TECHNICAL MANUAL

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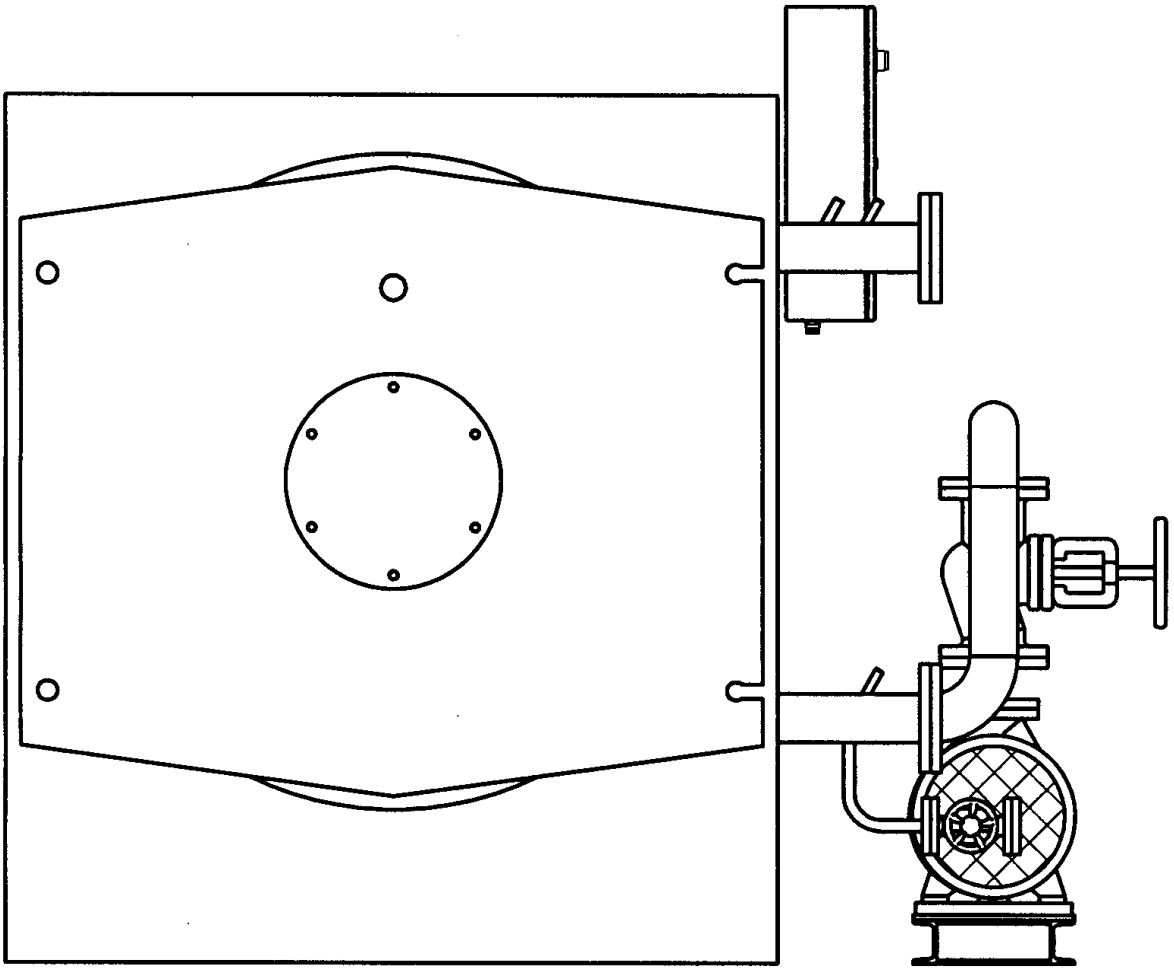

The above picture is only for reference.

OPX

DIATHERMIC OIL GENERATOR

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1 INTRODUCTION

OPX generators are suitable for operating with hot diathermic oil, that is with a fluid circulating at a temperature lower than boiling at atmospheric pressure.
Therefore in manufacturing them the technical principles regarding generators of superheated liquids other than water are not applied.

There are two types of **OPX** generator:

- With capacity 100.000 - 8.000.000 kcal/h (Fig. 1)

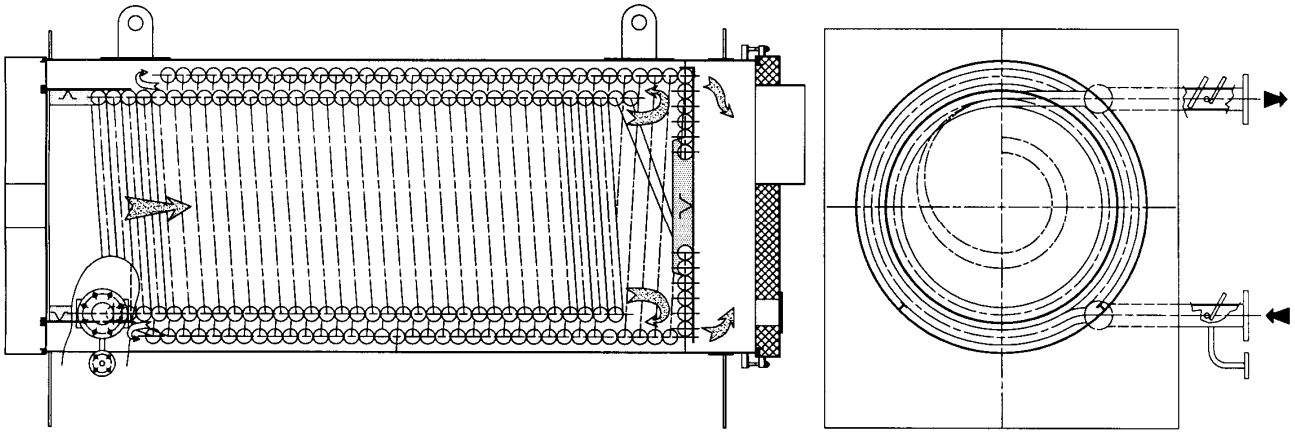

Fig. 1

- With capacity 1.000 000 - 8.000.000 kcal/h (Fig. 2)

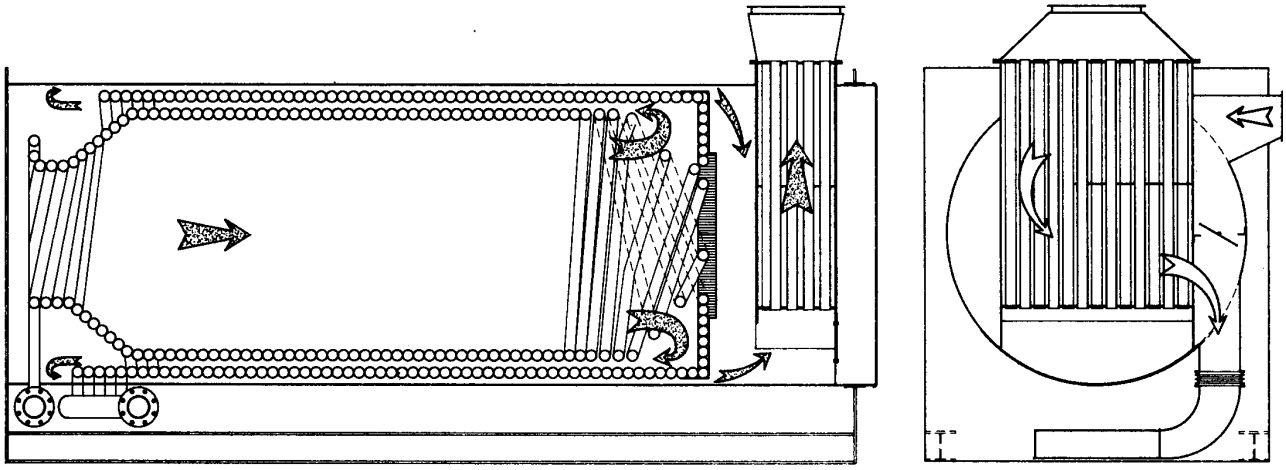

Fig. 2

2 TECHNICAL DATA

Characteristics	Heat output		Heat input		Efficiency 100% (N.C.V.)	NG max flow rate G20	NG max flow rate G30	NG max flow rate G31	Max flow rate of flues
	kW	kcal/h	kW	kcal/h	%	Stm³/h	kg/h	kg/h	kg/h
	Medium Temp. 260°C				Medium Temp. 260°C				
OPX 100	**116**	100.000	137	118.000	84,67	14,52	10,78	10,66	216,35
OPX 200	**233**	200.000	270	232.000	86,30	28,55	21,19	20,96	425,40
OPX 300	**349**	300.000	405	348.000	86,17	42,82	31,78	31,44	638,02
OPX 400	**465**	400.000	541	465.000	85,95	57,22	42,47	42,01	852,58
OPX 500	**581**	500.000	676	581.000	85,95	71,49	53,06	52,48	1065,20
OPX 600	**698**	600.000	810	697.000	86,17	85,76	63,65	62,96	1277,82
OPX 800	**930**	800.000	1081	930.000	86,03	114,43	84,93	84,01	1705,01
OPX 1000	**1163**	1.000.000	1351	1.162.000	86,08	142,98	106,12	104,97	2130,40
OPX 1200	**1395**	1.200.000	1622	1.395.000	86,00	171,65	127,40	126,02	2557,59
OPX 1500	**1744**	1.500.000	2028	1.744.000	86,00	214,59	159,27	157,54	3197,39
OPX 2000	**2326**	2.000.000	2707	2.328.000	85,93	286,45	212,60	210,30	4268,11
OPX 2500	**2907**	2.500.000	3380	2.907.000	86,01	357,70	265,48	262,60	5329,73
OPX 3000	**3488**	3.000.000	4050	3.483.000	86,12	428,57	318,08	314,63	6385,69
OPX 4000	**4651**	4.000.000	5410	4.653.000	85,97	572,54	424,93	420,33	8530,85
OPX 5000	**5814**	5.000.000	6760	5.814.000	86,01	715,39	530,96	525,20	10659,31
OPX 6000	**6977**	6.000.000	8100	6.966.000	86,14	857,14	636,16	629,27	12771,39
OPX 8000	**9302**	8.000.000	10820	9.305.000	85,97	1144,95	849,77	840,56	17059,76
OPX 1000 REC	**1163**	1.000.000	1277	1.098.000	91,07	135,11	100,27	99,19	2013,14
OPX 1200 REC	**1395**	1.200.000	1533	1.318.000	91,00	162,18	120,37	119,06	2416,48
OPX 1500 REC	**1744**	1.500.000	1916	1.648.000	91,02	202,78	150,50	148,87	3021,42
OPX 2000 REC	**2326**	2.000.000	2555	2.197.000	91,04	270,33	200,64	198,46	4027,92
OPX 2500 REC	**2907**	2.500.000	3194	2.747.000	91,01	338,01	250,87	248,15	5036,35
OPX 3000 REC	**3488**	3.000.000	3833	3.296.000	91,00	405,56	301,00	297,74	6042,84
OPX 4000 REC	**4651**	4.000.000	5110	4.395.000	91,02	540,79	401,37	397,02	8057,77
OPX 5000 REC	**5814**	5.000.000	6388	5.494.000	91,01	676,02	501,74	496,30	10072,70
OPX 6000 REC	**6977**	6.000.000	7666	6.593.000	91,01	811,25	602,10	595,57	12087,63
OPX 8000 REC	**9302**	8.000.000	10222	8.791.000	91,00	1081,70	802,83	794,13	16117,33

Characteristics	Pressure losses flue gas side	Heat losses through the chimney	Heat losses through the casing	Heat losses with burner off	Flue gas temp. at boiler output and air at 20 deg. C			CO2			Press. losses fluid side	Design Pressure	Max heating temperature	Total capacity	Total weight	Electric supply	Frequency	Insulation class	Fuel			
	mbar	%	%	%	°C	°C	°C	%	%	%	mbar	bar	°C	l	kg	Volt ~	Hz	IP				
					GAS	GASOIL	HEAVY OIL	GAS	GASOIL	HEAVY OIL	(ΔT=40K)								Nat. gas	Lpg	Gasoil	Heavy oil
OPX 100	0,5	14,13	1,20	0,10	350	351	350	10,5	13,5	14,0	1440,00	10	290	36	650	3/N~ 400	50	IP55	X	X	X	X
OPX 200	1,0	12,50	1,20	0,10	313	314	313	10,5	13,5	14,0	1700,00	10	290	80	900	3/N~ 400	50	IP55	X	X	X	X
OPX 300	1,5	12,63	1,20	0,10	316	317	316	10,5	13,5	14,0	1940,00	10	290	120	1200	3/N~ 400	50	IP55	X	X	X	X
OPX 400	2,0	12,85	1,20	0,10	321	322	321	10,5	13,5	14,0	1000,00	10	290	210	1500	3/N~ 400	50	IP55	X	X	X	X
OPX 500	4,0	12,85	1,20	0,10	321	322	321	10,5	13,5	14,0	1840,00	10	290	250	1650	3/N~ 400	50	IP55	X	X	X	X
OPX 600	3,5	12,63	1,20	0,10	316	317	316	10,5	13,5	14,0	1600,00	10	290	210	1750	3/N~ 400	50	IP55	X	X	X	X
OPX 800	4,0	12,77	1,20	0,10	319	320	319	10,5	13,5	14,0	1200,00	10	290	290	2200	3/N~ 400	50	IP55	X	X	X	X
OPX 1000	3,5	12,72	1,20	0,10	318	319	318	10,5	13,5	14,0	1680,00	10	290	460	2650	3/N~ 400	50	IP55	X	X	X	X
OPX 1200	4,0	12,80	1,20	0,10	320	321	320	10,5	13,5	14,0	1000,00	10	290	680	3750	3/N~ 400	50	IP55	X	X	X	X
OPX 1500	5,0	12,80	1,20	0,10	320	321	320	10,5	13,5	14,0	1700,00	10	290	700	3800	3/N~ 400	50	IP55	X	X	X	X
OPX 2000	4,0	12,87	1,20	0,10	321	322	322	10,5	13,5	14,0	1600,00	10	290	1350	8700	3/N~ 400	50	IP55	X	X	X	X
OPX 2500	7,5	12,79	1,20	0,10	319	320	320	10,5	13,5	14,0	1300,00	10	290	1600	10000	3/N~ 400	50	IP55	X	X	X	X
OPX 3000	6,5	12,68	1,20	0,10	317	318	317	10,5	13,5	14,0	1800,00	10	290	1520	10500	3/N~ 400	50	IP55	X	X	X	X
OPX 4000	8,5	12,83	1,20	0,10	320	321	321	10,5	13,5	14,0	2000,00	10	290	2300	13500	3/N~ 400	50	IP55	X	X	X	X
OPX 5000	9,0	12,79	1,20	0,10	319	320	320	10,5	13,5	14,0	1900,00	10	290	2500	15000	3/N~ 400	50	IP55	X	X	X	X
OPX 6000	8,5	12,66	1,20	0,10	316	317	317	10,5	13,5	14,0	2000,00	10	290	2800	19500	3/N~ 400	50	IP55	X	X	X	X
OPX 8000	18,0	12,83	1,20	0,10	320	321	321	10,5	13,5	14,0	2900,00	10	290	3650	26000	3/N~ 400	50	IP55	X	X	X	X
OPX 1000 REC	5,5	7,73	1,20	0,10	203	206	205	10,5	13,5	14,0	1680,00	10	290	460	3500	3/N~ 400	50	IP55	X	X	X	X
OPX 1200 REC	6,0	7,80	1,20	0,10	204	207	207	10,5	13,5	14,0	1000,00	10	290	680	4800	3/N~ 400	50	IP55	X	X	X	X
OPX 1500 REC	7,5	7,78	1,20	0,10	204	207	206	10,5	13,5	14,0	1700,00	10	290	700	5000	3/N~ 400	50	IP55	X	X	X	X
OPX 2000 REC	8,0	7,76	1,20	0,10	204	206	206	10,5	13,5	14,0	1600,00	10	290	1350	6800	3/N~ 400	50	IP55	X	X	X	X
OPX 2500 REC	9,0	7,79	1,20	0,10	204	207	206	10,5	13,5	14,0	1300,00	10	290	1600	8600	3/N~ 400	50	IP55	X	X	X	X
OPX 3000 REC	10,0	7,80	1,20	0,10	204	207	207	10,5	13,5	14,0	1800,00	10	290	1520	10500	3/N~ 400	50	IP55	X	X	X	X
OPX 4000 REC	12,0	7,78	1,20	0,10	204	207	206	10,5	13,5	14,0	2000,00	10	290	2300	14000	3/N~ 400	50	IP55	X	X	X	X
OPX 5000 REC	15,0	7,79	1,20	0,10	204	207	206	10,5	13,5	14,0	1900,00	10	290	2500	15000	3/N~ 400	50	IP55	X	X	X	X
OPX 6000 REC	18,0	7,79	1,20	0,10	204	207	206	10,5	13,5	14,0	2000,00	10	290	2800	21000	3/N~ 400	50	IP55	X	X	X	X
OPX 8000 REC	19,0	7,80	1,20	0,10	204	207	207	10,5	13,5	14,0	2900,00	10	290	3650	28000	3/N~ 400	50	IP55	X	X	X	X

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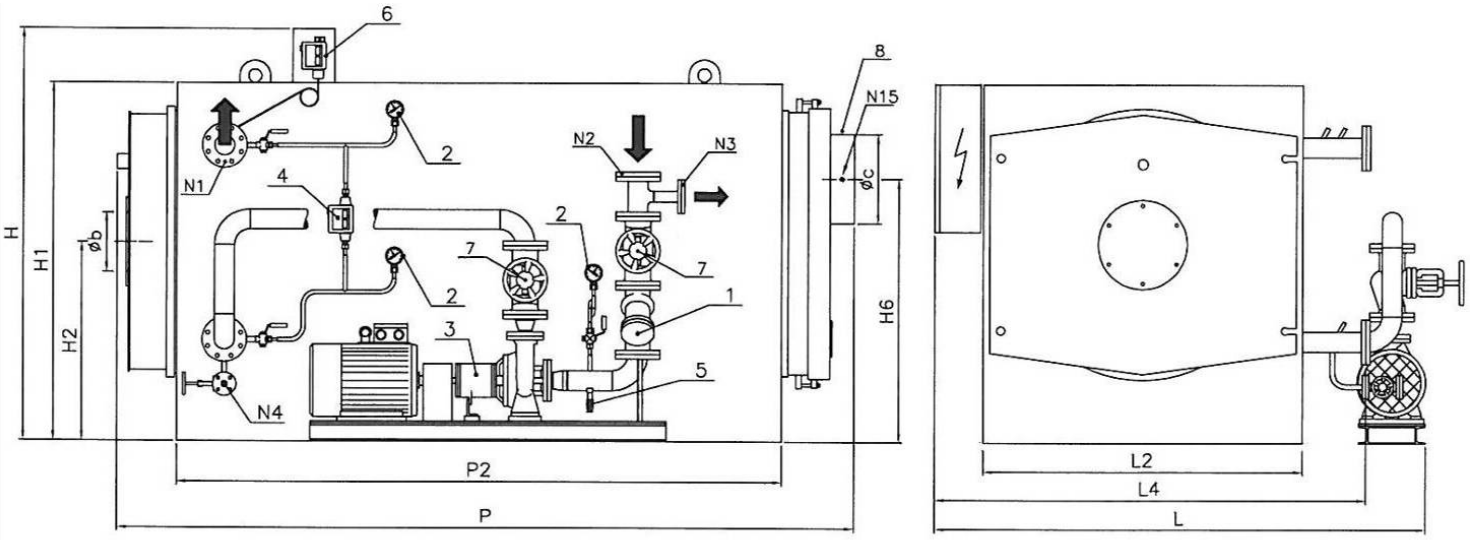
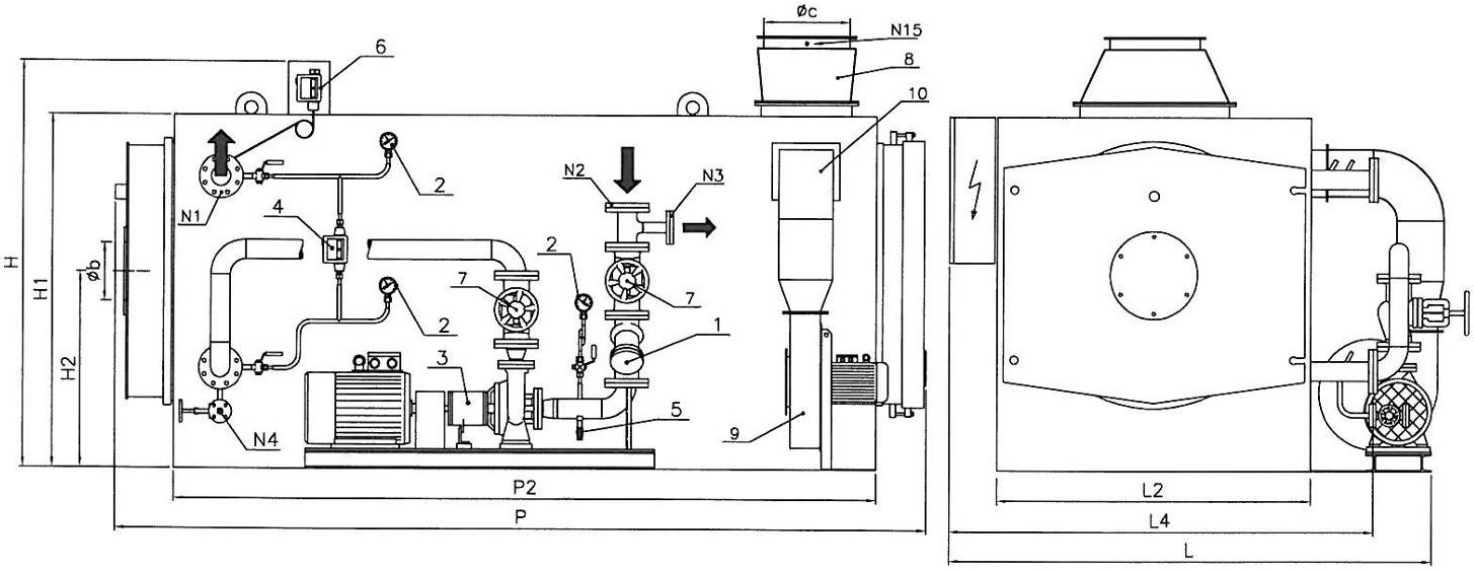
OPX



OPX REC



KEY

1. OIL FILTER
2. MANOMETERS
3. DIATHERMIC OIL CIRCULATION PUMP
4. CIRCULATION OIL DIFFERENTIAL PRESSURE SWITCH
5. DRAIN
6. BOILER SAFETY TERMOSTAT
7. OLIO OIL PUMP VALVES
8. SMOKESTACK FITTING
9. FAN
10. RECUPERATOR

N1 DIATHERMIC OIL FLOW
N2 RETURN DIATHERMIC OIL
N3 EXSANSION VESSEL FITTING
N4 PLANT DRAIN
N15 FLUE GASES TEMPERATURE CONTROL

NOTE: drawing, legend and data refer to standard models. For specific models, please refer to the provided accessory drawing.

Dimensions	H	H1	H2	H6	L	L2	L4	P	P2	Øb	Øc	N1	N2	N1/N2	N3	N4	N15
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	DN/in	DN/in	PN	DN/in	DN/in	in
OPX 100	**1150**	950	525	645	**1330**	850	1145	**1540**	1040	160	200	40	40	16	40	20	1/2"
OPX 200	**1400**	1200	700	850	**1510**	1000	1295	**1780**	1250	225	250	40	40	16	40	20	1/2"
OPX 300	**1600**	1400	800	1040	**1730**	1200	1495	**1805**	1275	225	250	50	50	16	40	20	1/2"
OPX 400	**1650**	1450	825	1100	**1790**	1250	1545	**2070**	1540	280	300	50	50	16	40	20	1/2"
OPX 500	**1645**	1445	818	1060	**1765**	1255	1515	**2315**	1775	280	350	65	65	16	40	20	1/2"
OPX 600	**1695**	1495	835	1095	**1885**	1320	1605	**2390**	1850	280	350	65	65	16	40	20	1/2"
OPX 800	**1725**	1525	850	1125	**1910**	1350	1635	**2940**	2440	280	350	65	65	16	40	20	1/2"
OPX 1000	**1805**	1605	890	1180	**1985**	1430	1715	**3050**	2720	280	400	80	80	16	40	20	1/2"
OPX 1200	**1915**	1715	935	1245	**2180**	1560	1845	**3500**	3170	320	450	100	100	16	50	20	1/2"
OPX 1500	**2050**	1850	1000	1250	**2300**	1650	1935	**3900**	3300	320	500	100	100	16	50	20	1/2"
OPX 2000	**2700**	2350	1350	-	**2700**	2100	2250	**4000**	3300	350	550	125	125	16	50	20	1/2"
OPX 2500	**2900**	2500	1400	-	**2900**	2200	2350	**4500**	3800	360	600	125	125	16	50	20	1/2"
OPX 3000	**2850**	2450	1350	-	**3000**	2300	2474	**4900**	4200	380	600	150	150	16	50	20	1/2"
OPX 4000	**3300**	2850	1650	-	**3300**	2500	2650	**5650**	4950	400	650	150	150	16	65	32	1/2"
OPX 5000	**3800**	3200	1800	-	**3450**	2800	2950	**6300**	5600	400	700	200	200	16	65	32	1/2"
OPX 6000	**3800**	3200	1800	-	**3600**	2800	2950	**7050**	6350	400	800	200	200	16	65	32	1/2"
OPX 8000	**3800**	3200	1800	-	**3750**	2800	2950	**7300**	6600	450	850	200	200	16	65	32	1/2"
OPX 1000 REC	**2000**	1605	890	-	**2150**	1430	1715	**3800**	3420	280	400	80	80	16	40	20	1/2"
OPX 1200 REC	**2120**	1715	935	-	**2300**	1560	1845	**4300**	3870	320	450	100	100	16	50	20	1/2"
OPX 1500 REC	**2250**	1850	1000	-	**2500**	1650	1935	**4600**	4000	320	500	100	100	16	50	20	1/2"
OPX 2000 REC	**2700**	2350	1350	-	**2700**	2100	2250	**4700**	4628	350	550	125	125	16	50	20	1/2"
OPX 2500 REC	**2900**	2500	1400	-	**2900**	2200	2350	**5200**	4976	360	600	125	125	16	50	20	1/2"
OPX 3000 REC	**2850**	2450	1350	-	**3000**	2300	2474	**5600**	5394	380	600	150	150	16	50	20	1/2"
OPX 4000 REC	**3300**	2850	1650	-	**3300**	2500	2650	**6350**	6152	400	650	150	150	16	65	32	1/2"
OPX 5000 REC	**3800**	3200	1800	-	**3450**	2800	2950	**7000**	6278	400	700	200	200	16	65	32	1/2"
OPX 6000 REC	**3800**	3200	1800	-	**3600**	2800	2950	**7750**	7028	400	800	200	200	16	65	32	1/2"
OPX 8000 REC	**3800**	3200	1800	-	**3750**	2800	2950	**8000**	7278	450	850	200	200	16	65	32	1/2"

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3 ACCESSORIES

3.1 CIRCULATION PUMP (Fig. 3)

It is a centrifugal one stage pump on horizontal axis, built according to European rules in spheroidal cast iron suitable for diathermic oil, having the following characteristics:

- MAX TEMPERATURE: 350°C
- MAX PRESSURE: 16 bar
- MOTOR SIDE SUPPORT: Grease lubricated ball bearing
- STAGE SIDE SUPPORT: Carbon bush lubricated by working fluid
- SHAFT SEAL: Self-cooled and self-lubricated mechanics
- PRESSING STOKEHOLE: Radial upwards

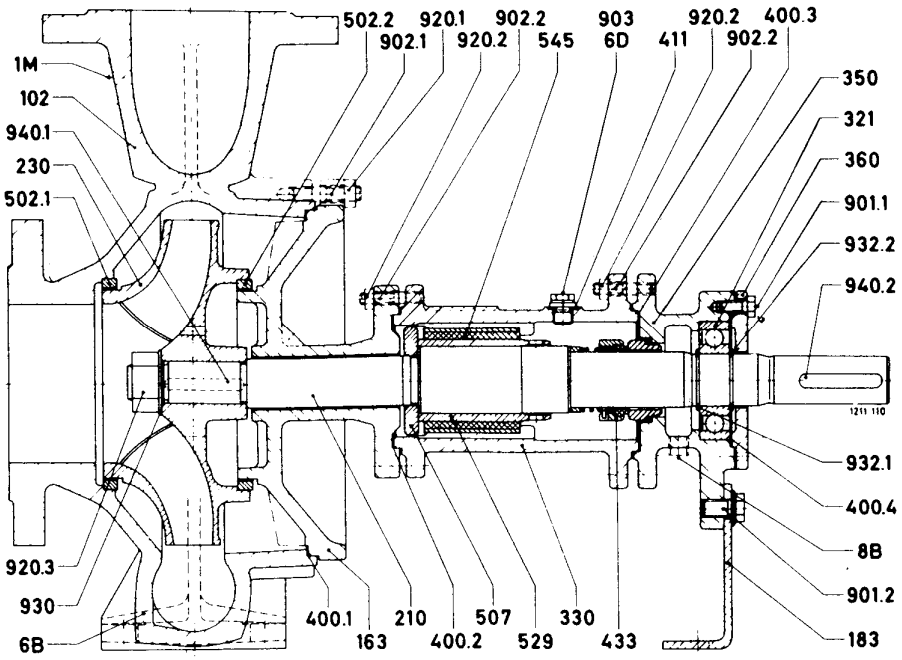
The **CAPACITY** of the pump is calculated for a temperature stage of 40°C and the oil circulation is surveyed by a differential pressure switch that comes into operation if the flow decreases.

The **HEAD** is the one that is necessary to win the charge losses of the boiler, of the possible evaporator plus a head "reserve", variable from pump to pump and in any case included between 0,3 and 0,7 bar at disposal for any direct uses.

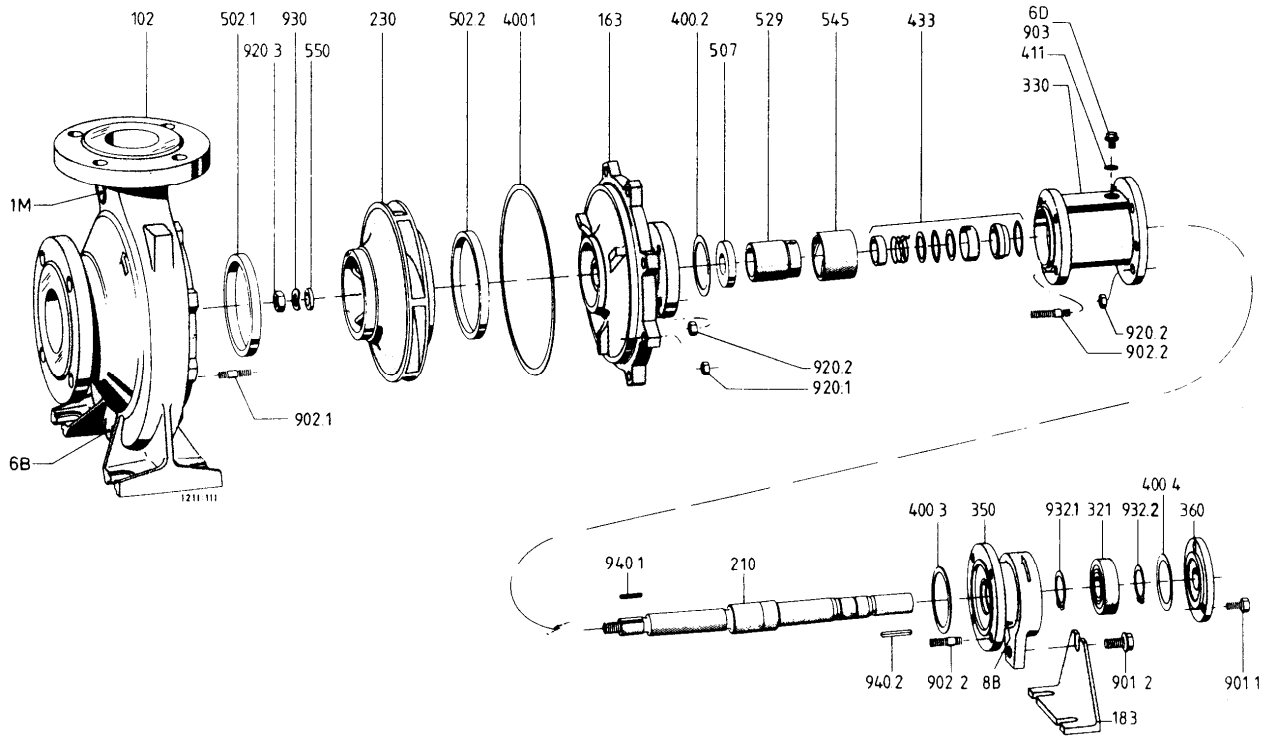
IT IS ABSOLUTELY NECESSARY TO GUARANTEE A CONSTANT CAPACITY THROUGH THE BOILER: therefore three-way valves or an automatic by-pass are to be installed on the users in order to make the oil not requested by the expander flow back to the boiler (see Fig. 8).

ETANORM SY PUMP (Fig. 3)

Cutaway view



Exploded drawing



3.1.1 PUMP START- UP OPERATIONS:

- Check that the bed-plate is firmly anchored to the ground or to a strong metal framework.
- Check the correct alignment of the connection (this operation is carried out in the workshop but it must be **re-checked** before the start-up); the connection is aligned if a line placed on the two half-joints, parallel to the shaft, maintains on the whole circle the same distance from the shaft. Moreover the distance between the two half-joints must remain the same along the whole circle.

REPLACE THE ELASTIC ELEMENTS OF THE CONNECTION AS SOON AS THEY SHOW ANY WEAR SIGNS.

- Rotate the shaft by hand and make sure it rotates freely.
- **Fill the pump with DIATHERMIC OIL only through the filling hole on the support and rotate the shaft by hand during this operation.**
- Check the pump rotation direction (see the arrow on the shaft support).

NOTE: A bad working pump may cause irreparable damage to the oil charge and the very boiler may shortly become unserviceable. Here is a list of the main inconveniences and prospective remedies on which to intervene at once:

- **Oscillations of the pressure gauges often accompanied by pulsating noises (*cavitation*):**
  - open the pump breather and the plant breather;
  - clean the suction filter;
  - tighten the suction bolts;
  - check that the oil level in the expansion tank hasn't dropped too low.
- **Decrease in the pressure difference between boiler entry and exit, which equals to a capacity decrease:**
  - check that the pump doesn't cavitate (see above);
  - stop the burner;
  - consult the assistance office.
- **Mechanical noises and vibrations:**
  - check the bearings;
  - check the connection;
  - check the stage balancing;
  - tighten the bolts.
- **Motor overheating (excessive mechanical stress):**
  - check the connection and in case re-align the unit ;
  - with amperometer pliers check the current and therefore the kW absorbed by the motor.
- **Seal losses (packing wear or mechanical seal breaking according to the type of pump):**
  - check the shaft state of wear;
  - replace the seal.

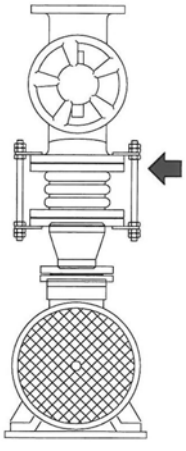
3.2 VALVES

They are flanged type PN16 special cast iron made, suitable for temperatures up to 300°C equipped with bellows seal made of stainless steel. Therefore they don't require any maintanance.

3.3 FILTER

Type Y, made of PN 40 steel with special PN 16 flanging, equipped with net cup that holds impurity.
Before removing the cup close the cut-out valves (with plant off!), then collect in a basin the little oil found in the filter.

3.4 EXPANSION COMPENSATORS (if present)



They are installed on particular sized plants when binding situations may produce unacceptable charges on the pump or difficulty for the circuit thermic expansion. Introducing compensators implies studying particular anchorage points (fixed points) able to permit the pipeline expansion, which runs down to the compensator, at the same time preventing the compensator from being burdened with any kind of load.

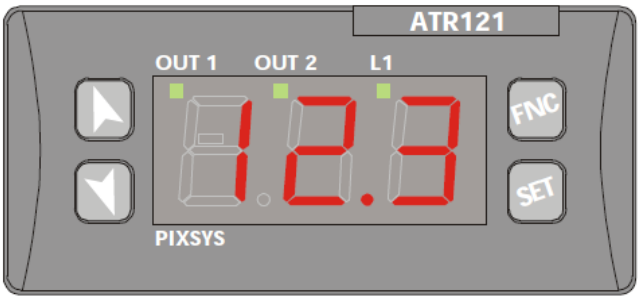
IMPORTANT: before starting the system, remove the joint locking spacers (see figure) in order for the joints to work properly.

Make sure that the compensator works **axially** during the operation; if it bends it causes the breaking of the bellows and the discharge of oil at high temperature.
Make sure without fail that during the hydraulic connection to the plant, the pipeline doesn't release its weight on the compensators.

3.5 THERMOSTATS

There are usually three electronical thermostats (a limit or regulation, return temperature visualization, flue gas safety) and a safety or cut-out one. The **limit thermostat** (electronic with Fe-Cost thermocouple) brings the burner to a stop when it reaches the right temperature and restarts it automatically at a preset value; moreover it provides for a contact to operate the second flame of a two-stage burner. The **safety thermostat** (mechanical and with bulb) stops the burner at a preset temperature value and starts an alarm bell. Restart only takes place once the cause of the alarm has been eliminated together with manual resetting of the electrical control panel.

3.5.1 TEMPERATURE CONTROLLER



SIMPLIFIED INSTRUCTIONS FOR FLOW TEMPERATURE CONTROLLER

The controller is supplied partially set-up.
The working temperature and the high limit temperature must be set-up.

Temperature setting:
OUT1= working temperature (setting of second stage of the burner – high)
OUT2= high limit temperature (burner on/off)

Note: if the buttons are not pressed for 8 seconds, the controller will pass automatically from setting mode to display mode.

Press SET for 1 second, OUT1 will appear on the display and it flashes with set-up value, alternatively.
Example; "115" (°C). (OUT1→115→ OUT1→115→ OUT1→115…….)
Using the buttons increments "▲" or decrement "▼" set the requested temperature value and then press "SET" to confirm the value.
Automatically will appear on the display "OUT2" (high limit setting), set the high limit temperature as the previous description, (▲▼), at the end of the setting press "SET" to confirm.
After 8 seconds, without pressing any bottoms, the controller will pass in display mode.
For further setting modifications, use the enclosed instructions.

Hysteresis values, factory set up:
Hysteresis on "OUT2" boiler working temperature (setting of second stage of the burner)
If the read temperature is over the working temperature set up plus the hysteresis value (5°C) = OFF of the second flame (the burner will run at low flame).
If the read temperature is less than working temperature set up minus the hysteresis value (5°C) = ON of the second flame (the burner will run at high flame)

Hysteresis on "OUT1" boiler high limit temperature (burner ON/OFF)
Read temperature = temperature set point = burner OFF
If read temperature is less than temperature set point minus Hysteresis (fixed at 5°C) = Burner ON

SIMPLIFIED INSTRUCTIONS FOR FLUE GAS SAFETY CONTROLLER

The controller is supplied partially set-up.
The flue gas temperature alarm and the advanced alarm must be set-up.

Alarm and advanced alarm temperatures setting;

OUT1= flue gas temperature alarm (notice and burner lock out)
OUT2= flue gas temperature advanced alarm (notice only)

Note: if the buttons are not pressed for 8 seconds, the controller will pass automatically from setting mode to display mode.

Press SET for 1 second, OUT1 will appear on the display and it flashes with set-up value, alternatively.
Example; "350" (°C). (OUT1→350→ OUT1→350→ OUT1→350…….).

Using the buttons increments "▲" or decrement "▼" set the requested temperature value and then press "SET" to confirm the value.
Automatically will appear on the display "OUT2" (high limit setting), set the high limit temperature as the previous description, (▲▼), at the end of the setting press "SET" to confirm.
After 8 seconds, without pressing any bottoms, the controller will pass in display mode.
For further setting modifications, use the enclosed instructions.

Hysteresis values, factory set up:

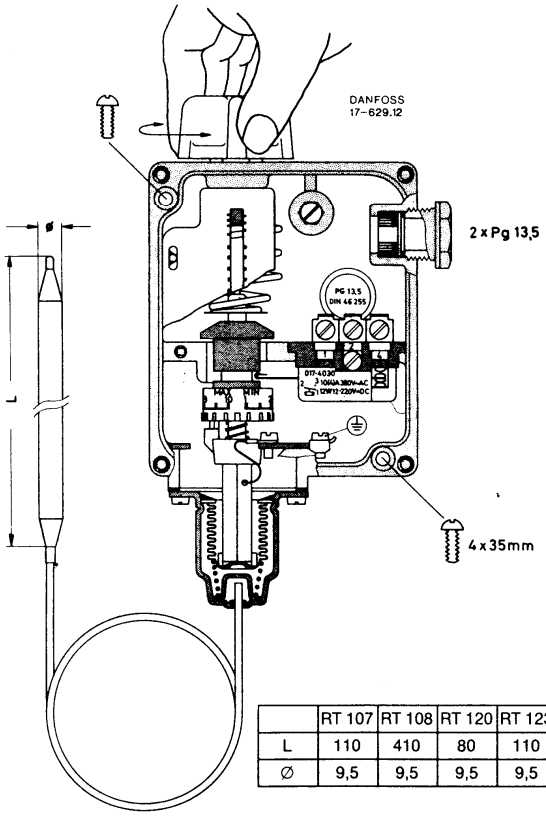
Hysteresis on "OUT2" boiler working temperature (setting of second stage of the burner)
If the read temperature is over the working temperature set up plus the hysteresis value (10°C) = the flue gas temperature advanced alarm is OFF
If the read temperature is less than working temperature set up minus the hysteresis value (10°C) = the flue gas temperature advanced alarm is ON
Hysteresis on "OUT1" boiler high limit temperature (burner ON/OFF)
Read temperature = temperature set point = burner OFF
If read temperature is less than temperature set point minus Hysteresis (fixed at °C) = Burner ON

Configuration parameters

	Flue gases temperature	Return oil temperature	Flow oil temperature
cou	o2.1	o2.1	o2.1
Sen.	tc.J (o Pt)	tc.J (o Pt)	tc.J (o Pt)
dP.	0	0	0
Lo.S	0	0	0
Hi.S	500	300	300
Lo.n	0	0	0
Hi.n	500	300	300
LAt	off	off	off
cAo	0	0	0
cA.G	0	0	0
rEG.	HER	HER	HER
S.c.c.	c.o.	c.o.	c.o.
Ld1	c.c.	c.c.	c.c.
HY.c	5	5	5
P.b.	0	0	0
t.i.	0	0	0
t.d.	0	0	0
t.c.	10	10	10
AL.	A. A	A. A	A. A
c.r.A	n.o.S	n.o.S	n.o.S
S.c.A	c.o.	c.o.	c.o.
Ld2	c.c.	c.c.	c.c.
HY.A	5	5	5
dE.A	0	0	0
P.S.E.	FrE	FrE	FrE
Fil	10	10	10
tun	off	off	off
Fnc	d.SE	d.SE	d.SE
GrA	°C	°C	°C
bd.r	-	-	-
Add	-	-	-
dE.S	-	-	-
co.F	Air	Air	Air
P.b.N	1	1	1
ou.d	0	0	0
t.c.2	10	10	10
FL.u	off	off	off
OUT1	450	-	260
OUT2	400	-	250

3.5.2 DANFOSS RT 124 THERMOSTAT (Fig. 5)

The electrical switch has three screws 2-1-3 from the right to the left side. The 2-1 connection closes when temperature is lower than the minimum and until maximum temperature is reached. The 2-3 connection is switched for temperature over maximum values.



	RT 107	RT 108	RT 120	RT 123	RT 124
L	110	410	80	110	110
Ø	9,5	9,5	9,5	9,5	11

Fig. 5

Thermostat calibration

a) Turn knob until the scale indicator is set to the temperature value required to restart the burner;
b) Remove the thermostat cover and position drum to the required value for the differential (burner stop) as shown in the diagram (Fig.5a). The differential value is added to the fixed value as at point a).

Example:

- SCALE INDICATOR:..... 280°C
- DRUM INDICATOR: ..... 1 (=3°C)

This means:

- THE BURNER STOPS AT:..... 283°C
- THE BURNER RESTARTS AT:..... 280°C

Since DANFOSS thermostat is used in standard plants as safety thermostat the drum indicator must be positioned at 1, that is with a practical null differential.

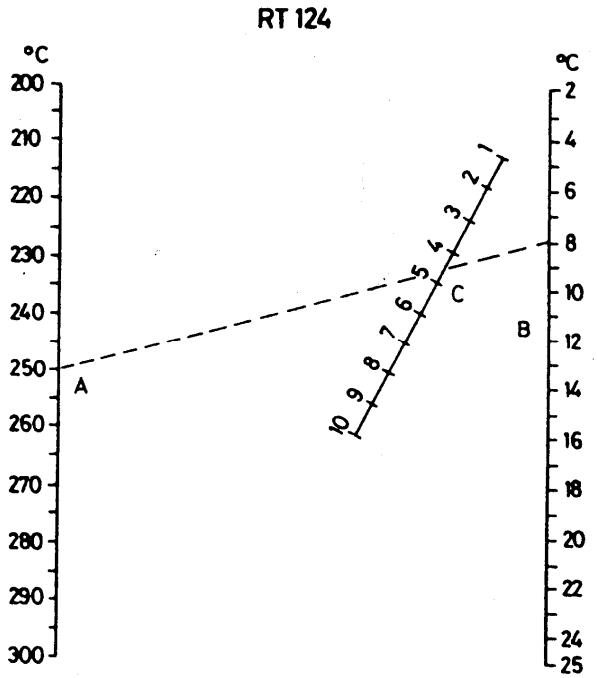


Fig. 5a

3.6 DANFOSS RT 262 A DIFFERENTIAL PRESSURE SWITCH (Fig. 6)

It is connected to the generator entry and exit and it opens the electrical circuit (burner cut-out) when the pressure difference between entry and exit falls below the preset value (usually 1 bar).

The lower fitting must be connected on the high pressure side (boiler entry=pump delivery) while the top one must be connected to the generator exit.

To calibrate the unit remove the front cover and turn the ring nut (1).

Once the operating pressure is reached, the initial conditions are restored at a fixed differential of 0,1 bar.

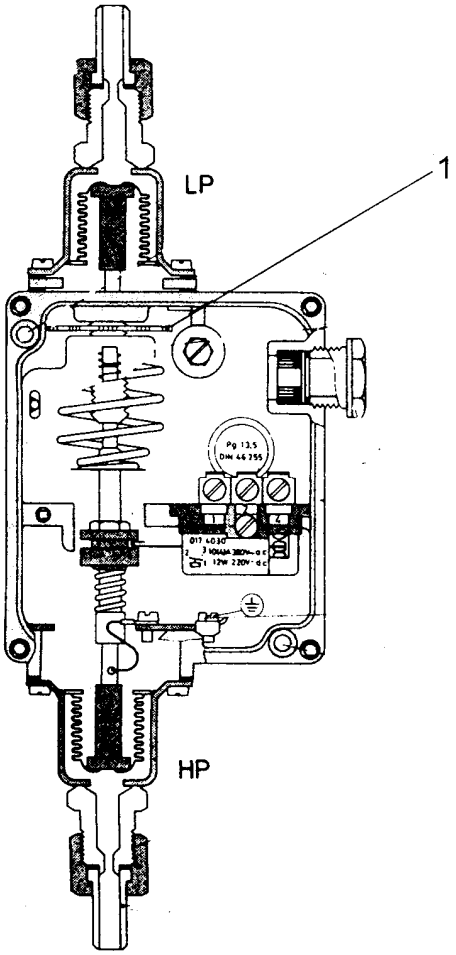


Fig 6

3.7 THERMOMETERS AND PRESSURE GAUGES

The difference between the temperatures read on the two thermometers at the boiler entry and exit must be 40°C max. A higher value means insufficient oil circulation and therefore a dangerous situation.
No problem instead if that difference were to be lower.

The difference in reading between the pressure on the two pressure gauges at the boiler entry and exit must generally be around 2 bar. A lower value means insufficient oil circulation. Anyway stick to the values given by our technician at the start-up (or consult our Technical Office).

4 EXPANSION VESSEL

It absorbs the volume variations of the oil inside the plant due to temperature rise. The average expansion coefficient of the currently used diathermic oils is about 0,0007 per °C, with a corresponding volume increase by 7% every 100°C temperature rise. Therefore going from cold to steady state (280°C) oil volume increase is about 20% of the total amount in the circuit. In cold plant it is best for the oil to occupy at least 1/4 of the total volume of the expansion vessel, while in steady state plant the 3/4 of that volume must not be exceeded, so as to assure a sufficient reserve margin and avoid any useless overflows. Therefore the total capacity of the expansion vessel must correspond to double the expected maximum oil expansion, that is it must be 40% of the total content of the plant. The expansion vessel can be the open atmospheric pressure type or the closed type pressurized with inert gas (nitrogen).

4.1 CLOSED EXPANSION VESSEL

The closed expansion vessel, which is usually supplied on our plants, is a tank where a variable nitrogen pressure is maintained. This pressure varies from 1 bar with plant at a standstill to 4 bar with plant at 280°C temperature.
This unit is under pressure (max. 5 bar), so it is subject to a Notified Body control and has its own registration book. The connection pipeline between vessel and plant must have a suitable section for the plant capacity; therefore it is advisable to refer to the following board partly taken from German normative law.

BOILER CAPACITY UP TO (kcal/h)	NOMINAL DIAMETER EXPANSION TUBE (mm)
1.000.000	40
2.000.000	50
6.000.000	65

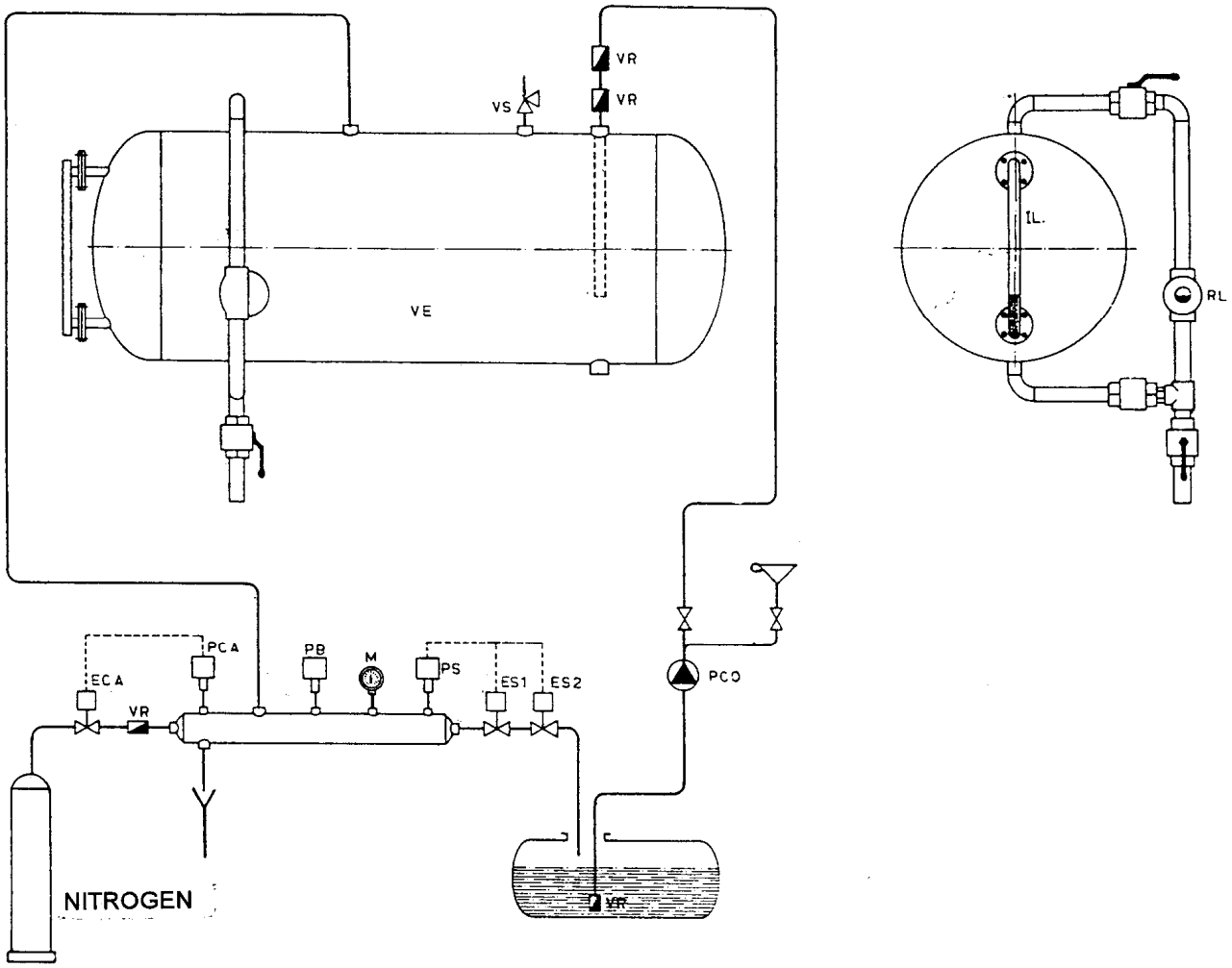
4.2 CLOSED VESSEL ACCESSORIES (Fig. 7)

- Spring loaded safety valve calibrated at 5 kg/cm². This valve intervenes to discharge nitrogen when pressure reaches rating value.
- Motor-driven pump for plant charging and restoring. It is a gearing type operated by the level regulator.
- Ball float level controller having the following functions:

a) charging pump halt when the minimum level at a standstill is reached and consequent nitrogen inlet if required by the pressure switch;
b) charging pump restart when the level slightly falls (restoration);
c) burner cut-out when the level considerably falls (serious loss).

- Safety pressure switch that cuts out burner in case the pressure.increases for failure of the regulation system.
- Nitrogen inlet solenoid valve with relative pressure switch calibrated at about 1 kg/cm²: at lower pressure the valve opens, at higher pressure the valve closes.
- Nitrogen bleed solenoid valve with relative pressure switch calibrated at about 4 kg/cm²: at lower pressure the valve closes, at higher pressure the valve opens.

For the electrical connections see the diagram inserted in the electrical control panel.
For the calibration of the pressure switches see the description of the evaporator pressure switch (paragraph 7.1).



Key

VE	Expansion vessel
VS	Safety valve
VR	Nonreturn valve
ECA	Nitrogen filling solenoid valve
PCA	Nitrogen filling pressure switch
PB	Burner pressure switch
M	Manometer
PS	Safety pressure switch
ES1	Safety solenoid valve n. 1
ES2	Safety solenoid valve n. 2
PCO	Charging oil pump
IL	Level gauge
RL	Ball float level controller

Fig. 7 - Hydraulic connections expansion vessel

5 HYDRAULIC CONNECTIONS

5.1 PIPELINE

Steel pipes must be used. NEVER USE COPPER AND COPPER ALLOYS not even for small parts or sheaths because copper degrades oil, thus fostering an oxidation process.

The pipeline diameters are according to the oil speed: in the plant it is advisable to maintain the speed between 1,5 and 2,5 m/sec.

Because of the temperatures involved it is necessary to build a circuit with straight-line sections, bends and support systems so as to permit the absorption of the thermic expansions; otherwise use a flow dilation compensator. In the highest points insert a bleed tank in order to favour an outlet for air and steam. Use threaded pipe fittings only for small diameter fittings using teflon which is suitable up to 250°C (yellow type). For the flanged joints use colloidal graphite gaskets.

5.2 TANK FOR OIL STOCKING

Consider a total capacity 1,5 times the amount of oil in the plant.

Set it up at a lower level than the plant (it is best if it is laid underground so as to discharge the plant for gravity).

Use tanks made of steel and externally bituminized in order to be put underground, very similar to those used for combustible oil.

5.3 OIL SAMPLING DEVICE

To check the chemical-physical conditions of the oil charge it is necessary to draw some oil samples and have them analysed.

For a correct sampling, about 1 kg of oil at 30÷40°C max must be drawn. To make the oil cool down during the drawing it is best to build a steel coil immersed in water or wait for the whole plant to cool down.

5.4 DIATHERMIC OIL BOILER WITH STEAM GENERATOR (Fig. 8)

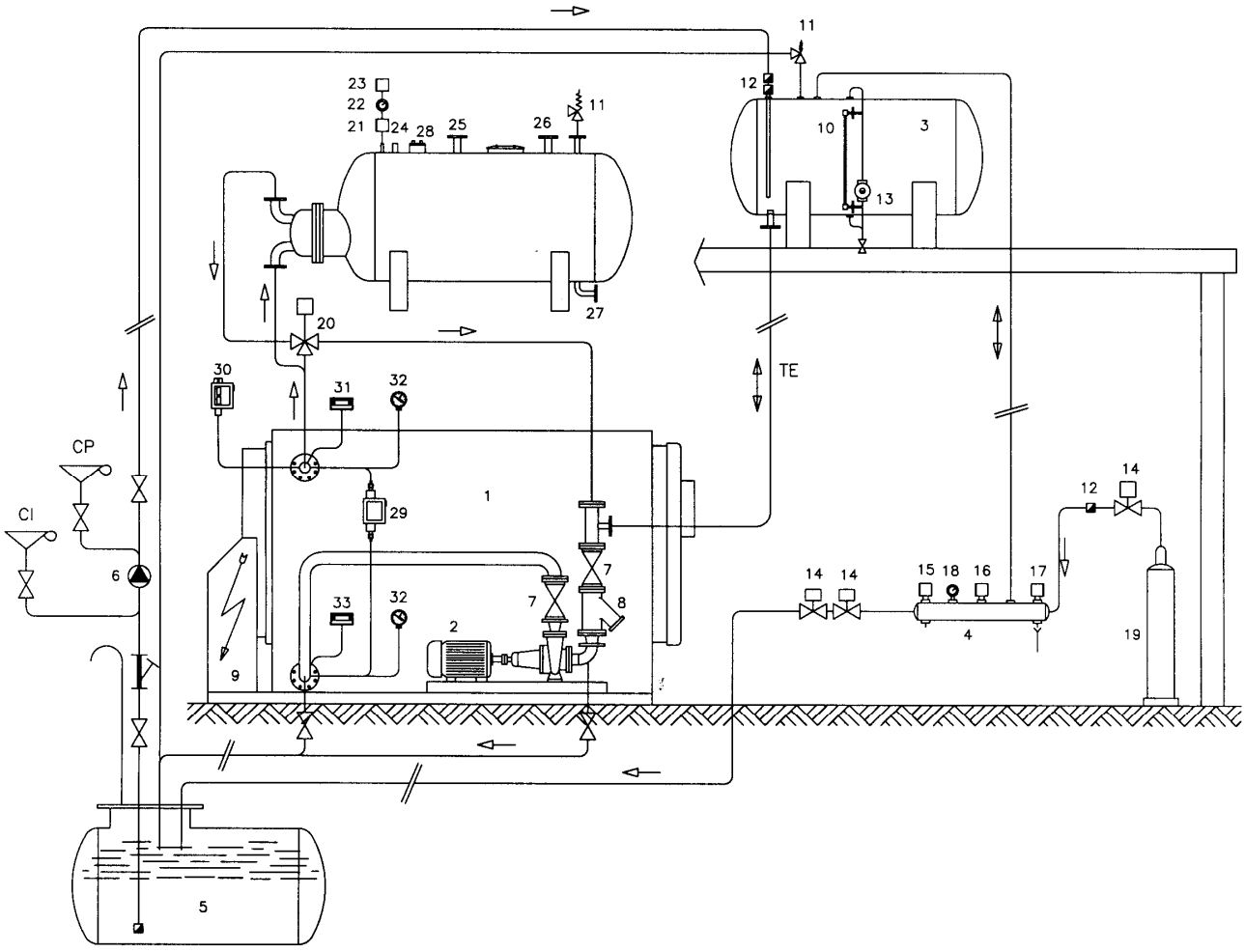


Fig. 8

KEY

1 OPX-diathermic oil boiler
2 Motordriven pump
3 Expansion vessel
4 Nitrogen pipe
5 Oil tank
6 Feeding pump
7 2-way valve
8 Filter
9 Electric board
10 Level gauge
11 Spring loaded safety valve
12 Nonreturn valve
13 Level control
14 Solenoid valve
15 Nitrogen exhaust press. switch
16 Safety presure switch
17 Nitrogen feeding press. switch
18 Manometer
19 Nitrogen tank
20 3-way valve
21 Pressure switch
22 Manometer
23 Pressure switch
24 Safety probe
25 Steam outlet
26 Water inlet
27 Blowdown
28 Level regulation probes
29 Differential pressure switch
30 Safety thermostat
31 Limit thermostat
32 Manometer
33 Thermometer

CI Plant feeding
CP Pump feeding
TE Expansion pipe

5.5 ELECTRIC CONNECTIONS

The boilers are provided with a switchboard (protection level IP 55) completely assembled to the various boiler accessories. Before connecting the switchboard, make sure that the electric system has been correctly installed, checking in particular the efficiency of the earthing system.

Wiring diagram
Refer to the diagram supplied with the specific switchboard.

5.6 SMOKESTACK

The smokestack must be dimensioned as to applicable regulations.

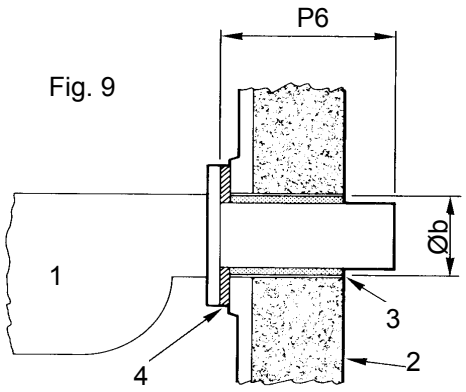
5.7 BURNER

To better answer to steam demand, it is advisable to install a **two-stage burner** or **a modulating burner;** this avoids large pressure variations consequent on sudden stream demands.
Further, and above all with natural gas, every burner start-up is preceded by a long period of preventilation of the combustion chamber, with consequent loss of heat to the smokestack.

5.7.1 BOILER - BURNER COUPLING

Verify that the spaces between the burner sleeve and the boiler door are suitable filled with flame-resistant ceramic insulation (Fig. 9).
The table shows the dimensions of the burner sleeves used on these steam boilers.

Fig. 9



KEY:
1. Burner
2. Manhole
3. Thermoinsulating material
4. Flange

All details on the draught tube length (**P6**), the diameter of the burner hole (**Øb**) and the pressurization are included in the par. Technical Specifications.

6 OPERATION OF THE PLANT

6.1 FILLING THE PLANT

Before proceding to the filling it is necessary to perform a plant seal test (for supplies of our boiler blick+evaporator this testing is done in the workshop).

For the test performance it is best to use compressed air introduced in the circuit and to check the fittings, welded joints, etc. with soap liquids. Lacking a compressed air net, diathermic oil can be used. It is advisable not to use water on the plant since it is difficult to eliminate it and eventually dry the plant. As far as the filling is concerned it is very important to perform it so as to eliminate completely the air in the circuit. As the oil enters the circuit, it pushes forward the air which in turn is expelled through the expansion vessel and through the bleed valves which must obviously be kept wide open during this phase.

The filling can be considered finished when the oil in the expansion vessel has reached the level corresponding to operating at a standstill (about 1/4 of the total capacity); on the expansion vessels supplied by us this operation is automatic thanks to the ball float lever controller.

6.2 FIRST START-UP

Circulate the oil at room temperature for some time, at least 2 hours, until the circulation of the cold oil has completely settled. This way the residual air pockets are eliminated, the complete filling of all the circuit is assured and the coarse impurities are removed.

During this period open up the breathers now and then to eliminate the air. At the end of the operation inspect the filters and, if necessary, clean them. During the first heating phase the generator thermic charge must be kept at very low values, that is it is necessary to procede with a reduced flame. The heating must be gradual: the temperature increase must not be higher than 40÷50°C per hour.
Between 90° and 120°C the heating must procede even more slowly; in fact during this phase most of the possibly present water is released as steam and it is important for its elimination to be progressive.

Then proceed with the heating which is always to be done with a temperature gradient of 40°÷50°C per hour and keeping on bleeding, if necessary, until the normal operating temperature is reached.

This temperature is to be maintained for a few hours, until the plant has evidently completely settled. During the start-up period the plant operation must be checked very carefully in all its details: expansion flow, supports position, joints seal, indications on the measuring instruments. During this phase there may occur some losses from the all-size flange gaskets caused by the increase in temperature and the consequent decrease in the oil viscosity. It is therefore necessary to tighten all the bolts until maximum temperature is reached. Once the steady state conditions are obtained, it is advisable to take note of as many elements as possible: measuring instruments readings, position of the regulation units, situation of the pipeline and of the supports after the expansions intervened, combustion efficiency, etc.

All this data noted on the plant at the first start-up will eventually turn out to be extremely useful in order to evaluate its behaviour during the operation. Finally remember that also during the start-up it is advisable to eliminate all the oil that is expelled during the bleeding because it may very well contain impurities and degradation products and so it cannot be re-used.

6.3 FOLLOWING START-UPS

No particular precaution is required as long as the oil hasn't been discharged and then put back in the circuit. It is necessary to maintain the burner at the minimum until the oil temperature reaches 120÷150°C.

The burner is to be turned on only after starting the circulation pump; anyway this is provided for by the electric circuit which doesn't start the burner if the circulation hasn't been activated first.

6.4 PLANT HALT

Every time the plant is stopped, the circulation pump **must stay on for some time** (approximately 1 hour), until the temperature has dropped under a preset limit (about 180/200°C), in any case until the heat accumulated by the generator structures has been eliminated.

7 MAINTENANCE

7.1 STANDARD CHECK-UP

- Clean the filter on the circulation pump suction.
- Check the valve seal.
- Check that the bearings and the circulation pump seal are in good working order and lubricate greasers.
- Check that the indicator, regulation and control instruments are in good working order carefully examining electrical and mechanical parts.
- Perform burner maintenance.
- Check that the boiler is clean.

7.2 OIL CHARGE CHECK-UP

The check-up must be performed by drawing some samples of oil from the circuit periodically and having them analysed by a specialized laboratory.
The drawn sample must be representative, that is it must have all the characteristics of the whole amount of oil present in the plant, so as to reproduce all its real conditions.
Take care the oil is made to flow preliminarily for some time before the sample is drawn, so that also the suction pipe is cleaned by eliminating the product there stagnant and any possible residue from previous drawings. The quantity of oil to be drawn must be about 1 kg and it is to be put in a hermetic sealing container on which necessary data for its identification are to be written (date of drawing, temperature of drawing, operating hours).
The periodicity of the samplings must be agreed with the oil supplier, also depending on the capacity of the plant and on the expected operating conditions. As a general rule see the following suggestions:

- A first sampling on new oil: it can also be used to check the correspondence of the product supplied;
- a sampling after 1000 hours or 3 months operating;
- Two following samplings at intervals of 2000 hours or 6 months operating;
- Afterwards samplings every 4000 hours of 1 year operating.

Check-ups must be intensified when analyses performed on the samples reveal anomalous circulation or thermic exchange phenomena.

7.3 OIL CHARGE REPLACEMENT

The life of the oil charge is linked to the deterioration degree it has undergone.
This deterioration depends on numerous factors, regarding both the plant itself and its operation.
The average life of the oil is a few years and it is especially influenced by the operating temperature.
If this temperature is 270°C÷280°C the life of the charge is 4÷6 years. If the operating temperature increases up to 300°C it drops to about 3 years.

DIATHERMIC OIL PLANT CARD

PLANT	c/o

OIL			TOPPING UP					BOILER		
Model..... Supplier..... Quantity.....liter.....kg Viscosity.....cSt.....°E at 50°C Absol. weight.....kg/dm^3 at 15°C Flash point.....°C	First load date ..... First start date	date kg	date kg	date kg	Constructor **ICI CALDAIE S.p.A.** Mod. OPX ..... Capacity.....kW .....kcal/h	Normal working temperature .....°C Max temperature .....°C

PLANT			USERS
Total content.....liter Working temperature: Flow temperature.....°C Return temperature.....°C Return pressure.....bar Flow pressure.....bar	Expansion vessel: type..... content.....liter max pressure.....bar working pressure.....bar working temperature.....°C	Pump/s n..... make..... type..... flow.....m^3/h.....lt/1' head.....bar electrical power.....kW.....Hp	....

TEST														
	Drawing date													
	Drawing point													
	Oil temperature													
	Plant (stop/on)													
	Working hours													

ANALYSIS														
	Viscosity at 50°C - °E													
	Flash point PM °C													
	First distillation °C													
	2% distillation °C													
	5% distillation °C													
	10% distillation °C													
	% carbon residual													
	Total acidity													
	% pentane insolubility													
	% benzol insolubility													
	% water/deposit													

DIATHERMIC OIL PLANT CARD	PLANT	c/o

NOTES

STARTING (Problems, faults, etc.)

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WORKING (trouble, inspection, repair, replacement, etc.)

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8 EVAPORATOR

Diathermic oil flows in the head and also in the coil, steam instead is produced in the cylindrical drum. Being a unit under pressure it is subject to a Notified Body control and it is so equipped with its own registration book.

8.1 ACCESSORIES OF THE EVAPORATOR

The main accessories are:

8.1.1 OPERATING PRESSURE SWITCH

This device controls the pressure in the evaporator and keeps it within the preset maximum and minimum values.

- **DANFOSS RT 5 pressure switches:**
  The electrical switch has three screws 2-1-3 from the right to the left side. The 2-1 connection closes at pressure lower than the minimum and until maximum pressure is reached. The connection 2-3 is switched for pressure over maximum values.
- **Pressure switch calibration** (Fig. 10)
  turn knob (1) until the scale indicator (2) is set to the pressure value required to restart the burner;
  remove the pressure switch cover and position drum (3) to the required value for the differential (burner stop) as shown in the diagram (Fig. 11). The differential value is added to the fixed value as at point a) above.

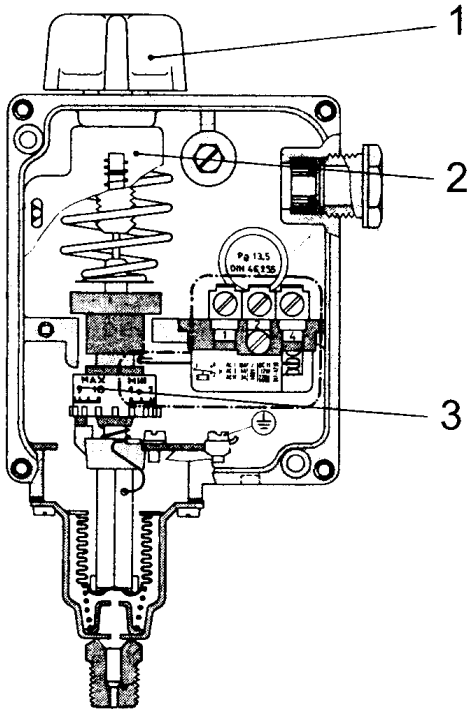

Fig. 10

Example: RT 5

- SCALE INDICATOR (1): ..... 8 bar
- DRUM INDICATOR (3): ..... 7 (=3 bar)

- **with the result that:**
- THE BURNER STARTS AT: ..... 8 bar
- THE BURNER STOPS AT: ..... 11 bar

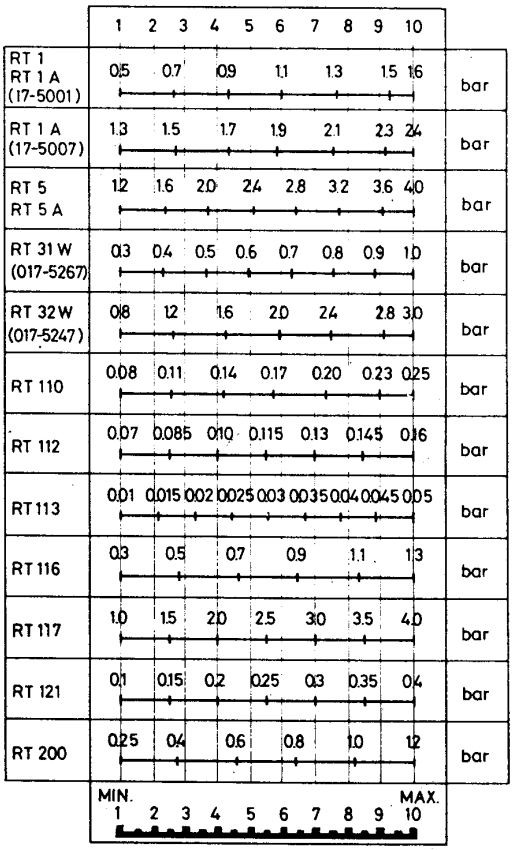

Fig. 11

8.1.2 SAFETY PRESSURE SWITCH

Its set point must be over than working pressure switch value, but it must be lower than safety valve intervention pressure. Safety pressure switch operates if working pressure switch is failure. It's necessary to check the boiler in order to find the failure cause, to solve the problem and to reset the red bottom on the board.

8.1.3 SAFETY VALVE

It's a component of evaporator in order to discharge steam when maximum working pressure has been exceeded.

8.1.4 MOTOR-DRIVEN PUMP

It is a 1 or more stage pump which the water passes through, thus progressively increasing pressure.

The intake opening must be "under head", that is under the pressure of a column of water resulting from the difference in height between the water in the collection tank and the axis of the pump itself.

The height of the tank varies with temperature variations, as shown in the table:

FEED WATER TEMPERATURE °C	HEAD ON INTAKE (m)
60	0,5
70	1,5
80	3,0
90	4,0

9 BUREAUCRATIC PRACTICES

Please follow your national regulations.

USER OBLIGATIONS

VERIFY WHICH STANDARDS FOR THE COMMISSIONING AND USE OF PRESSURE EQUIPMENT ARE APPLICABLE IN THE COUNTRY OF USE.

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