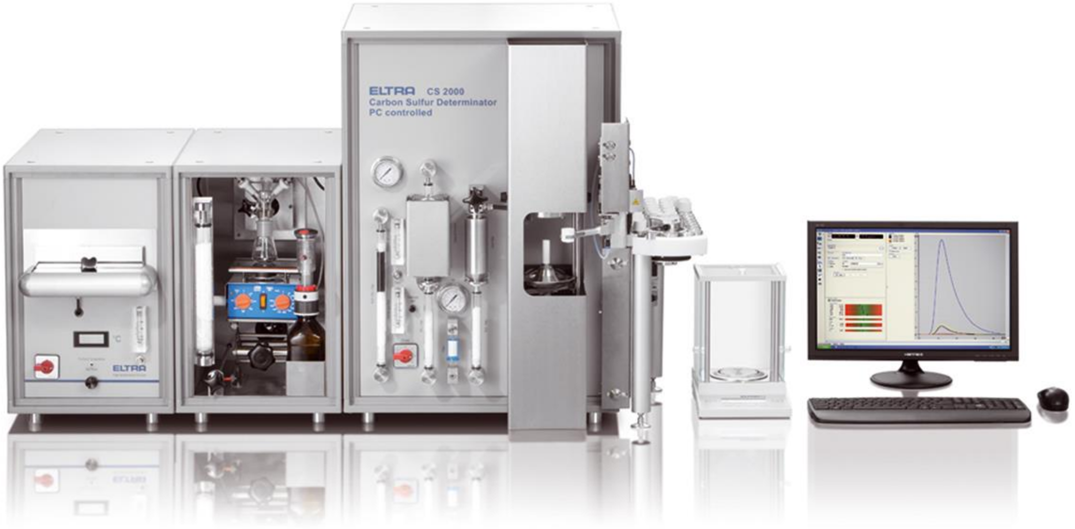
Service Manual

CS-2000 Carbon / Sulfur Determinator



Translation

ELTRA
ELEMENTAL ANALYSERS

Table of Contents

1 Notes on service instructions

1.1 Explanations of the Safety Instructions

In this Operating Manual we give you the following safety warnings

Mortal injury may result from failing to heed these safety warnings. We give you the following warnings and corresponding content.

DANGER

Type of danger / personal injury
Source of danger

– Possible consequences if the dangers are not observed.
- **Instructions on how the dangers are to be avoided.**

We also use the following signal word box in the text or in the instructions on action to be taken:

DANGER

Serious injury may result from failing to heed these safety warnings. We give you the following warnings and corresponding content.

WARNING

Type of danger / personal injury
Source of danger

– Possible consequences if the dangers are not observed.
- **Instructions on how the dangers are to be avoided.**

We also use the following signal word box in the text or in the instructions on action to be taken:

WARNING

Moderate or mild injury may result from failing to heed these safety warnings. We give you the following warnings and corresponding content.

CAUTION

Type of danger / personal injury
Source of danger

– Possible consequences if the dangers are not observed.
- **Instructions on how the dangers are to be avoided.**

We also use the following signal word box in the text or in the instructions on action to be taken:

CAUTION

In the event of possible **property damage** we inform you with the word “Instructions” and the corresponding content.

NOTICE

Nature of the property damage
Source of property damage

– Possible consequences if the instructions are not observed.
- **Instructions on how the dangers are to be avoided.**

We also use the following signal word in the text or in the instructions on action to be taken:
NOTICE

2 Discharging the oscillator

In order to carry out work on the oscillator of the CS800/2000, it is necessary to ensure that the oscillator has no stored energy. This is achieved by short circuiting the various potentials.

Attention:

This activity may only be carried out by a qualified electrician with sound knowledge of the CS800/2000 devices.

Only the Eltra discharge set (Order Number 11001-2005) may be used for discharging. The discharge set must always be inspected for visible faults before use.

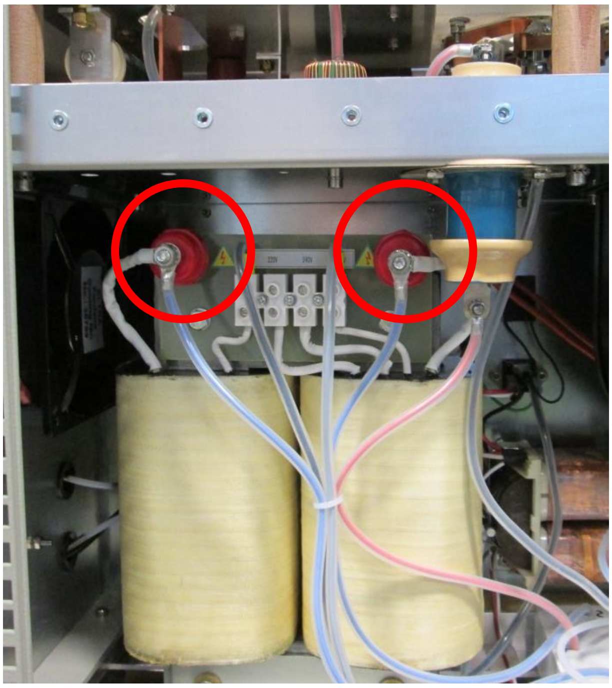
1000V insulating gloves (order number 8840-0453) must be worn during the discharging process to prevent an electric shock.

The protective measure is only effective if the discharge set and the insulating gloves are always worn together.

Discharge set: 11001-2005	Insulating gloves 1000V: 88400-0453
	

Implementation:

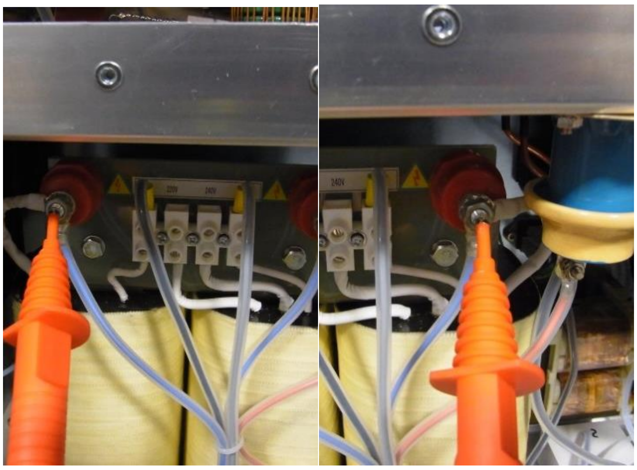
Disconnect the mains plug. Use a multimeter to check that the device is voltage-free	
Remove the housing cover on the device and disconnect the GND connector	

The clamp is attached to the mounting bracket of the oscillator	
In order to guarantee a safe GND connection between the crocodile clip and the device ground, a multimeter is used to ensures that the transition resistance of the set to the device ground is low (R<1 Ohm). To do this, one of the measuring tip on the multimeter is held on the protective earth of the device. The other measuring tip is connected to the tip of the discharge set.	
Attention! The oscillator cover must be removed carefully to expose the transformer connectors	

Attention!

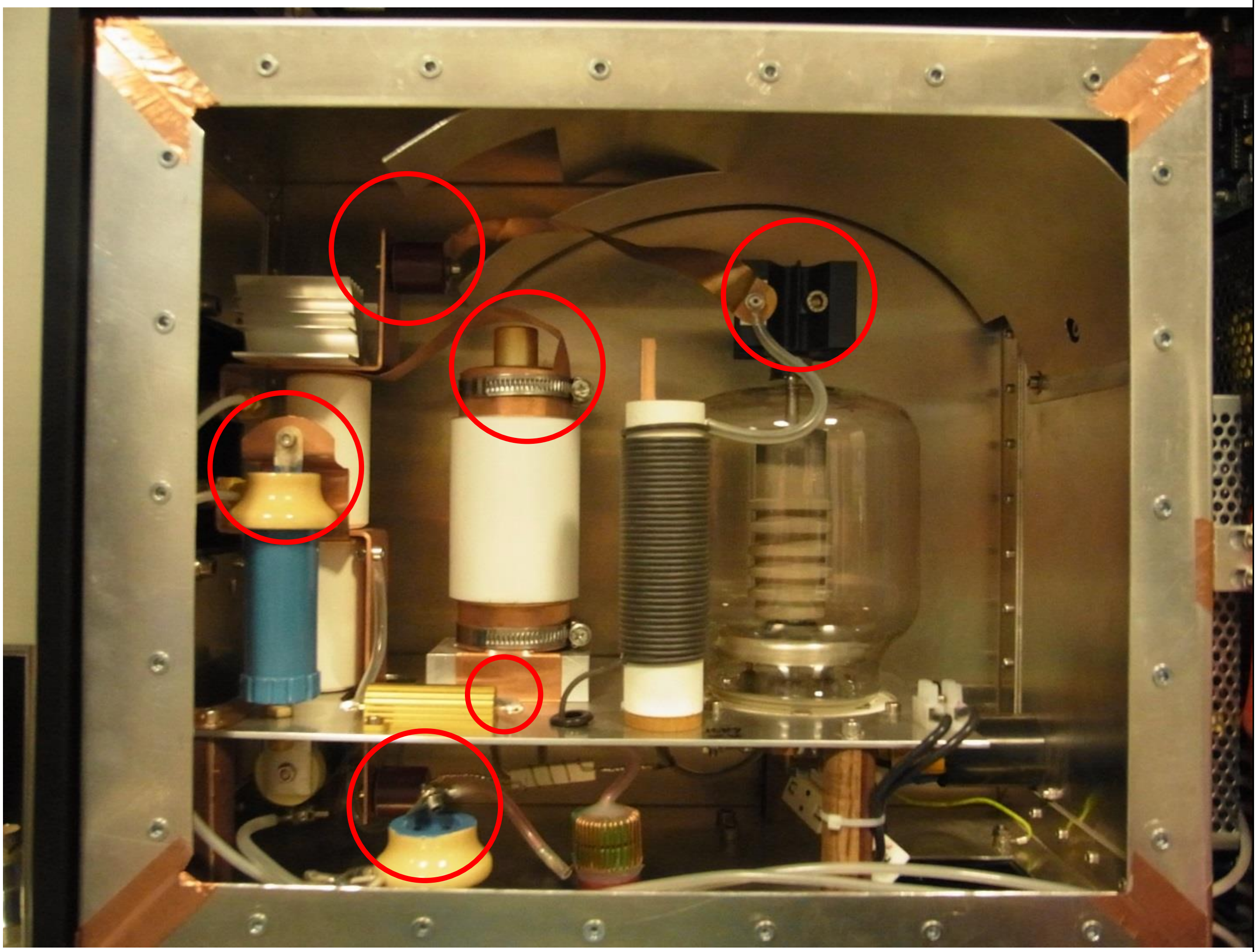
The measuring tip is now held first on the left-hand and then on the right-hand 4.4 KV connector of the transformer for approx. 5s

It is necessary to ensure that the tip stays on each contact for the full 5s.



Attention!

All marked components inside the oscillator are short circuited to ground using the measuring tip.



3 Faults

3.1 Check base lines

When this message appears on the PC screen, at least one of the base lines is either over +9.5Volts or below -9.5 Volts.
In order to read the base line voltages of all IR cells available, click on “base lines”

Fig. 1: Base line button

A window appears at the right upper end of the screen showing the base lines moving from the left to the right (time coordinate). In the middle of the right end of this base lines window, there is a small button. After clicking on it, a new window appears, displaying the base line voltages, described as “Inputs” and their “Averages”.
The description “Inputs” is made from the software point of view. The outputs of the cells are inputs for the microcontroller board and for the software.
It is advisable to watch the figures under “Inputs”. Do not observe the “Averages” because the response is delayed when the base lines change. This is a disadvantage when adjusting the base lines.

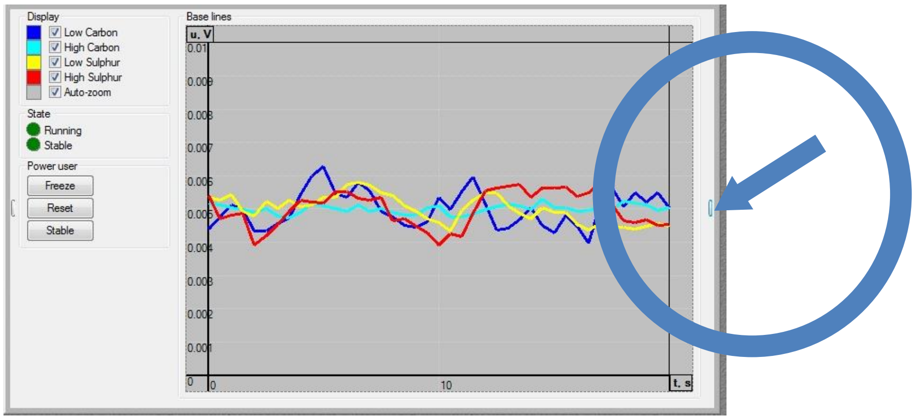


Fig. 2: : Activating Inputs and Averages Window

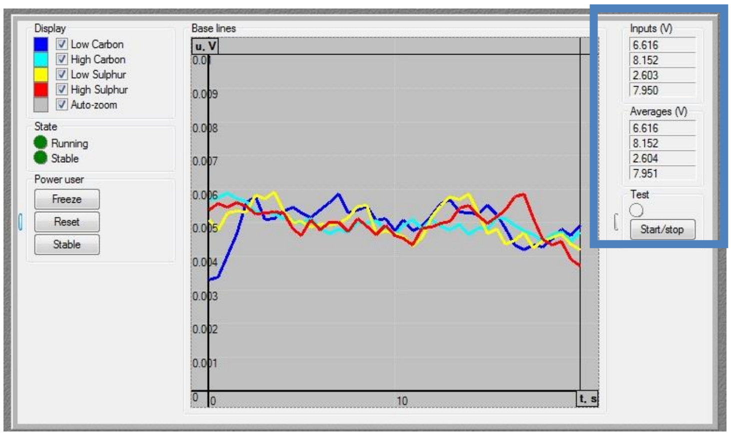


Fig. 3: Inputs and Averages Window

If any of the “Inputs” or “Averages” is over 9.5V, adjust a voltage of about 6 to 7V.

See chapter 3.2 “**Infrared base line adjustment**”.
The adjustment is preferably made when having carrier gas flow through the cells.

Notice

The IR cells have normally base lines adjusted to about 8V and the peak comes down during analysis, respectively during IR absorption by the measuring gas.
In case of golden paths, in the first couple of months after being in operation, the base line may goes up, which means that the paths become more reflective during this period. Therefore, the base lines of golden paths should be initially set rather at 5 or 6 volts instead of 8 volts. In the first couple of months the base lines go up, but the growing slows down and growing contamination finally causes the base line to start coming down.
The initial base line adjustment at 5 to 6 volts, prevents the maximum base line value from reaching 9.5V, where the error message “Check base line” appears. Note that this message is just a warning. The analyzer is not prevented from carrying out further analyses. As long as the base line remains below 10V, the results are correct.
If a base line is below -9.5V, an adjustment should be done as advised above. If this is not possible, then most probably there is a fault or a very strong contamination. See chapter 4.1 “**IR paths cleaning**”. In case of contamination, all cells available should have very low voltages, even negative ones.
If all available cells are below -9.5V there is most probably a fault that is common for all cells like no rotating chopper motor or a faulty infrared source. See chapter 2.35 “**The chopper motor doesn’t rotate**” and 3.3 “**IR source voltage setting**”.
See also Chapter 3.4 “**Analysis takes too long / RF-interference on the IR-cell, or on the electronic units**”

3.2 Fluctuating gas flow

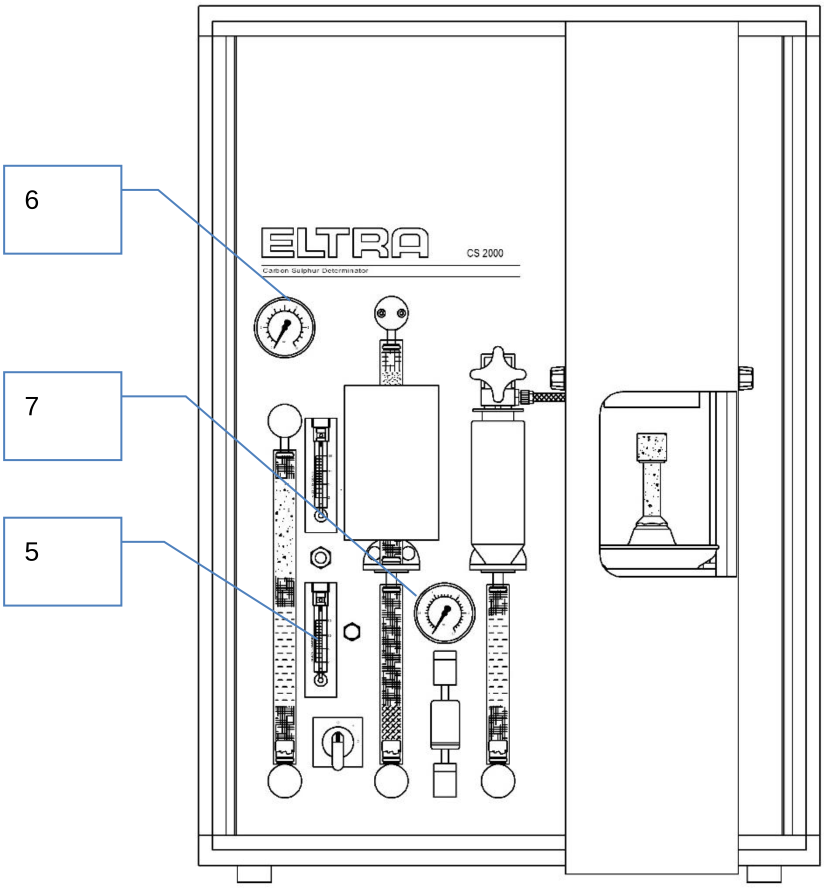


Fig. 4: Fluctuating gas flow

The flow rate is electronically controlled; therefore there should be no significant variation from the set value.

In case of a fault however, a control of the flow rate is no longer possible and the gas flow fluctuates. This can be caused, for example, by an excessive obstruction of the gas flow system or by a faulty component that needs to be replaced.

See the next pages of this chapter and chapter 3.1 "**Gas flow controller adjustment and jumper settings**"

Mostly, the problem lies in the saturation of the dust trap or of the chemicals.

In case the flow becomes lower and the regulating valve or the pump voltage goes higher during combustion, it is obvious that the flow regulator is working. Therefore the problem must be a restricted oxygen supply. When the accelerators start burning they take a lot of oxygen, so that the pressure in the furnace goes down, and as a result for this the flow may also go down

List of fault reasons in order of probability: (Details to the above points)

Induction furnace		Resistance furnace	
1.	Blocked metal dust filter	1.	Blocked chemicals
2.	Blocked chemicals	2.	Blocked furnace outlet
3.	Blocked paper filters	3.	Too low oxygen pressure
4.	Blocked lance hole over the crucible.	4.	The outlet tap of the oxygen bottle is not properly open
5.	Blocked hole of the ceramic heat shield	5.	A heavy item is placed on the plastic tube of the oxygen supply
6.	Too low oxygen pressure	6.	Twisted plastic tube inside the analyzer
7.	The outlet tap of the oxygen bottle is not properly open	7.	Blocked dust filter cartridge
8.	Faulty oxygen regulator	8.	Blocked fittings
9.	Contaminated or corroded solenoid valve	9.	Blocked flow sensor assembly
10.	Bent plastic tube of oxygen supply	10.	Electronic problem
11.	A heavy item is placed on the plastic tube of the oxygen supply	11.	Weak gas pump
12.	Twisted plastic tube inside the analyzer		
13.	The oxygen supply is interchanged with the compressed air supply		
14.	Blocked dust filter cartridge		
15.	Blocked flow sensor assembly		
16.	Electronic problem		

Blocked metal dust filter:

Clean the metal dust filter according to the operation manual.

Caution: Even if the filter may be brushed and cleaned in ultrasonic cleaner, some day will not be able to be cleaned any more. The filter doesn't last forever.

Check by removing the filter with the dust filter housing. See chapter: "**High carbon results are erratic**".

Don't remove the filter from its housing.

Turn the filter housing upside down and try to blow air through the smaller whole (about 16mm diameter) of the filter housing.

If you feel a remarkable restriction, replace the filter by a new one. With a new filter the air should pass practically free without any restriction.

Blocked chemicals:

The grains of magnesium perchlorate as well as of sodium hydroxide have to move when knocking on their glass tube. If they are cloggy, they are completely depleted and they have to be replaced. When the glass tube is turned upside down, the grains should fall off. If a screw driver is needed to stab the grains free, the chemicals had to be replaced much earlier.

Blocked paper filters:

The paper filters are small so that they are frequently forgotten or neglected, although they can block the flow when they are not replaced for long.

Blocked lance hole over the crucible:

The hole in the ceramic heat shield over the crucible in the induction furnace can be restricted or blocked.

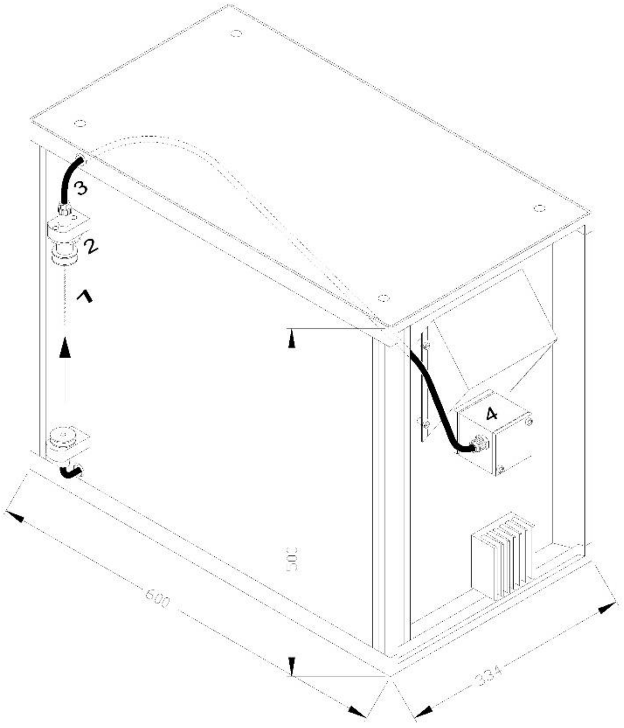
Clean by using the brass brush as described in the operation manual. If this may not be enough then clean the hole by using a piece of wire or a pipe cleaner.

Blocked furnace outlet:

For induction furnace, unscrew the cap-nut at the furnace outlet and remove the plastic tube. Pass through the fitting a pipe cleaner. Open the furnace in order to be sure that the pipe cleaner has passed thru the fitting reaching the furnace area.

Completely remove the plastic tube by unscrewing the left hand cap-nut on the dust filter assembly. Clean this fitting the same way like before. If necessary clean the plastic tube as well.

In case of resistance furnace operation clean the furnace outlet as shown below.



Push the tube (**1**) through the upper glass tube assembly (**2**), pass it through the tube (**3**) up to the inside of the dust trap box (**4**).

This should be done when the glass tube has to be removed anyway, for replacing the magnesium perchlorate (anhydrone). See also operation manual, chapter "**Dust cleaning".**

Too low oxygen pressure:

Check the oxygen gauge (6). The reading should be 1.5 bar (22.5psi). If the pressure is too low, it can be adjusted by pulling and turning clockwise the knob of the pressure regulator on the rear panel of the analyzer. It is placed on the left hand side and the knob is accessible from inside the analyzer. An adjustment is possible provided that there is sufficient pressure at the input of this pressure regulator.

Outlet tap of the oxygen bottle is not properly open:

It is important to properly open the small tap at the outlet of the pressure regulator of the oxygen bottle. If this outlet tap of the regulator is not properly open, you may have enough pressure at the analyzer when there is no or little oxygen demand. But when the oxygen demand grows, for example at the beginning of combustion in the

induction furnace when the sample needs a lot of oxygen to burn, the pressure may drop to a very low level if not enough oxygen can be supplied to the analyzer at the moment of high oxygen demand. The same problem will appear during furnace purging before or after the analysis, depending on the actual settings in the software.

Contaminated or corroded solenoid valve:

In case of exceptional materials like ores, solenoid valves can be contaminated up to the extent of failing. This depends mainly on the amount of sulfur and moisture in the sample. The most affected valves are the outflow valve V1 and the bypass valve V4 in as well as the valves switching from Induction to resistance furnace V11 and V12. See chapter "**Gas flow system**". The resistance furnace operation can only contaminate V11 and V12. The valves can be cleaned.

Faulty oxygen regulator:

A faulty oxygen regulator can of course cause a similar problem when it does not keep the pressure level at moments of higher oxygen consumption.

Bent plastic tube of oxygen supply:

When the plastic tube supplying oxygen from the bottle to the analyzer is bent, there will be the same problem like described in the above two subjects. There will be too low oxygen pressure in the analyzer, especially at moments of high oxygen consumption, like when burning samples or purging the furnace.

Oxygen supply is interchanged with the compressed air supply:

In case of reported bad combustion, check for correct connection of oxygen and compressed air supply. Compressed air in the induction furnace will provide combustion but a bad one, because of only 20% of oxygen existing in the air. Therefore the peaks are low and long, consisting of more than one peak, looking like mountains.

CAUTION Oxygen to the compressed air inlet can lead to the explosion of the pneumatic cylinder.

Blocked dust filter cartridge:

The dust filter cartridge is on the front panel so that contamination is visible for the operator. In the gas flow circuit, this dust cartridge is connected after the metal filter and its following glass tube with magnesium perchlorate, so that the carrier gas passing through the cartridge is already filtered.

Blocked fittings:

This case is very unlikely to happen in case of induction furnace operation, because the analyzed materials in question are inorganic materials like metals and ceramics, so that they don't create fumes, volatiles and moisture. Even cement analysis is not as critical as organics analysis. In case of analysis of materials causing major contamination, mainly when analyzing organic materials in the resistance furnace, the fittings of the IR cells can be blocked so that they have to be cleaned. See chapter "**IR paths cleaning and replacing**".

Also fittings elsewhere can be blocked, like the fittings for plastic tubes on the reagent glass-tube holders.

Blocked flow sensor assembly:

If the flow sensor is blocked, it should normally be replaced.

For those who may decide to clean them - please read the description about cleaning. Chapter "**Flow sensor replacing / cleaning**".

Electronic reasons for flow problems:

The flow controller consists of 3 components.

Induction furnace operation

1. The flow sensor
2. The board HF-42 (The lower half of the board only).
3. The proportional valve V6 (see chapter "Gas flow system").
4. Interferences from the induction generator. See chapter "**Analysis takes too long / RF-interference on the IR-cell, or on the electronic units"**.

The electronic devices involved in the flow regulation are the board HF-42 and the flow sensor. The only influence of the PC and of the microcontroller on the flow, is the start/stop the flow, for example to start it when oxygen pressure available, to stop it in case of gas saving mode etc.

For chasing flow problems, there is a possibility to avoid any involvement of the PC and of the microcontroller, by setting a jumper on the HF-42. To do this, move the jumper of J3 from A1-A2 to B3-B4. See chapter "**Gas flow controller and jumper settings**".

DANGER

G0002

Mortal danger from electric shock

Exposed power contacts - High Voltage

- An electric shock can cause injuries in the form of burns and cardiac arrhythmia, respiratory arrest or cardiac arrest.

• **Disconnect the mains power plug before opening the analyzer's cabinet.**

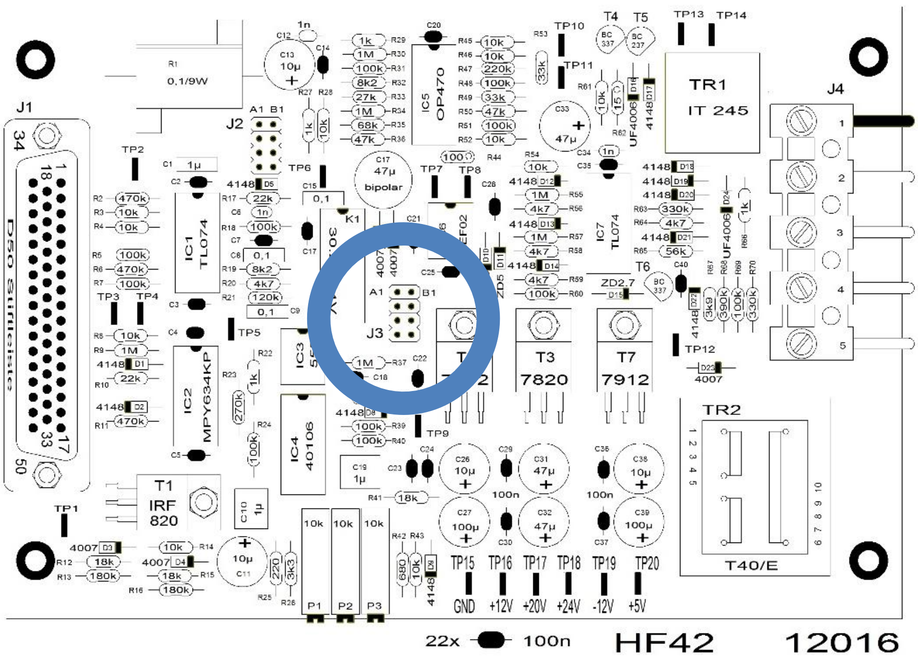


Fig. 5: HF-42

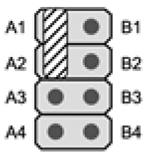


Fig. 6: Jumper position for gas saving mode

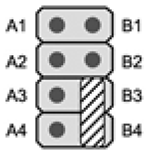


Fig. 7: Jumper position for continuous flow

In this case there is continuous flow when the main power switch is on Position 2.

Resistance furnace operation:

1. The flow sensor (same sensor also used in induction operation)
2. The electronic board PC-2 (see chapter “**Gas flow controller and jumper settings**”).
3. The gas pump (see chapter “**Gas flow system**”).

3.3 No combustion

3.3.1 Induction furnace operation

After clicking START of analysis or pressing F5 but the sample doesn’t burn, check the reports in the “status window” on the pc screen.

The following describes how to proceed depending on the displayed message

No oxygen pressure

See Chapter **“No or low oxygen pressure”**

No flow

If this message permanently remains in the “status window”, check the flow on the lower flow meter (Rotameter). The ball has to be in the range of 180 L/h. If it is in this range, then click on the “device state” window icon.

Fig. 8: device state window icon

Check the graph for L/h. (See software helps). If the vertical bar is not in the middle of the base line then calibrate the flow in the software as follows.

Pre-purging

If this message permanently remains in the “status window”, click the icon of the “configuration window”.

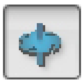


Fig. 9: configuration window icon

The duration of pre-purging is possibly entered much too long. Reasonable values are between 1 and 5 seconds, maximum 10 sec for very low carbon analysis.

Waiting for stability

If this message permanently remains in the “status window”, the infrared cell base lines are not stable or out of range. Click the Base line Icon and check.

Fig. 10: Base line icon

Integration delay

The message “Integration delay” appears for as many seconds as entered in the “configuration window”. Reasonable range is something between zero and 5 seconds. When the integration delay starts, the induction generator starts at the same time. In other words, the software starts the integration delay and the generator at the same time. This is valid also when the integration delay is set to zero seconds. In this case, the generator is started but “Integration delay does not appear in the status window. The status window displays then the next message of its sequence, which is “Analyzing”.

Analyzing

When “Analyzing” appears in the status window, it means that definitely the command for starting combustion is given by the software, so that if still there is no combustion, there must be probably a hardware reason for this fault.

After starting analysis, the word “Analyzing” appears in the configuration window.

The command from the microcontroller to start the generator is not received

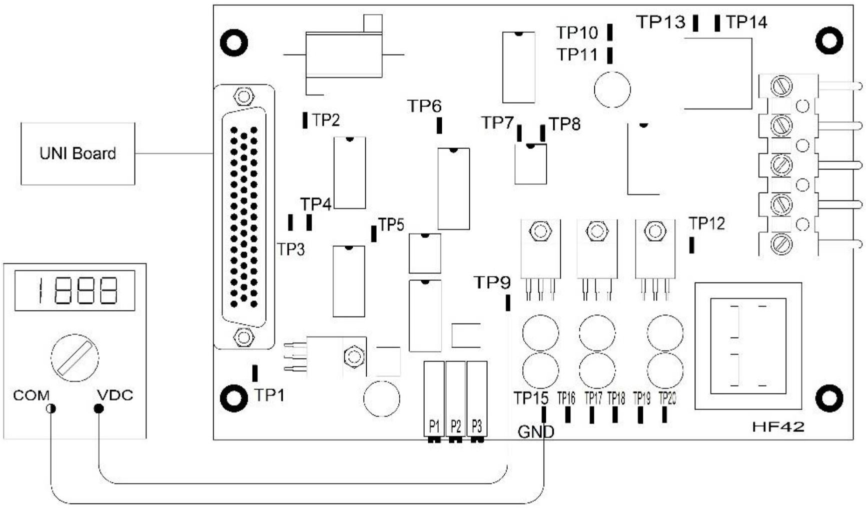


Fig. 11: Measurements on TP9

1. Measurements on TP9
– a signal of about 0.5 V should turn the generator on,
– a signal of about 12 V should turn the generator off.

If 12 V are measured, despite "Analyzing" appearing on the display, then the microcontroller board is defective or the connection from the HF 42 circuit board, pin 7 is loose.

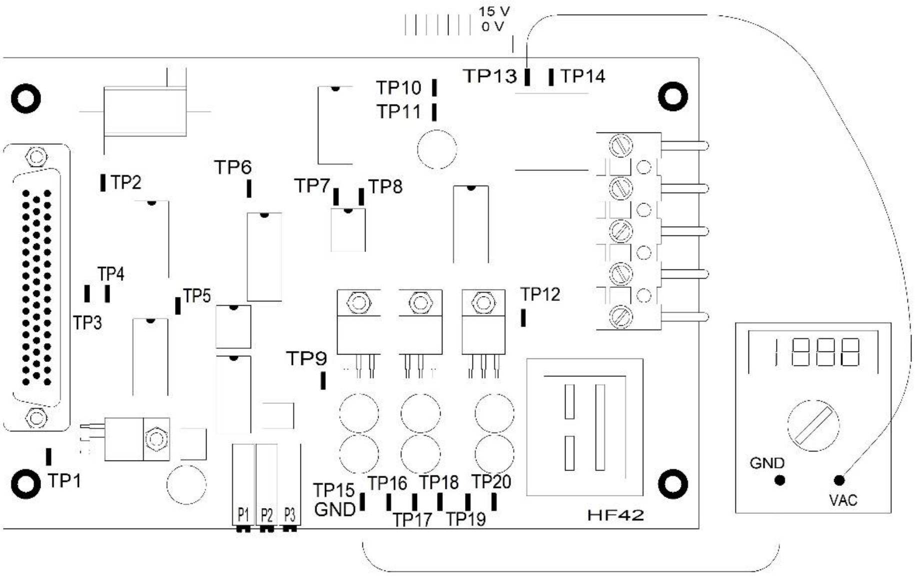


Fig. 12: TP13 test point

When the command for the generator is received (0.5 V DC), the triac triggering pulses must appear on the TP13 test point. If there is no oscilloscope available you can test this with a digital voltmeter. The displayed value depends on what type of digital voltmeter you have. There must be a voltage increase on TP13, once the word "Analyzing" has appeared on the display, or once 0.5 V are present on TP9. When no voltage increase occurs on TP13 , despite having 0.5 V on TP9; the HF 42 circuit board is defective.

NOTICE

After replacing the HF 42 board, make sure that the 50 pin plug is properly inserted. It takes a lot of force to push in 50 pins at once. 50 pin plugs that haven't been properly inserted are a frequent problem. Tighten the screws of the plug properly, to ensure a proper connection to the board.

2. Checking the generator tube

⚠ DANGER

Mortal danger from electric shock

Exposed power contacts - High Voltage

Ensure that the power switch is at position 3.

Check if the filament of the generator tube glows:

This can be easily checked:

Through the air vent holes of the furnace, the reflected light of the glowing filaments (heater of the cathode) should be visible.

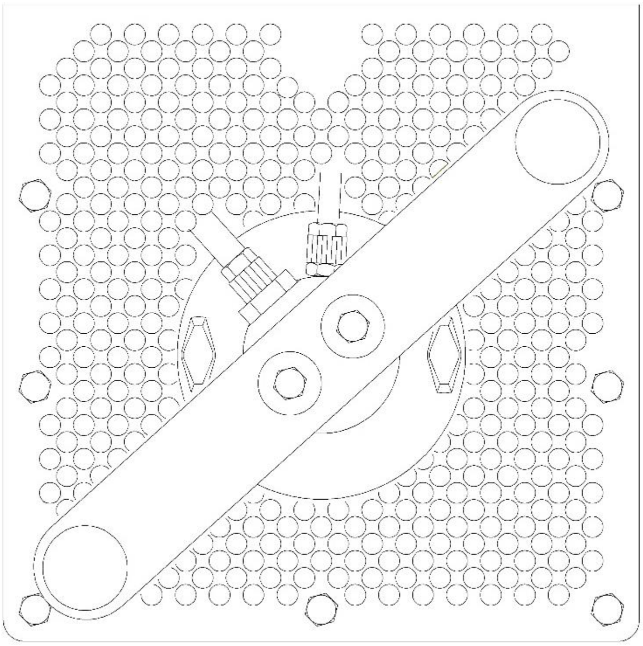


Fig. 13: Air vent holes of the furnace

3. The filament of the generator tube doesn't glow

Check the voltage of the filament, on the transformer, there should be 10 V AC on the secondary. If not, then measure 220 V AC on the primary, leads 2-3.

NOTICE

Set the power switch to pos. 1 before removing the tube, although it would be best to completely turn off the device and unplug the power cord.

⚠ DANGER

Mortal danger from electric shock

Exposed power contacts - High Voltage

Before touching any components or wiring, make sure the capacitors are discharged.

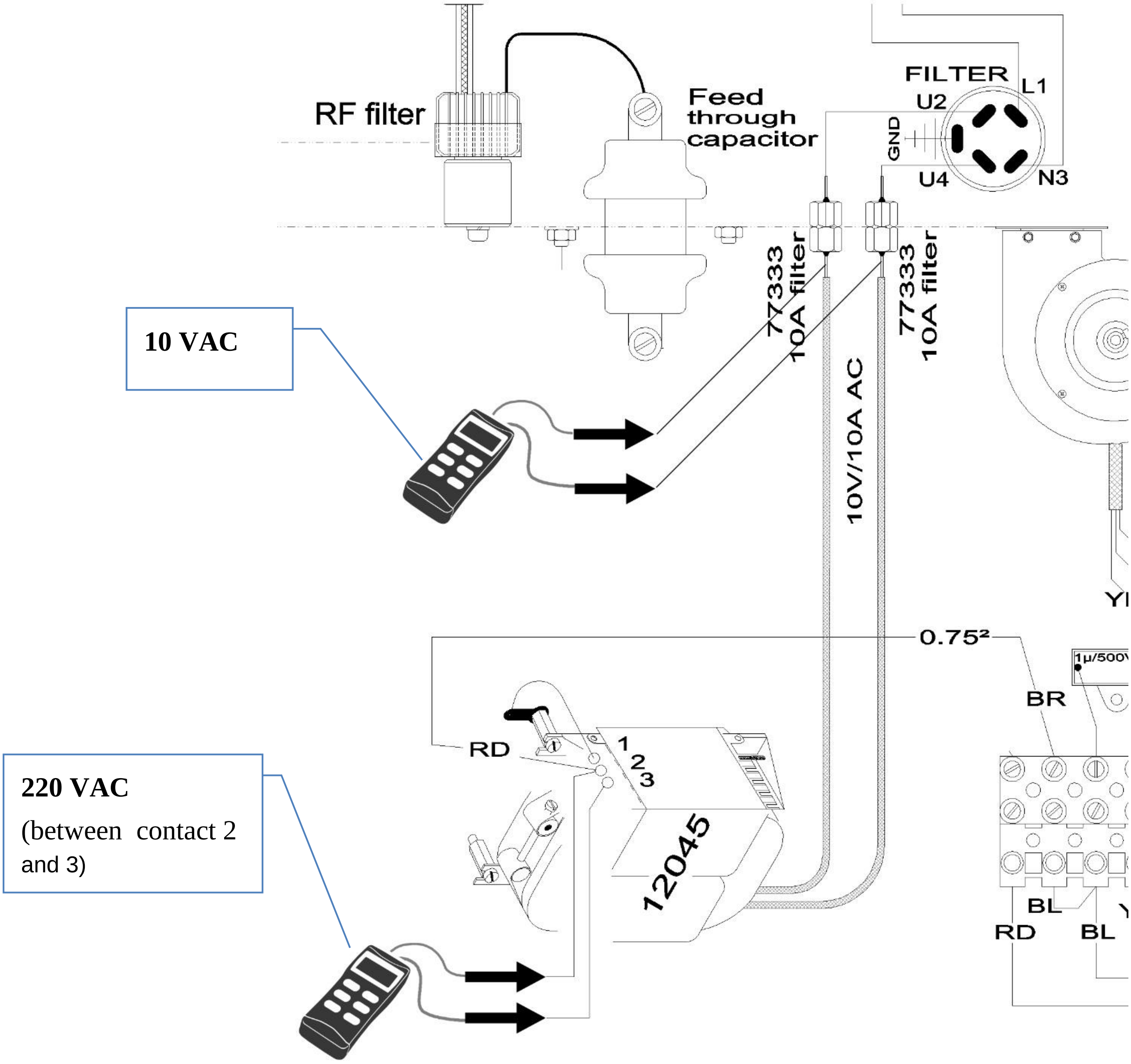


Fig. 14: Measurements

Check whether the filament is faulty, at the filament connections, only 1 Ohm must be measured. A very high or infinitive resistance means that the filament is burnt through and the tube needs to be replaced.

4. Checking the primary voltage on the high voltage transformer

DANGER

Mortal danger from electric shock

Exposed power contacts - High Voltage

When checking for induction power, always keep the furnace closed!

On the primary side of the high voltage transformer, you should be able to measure about 210 V AC; if not, the triac is possibly defective.

The filament voltage can be also measured as shown below. A direct measurement at the tube's socket rules out eventual interruptions on the way of the voltage from the transformer to the socket.

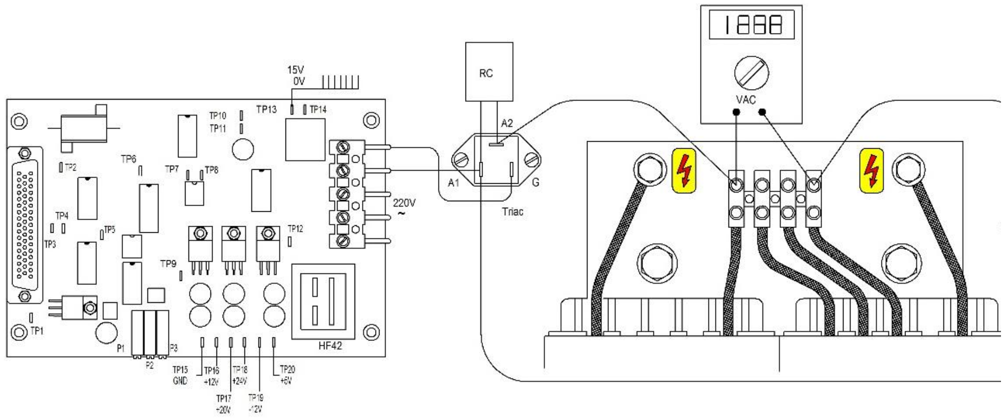


Fig. 15: Measurements - high voltage transformer

Once there is voltage on the transformer the triac must be OK. A relatively low voltage on the transformer could be a result of too high current so that the HF-42 board reduces the phase angle. IF so there is most probably a faulty component in the oscillator circuit preventing it from oscillating so that the oscillator tube takes a high DC current.

NOTICE

This can damage the tube. Therefore when you start for testing whether there is combustion keep your finger on the STOP button. If the sample does not start burning about 3 seconds after the generator starts, then immediately stop the analysis.

One thing that will give further evidence is the current taken by the analyzer from the mains power.

If the current goes up to a level of about 10A, then a faulty component prevents oscillations so that the tube takes all this power causing overheating of the tube within several seconds.

If the current does not increase, it means that the generator does not take power, for example due to a broken grid resistor.

In case the transformer has 210 V AC on the primary coil and there is still no combustion, check the windings of the transformer as follows:

- switch off the analyzer and disconnect the main power plug.
- Measure the resistance of the primary coil.
- It must be extremely low, about 0.8 Ohms between the
- screws labeled 0 and 270.
- Measure the resistance of the secondary coil between the two screws on the – ceramic insulators where the wires of the rectifier are connected.
- The resistance is approximately 322 Ohms.

5. The rectifier could also be faulty

Checking the high frequency generator

DANGER

Mortal danger from electric shock

Exposed power contacts - High Voltage

Never try to measure the voltage here!

Due to high voltage in the range of 7000 Volts (amplitude), there should be no measurement on the rectifier under power. If no spare rectifier available to exchange, then test by using a scope according to the following drawing.

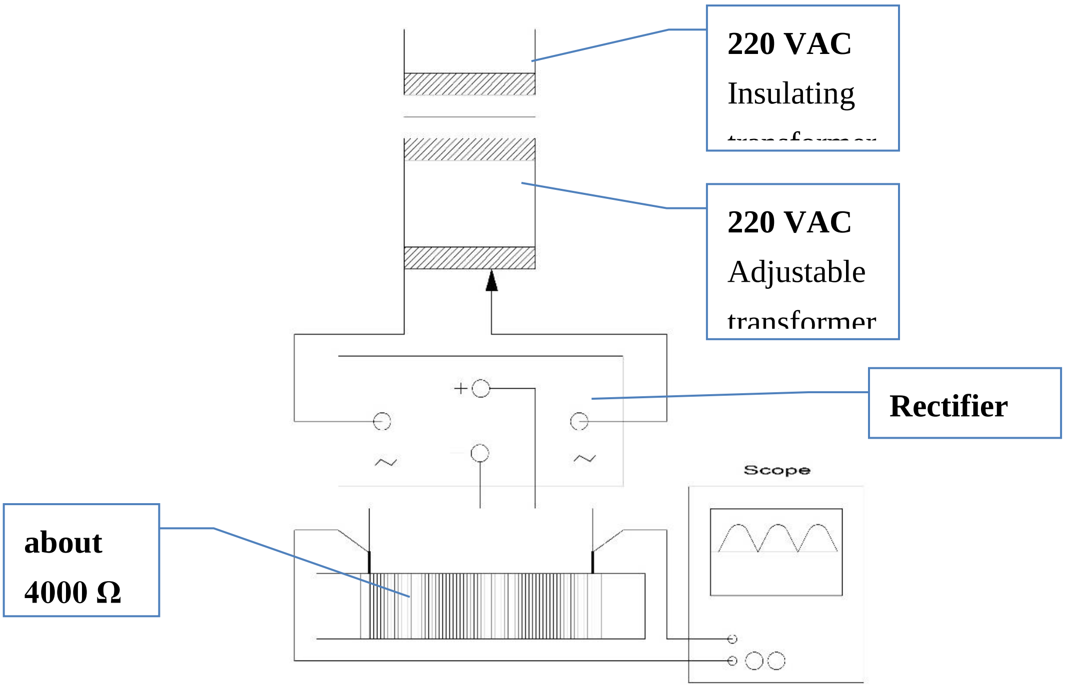


Fig. 16: Rectifier

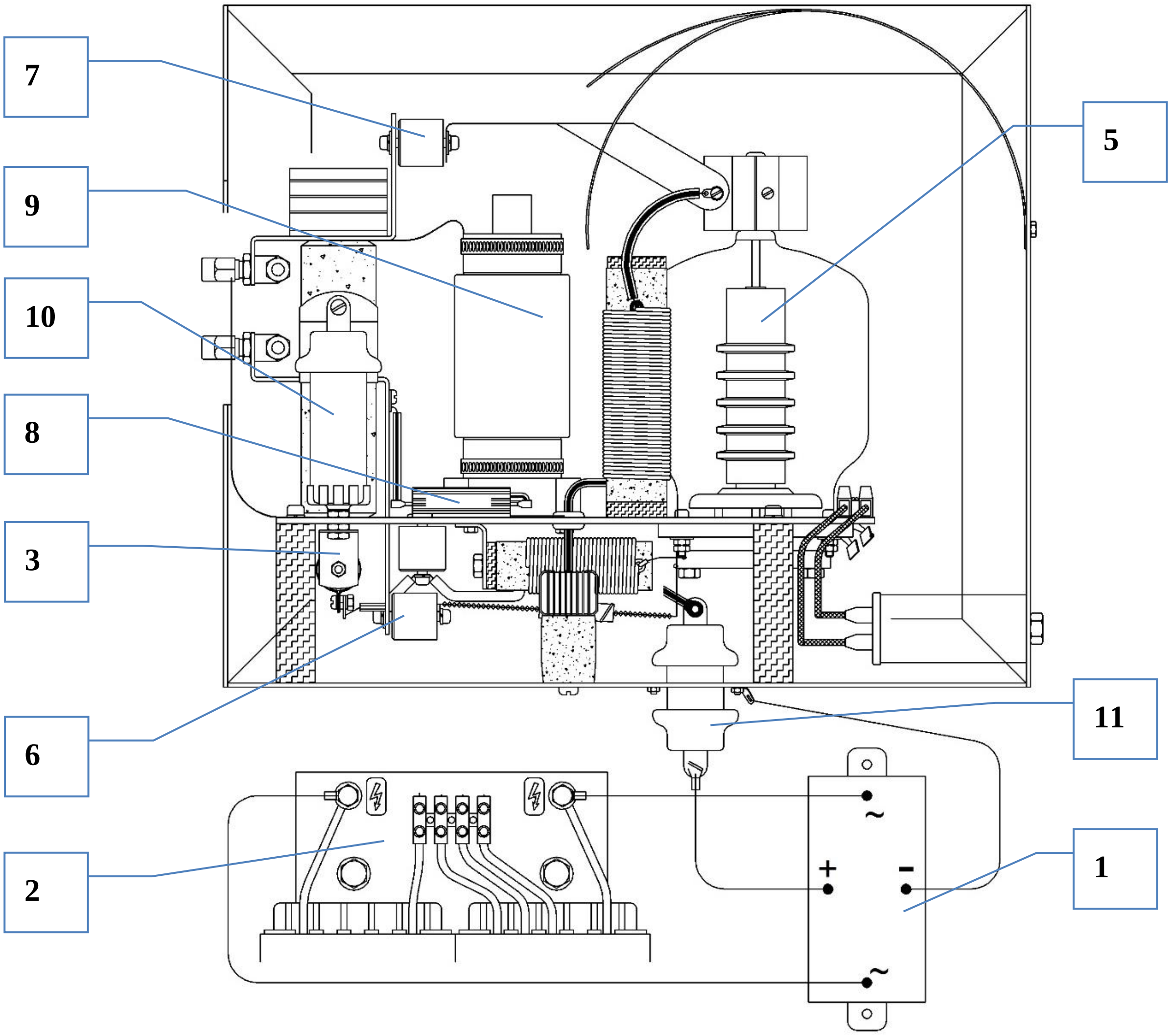


Fig. 17: Draft high frequency generator (1-4-4 + 1-4-5S)

As there is high voltage (5000V) and high frequency (19.2MHz) present, a measurement would be very difficult and, above all, very dangerous. Before the generator cover plate is unscrewed, the device should be turned off or, better, the power plug pulled out.

⚠ DANGER

Mortal danger from electric shock

Exposed power contacts - High Voltage

Before touching any components or wiring, make sure the capacitors are discharged.

You should check the connections in the oscillator circuit to ensure all screws are turned tightly, especially all the cap screws on the combustion coil.

The electrical connections and resistors should be checked with an ohmmeter. If the resistor 2.7K / 100W (3) is open circuit, then there is no oscillation, but also no power consumption.

The tube doesn't take any current at all. The parts e.g. tube and rectifier should be replaced one by one.

6. The ground connection of the tube’s cathode is interrupted.

The cathode of the oscillator tube is connected to the ground. The cathode is connected with one of the two leads of the filament inside the tube. So, one of the two filament plugs on the socket is connected to the chassis having this way a ground connection

The filament lead (socket) connected to the chassis, is the upper one of the two which are connected to the multimeter. The grownd connection is done by using a small copper sheet. It is on one side soldered to the socket and on the other end it is fixed on the chassis with a screw.

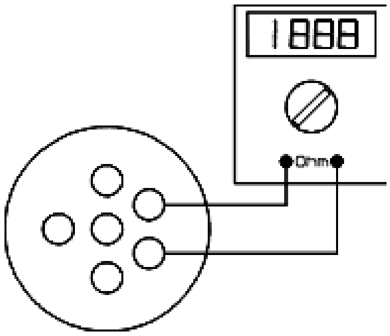


Fig. 18: Socket top view

7. Loud buzzing sound when the generator turns on

If during integration (combustion period) the high voltage transformer is making exceptionally loud buzzing sound when the generator turns on, also when running the furnace empty still the loud buzzing appears, this means that obviously for some reason, the triggering of the triac has changed.

If you are sure that the noise appears only during integration period (combustion period) then the problem could be in the generator. The unusually loud noise could be due to current limitation by phase angle control.

The oscillator tube may not be oscillating due to a tube fault so that it takes a very high DC current causing the current limit circuit to reduce the phase angle. Replace the tube. This is also the easiest thing to try so that it can be done by the customer.

NOTICE

The oscillator tube can be damaged due to overheating if for some other reason the new tube may not be able to oscillate. For testing after installing the new tube, put crucible with sample and accelerators into the furnace like you use to do with every normal analysis. After starting analysis watch carefully the furnace to see the light of the burning sample/accelerators. If a couple of seconds after generator start (transformer noise, base lines for peak on the PC screen) there is no combustion to see in the furnace then STOP the generator by clicking STOP on the screen.

NOTICE

When testing for induction power, always test with closed furnace.

NOTICE

When looking to find out whether there is combustion or not, STOP the analysis cycle about 3 seconds after it started. If there are oscillations, after 3 seconds the sample (steel or iron chips) will have visible signs of starting burning. But if you wait up to the end of the analysis cycle in order to check whether there was combustion, it could be already too late for the tube due to overheating.

When there are no oscillations, the tube takes a high DC current, so that after several seconds, the anode of the tube starts glowing from the lower end. This can be visible when the environment is not bright or it is dark.

It is practically not possible to do any measurements on the generator due to very high voltage and due to high frequency in the oscillator (in case of functioning). So we have to solve the problems by looking and trying.

One reason could be the resistor (8) having a short circuit. Normally its resistance has the value of 200K.

One more possibility is a faulty capacitor. Check the capacitors, mainly the one on top (7) of the oscillator circuit which is connecting the anode of the tube with the oscillator circuit. Check also the grid capacitor (6) which is placed underneath the oscillator chassis. Try to find out whether they are broken by applying a reasonable force on them to see whether they are still in one piece.

Check also the other, bigger capacitors (9), (10) and (11) however if one of them was faulty, most probably the fuses would blow.

3.3.2 Resistance furnace operation

See Chapter 2.4.2 **“IResitance furnace operation”**.

3.4 Bad combustion

3.4.1 Induction furnace operation

In most cases the reasons for bad combustion are:

– Problems with the flow
– The Generator (oscillator) tube is not powerful enough anymore. Norma lly this does not occur suddenly. It is rather a long process.
  (Part number 77210)
– The contacts of the tube are bad.

Some more hints:

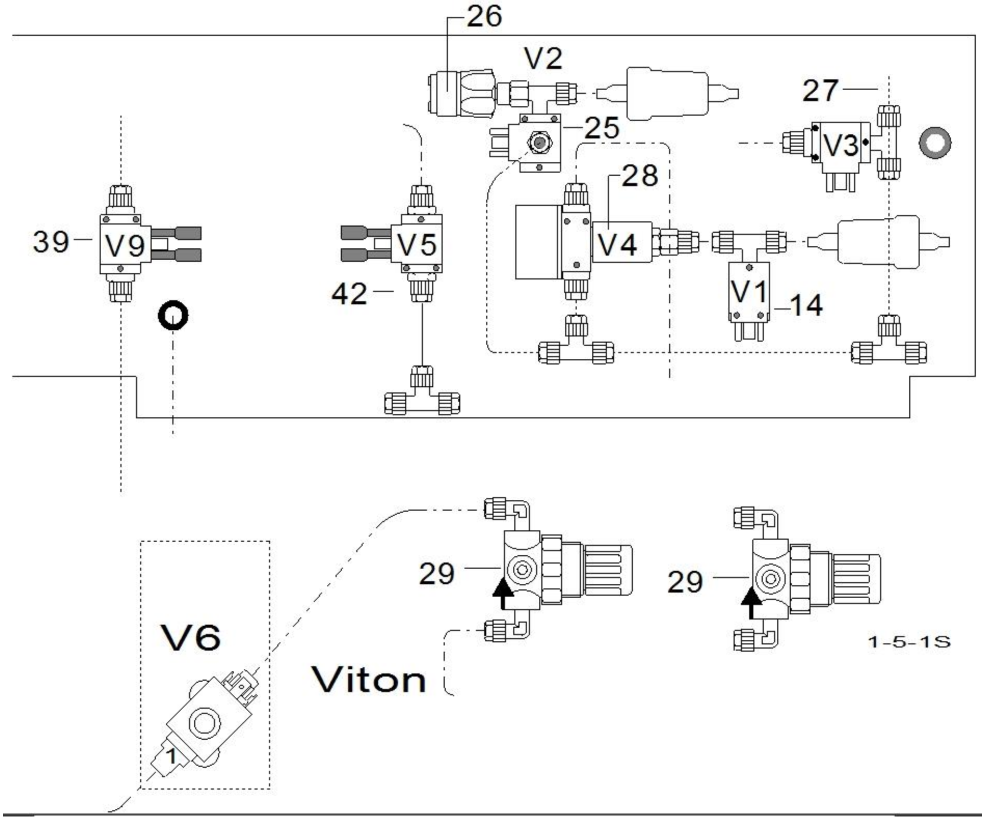


Fig. 19: bypass valves

The bypass valve V4 (28) is either falsely activated during combustion, or the plunger jams. In this case, the oxygen flows through the bypass valve into the IR-cell and not through the furnace. The furnace remains nonetheless under oxygen pressure.

– Measure the voltage to the bypass valve V4 (28)
  24 Volts DC while the furnace is open is normal.
  Zero volts when the furnace is closed is normal.
– Clean the valves

3.4.2 Resistance furnace operation

No combustion:

The operating temperature is mostly 1350°C so that it is easy to recognize by looking into the furnace, whether the furnace is hot or not.

Caution For looking into the furnace be sure to wear protective glasses and to hold radiation absorbing glass in front of your eyes.

In case the furnace is hot but still there are doubts about the true of the temperature, the resistance furnace temperature can be measured by entering a thermocouple connected to appropriate digital thermometer.

Fig. 20: Temperature control

The tip of the thermocouple should be in the middle of the hot zone where the combustion boat use to be. The thermocouple must be long enough in order to make sure that the junction of the thermocouple wires to the cable does not become hot. A thermocouple length of 50 cm is appropriate. In case the furnace temperature is over 1000°C the thermocouple has to be of type S. It is not usual to have it in this length available. If a 300mm type S thermocouple is available, a compromise is to enter the tip up to the beginning of the hot zone to prevent the junction temperature of the cable from overheating. If this is not available then set the furnace temperature to 1000°C and check with a long type K or N thermocouple.

In case the resistance furnace is completely cold:

- check the set temperature. If there is nothing shown on the display, then check the availability of mains power. Take a look at the breaker on the back of the furnace and at the breaker of the power line.
- If the display shows the right “Set point” and the displayed actual “Furnace temperature” is displayed very low but corresponding to the real furnace temperature, most probably the heating elements are worn out and broken so that they have to be replaced. See

operation manual chapter “**Replacing the heating elements**”. If you want to be sure that the heating elements are broken, then measure the voltage on the wires to the heating elements.

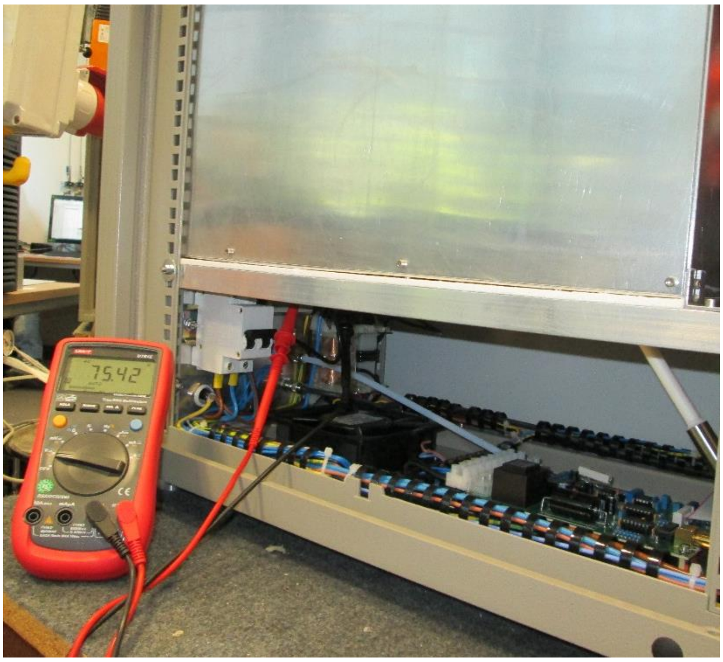


Fig. 21: Measuring the voltage

– If the voltage is 230VAC heating elements but the furnace is cold, the heating elements are broken. See chapter “**The resistance furnace is completely cold or too hot”.**

- In case the “Set point” is shown correctly but the “Furnace temperature” shows “-1” without any other following digits, the thermocouple is defective (interrupted). Replace the thermocouple. See chapter “**Thermocouple replacement”.**

Bad combustion:

– The furnace temperature is too low, see chapters “**Resistance furnace doesn’t reach full temperature**” and “**The resistance furnace is too cold or too hot.**”

– The sample contains a substance that **doesn’t burn easily**.

Some materials contain sulfur compounds which are very difficult to burn, i.e. they need higher temperature than **1550°C** to properly burn in a reasonable time.

An **improvement** can be achieved by **adding accelerators**, such as iron phosphate to coal samples that contain pyrites, or vanadium pentoxide to cement samples.

For materials which require such high temperatures to burn, we recommend induction furnace analysis.

– No oxygen flow, see chapter “**No oxygen flow”**

3.5 Furnace does not close

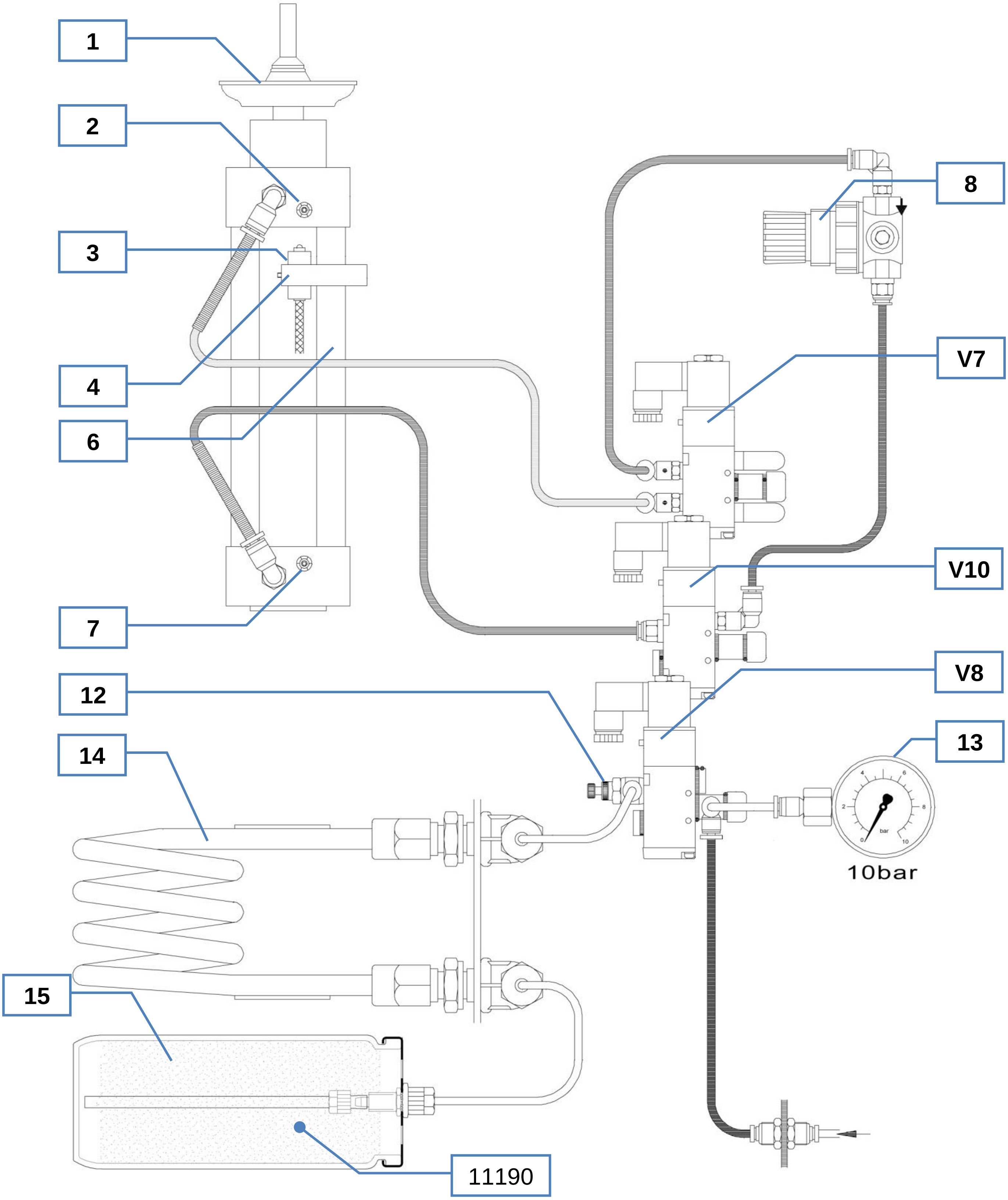


Fig. 22: Pneumatics (schematically)

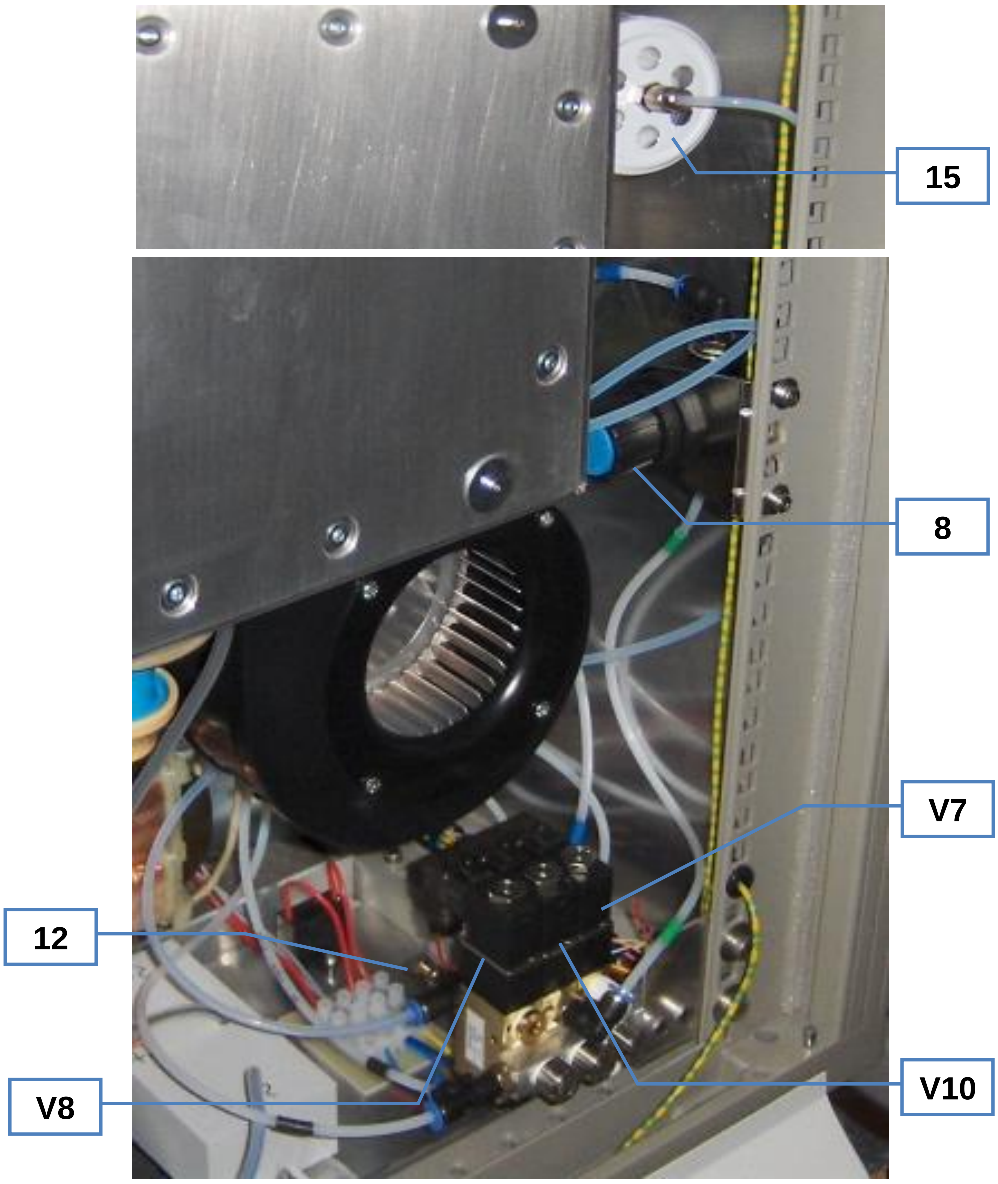


Fig. 23: Pneumatics (photo)

If there is little or no compressed air pressure, the furnace cannot close.

This pressure is shown on gauge (13), on the front-side of the analyzer.

It must be between 4 to 6 bar (60 to 90psi).

The screw (2) must be turned counter-clockwise, as much as possible.

Adjust regulator (8), so that the furnace floor can rise completely, without shaking; while a person still can stop the moving furnace floor with only one hand.

This is a safety precaution.

Repeat above instruction, until the adjustment is completed. Now, the upward speed is fast enough, yet safe for the operator. The pressure regulator (8) is found on the inside, on the right-side section of the analyzer, installed on the rear panel.

One of the pneumatic valves (V7) or (V10) (or both) is malfunctioning.

The magnetic coil of the pneumatic valve (V7) or (V10) is not powered. The furnace floor goes up, when valve (V10) receives 24 VDC.

3.6 Analysis takes too long

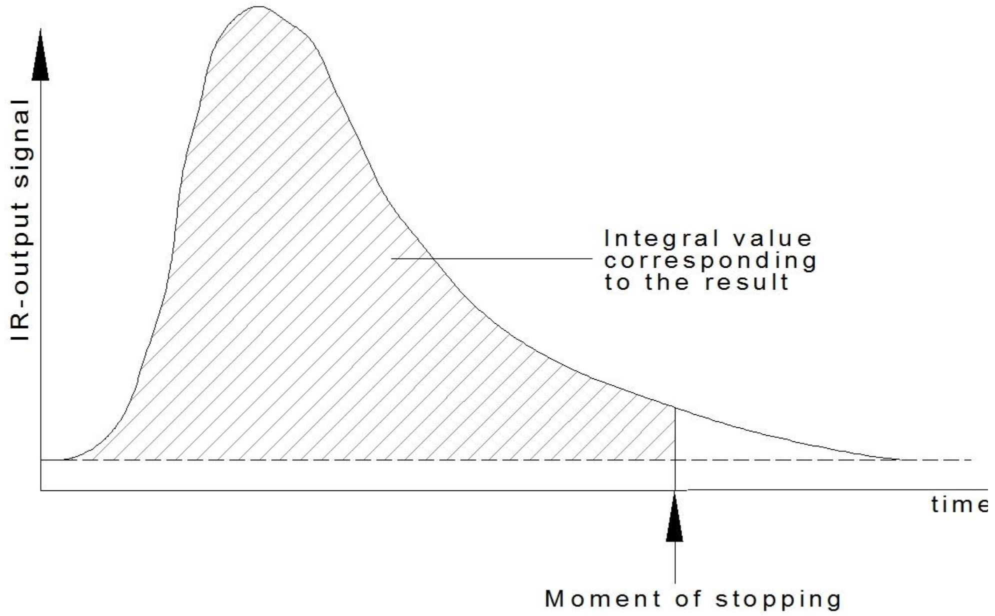


Fig. 24: Analysis time

The analysis respectively the combustion, takes normally a maximum of 100 seconds. At the beginning of combustion, the IR-cells signals start going up on the computer screen, reaching a peak maximum depending on the C resp. S concentrations in the sample. When the signal comes down, the analysis will be terminated when the signal has reached a comparator level. The value of this comparator level is entered in the configuration window of the software.

If, for some reason, the signal may not come down to the comparator level, the analysis is terminated when the maximum analysis time expires. This time is also entered in the configuration window.

The analysis stops also when the maximum analysis time expires before the signal comes down to the comparator level.

The meaning of setting a maximum analysis time is to protect the induction generator from overheating, in case the signal may not come down to the comparator level. One reason why the signal not to come down to the comparator level is that Hydrocarbons from the oxygen burn on the hot crucible, preventing the IR-signal from coming down to zero resp. down to the comparator level. One more reason is a too low comparator level, so that a small positive drift of the base line during analysis makes the base line higher than the comparator level at the end of the combustion. In such cases, the comparator level should be set higher.

The comparator level value entered into the configuration window is a minimum value which increases according to the peak maximum of each analysis. During combustion, the software takes the peak maximum to add to the entered comparator value an additional amount depending on the actual peak maximum.

3.6.1 RF-interference on the IR-cell, or on the electronic units

If the generator's high frequency disrupts the electronic units or the infrared cell, then the base line on the PC monitor appears jerky.

DANGER

Mortal danger from electric shock

Exposed power contacts - High Voltage

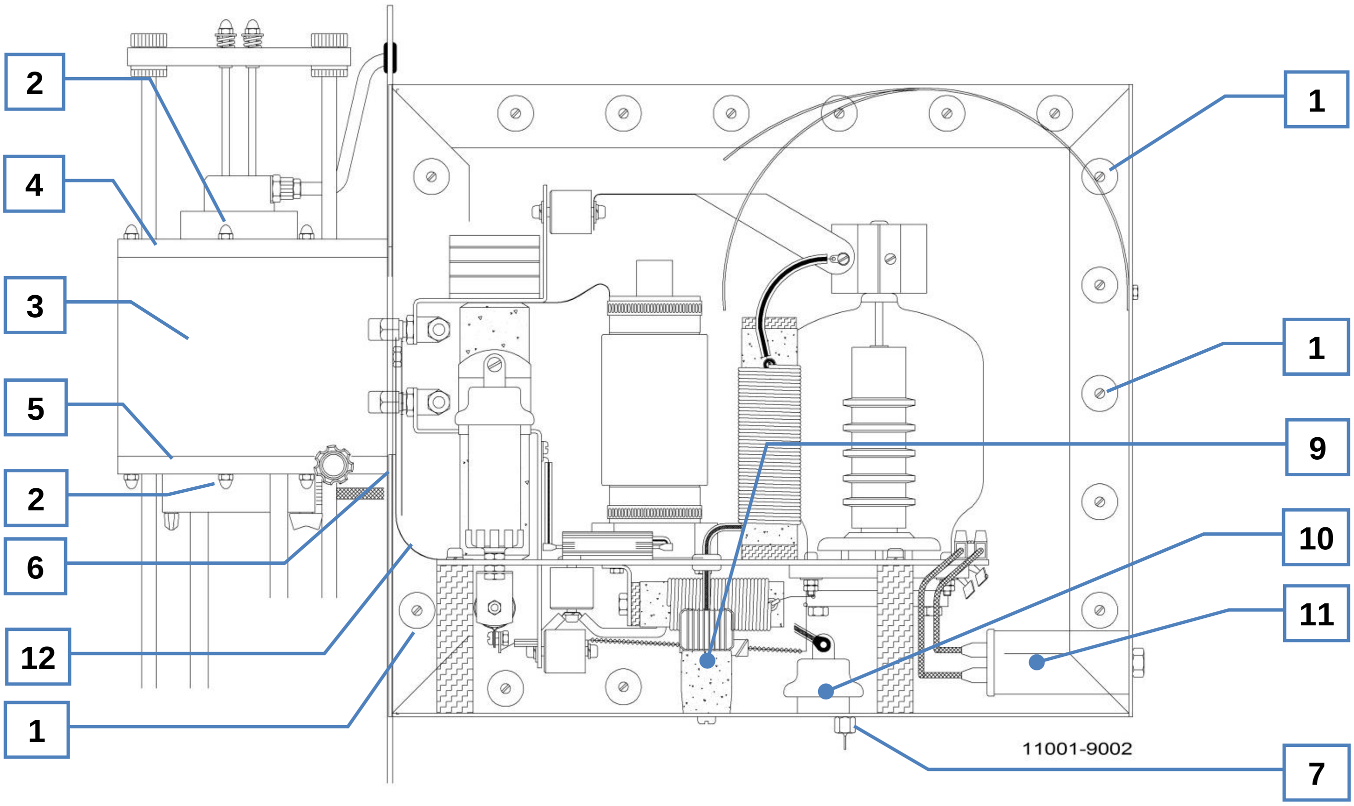


Fig. 25: Draft high frequency generator (1-4-4 + 1-4-5S)

The causes

– The screws (1) are not tightened properly, or not all 22 of them are screwed in.

– The cap nuts (2) are not tightened properly or not all 14 are in place.

– The cover (3) does not seal properly with the plates (4) and (5) or with the contract straps behind it, on the front panel (6)

– One or both filters (7) are not OK

– The filter (11) can also be damaged in this way.

– When the ground strip (12) is not connected after removal or replacement of the oscillator the filters (7) will defect. In this case the drift appears after the generator is started. In order to find out whether is high frequency interference, carefully disconnect a primary wire of the high voltage transformer. If the drift remains the same after starting analysis cycle, then high frequency interference is excluded.

– The capacitor (9) is out of order

– The capacitor (10) is out of order. This is however less likely.

In case of failure of this capacitor, most probably the fuses blow.

3.6.2 Additional reasons for excessive analysis duration

– Dirty dust trap, see Operation Manual chapter "**Cleaning the dust trap"**
– Saturated chemicals, see Operation Manual "**Filling the reagent tubes"**
– Cotton, glass or quartz wool is pressed too tight.
– The oxygen is not pure, or the catalyst furnace is faulty or cold, or the copper oxide is depleted, see Operation Manual "**Filling the reagent tubes"**
– The temperature of the infrared cell is not yet stable. Either it is not switched on for at least 1 hour, or the oxygen flow has not yet been running for 10 to 15 minutes (power switch on setting 2), see Operation Manual "**Main power connections"** and **"Work breaks"**
– The thermostatic control of the infrared cell is defective, see "**IR thermostatic control** "
– Excessive combustion temperature, resulting in high blanks from the crucible (**CO2**).

3.6.3 One of the IR-sources is unstable

– Small resistance changes of one or more **IR-sources** can cause the

current to vary, thus affecting the intensity of the **IR-radiation.**

This problem will affect all the channels, due to the fact that the **IR-sources** are all connected in series.

In order to find out whether this problem is present or not, an analysis cycle should be run without a sample or a crucible. The baseline of the **IR-cells** can then be monitored on the PC screen. See "**Software helps"**

The baselines should be quite stable. The drift within the usual time of analysis should be in the range of 2 to 5mv, depending on the path lengths.

Remark Drift is the average of the noise.

Due to the fact that the **IR sources** are connected in series, if one of them is damaged, a typical effect is that all base lines drift simultaneously in the same direction, with occasionally changing slope from positive to negative. However the same effect appears in case of faulty power supply when the IR source voltage drifts up and down. This is however less likely.

It is difficult, in case of such problem, to find which **IR-source** is faulty and it is therefore easier to replace them all.

– A window of an **IR-path** is not gastight. The measuring gases pass through the leakage, either into the chopper housing or to the **IR-detector**. In this case the typical effect is that the base line does not come down to the initial starting level at the end of analysis, but it remains at a constant level over the base line.

Perform a leakage test of the **IR-paths**. Replace the faulty **IR-path**. See chapter "**IR path cleaning and replacing"**

– The infrared power supply is defective, so that the voltage stabilisation does not function.
– The Infrared electronics are faulty. See chapter "**Infrared electronics"**

3.6.4 The power voltage sinks below 180 VAC

– Even a momentary drop in the voltage is enough to cause problems.

Use a voltage stabilizer.

3.7 Development of dust when closing the furnace

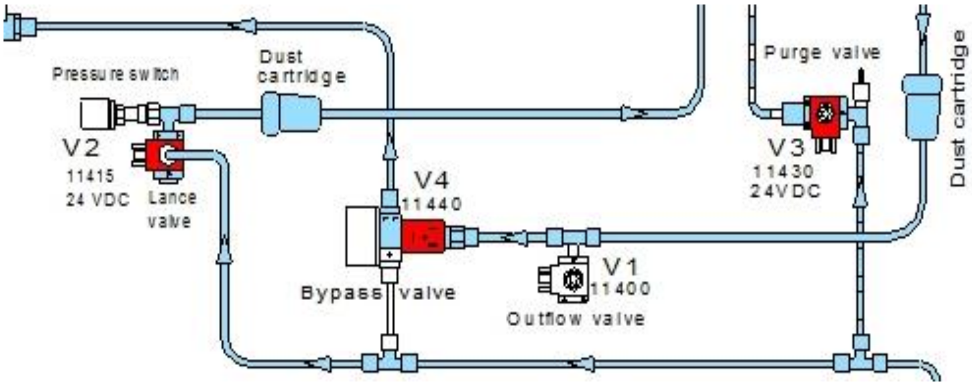


Fig. 26: Gas-flow diagram - furnace closed

This happens when there is no restrictor in the left hand fitting of the valve V3 or when the internal diameter of the restrictor is too large. This can easily be checked when removing the connected tube.

The restrictor should have an internal diameter of 1 mm.

See draft **"Gas-flow diagram - furnace closed"**

in the chapter "**Modification Overview**".

The sample material is causing dust:

This will be caused mainly through tin analysis. Tin causes a light grey dust. The same problem appears when tin is used as accelerator. Therefore using tin as accelerator should be avoided. Also the tungsten – tin mixture shouldn't be used. Almost all different materials can be analyzed without the need of tin accelerators.

See Operation Manual chapter "**Applications**".

Usage of other materials:

Cast-iron causes brown dust during the analysis.

When the dust is yellow, too much tungsten is used as accelerator. If the dust is brown, too much iron accelerator is used.

See Operation Manual chapter"**Applications**".

3.8 Erratic results

There are a lot of different reasons for this

- Saturated chemicals or clogged dust filter
- Heterogeneous samples
- Leakage
- Flow problems
- The electronic noise or drift of the infrared signal
- It can happen quite often that the combustion start is delayed and the analysis time is too long
- Incomplete or bad combustion
- Too high blank value for the crucible and tungsten. This will be especially noticeable, mostly though, in the low carbon channel
- Widely different weights of sample and accelerator (tungsten)

High carbon results are erratic:

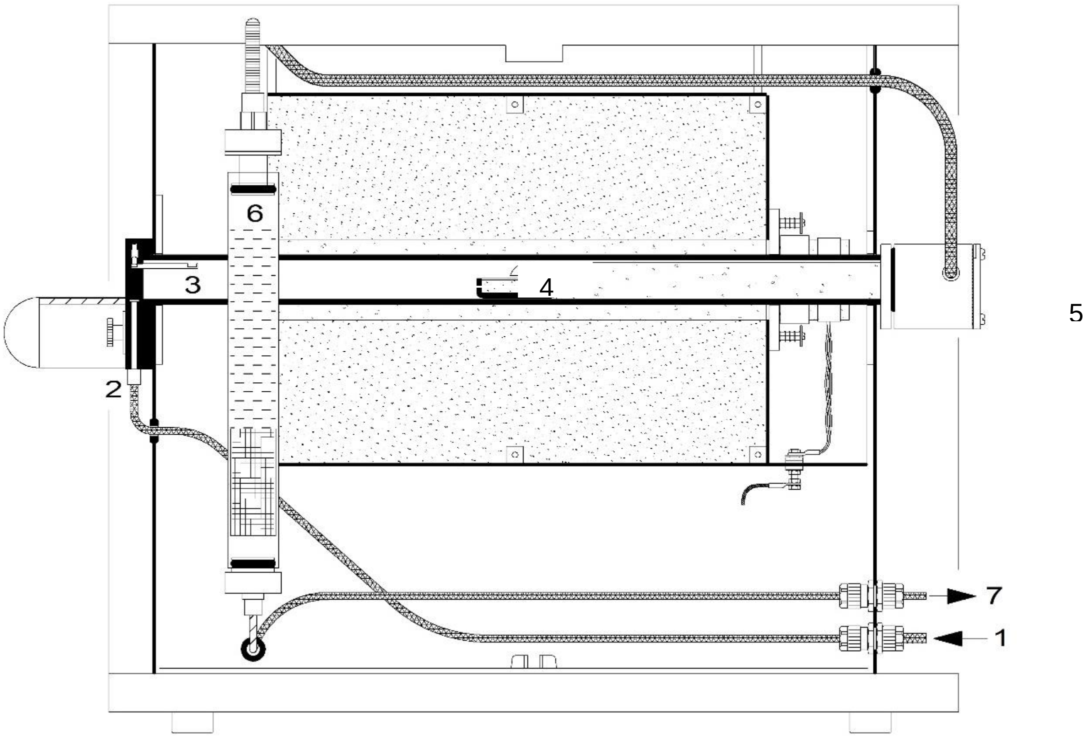
Even if the filter may be brushed and cleaned in ultrasonic cleaner, someday will not be able to be cleaned any more. Filters don’t last forever.

Clean the filter and make some analyzes again. Should the results still be erratic, replace it by a new one.

Sulfur results are not repeatable::

When the Sulfur results are not stable, but the carbon results are good, there are two possible reasons

– The magnesium perchlorate (anhydrone) is saturated.
  Replace the complete contents of the glass tube after the corresponding furnace.
– There is sulphuric acid in the combustion tube of the resistance furnace. Replace the combustion tube, see chapter “**Replacing the combustion tube**”



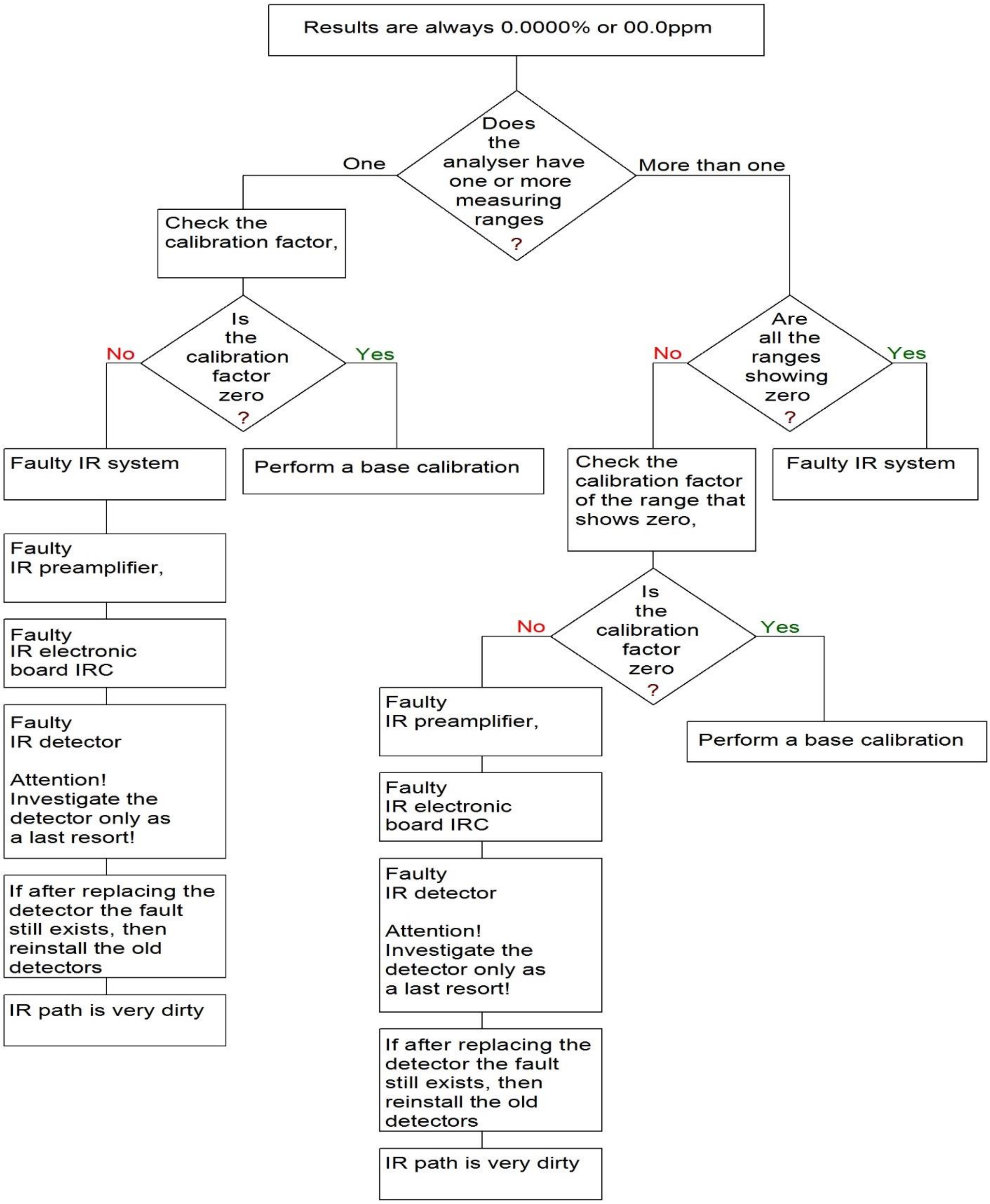
If the combustion tube (**4**) was in **use** for a **very long time** and many samples with **high Sulfur** were analyzed, then sulfuric acid may build up in the rear-side of the combustion tube.

When the heated tube is removed together with the connector (**5**), a **brown fluid** can be seen in the ceramic tube.

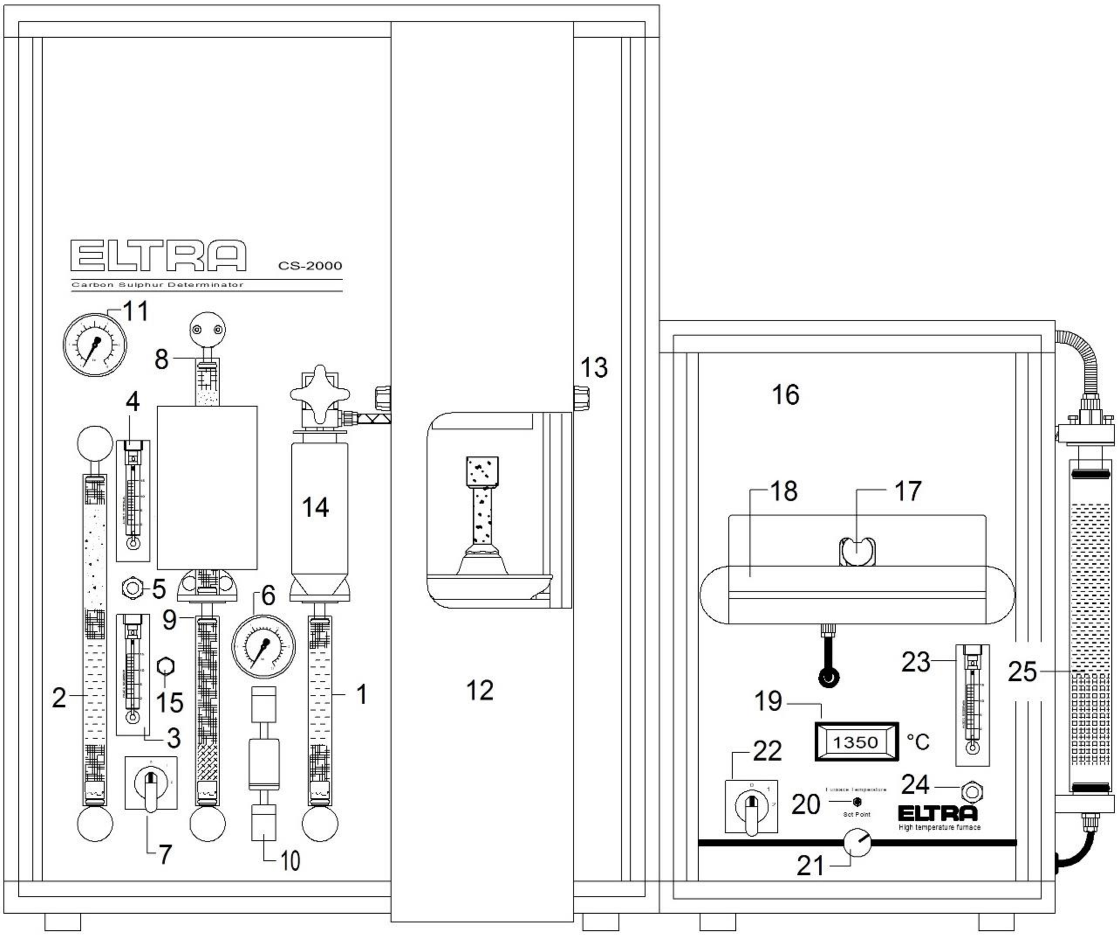
During the analysis, some **SO_2** is trapped in this fluid, causing **non**

repeatable results. It is recommended to **clean** the furnace outlet tube.

3.9 The results are always 0.0000% or 00.0ppm:



3.10 No oxygen flow



3.10.1 Induction furnace operation

- No oxygen pressure. See corresponding chapter "**No oxygen pressure**"
- The software is in the gas saving mode. If this is the case, the flow will be restored when the mouse is moved or when a key is pressed like F4 for entering the sample weight or F2 for opening and closing the furnace.
- Bent plastic tube. See chapter "**Fluctuating gas flow**"
- Faulty flow sensor, flow control board or valve. See chapter "**Gas flow controller**"
- The tubes of the flow sensor are interchanged (input <--¬¬> output).

  See chapter "**Gas flow diagrams**"
- The outflow valve V1 does not close. Open the left-side panel of the analyzer. When the furnace is closed (the lift is up), no oxygen should be flowing out of the lower (free) opening of the valve. See chapter "**Gas flow diagrams**". This can be checked by putting your finger under the lower opening of the valve. If the valve does not close correctly, you will feel a strong oxygen pressure. The voltage across the leads of the outflow valve V1 should be 0 Volt. If this is the case then the plunger of this valve jams. The valve should be cleaned (see chapter "**Cleaning the solenoid valves**") or be replaced. If the voltage on the outflow valve is permanently at 24 V, switch off the analyzer, exit the software and restart.

3.10.2 Other faults

– The screw for the upper furnace cushioning is too tight, see chapter "**Pneumatics**"
– The pressure switch does not close. Measure the voltage across its leads. Zero volts with pressure, 24 VDC without pressure.
– The furnace closes too slowly, adjust according to chapter "**Pneumatics**"
– The furnace does not close: see chapter "**The induction furnace does not close**"

3.10.3 Resistance furnace operation

– Check the oxygen pressure on the upper pressure gauge. The pressure should be about 1,5 bar (22 psi). If lower, see Chapter "**No or low oxygen pressure**"
– Check the pump voltage in the "Device state window".

3.11 IR-cell temperature control is out of range

If in the device state the graphs of IR-temperature °C or %IR are not in the green area, adjust the temperature. See chapter "**IR-cell temperature control**".

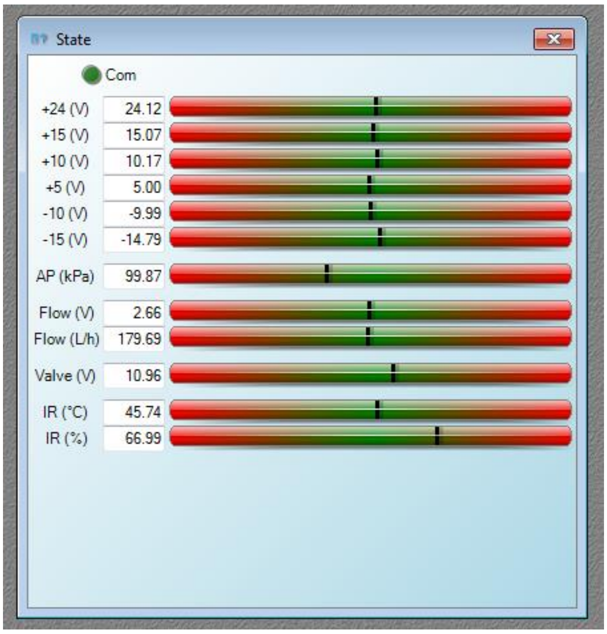


Fig. 27: Device state

– **Thermostatic control reports 0% or 100% power:**

The percentage of power required by the thermostatic control is displayed in the Device State Window . The power is 100% after switching on from cold while heating up. It takes about 30 minutes for the temperature to reach the set point. In stable condition, the power required should be between 30 and 70%.

If the value is less than 30%, adjust a higher temperature set point. If the value is over 70% without any tendency for coming down to lower values, adjust a lower set point.

3.12 Breaker turns off at the beginning of combustion

If the circuit breaker turns off at the beginning of combustion then:

– Unplug the analyzer mains power plug.
– Switch on the breaker.

⚠ DANGER

Mortal danger from electric shock

Exposed power contacts - High Voltage

Make sure all capacitors are discharged

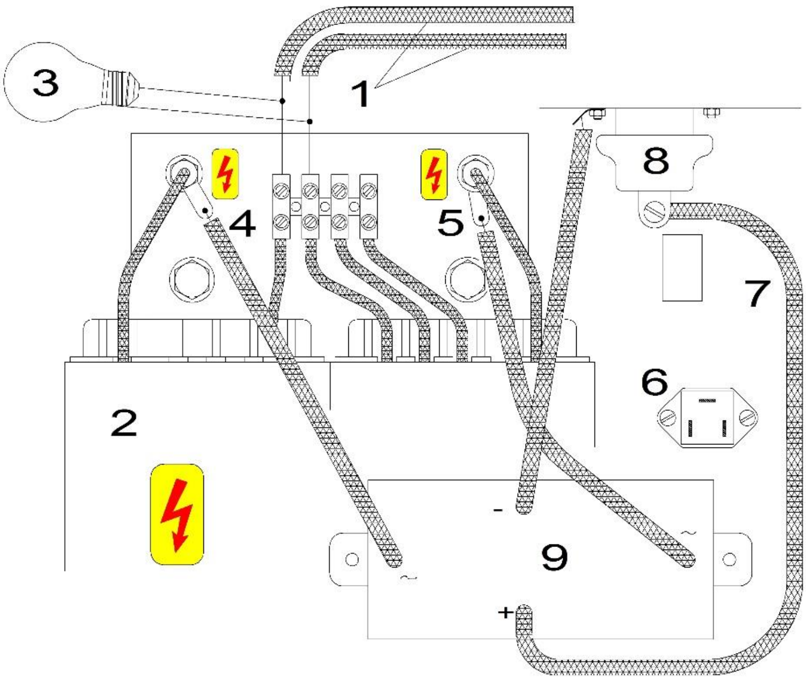


Fig. 28: Transformer

– Disconnect the cables (1) from the primary side of the transformer (2) and connect the cables (1) to a 220 V light bulb (3) which is inserted to a socket. An ordinary desk lamp can serve for this purpose. In case only 110 V light bulbs are available, connect two of them in series.

NOTE

Be careful that no short circuit occurs!

After the cables (1) have been connected, plug the analyzer to the mains power again.

– Set the power switch to pos. 3
– Enter a weight manually (for example, 500 mg).
– Press START
– The word "Analyzing" should appear in the status window.
  If not, but "Waiting for stability" appears instead, the reason is that after restarting the device and the oxygen flow, the infrared base line is drifting. In order to save time, there is a possibility to start the cycle without waiting for stability.
– Quit by pressing STOP
– Go to the "power user" level and click on the button "Stable".
– The analysis cycle starts then without waiting for base line stability of the cells.

When "Analyzing" appears on the status window, the light bulb should glow; this does not happen suddenly, but gradually (soft start).

Within a few seconds, the light bulb will gradually change from dark to fully bright.

– If not, but the lamp becomes immediately bright like switching on with a switch, replace the board HF-42.
– If the light is not fully bright but dim and flickering, replace the triac (6).

If yes (O.K.), unplug the mains power plug and reconnect the power cables (1) to the transformer (2).

Unplug the power plug and reconnect the cables (1).

When reconnecting the power cables (1), do not let these wires be close to the connectors for the cables (4) and (5). Otherwise the high voltage can create sparks.

The cables (4) and (5) should be unscrewed from the transformer and placed away from it.

⚠ DANGER

Mortal danger from electric shock

Exposed power contacts - High Voltage

After the generator starts the cable carries a voltage of about 7000 Volts!

– Plug in the mains power plug to power the analyzer.

A new analysis should be started. When "Analyzing" appears and the fuse is not damaged as well as the mains power current didn't exceed 10 A (RMS), then the transformer is functioning properly.

Otherwise, replace the transformer. The cables (4) and (5) are then reconnected.

If the problem still remains:

– Unplug the analyzer from the mains power.
– The cable (7) is unscrewed and removed from the capacitor (8)

After the generator starts (Analyzing) the cable (7) carries a voltage of about 7000 Volts! The cable (7) therefore should be laid so that its end is at least 10 cm away from the nearest object!

If, after pressing START and after "Analyzing" appears, the breaker turns off, then replace the rectifier (9).

Further causes could be found in the oscillator circuit

Because of the high voltage (7000 volts) and the high frequency (19.5 MHz), it is difficult to make measurements without any special measuring instruments.

Thus, the analyzer needs to be turned off, and the power plug disconnected.

⚠ DANGER

Mortal danger from electric shock

Exposed power contacts - High Voltage

Make sure all capacitors are discharged

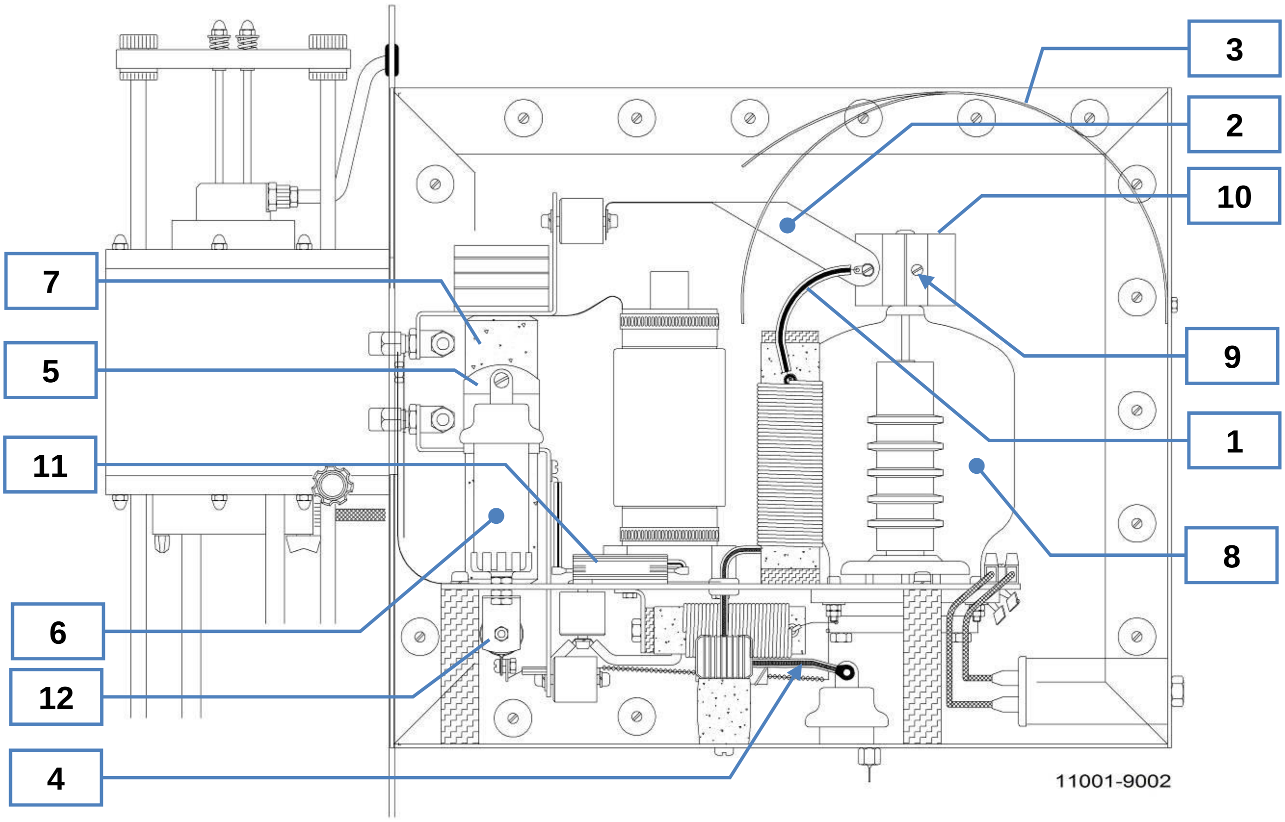


Fig. 29: Draft 11001-9002 (1-15-3-1S)

- Check that all the screws and soldering connections have a good contact.
- If the resistor 200 K (11) is a short circuit, then the fuse will blow when starting the generator.
- Check that all power conductors and copper bands are placed far enough away from any objects!
- The wire (1) and the copper band (2), for example, should be placed.
  far away from the plate (3).
- The power cable (4) should have a maximum distance from any surrounding object.
- The copper band (5) should be placed as far as possible away, from the capacitor (6)!
  This is why the copper band (5) should always be bent around the insulator (7).
- If the tube (8) needs to be replaced, loosen the screw (9) and pull out the heat sink (10) upwards ! Pull out the tube (8) upwards!

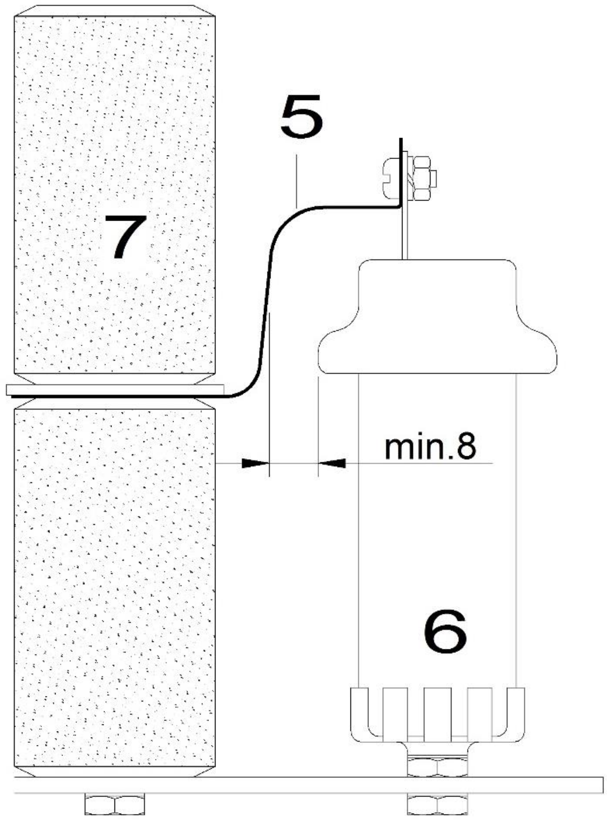


Fig. 30: Capacitor and insulator

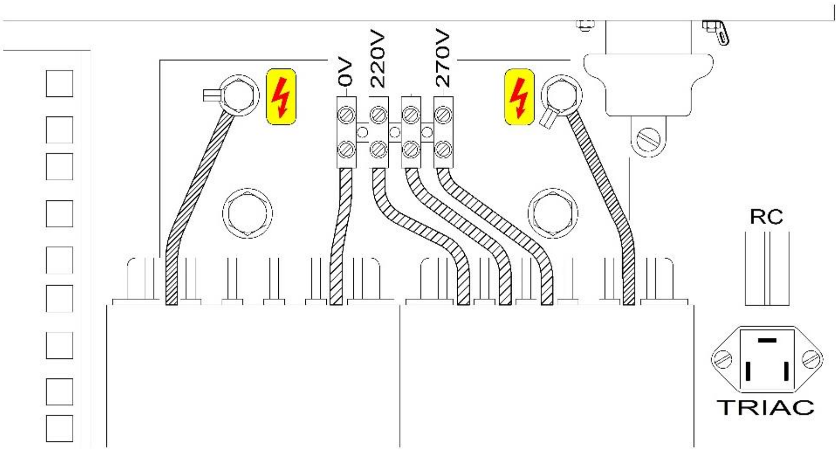
3.13 Breaker turns off at the end of the analysis

Causes:

The triac is malfunctioning.

The so-called Latch-up effect causes the triac to remain conductive in one direction after triggering. The transformer is then acting as a short circuit because it is fed with a DC voltage!

– Replace the TRIAC.



3.14 Dustcloud when opening the furnace

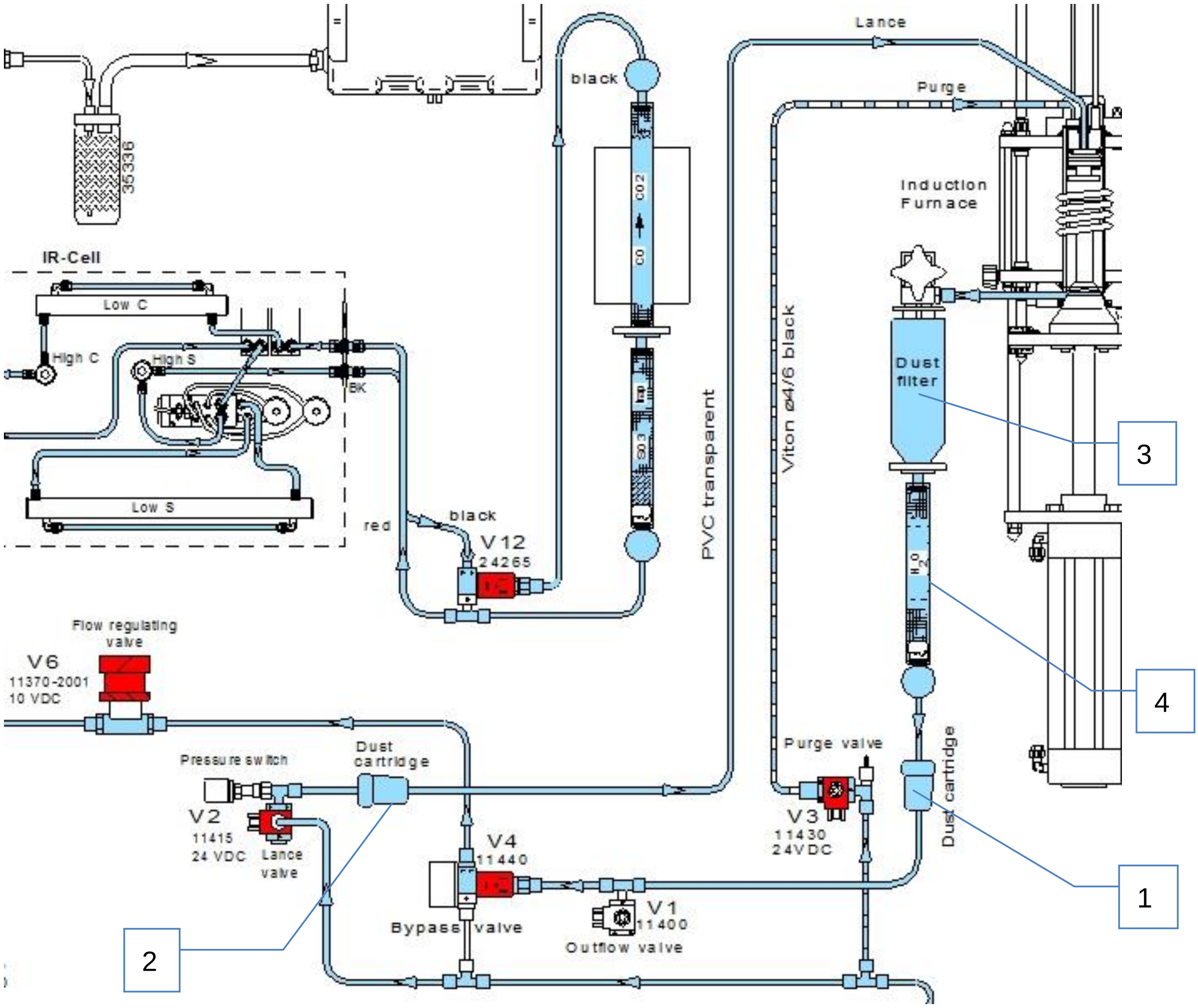


Fig. 31: Valves

After pressing the key to open the furnace, the valves (V1) and (V2) are energized. This means that they have across their coils 24V DC coming from the electronic unit.

Valve (V2) closes the oxygen supply to the furnace.

Valve (V1) opens, releasing the pressure from the furnace through the dust trap (3), through the moisture trap (4) and through the filter cartridge (1) into the open air (in the direction of the arrow).

Following this, the pneumatic valve shuts and the furnace opens (lift downwards). When dust comes out of the furnace after this process this will cause, that the pressure in the furnace is not sufficiently reduced.

The causes:

– Too much dust in the dust trap (3),
  (a few hundred analyses without cleaning)
– Saturated moisture trap (4)
– Clogged paper filter in the moisture trap (4)

– Clogged filter cartridge (1 and 2) (this would be unlikely though)
– One of the valves (V1) or (V2) receives no power (24V DC)

NOTE

The valve (V1) will only be supplied with voltage (24V DC) until the lift has reached the bottom position, then it will be switched off.

One of the valves (V1) or (V2) jumps, most likely valve (V1)

– Clean the valves.

3.15 No or low oxygen pressure

Possible faults:

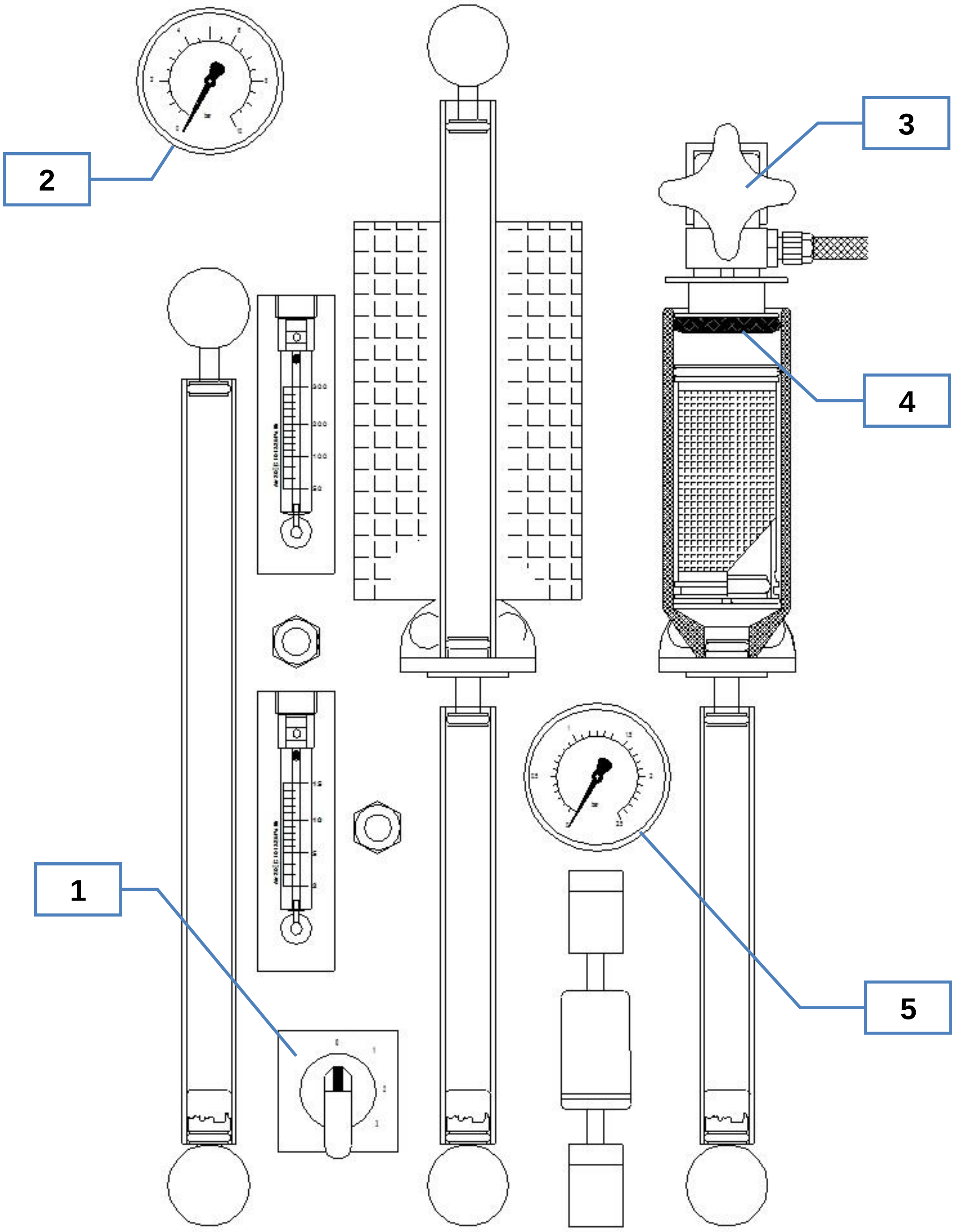


Fig. 32: Front panel

After starting an analysis", the following message appears: "**no oxygen pressure**".

If this message permanently remains in the "status window", then check

- Is the power switch (1) set on position 3?
- The pressure on the oxygen gauge (2) may be too low. 1.5bar is normal (22psi). The pressure remains constant when the furnace is closed, and it sinks during the upward movement of the furnace floor.
- Check the oxygen pressure in the supply line or tank. 4 to 6 bar (60 to 90psi) showing on the pressure gauge is normal.
- Check if the pressure gauge for compressed air (5) shows 4 to 6 bar (60 to 90 psi).
- Check if the cock (3) is properly shut, or else the O-ring (4) will not seal Check if the O-ring (4) is in a good condition.
- Check if the combustion tube is broken or cracked.
- Do leakage check. See chapter: "**Leak checking**".
- Check if the chemicals are saturated and have become hard.
- The paper filter could also be the cause. For changing the paper filter, read the operating manual.
- See chapter "**Fluctuating gas flow**"
- The contents of the gas cleaning furnace could be worn out and clogged.

Oxygen solenoid valve (V5) may be defective:

- Open the left-side panel of the analyzer.
- Unscrew the upper tube (1). The oxygen should rush out when the power switch is set to pos. 3

If not:

- There may be no oxygen supplied.

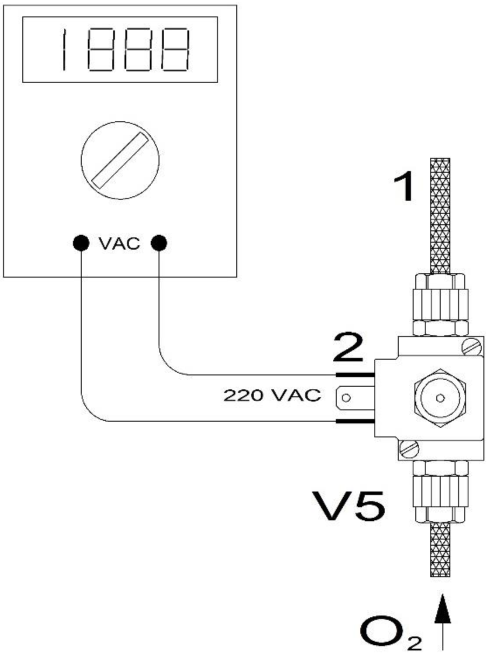


Fig. 33: Terminal of the solenoid coil

- 220V AC is not measured on the terminal (2) of the solenoid coil.
- The solenoid valve is clogged.

– Clean the solenoid valve, see chapter "**Cleaning solenoid valves**".

If the fault is still present, then:

– Switch off the power, (set the power switch to position 0).

– Pull out the socket (2) from the coil and measure the coil resistance. 3.3K is normal.

Outflow valve does not close:

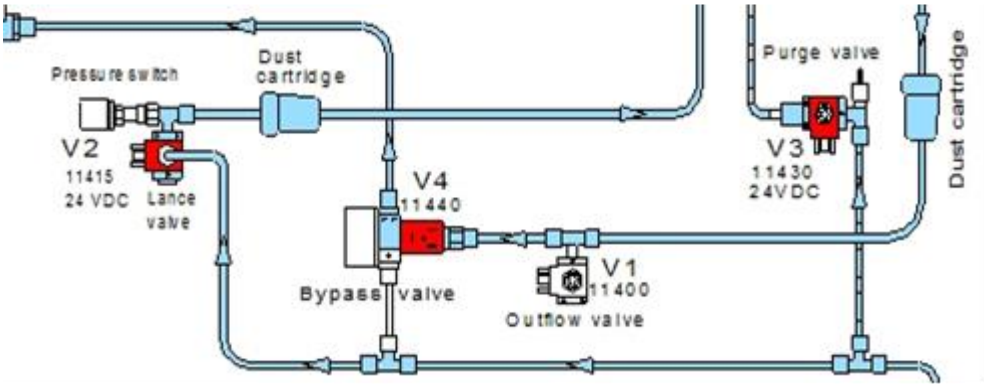


Fig. 34: Outflow valve

Open the left-side panel of the analyzer. When the furnace is closed (the lift is up), no oxygen should be flowing out of the lower (free) opening of the valve (1) (in the direction of the arrow). This can be checked by putting your finger under the lower opening of the valve. If the valve does not close correctly, you will feel a strong

oxygen pressure. The power supply to the valve (V1) should be 0 Volt. If this is the case then the outflow valve (V1) should be cleaned see chapter "**Cleaning solenoid valves**".

The voltage on the outflow valve is constantly at 24 V:

– Switch off the analyzer, exit the software and restart.

Other faults:

– The screw for the upper furnace cushioning is too tight, see chapter **"Pneumatics"**.

– The pressure switch does not close, see chapter **"Pressure switch"**.

– The furnace closes too slowly, adjust according to chapter **"Pneumatics"**.

– The furnace does not close: see chapter **"The induction furnace does not close"**.

3.16 Waiting for stability message

When this message appears in the status window after starting analysis, it means that the base lines are not within the "deviation-limit", set in the "configuration" window. A usual value is 10mV and the set time is 20 seconds. By setting the voltage and the time, both criteria for base line stability are considered, the noise and the drift.

Reasons for instability:

1. Too low deviation value

One reason for the above message is that the deviation value in the configuration window is too low, so that a higher value should be entered. The levels of noise of all cells are not necessarily identical. Longer cells have normally higher noise than shorter ones and the sensors themselves have noise level deviations between exemplars. The deviation can be increased in the Configuration window, Base lines. Usual value is are 10mV / 20 seconds.

2. Too high noise

One more reason could be exceptionally high noise. The base lines and the level of their noise can be seen on the screen when clicking on the base lines icon (with three waves).

Reasons for noise are:

- The infrared detector, replace, see chapter "**IR paths cleaning and replacing**" and "**Infrared base lines**".
- The pre-amplifier, replace it, see chapter "**Infrared electronics**".
- A fault on the IR circuit board IRC-1, replace it, see chapter "**Infrared electronics**"..
- The IR source is defective, see chapter "**The analysis takes too long**" and "**IR sources**".
- The microcontroller board.
- The power supply fluctuates, see chapter "**Infrared electronics**".

In case of a module (rack) of more than one IR-cell, mostly only one of the base lines has too high noise while the others have noise in normal range. In order to localize whether the noise is created by the sensor, preamplifier or the corresponding section of the IRC board, interchange the preamp connector of the noisy range with another one on the IRC board. If the noise moves to the other range on the PC screen (base line color), this means that the noise is created by the sensor or preamplifier.

In this case replace first the sensor as the more probable reason and if this doesn't help, replace the preamplifier.

NOTE

Don't forget to connect the interchanged connectors to the original position again.

- If the noise is created by the IRC board, change it.

3. Too high drift

Another reason for report of instability is a too high drift of at least one cell, so that the signal of one cell reaches the end of the set window (mV).

A drift can be due to temperature changes of the IR cell. It happens when the cell temperature is still not stable after switching on the power. When switching on the power after long break so that the cell is cold, allow the cell at least 30 minutes to stabilize the temperature. This has to be taken into consideration when checking the base line stability.

When starting the oxygen flow (power switch on position 3), the cell takes about 5 minutes to stabilize when restarting the oxygen flow after long time without flow (but with uninterrupted power).

3.17 Combustion tube breaks frequently

Induction furnace:

- The sample weight or the weight of the accelerator is too high.
- Don't use copper as accelerator.

Resistance furnace:

- The furnace temperature is too high. Usual operation temperature are 1350°C.The higher the temperature the shorter the service expectancy of the ceramic tube.
- The faster the furnace heats up, the higher the stress for the combustion tube. A compromise is to lower the current limit of the heating up current.

  See chapter "**Resistance furnace**". in this manual

3.18 Oxygen pressure falls when the furnace opens

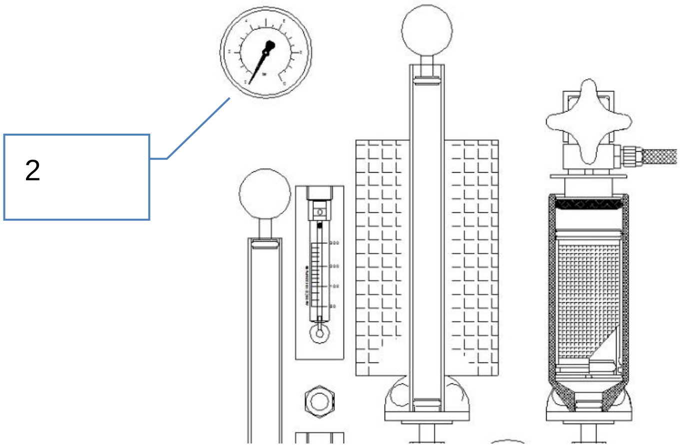


Fig. 35: Pressure gauge

Regardless of whether the furnace is opened or closed,

the oxygen pressure shown on the pressure gauge (2) must remain 1.5 bar (22.5 psi) constant.

If, however, the oxygen pressure falls when the furnace is open, then

either the valve (V2) is defective or its control is incorrect.

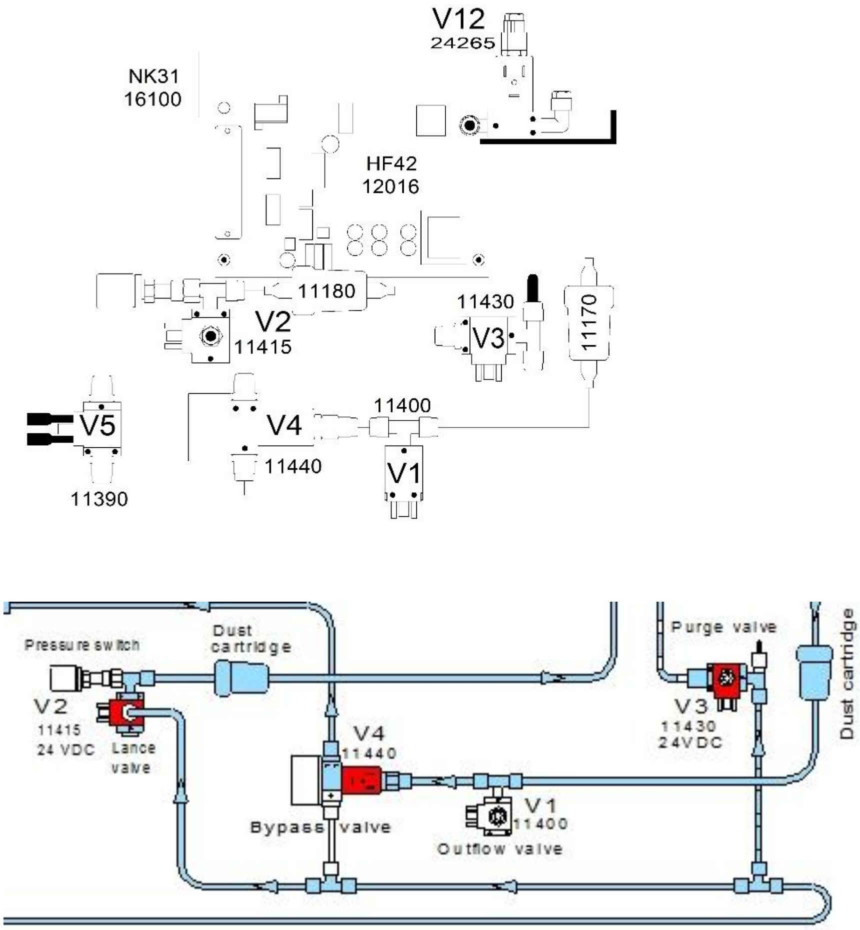


Fig. 36: Valves

When the furnace is open, the valve (V2) should have 23 V DC on its magnetic coil.

When the furnace is closed, the voltage should be at zero volts.

– If the voltage on the valve (V2) remains at 23 V DC, no matter whether the furnace is opened or closed, then there is an electronic problem.
– If the valve voltage always stays at zero, then either the wiring is broken, see chapter "**Wiring diagrams**" or the electronic unit is defective.
– If the voltage on the valve (V2) is correct, then the valve itself is defective, see chapter "**Cleaning the solenoid valves**".

3.19 Combustion without starting analysis

Induction furnace operation:

In this case, the combustion of the sample begins immediately after the sample enters the furnace area and before having pressed F5 to start analysis. Should the combustion start just after closing the furnace then there is a serious fault

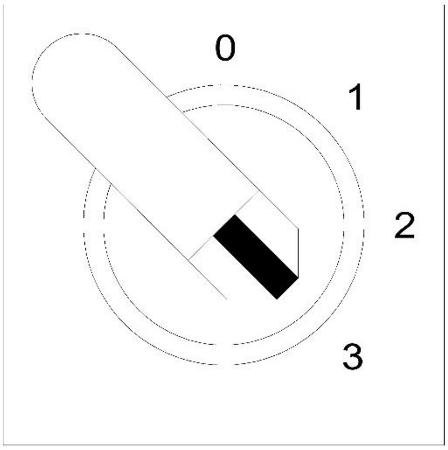


Fig. 37: Power switch

The power switch should be set immediately to pos. 1, in order to avoid any overheating of the generator.

NOTE

Always keep the furnace closed while testing availability of induction power.

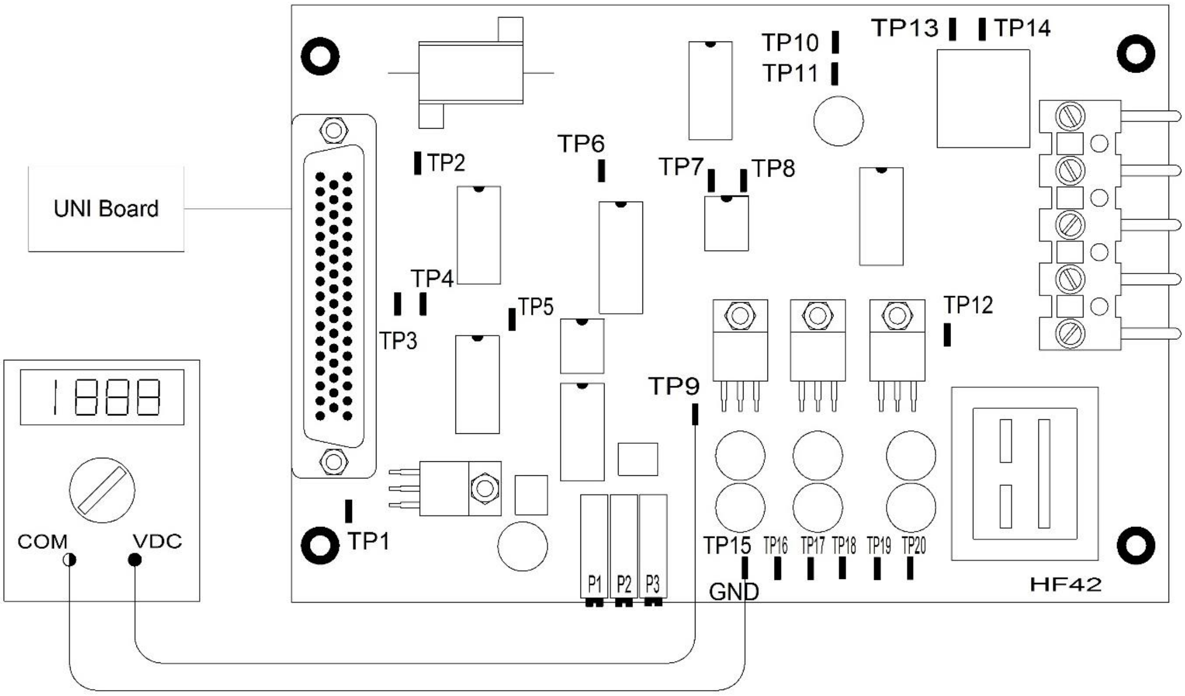


Fig. 38: Microcontroller board TP9

NOTICE

When software starts the generator, the voltage on the multimeter should change from 12VDC to 0.5VDC. The generator is again OFF when this voltage goes again to 12VDC.

The drivers of the microcontroller board are out of order, when the combustion starts without pressing F5 or clicking START and when without "Analyzing" on the screen, there is only 0,5V DC or lower on TP9 (instead of 12V DC). Replace the electronic drivers

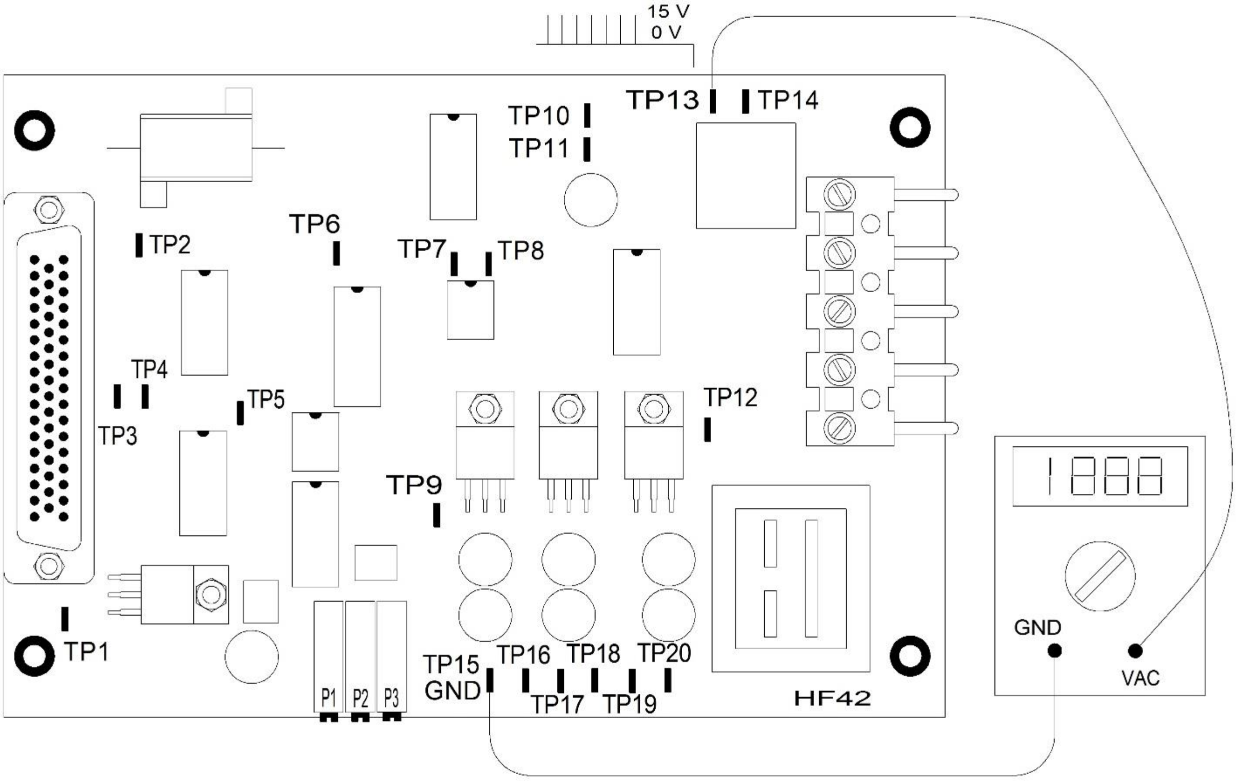


Fig. 39: Microcontroller board TP13

When the pulses at TP13 are present without starting analysis and with 12 V DC at TP9, then the circuit board HF 42 is out of order.

If no scope is available, the pulses can be detected by using a voltmeter.

Normal values are about 0 V AC without pulses, and about 1 V AC with pulses.

This indicated value can be different, depending on the type of the voltmeter used.

If this AC voltage is practically zero but even though the generator is powered, the next possible reason: The triac is faulty (short circuit), and has to be replaced.

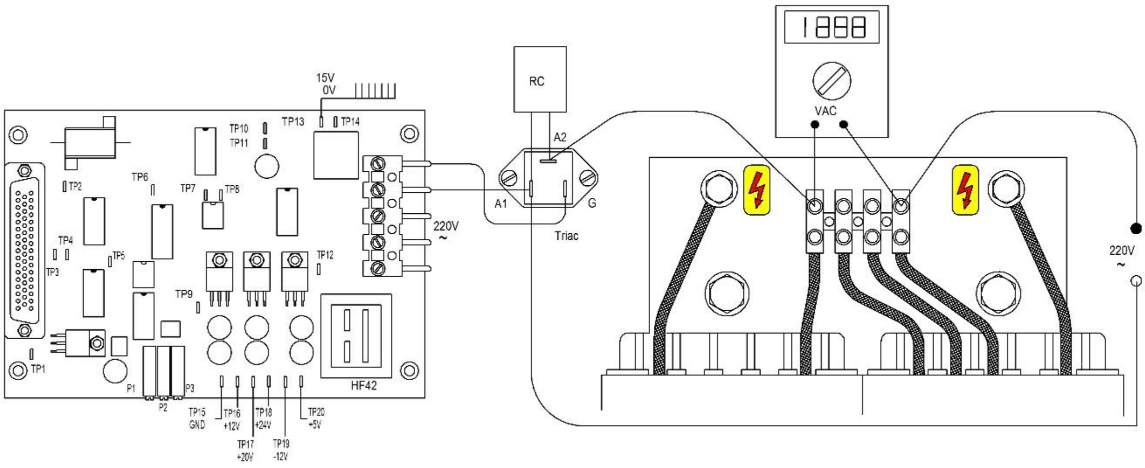


Fig. 40: Circuit board HF 42

3.20 Crucible or boat cracks or melts

3.20.1 Induction furnace

One reason could be that the quality of the crucible is bad. Use a better quality.

Another reason could be that the furnace temperature is too high, due to:

- Excessive main voltage.
- Excessive sample and / or accelerator weight.
- The use of a "sample or accelerator" that requires lower generator power.

In this case reduce the generator power in case of induction furnace. See chapter „**Induction generator control**".

3.20.2 Resitance furnace

In case of resistance furnace, the boat melts when there is excessive amount of metal in the combustion boat. The dangerous thing is that the molted metal destroys not only the boat but also the combustion tube, finally dropping thru the tube on the thermocouple. It is then very hard to remove the deformed tube from the furnace even after breaking it in two.

3.21 Oxygen pressure goes up very slowly

When using induction furnace operation:

After the button has been pressed to close the furnace (or to start the analysis by closing the furnace first), the oxygen gauge (6) should reach the normal level of

1,5 bar within a couple of seconds after the furnace has closed.

If this takes longer:

Then the problem is most probably outside the analyser.

Either the plastic tube supplying oxygen to the analyzer is squashed, or the oxygen regulator is not properly open.

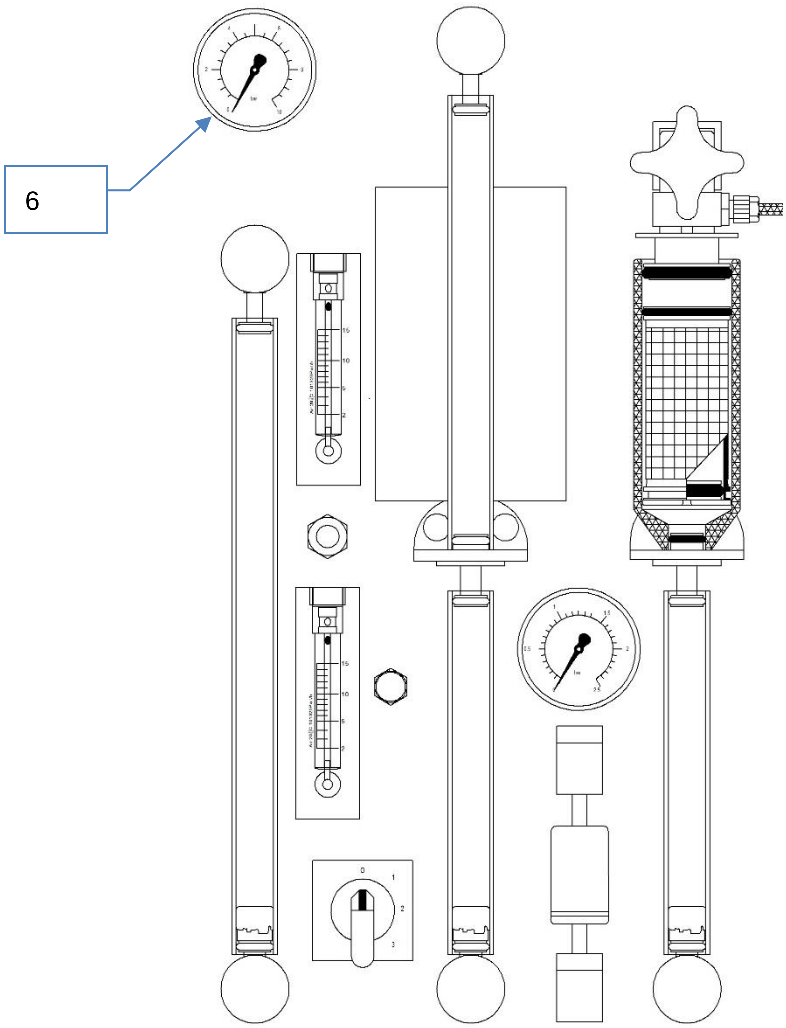


Fig. 41: Oxygen gauge

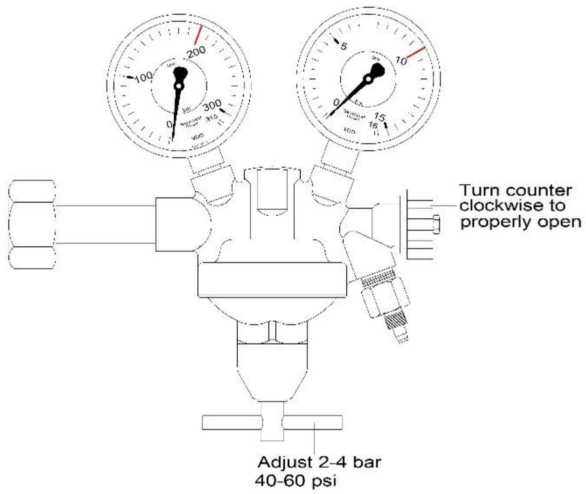


Fig. 42: Oxygen regulator

3.22 Pump voltage too high

Only for resistance furnace operation:

Check the pump voltage in the device status window. Normal value is around 7 VDC. The maximum possible value is 24 VDC. The pump voltage should be in any case much lower than 24V in order to have margin to compensate growing restriction of the flow due to growing saturation of the chemicals. Values over 10V or even up to 15V are not critical. In case of higher voltages it is advisable to replace the magnesium perchlorate. And if this doesn't help, check for restrictions due to contamination.

A typical example for this fault could be a combined partial blockage of the glass tube (22) and of the combustion tube outlet (36).

Make sure that the chemicals are not saturated and that the combustion tube is not blocked.

Usually, these faults caused by contamination occur due to frequent analyzing of samples that produce a lot of dust, and after a prolonged use of the combustion tube

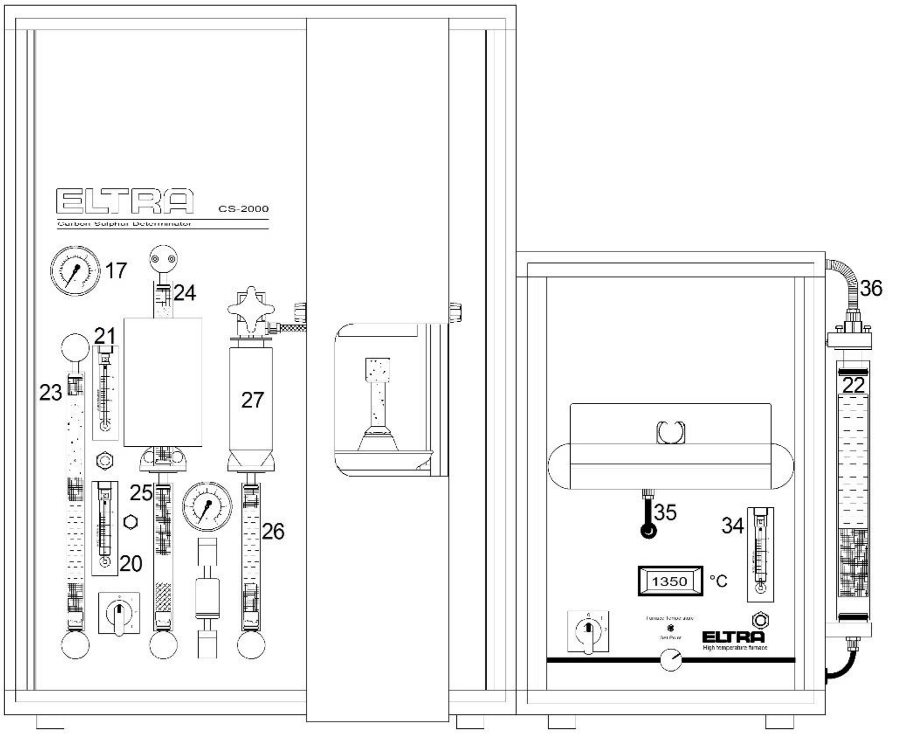
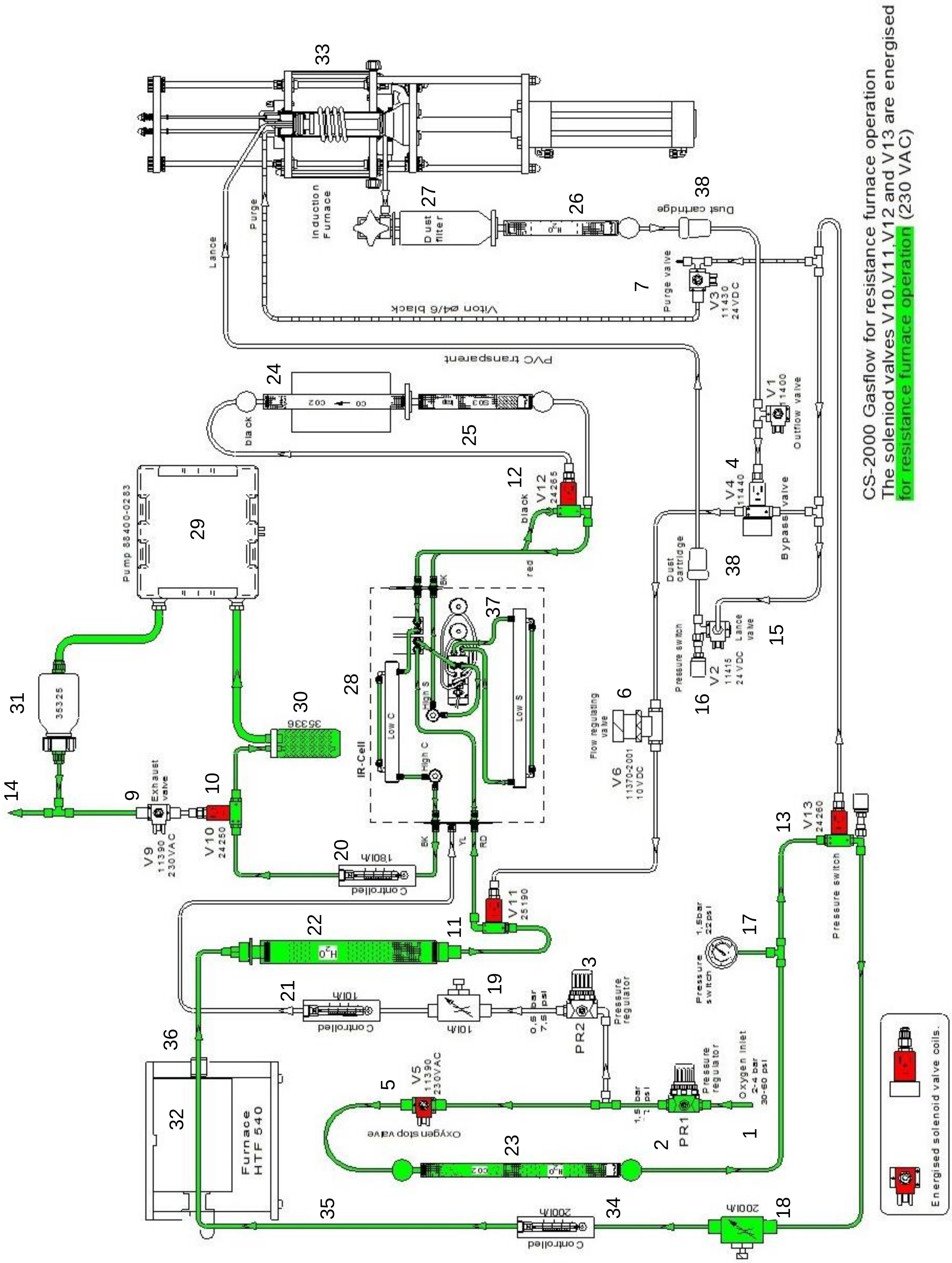


Fig. 43: Front of CS-2000



1 Carrier gas inlet

2 Pressure regulator

3 Pressure regulator

4 Bypass valve V4
5 Oxygen valve V5
6 Flow regulating valve V6
7 Purge valve V3
8 ----
9 Exhaust valve V9
10 Valve V10
11 Solenoid valve V11
12 Solenoid valve V12
13 Solenoid valve V13
14 Gas outlet
15 Lance valve V2
16 Pressure switch
17 Oxygen pressure gauge 1,5 bar
18 Restrictor
19 Restrictor
20 Carrier gas flow meter
21 IR purge flow meter
22 Moisture trap after the furnace
23 CO_2 / H_2O – purification trap
24 Catalyst furnace
25 SO_3 - trap
26 H_2O – trap
27 Dust filter
28 IR-cell
29 Gas pump
30 Attenuator before the pump
31 Attenuator after the pump
32 Resistance furnace
33 Induction firnace
34 Furnace input flow meter
35 Furnace inlet-oxygen
36 Furnace outlet measuring gas
37 Flow sensor

Detailed explanation of the faults indicated in the flow diagram

1. Blockage of the lower connection of the glass tube (22)

The bore hole of the lower connection of the glass tube (22) can get blocked when there isn't enough quartz wool at the bottom end of the glass tube (22) enabling fine particles of the magnesium perchlorate to fall into the bore blocking it. It is therefore absolutely important to fill the glass tubes exactly according to the Instructions. See Operation Manual "**Filling the reagent tubes**".

Holes of other reagent tube connectors need to be cleaned from inside and outside of the analyzer, due to the fact that the passage is not straight, but vertical outside and horizontal inside the analyzer.

CAUTION Switch off the mains power when handling inside the analyzer.

If a tube fitting is blocked, then the tube may be blocked as well.

Therefore the tube needs to be cleaned or replaced, otherwise the contamination could reach the IR-cell as well.

2. The IR-cell is blocked

This fault is caused mainly by a kink in one of the tubes.

A blockage due to contamination may appear in one of the fittings of the IR paths, where is a minimum diameter in the gas flow, compared to the inner diameter of the tubes.

3. Leakage

Not only blockages of the flow can cause the pump to run with full power, but also leakages between the flow sensor (37) and the pump (29) can cause the pump to run at maximum power.

Occasionally, the cover of the attenuator (30) (see also below) is not properly sealed, or the gas flow meter (20) has a crack at the fittings for the tube connections. Disconnect the gas flow gauge and check for cracks.

4. Blockage in the lower connection of the thick glass tube (22)

If there is not enough quartz wool used underneath the magnesium perchlorate, fine particles fall down to the glass fitting causing blockage in its hole.

– Remove the glass tube (22). See operation manual “**Filling the reagent tubes”.**
– Remove the tube from the lower fitting.
– Clean the hole by passing a wire or a pipe cleaner.

5. Cotton wool is dirty

Another possibility could be that the cotton wool inside the glass (30) is very dirty.

CAUTION Don’t interchange the tubes of the glasses

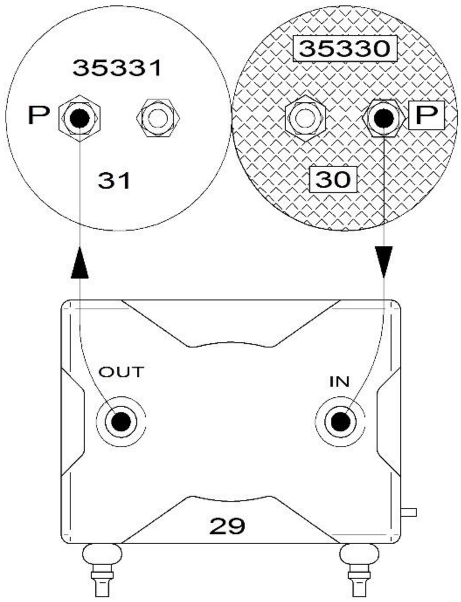


Fig. 44: Gas pump/ Attenuator

The end of the tube inside the glass must be free. It shouldn’t be blocked by cotton wool. The same applies for the fitting at the outlet of the glass.

The tubes of the pump are connected to the short fittings of the glass.

35331 without cotton wool

35330 with cotton wool

6. Furnace

Clean according to the Operation Manual

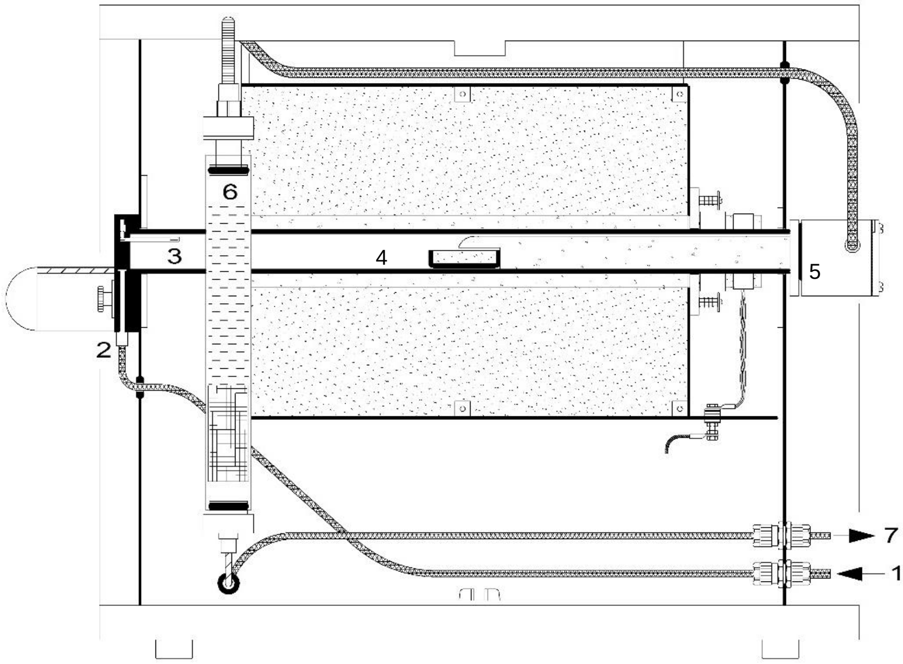


Fig. 45: Resistance furnace

3.23 Resistance furnace takes too long to warm up

Normal warm-up time: from room temperature to 1300°C, in 15-20 min unless the current limit on the board is set for lower heating-up current.

Faulty heating elements:

Investigate the problem the following way:

Set the temperature to maximum value and measure the voltage across the heating elements.

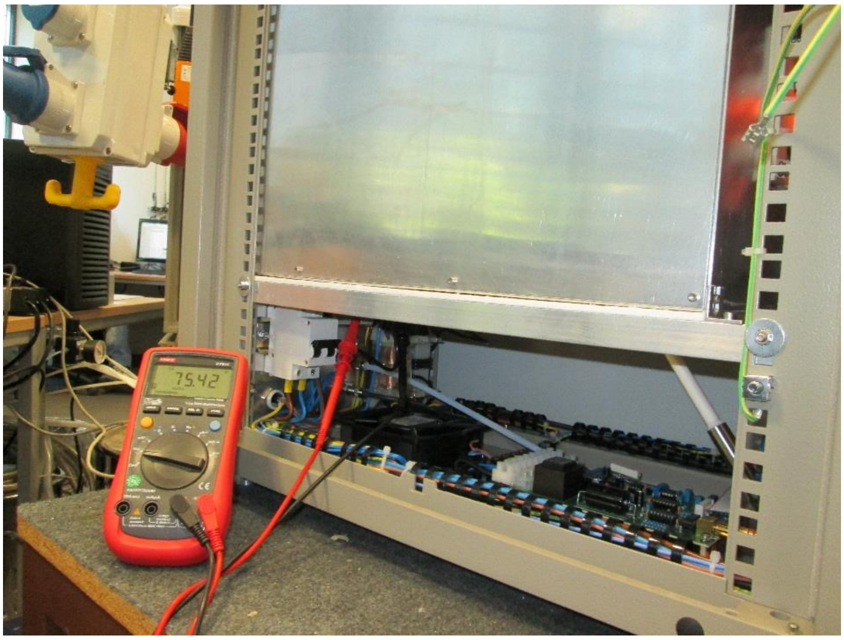


Fig. 46: Voltage across the heating elements

Fig. 47: Voltage across the heating elements

– Set the measuring range of a voltmeter to 1000 V AC. If the measured voltage is close to 220 V AC, then the heating elements are faulty.
– Replace the heating elements. See description in the operation manual.
– the measured voltage is much lower than 220 V AC, then the set value for the current limit is too low, see chapter "**Resistance furnace**".

A fault on the board TH-44 is also in question.

3.24 Negative drift after start

This **problem** can appear in resistance furnace operation, when some **material** from previous samples, fall off the combustion boat when shifted into the furnace. Then, when removing the boat out of the furnace, the hot combustion boat may touch and burn this material, causing an **unwanted small** peak on the base line.

If the following analysis is started while the base line is still above zero, then the electronics will take this level as base line at the beginning of analysis so that the base line drifts negative when that small peak comes down.

A problem of the **IR-cell** itself can be ruled out, when running a few blank analyses by just entering manually a sample weight into the memory and pressing "**START**", without inserting any sample into the furnace. If the base line doesn't show a negative drift, then the **IR-cell** is O.K.

3.25 Resistance furnace completly cold or too hot

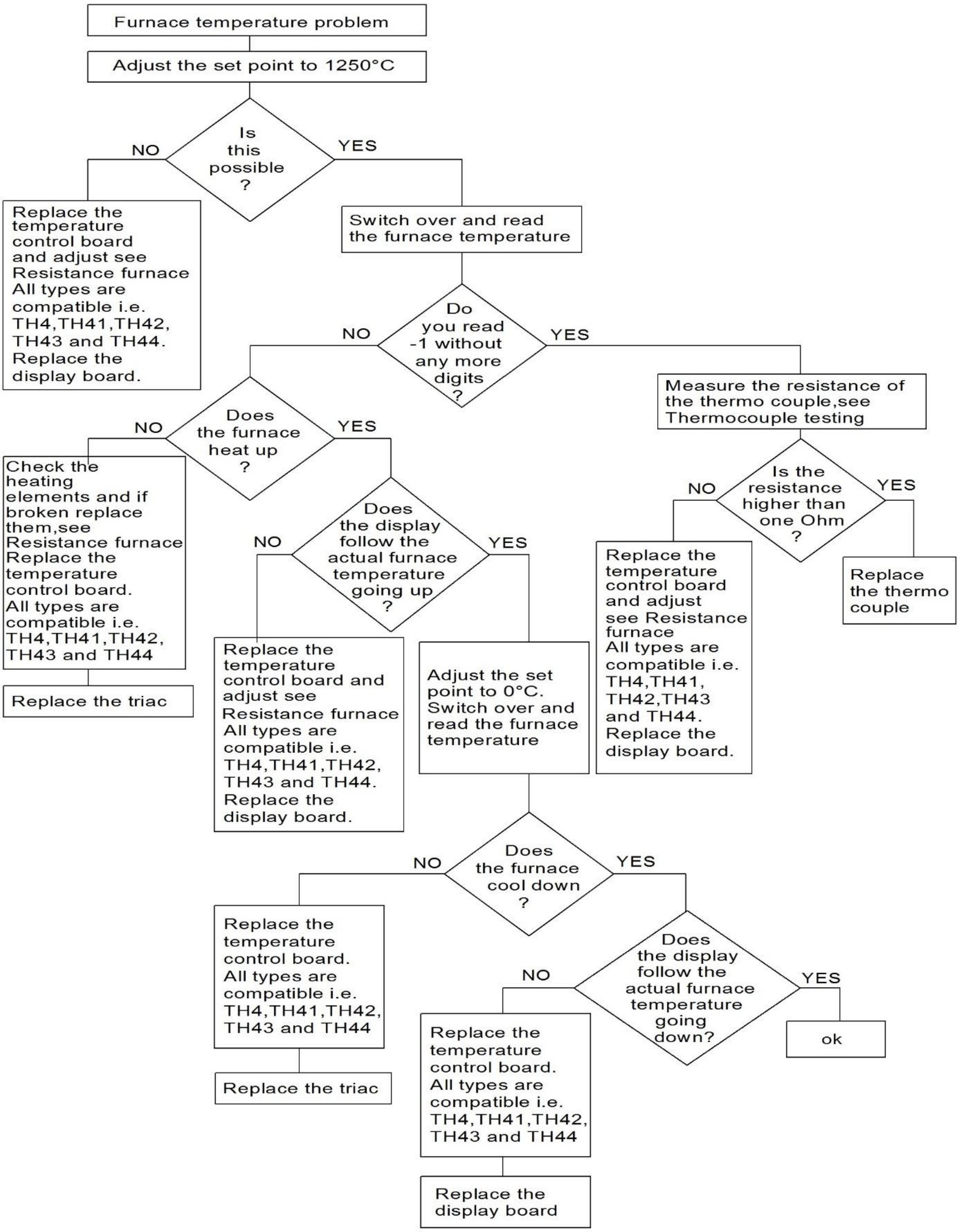


Fig. 48: Furnace temperature problem

3.26 Fumes in the resistance furnace

CAUTION! **Never turn on the oxygen flow**, when fumes come out of the furnace, or else there can be an *EXPLOSION!*

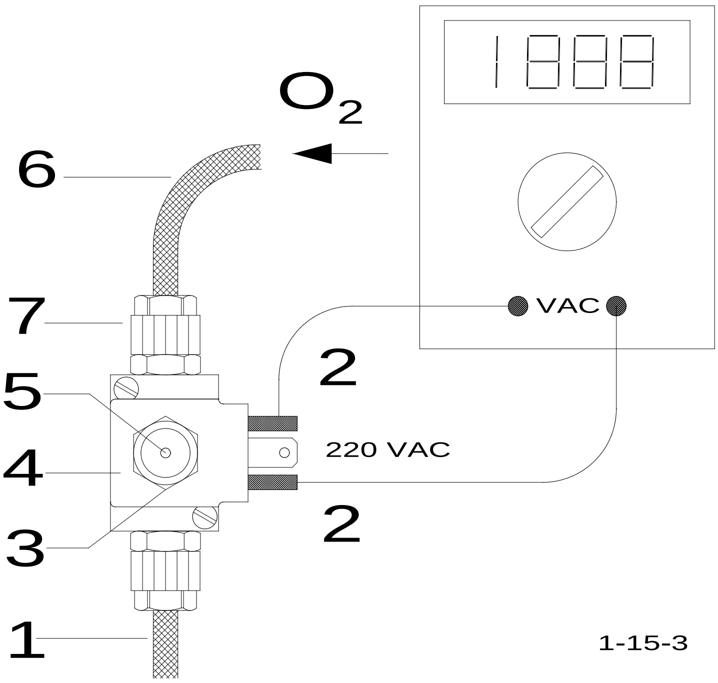
Wait for at least **15 minutes**, until the smoke has disappeared from the furnace before turning on the oxygen supply!

When smoke comes out of the resistance furnace front, mostly the reason is that a sample is entered into the hot zone of the furnace without having oxygen flow. If at that moment the oxygen flow is restored, the gases in the furnace will ignite and explode with a loud bang and with a flame shooting out of the combustion tube.

The explosive gases consist of carbon monoxide from carbon in the sample and (very little) oxygen from the air which was in the combustion tube and of volatiles driven out of the sample by the temperature without burning due to missing of oxygen.

Other possible reasons:

- It is a sign of bad combustion. See chapter "**Bad combustion**".
- The furnace temperature is too low.
- No oxygen flow. See chapter "**No oxygen flow**".
- The pressure switch is faulty.
- The oxygen inlet valve V5 is faulty. See chapter "**Wiring diagrams".** Check for pressure response. Unscrew the lower tube (1). The oxygen must exit the valve when the mains power switch is set to **pos. 2.**



If not:

- There is no voltage (220 V) on the leads (2) of the coil (4.)
- The valve is **blocked**. Clean the valve by

  a) closing the oxygen supply,

  b) setting the mains switch to pos. 0

c) clean the valve according to chapter “**Cleaning solenoid valves**”.

If the fault still remains, then:

- Switch off the power (pos. 0).
- Disconnect plug (2) from the coil (4) and measure the resistance. 3.3 K for 220VAC valves is a normal value.

3.27 Resistance furnace doesn`t reach full temperature

- The heating elements are used up. See chapter “**Bad combustion**”.
- The furnace is faulty. See Chapters “**No combustion”**, “**Resistance furnace”**, “**Resistance furnace doesn’t reach full temperature”**, “**The resistance furnace is too cold or too hot”** and “**Resistance furnace takes too long to warm up**”.

3.28 Unstable resistance furnace temperatur

- The heating elements are used up, and the required temperature can only hardly be reached so that there are no reserves of power, to properly regulate the temperature at a stable level. See chapter “**Resistance furnace doesn’t reach full temperature**”. To confirm this fault, set the temperature to a much lower value. If the temperature cannot reach the new higher level, it is obvious that the unstable temperature was at maximum level of temperature the heaters can reach.
- The temperature control board TH 43/44 is faulty. Replace the TH 43/44 board and adjust according to chapter “**Resistance furnace**”.
- The thermocouple is faulty. See chapter “**Thermocouple testing**”.

3.29 Dust or soot from the resistance furnace

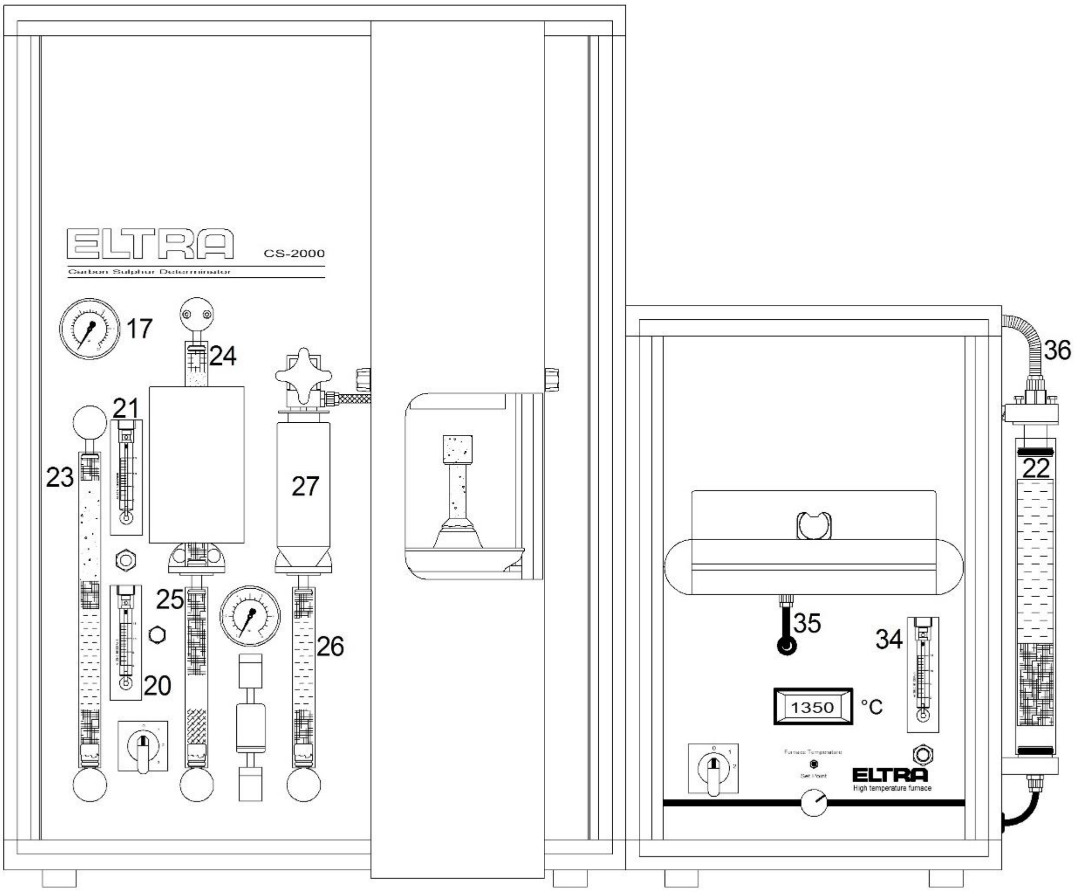


Fig 49: Front CS-2000

The sample has been inserted into the furnace too quickly:

– See Operation Manual chapter “**Applications / Coal analysis**”.

The sample weight is too high:

– If a sample burns explosively, then there could be a shortage of oxygen. This can cause some soot or oil vapors that pass through the hot zone of the furnace without burning. It is necessary to reduce the weight of the sample, e.g. to 100mg or even to 50mg. If the weight reduction doesn’t help, then operate differently by shifting the boat slowly towards the beginning of the hot zone of the furnace. Leave the boat there and allow the sample to start burning. Towards the end of the combustion, move the boat to the middle of the hot zone, in order to obtain a complete combustion. See Operation Manual “**Applications / Oil analysis**”.

The sample is metallic:

– Perform analysis by using the induction furnace. See Operation Manual.

3.30 Vibrations in induction furnace mode

If the Analyzer vibrates when the mains power switch is turned to position 3, the reason is dust accumulation on the blades of the oscillator's blower. The vibrations are caused by dust on the blades causing eccentrical rotations.

DANGER

Mortal danger from electric shock

Clean it carefully with a vacuum cleaner, if necessary:

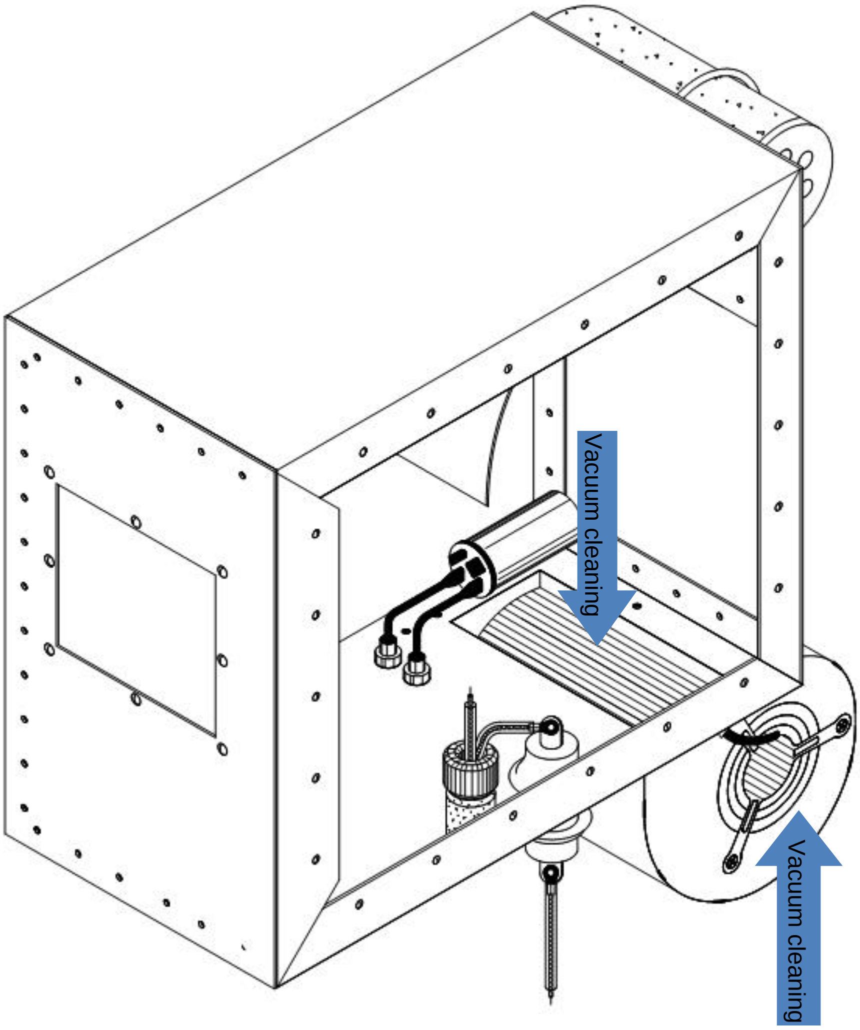


Fig. 50: Oscillator blower cleaning

3.31 Analysis cycle stops too early

The minimum analysis time is set too short in the configuration window, so that the analysis time expires before the peak starts coming up. Normally the peak starts about 6 to 8 seconds after the start of combustion. If the minimum analysis time is set for example to 4 seconds, the analysis may be terminated before the peak starts. If the minimum analysis time is set far over 8 seconds, the peak starts before the minimum time expires. Due to the IR signal being then higher than the comparator level, the analysis continues until the IR signal comes down to the comparator level, unless the maximum analysis time expires earlier. If so, it is advisable to increase the maximum analysis time in order to integrate the whole peak.

Especially in case of resistance furnace operation, the peak of hard-to-burn samples starts coming up quite late. In such cases, the minimum analysis time should be set to about 60 seconds.

If after prolongation of the minimum analysis time to a reasonable value, a peak still doesn't appear, possible reasons for the fault are:

– No combustion. See chapter "**No combustion**".
– There is no gas flow. See chapter "**No flow**".
– There is gas flow, but bypassing the furnace. See chapter "**Sample burns but no peak on the screen**".
– The IR cell is faulty. See chapter "**Check base lines**".

3.32 Chopper motor doesn't rotate

The rotation of the chopper motor needs to be checked in case of problems only, like when there are no combustion peaks on the screen or the IR signals are minus -10V (take care, minus) displayed on the PC screen in the window "inputs".

In order to check whether the chopper motor is rotating, the easiest way is to remove an IR path. See chapter "**IR-paths, cleaning and replacing**". Mostly, the easiest path to remove is the shortest one. Then, the chopper blade can be seen thru the hole of the chopper housing, which becomes free (open) after removing the path.

The reason of failure can be a faulty motor but also the controlling electronics of the motor may have become defective. If so, the motor or the IRC board has to be replaced. Before replacing, check at least the voltages on the board, mainly the supply voltage of 24VDC. See chapter "**Infrared cell adjustments**".

For replacing the chopper see chapter "**Chopper**".

3.33 Sample burns but no peak on the screen

When the analysis cycle is carried out normally and the sample is burned but no peak on the screen, possible reasons are the following:

- The IR cell could be faulty. Check the base lines. See chapters "**Check base lines**" and "**Infrared cell adjustments**". If the base lines look normal, the IR cell can be regarded as ruled out. If the base lines are practically at zero volts, the cell is faulty or without power. (24VDC). See chapter "**Bad combustion**".
- The plunger of bypass valve V4 jams. See chapter "**Cleaning solenoid valves**".

This is related to induction operation only:

This may happen in case of induction furnace operation. There is gas flow, but bypassing the furnace, so that there is gas flow shown on the flow meter and by the flow sensor on the screen, but no gas flow thru the induction furnace. In this case the bypass valve V4 jams, causing the oxygen flow to bypass the furnace like in case of open furnace. See chapter "**Gas flow system**".

The furnace has though oxygen pressure but without having oxygen flow. Due to oxygen being present, the metal sample and accelerator(s) burn, because there is availability of oxygen in the furnace, coming thru the chamber valve V3 and/or thru the lance valve V2. In case of metal analysis, the burned sample in the crucible looks like normally combusted sample. If so, check the bypass valve V4. See chapter “**Cleaning Solenoid valves**”.

3.34 IR signal does not come down to the base line at the end of analysis

There are several different reasons for this effect

1. Long combustion of a very low carbon sample:

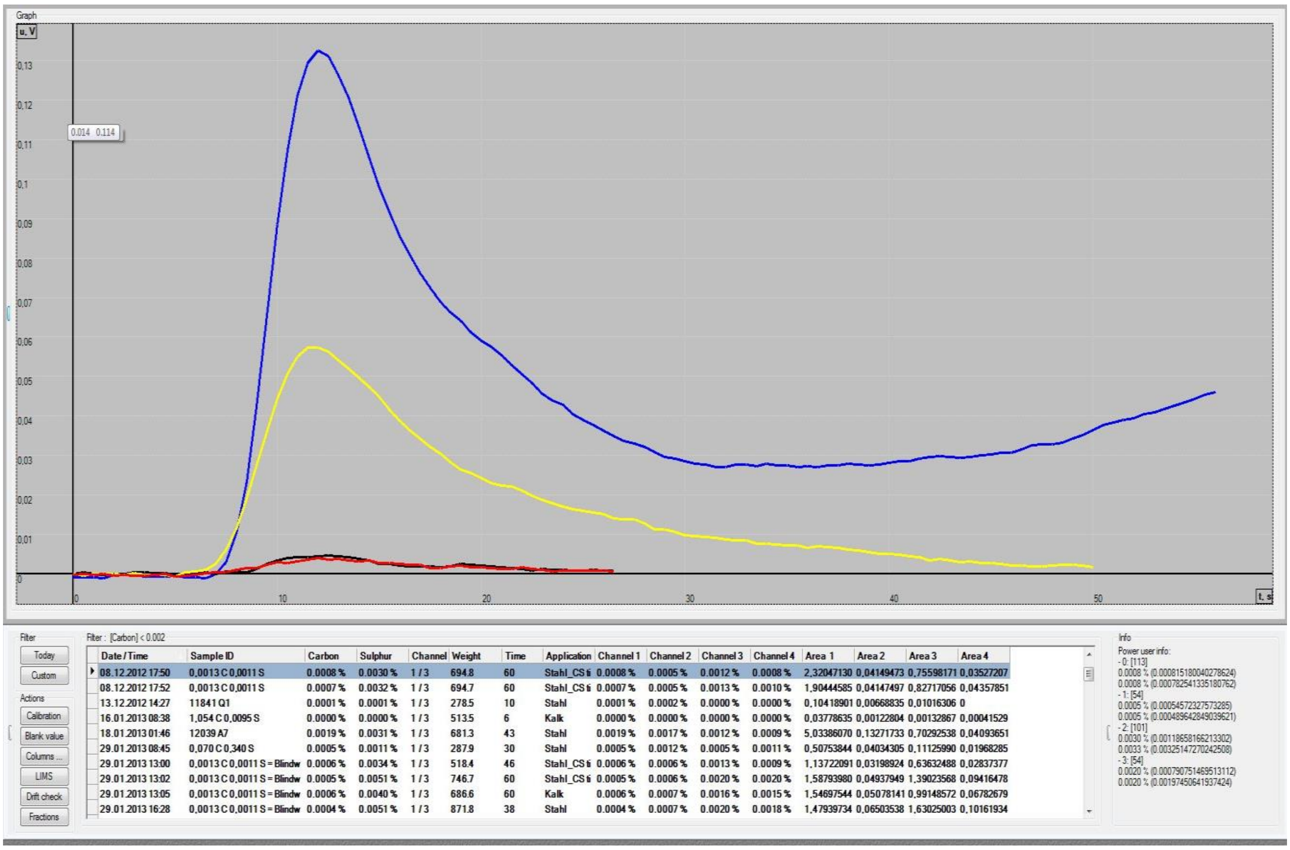


Fig. 51: Programm screenshot (graph example 1)

It appears like a long tailing at the end of the peak. It appears in the low carbon range only and the distance to the base line is in the range of 10 to 50mV. Depending on the blanks of the crucibles and on the oxygen purity, the level of the tailing can be as high as 100mV. When the burning is extremely long, the level of the low carbon tailing even starts to grow.

Possible solutions:

- Reduce the analysis time
- Increase the comparator level of the low carbon range,
- Reduce the generator time.

2. Copper oxide has a bad quality:

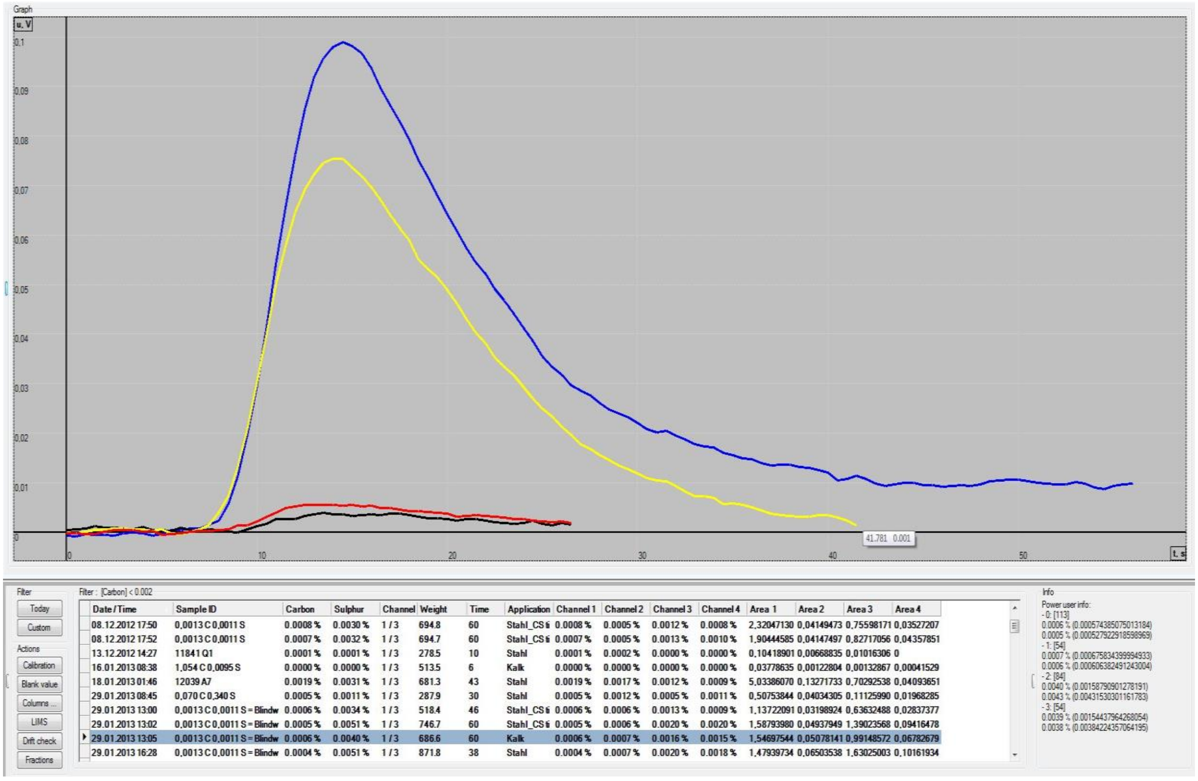


Fig. 52: Programm screenshot (graph example 2)

Memory effects of the copper oxide can cause tailing of the low carbon range in the level of 10 to 50 mV. However the tailing level does not grow due to faulty copper oxide.

Possible solution:

- Replace the copper oxide

3. Path window is not sealed or it is broken

If the faulty window is on the chopper housing side, all available cells have a tailing due to combustion gases entering the chopper housing causing permanent IR absorption for all cells available.

If the faulty window is on the IR sensor side, there is tailing of the damaged cell only.

Solution:

-Replace the part having the faulty window.

Replacing the window only, is rather tricky because the window should be available, the faulty window must be removed, the surface for gluing new window must be cleaned from old glue and rests of the broken window, there must be glue available being suitable to glue windows (two components glue) and time should also be available to wait until the glue is solid.

4. Flow stops during analysis

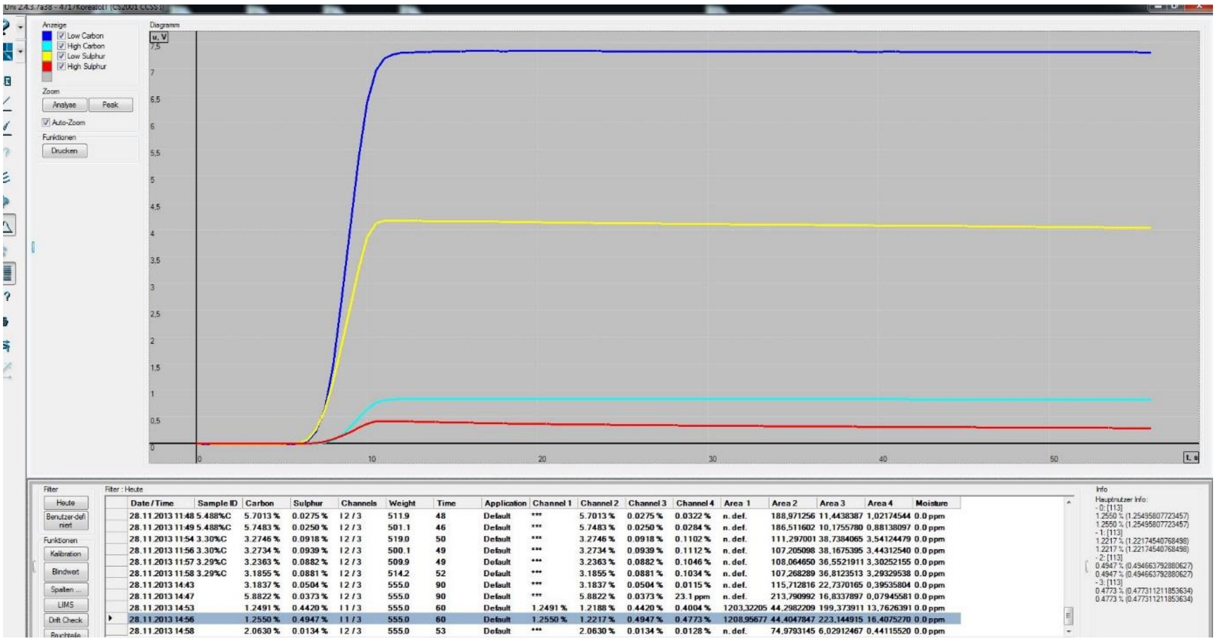


Fig. 53: Programm screenshot (graph example 3)

In such case all base lines remain high, keeping their level which they had at the moment the flow stops. Therefore the voltages of the horizontal continuation of the base lines can be high, depending on the voltage level of each peak at the moment the flow stopped.

Possible reasons why the flow may stop during combustion:

– The lance valve V2 jams.

  At the beginning of analysis, the oxygen is supplied to the furnace by the chamber valve V3 during T2 and T3 for the time (seconds) set in the software (configuration window). After expiring of T2 and T3, V3 closes the oxygen to normally continue being supplied by the lance valve V2 until the end of analysis. But if V2 blocks there is no flow any more so that the combustion gases remain in the IR paths constantly absorbing IR Radiation.

  In this case the shape of the IR signals is repeatable as long as T2 and T3 remain unchanged, unless V2 sometimes jams occasionally.

– Loose wire connection to the flow regulating valve V6.

  In this case it is not likely to have repeatable shape of the IR signal.

– The 50-pin connector of the HF-42 is not properly connected.

  Fix the connector’s screws.

– The flow control board HF-42 is faulty.

– For some reason the software goes to the gas saving mode

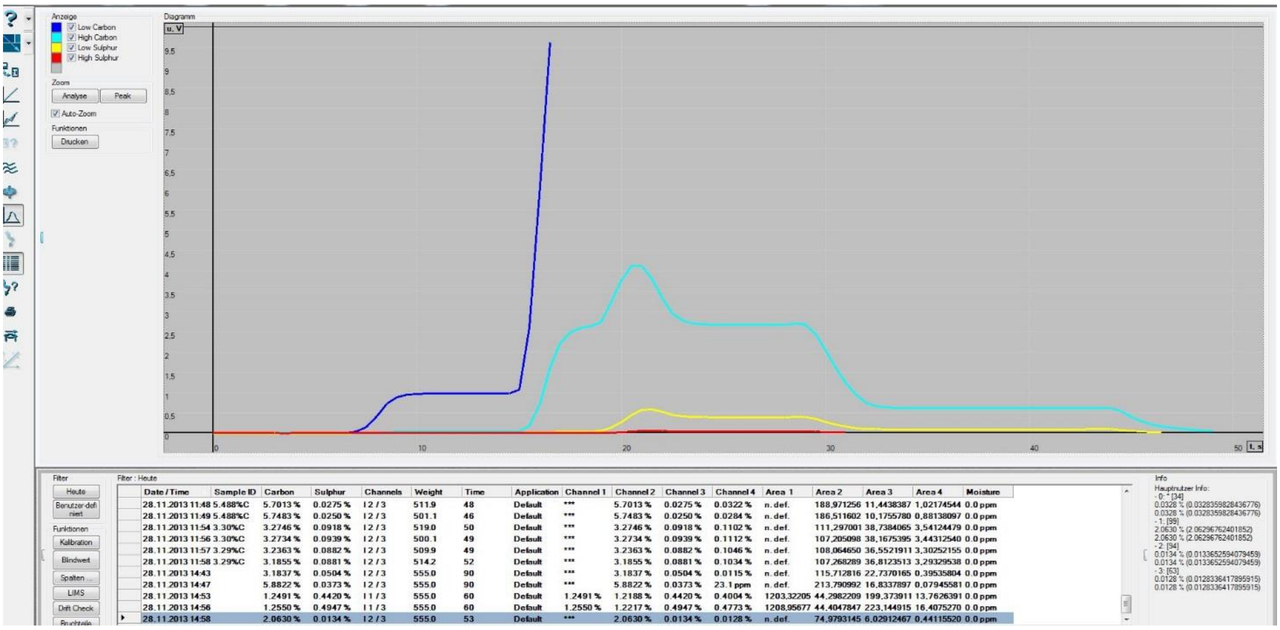


Fig. 54: Programm screenshot (graph example 4)

In this case, the flow blockage was not permanent. This can happen for example when the plunger of the valve V2 may shake due to contamination, enabling occasionally more or less or no flow at all, during one combustion.

4 Adjustments

4.1 Gas flow controller-adjustment and jumper settings

4.1.1 Flow controller for induction furnace operation

Gas flow controller adjustment

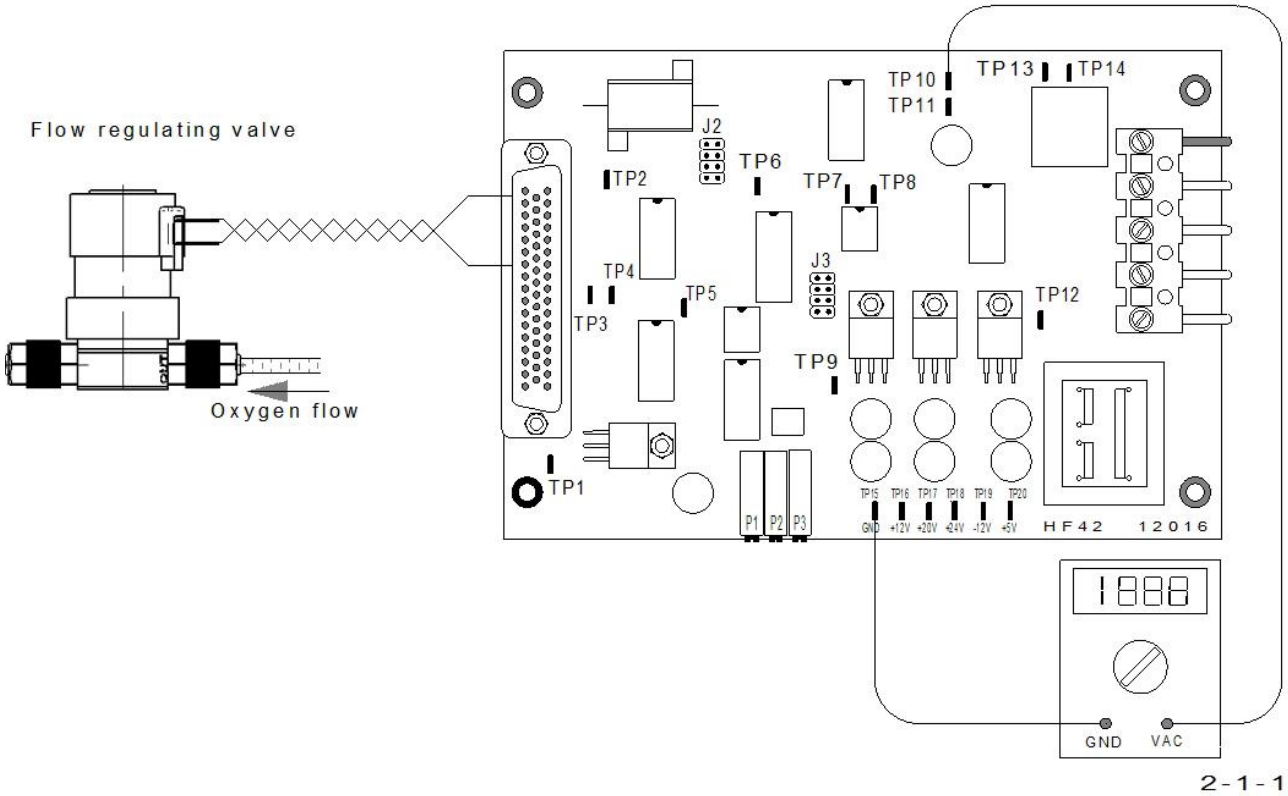


Fig. 55: Gas flow controller

– Set the flow rate with P1 of the HF 42, to about 180 l/h. Observe the flow rate on the lower flow meter of the analyzer. Wait until the value is stable.

The output of the flow sensor is on TP10 of the HF 42 board; TP15 is GND. With a flow of 180 l/h, the voltage is about 2.5 - 3V.

NOTE: without flow, the output voltage of the sensor is not 0V but about 0.6V.

– Adjust with P3 until the voltage on TP7 is 5V.

On TP8, the activity of the pulse width modulator can be checked.

The output voltage to the gas flow regulation valve can be measured on TP3.

With a constant flow of about 180 l/h, it should be between 5 and 15 volts.

– Check and if necessary readjust the pressure regulator (PR3) in front of the flow regulating valve.

Jumper settings:

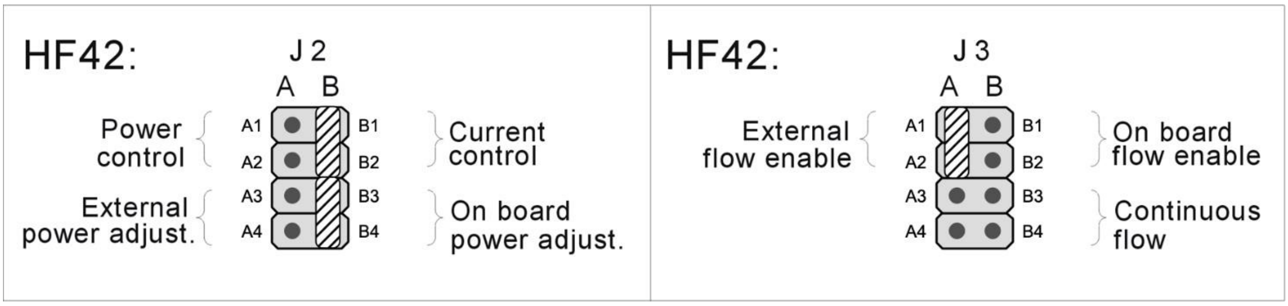


Fig. 56: Jumper settings

The connector J2 is for selecting different options for the induction generator control. By default, one jumper is set in the factory at the position “current control” connecting the pins B1-B2 and a second jumper is set to connect B3-B4 for “On board power adjustment”.

The connector J3 is for selecting options for the oxygen flow. The factory setting of the jumper is for “External flow enable”, by connecting the pins A1-A2. In this case, the microcontroller board can start and stop the flow enabling gas saving mode.

When moving the jumper to B1-B2 for “On board flow enable”, the flow will start and stop with the analysis begin and the analysis end, in other words, there is flow only during analysis. This can be interesting for older analyzers without gas saving function in their software, when they are used in automations running analyses only once in a while with long and regular idling period between analyses, for example 15 minutes

At position “Continuous flow” when the jumper connects B3-B4, there is continuous flow as long as the mains power switch is set to position 2. The continuous flow position is useful in case of looking to solve flow problems, because the flow is always enabled

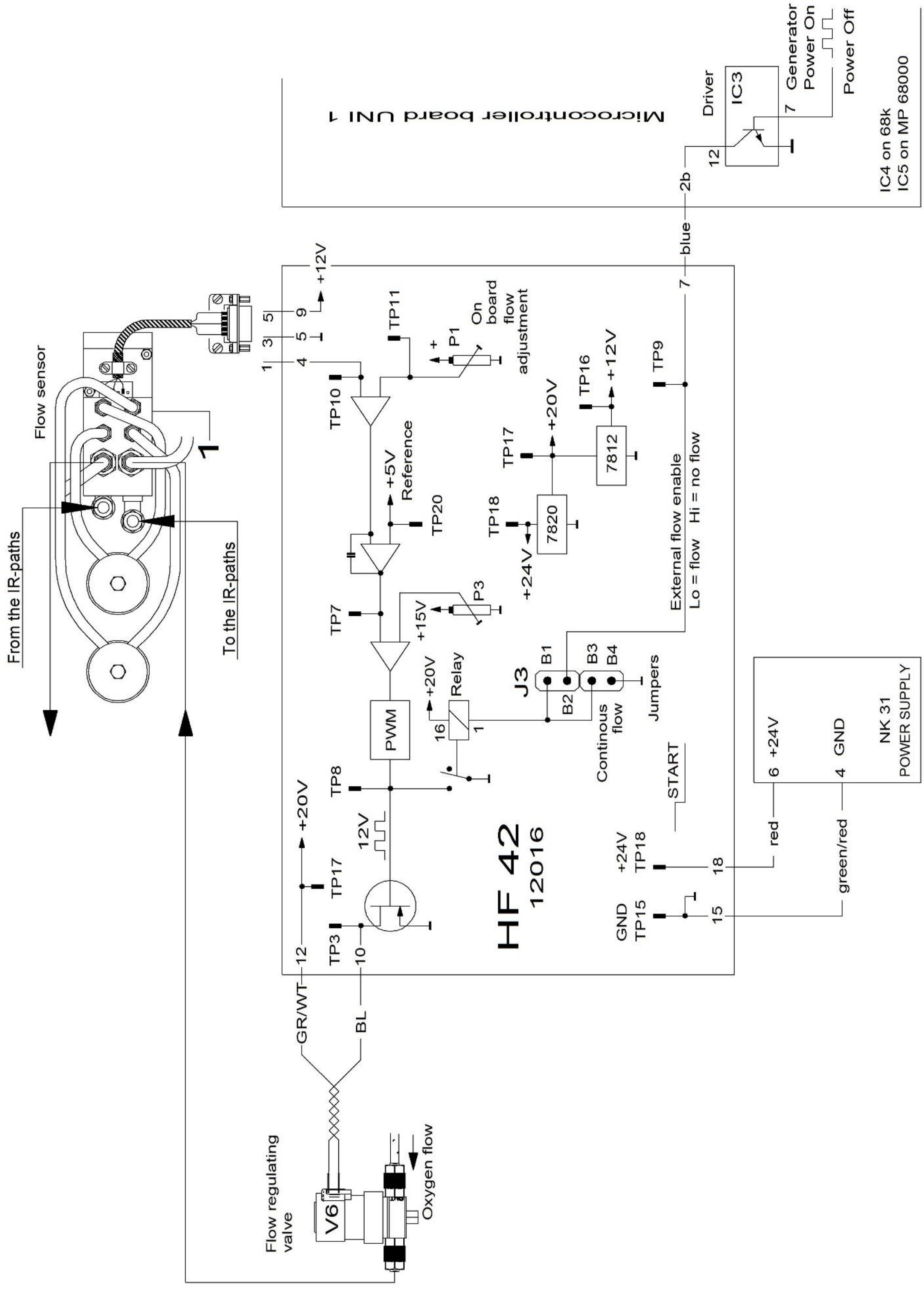


Fig. 57: Gas flow regulation

The flow controller mainly consists of the following components:

- The flow sensor (1)
- The flow regulating valve (V6)
- The flow control board HF 42

The flow sensor measures the gas flow rate, and converts its flow rate into an electrical signal (DC voltage).

The HF 42 board compares this flow value with the flow value set by P1.

The signal resulting from the comparator controls a pulse width modulator.

Its output can be seen on TP 8, TP 15 is GND.

The pulse width modulated signal controls a power transistor, which drives the flow regulating valve.

The duty cycle of the output signal determines the average DC voltage on the valve. In normal operation with a flow of about 180 l/h and with not depleted chemicals, the DC voltage across the valve coil is around 10V. This voltage can be measured between TP3 and TP17. This voltage on the valve has the value needed at any moment for keeping the flow constant, in other words for keeping the sensor voltage equal to the value set with P1.

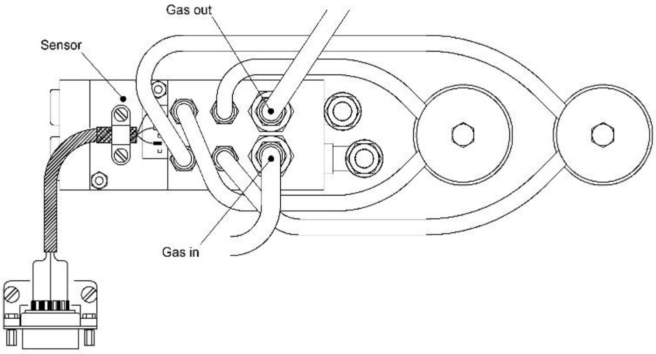
4.1.2 Flow controller for resistance furnace operation

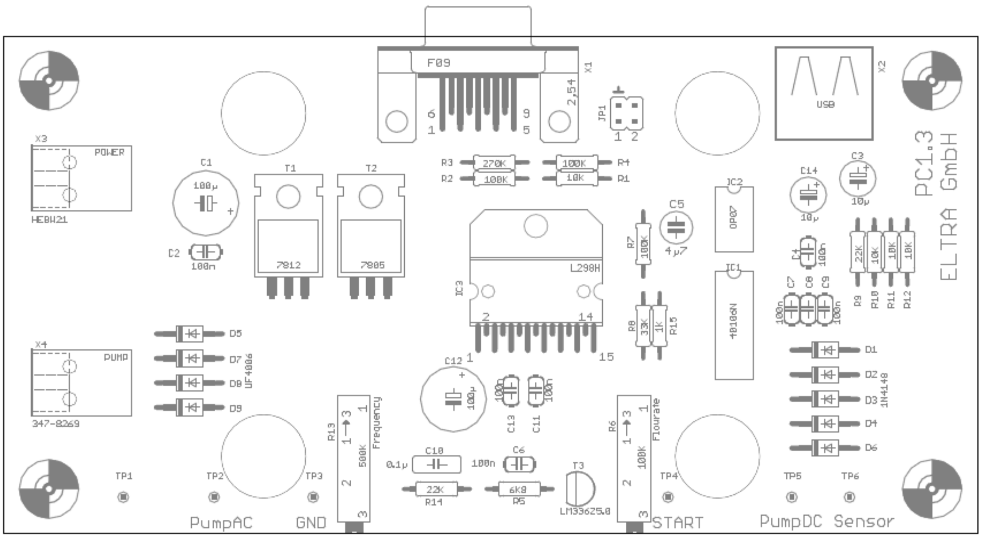
The flow sensor is common for both, induction and resistance furnace operation.

The sensor output is connected to both:

To the input of the HF42 board controlling the regulating valve V6 in induction operation and to the input of the pump control board PC-1.3 controlling the pump in resistance furnace operation.

See chapter “**Wiring diagrams**” and “**Gas flow diagram**”.





1

Fig. 58: Gas flow regulation

Caution: This board is installed in the analyzer upside down. The above schematic shows the components side of the board, which is the lower side of the board in the analyzer.

Test points explanations:

TP1–TP2: AC voltage across the pump coil

TP3: GND for measuring DC voltages on P4, P5, P6.

TP4: Start/stop controling of the pump by the UNI board. 5VDC means no start command. 0.5VDC means, the command for the pump to start is available.

TP5: DC Voltage corresponding (proportional) to the pump voltage. This voltage is used for displaying the pump voltage on the PC screen. The voltage displayed on the screen is recalculated and it is higher than what is measured on TP5. The maximum pump voltage displayed on the screen is 24V. This can be verified by squeezing a plastic tube causing the pump to run at maximum voltage.

One of the reasons why the voltage on TP5 is kept at lower level, is that the analog inputs of the microcontroller board has a maximum input voltage of 10V.

In normal operation the pump voltage is displayed in the “**device state window**”  lies between 5V to 8V.

TP6: Flow sensor output voltage. This voltage is displayed on the PC screen in the “**device state window**”  next to the flow rate in L/h.

R6: Flow rate adjustment. The flow rate can be adjusted by turning this trimmer, clockwise for higher and counter clockwise for lower flow rate.

R13: Pump frequency adjustment. The pumping frequency of the pump can be adjusted by turning this trimmer, clockwise for higher and counter clockwise for lower pump frequency. The pumps are basically designed for 50 Hz operation. The pump frequency has a factory adjustment so that it is not advisable to change it.

X1: Flow sensor connector FD9.

Pin 2: Sensor output

Pin 3: GND

Pin 5: +12V

X2: Connector to UNI board.

Pin 1: Sensor output / TP6

Pin 2: Input for flow start command/TP4. 12V means no flow. 0.5V for flow.

X3: 24V power supply.

Pin (middle) +24V. Outer contact GND.

X4: Pump connector.

Alternating 24V square voltage voltage/TP1 – TP2. Frequency adjustable by R13.

The duty cycle of this square voltage defines the power of the pump.

JP1: The pins 1 and GND must be connected with a jumper for late analyzers.

Older analyzers work also with a jumper, however the pump and flow voltages in the device state window are more stable without jumper.

For details about wiring see chapter “**Wiring diagrams**”.

Remark:

Due to a few failures of the flow sensors, almost exclusively with users who analyse samples with high sulphur and high moisture or regularly treat their samples with acid, we concluded that the reason of the failures should be of chemical nature i.e. sulphuric acid and other acids damage the sensor.

The solution is to prevent the analysis gases to get in contact with the sensors. Therefore the sensor ports are connected with long tubes to the gas flow system. There is no gas flow through the sensor tubes but only the pressure is sensed by the sensor.

In case of failure of a previous version sensor, it is advisable to replace it by the new version. In this case the part numbers of the complete assemblies should be used for ordering. In case the analyzer has already the new version sensor, the order should include the spare part number. See drawings below and chapter “**Ordering numbers**”.

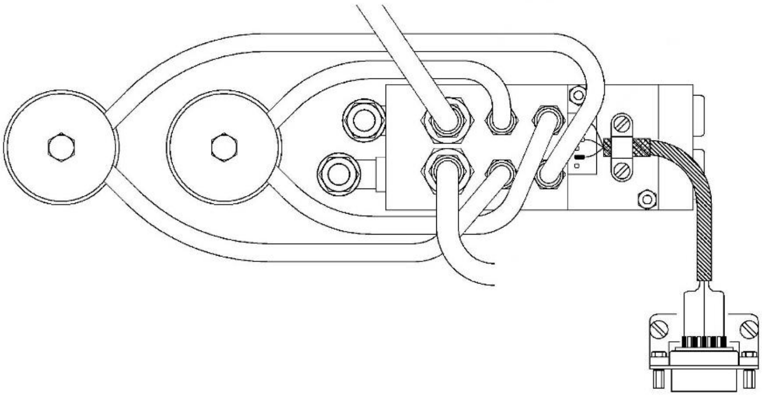


Fig. 59: New flow sensor

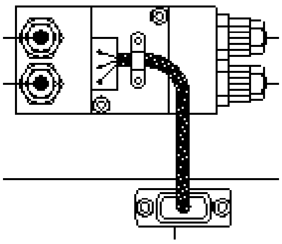


Fig. 60: Old flow sensor

4.2 Infrared base line adjustments

4.2.1 Infrared cell modification - general information

Eltra has changed the IR cell design. This modification makes the cells less susceptible to contamination problems and makes the calibration more stable. The changes are:

The IR-4 board is modified so that now the output voltage of the cell is adjusted at 8V instead of zero.

The voltage of each source remains unchanged at 1.75 volts as it used to be.

After this modification the peaks you see on the screen and the output voltage of the IR cell are two different things.

The Peaks on the screen look the same way like they used to look before starting from zero (base line) and going up positive.

The outputs of the IR cells (IR base lines) are factory set at 8V when the paths are new and clean. The peaks come down starting from 8V coming down to a minimum voltage (at the peak maximum) and they go back to the 8V baseline after completion of combustion. The 8V IR-base line is obtained through preamplifier adjustment only.

In real operation, with growing contamination resulting in gradually weakened radiation reaching the detector, the IR cell output base lines will move down to levels below 8V depending on the grade of contamination. The (negative output) peaks of the cell will also change to smaller amplitude.

The base line is not regulated any more.

Due to a recalculation formula, the base lines on the screen are always zero volts, the peaks are positive and they are always of equal amplitude and surface (for same sample and same weight) regardless the path contamination, regardless the cell base line level, and regardless the cell output peak amplitude. Consequently the integrated value (of the peak on the screen) remains the same and of course also the analyses results remain constant at any grade of contamination.

– When loading the UNI software select from now on "New cell" mode.

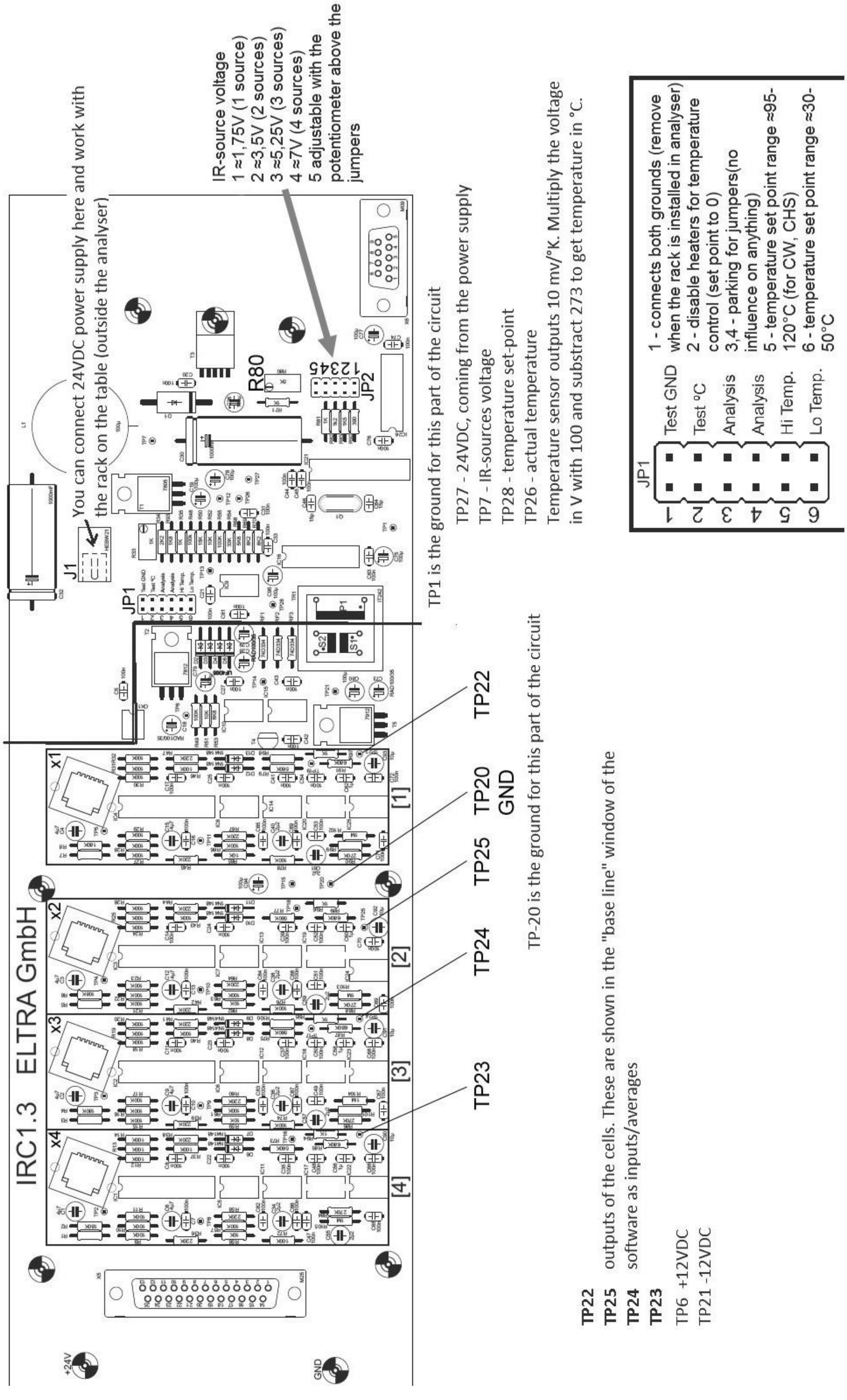

IR-source voltage
1 ≈1,75V (1 source)
2 ≈3,5V (2 sources)
3 ≈5,25V (3 sources)
4 ≈7V (4 sources)
5 adjustable with the potentiometer above the jumpers
You can connect 24VDC power supply here and work with the rack on the table (outside the analyser)
J1
JP1
R80
JP2
12345
IRC1.3 ELTRA GmbH
x1
x2
x3
x4
[1]
[2]
[3]
[4]
+24V
GND
TP22
TP20 GND
TP25
TP24
TP23
TP1 is the ground for this part of the circuit
TP27 - 24VDC, coming from the power supply
TP7 - IR-sources voltage
TP28 - temperature set-point
TP26 - actual temperature
Temperature sensor outputs 10 mv/°K. Multiply the voltage in V with 100 and substract 273 to get temperature in °C.
TP-20 is the ground for this part of the circuit
JP1
1 Test GND
2 Test °C
3 Analysis
4 Analysis
5 Hi Temp.
6 Lo Temp.
1 - connects both grounds (remove when the rack is installed in analyser)
2 - disable heaters for temperature control (set point to 0)
3,4 - parking for jumpers(no influence on anything)
5 - temperature set point range ≈95-120°C (for CW, CHS)
6 - temperature set point range ≈30-50°C
TP22
TP25
TP24
TP23
outputs of the cells. These are shown in the "base line" window of the software as inputs/averages
TP6 +12VDC
TP21 -12VDC

Fig. 61: IRC 1.3

4.2.2 General test points

Supply voltages and thermostatic control circuit

TP 1: GND

TP 7: IR source voltage

TP 12: + 5V supply

TP 13: Heating transistors control voltage

TP 26: IR temperature actual value

TP 27: +24V supply

TP 28: IR temperature set point

Supply voltages for IR signal processing circuit

TP 6: +12V

TP 21: -12V

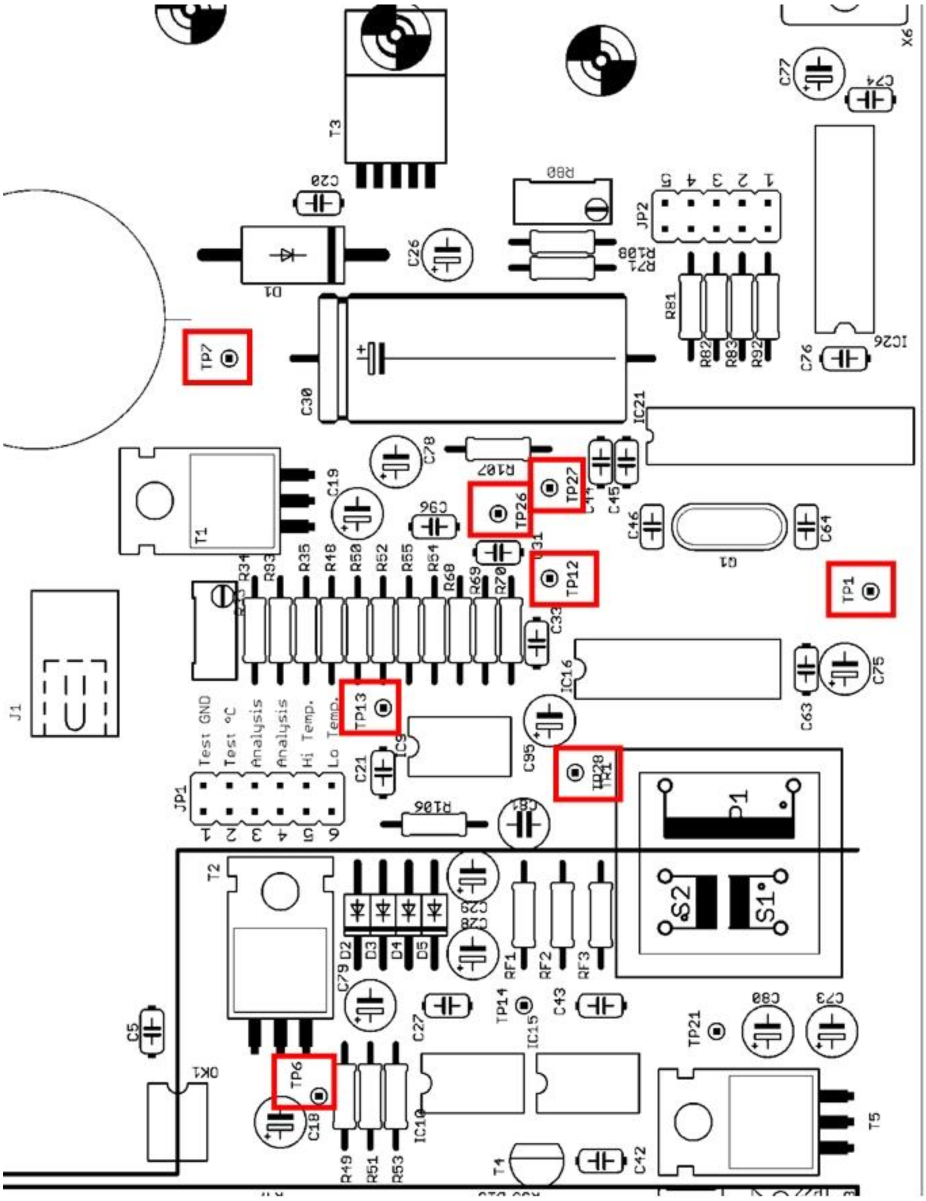


Fig. 62: Mainboard (Cut-out) IR-Cell – general test points

4.2.3 Test points IR-ranges

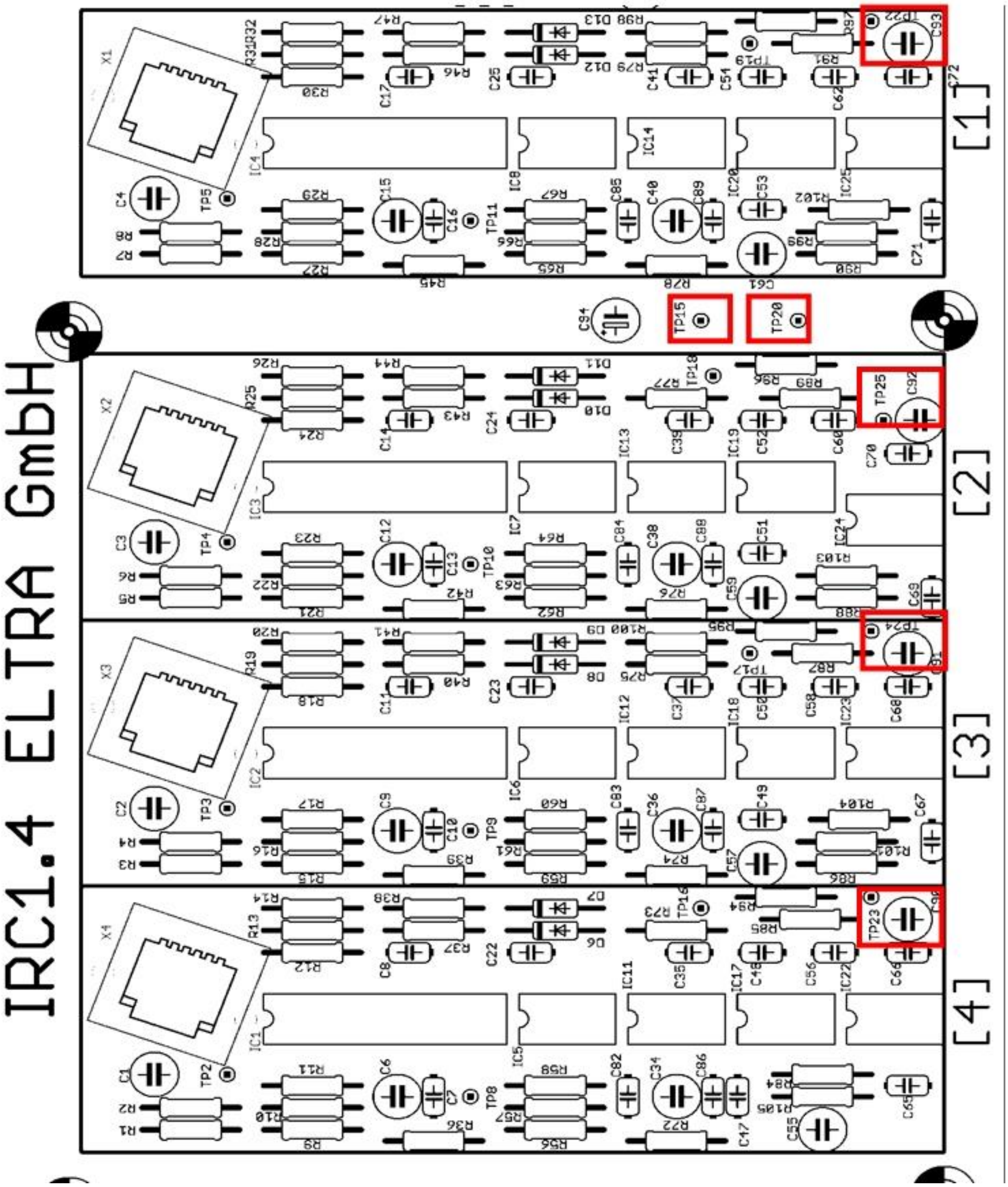


Fig. 63: Test points IR-ranges

Supply voltages for IR signal processing circuit

TP 15: +5V reference

TP 20: Analog GND

Outputs (base lines about 8VDC. For golden paths adjust 6VDC)

TP 22: Output section [1]

TP 25: Output section [2]

TP 24: Output section [3]

TP 23: Output section [4]

4.2.4 Base line adjustments.

See also chapter "**Check base lines**".

When the IR module (rack) is removed from the analyzer, it can be powered on the desk by a 24VDC power supply connected to J1 of the IRC board. The power supply should normally be capable to supply a current of 5A.

If a lower current power supply available, in order to prevent the temperature control from taking high current from the power supply, set a jumper to position 2 of the connector J1. In this case a 24V / 1A power supply will be enough.

CAUTION:

Remember to remove the jumper from position 2 before reinstalling the IR module into the analyzer, otherwise the thermostatic control will not work.

4.2.5 Infrared cell board IRC1.x sections assignment

board sections	[4]	[3]	[2]	[1]
4 cells IR module	Hi S	Lo S	Hi C	Lo C
3 cells IR module		S	Hi C	Lo C
3 cells IR module		Hi S	Lo S	C
2 cells IR module			S	C
2 cells IR module			Hi C	Lo C
2 cells IR module			Hi S	Lo S
1 cell IR module				C
1 cell IR module				S

Explanations

– Lo C: Low carbon range (long C path)
– Hi C: High carbon range (short C path)
– Lo S: Low sulfur range (long S path)
– Hi S: High sulfur range (short S path)
– C: single carbon range (single C path)
– S: single sulfur range (single S path)

The preamplifier connectors of the cells are of course connected to the corresponding sections according to the above assignment list. (4-pin module connectors).

Example

A three cell module with a low carbon, a high carbon and a sulfur cell has

– the low carbon signal on section [1], the LoC preamp is on X1
– the high carbon signal on section [2], the HiC preamp is on X2
– the Sulfur cell signal on section [3], the S preamp is on X3

The base line adjustments are done by adjusting the gain of the preamplifier of each IR cell in the IR module (rack). The gain adjustment is done by turning the trimmer which is inside of each preamplifier. The base line voltages can be measured on the following test points:

Outputs (base lines about 8VDC)

TP 22: Output section [1]

TP 25: Output section [2]

TP 24: Output section [3]

TP 23: Output section [4]

TP 20: Analog GND

NOTICE

Use a very thin screwdriver. With a big screwdriver, the trimmer can be mechanically destroyed before you feel it. The screwdriver should never get in touch with the hole resp. the housing of the preamp, otherwise the trimmer may be mechanically stressed and break.

4.2.6 Voltage of a base line is too high (higher than 9.5V)

The optimal value for the base lines of the IR-paths is about 8V. Golden paths have the effect to become more reflective in the first few months of their operation. To compensate this effect, the original value of the golden paths base line should be adjusted at 5 V. In case of a long golden paths (300mm) having sensors including on-chip preamplifier, the cell output sometimes cannot be adjusted down to the required 5 to 6V by turning counter clockwise the trimmer in the preamplifier. (Outputs: TP22 to TP25 against AGND = TP20).

In this case the IR sources voltage has to be reduced until you get a base line of the troubled golden cell down to about 5 to 6V. You will then need to increase the gain of the other cells preamps to get their base lines back to the range of 8V.

Source voltage – reducing

1. Take the IR cell out of the analyser.
2. Power the cell by an external 24VDC power supply connected to J1 of the IRC board.
3. If the external power supply cannot supply 5A then set a jumper on position 2 (Test °C) of JP1 in order to switch off the temperature control so that a power supply of 1A is adequate. If a jumper is available on position 3 or 4 (Analysis), this jumper can be moved to position 2. The positions 3 and 4 are simply parking positions for jumpers to simply be available when needed. There are no tracks connected on the pins of the (Analysis) positions 3 and 4 of JP1.
4. Make sure that the gain of the preamplifier in question is adjusted to a minimum gain. To do this, turn its trimmer counter clockwise up to the end of trimmer range. These trimmers have a maximum of 20 turns. When the end of range has been reached, you can hear a gently silent click with each turn. It is not possible to feel any mechanical resistance on the screw driver.
5. Measure the actual source voltage between on TP7 against GND=TP1 and note the value.
6. Turn the potentiometer R80 of the IRC board counter clockwise up to the end of its range. (Maximum gear range = 20 turns).
7. Switch off resp. disconnect the power supply.
8. Move the jumper of JP2 to position 5.
9. Connect the 24V power again.
10. Connect the multimeter to the cell output which has to be adjusted.
11. Wait for the sources to warm up until the output voltage will almost reach its maximum value.
12. Turn the trimmer R80 slowly clockwise until the base line of the cell in question has reached 8V. In case of a clean golden path, adjust between 5V and 6V instead of 8V.

13. Adjust the outputs of other cells (not golden paths) to have between 7 to 8V by adjusting the gains of their preamplifiers.
14. Set the jumper of the JP1 from position 2 (Test °C) to Position 3 (Analysis).
15. Install the IR module into the analyzer.
16. Allow sufficient time for the base lines to stabilize.

NOTICE It is necessary to turn slowly in order for the IR sources to stabilize their temperature with increasing IR source voltage.

– Adjust the other cells of the module (if any) at 8V baselines or 5V to 6V in case of clean golden paths.
– Install the IR module into the analyzer. Allow sufficient time for the base lines to stabilize.
– Start gas flow and check the base lines again. If any of them is significantly over 8V then readjust.

Drift too large

– Check the temperature regulation.
– Unstable power supply.
– Defective IR-source.

NOTICE If it is shown on the display that the infrared cell's output voltage is over 10 volts then there is a serious defect.

4.3 IR source voltage setting

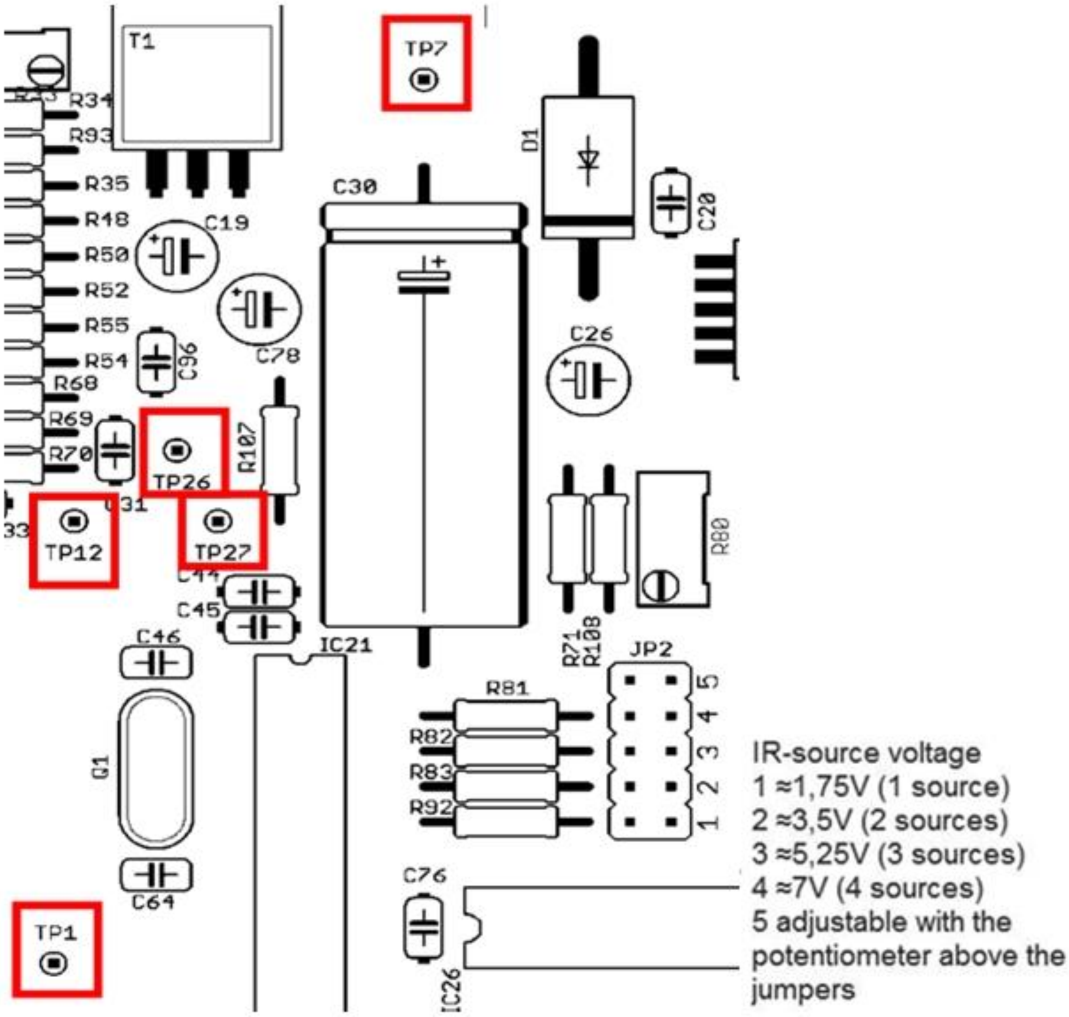


Fig. 64: IR source voltage setting

The jumper JP2 is for setting voltages of the IR sources. All available sources in an IR cell are connected in series. Normally the voltage of each source is 1.75 VDC. The total voltage of all available cells can be measured on test point TP7 against TP1=GND.

Caution: In case of adjusting resp. changing the IR source voltage, the base lines take a few minutes to stabilize at a new level.

In case of problems with adjusting the base line see chapters “Infrared cell adjustments” and “Infrared power supply”.

4.4 Infrared cell temperature regulation

IR cell temperature control

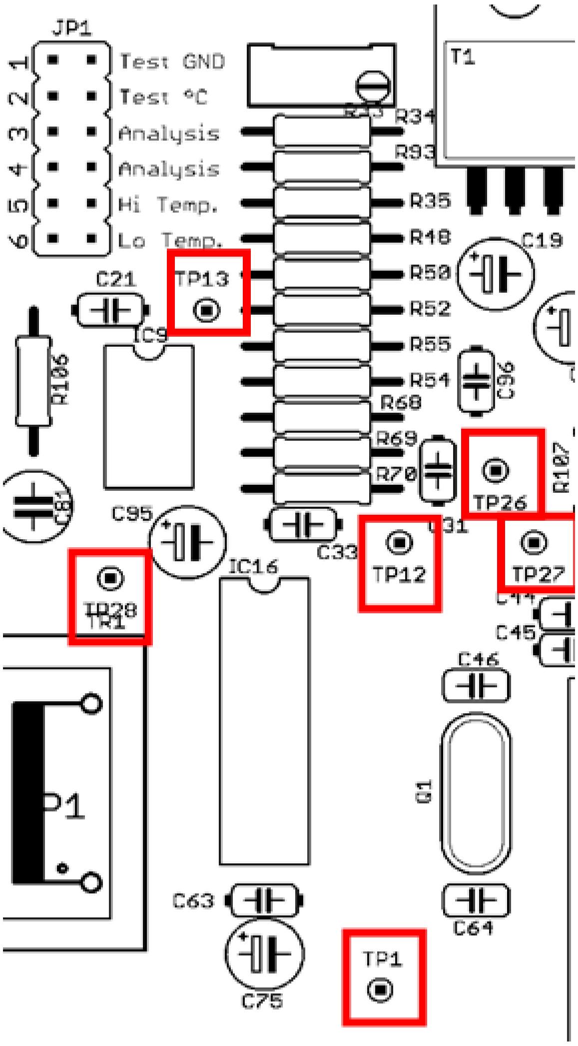


Fig. 65: IR cell temperature control

TP28 is the test point for measuring the set point of the IR temperature against TP1=GND.

At 3000 mV the temperature is 27°C growing with 10 mv /°C.

Examples:

3.10V → 37°C

3.30V → 57°C

This is the adjustable temperature range of the cell in normal cases. This temperature range is adjustable when there is a jumper set on position 6-Lo temperature of JP1 and mainly there is no jumper on position 5-Hi Temp of JP1. In other words, when no jumper is set, this temperature range is already by default. A jumper in position 6-Lo Temp will keep this range, so there is no difference, but the jumper will be available when a jumper is elsewhere really needed.

3.73V →100°C

3.98V →125°C

This temperature range is available for heated paths only. They are the paths for measuring water resp. hydrogen in the analyzers CW and CHS and possibly later in CHNS analyzers. In order to have the temperature adjustable in the above range, a jumper has to be set on position 5-Hi Temp. of JP1.

The temperature is set by turning the pot and measuring the set value on

The actual value of the temperature is measured on TP26.

Caution: After changing the temperature set point, it takes some time until the actual temperature value is stabilized at the new set level.

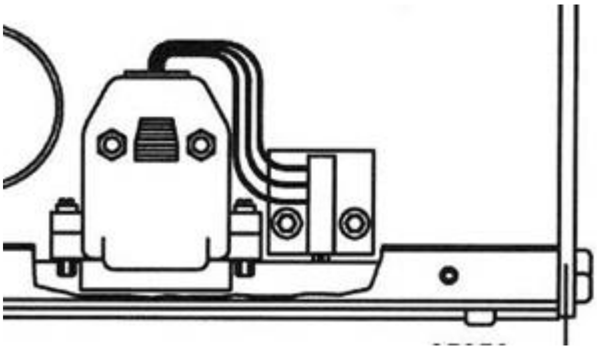


Fig. 66: Trimmer

This is the trimmer in the IR cell module for adjusting the cell temperature. It is accessible with a screw driver from outside the cell. There is no need to remove the cell block module from the analyzer’s cabinet in order to adjust the temperature

Modifications for higher sensitivity (gain) in the low sulphur range:

For LS: R101=47k R100 = 3M

4.1 x Standard gain

Recalculation factor = 92.664

For double the normal sensitivity: R101=180k

1.92 x standard gain

Recalculation factor = 39.5

For standard gain.

Recalculation factor = 20.59

4.5 Pneumatics

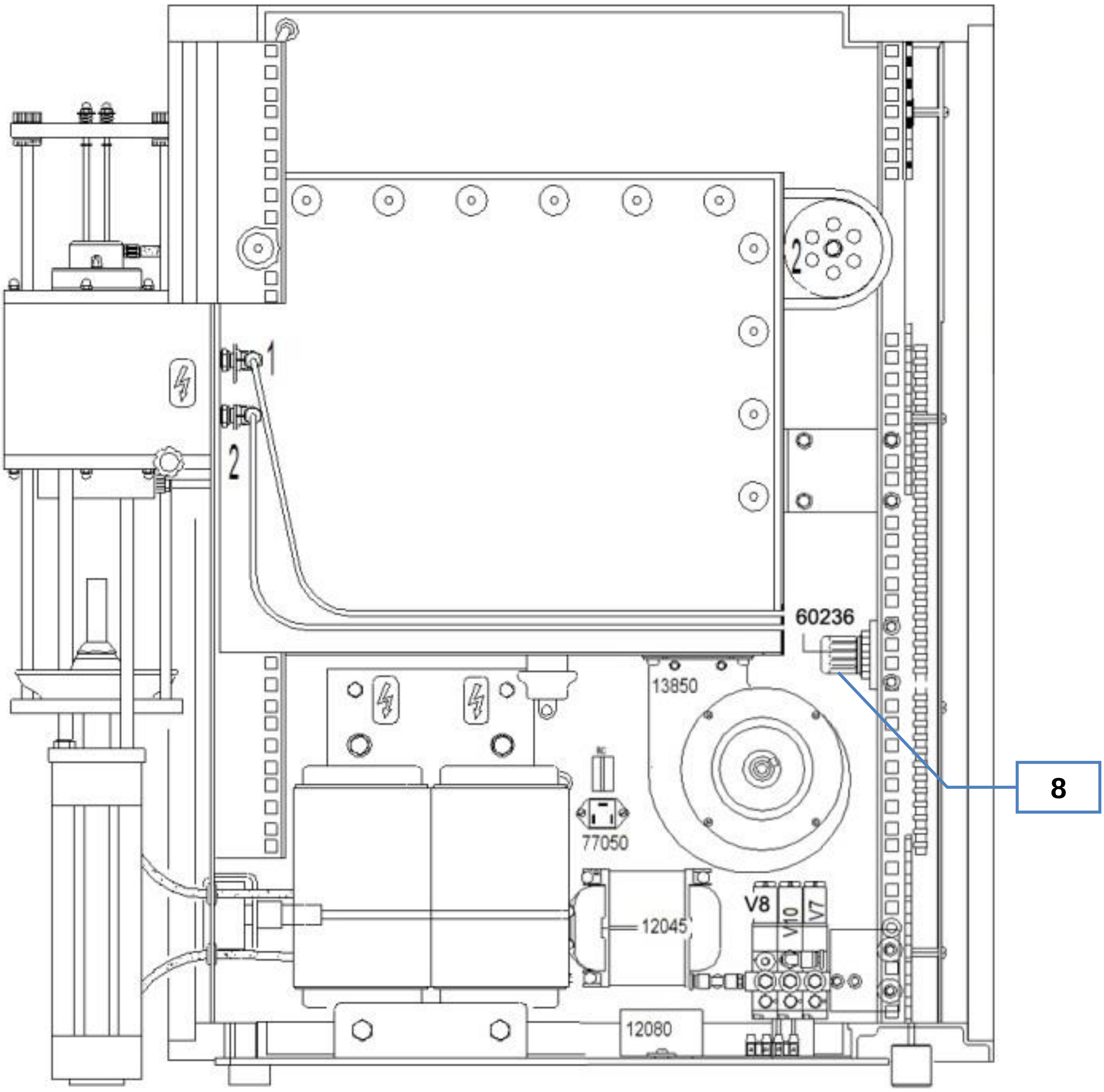


Fig. 67: Pneumatics parts

Pneumatics parts showing the location of the pneumatic valves V7, V8 and V10 as well as the position of the pressure regulator 8

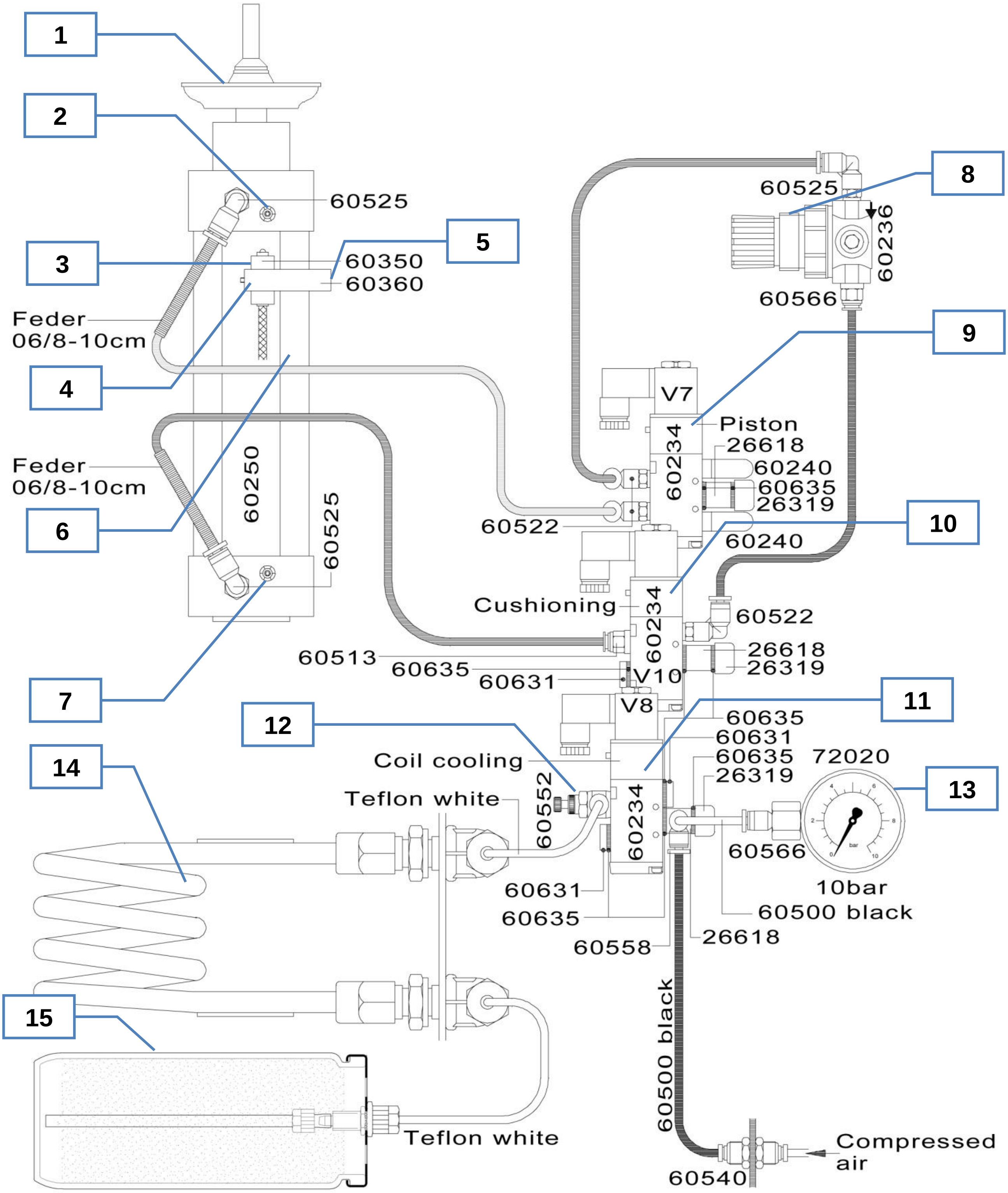


Fig. 68: Pneumatic parts

1	Furnace closing cone
2	Upper cushioning
3	Magnetic switch
4	Magnetic switch holder

5	Adjusting screw
6	Pneumatic cylinder
7	Lower cushioning
8	Pressure regulator
9	Piston valve
10	Cushioning valve
11	Coil cooling valve
12	Coil cooling adjustment
13	Pressure gauge
14	Combustion coil
15	Muffler

Pneumatics adjusting for correct furnace movement:

When closing the furnace, the piston moves.

Open the right side panel of the analyzer to find the pneumatic valves (9 / V7), (10 / V10) and (11 / V8) as well as the pressure regulator (8).

- Turn the restrictor (12) clockwise up to the end for complete restriction.
- Check the pressure on gauge (13) to be between 4-6 bar (60-85psi).
- Press F2 to open the furnace.
- Pull to unlock and then rotate the knob of the pressure regulator (8) counter clockwise for minimum pressure (zero pressure).
- Turn the screw (5) counter clockwise until the magnetic switch support (4) is free to move up and down on the cylinder (6).
- Shift the magnetic switch upwards up to the end of its adjusting range.
- Press F2 for closing the furnace. The furnace closing cone (1) won't yet move or move very slowly.
- Turn clockwise the knob of the pressure regulator (8) until the closing cone (1) can rise smoothly (without shaking) up to the upper end of its stroke. To do this, open and close the furnace (F2) as often as needed. Take software delays into account.
- The pressure should be only as high as necessary and low enough for a person to be able to stop by hand the cone from rising.
- Push the knob to lock the pressure regulator (8).
- When the furnace is closed, slowly shift the magnetic switch (3) with its support (4) downwards until it just switches on. This can be recognized due to the clicking of a pneumatic valve (10/V10) and the piston moving then slightly higher.
- Make a marking on the cylinder (6) at the upper end of the magnetic switch holder (4).
- Shift the switch with holder downwards until the magnetic switch is off (A valve clicks and the piston slightly moves downwards).
- Make a second marking on the cylinder (6) at the upper end of the switch holder (4).
- Adjust the switch holder (4) to have the upper end in the middle of the two markings.
- Open the furnace and then close it again (F2) to verify the correctness of the adjustment.
- Adjust the lower cushioning (7), so that the furnace opens without the piston banging at the bottom.

- Click on “Communication test”-“Digital outputs”, on the 9th button counting from the left, to energize the coil cooling valve (11/V8), or start analysis cycle.
- Turn the restrictor (12) counter clockwise until the pressure on the gauge (13) is reduced by about 0.2 to 0.3 bar (3 to 4 psi) when the coil cooling valve (11/V8) is open.
- Fix the locknut of the restrictor (12).

REMARK:

In case of using valuable gas for operating the pneumatics, the restrictor (12) should be adjusted for lower flow by turning it clockwise. It can even be completely closed by turning it clockwise up to the end of its range.

The flow adjusted with this restrictor is for cooling the combustion coil to ensure very long service life. According to our experience, the combustion coils of our analyzers don’t need replacement, even after years of operation.

Check the following :

– Open the furnace (piston down).
– Hold the piston down by pressing on the horizontal bar of the furnace. (with the fingers)
– Press the key to close the furnace.
– Allow the piston to go up very slowly by controlling the force of your fingers.
  If not possible do the pneumatics adjustment, see pages before.
– About 5 mm before the piston reaches its highest position the force will increase.
– With your fingers press down firmly to make sure that the piston can not be pushed down.
– If the piston starts vibrating by moving up and down with full force, then adjust the switch higher.
– If the piston goes down, then adjust the switch lower.

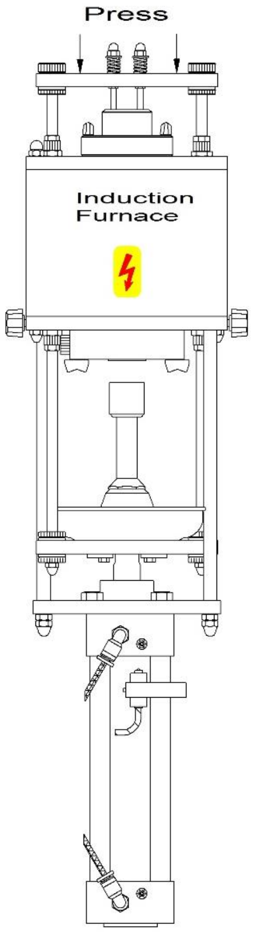


Fig. 69: Adjusting correct furnace movement

4.6 Pressure regulation

Inlet pressure

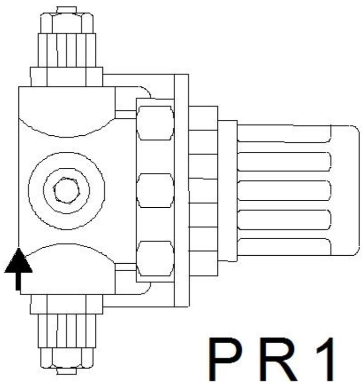


Fig. 70: PR1

PR1 is the inlet oxygen regulator, and is situated inside the analyzer, on the rear panel.

The outlet pressure needs to be set to 1.5bar (22.5psi).

– Pull and rotate the knob of the regulator, until the pressure gauge (6) shows the correct value.

– Ensure that the flow shown on the flow meter (5) shows between 180 and 200l/h; if not, adjust according to the related chapter.

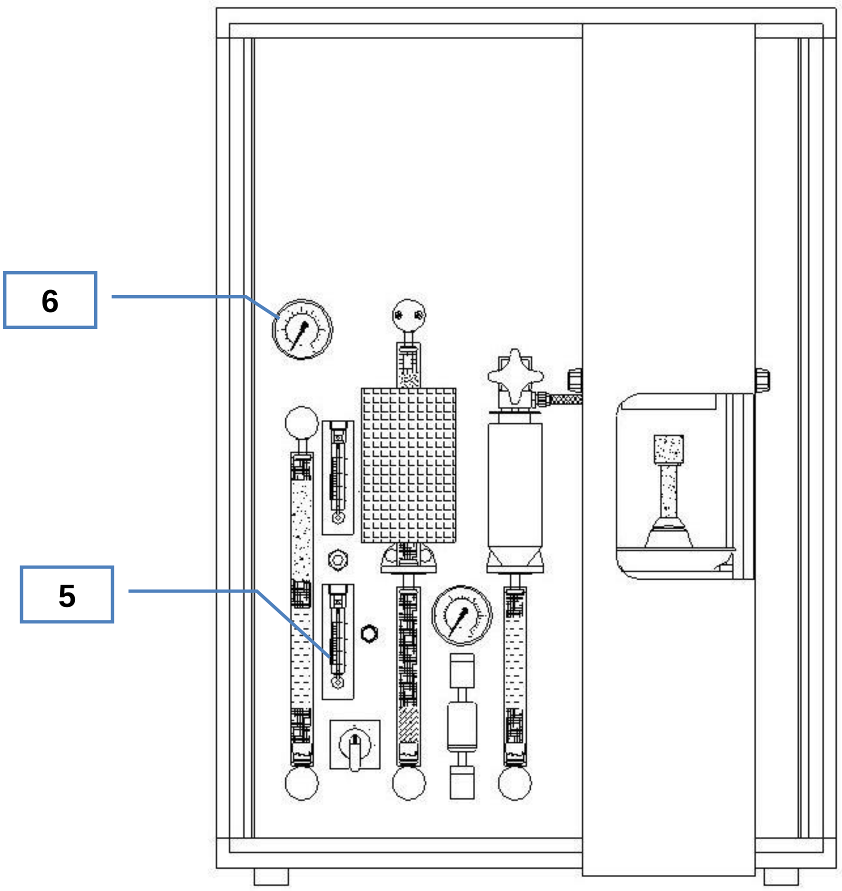


Fig. 71: Front side

Purge pressure

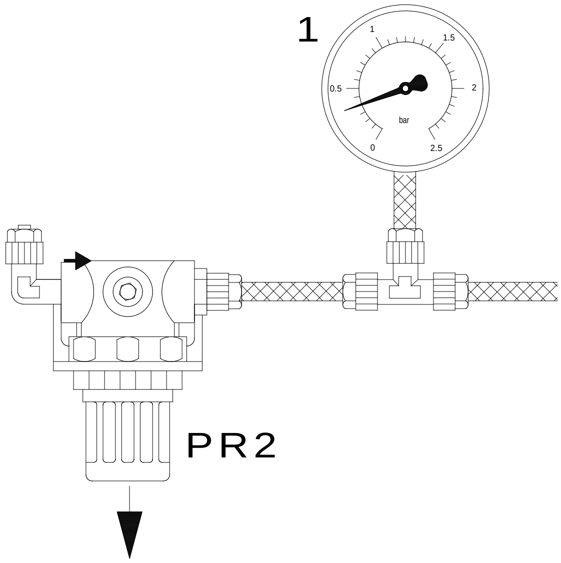


Fig. 72: PR2

PR2 is the pressure regulator for the purging system of the IR-cell and it is situated inside the analyzer, just behind the left-side of the panel. It is positioned horizontally.

– The oxygen pressure at the outlet of the PR2 should be 0.35 bar (5psi). The pressure can be checked by applying a T-piece on the outlet of the pressure regulator, and connecting a pressure gauge (1), as indicated above.
– Pull and rotate the knob of the pressure regulator (PR2), until the correct pressure is shown on the gauge.

4.7 Closing cone adjustment

– Ensure that the shaft (1) is securely fastened to the (1). (engineers wrench size 17).
– In order to adjust the cone, the screws (4) should be loosened so that the cone (3) moves horizontally on the bar (2).
– Close the furnace (with the lift upwards).
– Tighten the screws (4).
– The cone is now positioned correctly.
– The screws (5), (6), (7), must now be well tightened in this order.
– The screws (8) should be properly fastened (with a wrench).
– The screws (9) should be tightened by hand only.

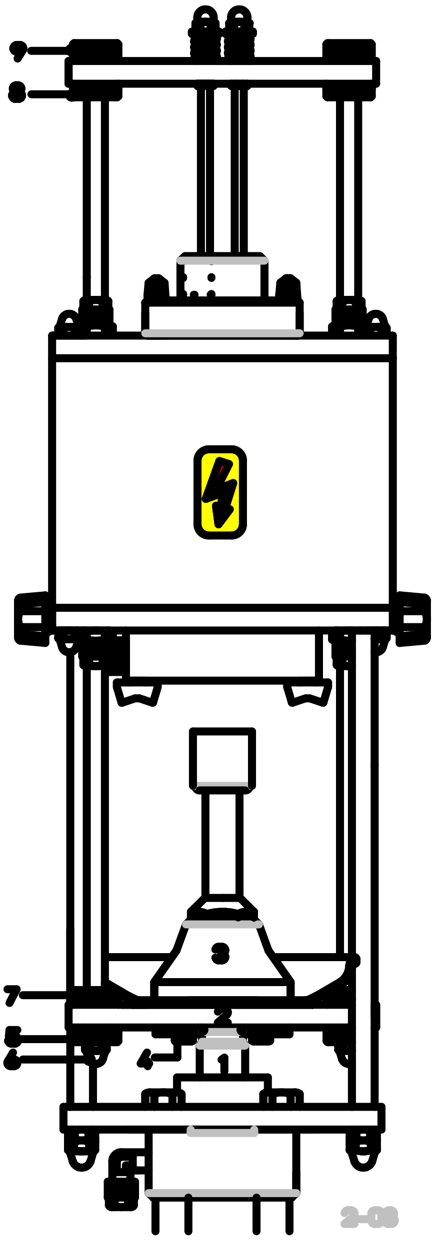


Fig. 73: Closing cone

4.8 Linearity correction

See **„Software helps“**!

4.9 Induction generator control

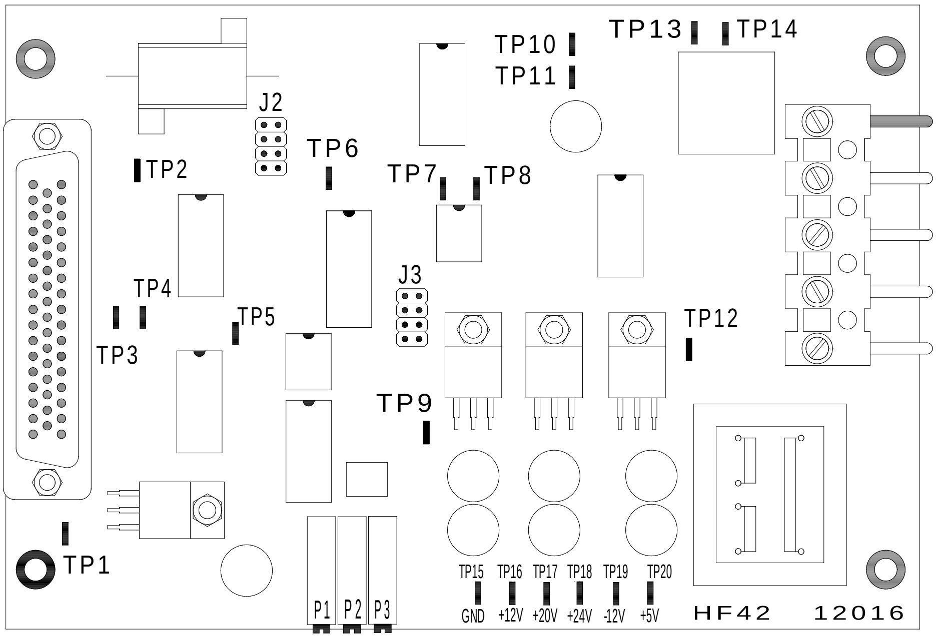


Fig. 74: HF 42

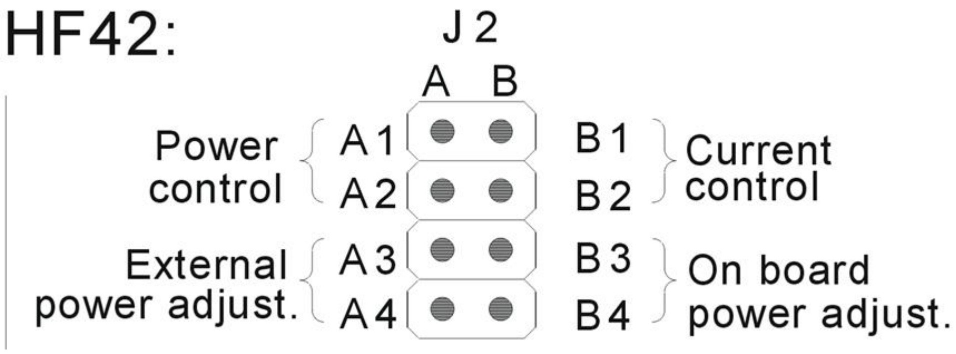


Fig. 75: Jumper settings HF 42

Current control:

The current control provides a safer and more accurate control of the furnace intensity.

– Set the jumper J2 to B1-B2. .

– Connect a digital multi meter on TP1 (TP15 is GND).

Adjust only, while the furnace is active:

– Start the analysis, adjusting P2 until 6.3V DC is reached on TP1 (for copper analysis, adjust 1.2V DC).

The following diagrams show the relationship between the set value (adjustment with P2 on the HF 42 board) and the generator parameters.

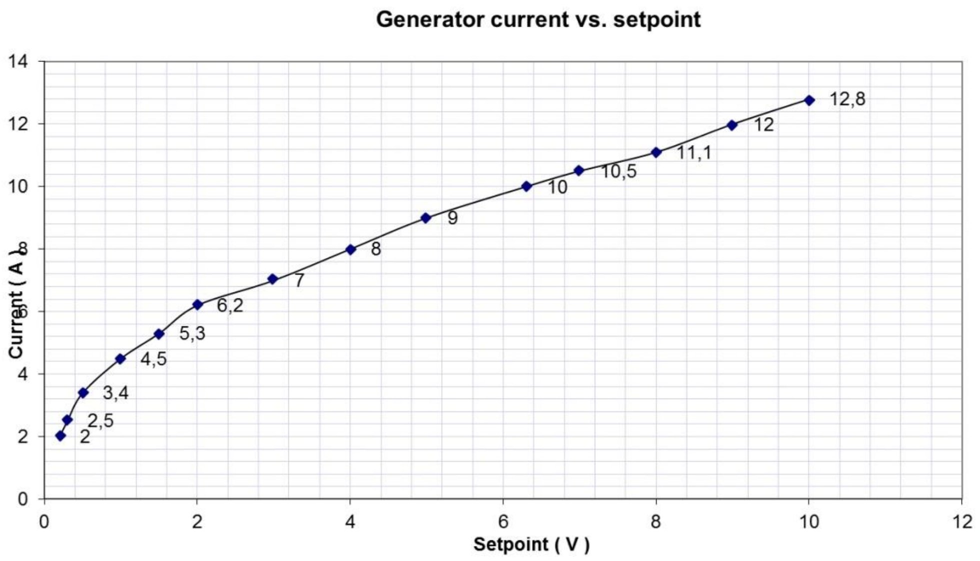


Fig. 76: Diagram Generator current vs. setpoint

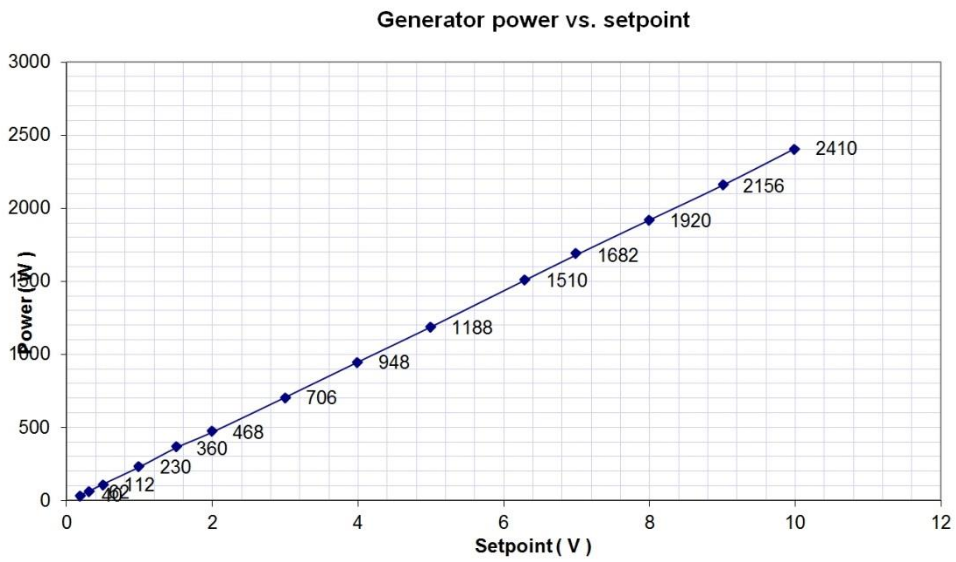


Fig. 77: Diagram Generator power vs. setpoint

4.10 Resistance furnace

4.10.1 Setting the furnace regulation card TH 43 / TH 44

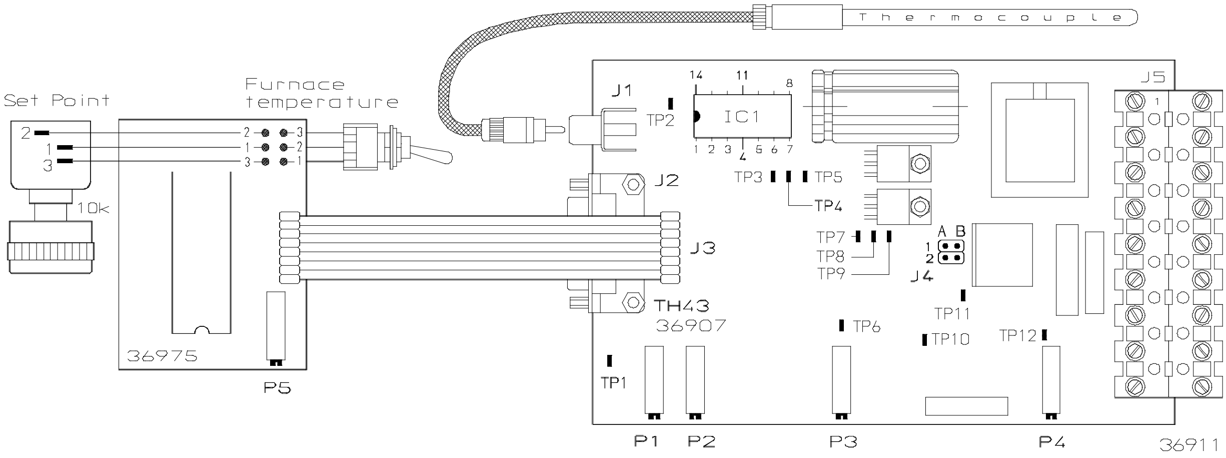


Fig. 78: Setting the furnace reulation card

1) Connect jumper J4 to A1 B1.
2) Disconnect plugs J2 and J3.
3) Turn trimmer P4 anticlockwise to the end-stop.
4) Set the power switch to pos. 2.
5) Measure about +15 V on pin 4 of the IC1; TP3 = GND.
6) Measure about +5 V on pin 14 of the IC 1.
7) Measure about –5 V on pin 11 of the IC 1.
8) Reconnect J2 and J3.
9) Turn the potentiometer on the front panel clockwise until maximum setting is reached.
10) Set the toggle switch to position set point .
11) Adjust with P1 to 1550 mV (maximum) on TP4 (to be measured with a digital DVM).
12) Set the trimmer to a value of 1550 on the LCD display.
13) Set the toggle switch to actual value (furnace temperature).
14) With P3 set the room temperature on the LCD display.
15) Set toggle switch back to set point.
16) Adjust set point to 1250°C.
17) Set toggle switch back to actual value.
18) Connect jumper J4 to A2 B2.
19) Adjust with P4 the max. AC current. For this purpose measure the current of the main power with an external amperemeter. Adjust 20A.

CAUTION! Use a true RMS meter

20) Measure the voltage of the thermocouple on TP1, using an external multimeter with a resolution of 0.01 mV.
21) By means of P2, set a value on the LCD display which relates to the value on the multimeter; e.g. if the multimeter shows 11,30 mV, then the LCD display must show 1130°C. Once the furnace temperature is stable at the set temperature of 1250°C, the multimeter must show 12.50 mV and the LCD display must show 1250°C. Repeat the adjustments, in case the readings deviate.

Replacement of the TH 43 board:

once the TH 43 board has been replaced, it is necessary to perform the above adjustments, to avoid errors due to the tolerance of any component in the furnace.

4.10.2 Furnace regulation board TH 43 / TH 44

Description of its function:

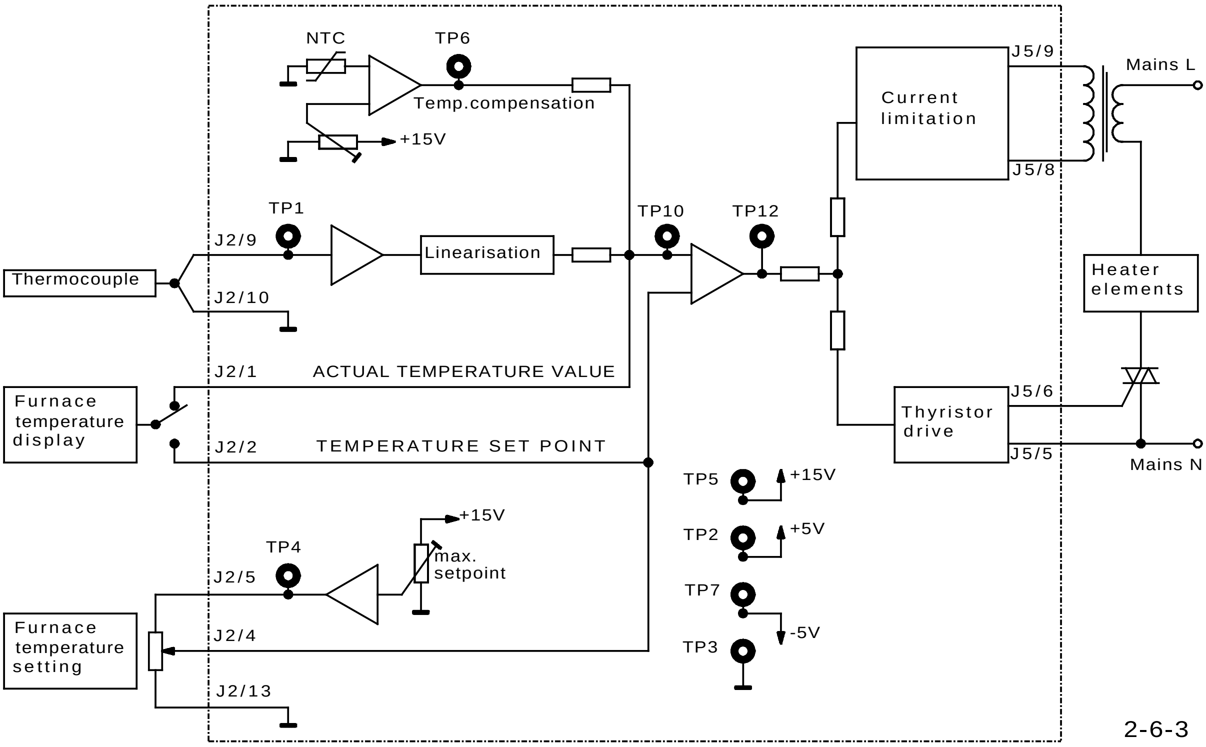


Fig. 79: Furnace regulation board TH 43/TH 44

The TH 43 or TH 44 control board regulates the furnace power, first by comparing the temperature set point with the actual furnace temperature, then by sending the appropriate signal to the thyristor drive unit.

The output voltage of the thermocouple (actual furnace temperature) can be read at TP1. Its range is about 13 mV at 1300°C.

The output voltage versus temperature characteristic of a thermocouple is not perfectly linear. A linearisation unit therefore, has been included in the above circuit.

Once linearized and amplified, the furnace temperature voltage can be read on TP10. The temperature set point, which is adjustable with the potentiometer on the furnace, is compared with the actual furnace temperature voltage.

The resultant voltage (on TP12) is then fed to the thyristor drive unit, thus increasing or decreasing the furnace voltage.

A current limitation circuit keeps the furnace current within safe limits.

Either the temperature set point or the actual temperature can be digitally displayed, depending on the switch setting on the furnace.

4.11 Thermocouple testing

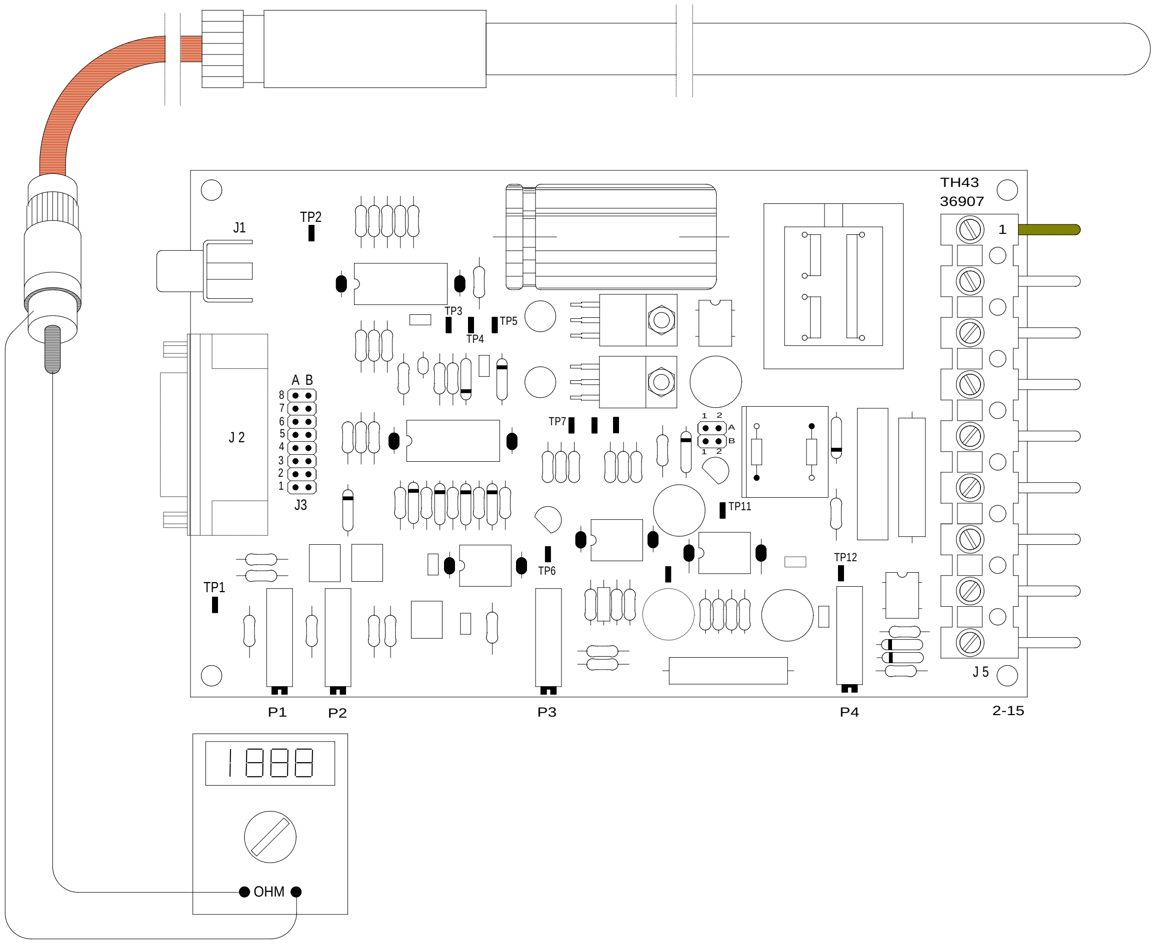


Fig. 80: Thermocouple testing

Disconnect the plug J1 from the board TH 43 and measure the resistance of the thermocouple with a digital multimeter, range 100 Ohm.

The resistance must be very low, about 0,5 Ohm.

If the resistance is very high or infinite, then the thermocouple is faulty and must be replaced.

5 Service

5.1 IR-paths, cleaning and replacing

- Remove the plastic tubes from the IR-paths (gas inlet / outlet).
- Unscrew the rings with windows on both ends of the paths and remove it for cleaning purposes (screws M 2.5 in the following schematics).
- After disassembly check the two windows for damage.
- For cleaning the path use the cleaning brush for golden IR-paths, see picture below.

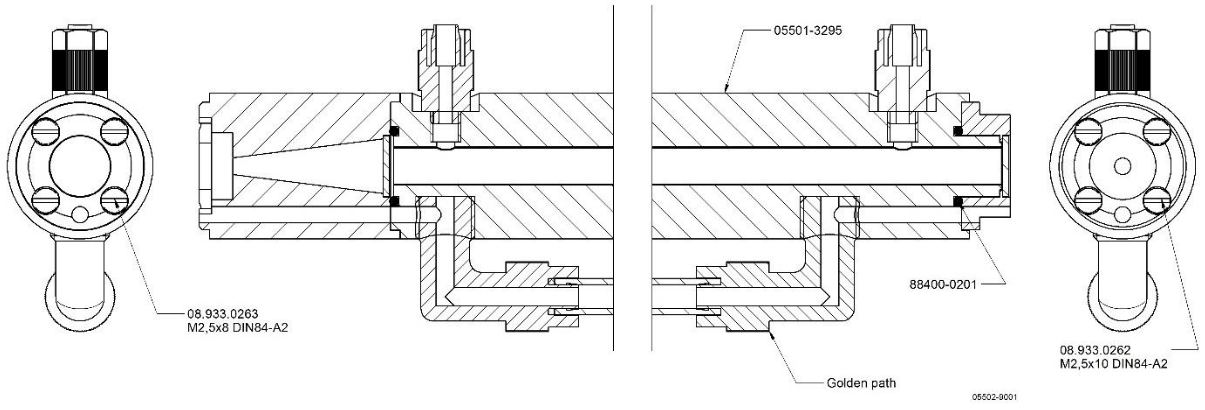


Fig. 81: Golden IR-Path

Fig. 82: Cleaning brush for golden IR-Path

- Assembly of the paths in the reverse order.
- After reinstallation, adjustments according to chapter “**Infrared base line** “and “**Infrared power supply**” are highly recommended.
- Check the calibration and if necessary calibrate. See operation manual.

List of available infrared paths for the CS-2000 see chapter “**Ordering numbers**”.

The following schematic is to help to make sure that the tubing is done correctly after reinstalling the cleaned paths.

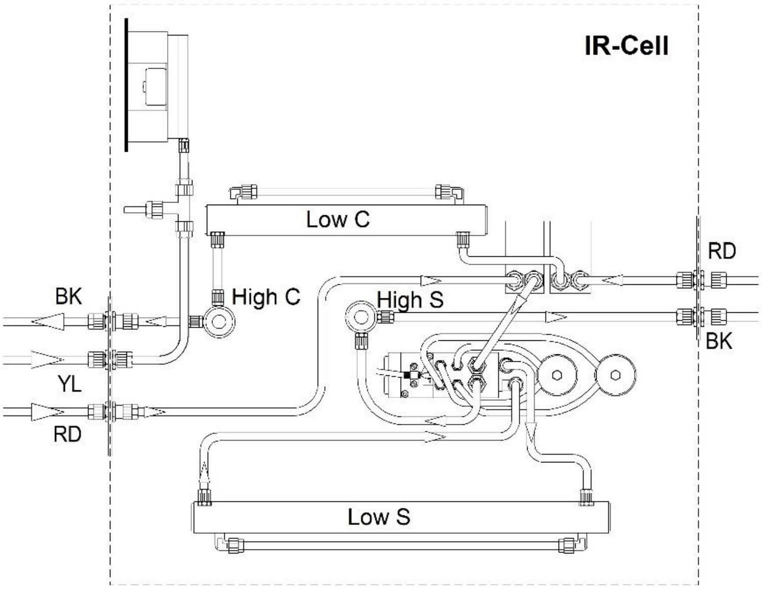


Fig. 83: The tubing

When reinstalling the infrared cell unit in the analyzer, pay attention to the color markings of the tubes and their fittings.

5.2 Infrared electronics

5.2.1 Removing the IRC-board

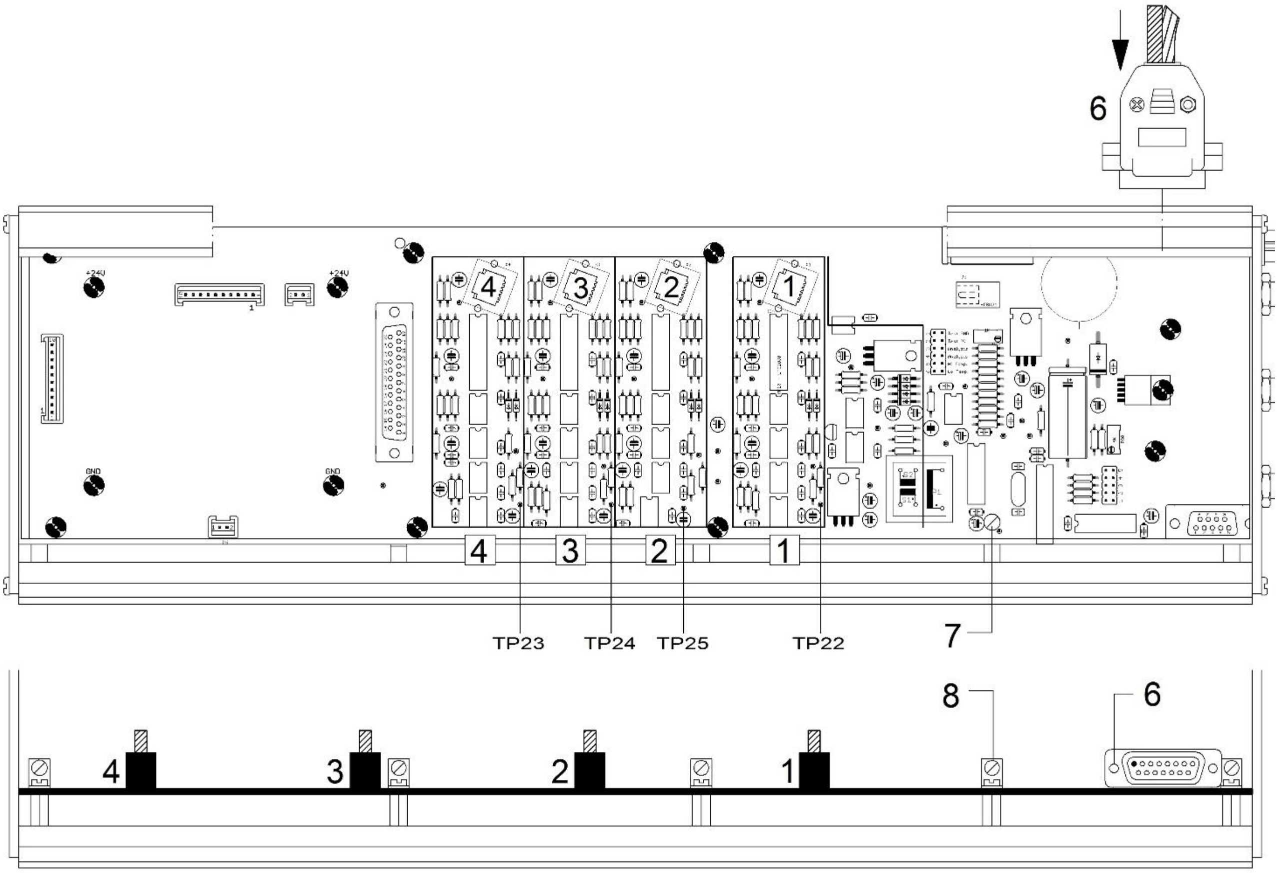


Fig. 84: IRC 1.4+

– The plugs (1 / 2 / 3 / 4 / 5 / 6) should be unplugged.

– The 10 screws (7 and 8) should be removed.

See also chapters “**Infrared baseline adjustments**”, “**IR source voltage setting**” and “**Infrared power supply**”

5.2.2 Changing the IR-source

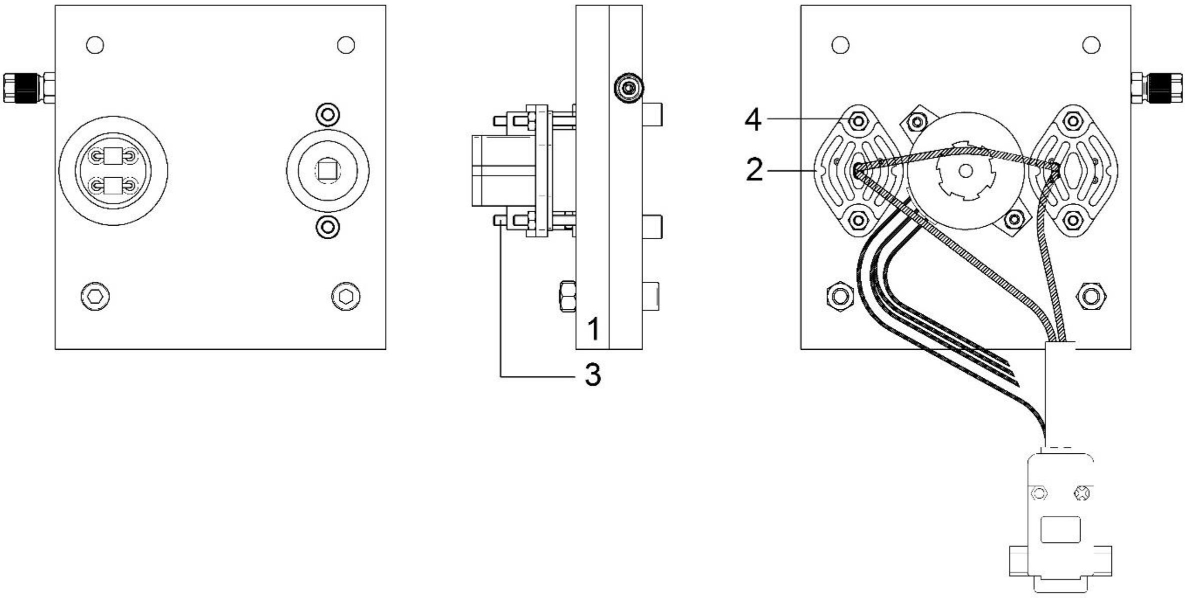


Fig. 85: Infrared source replacement

REMARK

– The IR sources (2) are fastened with the screws (3).

To install or removing the IR-source (2), the complete chopper motor assembly (1), together with the mounted paths and pre-amplifier, should be removed from the infrared unit. See chapter “**IR paths cleaning and replacing**”.

– The chopper motor housing (1) does not necessarily need to be unscrewed.

– In order to remove the IR-source, unscrew the nuts (4) with a (5.5 mm wrench).

– Unsolder the old IR source and solder the new one.

– Before re-assembling, check the position of the IR-source (2) and, if necessary, center the position of the source in the source housing before reassembling. See graphics below.

CAUTION

The wire of the IR source is hard, therefore do not move it back and forth. The wires of the source can break when bending. Rather be careful to correctly position the source with one attempt only.

For more details see chapter “**Chopper**”.

NOTICE

The position of the IR sources in their housing has to be as shown in the graphics A and B.

Correct: Wrong:

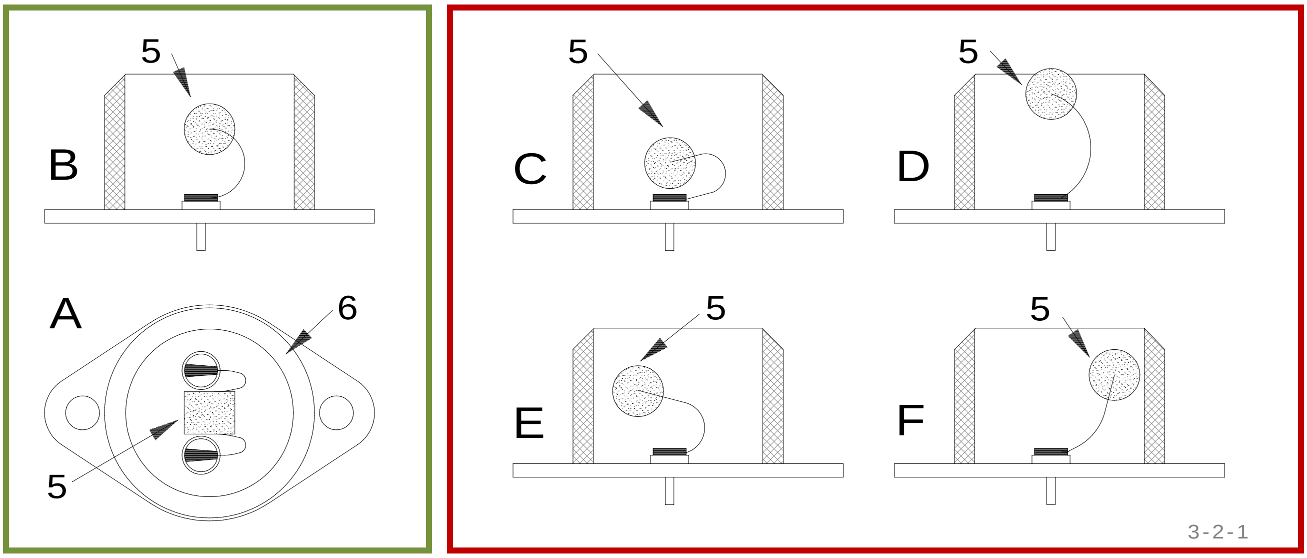


Fig. 86: IR sources in their housing

If the position of a source is wrong, the radiation reaching the IR sensor is lower than when the source is in the right position. It may happen that after transportation due to a strong shock that the base lines are not in the right level due to the sources being not in the right position any more. For correct base lines see chapter "**Infrared cell adjustments**".

(Take care in case of previous IR cell models having a base line around zero volts.)

For correcting the position of bent IR sources use a thin forceps or carefully push them to the right central position by using a thin screw driver. Take care not to bend the wires too far. They are quite hard so that when bending back and forth they may break.

In case of changing a source, the wires must be very properly soldered because the resistance of a source is below one Ohm.

All IR sources for all available cells in a module are connected in series.

For adjusting the IR source voltage see chapter "**IR-source voltage setting**".

5.3 Chopper

Motor replacement:

The replacement motors are supplied with their wires already soldered on a 9-pin plug, so that in case of replacing a chopper motor, only the two wires of the IR sources have to be soldered on the connector.

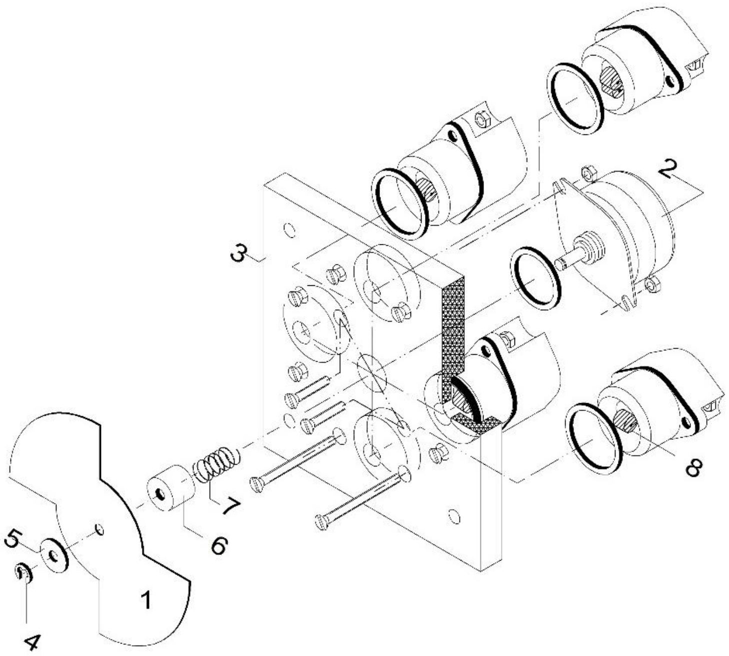


Fig. 87: Chopper motor replacement

The chopper blade (1) is fastened to the motor (2). The chopper blade must be removed first in order to dismount the motor (2) from the mounting plate (3)

Disassemble in the following order:

1. safety ring (4)
2. the washer(s) (5) (there could be two)
3. the chopper blade (1)
4. the cylinder (6)
5. the spring (7)

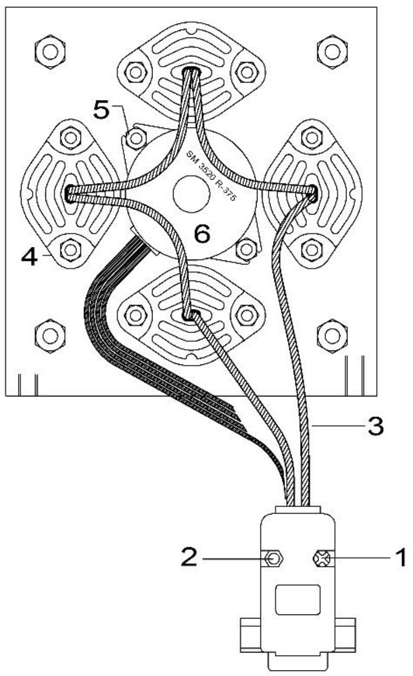


Fig. 88: Chopper

– Disassemble the plug (1) by removing the two screws (2).
– The cables (3) of the IR source (4) are then unsoldered from plug (1)
– Unscrew the nuts (5)
– Install the new motor (6)
– The IR source cables (3) are then soldered to the plug (1)

CAUTION

Due to the high current for the infrared cell; it is important that the soldering here is done accurately, because two pins inside the plug (1) will be soldered together to form one group. There are two such groups in one plug.

Each end of the IR-source cables (3) will then be soldered to each one of these groups. The polarity is irrelevant.

– Afterwards, the chopper blade is refastened.
– Reassemble in the reverse order.
– After installing, the infrared cell should be adjusted, see chapter "**Infrared base line adjustment**".

5.4 Leak checking

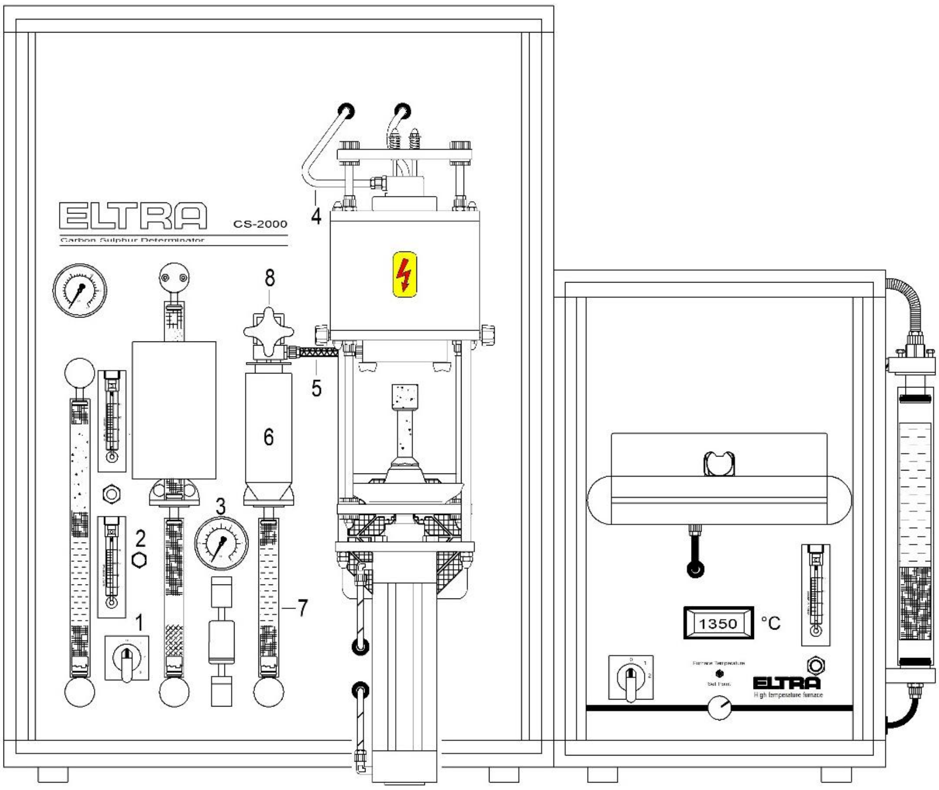


Fig. 89: Leak checking

– Set the power switch (1) to pos. 3.
– Close the furnace.
– Press and hold the button (2).

The entire system is checked for leaks.

– After pressing the button, the pressure drops on gauge (3) for about 5 seconds and then it remains constant. Watch it for about a minute. If there is no pressure drop any more, the complete gas system is seal so that the leakage test is successfully completed.

– Keep holding the button (2) for about one minute. Should there be a continuous pressure drop, then release the button (2), open the furnace, press and hold the button (2) again. If the pressure with open furnace remains stable then the leakage is in the furnace area. To the furnace area belong also the metal dust trap (6), the tube (5) and the moisture trap (7) underneath the metal filter, the dust filter cartridge on the front panel and the outflow valve V1.

1. Leakage in the furnace area:

According to experience over years, leakages are almost exclusively in the furnace area. Most common reasons in the order of probability are: (see graphic below).

- The combustion tube (12) has a crack or a hole due major accumulation of splashes from the analyzed samples. See graphic below.
- The two small O-rings (9) sealing the top of the furnace are damaged, deformed or dusty.
- The palm grip (8) is not in the right position so that the O-ring, sealing the upper end of the filter housing, is not properly pressed against the filter housing. Rotate to the right position (maximum force on the O-ring).
- The O-rings (10) sealing the combustion tube are very unlikely to leak, provided that the winged nuts fixing the furnace closure are driven normally by fingers. The use of excessive force is not needed and not recommended.
- The O-ring (11) sealing the furnace with the closing cone is very reliable as well. Only if it is burned by a hot crucible when taking the crucible from the pedestal, there may be a sealing problem.
- The tube (5) can be damaged due to aging and pressure.
- The moisture trap underneath the metal filter can be not seal when the glass tube may crack when fitting it.
- The plunger of the outflow valve V1 jams due to contamination. See chapter "**Cleaning solenoid valves**" and "**Wiring and gas flow diagrams**".
- The dust filter cartridge is leaking. Either one of the small O-rings sealing the cartridge leads is not seal or one of the hexagon socket screws on the front of the supporting fittings is not properly fixed.

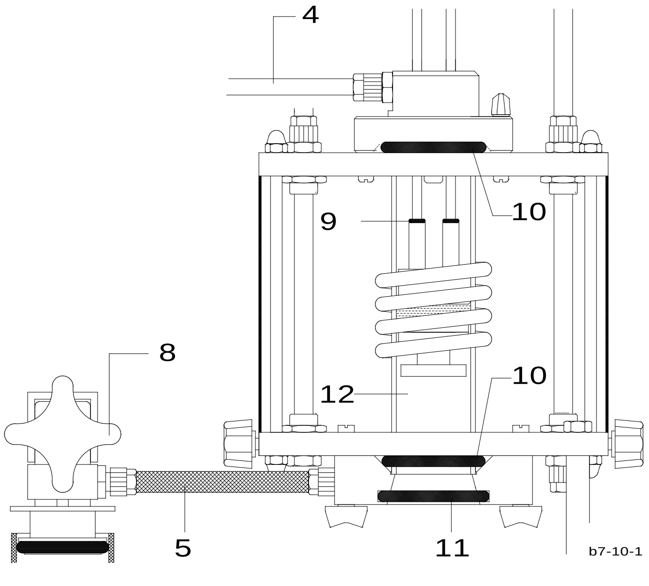


Fig. 90: Leak check induction furnace

– Open the furnace and check again. If the pressure decreases when checking with open furnace, then the leakage is not in the furnace area but elsewhere in the analyzer.

Most probable reasons:

– An infrared path is not seal, for example due to an infrared window with a crack or with not properly sealing glue.
– The lower flow meter may be not seal due to a crack.

2. Leakage outside the furnace area:

Localizing a leakage outside the furnace area with open furnace in induction mode:

– When pressing the button (2), the gauge (3) shows a pressure drop lasting for one minute (see details above) while the furnace is open, then localize the leakage, according to the sequence below.

Keep the furnace opened, squeeze the following tubes tightly, while pressing and holding the button (2). If there is no pressure drop any more when squeezing the corresponding tube, the leakage is in the place shown in the table below:

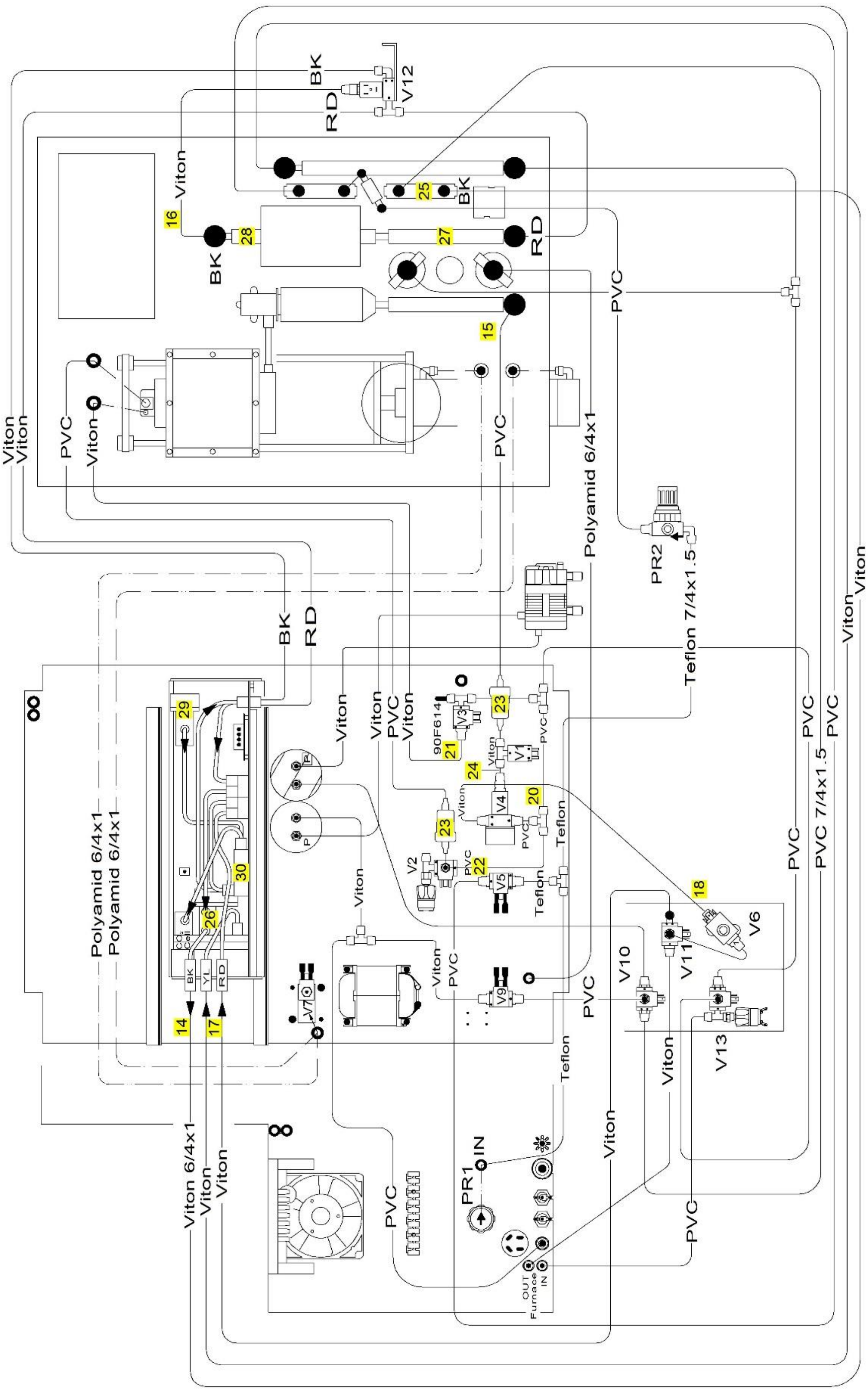


Fig. 91: Tubes to squeeze

Tube to squeeze:	Leak location:
13	Exhaust valve (V9)
14	Flow meter (25)
15	CO2-Paths (26)
16	SO3-Trap (27) or oxidizing furnace tube (28)
17	SO2-Path (29) or flow sensor (30)
18	Regulator valve (V6)
20	Bypass valve (V4), check for 24 V DC on the coil
21	Purge valve (V3), check for 0 V DC on the coil
22	Lance valve (V2), check for 24 V DC on the coil

ATTENTION do not cause a short circuit while measuring, otherwise the drivers will be destroyed. See chapter “**Electronic drivers malfunctioning**”.

– If the voltages on V2, V3, or V4 are wrong, then replace the electronic drivers.

5.5 Solenoid valves cleaning

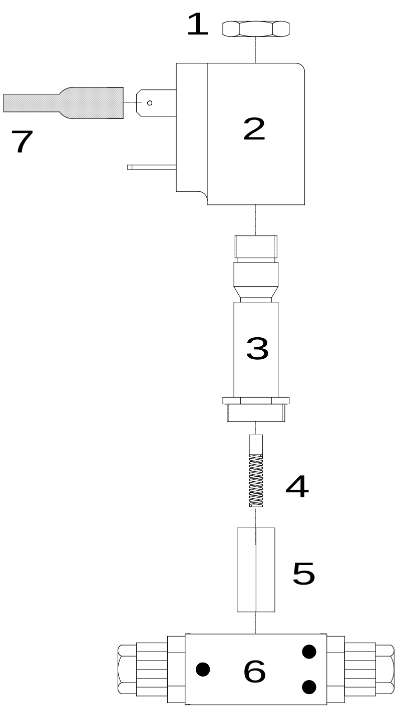


Fig. 92: Solenoid valve 2/2

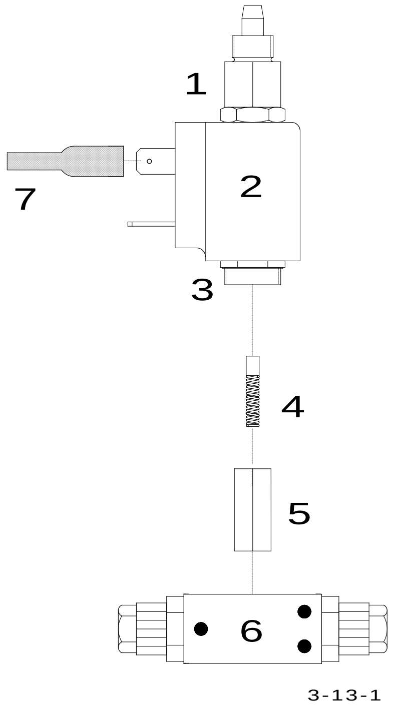


Fig. 93: Solenoid valve 3/2

- Turn the power switch to pos.0.
- Unplug the main power plug as well.
- Remove the connector (7).
- Unscrew the nut (1).
- Remove the coil (2) (only with the 2/2 valve).
- Unscrew counter-clockwise the hexagon screw on the plunger housing.
- Remove the plunger (5) (only with the 2/2 valve)

Caution Do not lose the spring (4)!

- With oxygen pressure or compressed air, clean the inside of the plunger housing(3), as well as the plunger (5) and re-assemble the solenoid valve. With the furnace closed and renewed oxygen pressure, check to ensure that the solenoid valve is sealed.

5.6 Flow sensor replacement

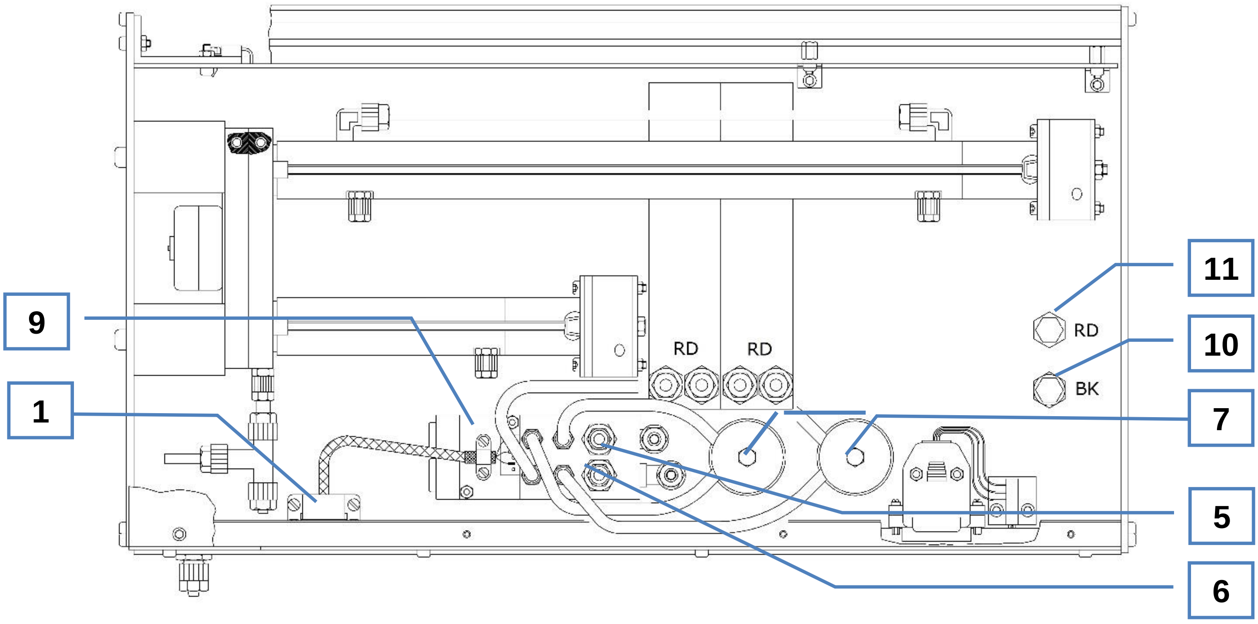


Fig. 94: Flow sensor(3-14)

- Set the power switch to pos. 0.
- Remove the left side panel of the analyzer’s cabinet.
- Remove the tubes (10) and (11) at the bottom-side of the infrared module.
- Remove the plastic tubes from the left hand side of the IR module.
- Remove the two plugs from the left hand side of the IR module.
- Remove the screw fixing the IR module in the analyzer. Take the infrared module out of the analyzer.
- Remove the two tubes (5) and (6) from the flow sensor (9).

CAUTION They shouldn’t be interchanged when reassembling! In case of doubt see chapter “**IR-paths cleaning and replacing**”

- Remove the two screws (7) underneath the flow sensor.
- Remove the old flow sensor (9) and install a new one.
- Reassemble the infrared rack in reverse order.
- Pay particular attention to the position of the tubes (5), (6), (10) and (11). In case of doubt see chapter “**IR-paths cleaning and replacing**”
- Adjust the flow sensor. See chapter “**Gas flow controller**” where is written:

“Set the flow rate with P1 of the HF 42, to about 180 l/h. Observe the flow rate on the lower flow meter of the analyzer. Wait until the value is stable.”

5.7 Gas pump replacement

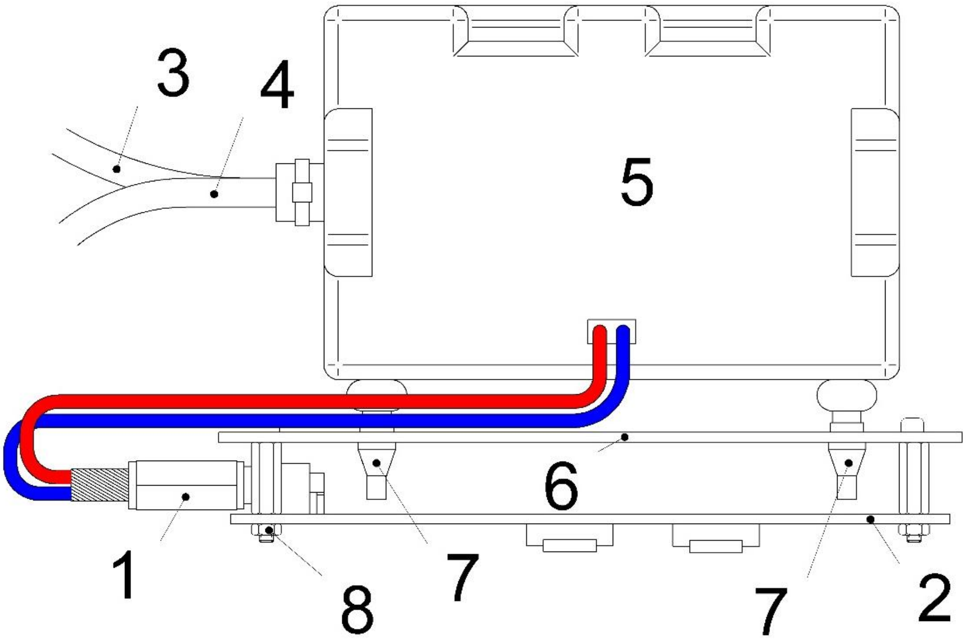


Fig. 95: Gas pump

- Switch off the analyzer and disconnect the mains power plug.
- Disconnect plug (1) of the pump from the socket X4 on the board (2).
- Disconnect the tubes (3) and (4) from the pump (5).
- Remove the pump from the supporting panel (6) by pulling the four rubber buffers (7). (If necessary they can be cut).
- Reinstall a new pump in reverse order.

REMARK

For installing a new pump, the rubber buffers (7) of the new pump have to be pulled down from underneath the supporting panel (6) by using slim pliers. If suitable pliers not available, the board (2) can be removed by unscrewing the four nuts (8).

5.8 Thermocouple replacement

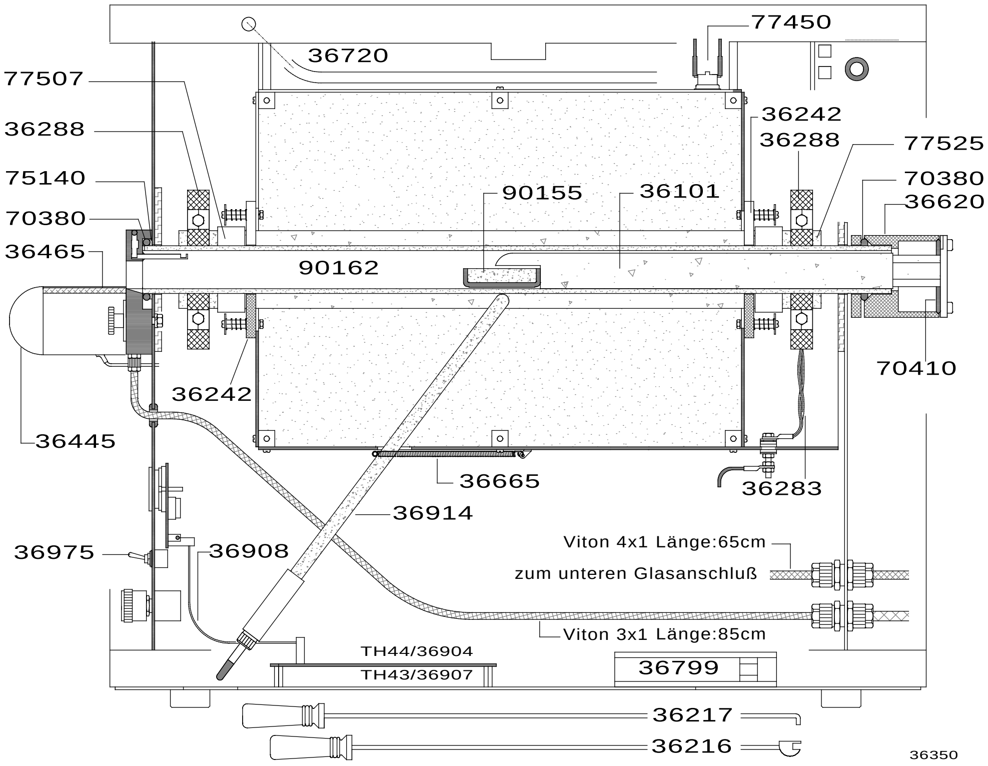


Fig. 96: Thermocouple replacement

– Remove the side panel of the furnace which does not carry the moisture trap. In case of CS-2000 it is the left hand panel.
– Shift the furnace to the front for about 10 cm over the edge of the desk where it is placed on.

– Disconnect the chinch connector of the thermocouple cable from the temperature control board.

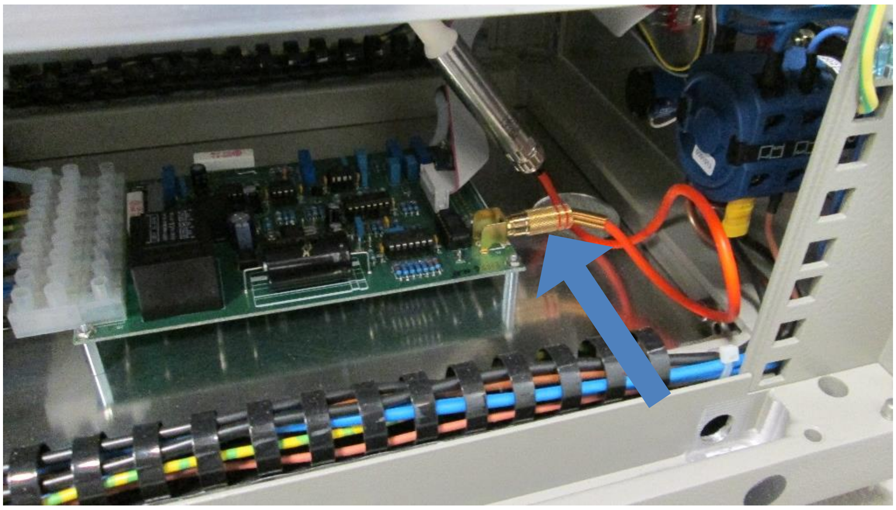


Fig. 97: Chinch connector of thermocouple

– Hold the spring (36665) which is holding the thermocouple in place, to slide along the thermocouple while pulling it down out of the furnace.

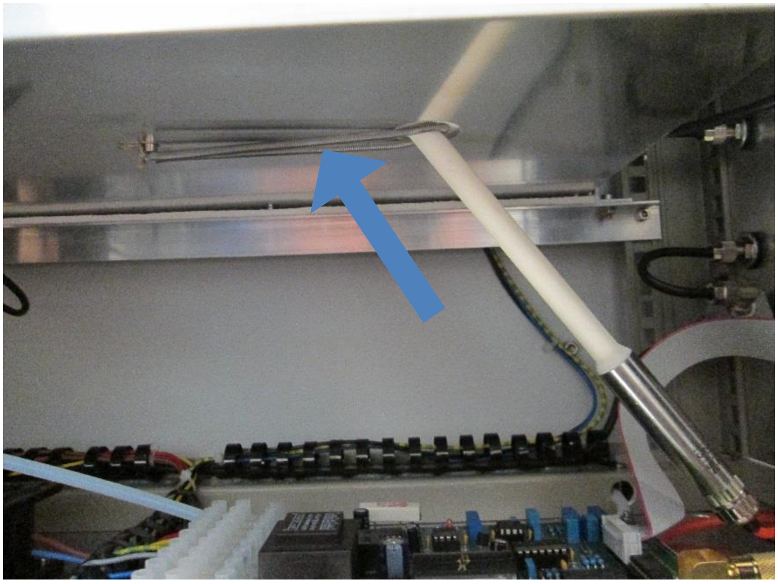


Fig. 98: Spring (36665) which is holding the thermocouple in place

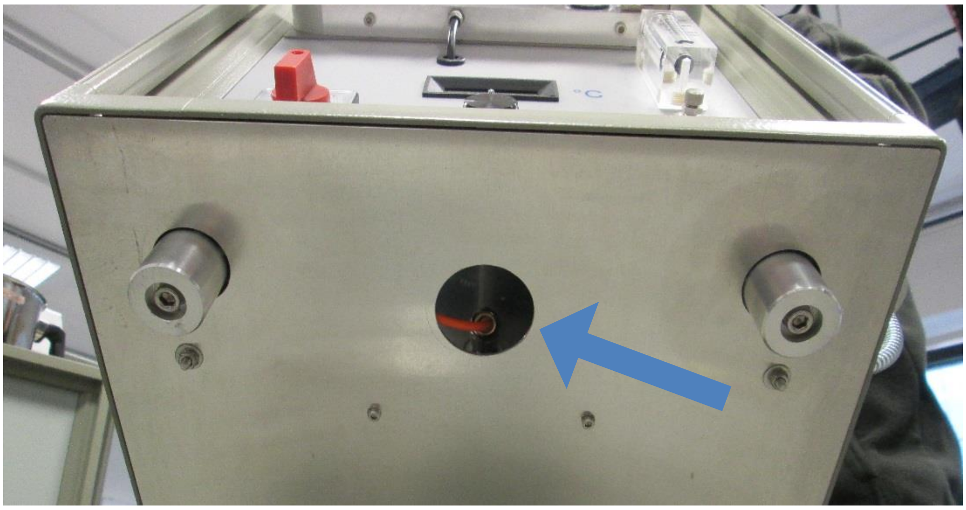


Fig. 99: Pulling the thermocouple down out of the furnace

– If you want to check the thermocouple, see chapter “**Thermocouple testing**”.

– Install a new thermocouple in reverse order.

CAUTION

Take care of the spring (36665) to be in place again, preventing the thermocouple from sliding down.

Take care to install the thermocouple with its top touching the combustion tube.

5.9 Gas saving mode

NOTICE

This option is functional with EPROMS.

If the analyzer has the HF41 board:

– Set the jumper to connect A1 with A2 on J2

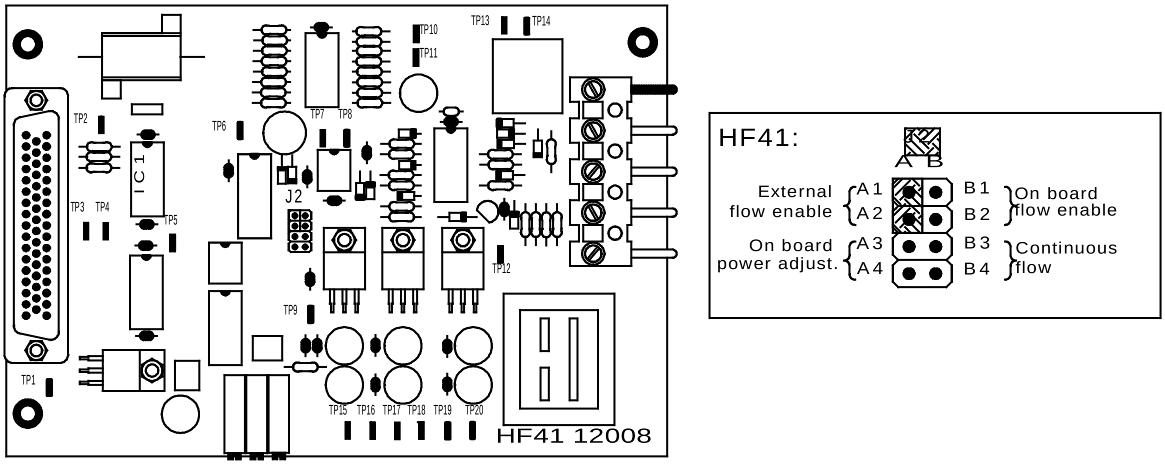


Fig. 1: HF41 board jumper setting for gas saving mode

If the analyzer has the HF42 board:

– Set the jumper to connect A1 with A2 on J3

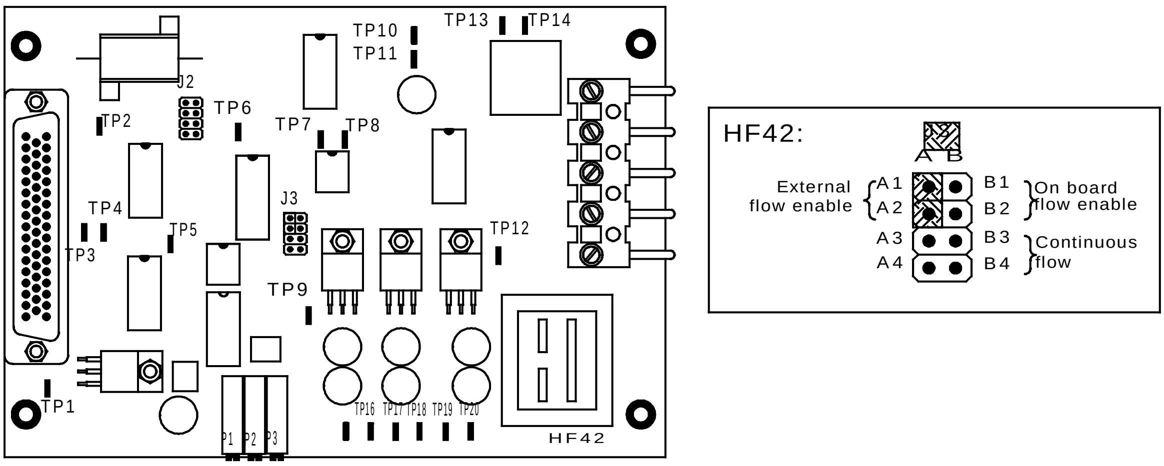


Fig. 2: HF42 board jumper setting for gas saving mode

5.10 Gas saving also for resistance furnace

If this feature is required, the CS-2000 can be upgraded as follows. But the customer must take care to have oxygen flow first before entering the sample into the furnace. The flow is restored as soon as any button on the PC-keyboard is pressed. For example taking a sample weight.

If an organic sample is entered into the furnace without oxygen flow and the flow is subsequently restored, it may lead to a very intensive ignition. Therefore, the gas saving feature for the resistance furnace operation should only be installed after the customer's consent to take full responsibility for entering a sample into the furnace only after the flow is restored.

The modifications are shown in the following schematics. For full

Details, see chapter „**Wiring diagrams**".

1. Install a solenoid valve No. 01160 in the analyzer's cabinet.

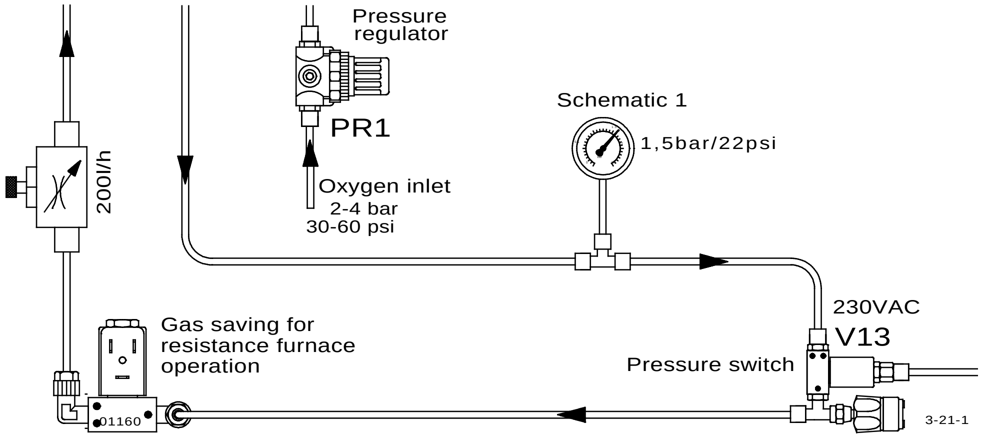


Fig. 100: Gas saving for resistance furnace operation

2. Connect the valve in the tube leading to the resistance furnace inlet (close one port of the T-piece of the valve, like already done for V3).

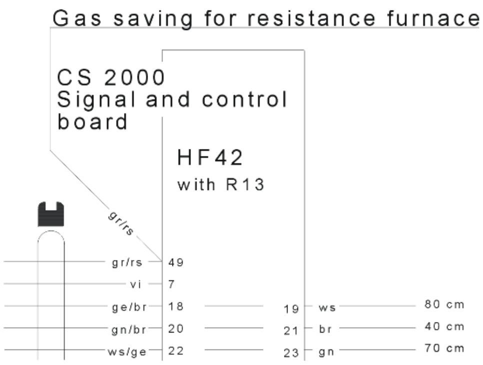


Fig. 101: Gas saving for resistance furnace operation

3. Connect a cable to pin 49 of the 50-pin plug to the board HF-42.

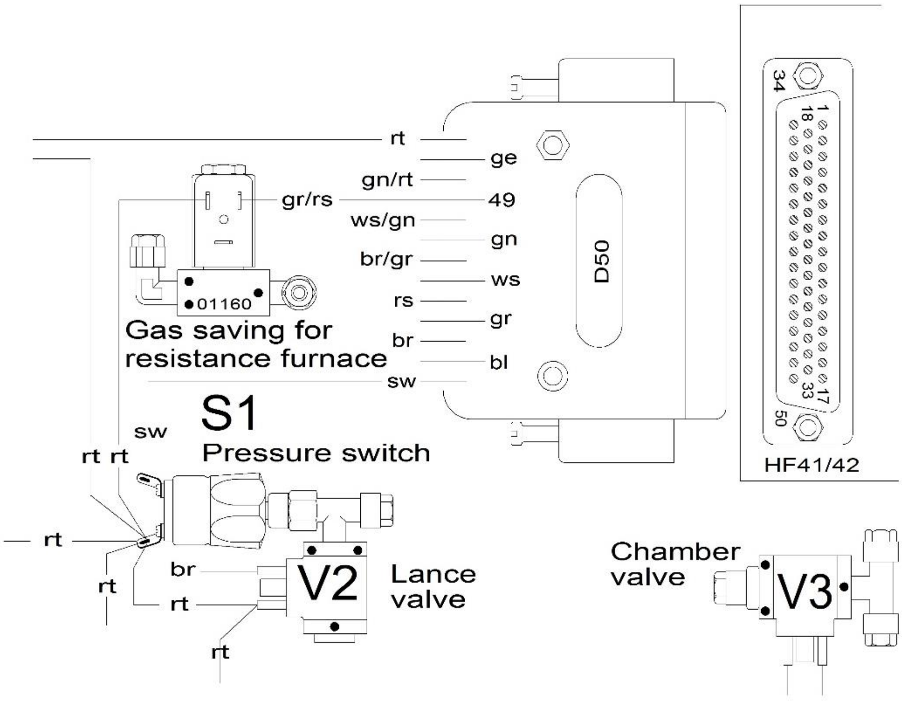


Fig. 102: Gas saving for resistance furnace operation

4. Connect the coil of 01160 as shown in schematic

5.11 Furnace pneumatics - additional safety features (optional)

The furnace doesn’t change position in case of a power failure.

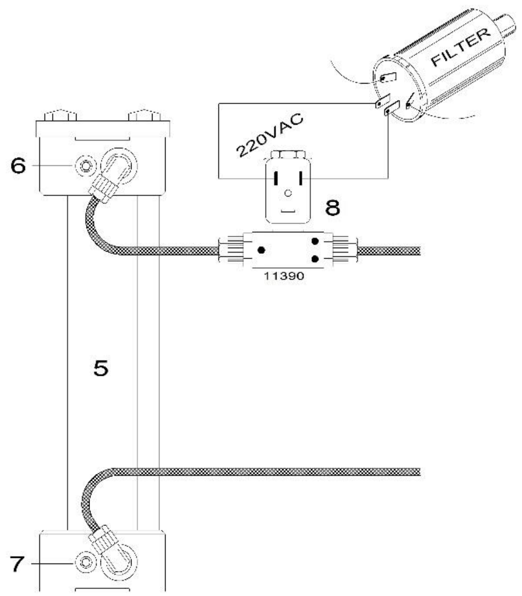
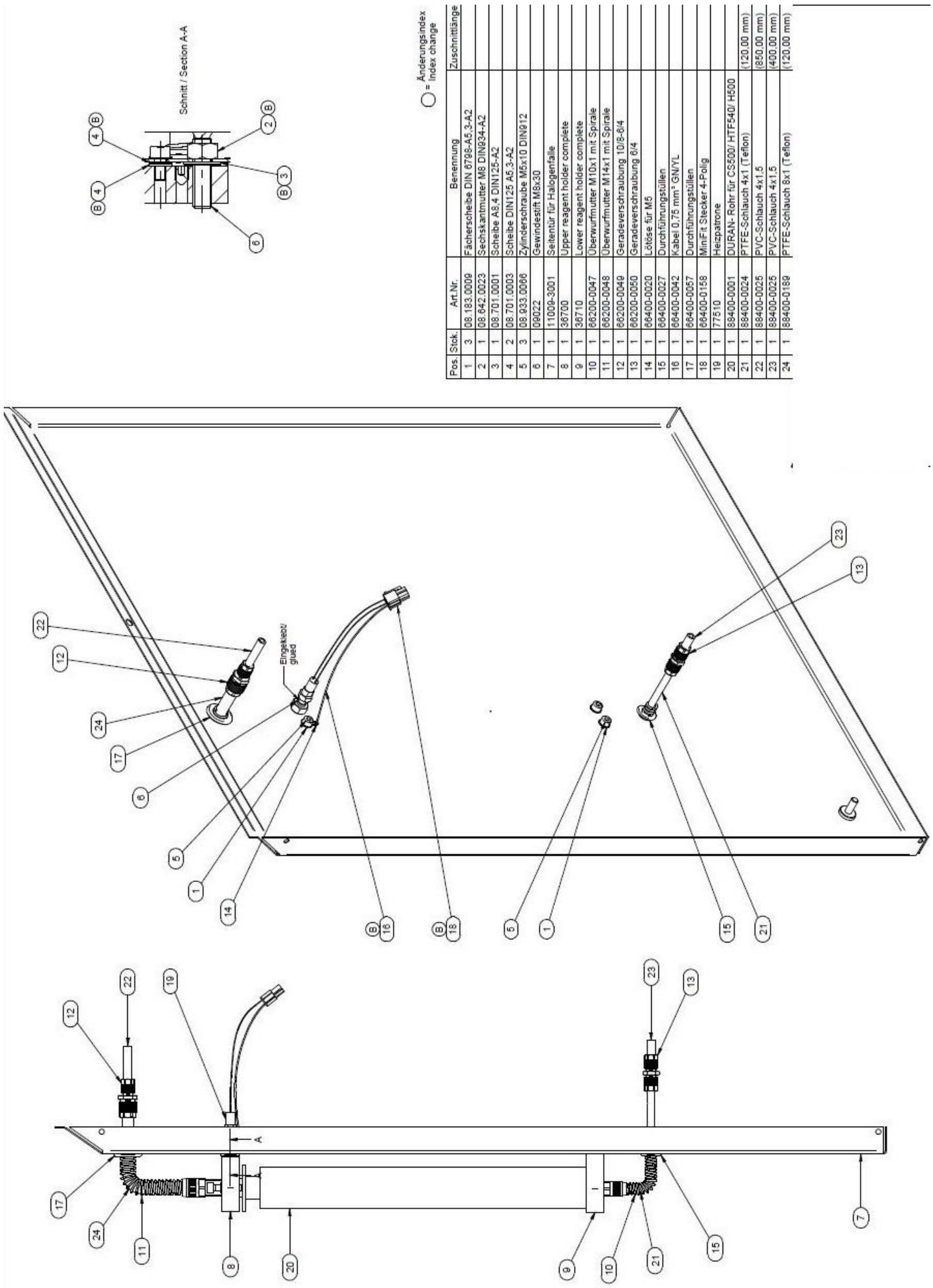


Fig. 103: Furnace power failure

By adding a solenoid valve (8) and connecting the coil directly to 220V AC, the piston won’t change position in case of a power failure. If the piston was down, it will remain down; if it was up, it will remain up.

5.12 Halogen trap - installing

Eltra analyzers don't need any halogen trap when they are equipped with golden paths. However, in case a user may insist in a halogen trap, the installation can be done as follows:



Pos.	Stck.	Art.Nr.	Benennung	Zuschnittlänge
1	3	08.183.0009	Fächerscheibe DIN 6798-A5,3-A2	
2	1	08.642.0023	Sechskantmutter M8 DIN934-A2	
3	1	08.701.0001	Scheibe A8,4 DIN125-A2	
4	2	08.701.0003	Scheibe DIN125 A5,3-A2	
5	3	08.933.0066	Zylinderschraube M5x10 DIN912	
6	1	09022	Gewindestift M8x30	
7	1	11009-3001	Seitentür für Halogenfalle	
8	1	36700	Upper reagent holder complete	
9	1	36710	Lower reagent holder complete	
10	1	66200-0047	Überwurfmutter M10x1 mit Spirale	
11	1	66200-0048	Überwurfmutter M14x1 mit Spirale	
12	1	66200-0049	Geradeverschraubung 10/8-6/4	
13	1	66200-0050	Geradeverschraubung 6/4	
14	1	66400-0020	Lötöse für M5	
15	1	66400-0027	Durchführungstüllen	
16	1	66400-0042	Kabel 0,75 mm² GN/YL	
17	1	66400-0057	Durchführungstüllen	
18	1	66400-0158	MiniFit Stecker 4-Polig	
19	1	77510	Heizpatrone	
20	1	88400-0001	DURAN- Rohr für CS500/ HTF540/ H500	
21	1	88400-0024	PTFE-Schlauch 4x1 (Teflon)	(120,00 mm)
22	1	88400-0025	PVC-Schlauch 4x1,5	(850,00 mm)
23	1	88400-0025	PVC-Schlauch 4x1,5	(400,00 mm)
24	1	88400-0189	PTFE-Schlauch 8x1 (Teflon)	(120,00 mm)

Fig. 104: Halogen trap installation

6 Miscellaneous

6.1 Ordering numbers

6.1.1 Front side

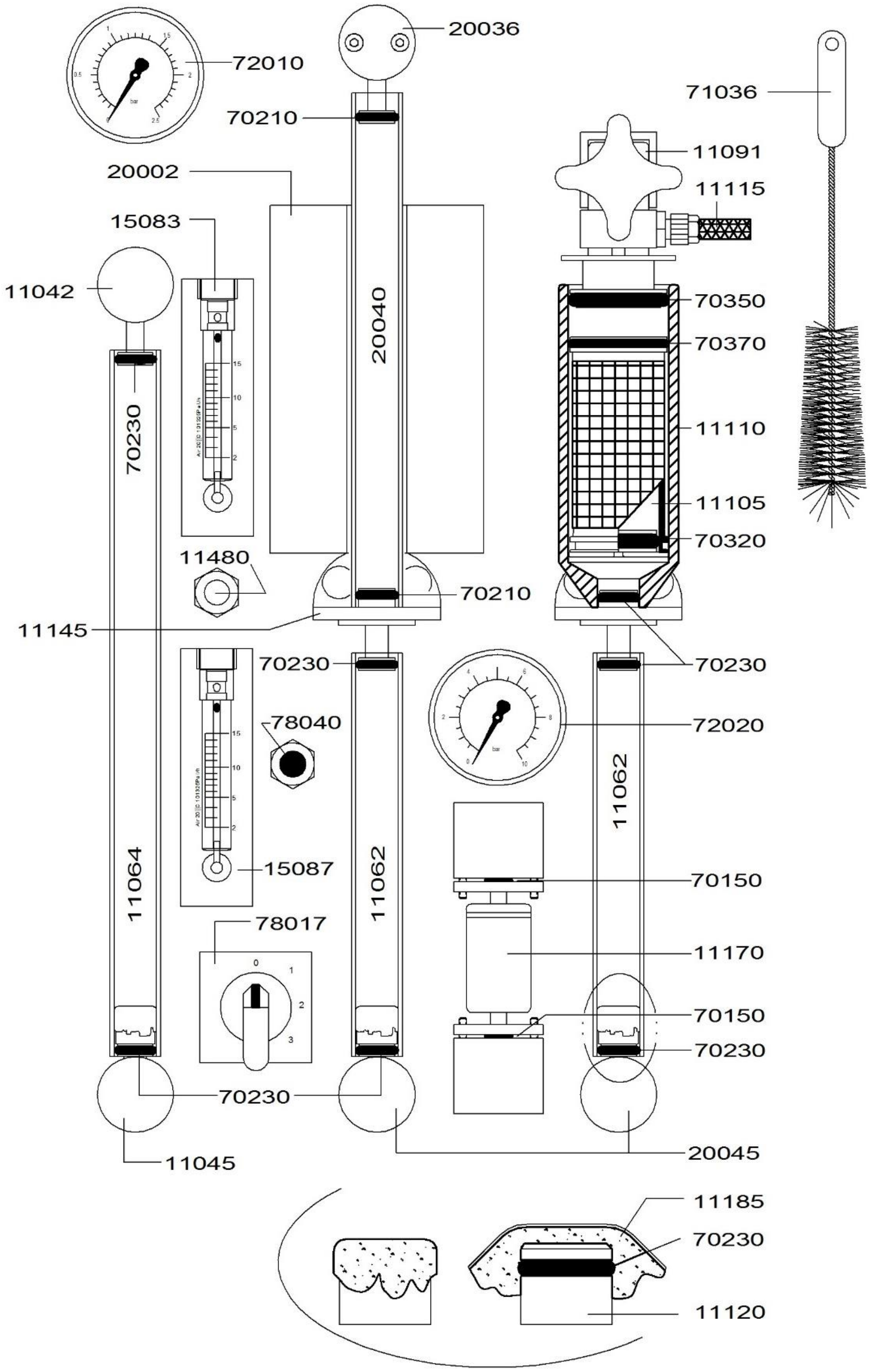


Fig. 105: Front side view

Part No.	Description
11042	Upper tube holder
11045	Lower tube holder
11062	Reagent tube
11064	Reagent tube
11091	Dust trap mechanism
11105	Metal dust filter
11110	Filter housing
11115	Furnace outlet tube
11120	Paper filter holder
11185	Paper filters
11480	Adjustable restrictor
15083	Gas flow indicator 15 l/h
15087	Gas flow indicator 300 l/h
20000	Catalyst furnace
20036	Upper tube holder
20040	Catalyst tube
20045	Lower tube holder
70150	O-ring
70210	O-ring
70230	O-ring
70320	O-ring
70350	O-ring
70370	O-ring
71036	Cleaning brush for filter
72010	Pressure gauge 2,5 bar
72020	Pressure gauge 10 bar
78017	Main power switch
78040	Button for leakage test

6.1.2 Left hand side

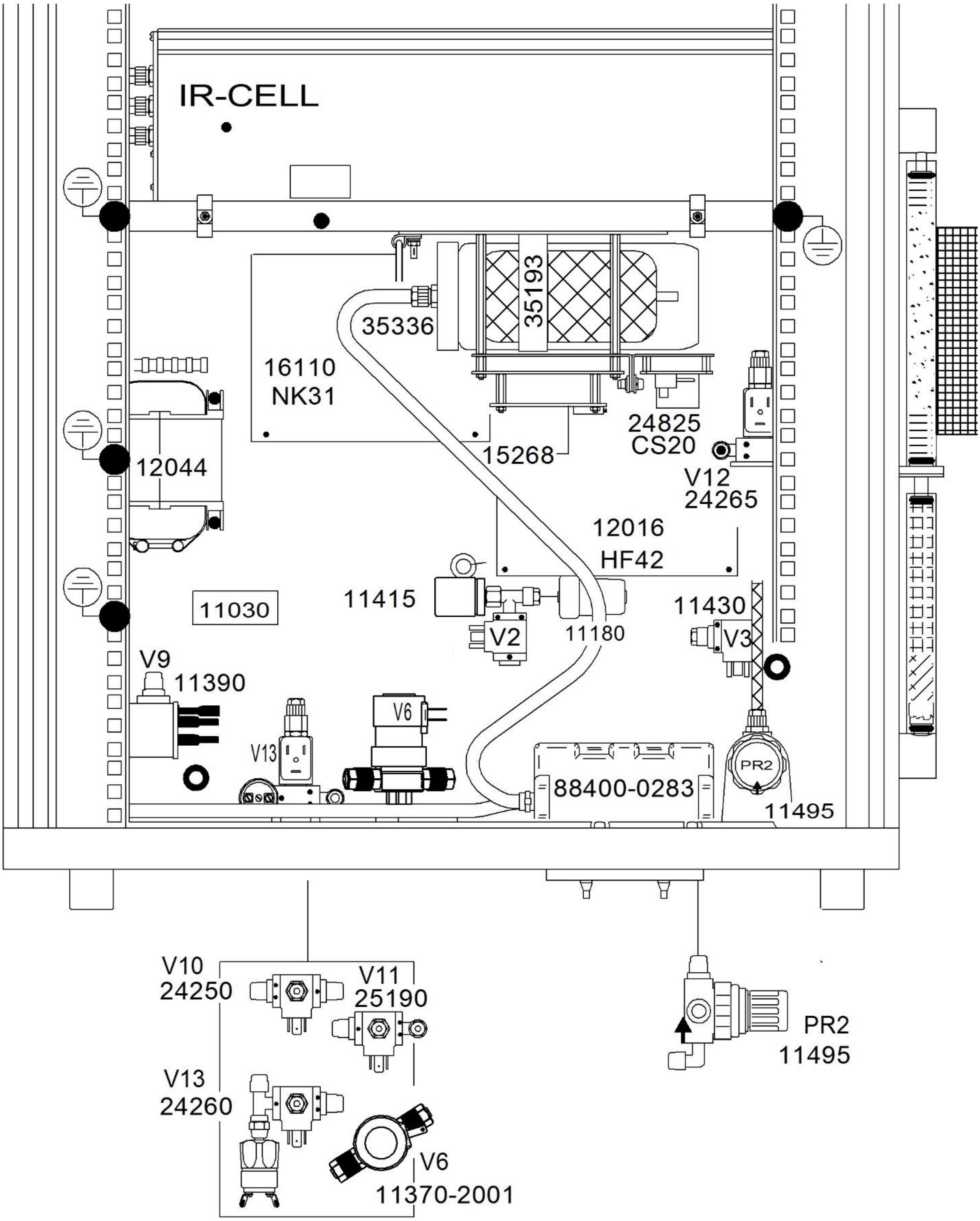


Fig. 106: Left hand side view

Part No.	Description
11180	Dust filter cartridge
11370-2001	Gas flow regulating valve
11390	Oxygen solenoid valve
11400	Pressure outlet solenoid valve
11415	Oxygen stop solenoid valve
11415	Lance valve
11430	Purge solenoid valve
11440	Bypass solenoid valve
11490	Pressure regulator
11492	Inlet pressure regulator
11495	Purge pressure regulator
12016	Gas flow and furnace control board HF 42
12044	Transformer
15268	Pump control board PC
15270	Gas pump
16110	Power supply board NK 31
24250	Valve V10
25190	Valve V11
24260	Valve V13
24265	Valve V12
24285	Board CS20
35336	Attenuator volume

6.1.3 Right hand side

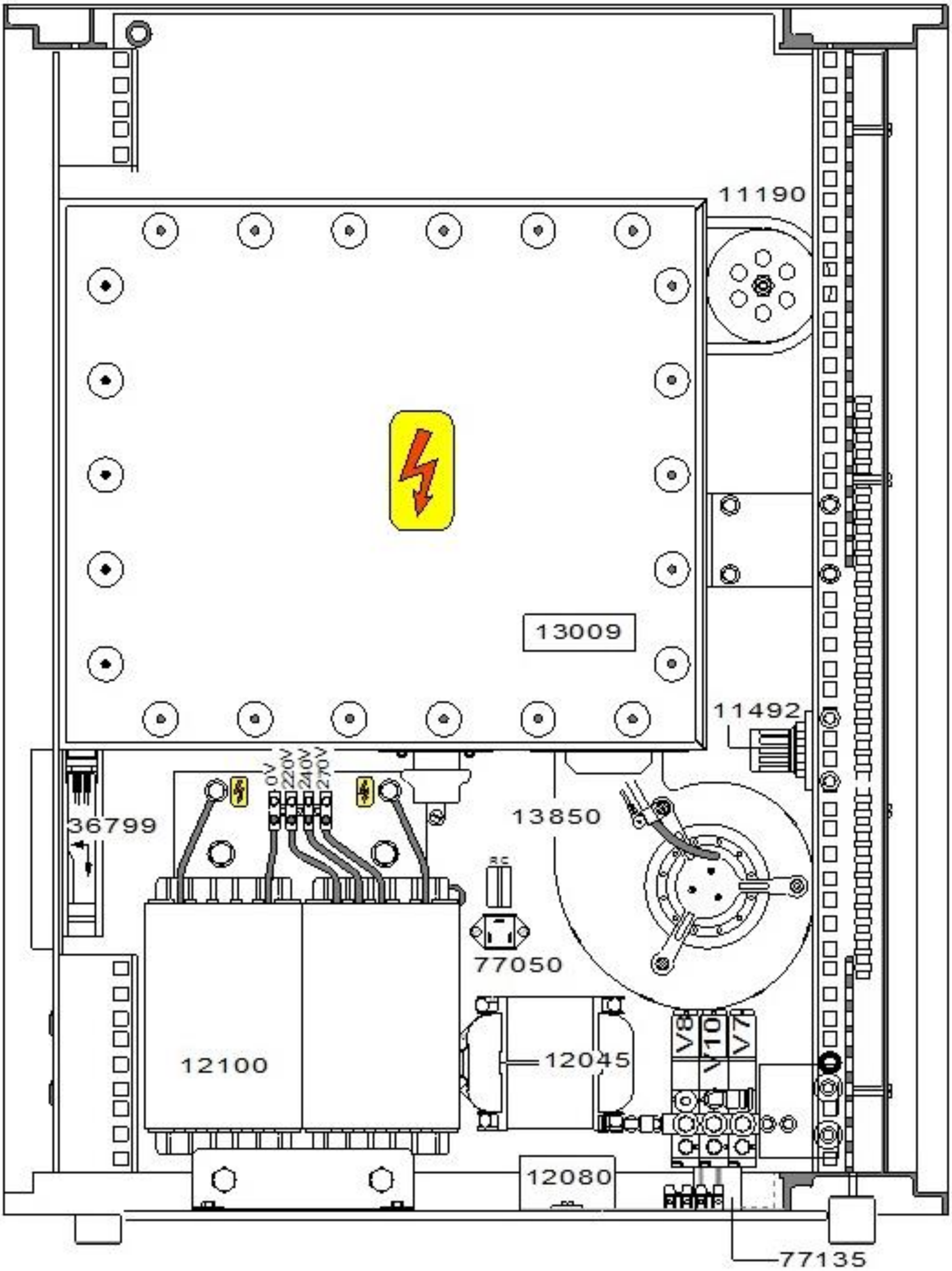


Fig. 107: Right hand side view

Part No.	Description
11190	Exhaust muffler
11376	Fixing plate for 11822
11492	Pressure regulator
11822	Pnematic valve block
12045	Transformer
12080	Rectifier
12100	Transformer
13850	Centrifugal blower
77050	TRIAC
77135	Capacitor

6.1.4 Induction furnace

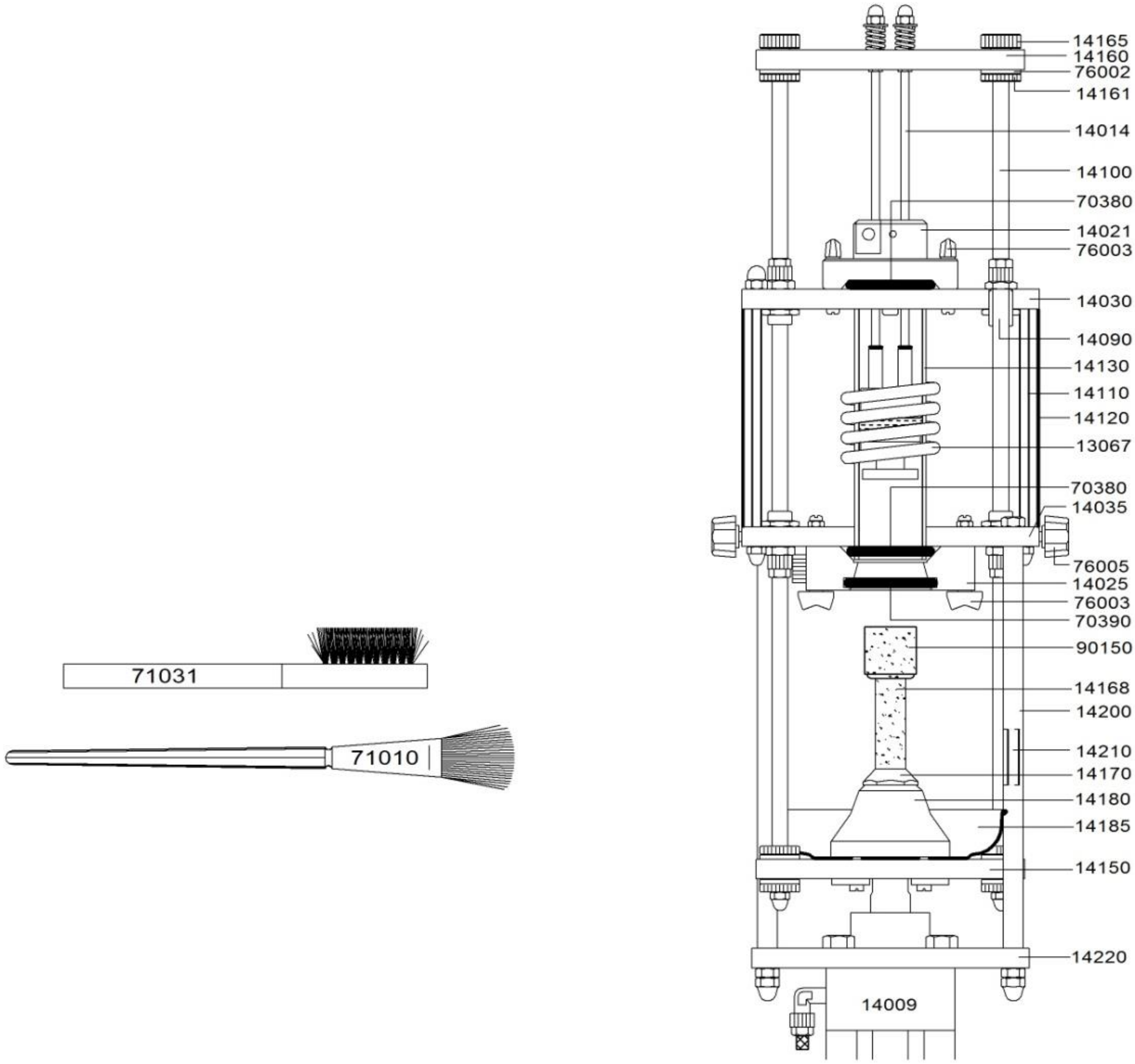


Fig. 108: Induction furnace

Part No.	Description
13067	Combustion coil
14009	Pneumatic cylinder for furnace lift
14021	Upper furnace lock
14026	Lower furnace lock
14030	Upper furnace plate
14035	Lower furnace plate
14090	Bearing
14100	Mounting rod

14110	Threaded rod
14120	Furnace cover
14130	Combustion tube
14150	Lower log
14160	Upper log
14161	Lower knurled nut
14165	Upper knurled nut
14168	Pedestal
14170	Pedestal mount
14180	Furnace closure
14185	Tray
14200	Metal tube
14210	Threaded rod
14220	Cylinder support
70380	O-ring
70390	O-ring
71010	Cleaning brush for pedestal
71031	Cleaning brush for radiation shield
76002	Washer
76003	Wing nut
76005	Knurled nut
90150	Crucibles

6.1.5 Furnace cleaning

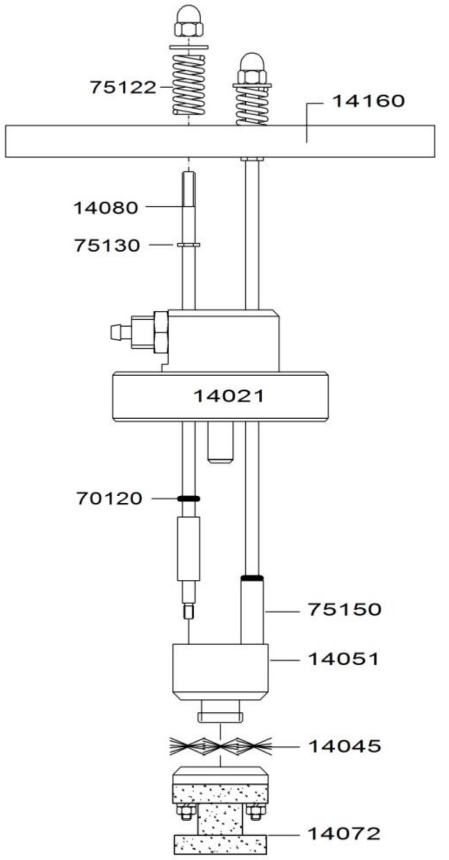


Fig. 109: Furnace cleaning mechanism

Part No.	Description
14014	Complete furnace cleaning assembly unit:
14021	Upper furnace lock
14045	Cleaning brush for combustion tube
14051	Brush holder
14072	Ceramic heat shield for brush
14080	Cleaning mechanism Rod
14160	Upper log
70120	O-ring
75122	Spring
75130	Safety spring
75150	Metal tube

6.1.6 Oscillating circuit

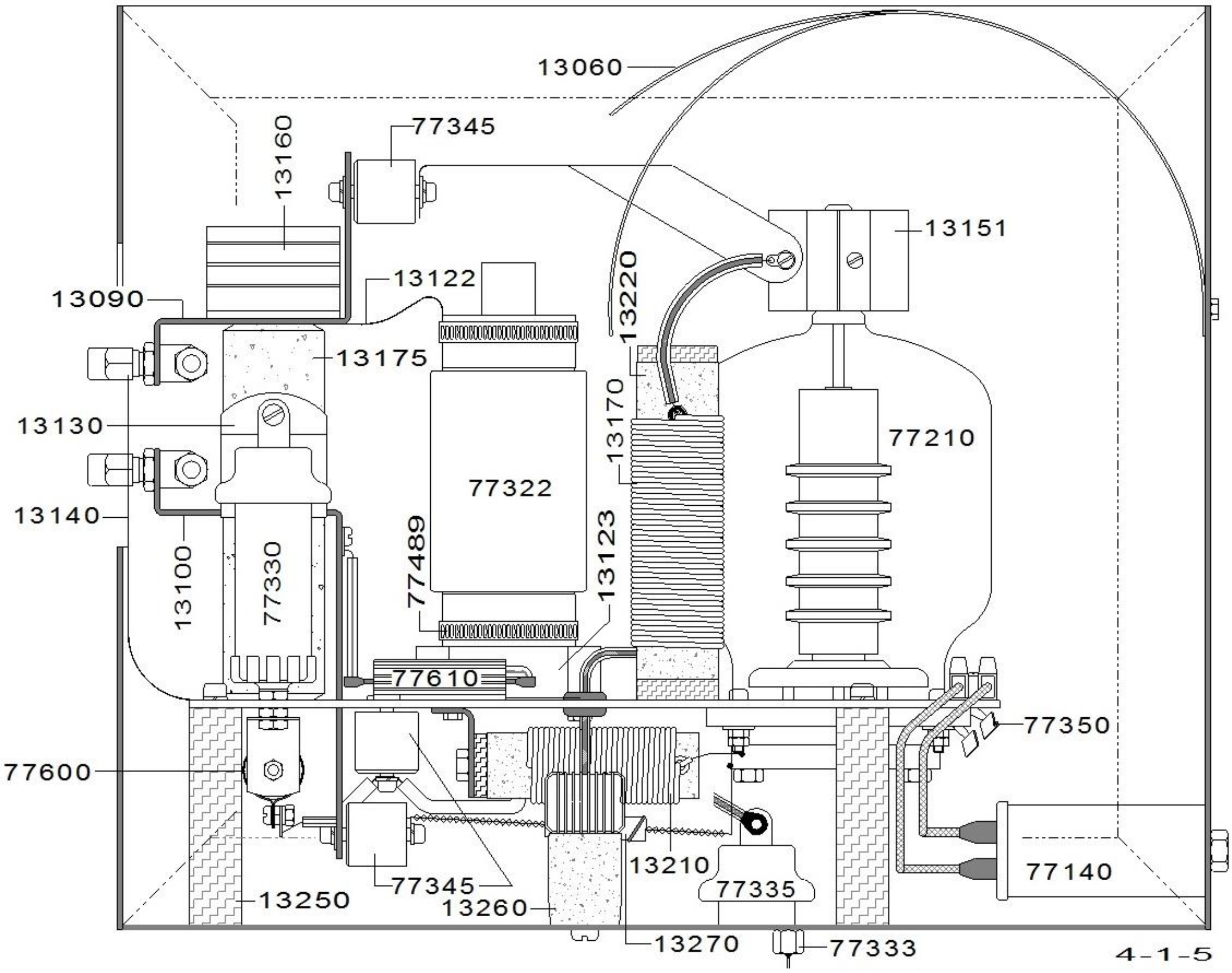


Fig. 110: Oscillating circuit

Part No.	Description
13060	Protection sheet
13081	Capacitor support
13090	Upper coil connector
13100	Lower coil connector
13122	Capacitor connector
13130	Capacitor connector
13140	Ground connector
13151	Anode connector and heat sink
13160	Coil heat sink
13170	Radiation shield
13175	Insulator
13210	Grid choke

13220	Anode choke
13250	Chassis support
13260	High voltage filter
13270	Resistor
77140	HF-filter
77210	Oscillator tube
77322	Capacitorr
77330	Capacitor
77335	Capacitor
77333	Filter
77345	(13261; 13262; 77340; 77341; 77342) Capacitor
77350	Capacitor 100 nF
77489	Bracket
77600	Resistor
77610	Resistor

6.1.7 Infrared cell

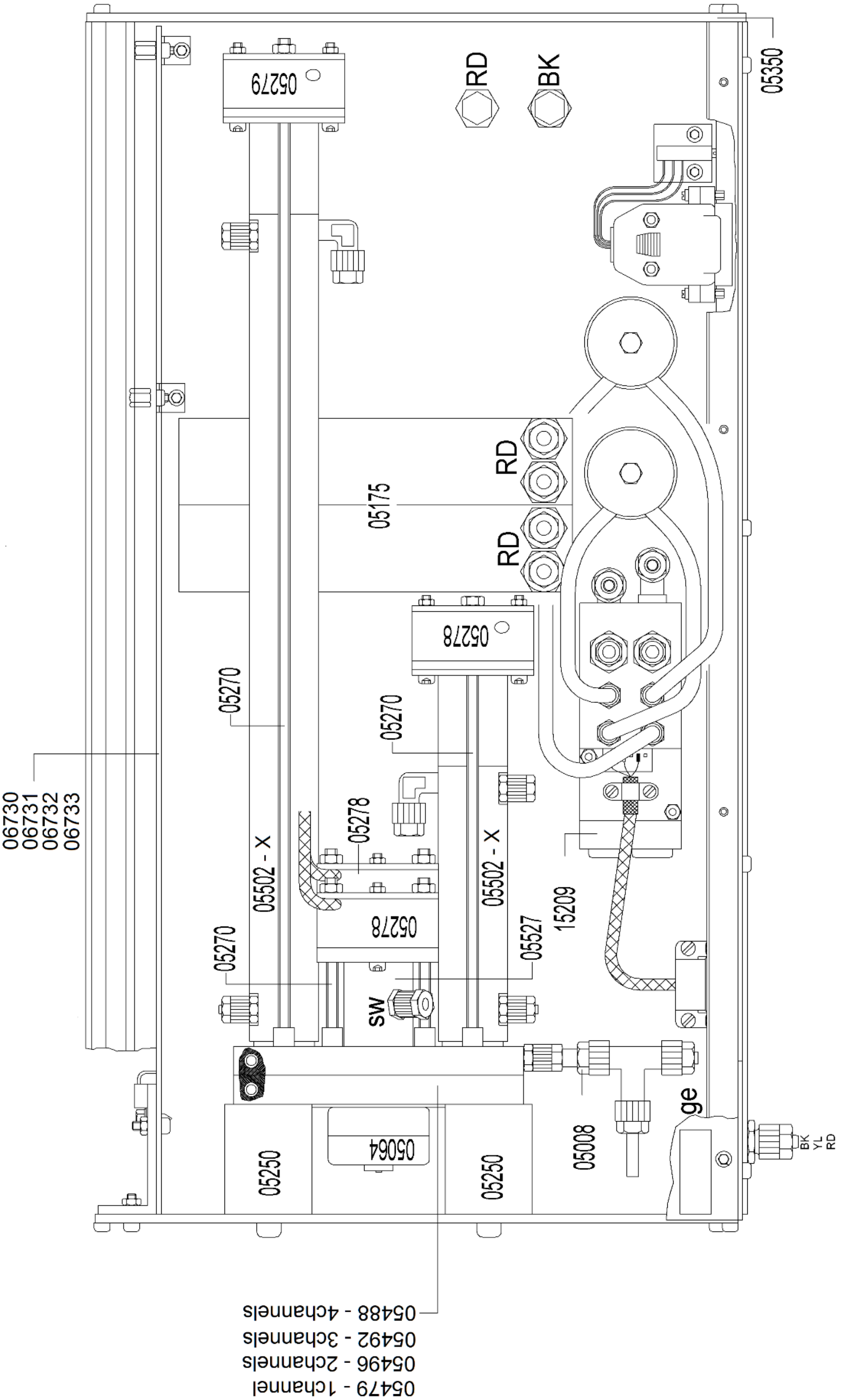


Fig. 111: Infrared cell

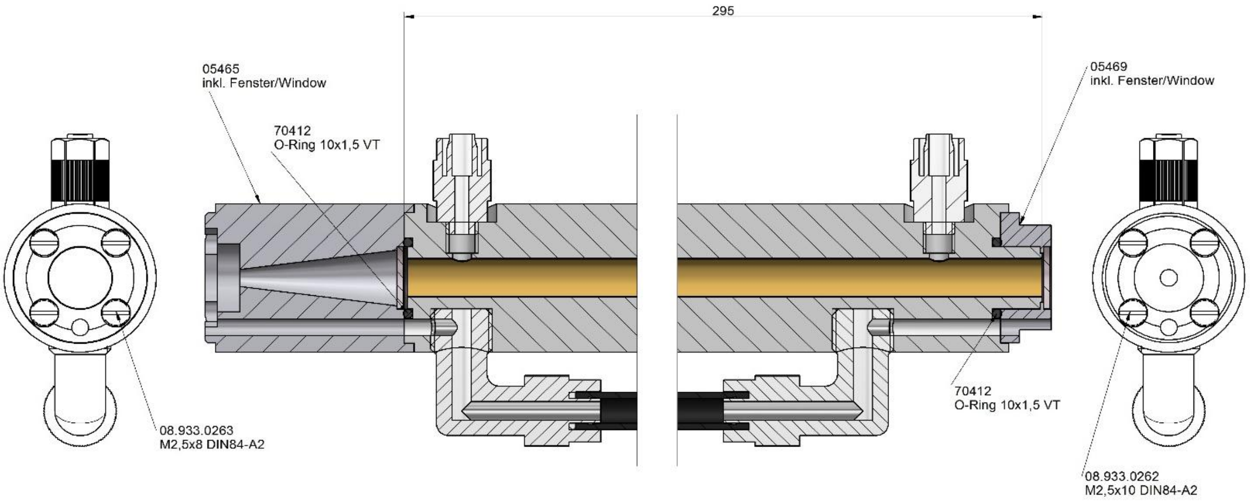


Fig. 112: Golden path

Part No.	Description
05008	IR fitting
05064	Chopper motor
05175	Gas conditioner
05250	IR-housing holder
05270	Threaded rod (advice the length)
05278	IR pre-amplifier V4
05279	IR pre-amplifier
05350	IR front panel
05465	IR path ring with window (source side)
05469	IR path cone with window (detector side)
05479	Chopperassembly, 1 channel
05488	Chopperassembly, 4 channels
05492	Chopperassembly, 3 channels
05496	Chopperassembly, 2 channels
05502-0100	Golden IR-path 100mm
05502-0120	Golden IR-path 120mm
05502-0140	Golden IR-path 140mm
05502-0170	Golden IR-path 170mm
05502-0200	Golden IR-path 200mm
05502-0275	Golden IR-path 275mm
05502-0295	Golden IR-path 295mm
05527	IR path 1-3mm

06730	IRC 1 channel
06731	IRC 2 channel
06732	IRC 3 channel
06733	IRC 4 channel
089330263	Cylinder screw 84 M2
15209	Flow meter
704120	O-ring

6.1.8 Chopper

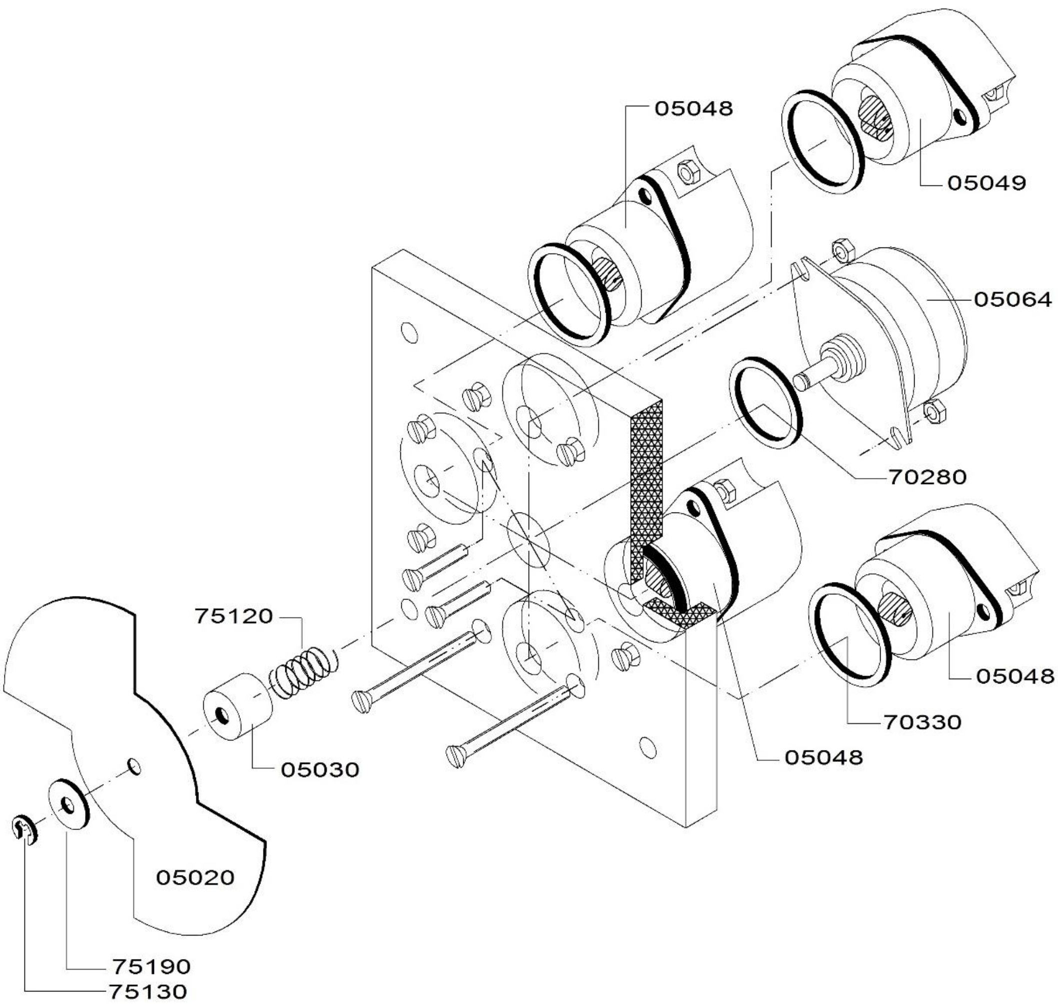


Fig. 113: Chopper

Part No.	Description
05020	Chopper blade
05030	Chopper blade holder
05064	Chopper motor
05048	Infrared source (emitter)

05049	Double source
70280	O-ring
70330	O-ring
75120	Spring
75130	Retaining washer
75190	Washer

6.1.9 Resistance furnace

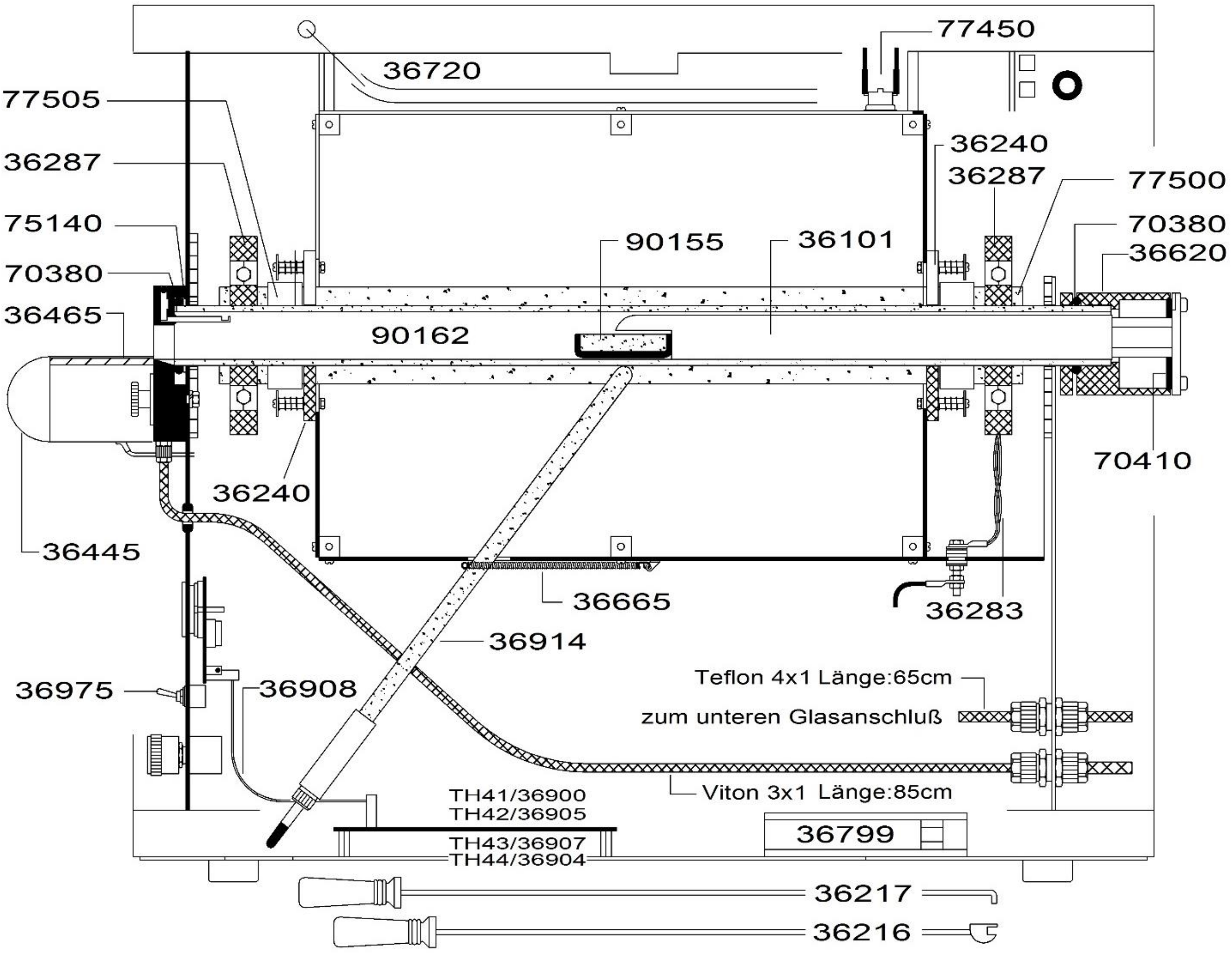


Fig. 114: Resistance furnace

Part No.	Description
36101	Boat stop
36216	Combustion boat insertion stick
36217	Combustion boat removing stick
36242	Ceramic plate
36283	Heating element connector
36288	Heating element connector

36445	Front panel for the combustion boat
36465	Ceran plate
36620	Dust trap
36665	Spring
36799	Cooling fan
36907*	Temperature control board TH 43 / TH 44
36908	Cable for TH 43 / TH 44
36914	Thermocouple
36975	LCD – display DVM 2
70380	O-ring
70410	O-ring
75140	Coil spring washer
77450	Temperature switch
77507	Ceramic tube
77525	Heating elements, 4 pcs
90155	Combustion boats
90162	Combustion tube

*** Note:**

36907	Temperature control board TH 43 is an older version.
36904	Temperature control board TH 44 is a newer version and fully compatible

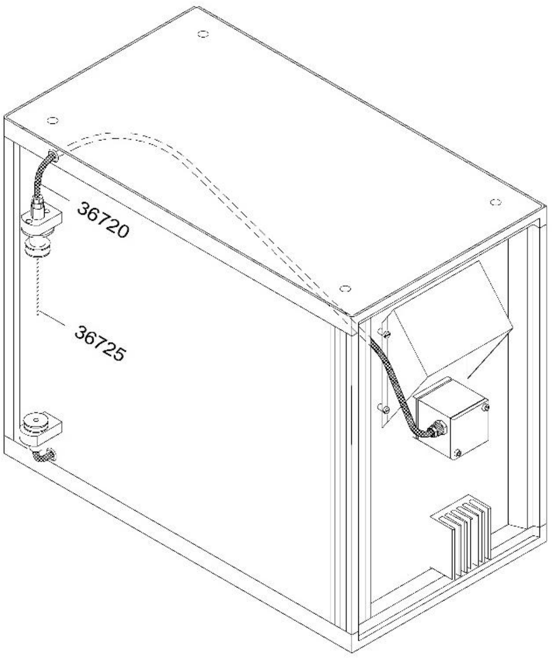


Fig. 115: Ordering Numbers resistance furnace

Part No.	Description
36720	Teflon tube
36725	Teflon tube for 36720

6.1.10 Oxygen purifying furnace

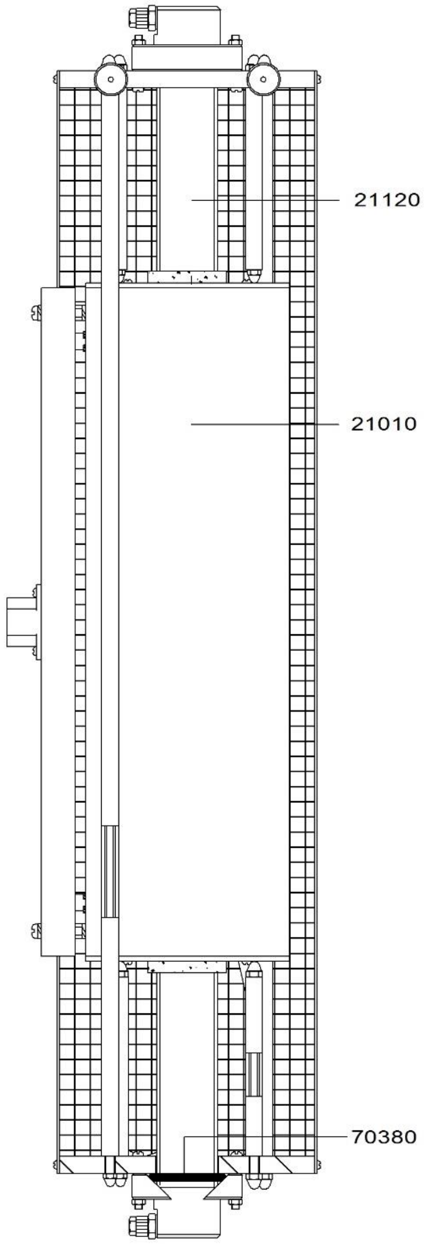


Fig. 116: Oxygen purifying furnace

Part No.	Description
21010	Heather section
21120	Quartz tube
70380	O-ring

6.1.11 Dust trap

Optional for metal analysis

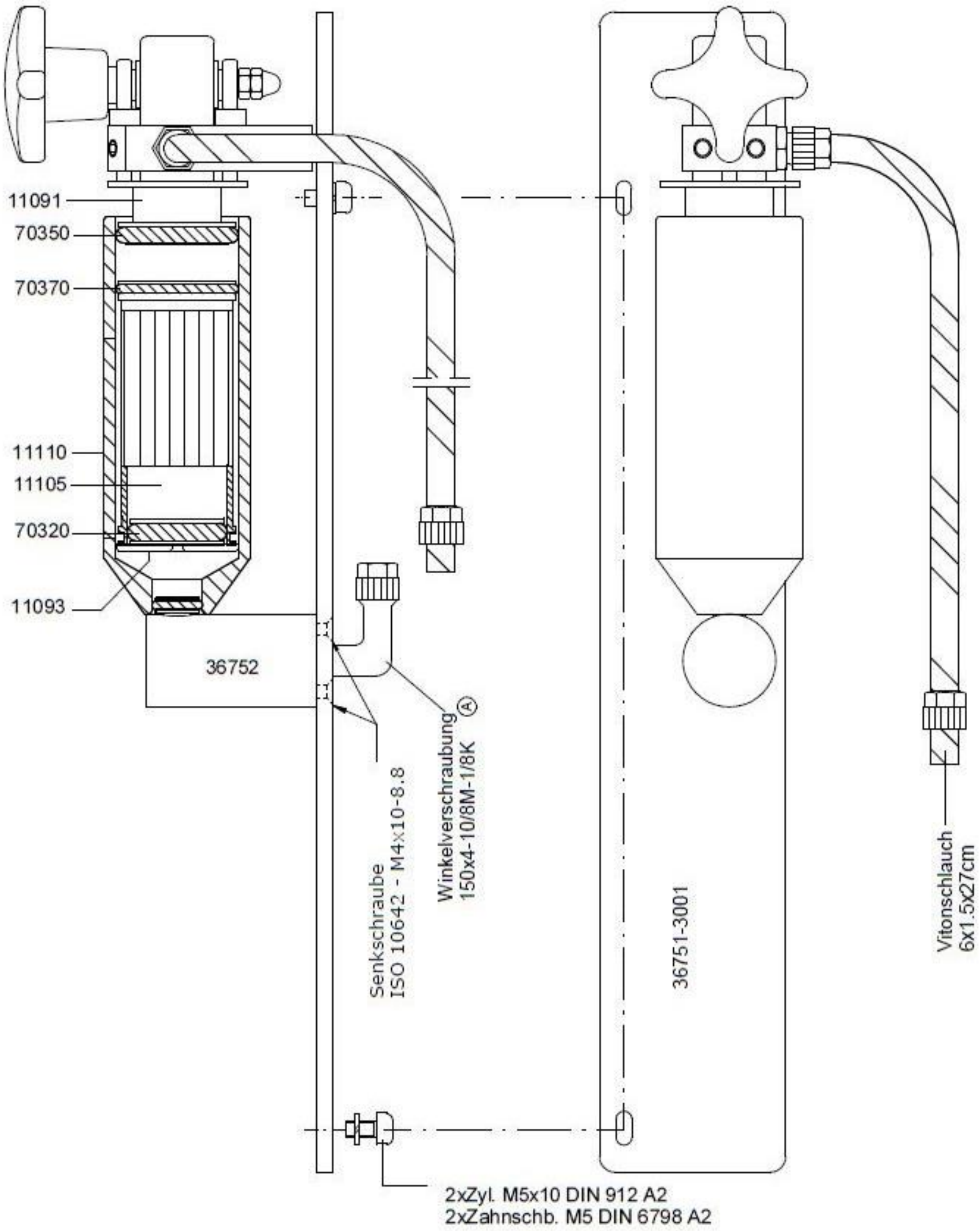


Fig. 117: Dust trap

Part No.	Description
70320	O-Ring
70350	O-Ring
07370	O-Ring
11091	Dust trap mechanism

11093	Filter plate
11105	Metal dust filter
11110	Filter housing
36751-3001	Panel
36752	Filter housing support

6.2 Wiring diagrams

6.2.1 Right hand side power wiring

Color Table	
BK	Black
BL	Blue
BN	Brown
GN	Green
GY	Grey
OR	Orange
PK	Pink
RD	Red
VT	Violet
WT	White
YL	Yellow

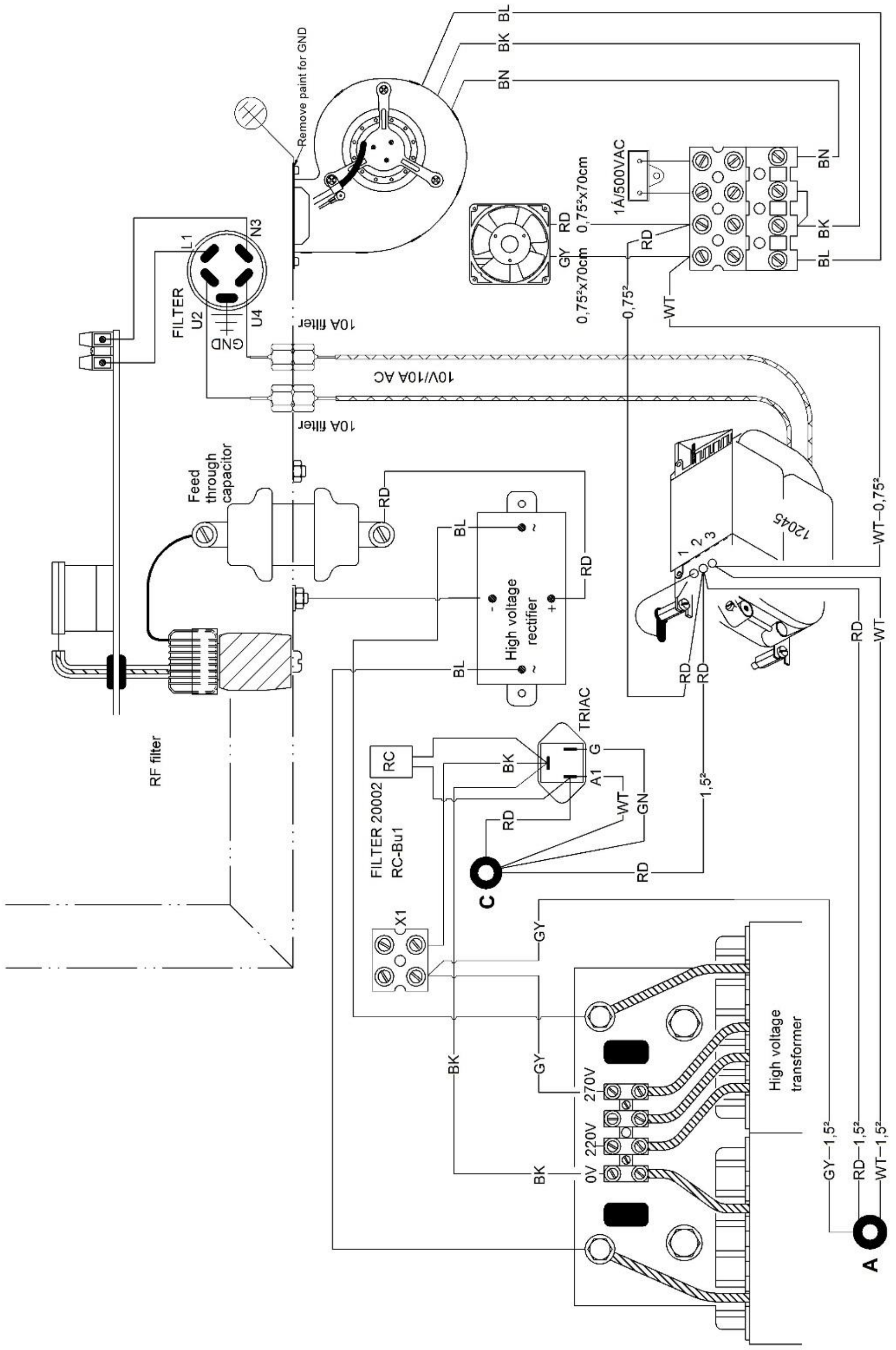


Fig:. 118: Rightt hand side power wiring

6.2.2 Left hand side power wiring

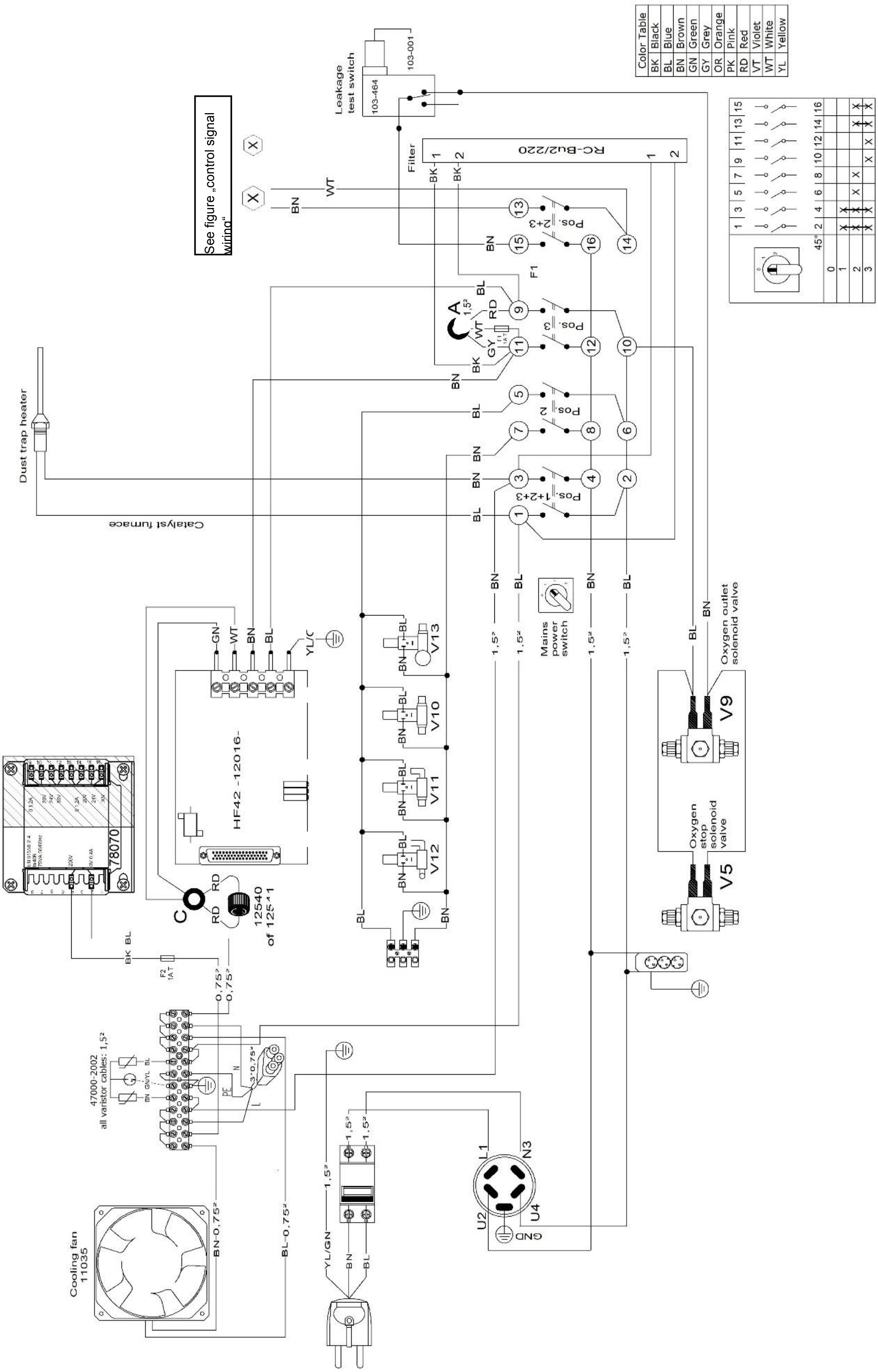


Fig. 119: Left hand side power wiring

6.2.3 Valve wiring

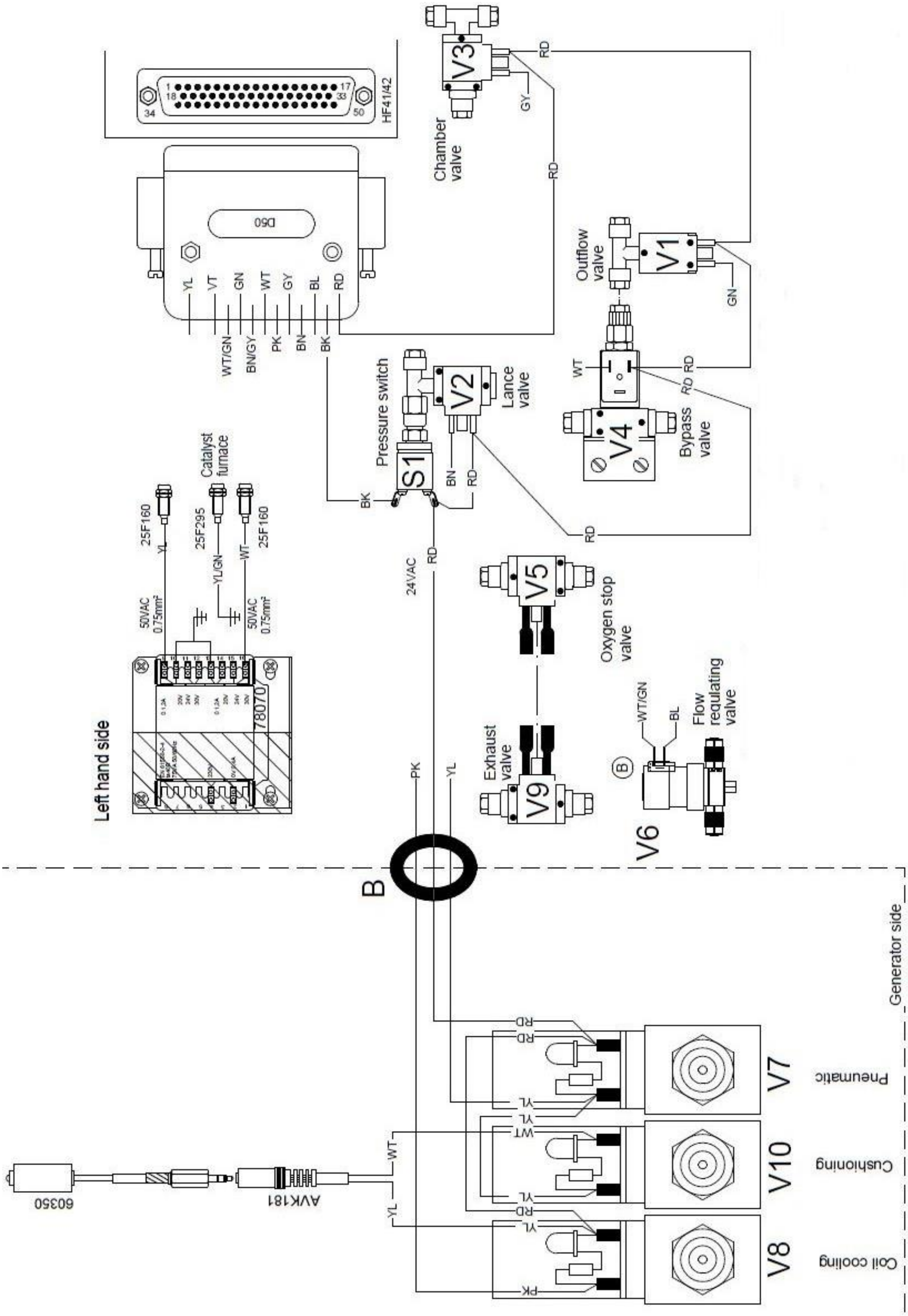


Fig. 120: Valve wiring

6.2.4 Control signal wiring

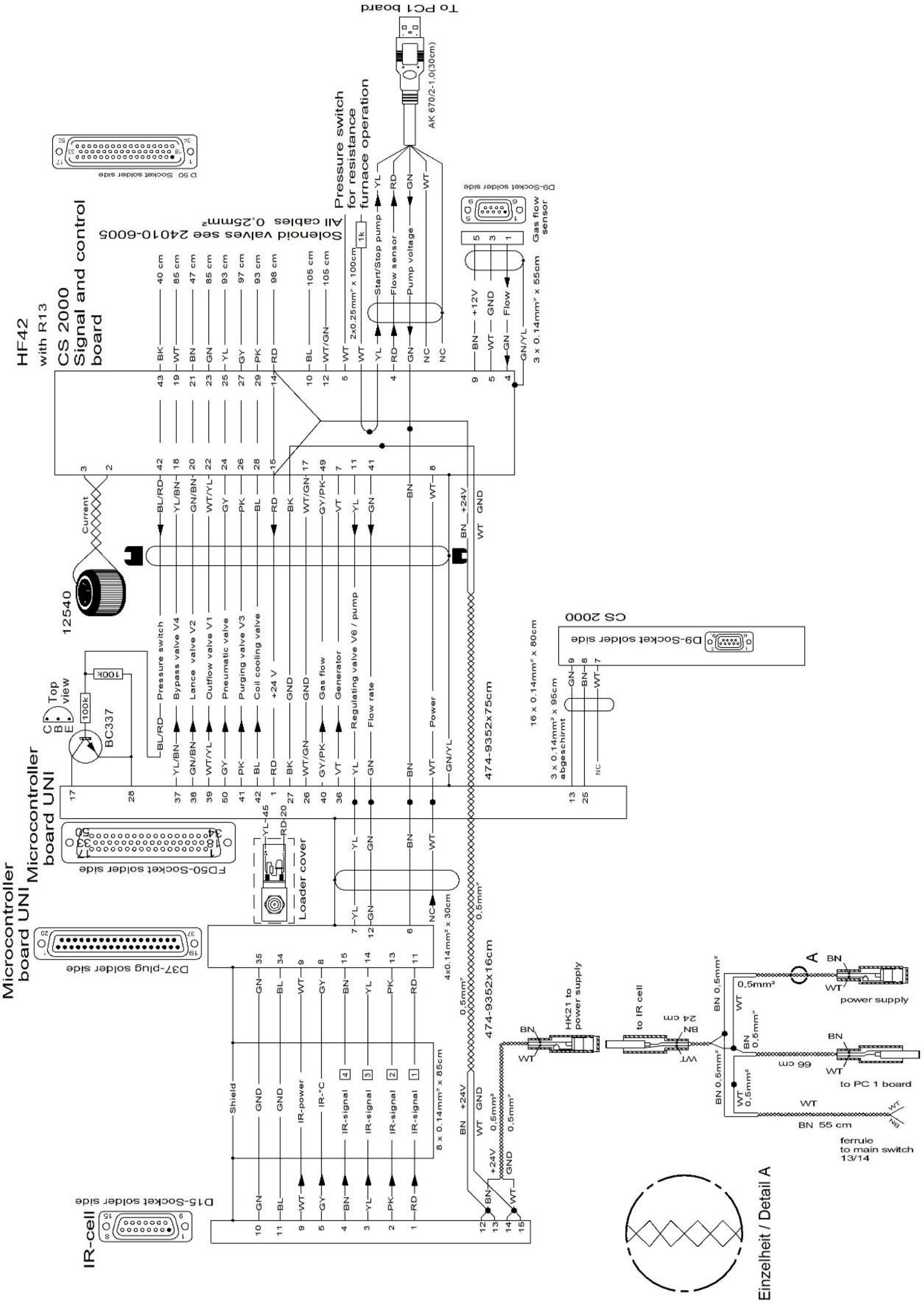


Fig. 121: Control signal wiring

6.2.5 IR-current supply, old version

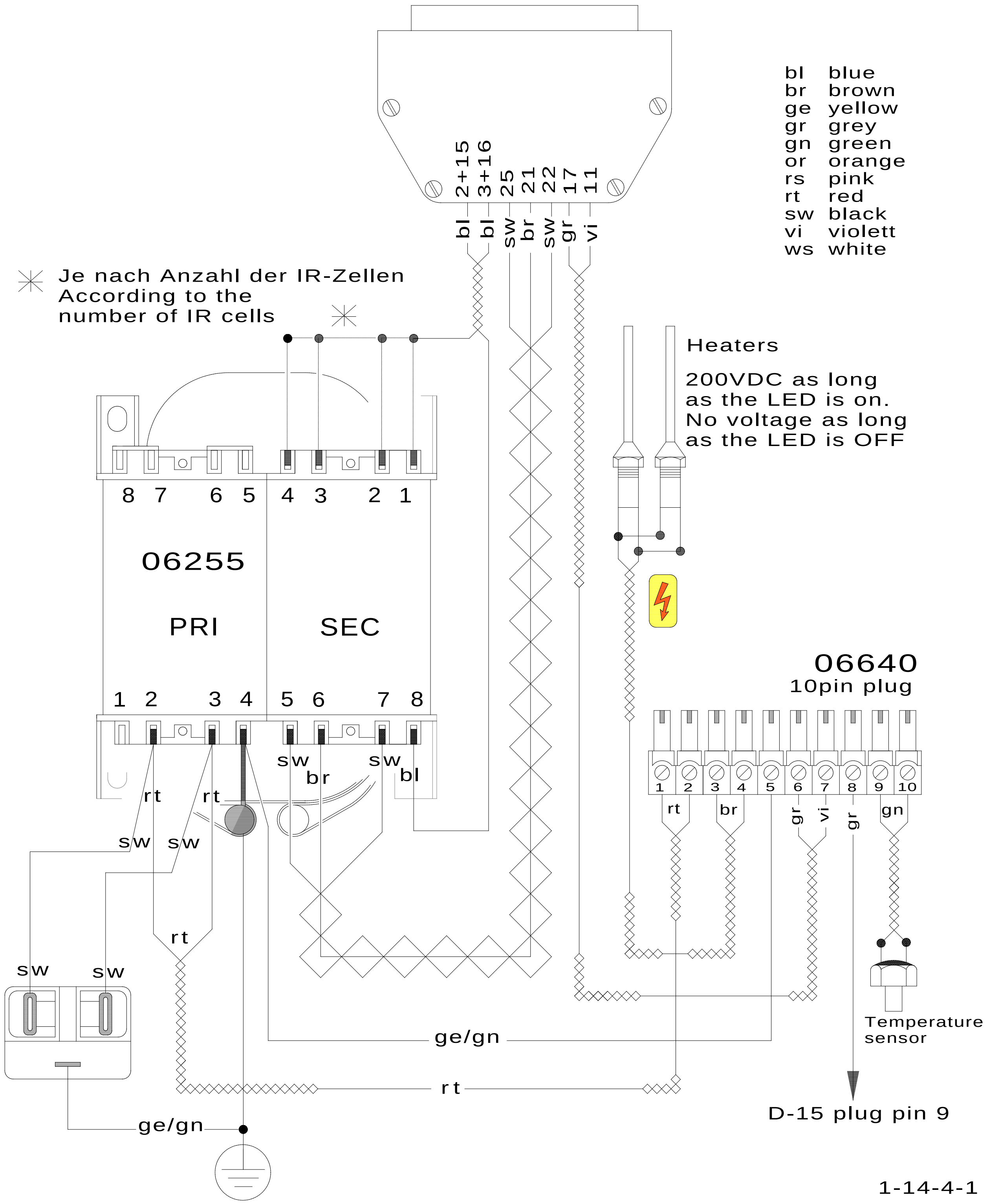
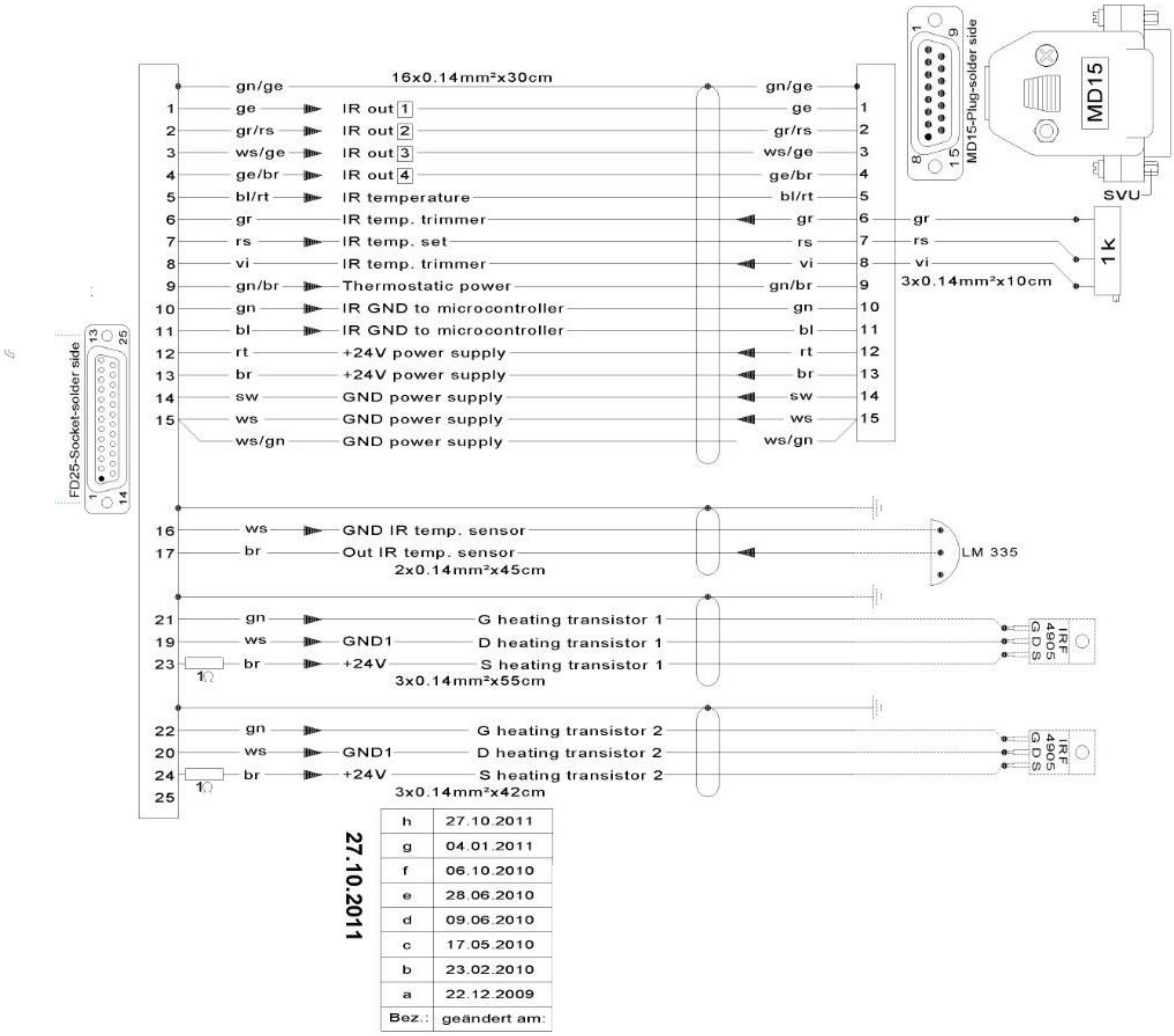


Fig. 122: IR-current supply, old version

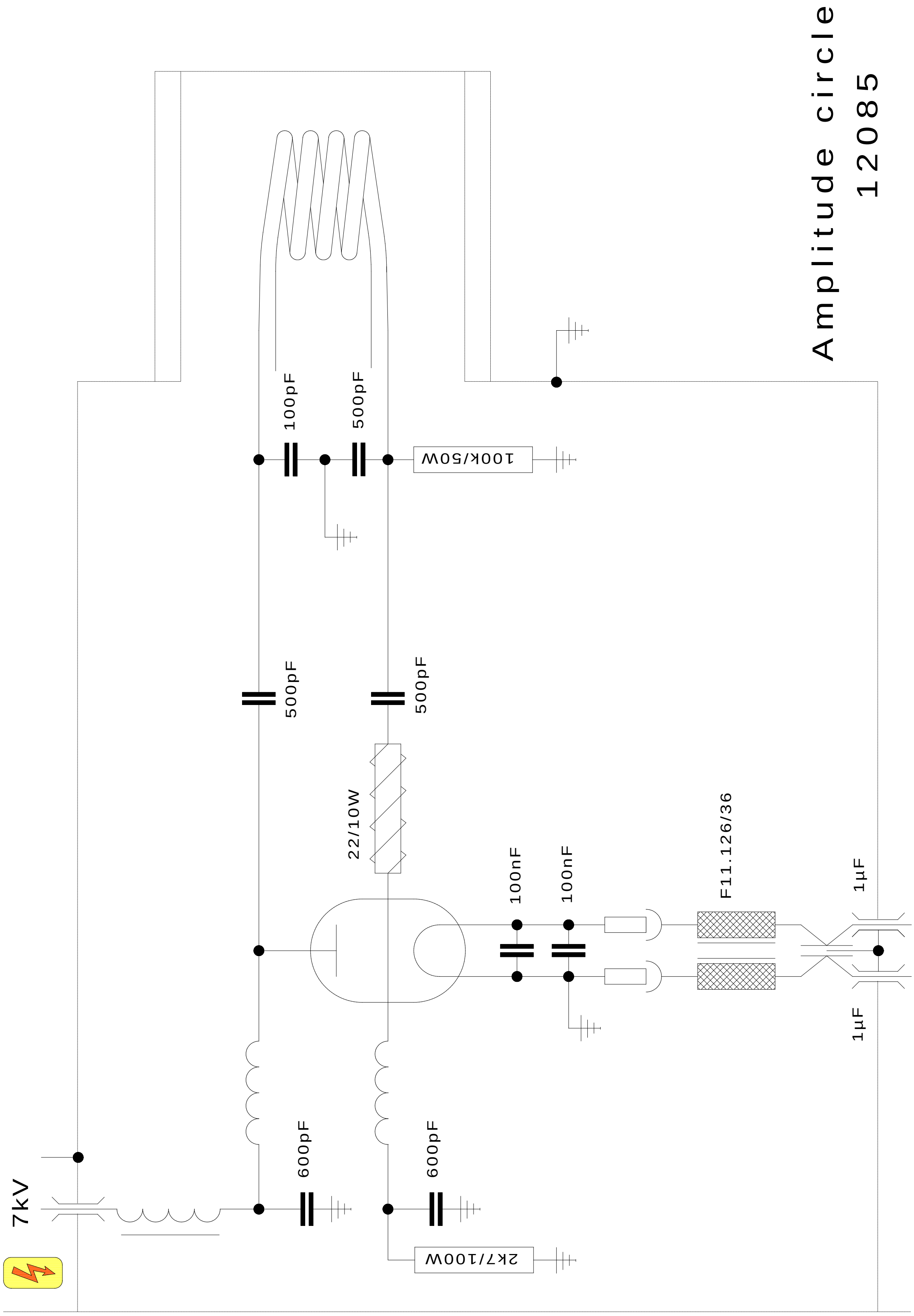
6.2.6 IR-cell internal signals



h	27.10.2011
g	04.01.2011
f	06.10.2010
e	28.06.2010
d	09.06.2010
c	17.05.2010
b	23.02.2010
a	22.12.2009
Bez.:	geändert am:

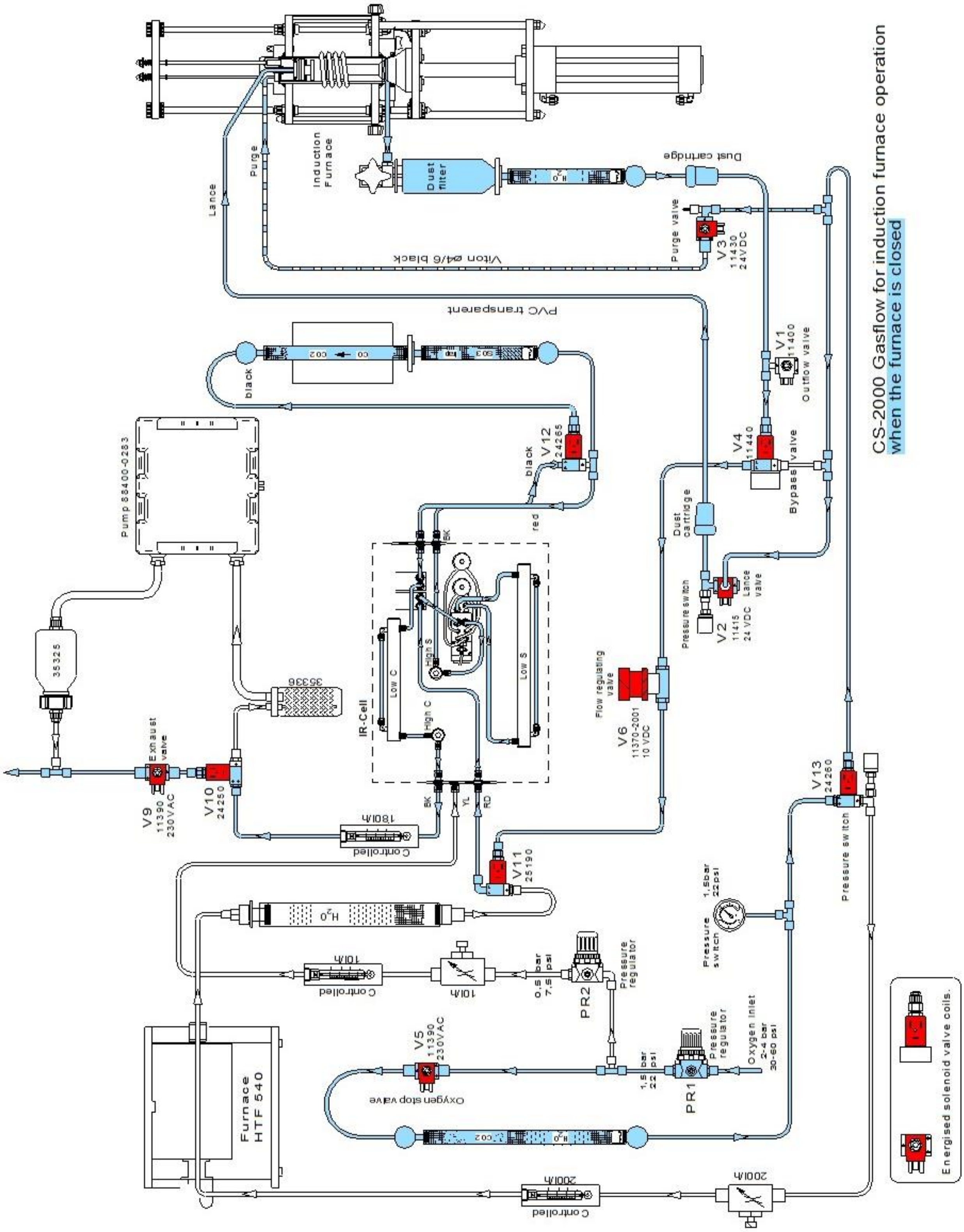
Fig. 123: IR-current supply, new version

6.2.7 Amplitude circle

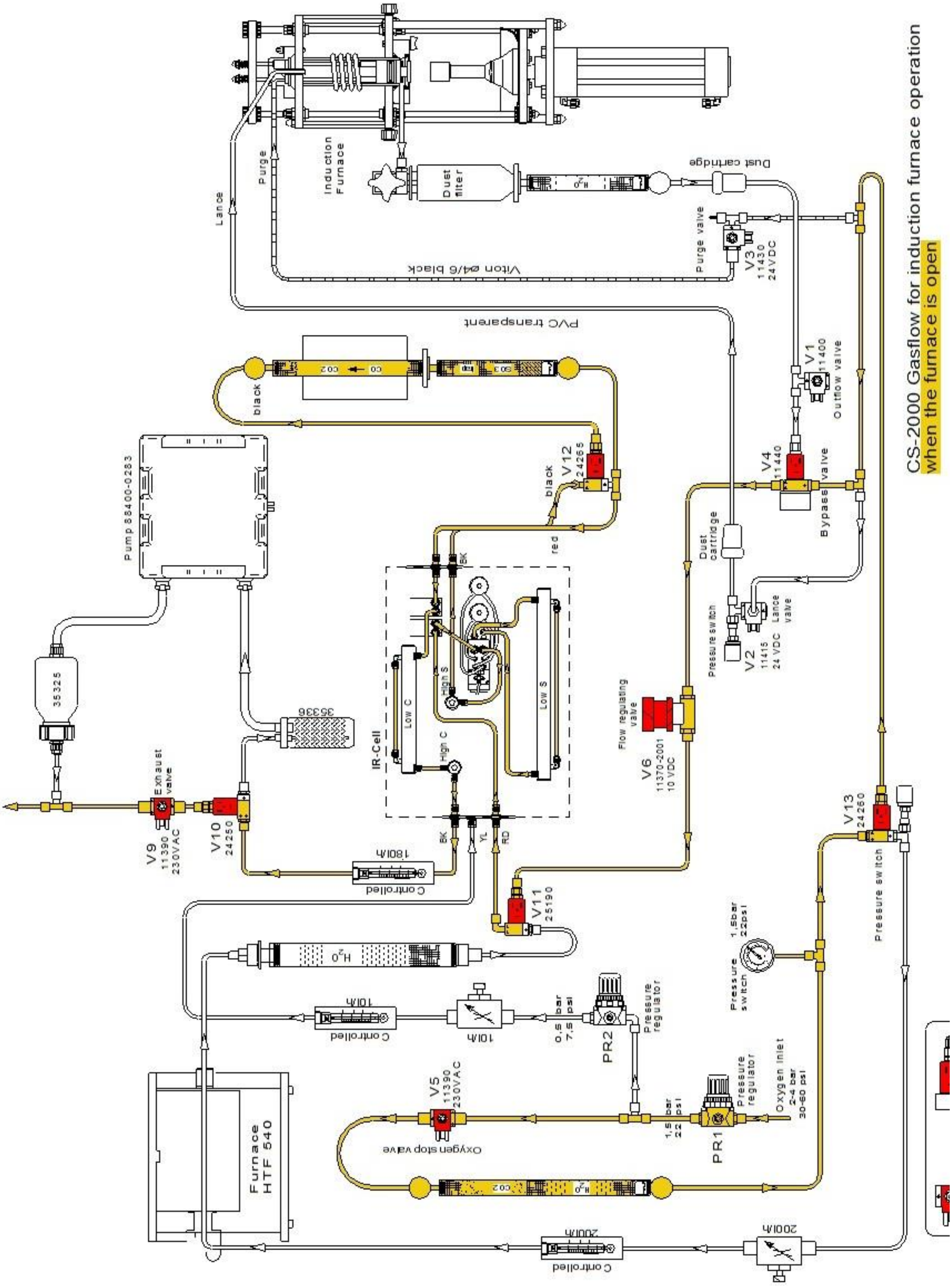


6.3 Gas flow diagrams

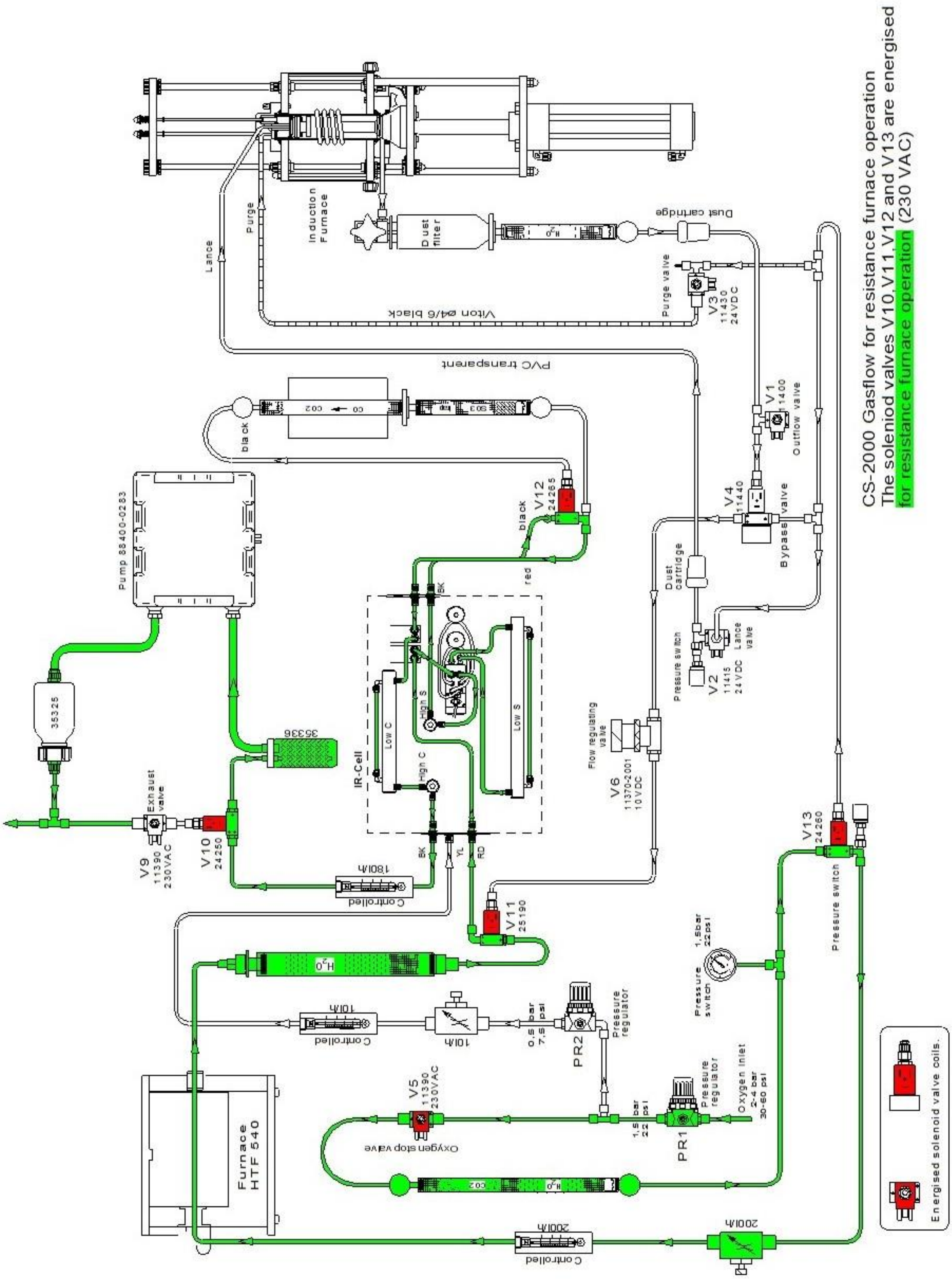
6.3.1 Gas flow for induction furnace when furnace is closed



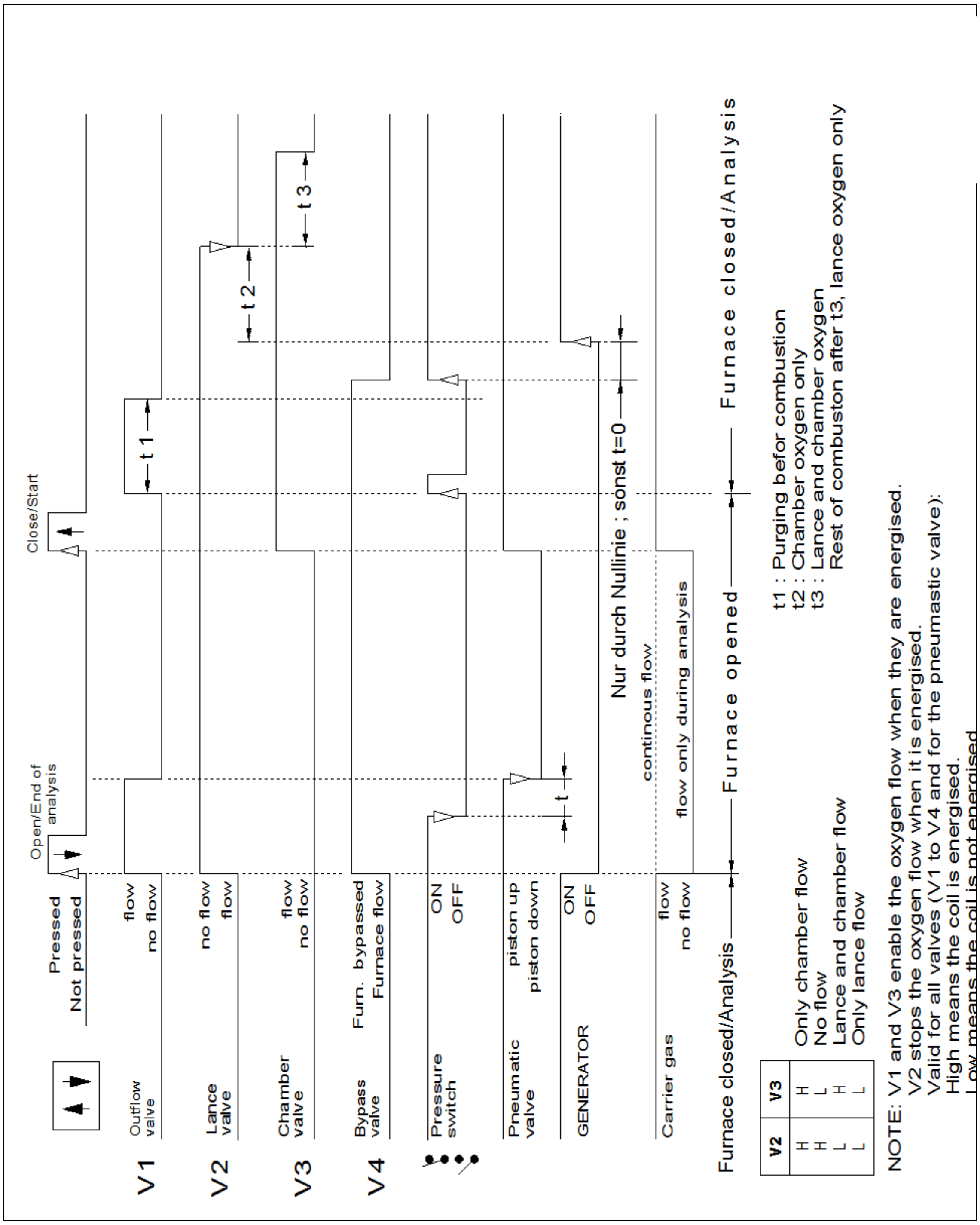
6.3.2 Gas flow for induction furnace when furnace is open



6.3.3 Gas flow for resistance furnace



6.3.4 Valve contolling



6.4 Spare parts kits

6.4.1 Common spare parts kti for all analysers

Part Number	description	quantity
05048	Infrared source (emitter)	1
05060	Reflector	1
05064	Chopper motor	1
05067	IR path for high carbon	1
05068	IR path for sulphur	1
05150	IR path connector with window source side	1
05160	IR path connector with window detector side	1
05260	IR path tube (80 to 320 mm)	1
05278	Infrared preamplifier for 3 pins	1
05279	Infrared preamplifier for 4 pins	
06032	Infrared detector with CO2 filter	1
06034	Infrared detector with SO2 filter	1
06058	IR Temperature control board TH61	1
06421	Infrared power supply assembly IR13	1
06630	IR Temperature control board TH62	1
06733	IRC board for 4 channels	1
11035	Cooling fan	1
11062	Reagent tubes 160 x 16mm	2
11064	Reagent tubes 280mm x 16mm	2
11380	Pneumatic valve	1
11390	Oxygen solenoid valve	1
11408	Pressure switch	1
11480	Adjustable flow restrictor	1
11492	Inlet pressure regulator	1
15037	IR Temperature regulation board NR32	1
15063	Gasflow sensor 300 l/h	1
15083	Gas flow meter 15 l/h	1
15087	Gasflow meter 300 l/h	1

15095	Gasflow meter 600 l/h	1
15098	Gas flow control board FC 21	1
16110	Power supply board NK 32	1
16114	Power supply 24V 5A	
18173	PC-cable	1
18454	Balance cable	1
21120	Quartz tube for purification furnace	1
35310	Pressure switch	1
70120	O-ring 3.4 x 1.9 VT furnace cleaning rods (CS 800) and for furnace platform	1
70150	O-ring 6 x 2.5 VT	1
70210	O-ring 8 x 3.5 VT for catalyst tube (CS 800) and for reagent tube (OH/ON 900)	1
70230	O-ring 9 x 3 VT for reagent tubes and dust filter	1
70280	O-ring 18 x 2 VT for chopper motor	2
70285	O-ring 19 x 3 VT for furnace ON/OH 900 (top)	1
70320	O-ring 20 x 5 VT for dust filter (CS 800) for furnace glass tube (CS 500) For reagent tube (HTF540)	1 2
70330	O-ring 21 x 2 VT for infrared source	6
70350	O-ring 29 x 5 VT for dust filter (CS 800)	1
70370	O ring 34 x 3 VT for dust filter (CS 800)	1
70380	O-ring 35 x 5 VT for combustion tube (CS 800) and for furnace internal (CS 500)	2
70390	O-ring 38 x 5 VT for furnace (CS 800)	1
70405	O-ring 47.2x 5.7 VT for furnace closure ON/OH	1
70410	O-ring 48 x 3 VT for furnace internal (CS 500)	1
70415	O-ring 62 x 3 VT for furnace ON/OH 900 (centre)	1
70425	O-ring 90 x 2.5 VT for furnace ON/OH (bottom)	1
72010	Pressure gauge 2,5 bar (37.5 psi)	1
72020	Gauge 10 bar/140 psi	1
73020	Tube transparent	5m
73030	Tube black id = 4 od = 5	5m
73040	Tube black id = 6 od = 9	1m
75120	Spring	1
75130	Retaining washer	1

75190	Washer	1
77140	HF-filter 250 V	1
78010	Mains power switch	1
90290	Copper oxide	100g
92610	Tube of grease	1

6.4.2 Spare Parts kit for CS2000 (including spare parts kits CS800 and HTF540)

Part Number	description	quantity
05390	Heatsink	1
09090	Reagent tube	1
11105	Metal dust filter	1
11115	Plastic tube	75mm
11120	Paper filter holder	1
11180	Dust filter cartridge	1
11185	Paper filters	10
11370-2001	Gasflow regulating valve	1
11400	Pressure outlet solenoid valve	1
11410	Oxygen stop solenoid valve	1
11430	Purge solenoid valve	1
11440	Bypass solenoid valve	1
11470	One way valve	1
11490	Pressure regulator	1
12005	Gasflow and furnace control board HF3	1
12016	Gasflow and furnace control board HF42	1
12080	Rectifier	1
13067	Combustion coil	1
13175	Insulator	1
13260	High voltage filter	1
13262	Capacitor 700 pF/40KV	1
13270	Resistor	1
14045	Cleaning brush for combustion tube	1
14072	Ceramic heat shield for brush	1

14080	Cleaning mechanism rod	1
14130	Combustion tube l=145 id=32 od=36 mm	2
14168	Pedestal	1
15208	Gas flow sensor	1
20000	Catalyst furnace	1
20040	Catalyst tube 200 x 16mm	1
35070	Ventilator frame	1
35355	Lower reagent tube connector	1
36101	Boat stop	1
36216	Combustion boat insertion stick	1
36217	Combustion boat removing stick	1
36242	Ceramic plate	2
36283	Heating element connector	1
36288	Heating element connector	1
36445	Front panel for the combustion boat	1
36465	Ceran plate	1
36620	Dust trap	1
36665	Spring	1
36700	Upper reagent tube connector	1
36720	Teflon tube	1
36725	Teflon tube for 36720	1
36798	Transformer	1
36799	Cooling fan	1
* 36907	Temperature control board TH 43 / TH 44	1
36908	Cable for TH 43 / TH 44	1
36914	Thermocouple	1
36975	LCD – display DVM 2	1
75122	Spring	1
75130	Safety ring	1
75140	Coil spring washer	1
77050	Triac	1
77135	Capacitor 2µF for blower (at the generator unit)	1
77210	Oscillator tube	1
77322	Capacitor 100 pF/30KVA	1
77333	10V/10A filter	2

77350	Capacitor 1µF/50V	2
77450	Temperature switch	1
77507	Ceramic tube	1/8
77525	Heating elements	4
77600	Grid resistor	1
77610	Resistor	1
80925	Sets of fuses	3
88400-0283	Gas pump VP-6035S	
90155	Combustion boats	
90162	Combustion tube	1
90220	Tungsten	2500g
90260	Iron chips	908g
92400	Steel standards (advice %C and %S)	100g

*NOTE:

36907	Temperatur control board TH43 is an older version	1
36904	Temperatur control board TH43 is a newer version and fully compatible	1

6.5 Maintenance

- Is the furnace closure cone still properly fixed? See chapter "**Closing cone**".
- Check whether the imprint of all the O-rings is at least of 2 mm thickness.
- Is the inlet pressure regulator set on 1,5 bar (22.5 psi)? See chapter **"Pressure regulators"**.
- Is the other two pressure regulator set on 0,35 bar (5 psi)?
- Check for leaks. See **chapter "Leak checking"**.
- Is the gas flow rate correct? See **chapter "Gas flow controller"**.
- Pressure switch: change over at about 1 bar? Measure across the leads. See **chapter "No or low oxygen pressure"**.
- Does the thermostatic control work correctly? See chapter **"IR thermostatic control"**.
- Check the infrared baseline. See chapter **"Infrared base line"**.
- Check whether all the screws of the generator housing are tight.
- Check whether all four „high voltage“ stickers are still in place.
- Check whether all plugs in the analyzer are properly plugged in.
- Check whether all the warning labels are still attached to the side-panels.
- Calibration of all measuring ranges.

7 Approved methodologies to which Eltra instruments conform

7.1 Inorganic materials (Metals)

Norm	Elements	Materials	Instruments
DIN EN ISO 9556:2002-04	C	Steel and Iron	CS-800 CS-2000
ISO 4935:1989 DIN EN 24935:1992-07	S	Steel and Iron	CS-800 CS-2000
ASTM E 1019:2011	C,N,O,S	Steel, Iron, Nickel / Cobalt Alloys	CS-800 CS-2000 ON-900 OH-900 ONH-2000
ASTM E 1587:2010	C,N,O,S	Refined Nickel	CS-800 CS-2000 ON-900 OH-900 ONH-2000
ASTM E 1409:2013	N,O	Titanium and Titanium Alloys	ON-900 OH-900 ONH-2000
ASTM E 1569:2009	O	Tantalum	ON-900 OH-900 ONH-2000
ASTM E 1447:2009	H	Titanium and Titanium Alloys	OH-900 ONH-2000
ASTM E1915 - 13	C,S	Metal Bearing Ores and Related Materials (i.e. tailings, waste rock)	CS-580 CS-800 CS-2000
UOP703 - 09	C	Catalysts	CS-800 CS-2000
ASTM E 1941:2010	C	Refractory and Reactive Metals	CS-800 CS-2000
ASTM E2575 - 08	O	Copper	ONH
DIN EN ISO 15351	N	Steel	ONH 2000 ON900
ISO 22963	O	Titan	ONH serie
ISO 17053	O	Steel/Iron	ONH serie

DIN EN ISO 15349-2	C	Steel	CS 800 CS 2000
ISO 13902	S	Steel/Iron	CS 800 CS 2000
ISO 4689-3	S	Iron ore	CS 800 CS 2000
ISO 7524	C	Nickel	CS 800 CS 2000
DIN EN 27526	S	Nickel	CS 800 CS 2000
DIN EN ISO 15350	C,S	Steel / Iron	CS 800 CS 2000
DIN EN ISO 3690	H	Steel	H 500
DIN EN ISO 10720	N	Steel	ON 900 ONH 2000
ISO 10719	C	Steel	CS 800 CS 2000

7.2 Organic materials (Oil, Coal, foodstuffs)

Norm	Elements	Materials	Instruments
ASTM D 1552:2008	S	Oil and Petrolium Products	CS-580 CS-2000
ASTM D 4239:2013;	S	Coal and Coke	CS-580 CS-2000
ASTM D 5016:2008	S	Coal and Coke Ash	CS-580 CS-2000
ASTM D 1619:2011	S	Carbon Black	CS-580 CS-2000
DIN EN 13137:2001-12	C	Waste	CS-580 CS-2000
DIN ISO 10694:1996-08	C	Soil samples	CS-580 CS-2000
ASTM D 7348:2013	Loss On Ignition (LOI)	Combustion Residues	TGA Auto TGA Thermo Chain
ISO 15178	S	Soil	CS 580 CS 800 CS 2000

8 Disposal

Please observe the respective statutory requirements with respect to disposal.

Information on disposal of electrical and electronic machines in the European Community.

Within the European Community the disposal of electrically operated devices is regulated by national provisions that are based on the EU Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE).

Accordingly, all machines supplied after 13.08.2005 in the business-to-business area to which this product is classified, may no longer be disposed of with municipal or household waste. To document this they have the following label:

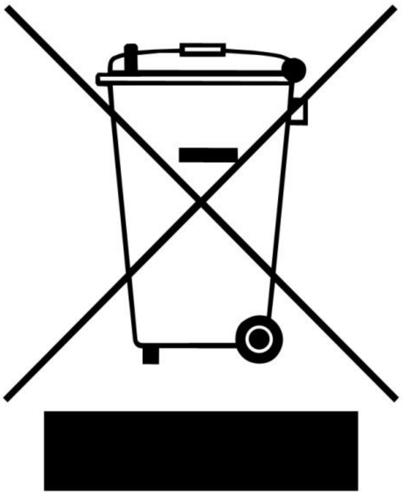


Fig. 3: Disposal label

Since the disposal regulations within the EU may differ from country to country we would request you to consult your supplier.

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ELEMENTAL ANALYSERS

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