Readjust the air damper if required.
5. **Adjusting the „Oil max." limit switch at about 120°.**
   Turn the compound controller until the slide block (8) is in a position approximately opposite to the second last setting screw. Check that the „Oil max." limit switch operates in this position.
6. **Measuring the full-load oil throughput rate**
   a) either with oil counter or
   b) by way of return pressure and nozzle diagrams
7. **Adjusting the full-load oil throughput rate**
   If the return pressure is found to be too low it will be required to increase the amount of lift by means of setting screw (7).
   Turn clockwise to increase the oil flow rate.
   Turn counterclockwise to reduce the oil flow rate.
   While doing this, observe the combustion process and readjust the air flow rate if required.
8. Each time the cam disk has been changed make sure to readjust the minimum pressure of the output pressure regulator valve in the low-load position. After this adjusting work, turn the compound controller into its maximum position again, read the return pressure, and return it to its minimum position. Repeat this operation until the correct minimum and maximum pressure settings have been achieved. Alternatively, the rocker arm (10) of the actuator may be changed over to disconnect the drive from the control element so that the compound controller plate can be moved by hand.







NOTE: The compound controller does not have a mechanical stop member. It must not be turned beyond the limits of the setting screw ranges.

Air flow rate adjustment

The cam plate of the compound controller is factory-set so that the air dampers are fully opened in maximum load position and closed in minimum load position. For the fine adjustment of the air flow rate according to the oil throughput rate, proceed with the minimum oil throughput rate and increase the compound controller setting step by step while at the same time selecting the air flow rate by means of the setting screws as required for the hygienically sound combustion of the oil. Turning clockwise will increase the air flow rate. Turning counterclockwise will reduce the air flow rate.

After the last step when the maximum oil pressure has been reached, proceed by reducing the compound controller setting step by step again and check the flame and the combustion data at the same time.

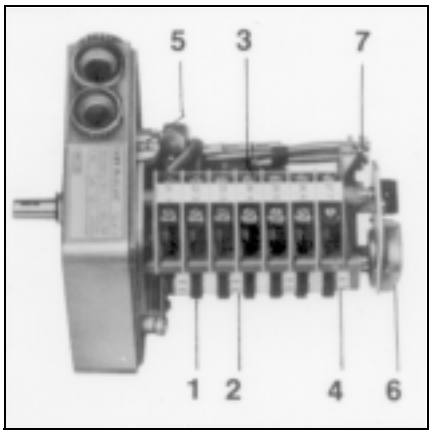
Adjusting Instructions
Mechanical Compound

Electrical Actuator
Limit Switch Setting

Technical data SQM actuator

Voltage	230 V -15% 50 / 60 Hz 240 V +10% 50 / 60 Hz
Power input	9 VA
Max. contact load	250 V 10 (3) A
Mounting position	as required
Ambient temperature	-20°C + 60°C
Protection classification	IP 54, DIN 40050
Weight	1,7 kg

	SQM10/11	SQM20/21
Running time at 130° turning angle	42 Sek.	66 Sek.
Torque	10 Nm	20 Nm



Positions

1 Cam plate
2 Scales for switching point setting
3 Terminals
4 Actuator position indicator
5 Rocker arm for uncoupling
6 Return potentiometer
7 Connection for „N“

Description

The SQM actuator is intended for use with two-stage sliding or modulating oil, gas or dual-fuel burners. The reversible actuator is fitted with a synchronous motor which drives a shaft via a gearbox. The shaft end carries a coupling to drive the fuel and combustion air controlling element.

The SQM actuator has been designed for dual-wire control by controller or switching units with change-over contacts. Potentiometers can be installed for a range of applications on customer's request.
The 60 Hz frequency will reduce the running times by approx. 17 %.

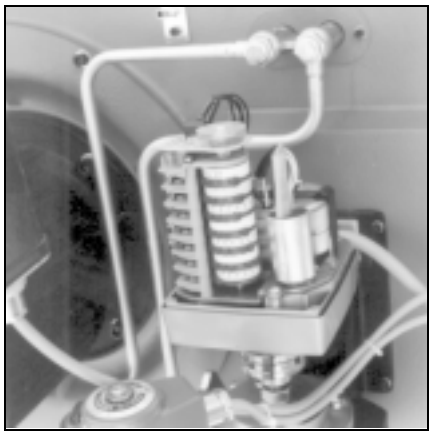
Limit switch factory setting

Description	Pre-setting	Function
II	0°	Air dampers closed
III	30°	Oil min.
I	130°	Oil max.
IV	20°	Gas min.
V	130°	Gas max.

The limit and auxiliary switches are set by means of manually adjustable latching cam plates. Scales are fitted between the disks to facilitate the selection of the switching points.
The cam plates are provided with a small pointer for indicating the switching point of a scale between the setting ranges.
An additional scale fitted to the end of the cam roller serves to indicate the position of the actuator.

The drive unit may be disconnected from the controlling element by changing over a rocker arm mounted to the gearbox. This will allow any desired position of the controller plate to be selected by hand. Drive and output will be coupled in the vertical position of the rocker arm.

The fuel-air curve should be set over the full range of the cam plate so that operating safety will be retained also when the limit switch is overrun.



Flushing and Oil Feed Start Thermostat ATH 22

Technical data
Setpoint adjustment:
For code 1:
Adjust switching point from outside by turning the setpoint screw accordingly.

For codes 2, 20, 7, 70:
Remove the top of the housing and adjust the switching point by turning the setpoint screw with a screw driver watching the interior scale.

Adjusting range: 20-150°C

Maximum switching current:
AC 250 V, 10(2) A, cosφ=1(0.6)
DC 250 V, 0.25 A

Switching difference in measuring system filled with liquid
TR, TW 3+1% standard feature
6+2% on request
1.5 ± 0.5% against extra price

Permissible ambient temperature on switching head and remote line
in use filled with liquid or gas max. +80°C

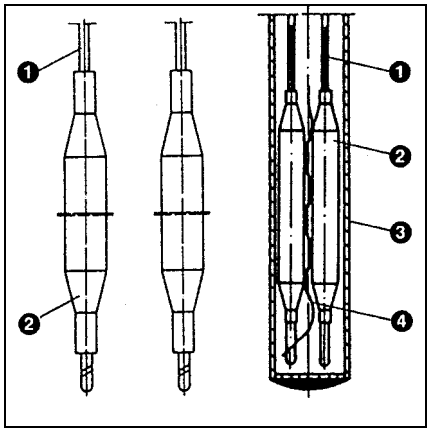
Operating fluid
water, oil, air, superheated steam

Protection classification
EN 60 529-IP54

Operation
The surface-type dual-thermostat works according to the principle of volumetric expansion. If the temperature of the fluid in the sensor system consisting of sensor, capillary line and membrane changes this will also cause the volume to change. The resultant lifting movement of the membrane will actuate the quick-break switch via a lever.

Switching function TR/TW/STW(STB)
If the temperature available at the temperature sensor exceeds the limit setting this will cause the switching ram of the microswitch to be relieved of load via the sensor system and the electric circuit opened or closed. In case the temperature falls below the limit setting (by the switching difference) the microswitch will be returned to its initial position.

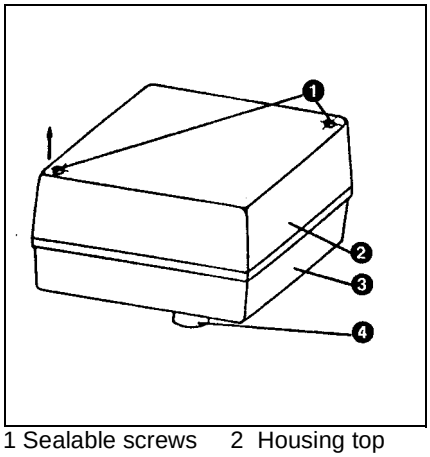
Temperature sensor with and without protective sleeve
The temperature will be sensed by means of the temperature sensor. Make sure the temperature sensor is immersed in the fluid over its full length because otherwise the switching point may be subject to larger variations.



1 Remote line 2 Temperature sensor
3 Protective sleeve 4 Pressure spring

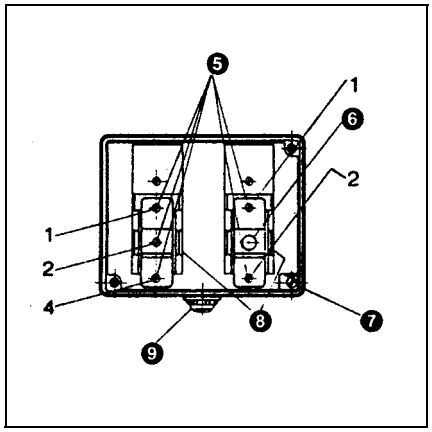
For code „f“ and connection mode „Ü“ the temperature sensor will be locked by fitting a clamp to the capillary line and securing the same by a screw in the extended sleeve opening. For codes „f“ and connection modes B, C, D, E, ES, Q and V the sensor is locked by the manufacturer by means of the terminal attached to the capillary line.

Electrical connection
1. Opening the housing
Remove the two sealable fillister-head screws (1) at the housing top (2) and remove the latter.



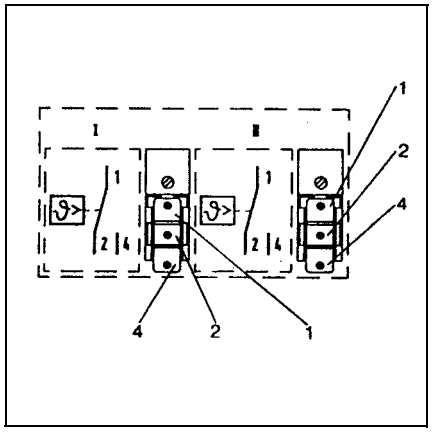
1 Sealable screws 2 Housing top
3 Housing bottom 4 Housing journal

2. Connection
Feed the line through the self-sealing grommet Pg 11 and connect as shown on the connection diagram. The connection diagrams relating to the thermostats are fixed to the inside of their housing tops.

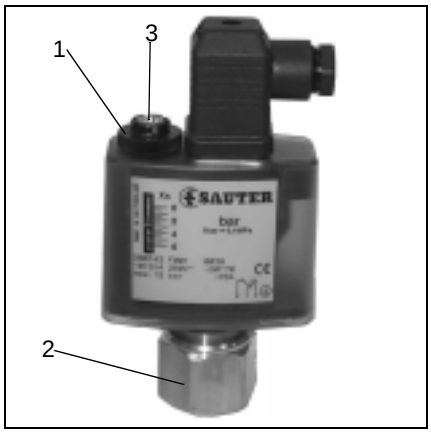


5 Terminal screw
6 Restart button (must move freely)
7 For type attachments s, g and b
8 For type attachment r
9 Self-sealing grommet Pg 11

Connection diagram
Codes 11, 12, 22, 120, 220, 2020
System I and II with change-over contact.



Oil Pressure Switch (Option)
Air Pressure Switch



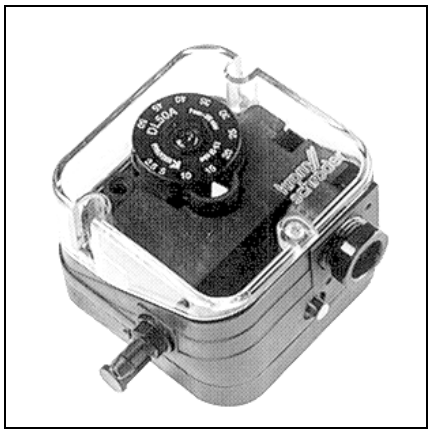
Oil pressure switch
Oil pressure switches are provided to burners for monitoring the oil pressure. Depending on the burner design, the oil pressure switches can be installed either in the return line only or in both the return line and feed line. The cut-out pressure will be selected depending on the burner system data (ring line pressure, oil nozzle, etc.).

Oil pressure damper
An oil pressure damper or a capillary pipe may be installed in the connection fitting (2) to make up for oil pressure variations.

Operating pressure adjustment
For adjusting the operating pressure, remove the setting know (1) by pulling it upward and reinstall it again the other way round. After the adjustment has been completed make sure to install the setting know in its original position again.

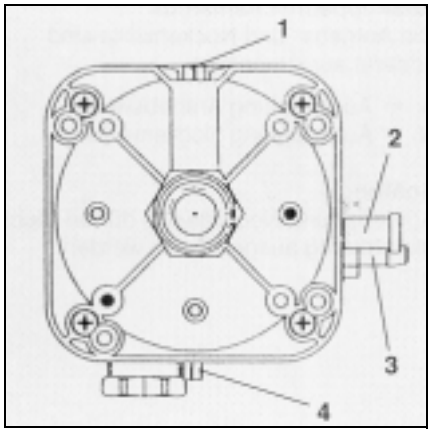
Switching difference
The switching difference may be selected on the pressure switches within the limits shown in the table. For the adjustment, turn the threaded pin in the set screw (3) for the switching point. One turn will change the switching difference by approx. 20 % of the total range of the switching difference. The oil pressure switch has a facility for attaching a seal.

Type	Setting range	Switching difference	Location
DSB 143 F...	0 - 6 bar	0,3 - 1,6 bar	Return line acc. to DIN / EN
DSB(F) 170 F...	15 - 40 bar	1,2 - 4,5 bar	Feed line acc. to DIN/EN in pumps without quick-action stop valve
DSF 146 F...	0 - 10 bar	0,5 - 2,5 bar	Return line acc. to TRD 604/ 72h
DSB 158 F...	3 - 25 bar	1,0 - 4,3 bar	Feed line acc. to TRD 604/ 72h



Air pressure switch
The air pressure switch is provided for monitoring the pressure of the combustion air fan.
The pressure switch DL 50A has been designed for switching on, off or over an electric circuit in the case of changes of the actual pressure levels from the set-point setting. The pressure switch DL 50A can be used as overpressure, vacuum or differential pressure monitor for air and non-aggressive gases but not for gases according to DVGW Worksheet G 260/l.

Certification
The pressure switch has been tested in accordance with DIN 3398 Part 2 and is registered by CE/DIN-DVGW. It has been registered in other important gas consumption countries.



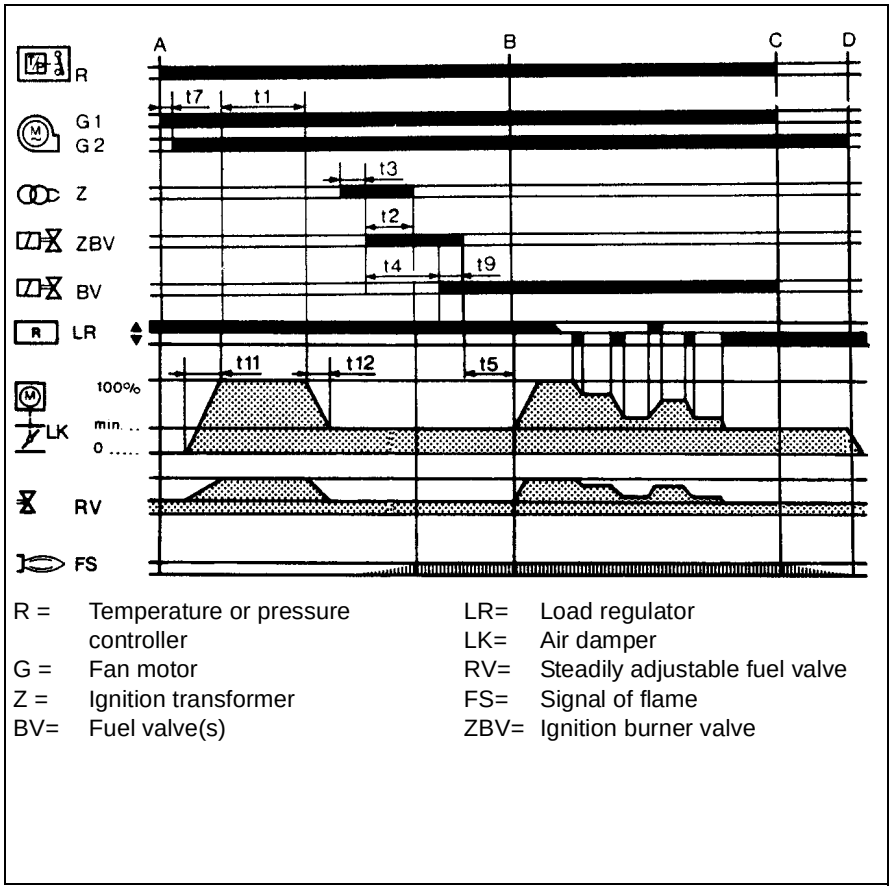
Determining the differential pre-flushing pressure and adjusting the differential pressure switch
- Burner in the pre-aeration phase.
- Measure pressure on test connection (2).
- Measure vacuum on test connection (3).
- Add the measured pressures.
- Set the scale to 90% of the calculated value.

Switch function test
Test buttons are provided to check the switch functions for proper operation (with safety cut-out and interlock). The burner is normally run in partial-load condition when testing the safety functions. On pressing button (4) the vacuum will be removed which causes the differential pressure to drop below the required level. If it is necessary to test the pressure switch functions under full-load conditions this may be done by pressing button (1).

Automatic Furnace Controller LFL 1... / LGK 16...
Regulator KS 92

The automatic furnace controllers LFL... and LGK 16... are designed to control and monitor burners of stepping or modulating mode of operation. For a detailed functional description of the automatic furnace controllers with technical data and design information see the enclosure hereto and further descriptive material:

LFL 1...-7451 D
LGK 16...-7785 D



R = Temperature or pressure controller
G = Fan motor
Z = Ignition transformer
BV= Fuel valve(s)
LR= Load regulator
LK= Air damper
RV= Steadily adjustable fuel valve
FS= Signal of flame
ZBV= Ignition burner valve

Functional diagram
LFL 1... / LGK 16...

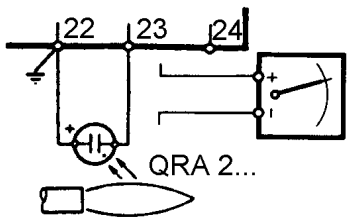
A = Starting type interval
A-B= Flame development interval
B = Burner has reached operating position
B-C= Burner operation (heat generation)
C-D= regular shut-off
t1 Pre-ventilating time
t2 Safety time
t3 Pre-ignition time
t4 Fuel valve enable
t5 Load regulator enable
t11 „OPEN“ run time of air damper
t12 „CLOSE“ run time of air damper

In steplessly variable burners use is made of the KS 92 industrial controller. This has specifically been designed for use with furnace systems, preferably for temperature and pressure controllers in conjunction with burners featuring steplessly variable fuel throughput rates. For adjusting the controller to the controlled condition, the desired set-point range and the way of detecting the actual value, the software configuration is structured accordingly.

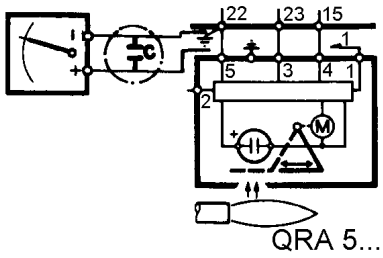
Technical documentation
KS 92 PMA

Flame Monitor
Sensor Current Measurement

Autom. furnace controller LFL 1...
UV sensor with QRA 2...



Autom. furnace controller LGK 16...
UV Sensor with QRA 5...



Flame monitor with UV sensor
The UV radiation of hot flame gases is utilized for generating the flame signal. The radiation detector used is a UV-sensitive tube with two electrodes and being live all the time. This UV tube will ignite when subject to light from the 190-270 nm range of the spectrum and thus cause a current to flow to the flame signal amplifier.
The UV tube will not respond to the after-glowing refractory lining of the furnace, sunlight, daylight or light of the boiler room lighting system.
The service life of the UV tube is about 10,000 hours at ambient temperatures up to 50°C; higher ambient temperatures will considerably reduce its service life.

Burners operated continuously or intermittently for more than 24 hours without interruption (e.g. boiler sequence control) or burners operated on steam boilers must be equipped with the automatic furnace controller of type LGK 16... and its associated self-controlling flame monitoring circuit (QRA 5...).
For data and design instructions refer to automatic furnace controller:

LFL 1...	No. 7451 D
LGK 16...	No. 7785 D

UV current measurement with QRA 5
For an accurate UV current measurement it is recommended to make use of the **tester KF 8832**. If a normal meter (microammeter) is used for UV current measurement it is advisable to make the measurement as shown in the figure. For this, a capacitor
C = 470 µF, 15V (or with higher electric strength) must be integrated in the measuring circuit.
Meter: 100 µA/Ri = 3 kΩ
Connect the meter between the automatic furnace controller and the UV flame sensor QRA 5... (terminal 22 (-) and 5 (+)).
Take care to observe the right polarity.

Alignment of the UV sensor QRA 5...
The mounting flange is movable supported on the sensor tube to allow the exact alignment of the sensor window relative to the direction of incidence of the UV radiation.

NOTE: The terminal (22) must be connected to earth all the time.

Cleaning the sensor
Check the UV sensor window for possible accumulation of dirt at regular intervals and clean if required. Take care the sensor window is free of dust all the time.
If upon cleaning the sensor does not properly work it will be required to replace it by a new one.

Sensor currents

Automatic controller	Minimum required	Maximum possible
Monitor	with UV	with UV
* LFL 1...	70 µA	630 µA
* LGK 16...	**	**

Recommended instrument range:
UV monitor 0 - 1000 µA

* See technical data for automatic furnace controller LFL 1 / LGK 16...

** See data on unit KF 8832 for sensor current measurement.

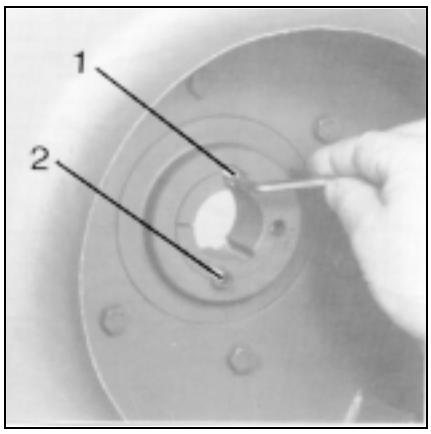
Burner Maintenance
Fan Impeller

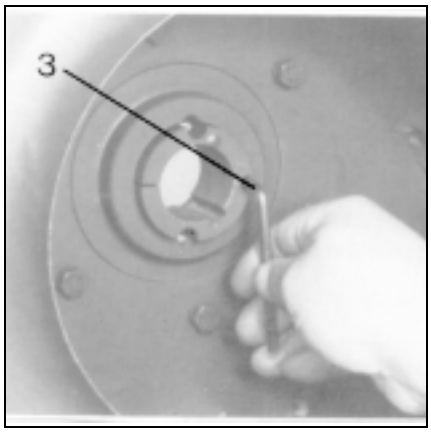
Furnaces should be inspected once a year. An extract from DIN 4755 reads as follows:

„To ensure a high operational readiness, functionality, safety and economic efficiency, the user should have the boiler system inspected by an authorized person of the manufacturer or other specialist once a year. The whole system must be checked for proper operation and faults detected should be rectified without delay. It is advisable however to make another inspection of the system in addition to the one specified herein.“ The inspection should comprise the following work:

1. Inspect the boiler internals and insulating packages and replace by new ones if required. Check boiler for possible accumulation of dirt.
2. Remove the nozzle, check it and replace it by new one if required.
3. Clean the ignition electrodes.
4. Check the ignition electrode and spark functions and readjust if required.
5. Clean the burner interior and exterior.
6. Clean the fan impeller.
7. Check the fan impeller for possible deformation and cracks.
8. Clean the flame sensor.
9. Clean the filters and screens.
10. Check the electrical connections.
11. Check the flame tube and retarder disk/swirl element (replace if required) and check the burner head setting after such replacement
12. Check the control equipment for proper operation, setting and safety period.
13. Check the pressure switch for proper setting and operation.
14. Check the oil pump by measuring its pressure and vacuum levels.
15. Check the hydraulic oil system for absence of leaks.
16. Check the oil hoses for possible damage and twisting.
17. Clean the air damper and check for smooth operation.
18. Check the combustion process and make exhaust gas tests:
    - Fuel throughput rate adjustment
    - Heating chamber temperature (intake temperature)
    - Exhaust gas temperature
    - Pressure in combustion chamber and exhaust gas pipe
    - CO_2 and O_2 contents of exhaust gases
    - CO test, soot test
    - UV sensor current measurement
19. Enter measured data in test record.

Important instructions:
With serious contamination or when cleaning cloths or other items are sucked in, there is a danger that imbalances will occur which, in extreme cases, could lead to Deformation of and crack formation on the impeller. The same can happen with defective ball bearings on the blower motor, which can cause an imbalance of the motor shaft and transfer of this imbalance to the impeller. Should Deformation or cracks occur, the impeller must be exchanged without delay.





The fan impeller can be locked in any desired position on the motor shaft.
To ensure a high slipping moment take care that all parts to be joined are clean and free of grease.

Removing the fan impeller

NOTE:
Apply a mark on the shaft prior to removing the fan impeller to ensure it can be remounted in the same position.
An axial displacement of the impeller on the shaft can lead to a reduction of the fan efficiency with a resultant lower air flow rate.

For removing the fan impeller unscrew the bolts (Items 1 and 2) and install one of them in the hole with semi-tapped thread (Item 3) to act as a forcing screw. Tighten this bolt to force off of the bush. Remove the loosened disk unit by hand without hammer blows and taking care not to damage it.

Mounting the fan impeller
- Clean all bright surfaces and ensure they are free of grease.
- Mount disk and bush and align the holes.
- Align the two opposing bolts (Items 1 and 2) and tighten evenly.

Apply the following tightening torques:

SM 16, bush no. 1615 hub bores 28 mm and 38 mm: tightening torque 18 Nm.

SM 20, bush no. 2012 hub bores 42 mm and 48 mm: tightening torque 31 Nm.

SM 25, bush no. 2517 hub bore 48 mm: tightening torque 45 Nm.

Exhaust Gas Test

Exhaust gas test
To ensure an economically efficient and trouble-free operation of the system it will be necessary to adjust the burner specifically in accordance with the furnace system. This is achieved by means of a fuel-combustion air compound control unit which adjusts the burner to ensure a proper combustion. Exhaust gas tests are required for this purpose. The percentage CO_2 and O_2 and the exhaust gas temperature will have to be measured to determine the efficiency and combustion quality.
Prior to any measurement make sure to check the boiler and exhaust gas system for absence of leaks.

Secondary air will falsify the measured results
Check that the exhaust gases have a residual oxygen (O_2) content as low as possible and a carbon dioxide (CO_2) content as high as possible.
The carbon monoxide content of the exhaust gases must be below the currently applicable specifications in all load stages.
In the fuel oil combustion mode the permissible soot number in the exhaust gas is not allowed to be exceeded.

Ratio between O_2- and CO_2- for light oil EL (CO_2max =15,40%)

$$O_2 = 21 \times \frac{CO_{2max} - CO_{2gem}}{CO_{2max}} = \ \%$$

% O_2	% CO_2	% O_2	% CO_2
0,00	15,40	3,00	13,19
0,10	15,33	3,10	13,12
0,20	15,25	3,20	13,04
0,30	15,18	3,30	12,97
0,40	15,11	3,40	12,89
0,50	15,03	3,50	12,82
0,60	14,96	3,60	12,75
0,70	14,88	3,70	12,67
0,80	14,81	3,80	12,60
0,90	14,74	3,90	12,53
1,00	14,66	4,00	12,45
1,10	14,59	4,10	12,38
1,20	14,52	4,20	12,31
1,30	14,44	4,30	12,23
1,40	14,37	4,40	12,16
1,50	14,29	4,50	12,08
1,60	14,22	4,60	12,01
1,70	14,15	4,70	11,94
1,80	14,07	4,80	11,86
1,90	14,00	4,90	11,79
2,00	13,93	5,00	11,72
2,10	13,85	5,10	11,64
2,20	13,78	5,20	11,57
2,30	13,71	5,30	11,49
2,40	13,63	5,40	11,42
2,50	13,56	5,50	11,35
2,60	13,48	5,60	11,27
2,70	13,41	5,70	11,20
2,80	13,34	5,80	11,13
2,90	13,26	5,90	11,05

Ratio between O_2- and CO_2- for heavy oil (CO_2max =15,90%)

% O_2	% CO_2	% O_2	% CO_2
0,00	15,90	3,00	13,63
0,10	15,82	3,10	13,55
0,20	15,75	3,20	13,48
0,30	15,67	3,30	13,40
0,40	15,60	3,40	13,33
0,50	15,52	3,50	13,25
0,60	15,45	3,60	13,17
0,70	15,37	3,70	13,10
0,80	15,29	3,80	13,02
0,90	15,22	3,90	12,95
1,00	15,14	4,00	12,87
1,10	15,07	4,10	12,80
1,20	14,99	4,20	12,72
1,30	14,92	4,30	12,64
1,40	14,84	4,40	12,57
1,50	14,76	4,50	12,49
1,60	14,69	4,60	12,42
1,70	14,61	4,70	12,34
1,80	14,54	4,80	12,27
1,90	14,46	4,90	12,19
2,00	14,39	5,00	12,11
2,10	14,31	5,10	12,04
2,20	14,23	5,20	11,96
2,30	14,16	5,30	11,86
2,40	14,08	5,40	11,81
2,50	14,01	5,50	11,74
2,60	13,93	5,60	11,66
2,70	13,86	5,70	11,58
2,80	13,78	5,80	11,51
2,90	13,70	5,90	11,43

Exhaust Gas Test

Trouble Shooting Instructions

Exhaust gas loss
Exhaust gas loss by way of free heat will occur as a result of the temperature difference between the fuel-air mixture entering the furnace chamber and the gases discharged. Any increase in the excess of air and the resultant higher exhaust gas volume will cause the exhaust gas loss to rise. The exhaust gas loss can be calculated as follows:

$$q_A = (t_A - t_L) \cdot \left(\frac{A_1}{CO_2} + B\right)$$

q_A = exhaust gas loss in %
t_A = exhaust gas temperature in °C
t_L = combustion air temperature in °C
CO_2 = volumetric content of carbon dioxide in %

	Light oil EL	Heavy oil S
A_1 =	0,50	0,490
B =	0,007	0,007

Example:
Data measured in fuel oil mode:
CO_2 content of exhaust gases 12,8%
Exhaust gas temperature 195°C
Air intake temperature 22°C

The exhaust gas loss can be calculated as follows:

$$q_{Af} = (195\text{-}22)\left(\frac{0,49}{12,8} + 0,007\right) = \underline{7,83\ \%}$$

In any case of trouble proceed with checking the basic conditions for a proper operation of the boiler system:
1.Is electric power available?
2.Is fuel oil contained in the tank?
3.Are the shut-off valves opened?
4.Are all control and safety instruments such as boiler thermostat, water supply failure cut-out, limit switches, etc. properly set?

1. Ignition failure

Cause	Remedy
Ignition electrode short circuit.	Adjust electrodes.
Wide ignition electrode spacing.	Adjust electrodes.
Dirty and wet electrodes.	Clean electrodes.
Cracked insulator.	Replace insulator.
Defective ignition transformer.	Replace transformer.
Defective automatic furnace controller.	Replace controller.
Burnt ignition cable.	Replace cable; search for cause and eliminate.
Pilot burner failure.	Adjust ignition gas pressure
Ignition gas valve does not open.	Search for cause and eliminate
Defective solenoid.	Replace

2. Motor running failure

Cause	Remedy
Motor protection relay and fuses.	Check and replace if required.
Air pressure switch not changed over or defective.	Check and replace if required.
Defective motor.	Replace motor.
Defective power contactor.	Replace contactor.
Air fan motor starts but stops after 20-25 secs.	Check for solenoid leaks
Air fan motor starts, but stops after about 10 secs in pre-ventilating mode.	Air pressure switch fails to change over; replace switch if defective; clean switch if dirt has accumulated; check electrical connections.

3. Pump oil delivery failure

Cause	Remedy
Shut-off valves closed.	Open valves.
Filter blocked by dirt.	Clean filter or replace cartridge.
Filter leaks.	Replace filter
Oil lines leak.	Retighten screwed unions; tighten oil lines.
Suction valve leaks.	Remove and clean or replace.
Direction of rotation of pump.	Check irection of rotation.
Damaged gearbox.	Replace pump.
Reduced pump output.	Replace pump.
-Strong mechanical noise.	
Pump takes in air	Retighten screwed unions.
High vacuum in oil pipe	Clean filter; fully open valves.
For heavy oil: Incorrect oil temperature.	Check pre-heater: thermostat setting, dirt

Trouble Shooting Instructions

4. Unsteady atomization

Cause	Remedy
Loosened nozzle.	Tighten nozzle
Hole partly clogged.	Remove and clean or replace.
Worn by long-time use.	Replace by new one.
Oil flow blokkage	
Due to clogged nozzle.	Remove and clean.
Nozzle leaking.	Replace nozzle.
Shut-off valve in nozzle rod leaking.	Replace valve.

5. No response to flame by automatic furnace controller with flame sensor

Cause	Remedy
Dirty flame sensor.	Clean flame sensor.
Burner fails to start.	Check connection of automatic furnace controller.
Trouble lamp lights; flame trouble.	Unlock and search for cause
Weak flame sensor signals.	Check combustion setting.
Burner starts without flame formation. Solenoid valve fails to open.	Defective coil or rectifier. Check connection.

6. Mixing unit gives poor combustion data due to heavy inside accumulation of oil or coke

Cause	Remedy
Incorrect settings.	Correct settings.
Incorrect mixture ignition unit.	Replace unit.
Nozzle too large or too small.	Replace nozzle.
Incorrect angle of spray.	Replace nozzle.
High or low combustion air flow rate.	Readjust burner.
Furnace chamber not sufficiently ventilated.	Furnace chamber to be ventilated through a non-closed opening with a cross section of min. 50 % of all chimney cross sections of the furnace system. Take care to observe the application regulations.

7. Solenoid valve fails to open

Cause	Remedy
Defective coil.	Replace coil.
Defective automatic furnace controller.	Replace automatic furnace controller.
Valve does not close tightly; dirt accumulated on sealing surfaces.	Open valve; remove foreign matter; replace valve if required.

8. Cleaning and lubricating instructions

Depending on the amount of dirt introduced by the combustion air it will be necessary to clean the fan impeller, ignition electrodes, flame sensors and air dampers as required.

For burner with mechanical compound controller:
Lubricate the ball heads of the compound controller setting screws with grease.

The bearing points of the burner moving parts require no maintenance.
Damages of ball bearings should be detected and eliminated at an early stage to avoid greater subsequent trouble. Listen to the motor bearing noise to identify possible irregularities.

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