Manual

Carbon and Sulfur Analyzer CS-2000

Translation

ELTRA
ELEMENTAL ANALYSERS

Table of Contents

1 Contact information

Please contact your local representative in the event of problems. You can find the complete list of dealers at www.eltra.com.

Of course you can also contact ELTRA-Germany directly:

ELTRA GmbH
Retsch Allee 1-5
42781 Haan
Germany
Web: www.eltra.com
Email: service@eltra.com

2 Notes on the Manual

This Operating Manual provides technical instructions for the safe operation of the device and contains all necessary information about the topics given in the table of contents. This technical documentation is meant to be a tutorial and a reference. The individual chapters are self-contained.
Knowledge of the relevant chapters (for the respective target groups defined according to areas) is a prerequisite for the safe and correct use of the device.
This Operating Manual contains no repair instructions. In the event of any faults or necessary repair work, please contact your supplier or Eltra GmbH directly.

Amendments
Subject to technical changes.

2.1 Explanations of the Safety Instructions

In this Operating Manual we give you the following safety warnings

Mortal injury may result from not following 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 not following 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 not following 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

2.2 General Safety Instructions

C1.0002

CAUTION

Read the manual

Non-observance of the operating instructions

– The non-observance of this manual can result in personal injuries.
- **Read the manual before using the device.**
- **The adjacent symbol indicates the necessity of knowing the contents of this manual.**

Target group:

All activities required for correct use are described in this Operating Manual. Any activities that go beyond this may only be performed by authorised electricians who have received in-depth training for this analyzer.

As the operating company, you must ensure that the following applies to the persons working on the analyzer;

- Operating personnel have been made aware of and have understood all safety regulations;
- Operating personnel are familiar when starting work with all handling instructions and regulations that apply to the relevant target group for them;
- Operating personnel have access at all times to the technical documentation of this analyzer;
- New personnel are familiarised with the safe and intended use of the analyzer before starting work on it by means of a verbal introduction by a competent person and using this technical documentation.

Incorrect operation can result in injury and damage to property. You are responsible for your own safety and for that of your employees.
Ensure that no unauthorised persons have access to the analyzer.

C2.0089

CAUTION

Changes to the machine

– Changes to the machine may lead to personal injury.
- **Do not make any change to the analyzer and use spare parts and accessories that have been approved by Eltra exclusively.**

N1.0074

NOTICE

Changes to the machine

Improper modifications

– The conformity declared by EltraEltra GmbH with the European Directives will lose its validity.
– Any warranty claims will be terminated.
- **Do not make any modification to the machine.**
- **Use spare parts and accessories that have been approved by EltraEltra GmbH exclusively.**

2.3 Explanation of signs and symbols

Number	Symbol	Reference	Meaning
12			Danger, high voltage, electric shock
13		IEC 60417-5041	Caution, hot surface
14		ISO 7000-0434B	General hazards – see documentation
-		BGV A8 W27	Risk of crushing

3 Packaging, Transport and Installation

3.1 Packaging

The packaging has been adapted to the mode of transport. It complies with the generally applicable packaging guidelines.

3.2 Transport

N2.0075

NOTICE

Transport

- Mechanical or electronic components may be damaged.
- **The device must not be bumped, shaken or thrown during transport.**
- **The device must be transported upright**

3.3 Intended use

The induction furnace of the analyzer was designed for the analysis of mainly steel and other metals. However, a wide variety of materials such as cement, ceramics and soil can also be analyzed for its carbon and sulfur content.

With restrictions concerning sample weight and accuracy, also coal, rubber, plastics etc. can be analyzed.

The resistance furnace is rather suitable for the last mentioned samples (combustibles, plastics), whereas an analysis of metallic samples is not recommended in this due to low temperature and dust.

Depending on the application, the sample weights, accelerator(s) and settings on the analyzer can significantly influence the accuracy and precision of the measured values.

Use is only permitted in the laboratory by appropriately trained and briefed personnel.

All other applications are prohibited, in particular the use in non-industrial areas.

3.4 Conditions for the Installation Site

Requirements regarding the operating conditions:

– For indoor use only.
– Operation up to max. 2,000 m above sea level.
– Ambient temperature of between 5°C and 40°C.
– Maximum relative air humidity < 80 % (at ambient temperatures ≤ 31°C), with linear decrease up to 50% relative air humidity at 40˚C, non-condensing.
– A residual current operated device (RCD), and a corresponding fuse (30 mA).

⚠ **WARNING** Provide an external fuse when connecting the mains lead to the mains in accordance with the regulations at the installation site.

– Information about the required voltage and frequency of the device can be found on the type plate .
– The data listed must be consistent with the existing power supply system.
– The device may only be connected to the power supply system using the connecting lead supplied.

N3.0022

NOTICE

Electrical connection

Failure to heed the data on the type plate

- Electronic and mechanical components may be damaged.
- **Only connect the device to a power supply system that is consistent with the data on the type plate.**

– Fluctuations of the mains supply voltage up to ± 10 %.
– The device must be operated in accordance with overvoltage category II and pollution category 2, DIN EN 61010-1.
– Industrial environment in accordance with DIN EN 61010-1

3.5 Type Plate Description

N4.0022

NOTICE

Electrical connection
Failure to observe the values on the type plate

- Electronic and mechanical components may be damaged.
- **Connect the device only to mains supply matching the values on the type plate.**

Fig. 1: Type plate

1	Device designation
2	Serial number
3	Year of manufacture
4	Voltage definition
5	Amps
6	Power
7	Manufacturer’s address
8	Item number
9	Mains frequency
10	Protection type
11	Disposal label
12	CE mark

Please quote the device designation (1), the serial number (2) of the device and the item number (7) if you have any queries.

4 Installation

4.1 Setting check up

CAUTION V0092

Device falling down
Incorrect erection or inadequate working space

– Due to its weight, the device can cause injuries if it falls down.
- **Only operate the device on a sufficiently large, strong, non-slip and stable working area.**
- **Ensure that all feet of the device are standing securely.**

WARNING W1.0021

Fire hazard / Risk of burns
Hot parts (crucibles, reagents,...) can fall down

– Ignition of tables, floors, or any other surface the hot part falls on
– Ignition of clothes and any other material
- **Set up the analyser in a flame retardant environment. Pay special attention to the table, the floor and any other surface being in the near of the analyzer**
- **Always wear suitable clothing**
- **Keep the work environment clear of all materials that could catch fire**

NOTICE

Installation of the machine

– It must be possible to disconnet the machine from the mains at any time.
- **Install the machine such that the connection for the mains cable is easily accessible.**

WARNUNG W2.0023

High temperature / Burning of the skin
Hot combustion tube

- **When the analyzer (HTF, resistance furnace) is switched on again after switching off, the adjusted set point is driven immediately. Please check this!**

The analyzer weighs about 110 kg and the resistance furnace 36 kg so that they should be placed on a suitably stable surface. The balance should be placed in a position so that it is free of vibration.
The balance can be placed in any position, although positioning it to the right of the analyzer has proved to be best suited.
The balance can of course also be placed on a weighing table next to the analyzer.

There are no special requirements for setting up the computer monitor and printer. They can be placed on a normal desk.
Below is an example of installation:

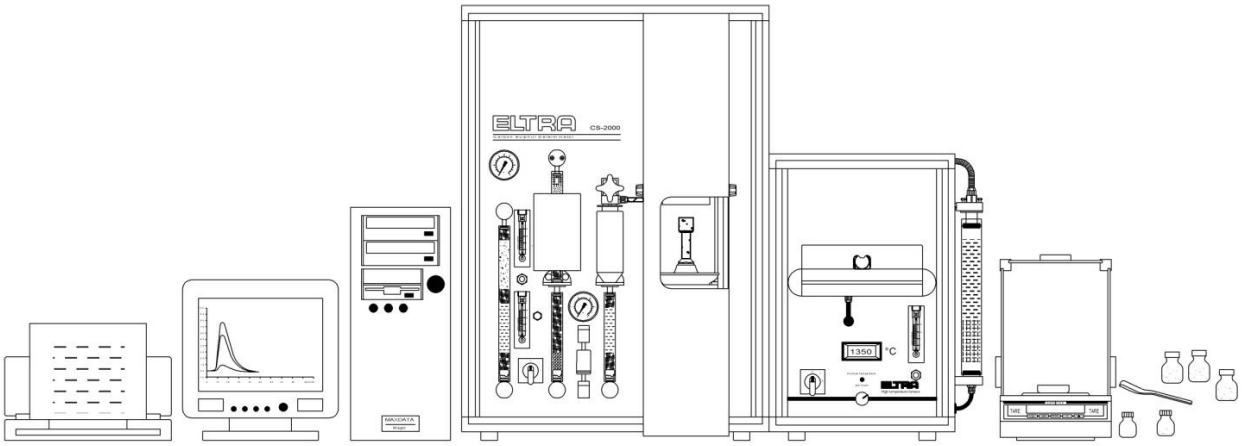


Fig. 2: Example of installation

Although the analyzer's operating environment does not necessarily need to be air conditioned, it is advisable to keep the room temperature between 18°C and 30°C.
Under no conditions should the device be exposed to direct sunshine!
Avoid places exposed to the wind of air conditioners or to the wind blowing through open windows or doors.

4.2 Front panel illustration

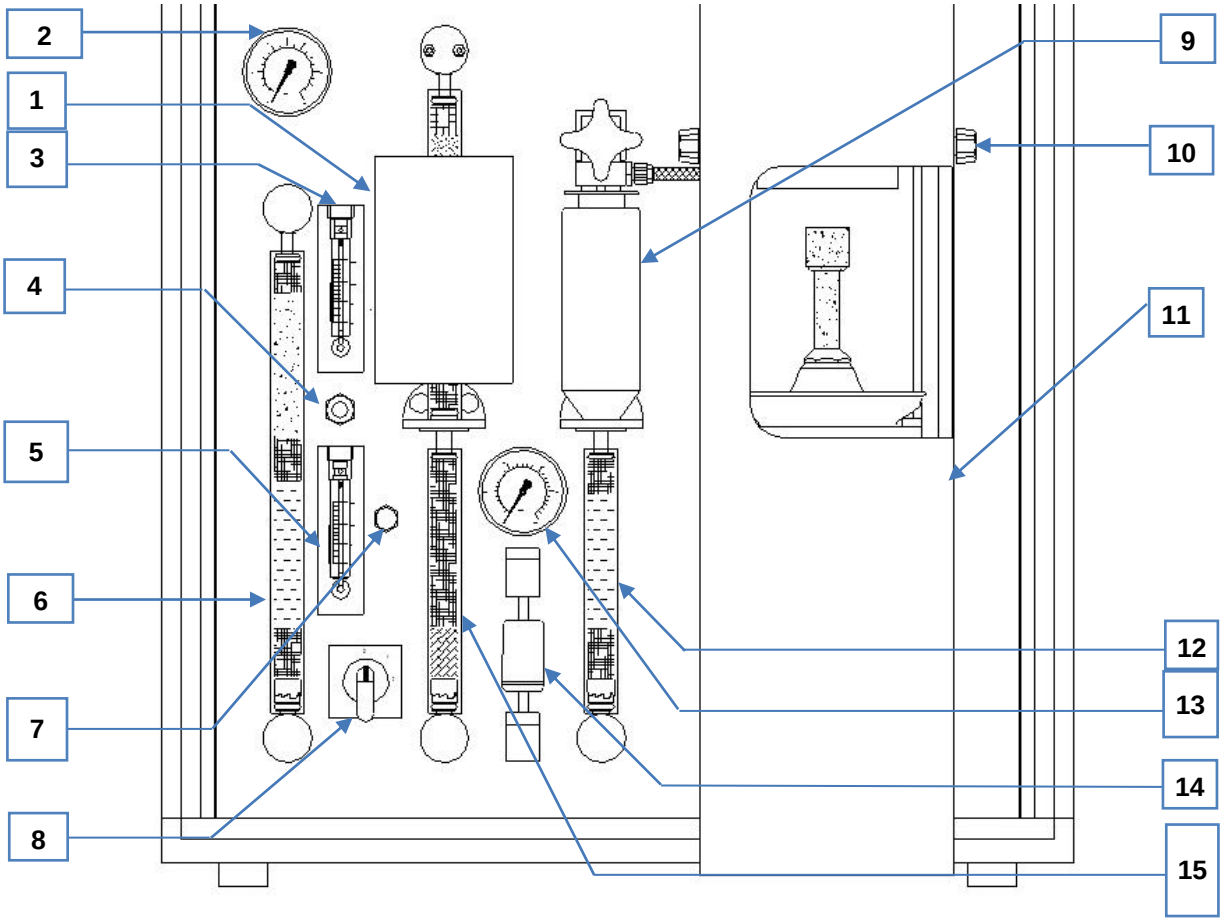


Fig. 3: Induction furnace-Front view

1	Catalyst furnace
2	Oxygen pressure gauge (norm. 1,5 bar)
3	Infrared cell purge 10 l/h
4	Regulator for infrared cell purge (3)
5	Carrier gas flow
6	CO_2 / H_2O – trap
7	Button for leakage test
8	Mains power switch
9	Dust filter
10	Cover attachment knobs
11	Furnace cover
12	H_2O – trap
13	Compressed air gauge (norm. 5 bar)
14	Dust filter cartridge
15	SO_3 – trap

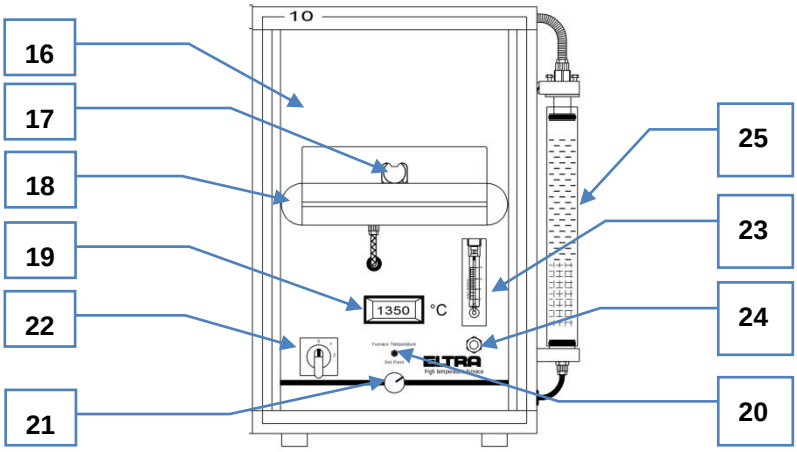


Fig. 4: Resistance furnace-Front view

16	Resistance furnace
17	Furnace entrance
18	Platform for combustion boats
19	Temperature display
20	Actual temperature/set point switch
21	Set point adjustment
22	Power switch
23	Furnace input flow meter
24	Adjustment for 23
25	Moisture trap

4.3 Mains power connections

NOTICE

Installation of the machine

– It must be possible to disconnet the machine from the mains at any time.

• **Install the machine such that the connection for the mains cable is easily accessible.**

W3.0023

WARNUNG

High temperature / Burning of the skin

Hot combustion tube

- **When the analyzer (HTF, resistance furnace) is switched on again after switching off, the adjusted set point is driven immediately. Please check this!**

Since the infrared cell requires about 1 hour to reach a stable operation temperature, it is advisable to connect the analyzer to the mains power first immediately switch it on before further installation work is carried out.
This waiting time is only necessary when switching on the analyzer from cold condition. It is then normally not switched completely off, in order to always be at constant operation temperature. During long work breaks, the analyzer is on stand-by, which is on position 1 of the mains power switch.

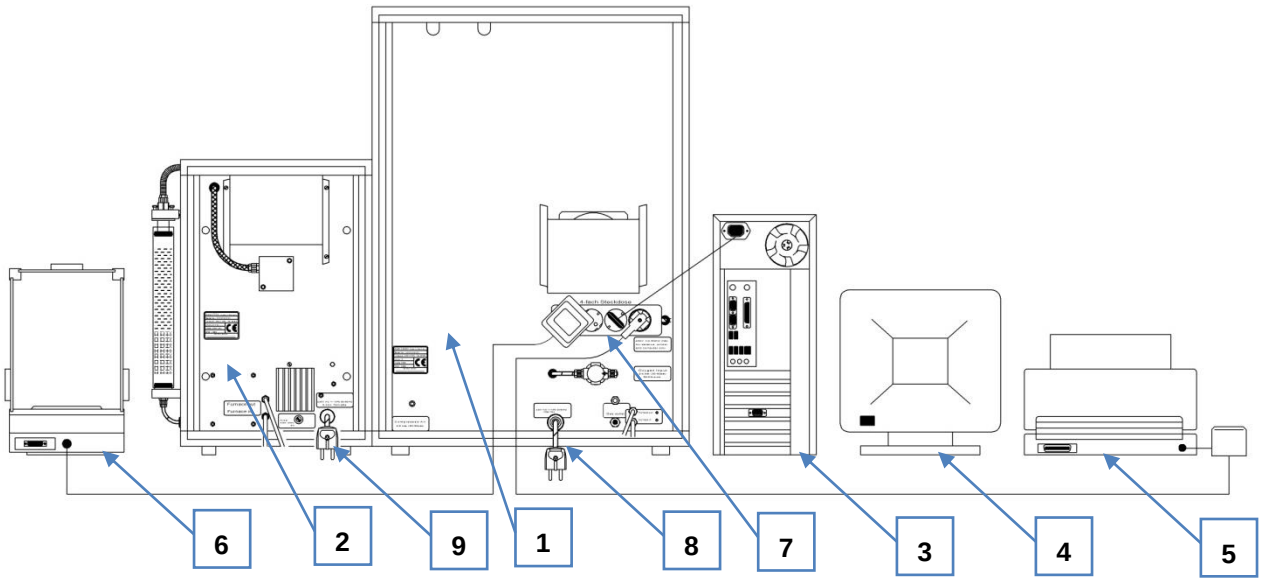


Fig. 5: Mains power connection - rear view

1	Analyzer
2	Resistance furnace
3	Computer
4	Monitor
5	Printer
6	Balance
7	Quad power socket
8	Analyzer mains plug
9	Furnace mains plug

First connect the analyzer to the mains power and switch it on to position 1 in order to win time. The power switch is located on the front panel in the low left hand corner. Set to position 1. The reason why to first switch on the analyzer is for the infrared detectors to have time to stabilize their temperature while cable connections and software start are made.

NOTICE

Never plug the furnace plug (9) into the triple socket on the rear panel of the analyzer.

4.4 Data Interface

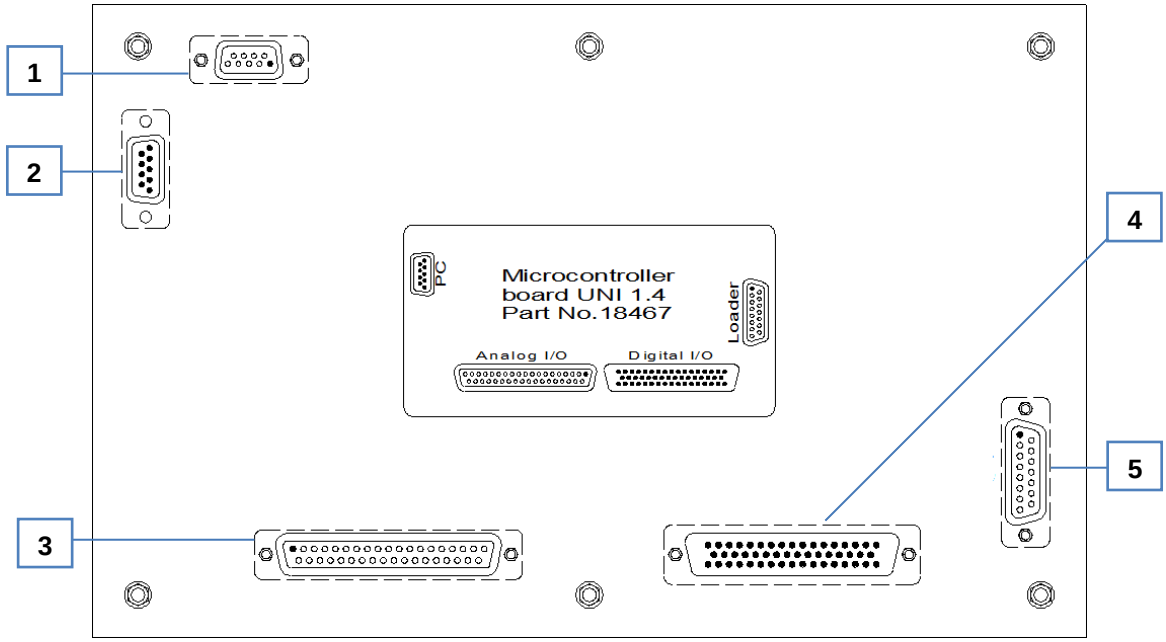


Fig. 6: Data interfaces

1	Spare serial interface
2	PC connection (serial interface (COM-port))
3	Analog input/output signals
4	Digital input/output signals
5	Autoloader connection

When all devices are connected to the mains power, then data connections can be made. The plugs are all different to each other, so that they cannot be interchanged. The required data

cables are included in the boxes of additional peripheral devices supplied with the analyzer. These are adapted to the interfaces when the analyzers are put into operation in our company. The serial interface of the balance is programmed in order to match the required configuration for weight transfer to the PC.
The computer is already provided with an operating system and software for controlling the analyzer.

NOTICE

For information about using the PC for operating the analyzer, refer to the UNI-software help manual.

4.5 Gas connections

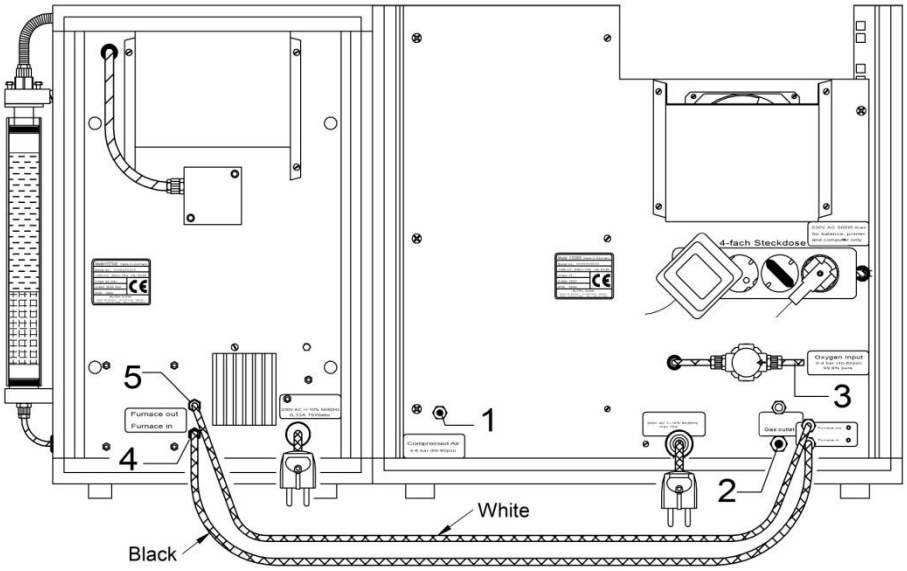


Fig. 7: Gas connections

1	Compressed air (4-6 bar, 60-90psi)
2	Gas outlet
3	Oxygen inlet (2-4 bar, 30-60psi)
4	Resistance furnace inlet
5	Resistance furnace outlet

Four tube connections are necessary for the operation of the analyzer. The required tubes are included in the delivery. See diagram above.

– One tube for Oxygen supply with 5 meters length and fitting.
– One tube for the compressed air with 5 meters length and fitting.
– One black tube of 0.8 meters length for the resistance furnace inlet.
– One white tube of 0.8 meters length for the resistance furnace outlet.

The 5m long tubes are delivered with fittings for pressure regulators with R¼" inner thread as well as the copper gaskets.
The tube (3) connects the analyzer with an oxygen bottle via a pressure regulator. This connection must be very secure, since the operating pressure in the tube is 2 to 4 bar (30 to 60 psi). Gas connection (1) is for the compressed air supply to the pneumatic furnace piston and to the internal cooling of the induction coil. The pressure is 4 to 6 bar (60 t0 90 psi).
Gas connection (2) is for the gas outlet to lead to a vent or hood. It is mostly not used, since only low quantities of CO2 and even lower quantities of SO2 result from the sample combustion.

When the analyzer's mains power switch is set to position 2, a valve opens and the oxygen can flow through the gas flow system. The flow rate is stabilized within a few seconds to 180 l/h and it is displayed on the lower flow meter.

4.6 Resistance furnace-Temperature adjustment

C3.0096

Caution

Eye injury
Hot combustion tube.

– Eye damage.
- **Avoid looking directly into the hot combustion tube. For eye protection use the supplied protective glass.**

W4.0023

WARNUNG

High temperature / Burning of the skin
Hot combustion tube

- **When the analyzer (HTF, resistance furnace) is switched on again after switching off, the adjusted set point is driven immediately. Please check this!**

Depending on the material, the necessary temperature of the resistance furnace may be different. See chapter "Applications – resistance furnace". The procedure of adjusting the resistance furnace temperature is described below.

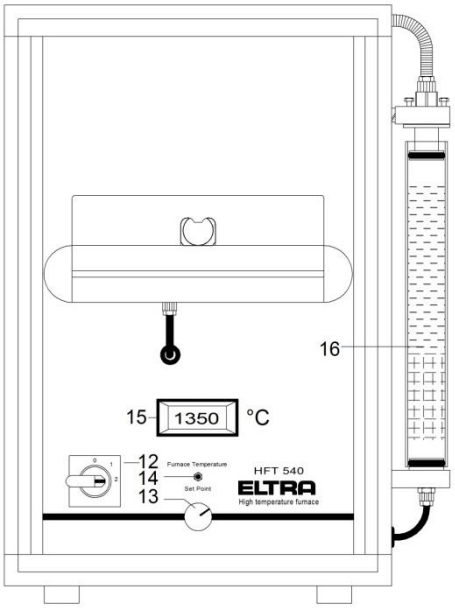


Fig. 8: Resistance furnace-Temperature adjustment

- Set the mains power switch to position 2.
- Set the switch (14) to "Set Point" position.
- Adjust 1350 on the display (15) by turning the potentiometer (13).
- Set the switch (14) to "Furnace temperature" position.
- The display (15) shows now the actual furnace temperature.

- Normal operation temperature for the resistance furnace is 1350°C.

4.7 Gas purification furnance connecting (optional)

CAUTION

C4.0076

Scalding/burns

Hot furnace / combustion tube / analyzer parts

- Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**

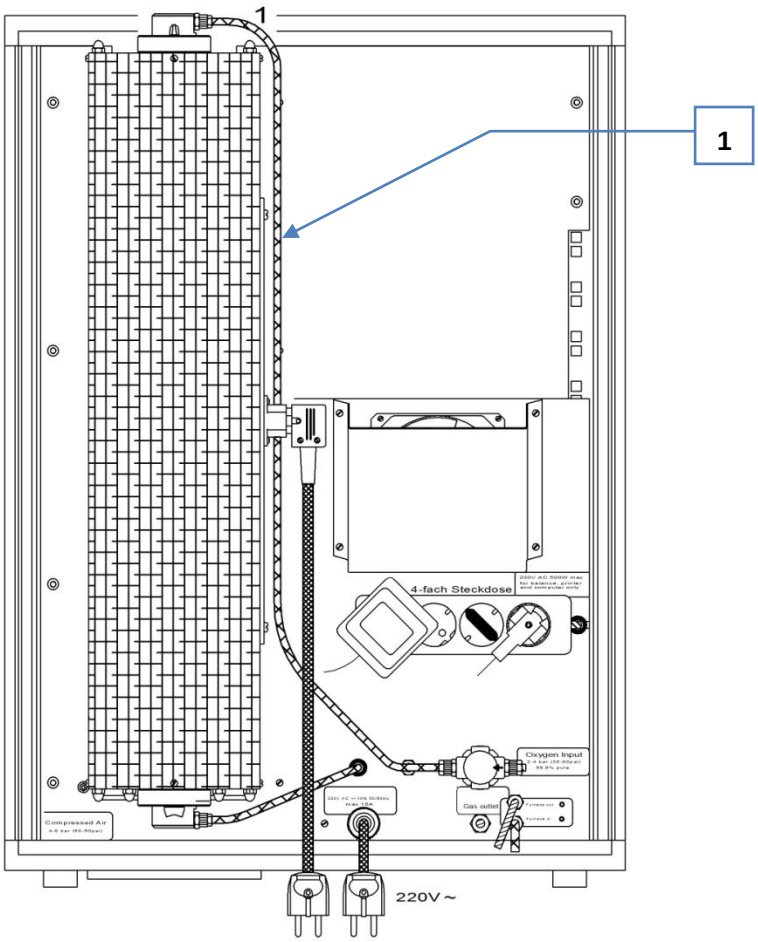


Fig. 9: the gas purification furnace

The tube from the pressure regulator is connected to the lower fitting of the gas purification furnace (optional), and the tube (1) is connected on its place. See above diagram.

4.8 Autoloader (optional)

Fig. 10: Auto loader

The CS-2000 can be supplied with an automatic sample loading system. This loading system may also be retrofitted at a later date. Unlike many other auto loaders, the ELTRA system can accommodate 130 samples giving hours of unattended operation. On request, the loader can be delivered for more crucibles. The auto loader, which does not occupy any additional bench space, is mounted above the area where the balance, PC and consumables are normally placed. The crucibles positions on the loader are easily accessible to the operator even from sitting position. The controlling of the auto loader, including sample weight storage and out of sequence samples, are performed by the same PC controlling the CS-2000. The PC software also includes all features needed. For installing the auto loader, the resistance furnace should be positioned to the left of the analyzer.

For instructions on installing and operating the auto loader read the Loader manual which is delivered with the loader.

5 Analysis

5.1 Working procedure

D1.0006

DANGER

Danger caused by scalding by samples
Sample material

- Damage to the respiratory tracts, skin and/or mucous membranes.
- Radiation damage.
- **The user must himself assess the risk emanating from a sample during the analysis.**

W5.0021

WARNING

Fire hazard / Risk of burns
Hot parts (crucibles, reagents,...) can fall down

- Ignition of tables, floors, or any other surface the hot part falls on
- Ignition of clothes and any other material
- **Set up the analyser in a flame retardant environment. Pay special attention to the table, the floor and any other surface being in the near of the analyzer**
- **Always wear suitable clothing**
- **Keep the work environment clear of all materials that could catch fire**

C5.0093

CAUTION

Hot crucibles

- A hot crucible can cause injuries or damage to property on contact or if it falls down.
- **Adapt the "Post waiting time" so that the crucible can cool down sufficiently.**
- **Take care that no flammable materials are situated below the furnace opening**

C6.0096

Caution

Eye injury
Hot combustion tube.

- Eye damage.
- **Avoid looking directly into the hot combustion tube. For eye protection use the supplied protective glass.**

With the CS-2000 a wide variety of materials can be analyzed. The analysis methods are therefore diverse. As different materials burn differently, the chosen sample weight, the possible accelerators, the procedure for the insertion of the sample into the furnace and, finally, the sensitivity of the infrared cell will be different. The user of the device can receive from us free advice regarding the different methods involved for different materials. We optimize the

sensitivity of the infrared cell for free when the customer sends us samples before shipping the analyzer.

5.1.1 Resistance furnace

The following describes the procedures for coal analysis.
Ensure the following before analyzing:

- The temperature of the analyzer is stable (Power switch at least one to two hours on position 1).
- The moisture trap is checked and if necessary, the magnesium perchlorate is replaced. See chapter “Reagent tubes filling“.
- The incoming oxygen supply has a pressure of 2-4 bar (30 to 60 psi).
- The mains switch is set to setting 2 for at least 10 to 15 minutes.
- The furnace has reached its operating temperature. See chapter ”Resistance furnace temperature Adjustment”.
- The software is started on the connected PC. Please, refer to the “Help” function in the software for all instructions concerned the operation of the software.

A combustion boat is then placed on the balance and, by pressing the TARE button, the weight of the combustion boat is tared. Around 250 mg of coal sample are put into the combustion boat.
Pressing the “F4-Balance” button or simply F4 on the keyboard of the PC, the weight is read from the balance and appears in the “Weight-mg” field above. The transfer function is performed regardless of how often the button is pressed. This enables a correction of any entered false weight value.
The weight which is shown on the screen when the “F5-START” button is pressed, is the weight which is used for calculation of the result for the running sample.
While the analysis is running, the weight of the next sample can already be transferred to the PC. This way, work can be continued without loss of time.
If necessary, after a sample weight transfer, an accelerator can be added. With coal samples, accelerators are normally not necessary. There are samples, however, that contain hard-to-burn components. In such cases, about 500 mg FePO4 is recommended.

Remark

Only the sample weight must be read, under no circumstances the weight of the accelerator.
The combustion boat should be placed on the platform of the furnace. Then the “F5-START” button is pressed. The word “ANALYSIS” will appear on the screen in the status-window of the software indicating the beginning of the analysis cycle. Immediately thereafter, the combustion boat is pushed into the hot area of the furnace. This is done with a metal rod. The rod is pushed into the furnace far enough so that the combustion boat reaches the boat stop. Afterwards, the rod is pulled out of the furnace.
The analysis then runs automatically, so that no more handling is necessary. The infrared cell signals can be observed and followed on the PC screen.
In case of an overflow or when a new, unknown sample is to be analyzed, all ranges should be reactivated. Refer to the “Help” function of the software.
At the end of the analysis, the measurement results appear on the screen and the indication “ANALYSIS” disappears.

- Any overloaded range is automatically deactivated during an analysis.
- Any deactivated range is automatically reactivated after the end of analysis.
- Only manually deactivated ranges remain inactive, until manually reactivated.

Remark

- The sulfur range should be deactivated when only carbon is required. This will avoid undue delay of the analysis caused by sulfur compounds which are difficult to burn, as it is in case of cement analysis. Carbon burns normally quickly. Accelerators are also not necessary.

– In order to make the work easier, two different rods (2/3) are supplied with the analyzer. Make sure that the boat stop (4) is in the right position. See picture below.

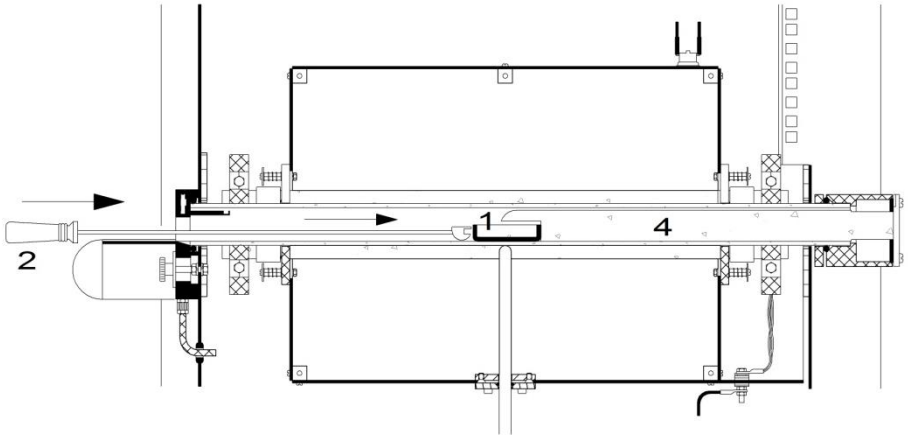


Fig. 11: Pushing the combustion boat into the furnace
With the insertion rod (2) push the combustion boat into the furnace until the stop is felt.

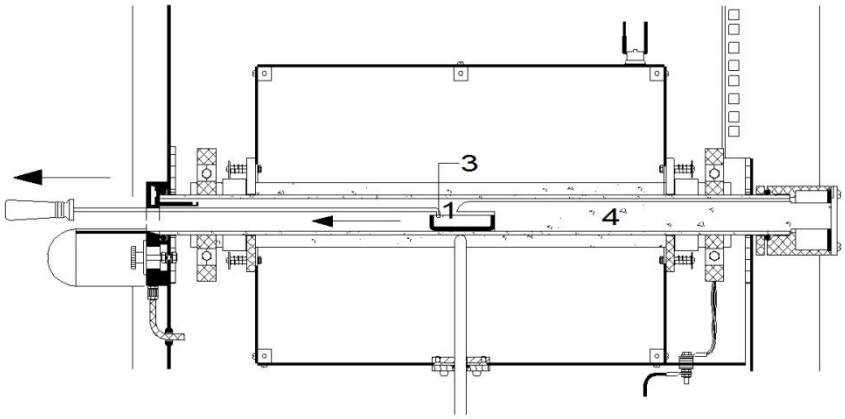


Fig. 12: Combustion boat removing
To remove the combustion boat (1) grab it with the hook (3) and pull it out.
NOTICE
The combustion boat (1) should be removed immediately at the end of the analysis. During removal, the hot combustion boat (1) might burn dust or sample remains in the combustion tube, thereby altering the base line of the infrared system. When the base line is not stable after starting analysis, the following message appears in the status window of the software: “Waiting for stability”.
Only after this message disappears and the message “Analysis” appears in its place, the combustion boat can be entered into the furnace.
Remark
The sample weights are in reasonable range when they are appropriate to the sensitivities of the IR-cells and to the path IR lengths. If not, the analysis condition can be improved by sample weight variation.
Generally, the weight has an optimum size when the peaks on the screen reach the middle of the range, i.e. the peak maximum goes up to 4 to 6 volts.
The sample weight should be reduced when the IR-cell is saturated. However, when the weight is lower than 100 mg, the accuracy will be reduced due to the samples being not perfectly homogenous and due to lower weighing accuracy.
When the samples have high content of volatiles, they should be analyzed like oil. See chapter “Applications“.

5.1.2 Induction furnace

The steel analysis is described in the following section, as an example.
Ensure that the compressed air and oxygen supply are turned on. They should normally not be turned off anyway during working hours. By turning the mains switch to position 3, the heating for the generator tube and the cooling blower are switched on, as well as a valve which allows the oxygen to flow through the analyzer. It is advisable to let the oxygen flow through the analyzer for several minutes before beginning of analysis after a break, so that the temperature inside the analyzer is stabilized. During brief work breaks, therefore, the oxygen is not turned off and the mains switch is left on position 3.
Make sure that the chemicals are in proper condition. See chapter ”Reagent tubes filling”.
A crucible is placed on the balance and tared by pressing the ”TARE” key. 1.5 g tungsten are put into the crucible. Tare the balance again. Put the sample into the crucible. A weight of about 500 mg steel or cast iron is usual. Then the weight is transferred to the PC and can be seen on the screen.
Remark
The crucible must only be picked up with clean crucible tongs and never be handled with fingers!
Remark
Only the sample weight should be transferred to the PC; on no account the weight of the accelerator.
For all instructions on operating the PC software refer to the Help-function of the software.

The crucible is placed on the pedestal and the analysis is started (F5). The furnace closes. “ANALYSIS” appears in the “status” window of the software, indicating that the analysis cycle is running. The analysis now runs by itself, so that nothing more needs to be done manually. The signals from the infrared cells are monitored on the “graphics” window of the software. At the end of analysis the results are shown on the screen.
When an IR range cell is saturated, it is automatically deactivated. In case of two cells for one element, if the low range is saturated, the analyzer changes automatically over to the high range. If high ranges are saturated, a row of asterisks appears on the screen. When the next analysis is started, any overloaded ranges are automatically reactivated.
Remark
The mains switch should not be changed from position 3 while “ANALYSIS” is shown in the status window. If, however, the analysis is mistakenly started while the mains switch is on position 1, the analysis should be interrupted with the “Abort” button. The sample weight must be re-entered, and then the analysis is restarted.
Remark
Note the sample weight before pressing “Abort”, because the sample weight must be entered again manually before starting an analysis after “Abort”. The first analysis after switching from position 1 to position 2 (or 3) should be carried out after about 10 minutes, because the oxygen supply is thereby switched on, purging air and moisture out of the gas flow system.

5.2 Analysis example

The analysis of steel and cast iron is generally carried out with approx. 500mg of sample (normally grains or pieces) by adding 1,5 tungsten accelerator.

5.2.1 Combustion peak

The combustion is quite rapid and the peaks on the PC screen look as follows:

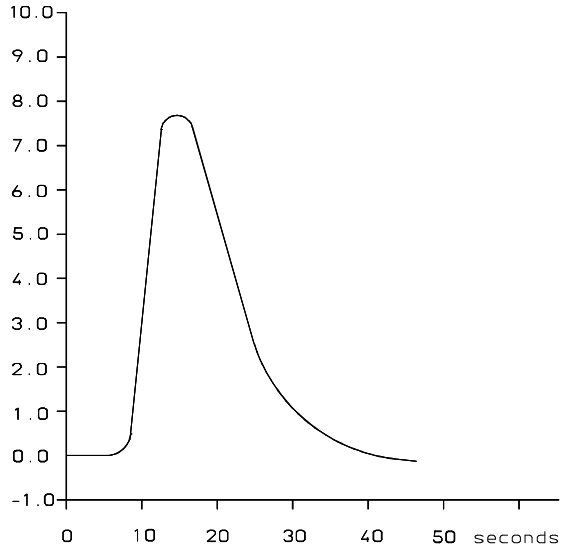


Fig. 13: Combustion peak

5.2.2 Combustion double peak

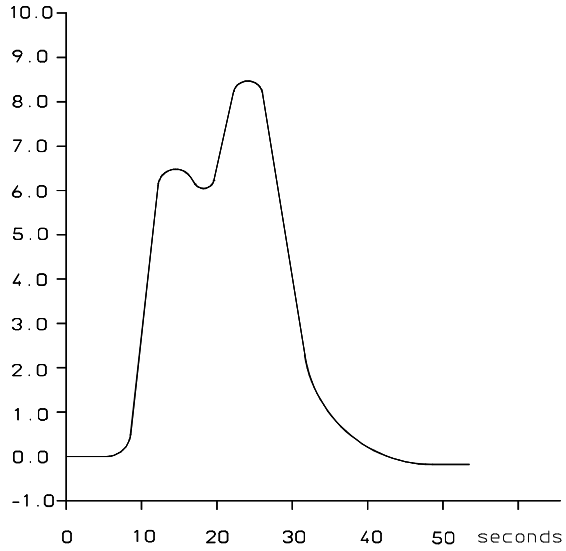


Fig. 14: Combustion double peak

The reason is that either the sample doesn't contain enough iron or the sample is made of metal powder.

In this case take 2g tungsten instead of 1.5g. If the combustion still provides double peaks or there is yellow dust on the inner surface of the crucible after the analysis, take 1g tungsten, 500mg pure Iron accelerator and 500mg sample.

In case of metal analysis the dust trap has to be cleaned and the moisture trap has to be replaced every 100 analyses or at least every two days. See chapter General Information (Maintenance)

The combustion tube doesn't need any cleaning by the operator, due to automatic cleaning after each analysis.

5.3 Work breaks

W6.0023

WARNUNG

High temperature / Burning of the skin
Hot combustion tube

- **When the analyzer (HTF, resistance furnace) is switched on again after switching off, the adjusted set point is driven immediately. Please check this!**

Work breaks, e.g. during lunch breaks, the mains switch remains on position 2. During longer interruptions, e.g. after finishing work for the day, the mains switch is set to position 1 (standby). The analyzer's thermostatic control is then working and no long warm-up time is needed, when re-starting the analyzer. The energy consumption and wear are negligible on standby.
The mains switch is set to pos.2 or pos.3 for about 10-15 minutes before starting the first analysis. Air and any moisture which has entered the analyzer are purged by the oxygen flow. The minor influence which the oxygen flow has on the temperature of the infrared cell is compensated by the thermostatic control. The analyzer is designed for long term use, so that no damage results.
The induction furnace should always be kept closed during work breaks, so that no moisture can enter. Only the resistance furnace remains open when the analyzer is completely switched off. The mains switch is only set to zero for safety reasons, the crucible lift is then at the bottom.

5.4 Crucibles preheating

C7.0096

Caution

Eye injury
Hot combustion tube.

- Eye damage.
- **Avoid looking directly into the hot combustion tube. For eye protection use the supplied protective glass.**

C8.0076

CAUTION

Scalding/burns
Hot furnace / combustion tube / analyzer parts

- Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**

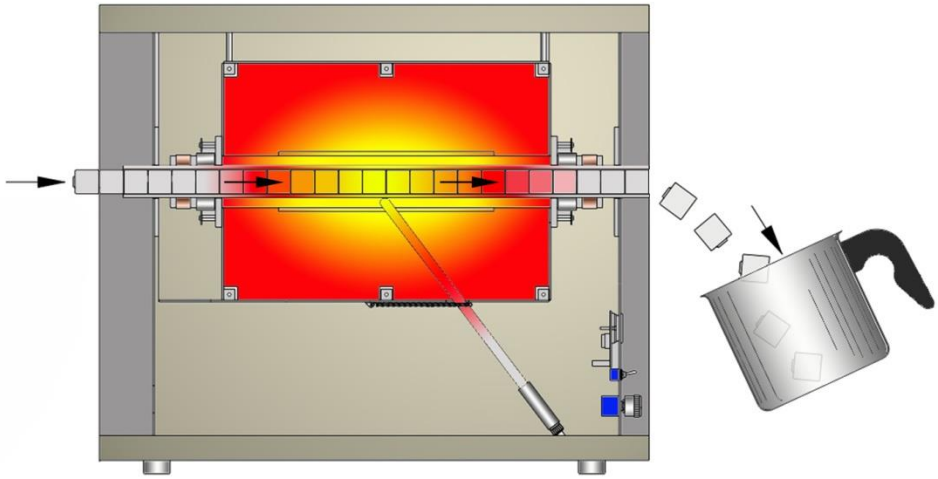


Fig. 15: Crucibles preheating

The above furnace is used for preheating crucibles. It is an optional accessory and can be purchased separately.

When analyzing samples with low concentration of carbon or sulfur (<1000 ppm), the pre-heating of the crucibles is advisable.

The crucibles contain traces of carbon, which can vary from 20 to several hundred ppm, depending on their quality. Additionally, this blank value is not constant; it can be different for different crucibles. These problems, of course affect the accuracy of the analyses, therefore by pre-heating the crucibles, their carbon impurities will be largely eliminated. The remaining blank value therefore, will be very low and it will remain fairly identical for each crucible. This is important for keeping results deviations low.

5.4.1 Operating the pre-heating furnace (optional)

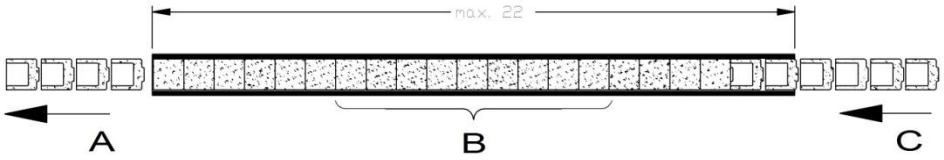


Fig. 16: Operating the pre-heating furnace

NOTICE

Do not move more than 4 crucibles at a time into the furnace. Otherwise the combustion tube may break, due to temperature shock caused by incoming cold crucibles.

Set temperature: 1000°C

After five minutes feed-in the next four crucibles if needed(C).

Up to 22 crucibles fit inside the furnace. (B) is the hot zone inside the furnace.

When entering new crucibles into the furnace for preheating, an equal number of preheated crucibles will fall off the other end (A) of the furnace tube.

5.5 TIC-determination (optional)

WARNING

W7.0022

Burning of the skin, eyes and respiratory system.

Corrosive substances:

- Corrosive substances can cause burning of the skin, eyes and respiratory system.
- **Refer to the material safety data sheet for the substance being used.**
- **Always wear suitable clothing, including protective gloves and eye protection.**

5.5.1 TIC-module

Due to the modular design of the CS-2000, a module for Total Inorganic Carbon (TIC) can be placed between the resistance furnace and the analyzer. For the TIC determination, the sample is treated with acid in the TIC module.
TIC and Total Carbon (TC) can be alternatively analyzed without the necessity of modifying the analyzer.

5.5.2 TIC analysis

The sample is treated with acid in an Erlenmeyer flask inside the TIC-module. The acid decomposes the carbonates in the sample, creating CO2. The oxygen flow purges the CO2 out of the flask through the gas flow system to the infrared detector.

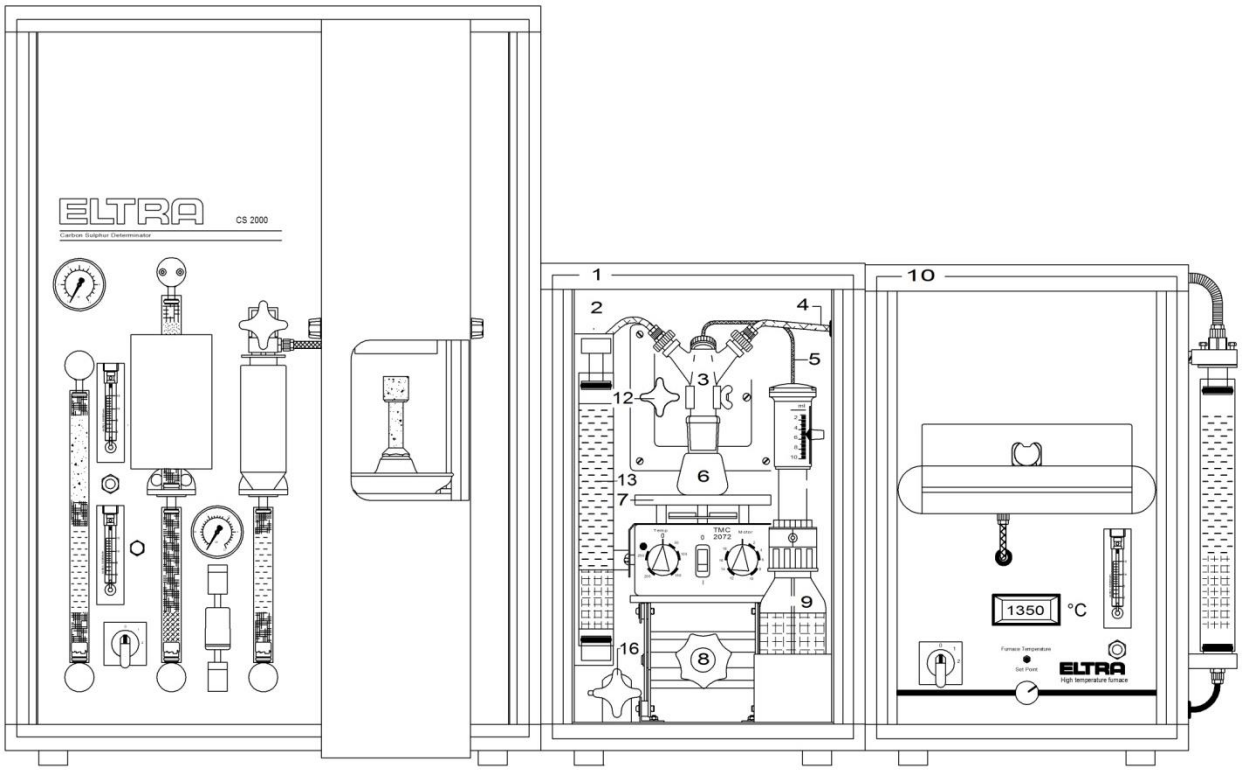


Fig. 17: Installation of TIC-module

1	TIC module
2	Connection to the analyzer

3	Glass distributor
4	Connection to the furnace
5	Acid supply
6	50 ml glass flask
7	Heater with magnetic stirrer
8	Elevator with variable height
9	Acid bottle with dispenser
10	Furnace
11	Analyzer
12	Position adjustment
13	Moisture trap
16	TIC/TC toggle
14	Analyzer inlet (see below :rear view)
15	Furnace outlet (see below :rear view)

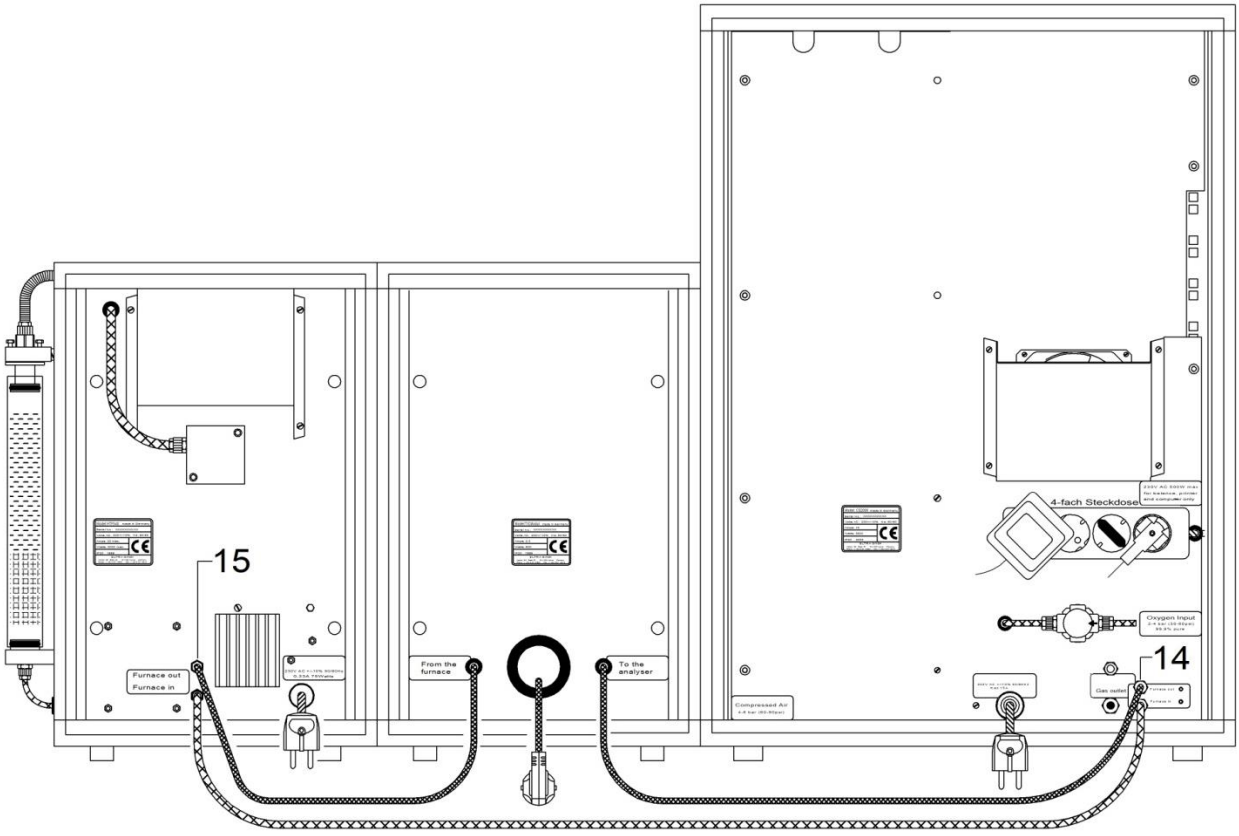


Fig. 18: Installation of TIC-Module-Rear view

1. The TIC module is placed between the furnace and the analyser:
2. The outlet (15) of the furnace is connected to the connection (4) of the glass distributor (3).
3. The outlet (2) of the glass distributor (3) is connected to the upper fitting of the moisture trap (13).
4. The lower fitting of the moisture trap (13) is connected to the analyser inlet (14).
5. The bottle of acid with dispenser (9) is placed to the right of the platform (8) and it is connected to the connection (5) of the glass distributor.
6. The glass distributor (3) with the glass bottle (6) are adjusted so that the whole surface of the bottom of the glass bottle (6) is in touch with the surface of the heater (7).
7. The heater (7) is switched on and the temperature is set at about 75°C (between setting 3 and 4).
8. The stirrer is set to 400.

5.5.3 TIC-module Operation procedure

1. Place the empty glass flask (**6**) on the balance.
2. Press tare.
3. Put the sample into the flask and enter the weight into the analyzer (F4- button). When powder sample sticks in the flask neck, add 2 ml of water (but don't transfer the weight of the water!)
4. Place a magnetic stirrer into the flask and attach the flask to the distributor (**3**).
5. Raise the adjustable platform to support the flask. Check, and if necessary, readjust the flask so that its bottom lies flat on the heated platform.
6. Switch to TIC-mode with the TIC/TC toggle (16).
7. Start analysis (F5 or click START).
8. Inject acid in two or three doses, when the word “Analyzing” appears.
9. When all the CO2 has been released from the sample, the analyzer's signal will return to the baseline level and the analysis will be terminated.
10. Switch to TC-mode with the TIC/TC toggle (16).

NOTICE

The rotary speed of the stirrer should be kept low. The rotary speed and the acid dosing should be done in a way to avoid sample particles being pushed up and stick on the inner glass surface.

The heater must be switched on. Do not allow boiling or evaporation of the solution in the flask!

The table below shows approximate sample weight and acid volume depending on the expected TIC content in the sample.

TIC-content	Sample weight	Acid
>5 %	100 - 200 mg	2×2 ml
1-5 %	200 - 500 mg	3×2 ml
<1 %	1000 - 2000 mg	3×3 ml

Used Acids:

Acetic acid 25% concentration or Phosphoric acid 50% concentration.

NOTICE

Only the carbon of easily decomposable carbonates can be determined. Carbonates which are difficult to decompose cannot be measured. For example, elementary carbon (graphite, soot) and cyanides cannot be analyzed.

5.6 Applications

5.6.1 Induction furnace

LC – low carbon measuring range
HC – high carbon measuring range
LS – low sulphur measuring range
HS – high sulphur measuring range

Material/ Analysis time (s)	Sample + Accelerators	Calibration		Typical results
Aluminium 50s	1.5g ± 0.2g Tungsten 700mg ± 50mg Sample 0.7g ± 0.1g Nickel	**LC**	0.1% C Steel	60ppm C
		HC	2.0% C Steel	3% C
		LS	0.1% S Steel	0.2% S
		HS		
Ash 50s	1.6g ± 0.2g Tungsten 120mg ± 50mg Sample 0.5g ± 0.1g Iron	**LC**	0.1% C Steel	
		HC	2.5% C Steel	3.5% C
		LS	0.1% S Steel	
		HS		
$BaCO_3$ 50s	1.7g ± 0.2g Tungsten 110mg ± 30mg Sample 0.8g ± 0.2g Iron	**LC**		
		HC	6.08% C $BaCO_3$	6.08% C
		LS		
		HS		
$BaSO_4$ 50s	1.0g ± 0.2g Tungsten 200mg ± 100mg Sample 1.0g ± 0.2g Iron	**LC**		
		HC		
		LS		
		HS	13.7 %S $BaSO_4$	13.7% S
Lead pieces 100s Comparator level =1	2.5g ± 0.2g Tungsten 2.0g ± 0.1g Sample	**LC**	0.1% Steel	60ppm C
		HC		
		LS	0.1% S Steel	100ppm S
		HS		
Lead powder 100s Comparator level =1	2.5g ± 0.2g Tungsten 800mg ± 100g Sample	**LC**	0.1% Steel	60ppm C
		HC		
		LS	0.1% S Steel	100ppm S
		HS		
Soil 60s	1.8g ± 0.2g Tungsten 250mg ± 50mg Sample 0.7g ± 0.1g Iron	**LC**	0.048% C Steel	0.03% C
		HC	1.03% C Steel	3.0% C
		LS	0.13% S Cast iron	1.0% S
		HS	0.336% S Steel	2.0% S
$CaCO_3$ 50s	1.7g ± 0.2g Tungsten 110mg ± 30mg Sample 0.8g ± 0.2g Iron	**LC**		
		HC	12% C $CaCO_3$	12% C
		LS		
		HS		
CaO 60s	1.7g ± 0.1g Tungsten 370mg ± 20mg Sample 0.8g ± 0.1g Iron	**LC**	0.048% C Steel	
		HC	1.33% C Steel	0.192% C
		LS	0.13% S Cast iron	0.017% S
		HS	0.336% S Steel	
Cast iron 50s	1.2g ± 0.2g Tungsten 400mg ± 100mg Sample	**LC**		
		HC	1.33% C Steel	0.192% C

	0.3g ± 0.1g Iron	**LS**	3.0% S Cast iron	0.017% S
		HS	0.1% S Cast iron	
Ceramics 60s	2.2g ± 0.2g Tungsten 150mg ± 50mg Sample 0.7g ± 0.1g Iron	**LC**		
		HC	12% C $CaCO_3$	5.98% C
		LS	0.103% S	
		HS	0.336% S Cast iron	2.57% S
Cement 60s	0.8g ± 0.1g Tungsten 200mg ± 50mg Sample 0.8g ± 0.1g iron	**LC**		
		HC	12% C $CaCO_3$	
		LS		
		HS	13.7% S $BaSO_4$	
Cement 60s	200mg ± 50mg Sample 1.1g ± 0.1g Iron	**LC**	1% C Cement	
		HC	2% C Cement	
		LS	1% S Cement	
		HS		
Chrome 70s	1.5g ± 0.2g Tungsten 200mg ± 50mg Sample 0.8g ± 0.1g Iron	**LC**	0.048% C Steel	0.003% C
		HC	1.33% C Cast iron	
		LS	0.13% S Cast iron	0.001 %
		HS		
Chrome oxide 50s	1.5 ± 0.2g Tungsten 220mg ± 50mg Sample 0.6g ± 0.1g Iron	**LC**	0.1% C Steel	0.02% C
		HC		
		LS	0.1% S	0.025% S
		HS		
Limestone 60s	1.8 ± 0.1g Tungsten 250mg ± 50mg Sample 0.8g ± 0.1g Iron	**LC**	0.048% C Steel	
		HC	1.3% C Steel	1.5% C
		LS	0.13% S	0.11% S
		HS		
Cobalt 50s	1.8 ± 0.2g Tungsten 350mg ± 50mg Sample 0.3g ± 0.1g Iron	**LC**	0.048% C Steel	
		HC	1.3% C Steel	1.5% C
		LS	0.13% S	0.11% S
		HS		
Coal and coke 50s	1.5 ± 0.2g Tungsten 50mg ± 10mg Sample 0.5g ± 0.1g Iron	**LC**		
		HC	3.0% C Cast ironl	70% C
		LS	0.1% S Steel	5% S
		HS		
Copper swarfs Min. 60s Max. 90s Power: 4,5V Comp.level: 30mV	5g Sample	**LC**		
		HC		
		LS	15ppm S Copper	10ppm S
		HS		
Copper pin Min 60s Max. 90s Power: 4,5V Comp.level: 30mV	2.0g ± 0.2g Tungsten 1.0g - 2.0g Sample 0.1g ± 0.01g Iron	**LC**		
		HC		
		LS	0.1% S Steel	10ppm S
		HS		
Copper pieces Min. 60s Max. 90s Power: 4,5V Comp.level: 30mV	5g Sample (max. 1g/piece)	**LC**		
		HC		
		LS	0,1% S Steel	10ppm S
		HS		

Cu-Ni 50s	2.0g ± 0.2g Tungsten 0.7g ± 0.1g Sample	**LC**	0.048% C Steel	0.036% C
		HC	1.03% C Steel	
		LS	0.1% S Steel	40ppm S
		HS		
Nickel 50s	2.0g ± 0.2g Tungsten 0.8g ± 0.1g Sample 0.8g ± 0.1g Iron	**LC**	0.048% C Steel	
		HC	1.03% C Steel	
		LS	0.1% S Steel	17ppm S
		HS		
Fe-Cr 50s	2.5g ± 0.2g Tungsten 450mg ± 50mg Sample 0.2g ± 0.1g Iron	**LC**	0.1% C Steel	0.2% C
		HC	1.03% C Steel	6% C
		LS	0.1% S Steel	0.3% S
		HS		
Fe-Mn Fe-Mo 50s	1.5g ± 0.2g Tungsten 250mg ± 50mg Sample 0.4g ± 0.1g Iron	**LC**	0.1% C Steel	0.2% C
		HC	3.0% C Cast iron	6% C
		LS	0.1% S Steel	0.3% S
		HS		
Fe-Ni 50s	1.7g ± 0.2g Tungsten 700mg ± 100mg Sample	**LC**	0.1% C Steel	0.2% C
		HC	3.0% C Cast iron	6% C
		LS	0.1% S Steel	0.3% S
		HS		
Fe-Si 50s	1.5g ± 0.2g Tungsten 250mg ± 50mg Sample 0.9g ± 0.1g Iron	**LC**	0.1% C Steel	0.2% C
		HC	3.0% C Cast iron	6.0% C
		LS	0.1% S Steel	0.3% S
		HS		
Fly ash 60s	2.2g ± 0.1g Tungsten 100mg ± 20mg Sample 0.3g ± 0.05g Iron	**LC**	0.048% C Steel	
		HC	6.08% C $BaCO_3$	10% C
		LS	0.13% S Cast iron	0.3% S
		HS		
Gypsum 60s	0.8g ± 0.1g Tungsten 200mg ± 50mg Sample 0.8g ± 0.1g Iron	**LC**		
		HC	12% C $CaCO_3$	
		LS		
		HS	13.7% S $BaSO_4$	18% S
Ores 60s	1.0g ± 0.2g Tungsten 130mg ± 30mg Sample 1.0g ± 0.2g Iron	**LC**		
		HC	12% C $CaCO_3$	10% C
		LS	0.1% S Steel	≈3% S
		HS	13.7% S $BaSO_4$	30% S
Iron ores 60s	2.0g ± 0.2g Tungsten 250mg ± 50mg Sample 0.5g ± 0.1g Iron	**LC**		
		HC	12% C $CaCO_3$	10% C
		LS	0.1% S Steel	≈3% S
		HS	13.7% S $BaSO_4$	30% S
Rock sample 60s	2.2g ± 0.2g Tungsten 150mg ± 50mg Sample 0.7g ± 0.1g Iron	**LC**		
		HC	12% C $CaCO_3$	5.98% C
		LS	0.103% S Steel	
		HS	0.336% S Steel	2.57% S
Rubber 60s	1.5g ± 0.2g Tungsten 40mg ± 10mg Sample 0.5g ± 0.1g Iron	**LC**		
		HC	3.0% C Cast iron	60% C
		LS	0.1% S Steel	1.9% S
		HS		

Silicon 60s	1.7g ± 0.2g Tungsten 80mg ± 20mg Sample 0.4g ± 0.1g Iron	**LC**		
		HC	12% C $CaCO_3$	
		LS	0.1% S Steel	0.02% S
		HS		
Silicon Carbide 70s	2.0g ± 0.2g Tungsten 60mg ± 10mg Sample 0.7g ± 0.1g Iron	**LC**		
		HC	12% C $CaCO_3$	30% C
		LS	0.1% S Steel	0.02% S
		HS		
Slag 60s	1.0g ± 0.2g Tungsten 500mg ± 100mg Sample 1.0g ± 0.2g Iron	**LC**	0.1% C Steel	
		HC	2.0% C Cast iron	
		LS	0.1% S Steel	0.8% S
		HS		
Steel 50s	1.5g ± 0.2g Tungsten 500mg ± 100mg Sample	**LC**	0.1% C Steel	0.1% C
		HC	3.0% C Cast iron	6% C
		LS	0.1% S Steel	0.3% S
		HS		
Titanium 50s	1.4g ± 0.2g Tungsten 500mg ± 100mg Sample 0.6g ± 0.1g Iron	**LC**	0.1 %C Steel	0.016% C
		HC		
		LS	0.1% S Steel	10ppm S
		HS		
Titanium oxide 60s	2.2g ± 0.2g Tungsten 300mg ± 50mg Sample 0.6g ± 0.1g Iron	**LC**	0.048% C Steel	
		HC		
		LS	0.013% S Cast iron	23ppm S
		HS		
Titanium oxide 60s	2.0g ± 0.2g Tungsten 220mg ± 20mg Sample	**LC**	0.048% C Steel	0.230% C
		HC		
		LS		
		HS		
Tungsten carbide 70s	1.7g ± 0.2g Tungsten 200mg ± 50mg Sample 0.6g ± 0.1g Iron	**LC**		
		HC	6.14% C WC	6.14% C
		LS		
		HS		
Uranium 50s	1.0g ± 0.1g Tungsten 800mg ± 100mg Sample 0.5g ± 0.1g Iron	**LC**	0.1% C Steel	0.50% C
		HC		
		LS	0.1% S Steel	0.07% S
		HS		

5.6.2 Resistance furnace

C9.0096

Caution

Eye injury
Hot combustion tube.

– Eye damage.
- **Avoid looking directly into the hot combustion tube. For eye protection use the supplied protective glass.**

5.6.2.1 Coal analysis

Furnace temperature: 1350°C.
Sample weight around 300mg, depending on the sensitivity of the analyzer and on the C and S content of the sample. The sample weight should not be higher than 500mg. The sample should be put into the front part of the combustion boat. Press “START” and push the combustion boat directly into the hot zone up to the boat stop. Usually, no accelerators are needed. Only in exceptional cases, when the sample contains pyrites, the furnace temperature has to be set at 1500°C or approx. 300mg iron phosphate have to be spread upon the sample.
There are two different types of combustion boats available:

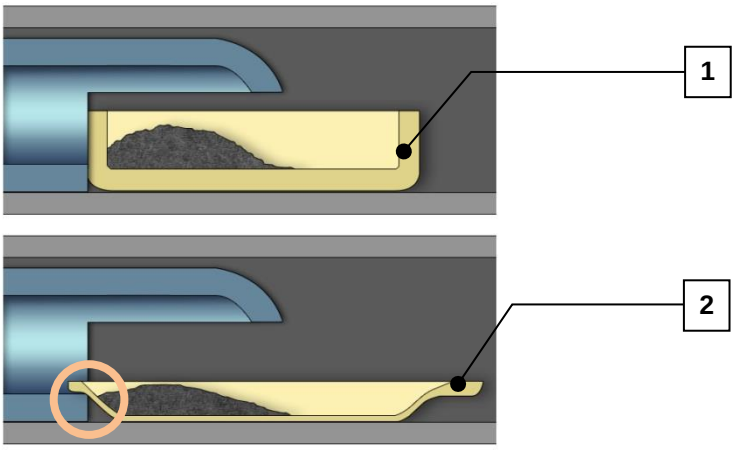


Fig. 19: Combustion boat types
Due to the front shape of the combustion boat type 2, it should be carefully pushed up to the boat stop, otherwise it may slide into the boat stop. Stop pushing as soon as the boat stop is reached.
– The combustion boat (1) is reusable (10, 20, 30 analyses or more).
– The combustion boat (2) can only be used once.

5.6.2.2 Oil, plastics, asphalt and rubber analysis

For fuel oil and other thick oils, the sample weight is approx. 80mg.
The sample weight should never exceed 100mg.
For thin oil analysis, the sample weight should not be higher than 50mg.
For plastics take sample weights between 50 and 100 mg.

- Adjust the furnace temperature to 1450 °C.
- Weigh the sample of the above mentioned materials, 50 to 100mg.
- Transfer the weight to the PC.
- Start analysis (F5).
- Insert the boat very slowly up to the beginning of the hot zone.
- When you hear the noise of the ignition, stop pushing and put a marker on the insertion rod, at the beginning of the furnace platform where the boats are placed on.

Remark

The marker can be a piece of tape wrapped around the rod. Check the right position of the marker by pushing another sample up to the level of the marker. The marker is at the correct position when the sample takes 3 to 5 seconds to ignite after stop pushing. Otherwise repeat and check again.

Once the marker is at the correct position, all samples of the same kind of material are inserted into the furnace up to the point shown by the marker on the rod and left there for analysis. This position corresponds to an area just before the hot zone. The sample then ignites in about 3 to 5 seconds. The signals of the IR-cell go up. They can be observed on the computer screen. When the signals are moving down and have reached about 25% of their maximum peaks, push the combustion boat up to the boat stop to reach the middle of the hot zone, to completely burn any rest of the sample.

NOTICE

It is very important to run the analysis this way!

Never push such kinds of samples immediately into the hot zone.

Some fumes may leave the hot zone without being completely burned. They may contaminate the gas flow system, including the infrared cell.

Some users push the sample “slowly” into the furnace up to the hot zone. This is wrong. The sample must stay at the ignition point and after the peak comes down to a low level, then the boat should be pushed into the hot zone.

5.6.2.3 Ash analysis

- Adjust the furnace temperature to 1450 °C.
- Take 200 mg sample weight. The weight can also be much higher, depending on the C and S concentrations and on the sensitivity of the IR-cells.
- After starting the analysis, push the sample up to the middle of the hot zone, resp. up to the boat stop.

Ash content determination:

Close the adjustable flow restrictor (on the resistance furnace front panel, below the flow meter). Turn it clockwise up to the end. Adjust the furnace temperature between 790 °C and 800 °C. Take about 1g sample in a quartz boat. Insert the sample into the furnace, just at the beginning of the hot zone. Leave the sample for one minute. Push the sample into the hot zone and leave it there for 6-7 minutes.

After combustion, remove the sample. After cooling down, weigh the sample again. This is the weight of the remaining ash.

The percentage of ash contents is calculated as follows:

$$C[\%] = \frac{W_{after}}{W_{before}} \cdot 100$$

Where:

– C: ash contents in the sample;
– W after: sample weight after combustion;
– W before: sample weight before combustion;

C and S determination :

For sulfur and carbon analysis, readjust the flow restrictor until the lower flow meter of the resistance furnace shows 200 l/h. Ensure that the moisture absorber is dry, replace if necessary, even if the signals of the infrared cells are ignored when determining ash. The gases passing through the IR-cells have to be dry in any case.

5.6.2.4 Graphite analysis

- Analyzers with a range of 100% C can be calibrated with graphite.
- Any furnace temperature over 1000 °C is sufficient.
- Sample weight approx. 400 mg.
- The boat is pushed directly into the hot zone up to the boat stop.

5.6.2.5 Calcium carbonate analysis

- This material can be used for calibration in the range of 12% C.
- Depending on the sensitivity of the IR-cell, the weight can be between 100mg and 500mg.
- Any furnace temperature over 800 °C is sufficient.
- The sample is directly pushed up to the boat stop.

5.6.2.6 Limestone analysis

- Furnace temperature 1250 °C or higher.
- Calibrate with calcium carbonate (12% C).
- The usual sample weight is 500mg.
- Push directly into the hot zone up to the boat stop.

5.6.2.7 Cement analysis

If only carbon determination is required, deactivate the sulfur range.

- The sample weight is between 200mg and 500mg, depending on the C-concentration and on the sensitivity of the IR-cell. Adjust the furnace temperature at 1250 °C.
- Enter the sample directly into the hot zone up to the boat stop.
- For sulfur analysis in cement we recommend to use the induction furnace.

5.6.2.8 Gypsum and desulfurization products (from power plants) analysis

Carbon determination

For carbon determination only, deactivate the sulfur range(s).

- Adjust the furnace temperature to 1250 °C.
- Take 300 to 1000mg sample weight, depending on the C content and the sensitivity of the IR-cell. Enter the boat directly up to the boat stop.

Sulfur determination

- Take nitrogen as carrier gas (instead of oxygen).
- Adjust the furnace temperature at 1450 °C.
- Take 30 to 50mg sample weight. Add 500mg iron phosphate.
- Enter the sample directly into the hot zone up to the boat stop. The calibration can be done with pure gypsum 18,6 % S.

Wood analysis

- Use the big ceramic boats (58 x 22 x 14 mm).
- Adjust the furnace temperature to 1300 °C.
- Take 350 mg of sample.
- Set the minimum analysis time to 50 s.
- Set the comparator level to 20mV.

5.6.2.9 Low Carbon Analysis

The IR-path of the low carbon range is usually 100mm. The maximum possible length is 320mm. Even though with 100mm IR-path a sample of 50ppm can give reasonable results and good carbon peaks. This shows that the CS-2000 is capable to analyze even much lower carbon values when the path length is 15 times longer! Please note that it is not a problem to

make the CS-2000 very sensitive in carbon. The limits are set by the air entering the resistance furnace and by the blanks of the boats. Good results can be obtained by using quartz boats. There is no chance to measure in this low range if you use ceramic boats. Their blanks and their deviations are huge compared to the sample's carbon.
Even without using any low carbon attachment for preventing the air from entering the furnace, it is possible to obtain acceptable results in the 50ppm range.
A PC should be connected so that the base line and the peaks of combustion can be seen. First thing to do is to check the base line. The blank value should be set to zero and the analyzer should be calibrated with a higher sample so that the calibration factor is at least in a correct range.
Enter manually a usual sample weight taken for low carbon analysis, i.e. about 1000mg. Start the analysis cycle without entering sample or boat into the furnace. Repeat this 3 to 5 times. This way you know what is the reading caused by the air entering the furnace as well as by the base line drift and noise. So, when you run analyses later on, any higher value comes from sample and boat.
Of course the boats themselves can also be tested without sample: Enter manually 1000mg, press START and enter empty boats. The difference of the results to those without boat, give evidence about the blanks of the boats. These blanks and their deviations must be much lower than the expected sample results and much lower than the expected sample deviations, otherwise an analysis doesn't make any sense.
For even lower carbon samples, a low carbon attachment needs to be attached to the resistance furnace inlet. See following graphic.
The reason is that the thick short combustion tube allows some air to enter the combustion area. The air contains some CO2 which is detected by the carbon cell. As the CO2 concentration resp. the air flow entering the furnace is not necessarily constant, the varying CO2 of the air will lead to a corresponding variations of the base line. Using high carbon analysis in % range, resp. for high carbon IR-cells, the CO2 of the entering air, practically doesn't have any influence on the results. For low carbon analysis, with sensitive CO2 cells, the entrance of the resistance furnace has to be restricted in order to have less air entering the furnace.
The combustion boats that are used are the slim quartz boats. They have to be used, not only because the bigger ceramic boats can't pass through the restriction attachment, but also because the quartz boats have much lower blanks than the ceramic boats.
Even if the ceramic boats were able to pass through the attachment, they couldn't be used for low carbon analysis anyway, because of their high carbon blanks.

Operation procedure:

1. Check the base line. (The blank value should be set to zero and the analyzer should be calibrated with a higher sample so that the calibration factor is at least in a correct range.)
2. Enter manually a usual sample weight taken for low carbon analysis, i.e. about 500mg.
3. Start the analysis cycle without entering sample or boat into the furnace.
4. Repeat this 3 to 5 times. This way you know which influence is caused by the air entering the furnace as well as by the base line drift and noise. So, when you run analyses later on, any higher value comes from the sample and boat.

Of course the boats themselves can also be tested without sample:

1. Enter manually 500mg.
2. Press START.
3. Enter an empty boat.

The difference of the results to those without boat gives evidence about the blanks of the boats. These blanks and their deviations must be much lower than the expected sample results and much lower than the expected sample deviations, otherwise an analysis doesn't make any sense.

For even lower carbon samples, a furnace extension piece, supplied by ELTRA, needs to be attached to the furnace inlet.
The reason is that the thick short combustion tube allows some air to enter the combustion area. The air contains CO2 which is detected by the carbon cell. As the CO2 concentration resp. the air flow entering the furnace is not necessarily constant, the varying CO2 of the air leads to corresponding variations of the base line. For low carbon analysis, with sensitive CO2 cells, the entrance of the resistance furnace has to be restricted.
Using high carbon analysis in % range, resp. for high carbon IR-cells, the CO2 of the entering air, practically doesn't have any influence on the results.
The combustion boats that are used are the slim quartz boats. They have to be used, not only because the bigger ceramic boats cannot pass through the restricting attachment, but also because the quartz boats have much lower blanks than the ceramic boats.
Even if the ceramic boats were able to pass through the attachment, they couldn't be used for low carbon analysis anyway, because of their relatively high carbon blanks.
Installing the low carbon attachment:

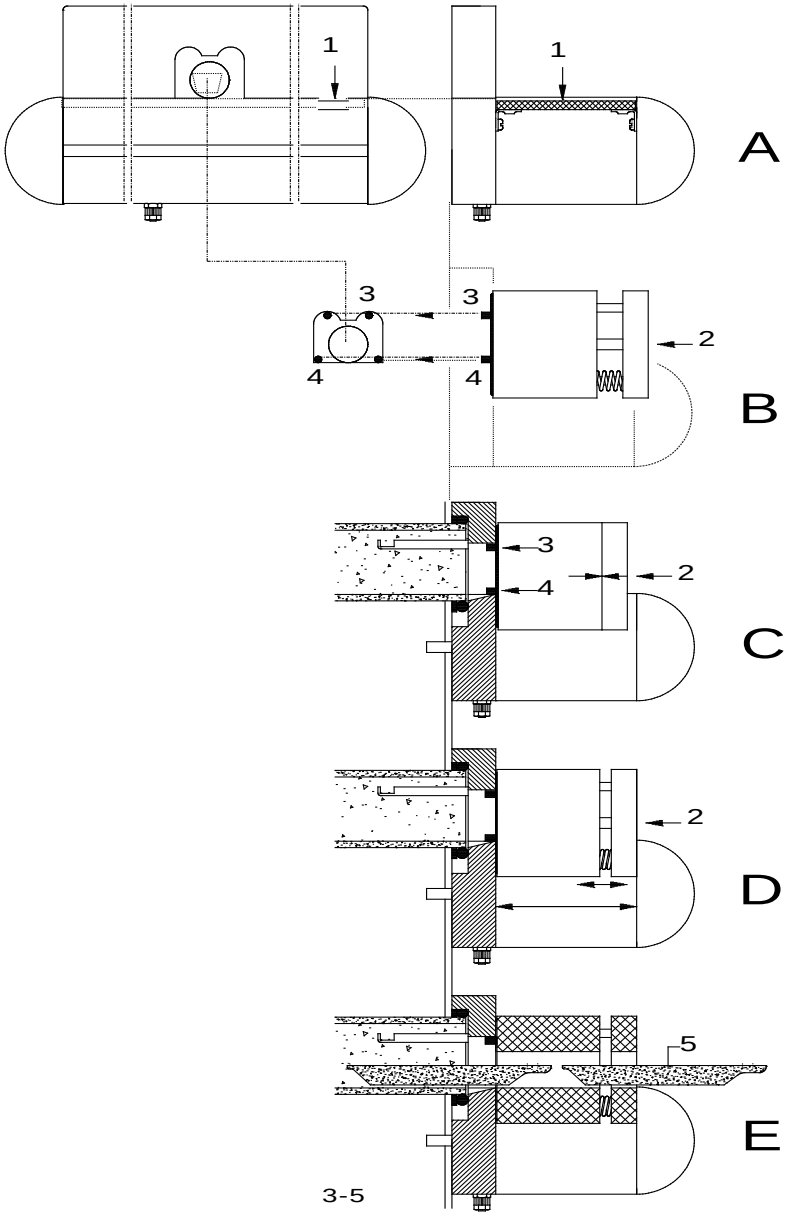


Fig. 20: Installation of low carbon attachment

1. Lift and remove the glass platform (**1**) from the furnace inlet. Make sure that the two hexagon socket screws (**2**) of the low carbon attachment are turned clockwise up to the end. Use 4mm socket wrench.
2. Attach the device to the furnace inlet, so that the pins (**3**) and (**4**) fit into the furnace inlet.
3. Loosen the two screws (**2**) until the front ring holds the device firmly in place.
4. The combustion boat (**5**) can now be moved in and out the furnace.

6 Maintenance

CAUTION V0074

Scalding/burns
Hot furnace / combustion tube / analyzer parts

– Parts of the analyzer can be very hot.
- C**heck the furnace temperature in the software.**
- **For maintenance the furnace temperature has to be less than 40°C.**

WARNUNG W8.0023

High temperature / Burning of the skin
Hot combustion tube

- **When the analyzer (HTF, resistance furnace) is switched on again after switching off, the adjusted set point is driven immediately. Please check this!**

6.1 General information

6.1.1 Resistance furnace operation

Maintenance every 25 to 40 analyses:

- Replace the magnesium perchlorate of the moisture trap of the resistance furnace. To save material, replace first the upper half. The next time replace the whole quantity. See chapter “Filling the reagent tubes”. It is not necessary to replace the glass wool, unless it is penetrated by dust and particles from the magnesium perchlorate.

Remark
The above is related to coal analyses.

6.1.2 Induction furnace operation

The maintenance example mentioned below is related to steel analyses and oxygen 99.5% pure.

Maintenance every 100 analyses:
Or at least once a month

- Replace the magnesium perchlorate after the metal filter. See chapter Reagent tubes filling
- Brush the metal filter. See chapter dust trap cleaning.

Maintenance every 500 analyses:

- Clean the metal filter in an ultrasonic cleaner. See chapter dust trap cleaning

Maintenance every 1000 analyses:
Or if 1/3 of the material turned grey

- Replace the paper filters.
- Replace the magnesium perchlorate of both glass tubes. See chapter Reagent tubes filling
- Replace the sodium hydroxide. See chapter Reagent tubes filling

Maintenance every 2000 analyses:

- Replace the copper oxide in the catalyst furnace. See chapter Reagent tubes filling
- Replace the furnace cleaning brush. See chapter furnace cleaning brush-replacing

- Replace the cotton wool. It should be replaced earlier when the upper half becomes dark. See chapter Reagent tubes filling

NOTICE

The above is related to steel analyses and oxygen 99.5% pure.

NOTICE

There are especially developed chemical qualities and accelerators for analytical instruments.

– Magnesium perchlorate (Anhydrone), Sodium hydroxide (ascarite) and iron phosphate, among others. Normal commercially available materials of this type either fall short or they are entirely useless for this purpose.
– Normal magnesium perchlorate, for example, causes memory effects causing non repeatable results. A further typical effect is that the analysis takes too long and often never comes to an end. This effect also occurs with magnesium perchlorate of suitable quality after been saturated.
– Normal sodium hydroxide binds CO2 quite inadequately at room temperature. The special quality, on the other hand, reacts quite well at room temperature and has at the same time an indicator (grey coloration when saturated).
– The glass tubes and the O-rings should only be greased with high vacuum grease. Ordinary silicon grease is inadequate.
– It is up to the user to test common materials. The analyzer will not be damaged. When however problems appear, proper quality materials should be used which are in absolutely unsaturated condition, before technical service is called.
– The chemical flasks must be immediately and quite securely closed, so that they are not saturated with CO2 or moisture from the environmental air.

6.2 Reagent tubes – removing and installing

CAUTION

C10.0076

Scalding/burns

Hot furnace / combustion tube / analyzer parts

– Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**

CAUTION

V0062

Injuries in the form of cuts and other personal injuries

Danger from glass splitters

– Injuries in the form of cuts can be caused by damaged sample flasks and glass splitters.
- **Replace damaged sample flasks**
- Do not touch glass splitters with your hands.

CAUTION

C11.0081

Danger of bursting

– Defective reagent tubes may cause injuries in the form of cuts and other personal injuries.
- **Before installing the new reagent tubes, check if they are damaged.**

- **Wear protective gloves and safety glasses when installing/removing the reagent tubes.**

C12.0090

CAUTION

Risk of injury to eyes
Chemicals

- When changing the chemicals, the smallest particles of chemicals may be suspended in the air and cause damage to eyes.
- **Always wear protective goggles when working with chemicals.**
- **Please heed the safety data sheets for the chemicals used.**

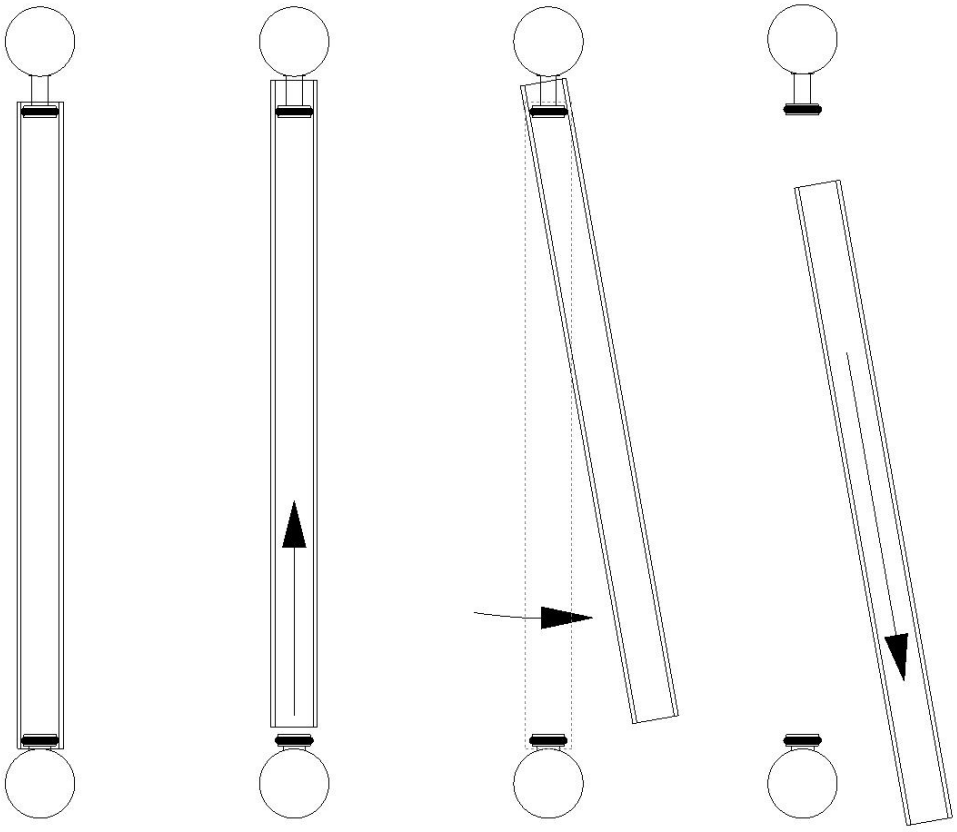


Fig. 21: Reagent tubes installing and removing I
The reagent tubes are first lifted then swung to one side, detached diagonally downwards and emptied.

NOTICE

The dimensions for filling the glass tubes given in the schematic of the chapter Reagent tubes filling should be respected in all cases.
When, for example, there is not enough quartz wool in the bottom of the glass tube, it is possible that dust from magnesium perchlorate can fall through blocking the fitting below causing corrosion along the gas flow system.

NOTICE

Before the reagent tubes are fitted, both, the O-rings and the inner ends of the tubes are lubricated with high vacuum silicon grease.

The copper oxide of the catalyst furnace is replaced after about 2000 analyses. See chapter Reagent tubes filling
It is safer, but not absolutely essential, to switch off the analyzer.
The components are refitted in reverse order.

NOTICE

Only the outside grid of the furnace is to be handled; the quartz reagent tube must only be held at the ends.

CAUTION

V0076

Scalding/burns
Hot furnace / combustion tube / analyzer parts
– Parts of the analyzer can be very hot.
• **Use heat protecting gloves.**

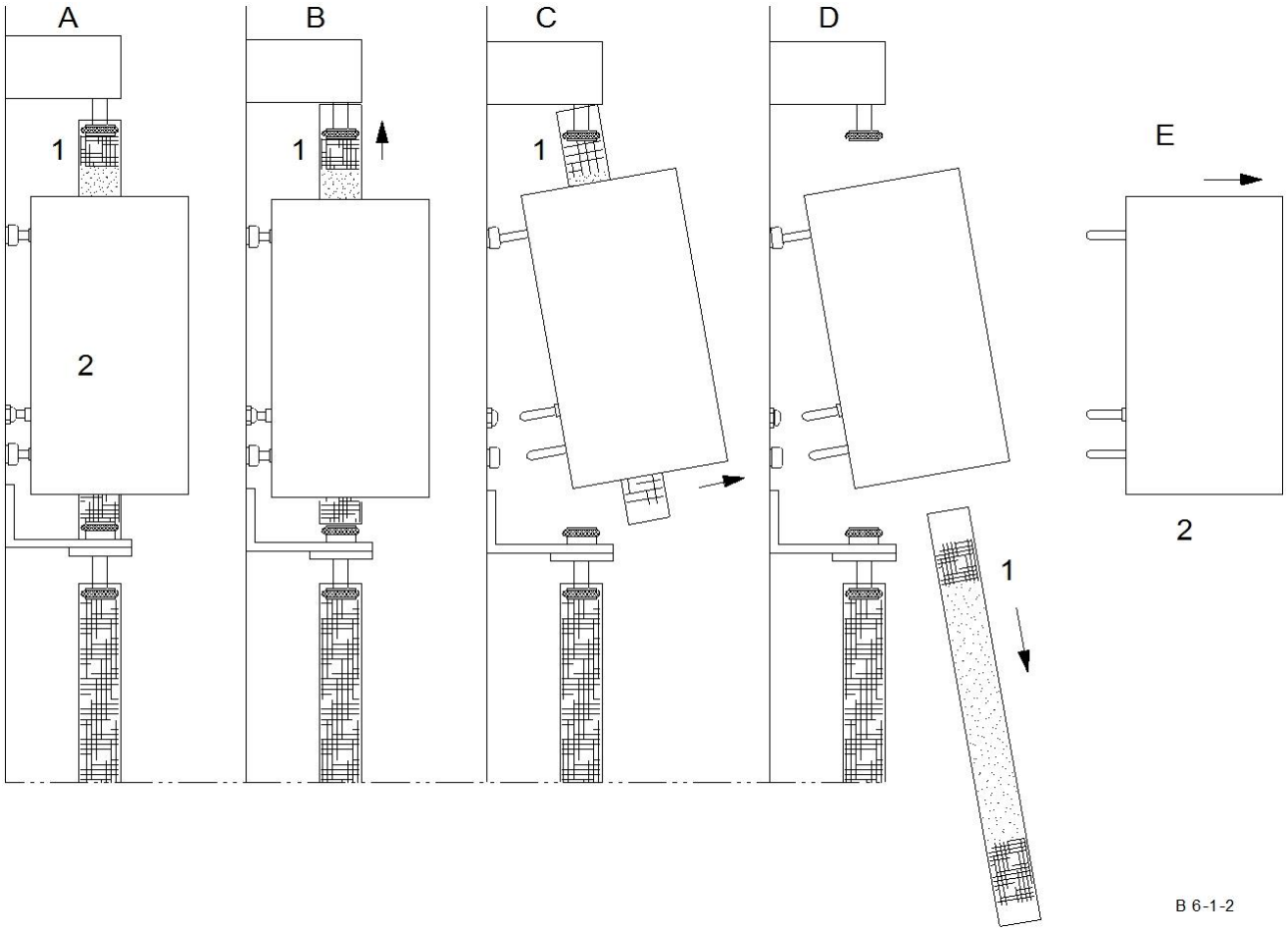


Fig. 22: Reagent tubes installing and removing II

A: Normal position during operation.
B: The quartz tube (1) of the furnace (2) is raised as far as possible.
C: It is then swung out together with the furnace (2).
D: The quartz tube (1) is pulled downwards at an angle.
E: The furnace (2) is removed.

After replacing the copper oxide, the removed components are refitted in reverse order.

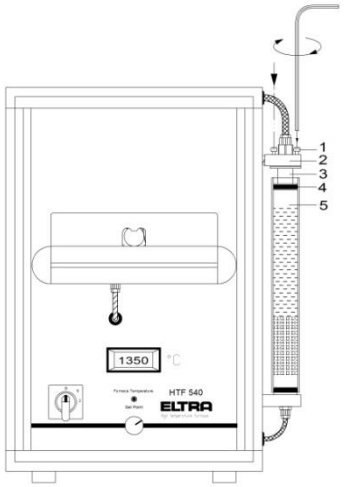


Fig. 23: Replacement of moisture trap

1. Turn both screws (**1**) counter clockwise, until the ring (**3**) touches the part (**2**).
2. Lift the glass tube (**5**) upwards, tilt it to the side and pull downwards.
3. Replace the magnesium perchlorate (Anhydrone). See chapter reagent tube replacing
4. Install the glass tube (**5**) in reverse order after greasing the lower O-ring.
5. Turn both screws (**1**) clockwise until the O-ring (**4**) is properly pressed on the inner surface of the glass tube (**5**).

Remark

The O-ring imprint on the whole circle length of the glass tube should be of about 2 mm width.

6.3 Reagent tubes filling

6.3.1 Chemicals

CAUTION

C13.0076

Scalding/burns

Hot furnace / combustion tube / analyzer parts

- Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**

WARNING

W9.0017

Danger of toxication and personal injuries

- Some chemicals may cause a fatal toxication or dangerous skin corrosion.
- **Refer to the material safety data sheet of the used substances.**
- **Never eat or drink close to the chemical substances.**

C14.0090

CAUTION

Risk of injury to eyes
Chemicals

- When changing the chemicals, the smallest particles of chemicals may be suspended in the air and cause damage to eyes.
- **Always wear protective goggles when working with chemicals.**
- **Please heed the safety data sheets for the chemicals used.**

Magnesium perchlorate (anhydrone)	as moisture absorber
Sodium hydroxide (ascarite)	as CO2 absorber
Copper oxide on rare soils	as oxidizer (CO → CO2)

The reagent tubes are replaced when they are saturated. See chapter General Information .
It is not possible to dry the magnesium perchlorate and use it again, as it is chemically changed after reacting with the moisture. The saturation of the sodium hydroxide changes its color (it turns to light grey).
The magnesium perchlorate is saturated if its particles do not move when tapping on the glass tube. It is essential to change the absorber before it becomes cloggy. The moisture absorber should be checked every 100-200 induction analyses and if necessary, it should be replaced (glass tube underneath the metal filter).
Please refer to the following schematics to identify the glass tubes on the analyzer. In addition to the reagents in the glass tube, fill the bottom end of the tube with glass wool. One should pay attention that the glass wool should be only as thick as necessary. Otherwise the gas flow can be choked. Under no conditions should the amount of glass wool be less than that shown in the following schematics. Otherwise fine particles of magnesium perchlorate can pass through the glass wool layer blocking the hole of the fitting underneath.
It should be pointed out that magnesium perchlorate is a very strong oxidizing material.

NOTICE

There are qualities of chemicals such as Anhydrone, ascarite, copper oxide, Schuetze reagent, tungsten granules, iron chips, copper chips etc. which have been specially developed for combustion analyzers and other analytical instruments. The commonly available materials fulfill their specific purposes either inadequately or not at all.

- The magnesium perchlorate which is commonly available causes memory effect and affects repeatability. Another typical effect is that the analysis takes too long and it is often not even completed. This effect also occurs with magnesium perchlorate of suitable quality when it is saturated.
- The commonly available sodium hydroxide binds CO2 very inadequately at room temperature, whereas the special quality not only perfectly binds CO2 at room temperature but also contains an indicator.
- The glass tubes and the O-rings should be lubricated with high vacuum silicon grease and not with ordinary silicone grease.

The user is free to test commonly available materials; the analyzer will not be damaged. If problems should arise, however, suitable materials, in proper, unsaturated condition, should be used, before calling technical service.
The bottles with chemicals must be closed very tight, immediately after use, so that they do not become saturated with air moisture or CO_2.

6.3.2 Reagent tube filling-Induction furnace

CAUTION

C15.0076

Scalding/burns
Hot furnace / combustion tube / analyzer parts

– Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**

CAUTION

C16.0081

Danger of bursting

– Defective reagent tubes may cause injuries in the form of cuts and other personal injuries.
- **Before installing the new reagent tubes, check if they are damaged.**
- **Wear protective gloves and safety glasses when installing/removing the reagent tubes.**

CAUTION

V0095

Injuries in the form of cuts and other personal injuries
Danger from glass splitters

– Injuries in the form of cuts can be caused by damaged glasware and glass splitters.
- **Replace damaged glassware / reagent tubes**
- Do not touch glass splitters with your hands.

WARNING

W10.0017

Danger of toxication and personal injuries

– Some chemicals may cause a fatal toxication or dangerous skin corrosion.
- **Refer to the material safety data sheet of the used substances.**
- **Never eat or drink close to the chemical substances.**

CAUTION

C17.0090

Risk of injury to eyes
Chemicals

– When changing the chemicals, the smallest particles of chemicals may be suspended in the air and cause damage to eyes.
- **Always wear protective goggles when working with chemicals.**
- **Please heed the safety data sheets for the chemicals used.**

The lower end of each glass tube is filled with glass wool, for the chemicals to be retained in the reagent tubes. Do not stuff the glass wool to tight otherwise the gas flow will be blocked. The rest of the tube is filled with reagents as shown in the schematic below. The lower half of the reagent tube for the oxygen pre-cleaning tube is filled with magnesium perchlorate (Anhydrone) and the upper half with sodium hydroxide. The chemicals are separated by a glass wool layer. Provide sufficient space at both ends of the tube so they can be attached to the glass fittings without blocking the fitting holes. Free inner surfaces at the ends of the tubes serve as sealing surfaces and must be cleaned after filling.

NOTICE

Use quartz wool for the catalyst furnace.

The O-rings also have to be clean. Both the O-rings and the sealing surfaces of the tubes should be greased with silicon grease. This simplifies the fitting and particularly the removal of the tube, and ensures proper sealing.

The O-rings must be cleaned. Both the O-rings as well as the sealing areas of the tube must be greased with high vacuum silicon grease. This will be easier to assemble or disassemble and further it improves the sealing of the glass tubes.

Make sure that the O-rings are completely sealed around the glass tubes, by looking at the imprint of the O-ring on the inner surface of the glass tube. Check whether there are fibers of glass wool trapped between O-ring and glass tube. This causes leakages.

The O-rings are only replaced when they can no longer adequately seal, due to a damage or age. When removing the old O-rings, be ensure that the sealing areas of the fittings are not damaged.

NOTICE

When replacing the O-rings never grease the new O-rings before installation. Otherwise, the O-rings will turn with the glass tube when trying to remove it.

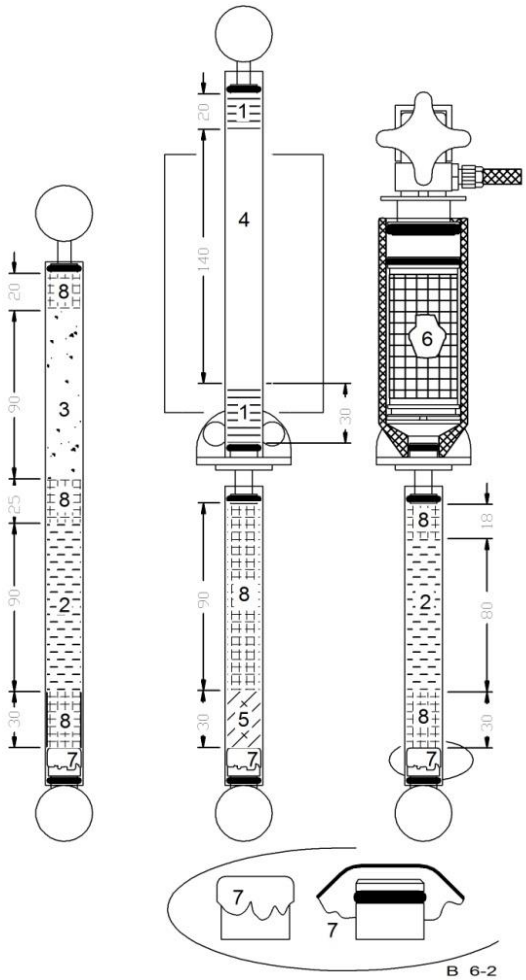


Fig. 24: Glass tubes Schematics

Keep a tolerance of about ± 20 % of the filling lengths of the drawing.

Material	Part No.
1. Quartz wool	90330
2. Anhydrone	90200
3. Sodium hydroxide	90210
4. Copper oxide	90290
5. Cotton wool	90340
6. Metal filter	11105
7. Paper filter	11185
8. Glass wool	90331

6.3.3 Reagent tube filling-Resistance furnace

CAUTION

C18.0076

Scalding/burns
Hot furnace / combustion tube / analyzer parts

– Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**

CAUTION

C19.0081

Danger of bursting

– Defective reagent tubes may cause injuries in the form of cuts and other personal injuries.
- **Before installing the new reagent tubes, check if they are damaged.**
- **Wear protective gloves and safety glasses when installing/removing the reagent tubes.**

CAUTION

V0095

Injuries in the form of cuts and other personal injuries
Danger from glass splitters

– Injuries in the form of cuts can be caused by damaged glasware and glass splitters.
- **Replace damaged glassware / reagent tubes**
- Do not touch glass splitters with your hands.

WARNING

W11.0017

Danger of toxication and personal injuries

– Some chemicals may cause a fatal toxication or dangerous skin corrosion.
- **Refer to the material safety data sheet of the used substances.**
- **Never eat or drink close to the chemical substances.**

CAUTION

C20.0090

Risk of injury to eyes
Chemicals

– When changing the chemicals, the smallest particles of chemicals may be suspended in the air and cause damage to eyes.
- **Always wear protective goggles when working with chemicals.**
- **Please heed the safety data sheets for the chemicals used.**

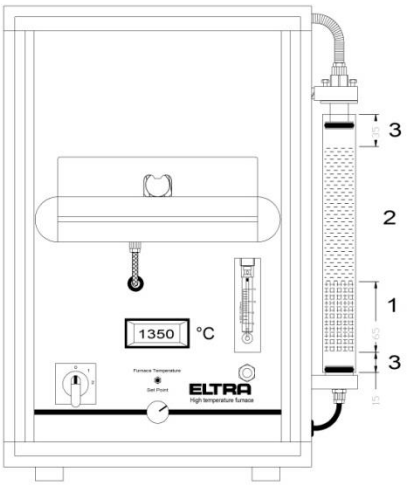


Fig. 25: Moisture trap filling

Keep the shown filling sizes with a tolerance of about ± 20 %

Material	Part. No
1. Glass wool	90331
2. Magnesium perchlorat (anhydrone)	90200
3. Free (empty)	

6.3.4 Oxygen purification furnace quartz tube filling (optional)

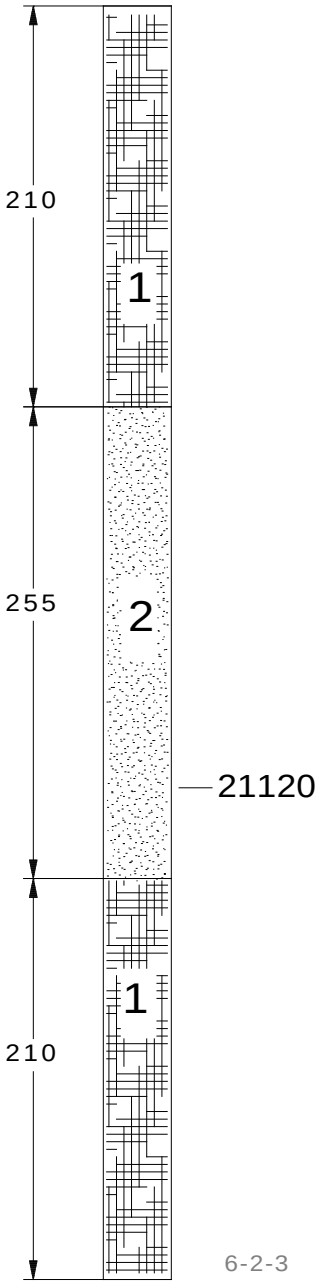


Fig. 26: Oxygen purification furnace glass tube
Keep a tolerance of about ± 20 % of the filling lengths of the drawing.

No.	Material	Part No
1	Quartz wool	90330
2	Copper oxide	90290

6.3.5 Halogen trap filling (optional)

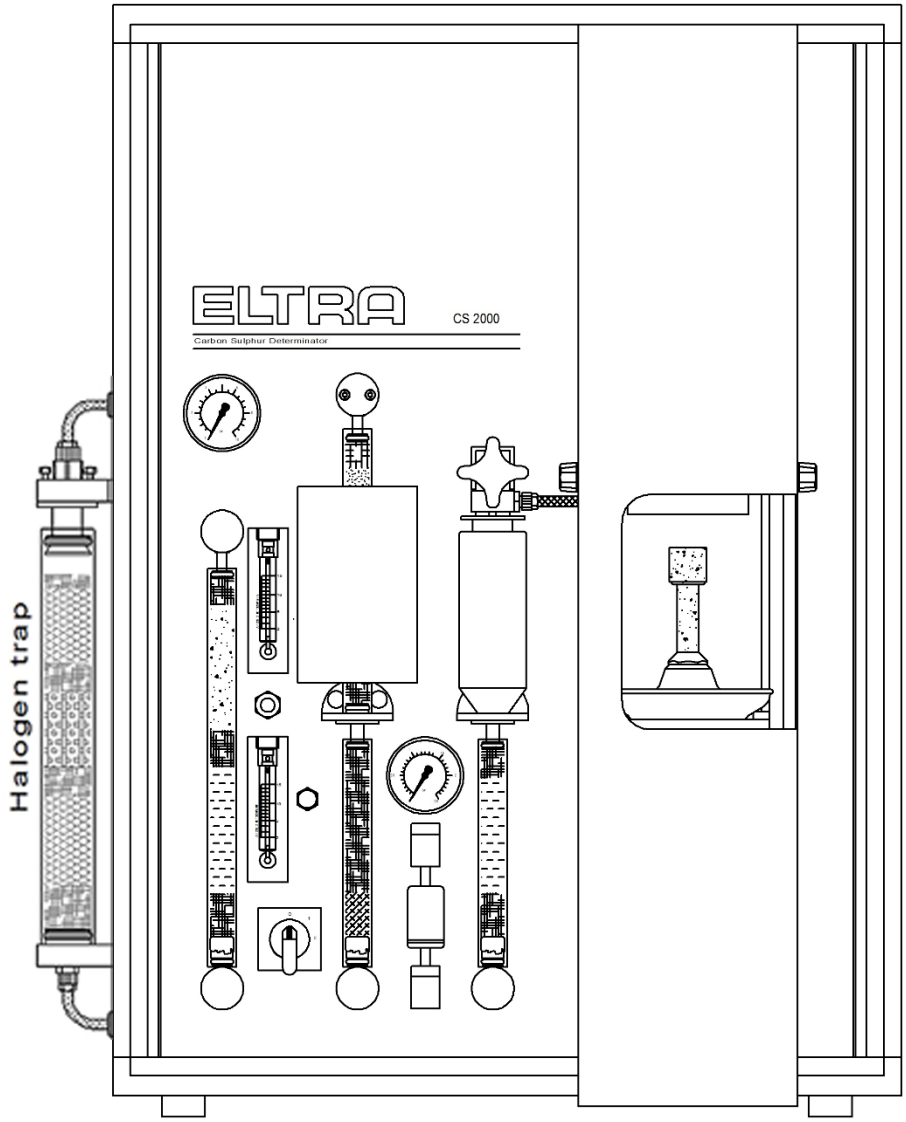


Fig. 27: Halogen trap position

On request the CS-2000 can be supplied with a halogen trap. The glass tube must be filled with halogen trap material.

If the customer orders an analyzer pointing out that he has to analyze materials containing halogens, the analyzer will be delivered with a halogen trap tube attached to the left panel of the analyzer.

Keep a tolerance of about ± 20 % to the filling lengths of the drawing.

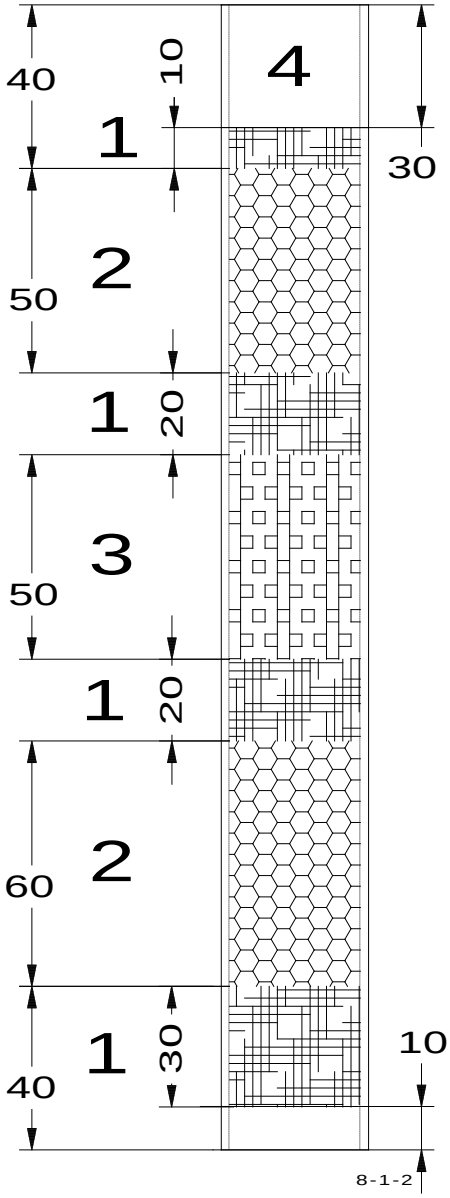


Fig. 28: Halogen trap filling

No.	Material	Part No.
1	Glass wool	90331
2	Halogen trap metal	90235
3	Halogen trap material	90234
4	Glass tube	09090

6.4 Paper filter changing

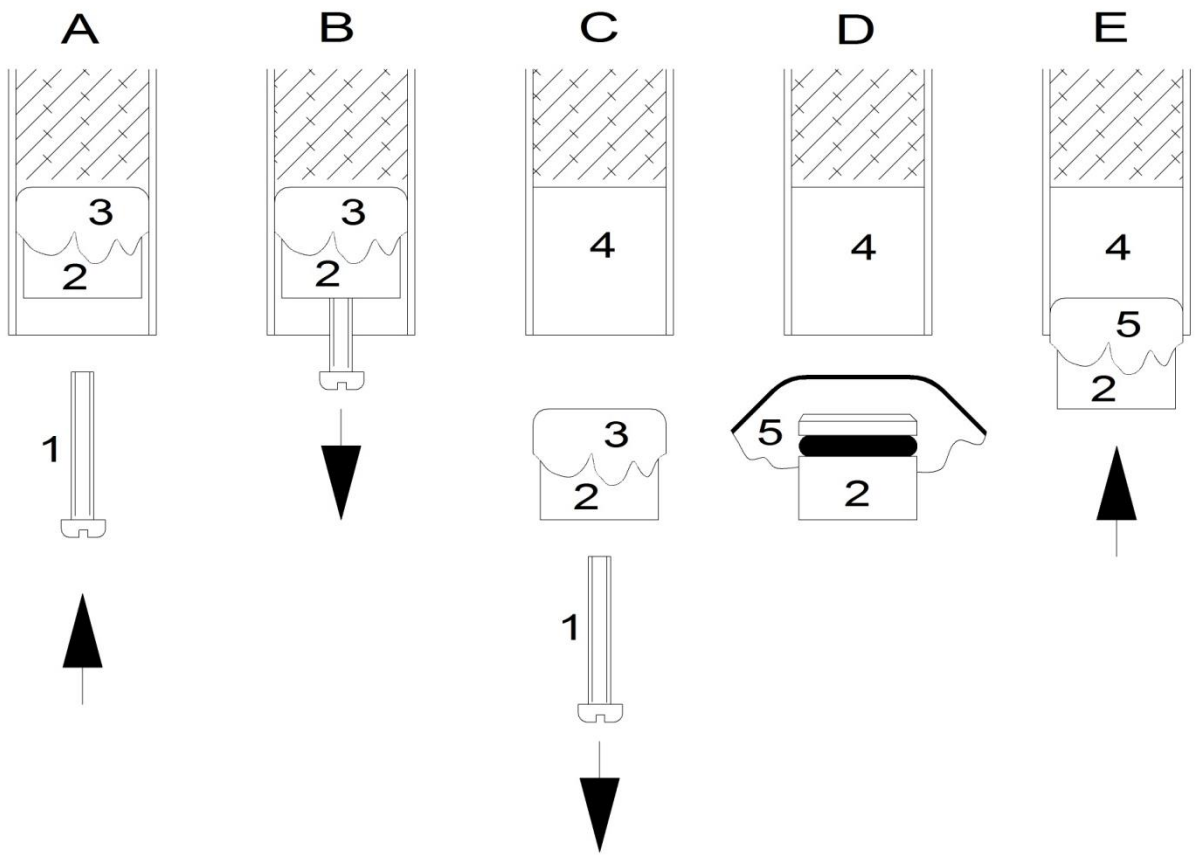


Fig. 29: Paper filter changing

A. Screw an M4 screw (1) into the paper filter holder (2).
B. With this screw, pull the filter holder (2) and the filter (3) out of the reagent tube (4).
C. Remove the screw (1) from the filter holder (2). Remove the old filter (3).
D. A new filter (5) is placed on the filter holder (2) and folded over.
E. The filter holder (2), with the new filter (5) is pushed carefully, back into the reagent tube (4).

6.5 Dust filter cartridge replacing

The dust filter cartridge filters smallest dust particles from the combustion gases. Its saturation depends on the sample material and its combustion characteristics. The filtering material of a new cartridge is white. Replace the dust filter cartridge when the filtering material shows coloration, or at least every 500 analysis.

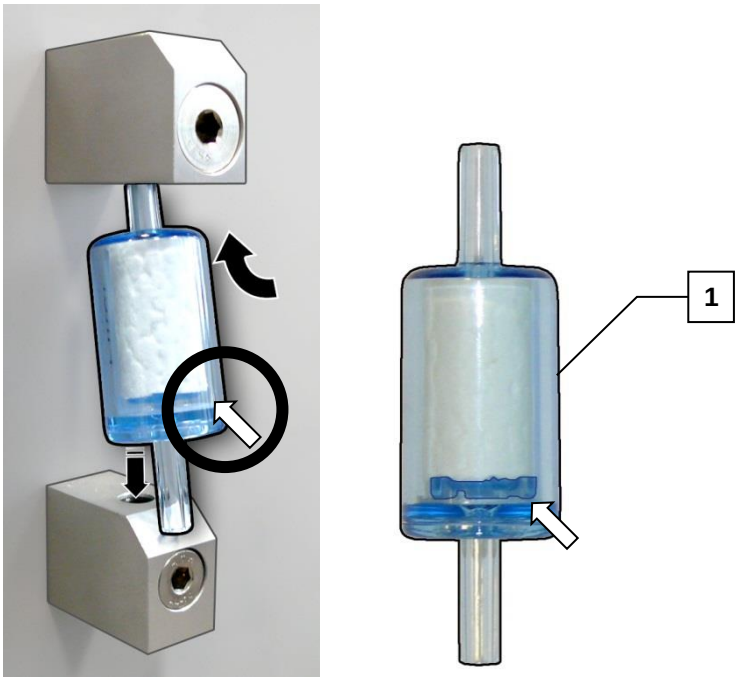


Fig. 30: Dust filter cartridge - inserting

1. Lift the dust filter cartridge (**1**) upwards.
2. Tilt its low end to the front and pull downwards.
3. Install a new cartridge by acting in reverse order.

Take care for the cartridge body to have the smaller diameter up and the bigger down.

6.6 O-rings replacement

C21.0076

CAUTION

Scalding/burns

Hot furnace / combustion tube / analyzer parts

– Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**

V0062

CAUTION

Injuries in the form of cuts and other personal injuries

Danger from glass splitters

– Injuries in the form of cuts can be caused by damaged sample flasks and glass splitters.
- **Replace damaged sample flasks**
- Do not touch glass splitters with your hands.

W12.0023

WARNING

High temperature / Burning of the skin

Hot combustion tube

- **When the analyzer (HTF, resistance furnace) is switched on again after switching off, the adjusted set point is driven immediately. Please check this!**

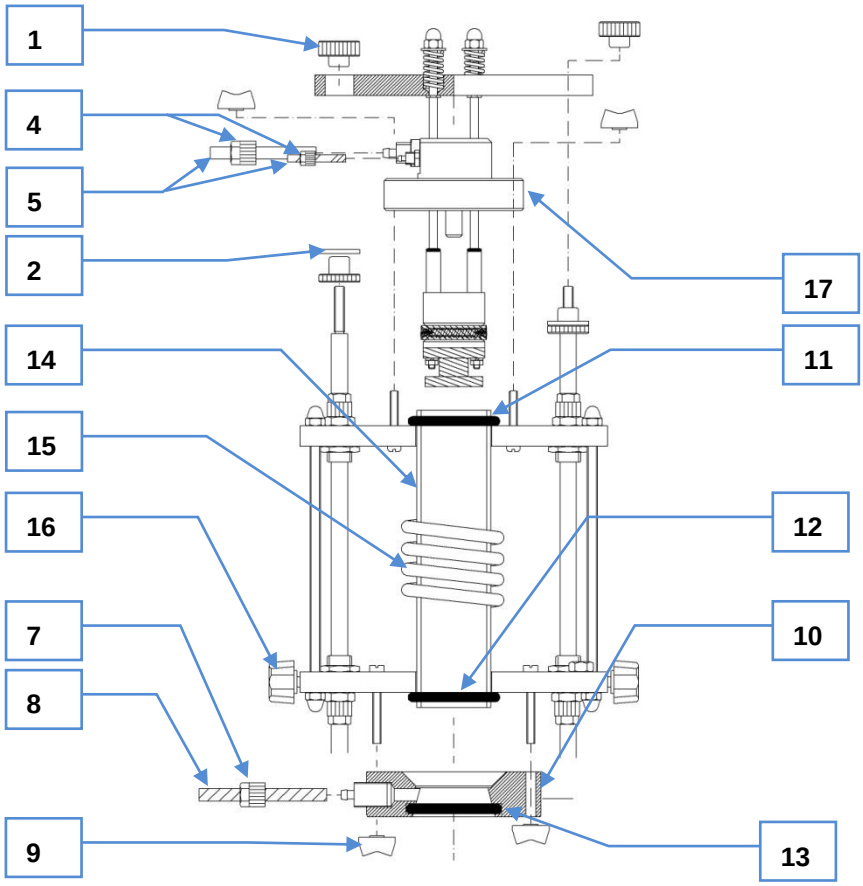


Fig. 31: furnace details

1	Knurled nut
2	Washers
3	Wing nuts
4	Nut for gas inlet tube
5	Gas inlet tube
6	Mounting
7	Nut for gas outlet tube
8	Gas outlet tube
9	Wing nuts
10	Lower furnace lock
11	Upper o-ring for combustion tube
12	Lower o-ring for combustion tube
13	O-ring for lower furnace lock
14	Combustion tube
15	Induction coil
16	Nuts for furnace housing
17	Upper furnace lock

6.6.1 Replacing the o-rings 11 and 12 for combustion tube:

- Remove the furnace housing by just loosening the nuts (16).
- Open the furnace.
- Unscrew the knurled nuts (1) and washers (2).
- Unscrew the wing nuts (3).
- Unscrew the nuts (4) and detach tubes (5).
- Remove the furnace cleaning system, by pulling up the mounting (6).
- Unscrew the nut (7) and detach the tube (8).
- Unscrew the wing nuts (9) and pull down lower furnace lock (10).
- Now the O-rings (11) and/or (12) can be removed and replaced. Apply a thin layer of grease on the inner surface of the new O-rings, before mounting them. Apply a thin layer of grease on the outer surface of the combustion tube, where the new O-rings will be placed.
- Reinstall in reverse order.

6.6.2 Replacing the o-ring 13 for lower furnace lock

- Remove the furnace cover by just loosening the nuts (16)
- Unscrew the nut (7) and detach tube (8)
- Unscrew the wing nuts (9) and pull down lower furnace lock (10)
- Remove the O-ring (13) with a screwdriver; insert a new one without greasing it.
- Reinstall in reverse order.

6.6.3 Replacing the o-rings for furnace seal

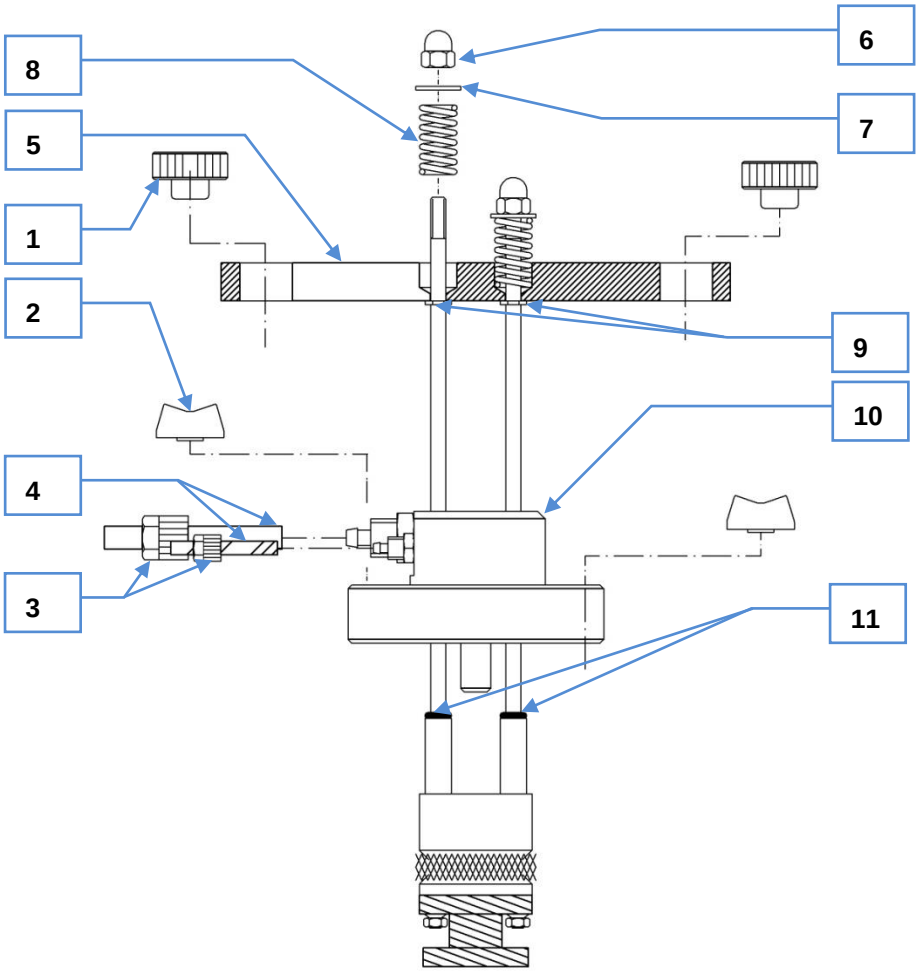


Fig. 32: Cleaning mechanism details

- Unscrew the knurled nuts (1).
- Unscrew the wing nuts (2).
- Unscrew the nuts (3) and gas inlet tubes (4).
- Remove the furnace cleaning system, by pulling up the bar (5).
- Unscrew the nuts (6) and remove the washers (7) and springs (8).
- Remove the bar (5).
- Remove the circlips (9).
- Remove the upper furnace lock (10).
- Remove and replace the O-rings (11) do not grease the O-rings!
- Reinstall in reverse order.

The O-rings are only replaced when they can no longer adequately seal, due to a damage or age. When removing the old O-rings, be ensure that the sealing areas of the fittings are not damaged. The sealing surfaces of the o-rings, on the rods and inside the furnace lock (10), must be cleaned to be free of grease and dust.

Don’t grease these O-rings.

Remark

– Neither the upper O-ring nor the upper end of the thick glass tube of the resistance furnace is to be greased.

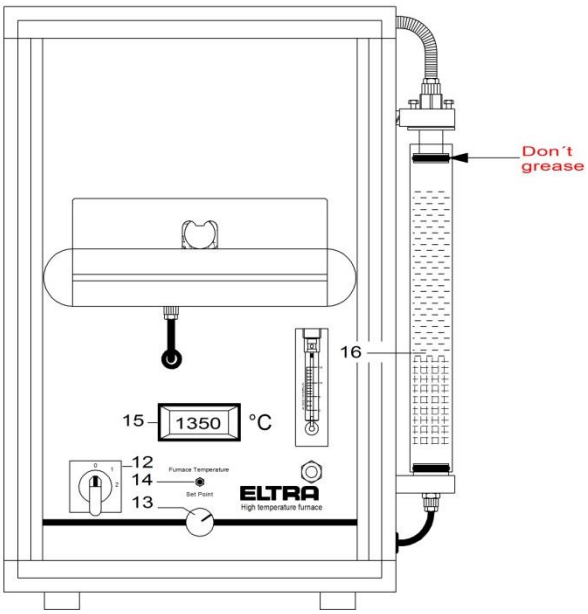


Fig. 33: Resistance furnace

– The small O-rings for sealing the top of the induction furnace should also not be greased.

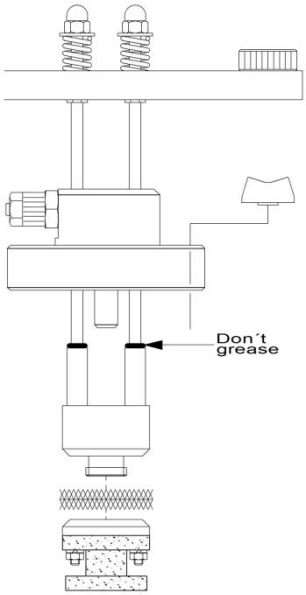


Fig. 34: Induction furnace

– The O-ring for sealing the cone should also not be greased.

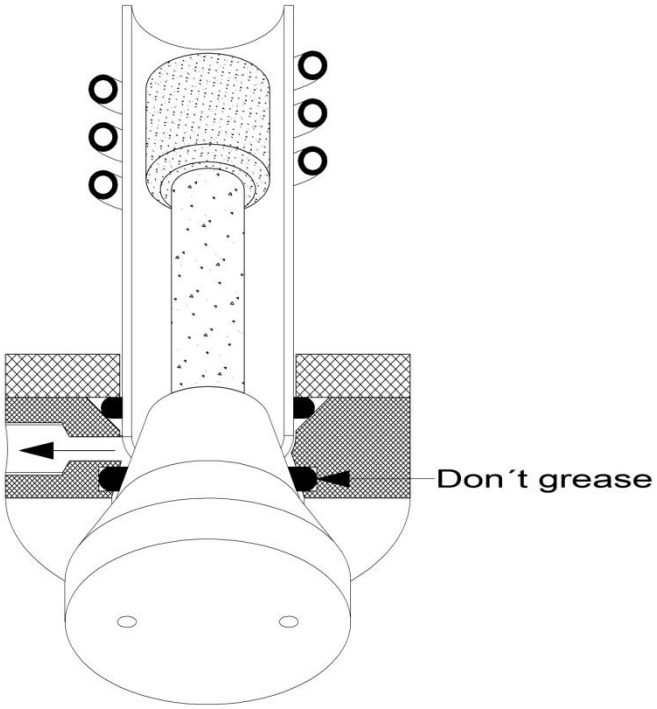


Fig. 35: Induction furnace-Cone

6.7 Furnace cleaning brush - replacing

CAUTION

C22.0076

Scalding/burns
Hot furnace / combustion tube / analyzer parts

- Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**

The furnace is equipped with an auto-cleaning system. This mechanism contains a brush, which cleans the quartz tube (combustion tube).
For replacing the brush during working time, it is advisable to set the power switch to position 1. If the replacement is done during a long maintenance break, the power switch can be of course at position 0.

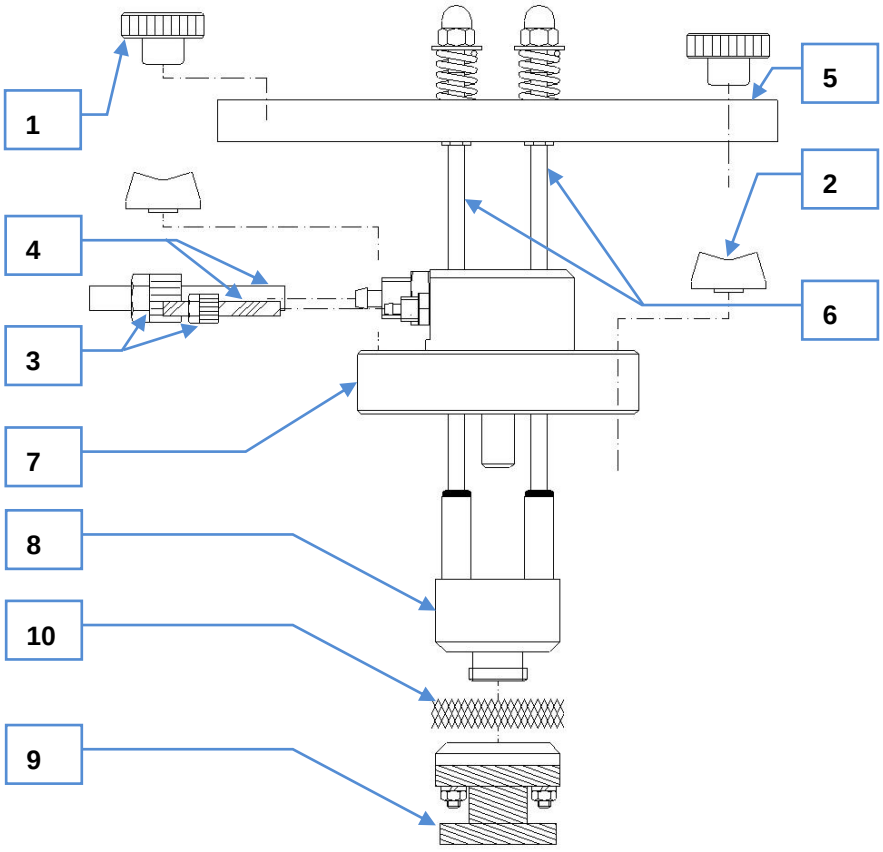


Fig. 36: Furnace cleaning brush-replacing

- Loosen the cover knobs and remove the cover.
- Open the furnace.
- Remove the knurled nuts (1).
- Unscrew the wing nuts (2).
- Loosen the nuts (3) and detach the tubes (4).
- Remove the furnace cleaning system, by lifting up the mounting (5).
- Hold tight the brush holder (8) and unscrew the heat shield (9), together with its brass ring.
- Remove and replace the brush (10).

- Reassemble in reverse order

NOTICE

It is absolutely important to hold the brush holder (8) and not the bar (5), when unscrewing the heat shield (9), otherwise the rods (6) will bend.

6.8 Dust trap cleaning

CAUTION

C23.0076

Scalding/burns

Hot furnace / combustion tube / analyzer parts

- Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**

WARNUNG

W13.0023

High temperature / Burning of the skin

Hot combustion tube

- **When the analyzer (HTF, resistance furnace) is switched on again after switching off, the adjusted set point is driven immediately. Please check this!**

6.8.1 Dust trap cleaning-Induction furnace

The dust from the furnace is trapped in the metal dust filter (2). The dust filter needs to be cleaned after about 100 analyses.

Make sure that the filter is absolutely dry after ultrasonic cleaning. The porosity of the filter is 10 microns only and it is impossible to recognize whether the inside of the filter is dry, by simply looking into it. Therefore it is advisable to have a second filter, in order to use it while drying the other one. The filter can be dried with hot air. The replacement of the dust filter (2) takes only about 5 seconds.

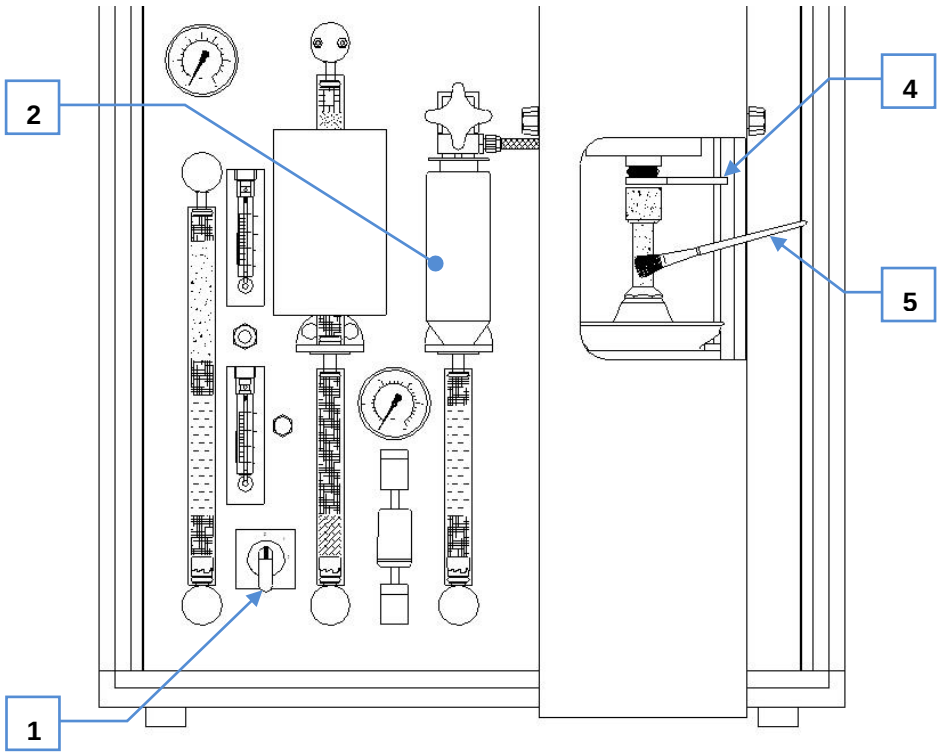


Fig. 37: Dust trap

- The main switch (1) can stay at position 3.
- The oxygen does not need to be turned off, but only the furnace has to be opened.
- The heat shield (4) and the pedestal (5) can occasionally be cleaned.
- Remove the dust trap (2), as follows:

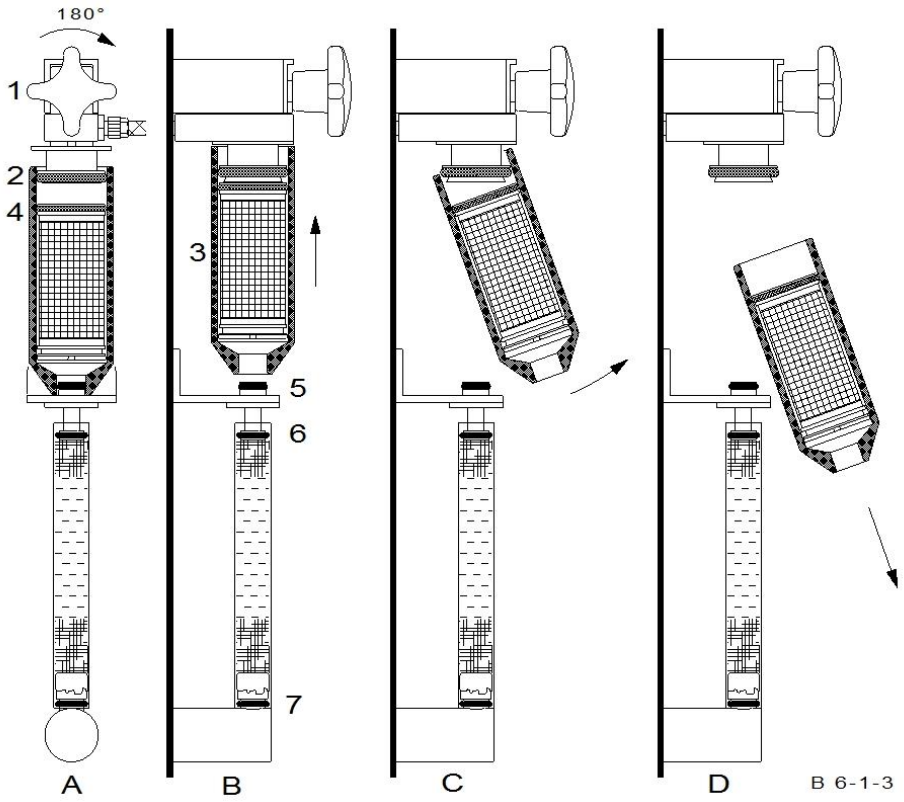


Fig. 38: Dust trap removing

A: The cock (1) is rotated by 180°, so that the O-ring (2) loosens.
B: The dust trap (3) is raised as far as it will go.
C: Then it is swung to the side and
D: Detached downwards at an angle.

- Clean the dust trap (3).
- Reinstall in reverse order after cleaning.

Fast filter cleaning

– once every 200 analyses when using tungsten accelerator
– once every 100 analyses when using tungsten and Iron

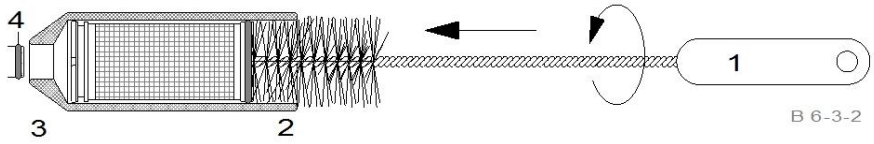


Fig. 39: Dust trap: fast cleaning

- Clean the dust using the brush (1) delivered with the analyzer.
- Rotate in only one direction.
- Clean the upper end of the filter housing (2).

NOTICE

Grease only the lower end of the filter housing (3) and the lower O-ring (4). The upper end of the filter housing (2) and the O-ring of the upper sealing mechanism should remain clean and absolutely free of grease.

Thorough cleaning

– once every 1000 analyses when using tungsten accelerator
– once every 500 analyses when using tungsten and Iron

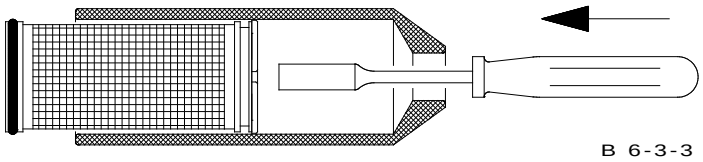


Fig. 40: Dust trap: disassembling

- Remove the metal filter out of the filter housing.
- Perform a preliminary cleaning, by using the brush.
- Clean the metal filter in the ultrasonic cleaner.
- Dry and, if necessary for assembling, lubricate the 0-ring.
- Clean the upper end of the filter housing (2) from any grease.

NOTICE

When reinstalling the filter in the filter housing, the O-rings must be correctly installed otherwise the gas flow will be completely blocked.
Outer O-ring on top, inner O-ring to the bottom.

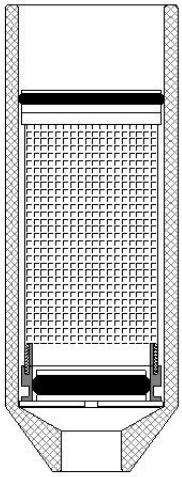


Fig. 41: Dust trap: outer and inner o-rings

6.8.2 Dust trap cleaning-Resistance furnace

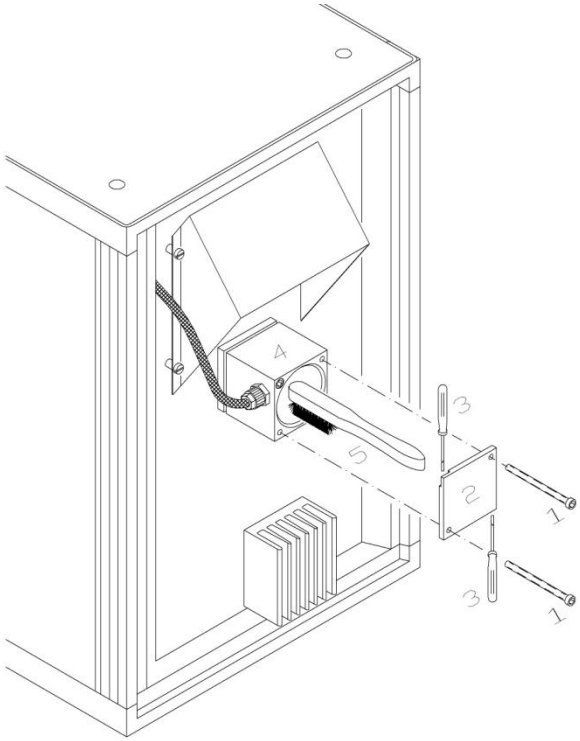


Fig. 42: Dust trap-Resistance furnace

- Remove the two screws (1).
- Remove the cover (2) using a screw driver if necessary.
- Remove the dust from the inside of the dust trap (4) using the brush (5).
- Do the assembling in reverse order.

Remark

The two screws (1) should be properly tighten to make sure that the system is sealed

6.9 Combustion tube replacement

CAUTION

C24.0076

Scalding/burns

Hot furnace / combustion tube / analyzer parts

– Parts of the analyzer can be very hot.

- **Use heat protecting gloves.**

CAUTION

C25.0081

Danger of bursting

– Defective reagent tubes may cause injuries in the form of cuts and other personal injuries.

- **Before installing the new reagent tubes, check if they are damaged.**
- **Wear protective gloves and safety glasses when installing/removing the reagent tubes.**

CAUTION

V0095

Injuries in the form of cuts and other personal injuries

Danger from glass splitters

– Injuries in the form of cuts can be caused by damaged glasware and glass splitters.

- **Replace damaged glassware / reagent tubes**
- Do not touch glass splitters with your hands.

6.9.1 Induction furnace

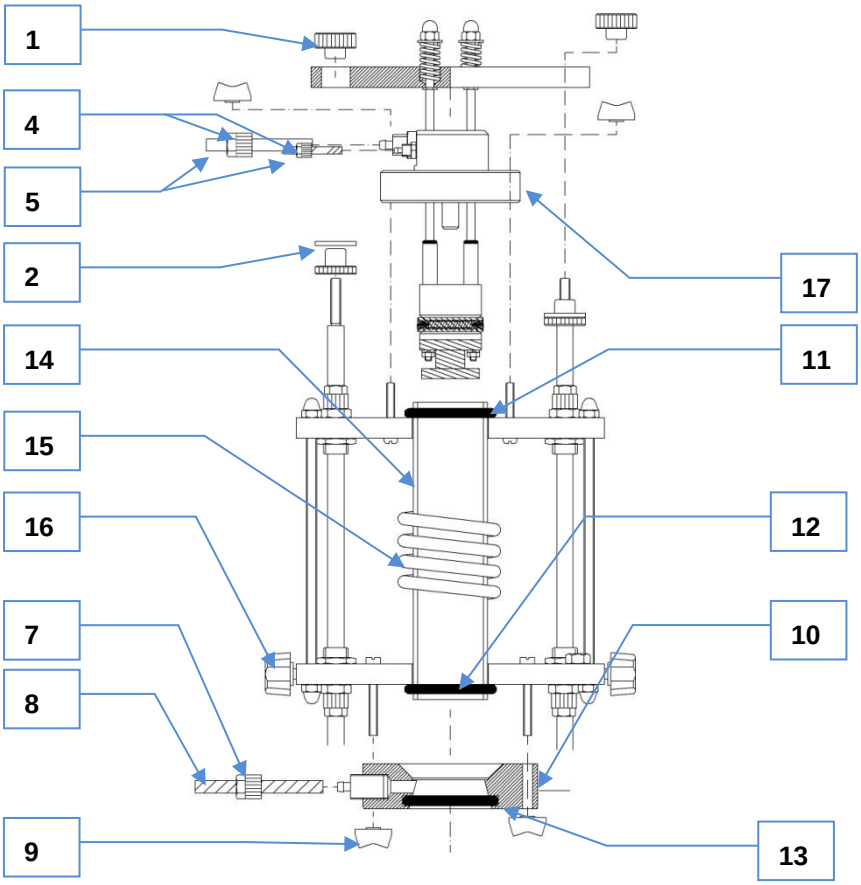


Fig. 43: Induction furnace details

1	Knurled nut
2	Washers
3	Wing nuts
4	Nut for gas inlet tube
5	Gas inlet tube
6	Mounting
7	Nut for gas outlet tube
8	Gas outlet tube
9	Wing nuts
10	Lower furnace lock
11	Upper o-ring for combustion tube
12	Lower o-ring for combustion tube
13	O-ring for lower furnace lock
14	Combustion tube
15	Induction coil

16	Nuts for furnace housing
17	Upper furnace lock

- Remove the furnace cover by just loosening the nuts (16).
- Unscrew the knurled nuts (1) and washers (2).
- Unscrew the wing nuts (3).
- Unscrew the nuts (4) and detach the tubes (5).
- Remove the furnace cleaning system, by pulling the mounting (6).
- Unscrew the nut (7) and the detach tube (8).
- Unscrew the wing nuts (9) and pull down lower furnace lock (10).
- Pull-off the lower O-ring (12) from the combustion tube, remove the combustion tube (14) by pulling it up; remove the upper O-ring (11).
- Apply a thin layer of grease on the inner surface of the new O-rings (11) and (12), before mounting them. Apply a thin layer of grease on the outer surface of the combustion tube, where the new O-rings will be placed.
- Reinstall in reverse order.

6.9.2 Resistance furnace

W14.0023

WARNUNG

High temperature / Burning of the skin
Hot combustion tube

- **When the analyzer (HTF, resistance furnace) is switched on again after switching off, the adjusted set point is driven immediately. Please check this!**

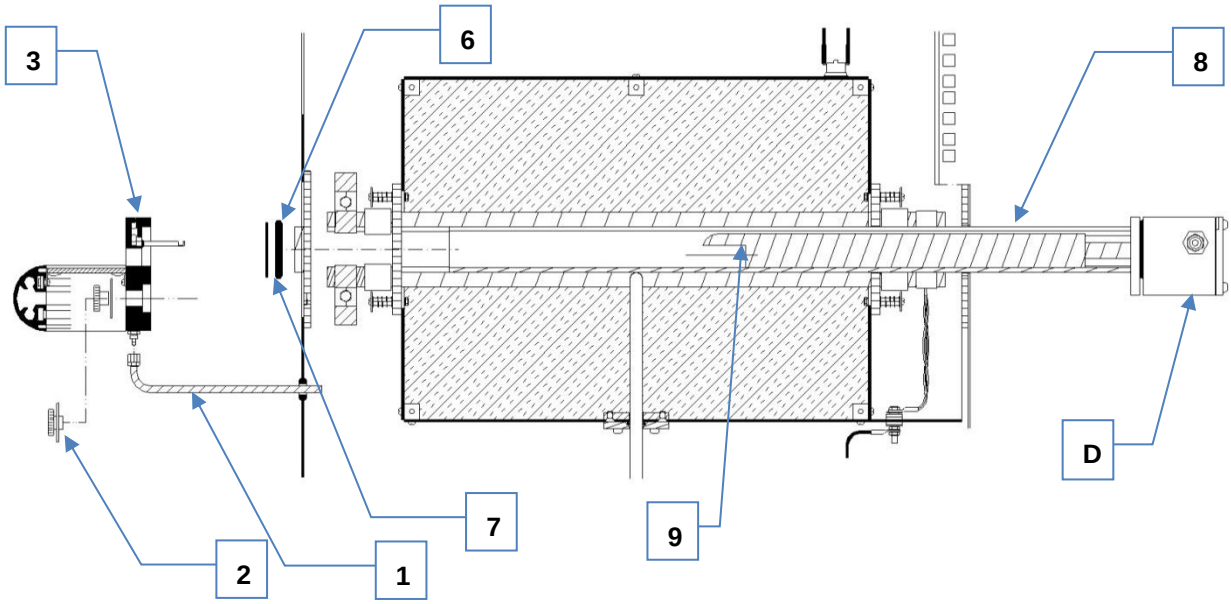


Fig 44: Removing the combustion tube

CAUTION: Unplug the mains power cable before opening this device!

1. Switch off the furnace and disconnect the power plug.
2. Remove the oxygen tube (**1**).
3. Remove the plastic tube from the dust box (**D**) at the furnace outlet.
4. Dismantle the dust box by removing the screws (**10**) and remove the cover (**11**) using a screw driver (**12**) if necessary.

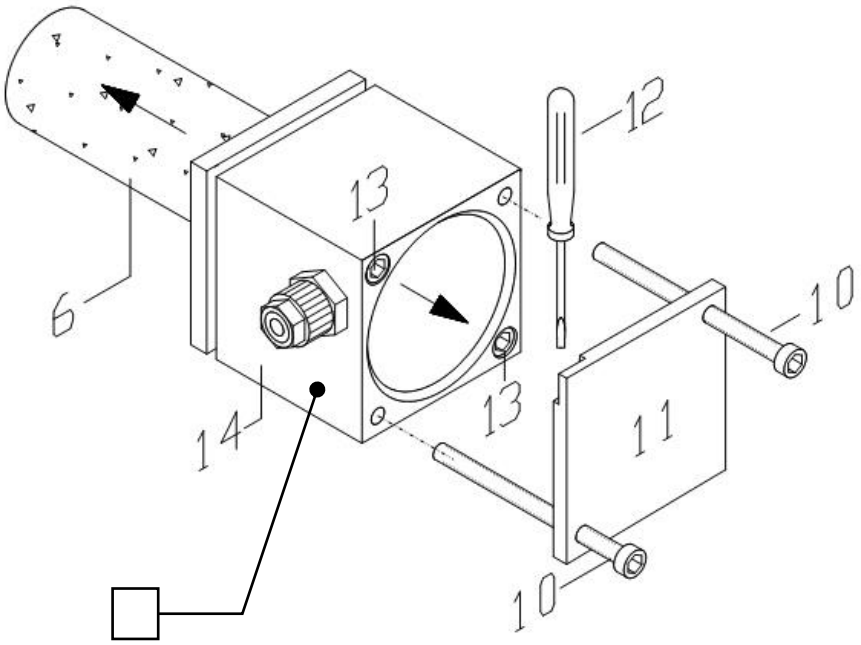


Fig 45: dust box

5. Remove the boat stop (**9**) out of the combustion tube.
6. Unscrew the screws (**13**) and remove the complete dust box assembly (**14**).
7. Unscrew the screws (**2**) and remove the front assembly (**3**).
8. Remove the O-ring (**6**) and the safety spring (**7**).
9. Pull the dust box (**D**) together with the combustion tube (**6**) out of the rear of the furnace.
10. Remove the old combustion tube (**8**), install the new one.

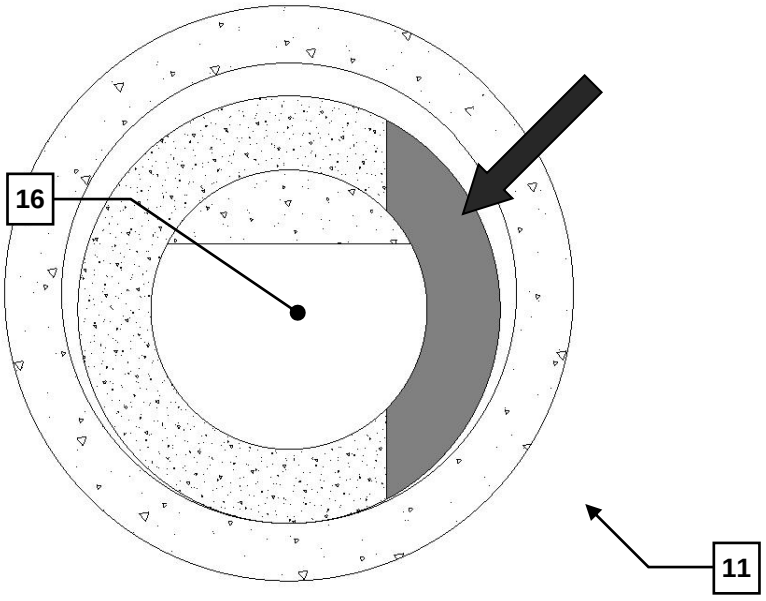


Fig. 46: Front view – combustion tube with boat stop

NOTICE

Slide the new combustion tube very slowly and perfectly horizontal into the furnace, otherwise the heating elements may break.

11. Slide the boat stop (**9**) into the combustion tube (**8**) and ensure that it is positioned according to this drawing, (furnace rear-side).
12. Reinstall furnace in reverse order.

NOTICE

When you turn on the device after reinstalling, the set setpoint value is driven immediately. Please check it, see chapter 4.6: Resistance Furnace-Temperature adjustment.

6.10 Generator tube replacing

For the replacement of the generator tube a separate manual is available.

Please contact the service, see Chapter 1, contact information.

6.11 Combustion coil replacing

For the replacement of the combustion coil a separate manual is available.
Please contact the service, see Chapter 1, contact information.

6.12 Pedestal removing

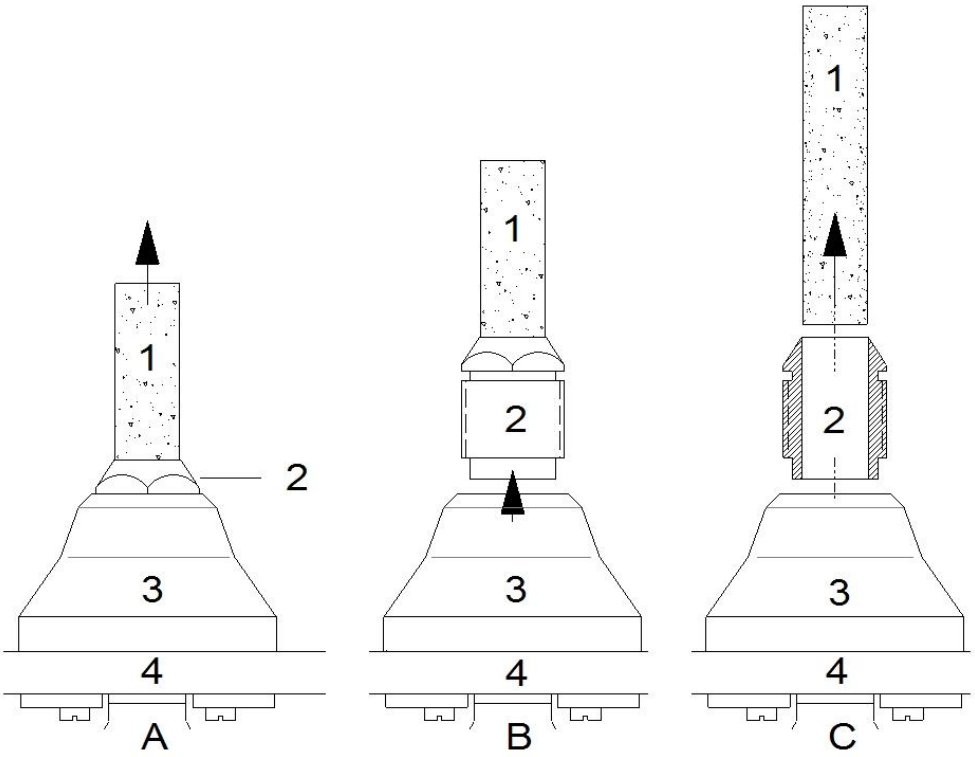


Fig. 47: Pedestal removing

A: Remove the pedestal (1) from the furnace closing cone by lifting.

B: If the pedestal cannot be easily lifted, unscrew with a 24 mm wrench the nut (2) from the cone (3).

C: This will give access to the bottom off the pedestal allowing its removal. When fitting the nut (2) to the cone (3), ensure there is no dust in the threads of the two parts. A vacuum cleaner can be used to clean the threads prior to reassembling

6.13 Heating elements replacing

DANGER

D2.0005

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.
- **Set the mains switch of the analyzer to position 0 and pull the mains plug of the mains socket.**

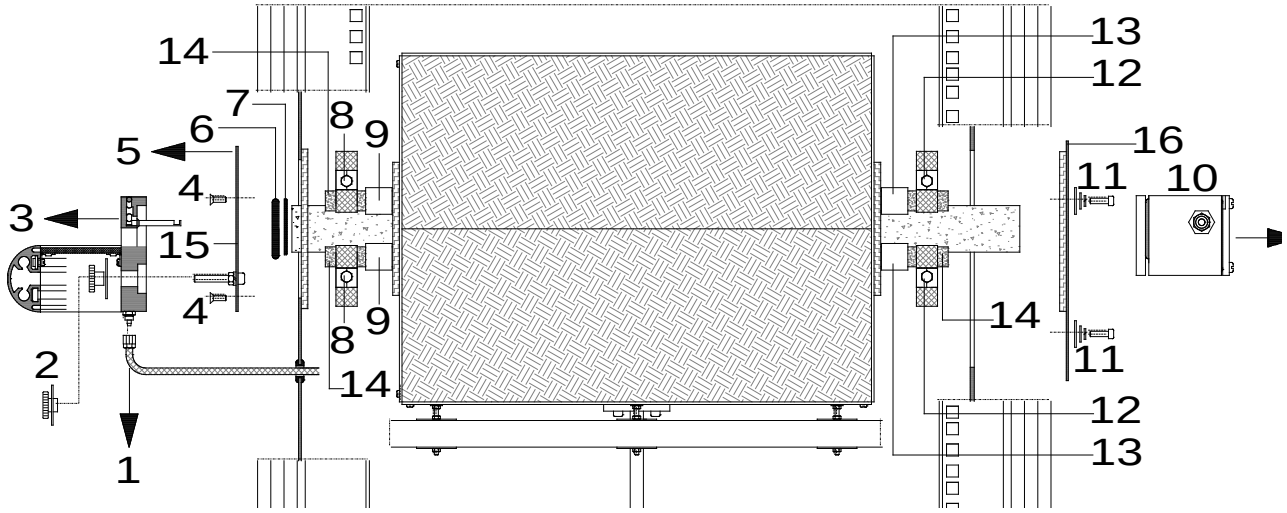


Fig. 48: Operating procedure for replacement of heating elements

1. Disconnect the oxygen tube (**1**).
2. Unscrew the two knurled nuts (**2**) and remove the front assembly (**3**).
3. Remove the O-ring (**6**) and the safety spring (**7**) from the front end of the ceramic tube.
4. Pull the dust trap (**10**) with the ceramic combustion tube out of the furnace.
5. Unscrew and remove the four screws (**4**)
6. Remove the front stainless panel (**15**)
7. Unscrew and remove the four screws and (**11**).
8. Remove the rear stainless cover (**16**).
9. Remove the clamps (**8**) and (**12**) from the heating elements.
10. Remove the ceramic spacers (**9**) and (**13**).
11. Remove the heating elements (**14**).
12. Re-assemble in reverse order.

NOTICE

Install the clamps (**8**) and (**12**) in a position which allows the heating elements to move at least 5 mm in horizontal (axial) direction.

NOTICE

When you turn on the device after reinstalling, the set setpoint value is driven immediately. Please check it, see chapter 4.6: Resistance Furnace-Temperature adjustment.

6.14 Gas leaks checking

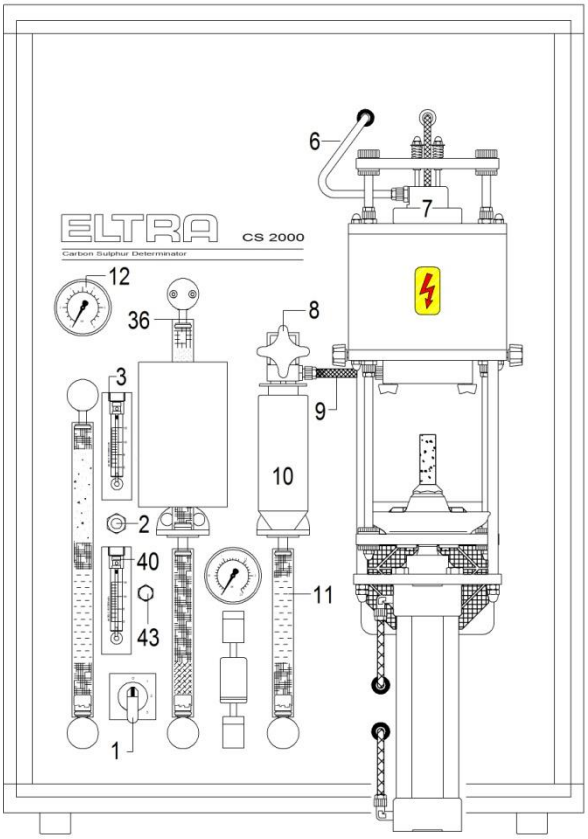


Fig. 49: Gas leaks check-Analyzer

- Set the power switch (1) to pos. 2.
- Close the furnace (piston up).
- Press the button (43) and keep it pressed. The entire system is then checked for leaks.
- After about 5 seconds of initial pressure drop, the pressure on the gauge (12) remains constant, which means there is no leakage in the gas flow system. The leakage test is completed. The gas system is seal.
- In case there is a continuous pressure drop, then release the button (43), open the furnace. Then press and hold the button (43) again.
- If the pressure remains constant after an initial drop, then the fault is in the furnace area, including the metal dust filter.
- If the pressure still decreases, then the leakage is somewhere in the gas flow system outside the furnace area.
- Read the service manual or contact the local Eltra agent or contact Eltra GmbH directly.

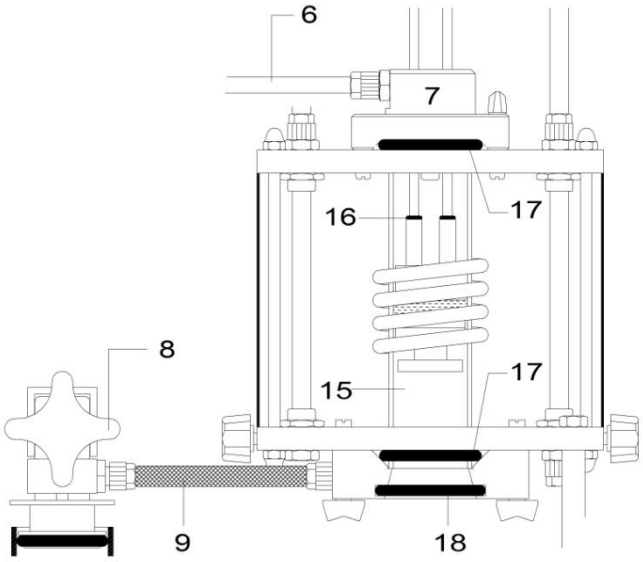


Fig. 50: Gas leaks check-furnace

- Release the button (43), close the furnace, squeeze the tube (6) tight and press and hold the button (43).
- If the pressure on gauge (12) remains constant, then the furnace has to be checked for leaks.
- If the pressure shown on gauge (12) drops, then the leakage must be somewhere before the furnace, between oxygen inlet and furnace.

6.14.1 Leaks in the furnace inlet system

- After following the above instructions, check the inlet tubes (6) for leakage

6.14.2 Leaks in the furnace

- After following above instructions, close the furnace, squeeze tight the tube (9), press and hold the button (43), observe the pressure gauge (12).
- If the pressure drops, then the furnace is leaking. Check whether the O-rings (16), (17) and (18) are dirty or defective. See chapter O-Rings replacing.
- Check whether the combustion tube (15) is broken or cracked. See chapter Combustion tube replacing.
- If the pressure remains constant, then the leakage must be after the furnace.

6.14.3 Leaks in the furnace outlet system

After following the instructions in the section Leaks in the furnace, check if the handle (8) is properly shut, or else there will be a major gas leakage from the dust filter. Check the dust trap (10) and the glass tube (11) for leakage.

7 Function description

7.1 System overview

The CS-2000 automatic analyzer incorporates the latest in combustion technology. It is designed for the rapid simultaneous determination of carbon and sulfur in steel, cast iron, copper, alloys, ores, cement, ceramics, carbides, minerals, coal, coke, oil, ashes, catalysts, lime, gypsum, soils, rubber, leaves, soot, tobacco, waste, sand, glass and other solid and fluid materials. The CS-2000 can be supplied with up to three independent Infrared cells, giving the following options:

1. Two IR-cells for carbon and one for sulfur.
2. Two IR-cells for sulfur and one for carbon.

These configurations offer optimum precision for the analysis of high and low levels of the chosen element. The change over from the low to the high range is done automatically during the analysis and doesn't require any pre-setting by the operator.

7.2 Measuring principle

The measuring procedure is based on sample combustion and measurement of the combustion gases by means of infrared absorption.
A wide variety of sample materials in various forms is possible; powder, chips, grains, solid pieces and also some materials in liquid form. Typical materials are coal, ashes, steel, cement, soil samples, rubber etc.
During combustion, the sulphur and carbon components present in the sample are oxidised forming SO2 and CO2. The usual combustion temperature is 1350°C in the resistance furnace. The sample temperature in the induction furnace depends on the kind of sample and accelerators as well as on their quantity. Usual temperatures are between 1800°C and 2000 °C.
Combustion is obtained by supplying oxygen, which at the same time acts as carrier gas. An electronic flow regulator keeps the flow quantity at a constant level of 180 l/h (unless the analyser is a special model).
Dust traps and a moisture absorber ensure that a dry, dust free gas mixture is supplied to the infrared cells.
The signals emitted from the infrared cells are selective and correspond to the SO2 and CO2 concentrations in the gas mixture. They are electronically linearized and integrated, divided by the sample weight and digitally displayed as % S and % C.
Since the sample weight is taken into account, the results do not depend on the sample weight. For this purpose, the sample is weight is taken before being analysed and entered into the PC. If necessary, blank values can also be entered; the software takes them into account when determining results.
The analyser is PC controlled, using the software "UNI". For information about software, please refer to the Help-function of the software.
The graphical representation of the detectors' signals (peaks) is shown on the PC's screen during and after analysis. At the end of analysis the results are displayed as well. All analysis data for every finished analysis are saved in the PC and remain available for review, results recalculation, calibration, etc. and can be printed on a printer or exported to another software, if necessary.

7.3 Gas flow system

The oxygen supply is connected to the inlet of the gas flow system. Pure oxygen is available in steel bottles. A 99.5% purity is fully sufficient. Any CO2 or H2O which may be contained in the oxygen is retained in the CO2 and H2O trap. The upper half of the trap is filled with CO2 absorber and the lower half with H2O absorber.
Magnesium perchlorate (anhydrone) acts as H2O absorber. Sodium hydroxide acts as CO2 absorber, preferably with an indicator, so that the degree of saturation can be seen from the coloration.
The oxygen inlet pressure should be 2 to 4 bar (30 to 60 psi), which is then regulated inside the analyzer to 1.5 bar (22 psi), and shown on the pressure gauge. Any pressure fluctuation of the external oxygen supply has no influence on the accuracy of the measurements.
The oxygen then enters the furnace after passing thru the oxygen valve. A pressure switch reports whether there is sufficient pressure in the furnace and whether the furnace is closed, in order to start the analysis cycle
The combustion gases from the furnace, flow first thru a dust trap and then through a H2O absorber. Via the bypass valve, they reach the electronic controlled flow regulating valve V6, which is the adjusting element of the electronic flow regulation.
Then, the gases pass through the SO2-selective cells. Any CO, that may be present, is oxidized to CO2 in the catalyst furnace, which is filled with copper oxide. Unwanted SO3, which results thereby from SO2, is retained in the SO3 trap which is filled with cotton wool.
A flow meter displays the gas flow. The flow rate is set internally to 180 l/h. The exact level of the flow is not important, since the calibration of the analyzer takes this into account.
Very important is that the flow rate is constant. An electronic board ensures this. A slight deviation from the set value or a conflict, as with mechanical regulators, cannot arise. The regulation either functions precisely, in which case the flow rate is correct or, in the event of a defect, the flow rate is completely blocked or extremely high.

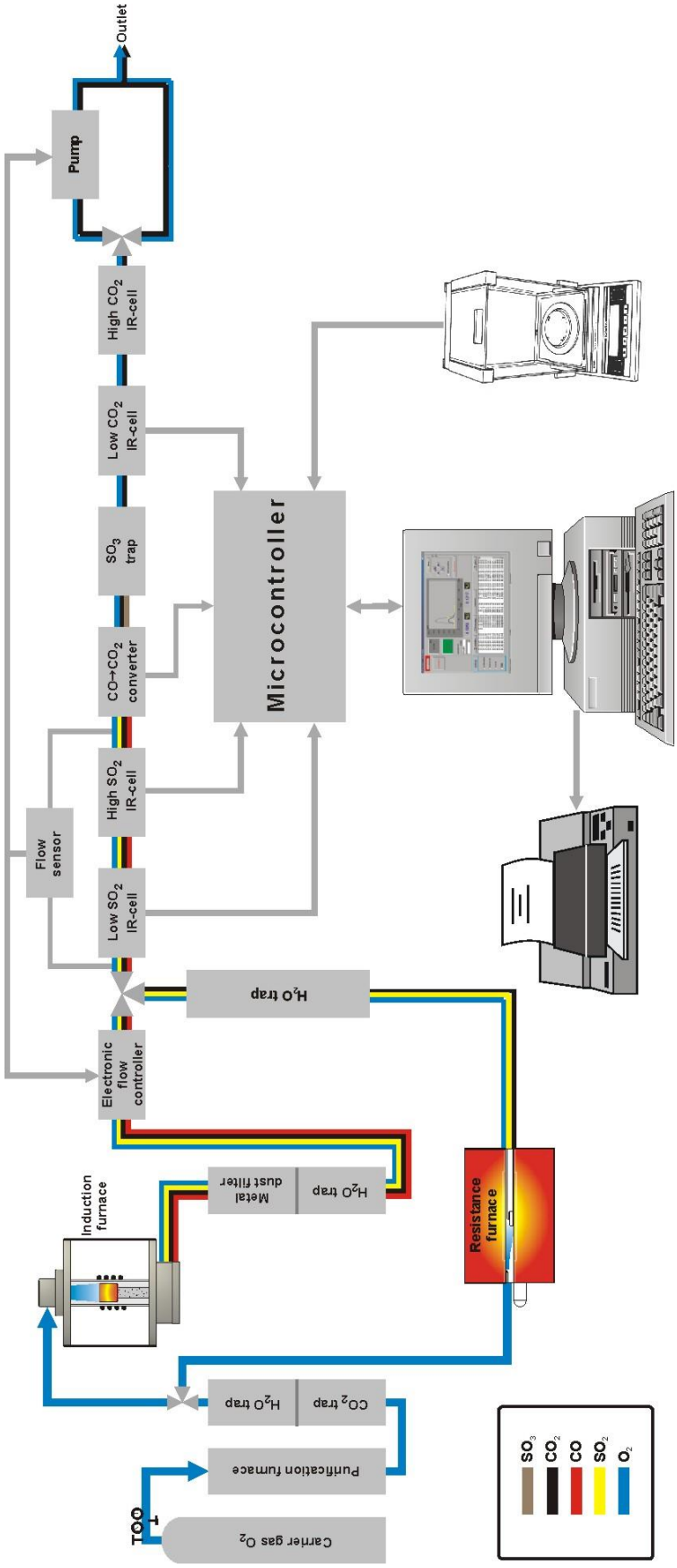


Fig. 51: Gas flow system

7.4 Infrared cell

The measuring principle is based on the infrared radiation absorbing properties of many gases. Each of these gases absorbs specific characteristic spectral wavelengths of infrared radiation. The absorption spectrum is determined by the number, configuration and type of the atoms in the gas molecules.

Graphic: Infrared cells with flexible measuring range

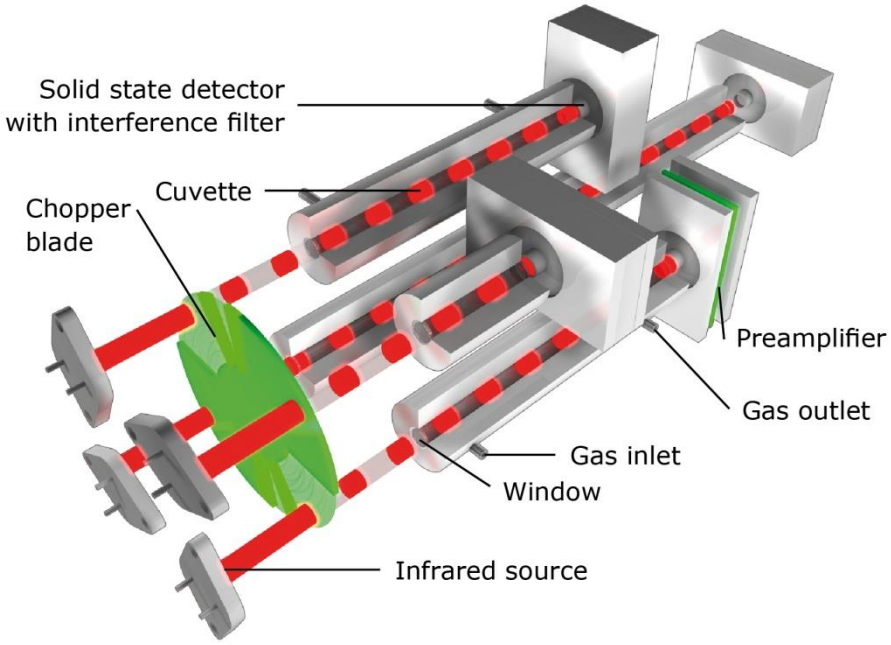


Fig. 52: Infrared cell

An infrared source is electrically heated emitting wide band infrared radiation. The radiation is interrupted by a rotating chopper blade, resulting in an alternating light. The chopper is crystal controlled, so that the chopper frequency is very stable. The infrared radiation then passes thru the measuring IR-paths, thru which a mixture of combustion gases and carrier gas flows. Depending on the composition of the gas mixture, certain frequencies of the infrared spectrum are absorbed. The rate of absorption depends on the concentration of the gases.

As the infrared beam exits the IR-path, it passes through an infrared filter which allows a narrow band only of the infrared radiation to pass thru. This narrow band must correspond to the IR wavelength which is absorbed by the gas which is to be measured. The loss of intensity of the radiation on the IR sensor after this filter corresponds to the concentration of this gas in the absorption path. The electrical signal given by the sensor corresponds to the intensity of the radiation and therefore to the gas concentration in the absorption paths. Since the beam is interrupted by the rotating chopper, as mentioned above, the detector has an alternating signal. Temperature and aging influences of the detector, as well as noise, are thereby suppressed. The signal obtained is amplified and rectified, so that the infrared cell output is DC voltage.

The detectors utilize solid state sensors combined with infrared filters. The sensors are not gas filled, thus eliminating long term problems due to gas leakage. The CS-2000 can be equipped with up to four independent Infrared cells.

The lengths of all four cells can be individually optimized to obtain maximum precision for the target C and S levels of the samples of each customer. Each of the cells can be installed with infrared absorption lengths ranging between 1 mm and 320 mm.

The infrared cell rack is temperature-controlled, so that the gas which flows through it, is kept at a constant temperature.

7.5 Furnace

7.5.1 Induction furnace

The combustion is carried out in a high frequency induction furnace. The sample is inserted into the induction coil of the oscillating circuit of the pedestal, then heated by high frequency induction and combusted by supplying oxygen.
By starting the analysis, the HF generator's high voltage supply is switched on. Inside the coil, a quartz tube is fitted to an upper and a lower holder. The gas flows downwards. The furnace inlet leads through a lance, which blows the oxygen for combustion directly into the crucible and onto the burning sample. When the sample is inserted into the furnace by the pedestal, the lower opening of the quartz tube is closed with the sealing cone.

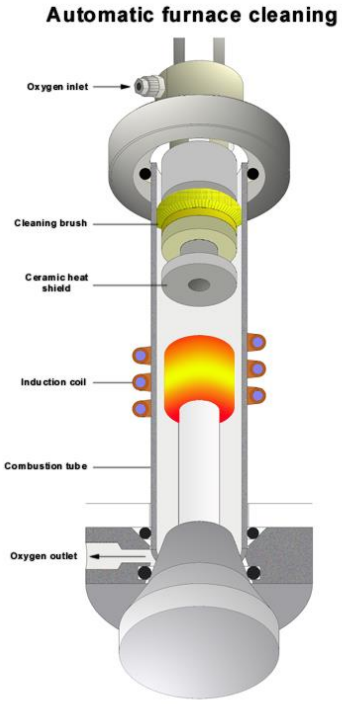


Fig. 53: Automatic induction furnace cleaning
The users of carbon and sulfur analyzers with induction furnaces know that dust accumulates during the combustion (mainly of iron and tungsten oxides) in the combustion chamber.
The CS-2000 induction furnace is cleaned automatically after each analysis, thus ensuring repeatable and accurate results. The cleaning mechanism is mechanically attached to the furnace open/close system, to ensure that the cleaning brush will not collide with the hot crucible.The cleaning brush will never burn. The efficient design of the cleaning mechanism rules out any possibility of the cleaning brush to burn.

– After each analysis start, a thyristor switches on the high voltage transformer "smoothly", to prevent any current surge in the mains power supply and therefore eliminating the risk of blowing any fuses.
– The induction coil is cooled internally with compressed air. The outside is cooled by a blower, which also ventilates the generator.
– The induction furnace uses standard ceramic crucibles, which are 1“ resp. 25 mm in diameter.

7.5.2 Resistance furnace

Description

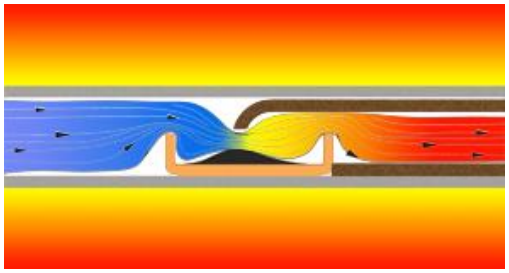
The temperature of the furnace is adjustable up to 1550°C. The combustion tube has an inner diameter of 27 cm and a hot zone of about 200 mm. The temperature, which is digitally displayed, can be adjusted with an accuracy right down to 1°C. The platform on the front-side of the furnace serves to carry samples for the analyses, as well as hot combustion boats, after been removed from the furnace. Inside the furnace inlet there is a gas supply lance for supplying oxygen into the furnace.

Temperature adjustment

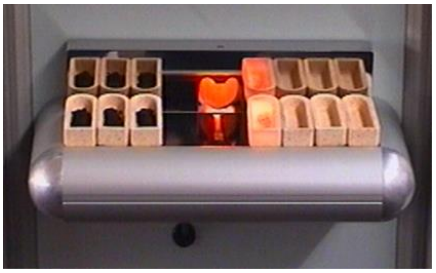
The resistance furnace HTF-540 employs silicon carbide heating elements. Full electronic control includes current limitation during cold-start conditions to promote long element life. A separate sensor is used to monitor ambient temperature and to provide data for automatic reference point compensation ensuring that the furnace temperature is not affected by fluctuations of the ambient temperature. The furnace requires approximately 10 to 15 minutes to reach its operating temperature.

Combustion efficiency

The design of the furnace boat-stop guaranties that the oxygen carrier gas enters the combustion boat, ensuring efficient combustion. This design eliminates the need of fragile lances and honeycomb boat stops which tend to block easily with ash. Additionally the boat stop protects the combustion tube from aggressive combustion products, thus extending the service life of the tube.



The combustion tube is a simple straight ceramic tube that is robust and inexpensive to replace. The life expectancy of the tube is hundreds of analyses.
(protected by German utility model).



A variety of combustion boats can be used including the reusable ceramic boats (L=57mm, W=22mm, H=13mm). Porcelain or quartz boats are also an option.

Preheating crucibles

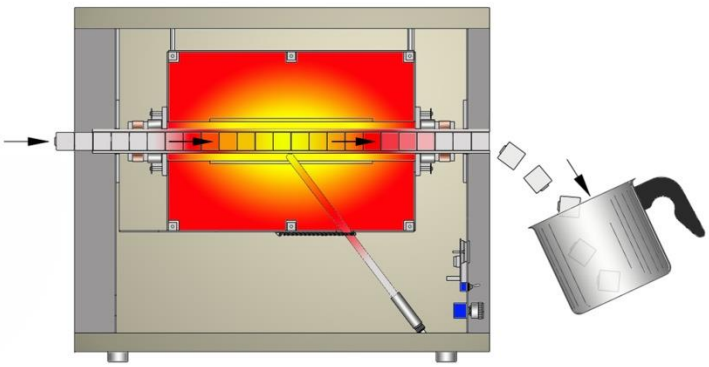


Fig. 54: Preheating furnace

The HTF-540 can be used for preheating of ceramic crucibles for induction furnaces. The crucibles have the standard size of 25mm (1”) diameter and are used for combustion analysis of carbon and sulfur in solid materials. The preheating reduces the blank value of the crucibles.

This is important for analysis in the very low ppm range. The crucibles are inserted into the furnace tube and they remain preheated in the tube until needed. Each time a crucible is needed, a new one is inserted into the tube, and a preheated crucible falls out the other end of the furnace tube. The recommended pre-heating temperature is between 1250°C and 1350°C. For preheating crucibles the boat stop is removed.

8 Miscellaneous

8.1 Ordering numbers

8.1.1 Front side

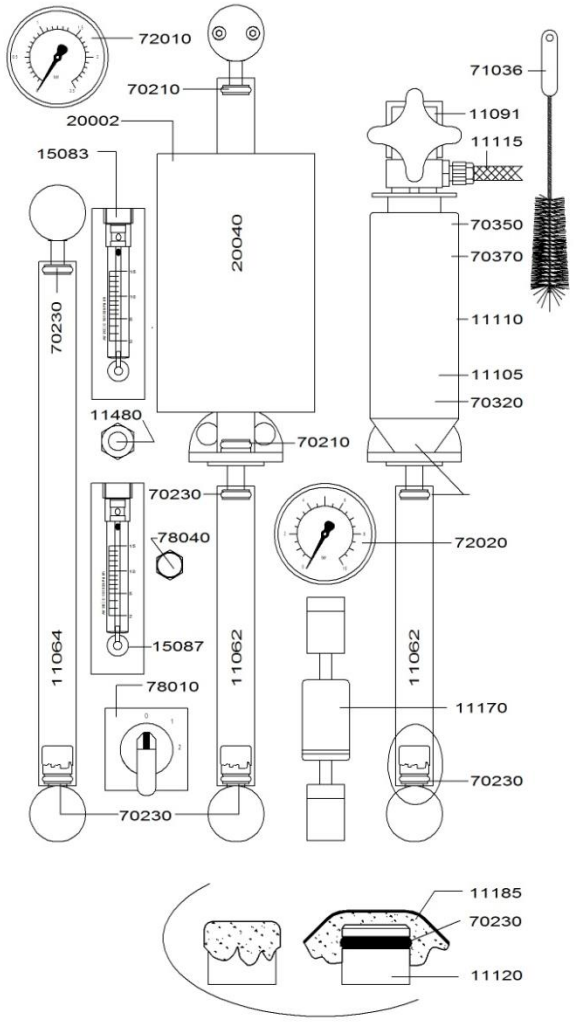


Fig. 55: Front side

Part No.	Description
05000	IR-cell
11170	Dust cartridge
11390	Oxygen solenoid valve
11400	Pressure outlet solenoid valve
11415	Oxygen stop solenoid valve
11430	Purge solenoid valve
11440	Bypass solenoid valve
11492	Pressure regulator
11492	Inlet pressure regulator
11495	Purge pressure regulator
12016	Gas flow and furnace control board HF 42
12044	Transformer

16100	Power supply board NK 31
18467	Microcontroller board UNI

8.1.2 Left hand side

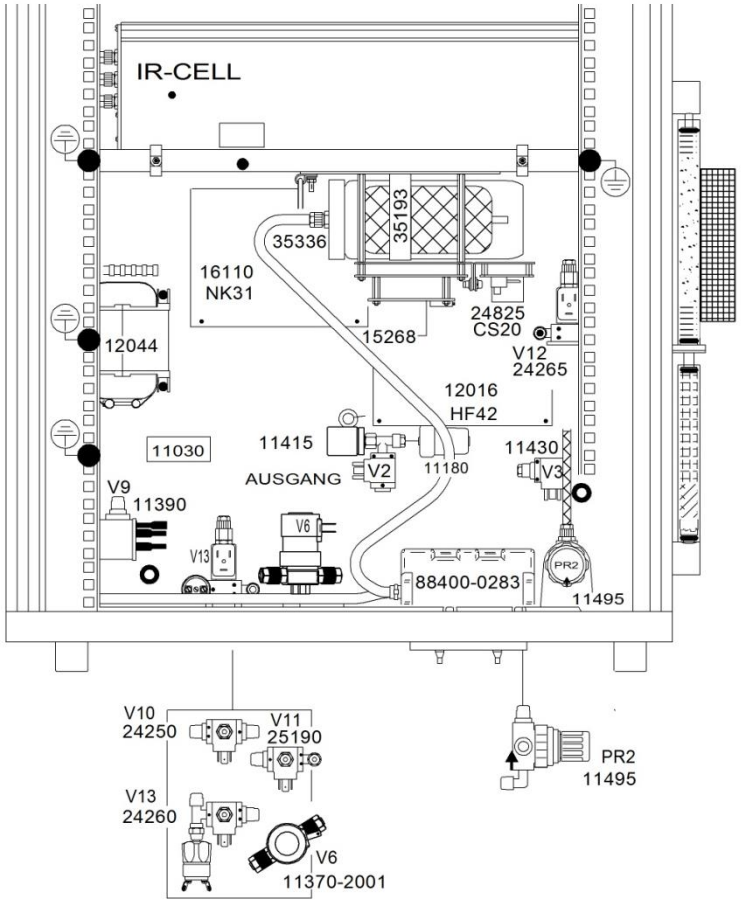


Fig. 56: Left hand side view

Part No.	Description
11180	Dust filter cartridge
1370-2001	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

8.1.3 Right side

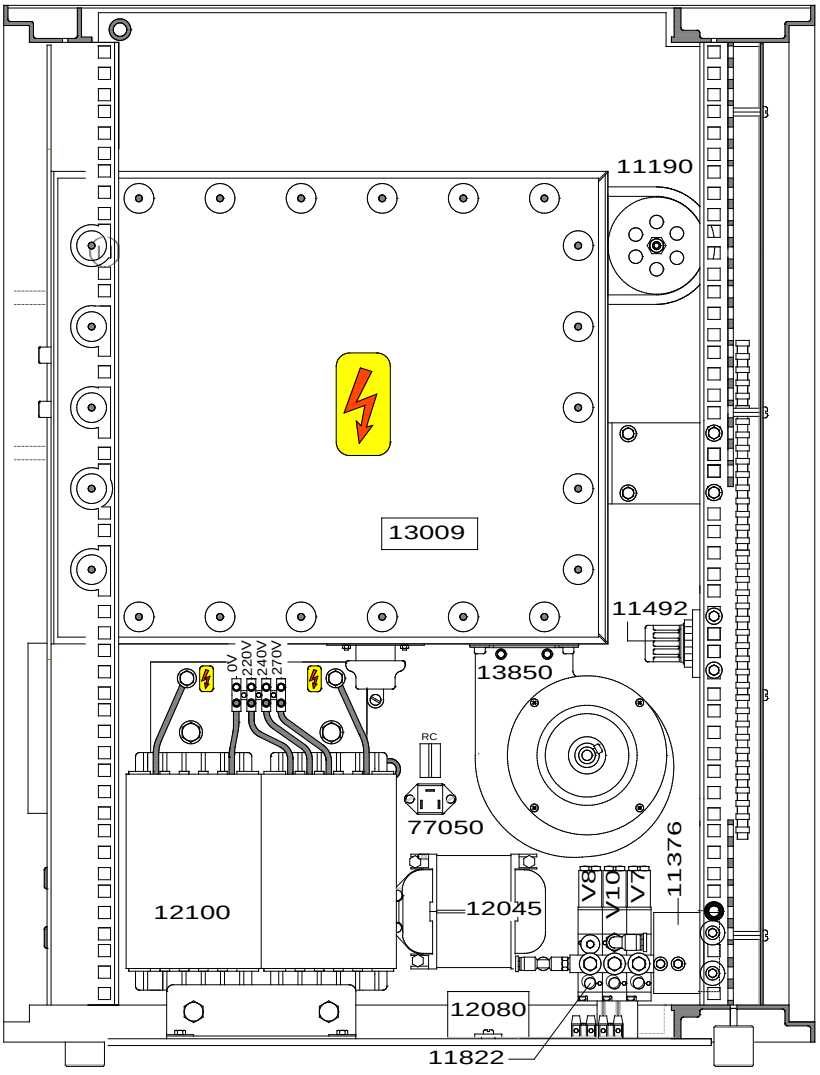


Fig. 57: Right side

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

12045	Transformer
12080	Rectifier
12100	Transformer

8.1.4 Pneumatics

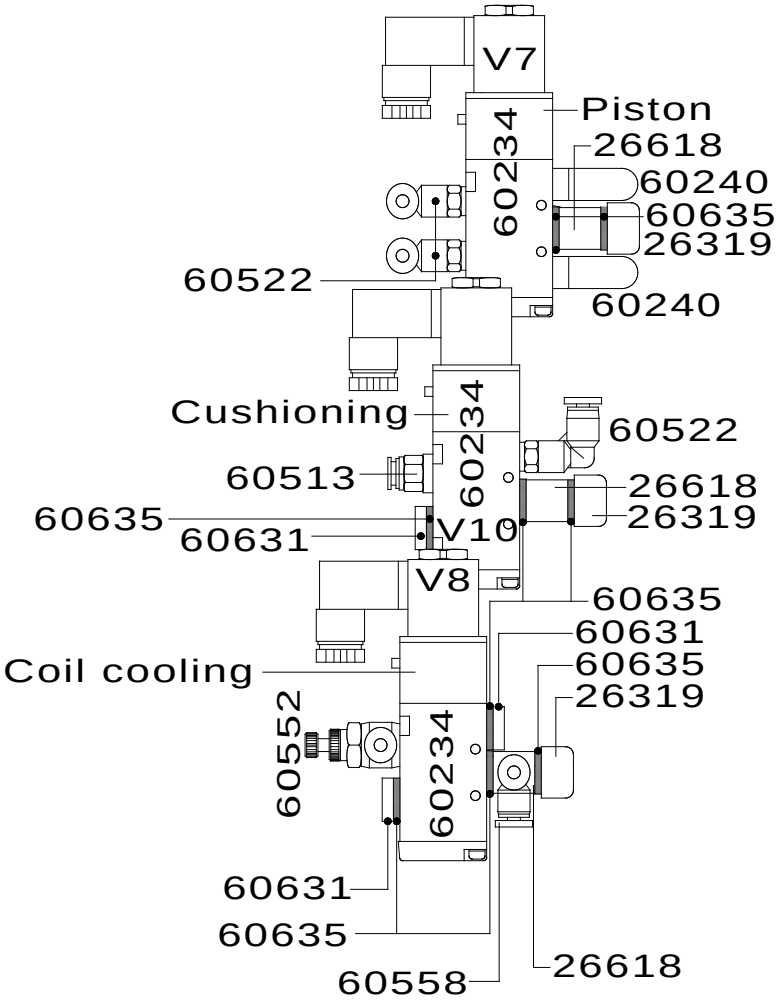


Fig. 58: Pneumatics

Part No.	Description
26319	Hollow screw
26618	Valve block
60234	Pneumatic valve
60240	Silencer
60513	Fiting
60522	Fiting
60631	Closure
60635	Seal

8.1.5 Oscillating circuit

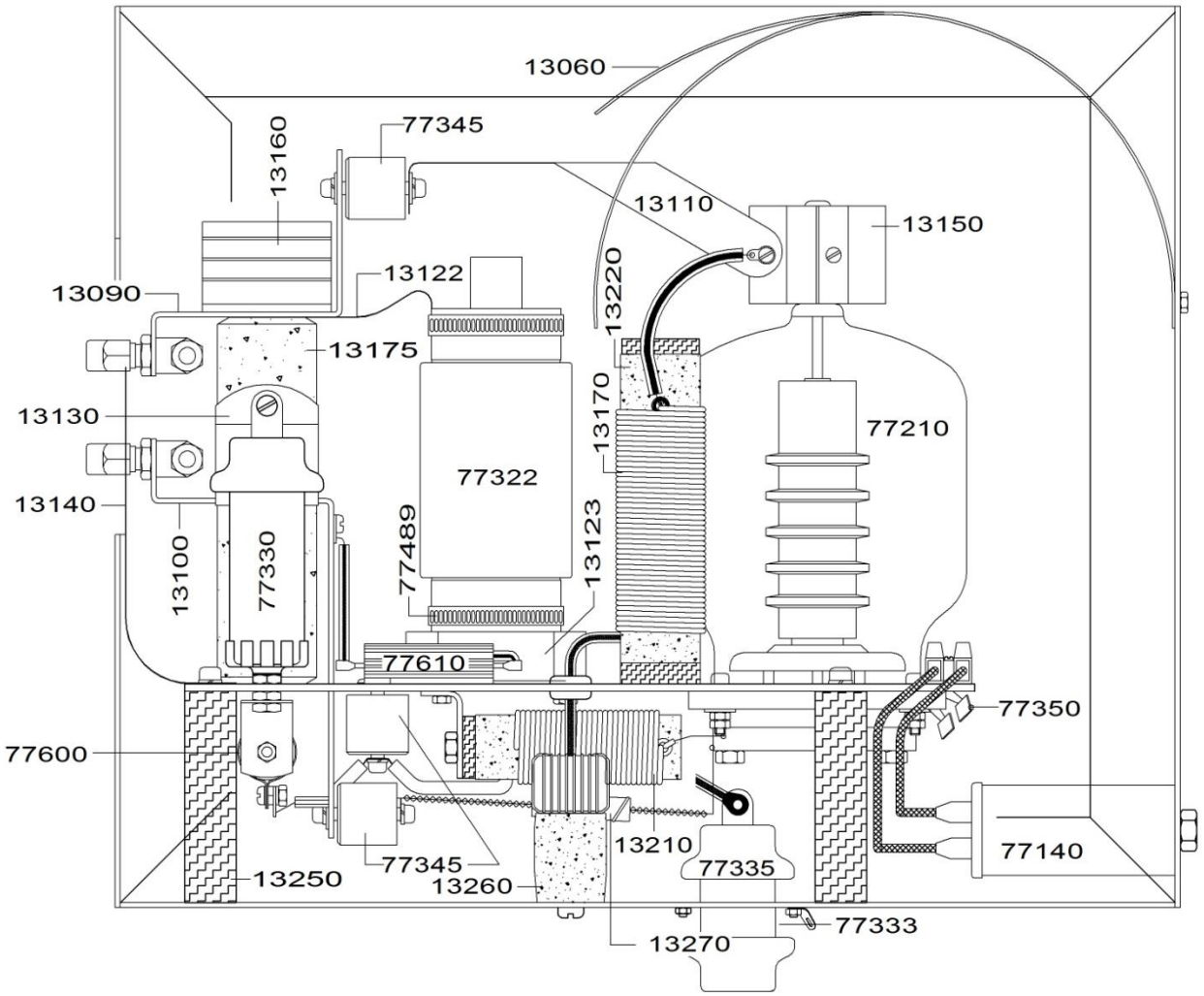


Fig. 59: Oscillating circuit

Part No.	Description
13060	Protection sheet
13081	Capacitor support
13090	Upper coil connector
13100	Lower coil connector
13110	Anode connector
13122	Capacitor connector
13130	Capacitor connector
13140	Ground connector
13150	Anode 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

8.1.6 Furnace

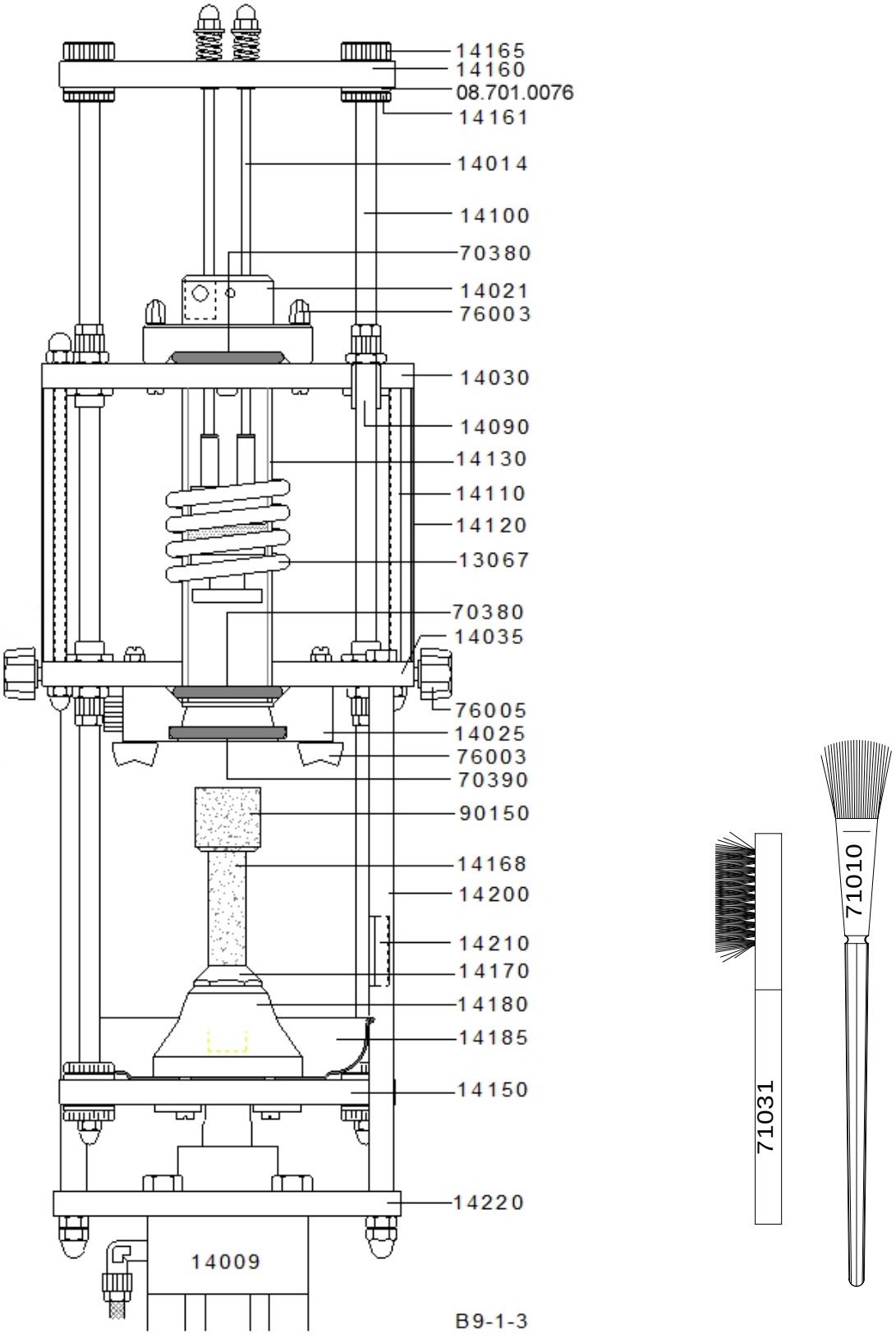


Fig. 60: Furnace

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
76003	Wing nut
76005	Knurled nut
90150	Crucibles
08.701.0076	Washer

8.1.7 Furnace cleaning mechanism

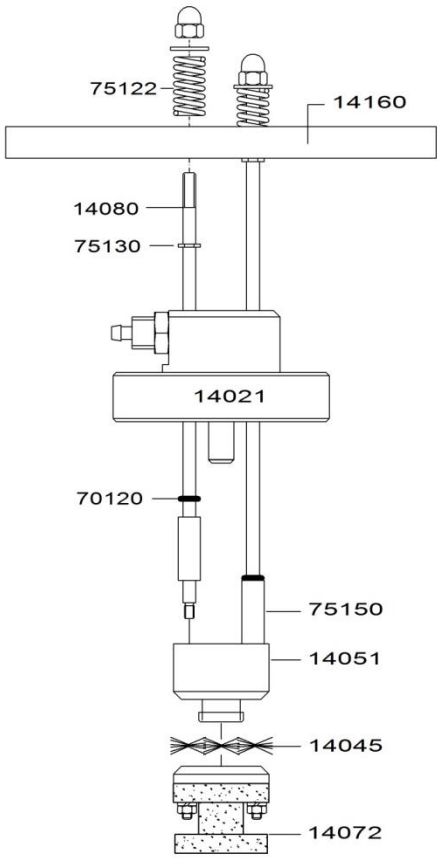


Fig. 61: Furnace cleaning mechanism

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

8.1.8 Gas purification furnace

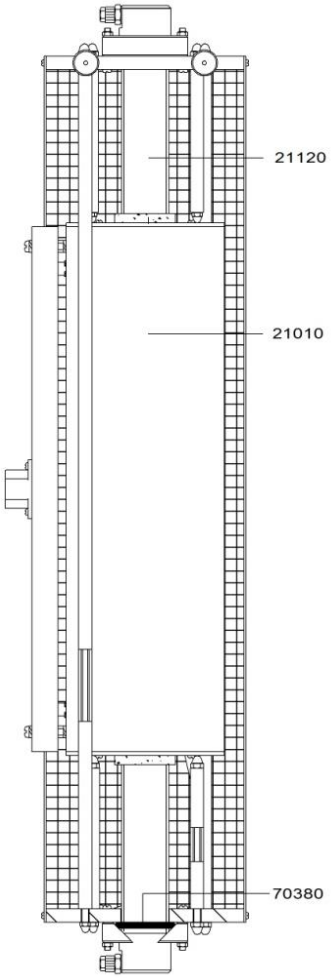


Fig. 62: Gas purification furnace

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

8.1.9 Front side and rear side

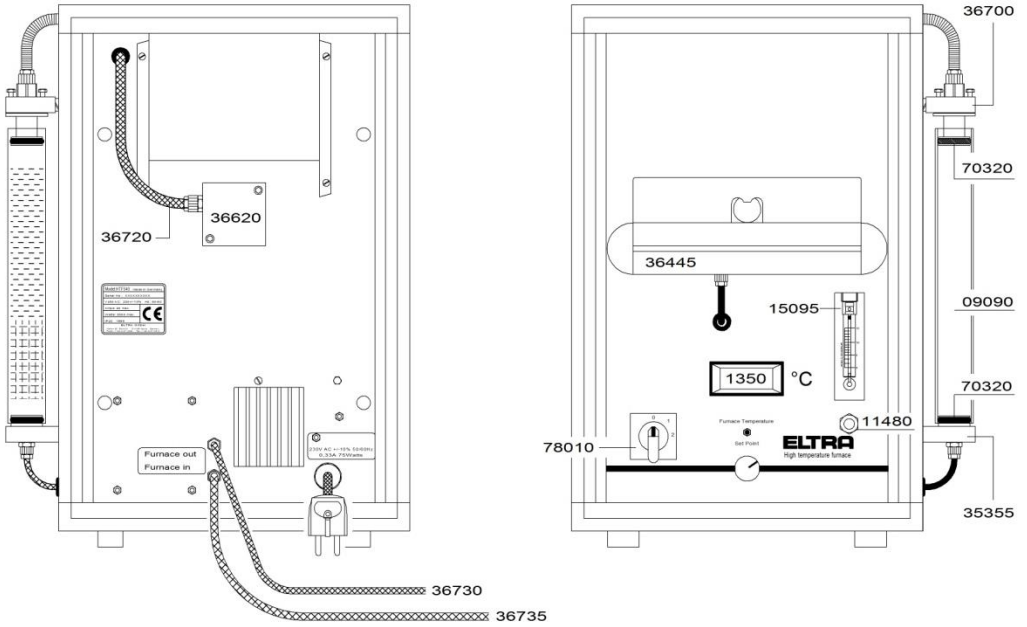


Fig. 63: Front side and rear side

Part No.	Description
09090	Reagent tube
11480	Adjustable restrictor
15095	Flow display 600l/h
35355	Lower reagent tube connector
36445	Platform
36700	Upper reagent tube connector
36730	White tube
36735	Black tube
70320	O-ring
78010	Mains power switch

8.1.10 Restistance furnace details

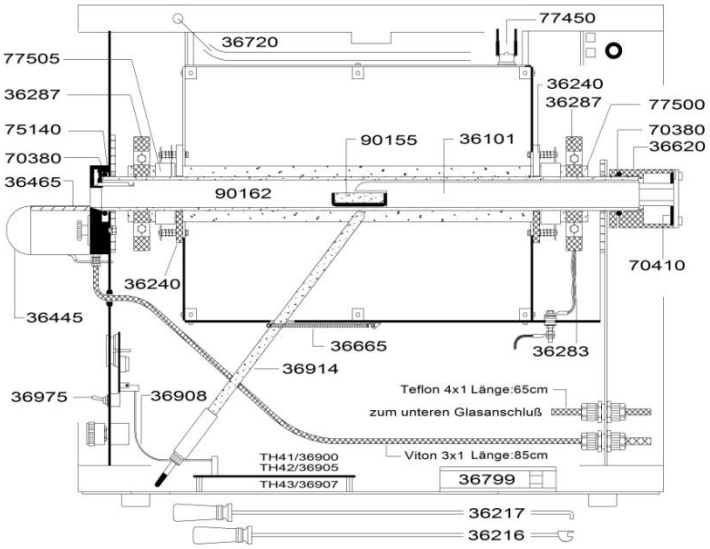


Fig. 64: Resistance furnace details

Part No.	Description
36101	Boat stop
36216	Combustion boat insertion stick
36217	Combustion boat removing stick
36242	Ceramic plate
36283	Heating element connector
36445	Front panel for the combustion boat
36465	Platform 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
77500	Heating elements, 4 pcs
77505	Ceramic spacer, 4pcs
90155	Combustion boats
90162	Combustion tube

Remark

*: 36907: temperature control board TH43 is an older version 36904 Temperature control board is a later version and fully compatible.

8.1.11 Furnace tube cleaning

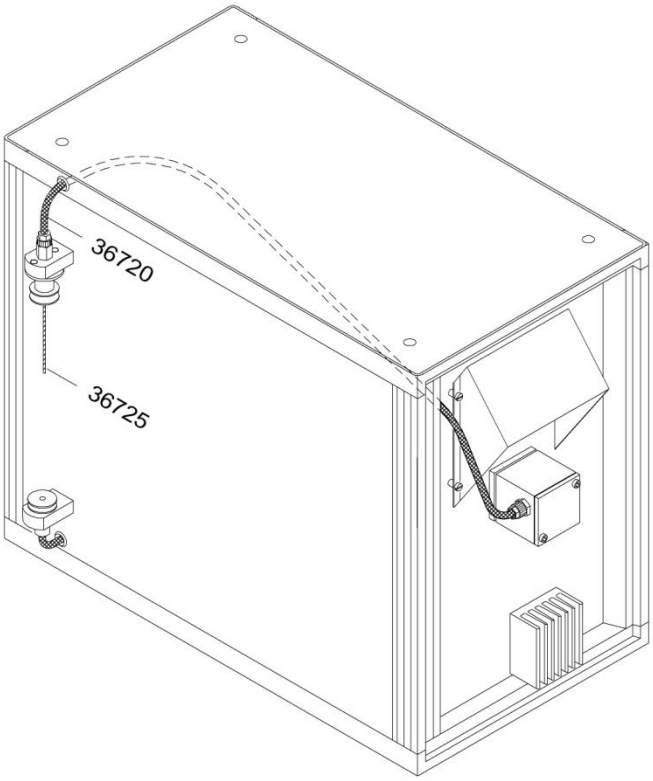


Fig. 65: Gas outlet tube

Part No.	Description
36720	Furnace outlet tube
36725	Cleaning tube

8.1.12 Tic-module

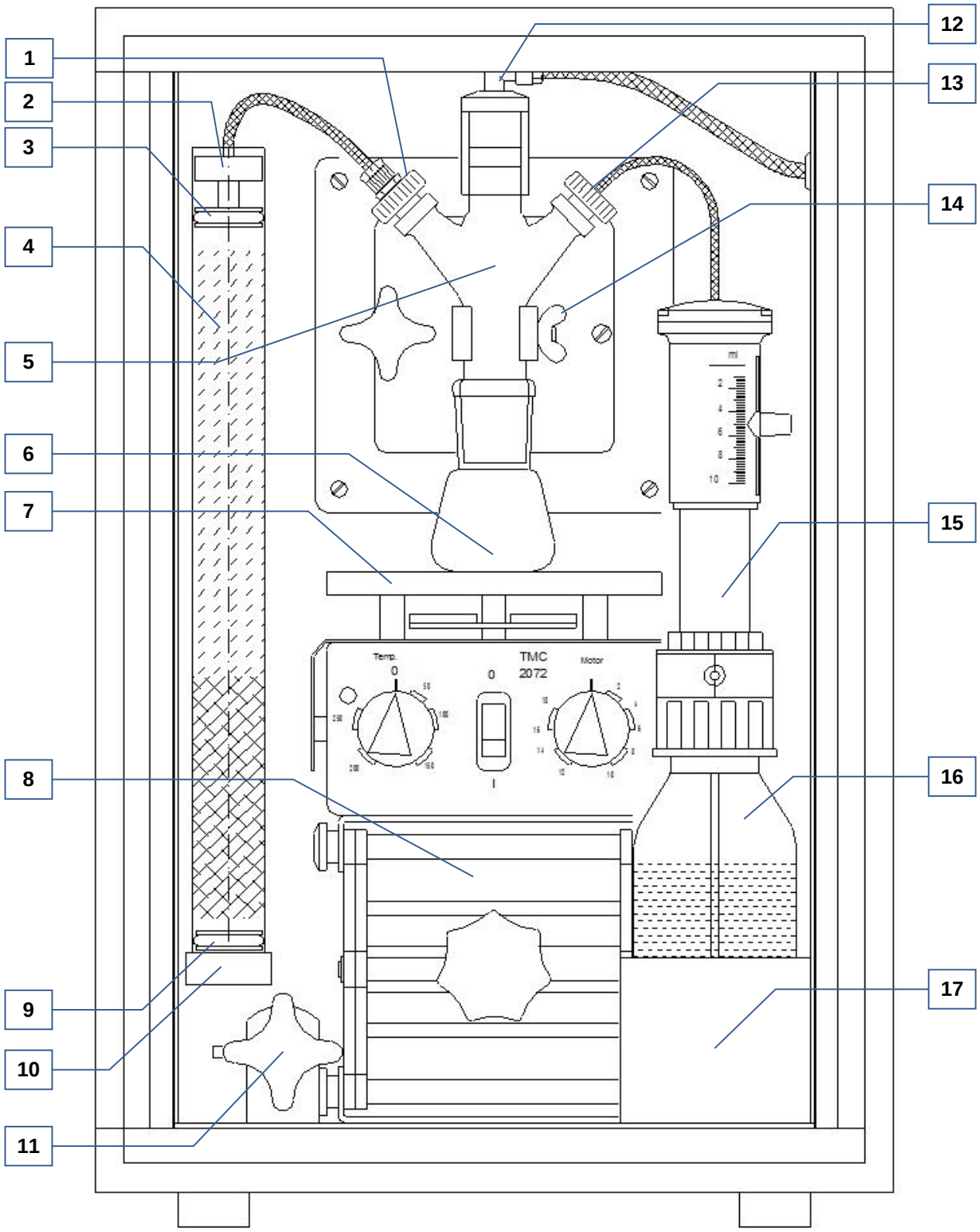


Fig 66: TIC-module [35543-9008]

No.	Description	Part No.
1	Glass stopper (connection to the analyzer)	38225
2	Upper moisture trap connector	11042
3	O-ring 9*3	70230
4	Moisture trap	11064
5	Glass distributor	38200
6	50 ml glass flask	90900
7	Heater with magnetic stirrer	71070
8	Support with variable height	38400
9	O-ring 9*3	70230
10	Lower moisture trap connector	11045
11	Geared mechanism	38850
12	Glass stopper (connection to the furnace)	38227
13	Glass stopper (connection to the acid supply)	38220
14	Glass support	38340
15	Dispenser Assimat	71065
16	Acid bottle	71060
17	Bottle support	38677

8.2 Packing

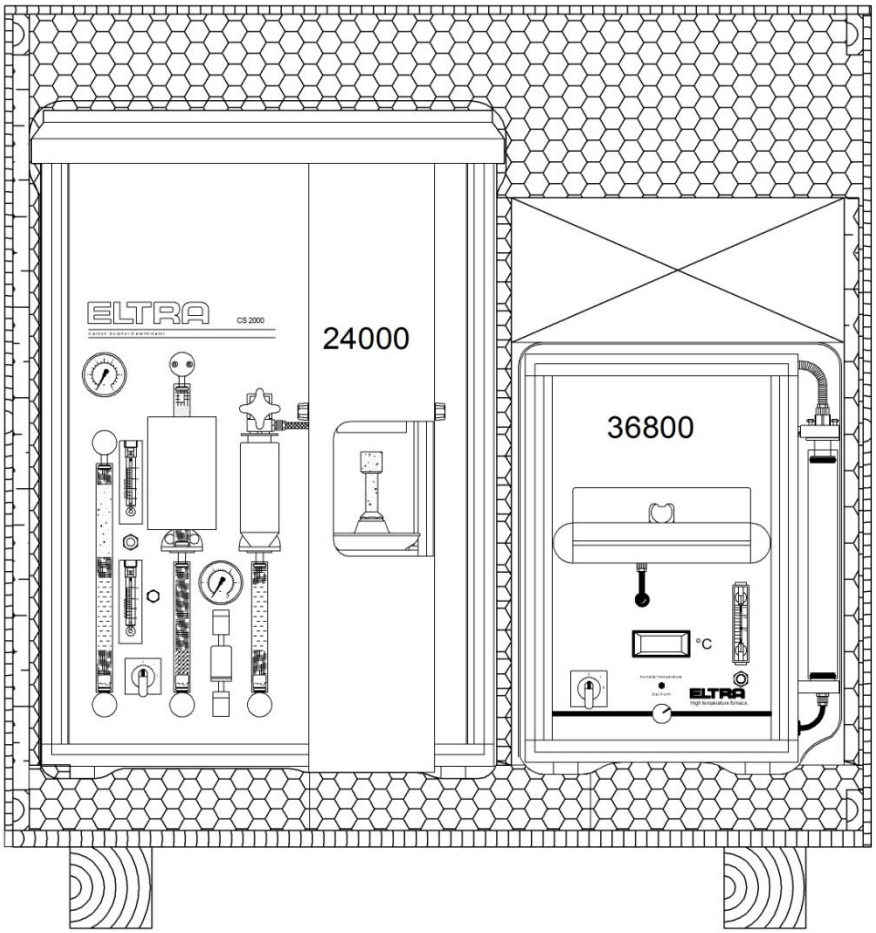


Fig. 67: Packing

Before packing, the analyzer and furnace must be wrapped in plastic foil, to protect it from moisture and dust, and then to be placed in a wooden case. The wrapped analyzer should be surrounded by a layer of foam (chips) of at least 10cm, in order to avoid any damage due through transportation.
Especially the foam where the analyzer is placed on, is very important. It should neither be too hard nor too soft. When the foam is too soft, the analyzer will practically touch the wood. Fix the foam on the bottom of the wooden case by gluing.
The analyzer and the furnace should be wrapped in plastic foil, especially when you use chips or any other kind of material in small pieces. The glass tubes must be empty.
In case of transportation by vessel, use a seaworthy crate.
Packing is done as follows:

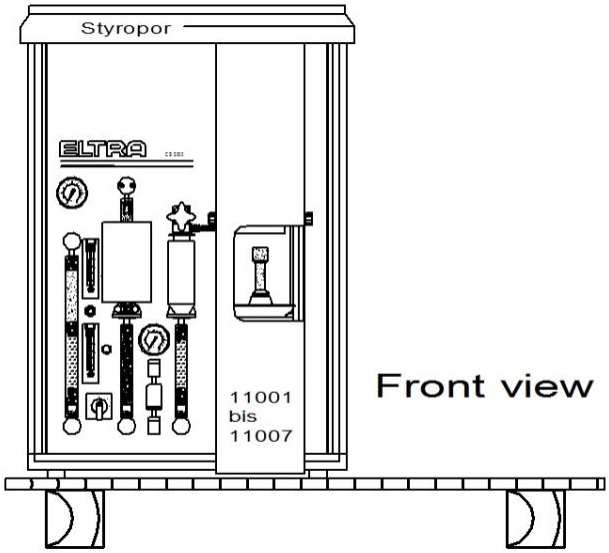


Fig. 68: Packing-Front view

- Place the analyzer directly on the pallet with the right side towards the middle of the pallet, because the furnace and the transformer are the heaviest parts of the analyzer.

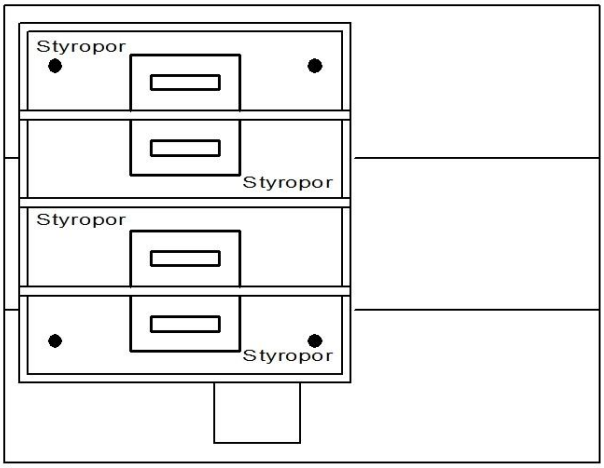


Fig. 69: Packing-Top view

- Shift the analyzer to the exactly required position.

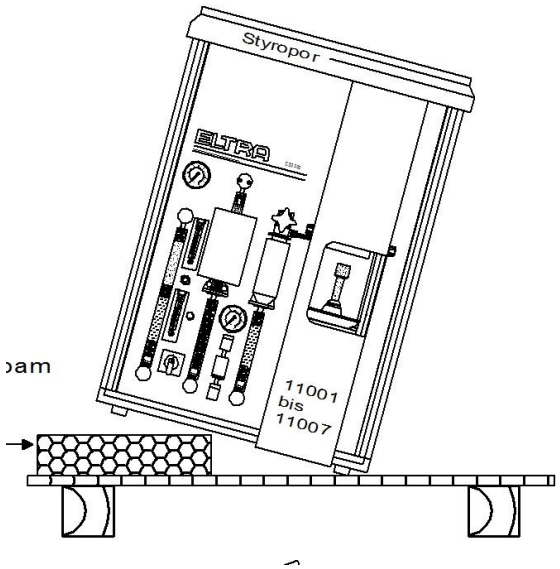


Fig. 70: Packing-Foam I

- Tilt the analyzer to the furnace side and place a piece of foam at the right position.

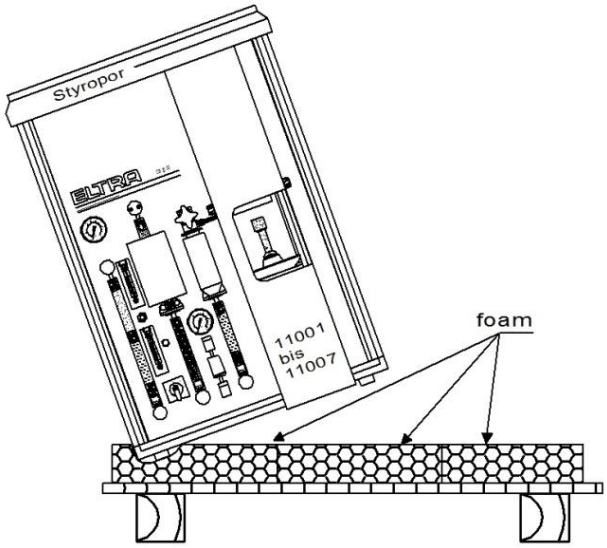


Fig. 71: Packing-Foam II

- Tilt the analyzer to the other side and place the second piece of foam at the right place. If necessary, a third piece of plastic foam can be placed on to the pallet.

8.3 Pre-installation guide

W15.0021

⚠ WARNING

Fire hazard / Risk of burns

Hot parts (crucibles, reagents,...) can fall down

- Ignition of tables, floors, or any other surface the hot part falls on
- Ignition of clothes and any other material

- **Set up the analyser in a flame retardant environment. Pay special attention to the table, the floor and any other surface being in the near of the analyzer**
- **Always wear suitable clothing**
- **Keep the work environment clear of all materials that could catch fire**

Following requirements apply, when installing the analyzer:

Carrier gas	Oxygen 99.5% pure; 2 - 4bar (30 - 60psi)
Compressed air	4 – 6 bar (60 - 90psi)
Mains power supply :	
Analyzer:	230VAC ±10%, 50/60Hz; 16A fuse (CEE-Plug 230V, 16A)

Resistance Furnace:	230 VAC ±10%, 50/60 Hz; 20A fuse CEE-Plug 230V, 32A

Analyzer dimension	560 x 780 x 600 mm (WHD)
Furnace dimension	340 x 525 x 600 mm (WHD)
Analyzer weight	approx. 140 kg.
Furnace weight	approx. 38 kg.

– It is important to install the instrument on a stable place.
– The balance should rest on a vibration free support.

Gas connections:
The supplied tubes carry a connector with G¼" inner diameter ".

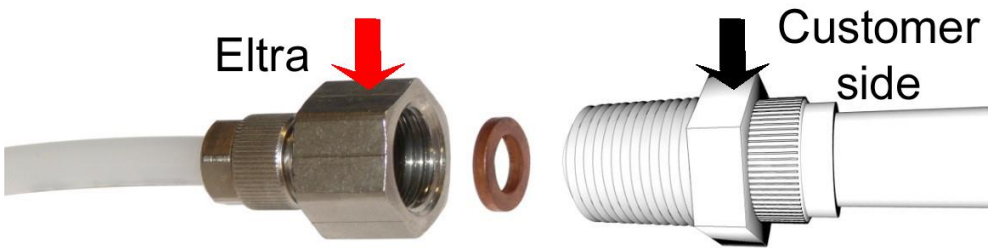


Fig. 72: Carrier gas tube

Connections for compressed air:
The tubes supplied together with the analyzer, carry a connector with G¼" inner diameter.

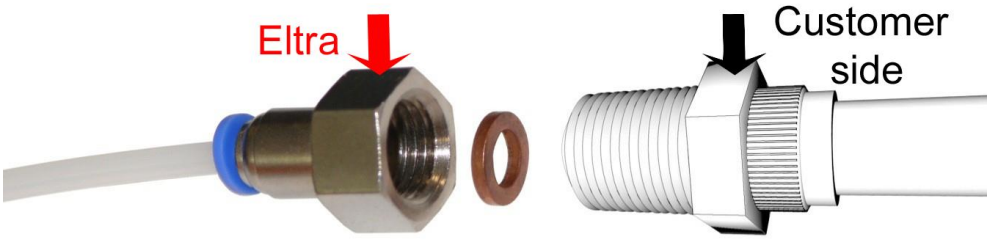


Fig. 73: Compressed air tube

9 Approved methodologies to which Eltra instruments conform

9.1 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

9.2 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

10 Disposal

NOTICE

N5.0079

Disposal of the Elementrac packaging
Please refer to your country's packaging disposal guidelines and, if applicable, your company's packaging guidelines.

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:

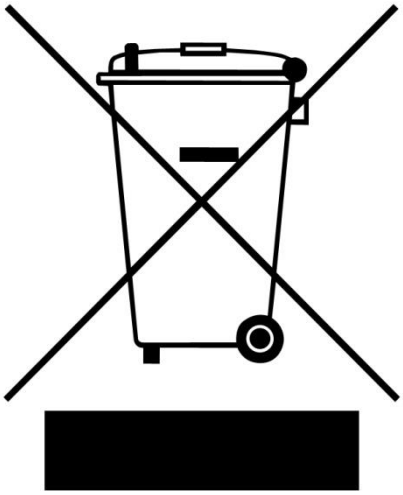


Fig. 74: Disposal label

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

11 Index

ELTRA
ELEMENTAL ANALYSERS

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