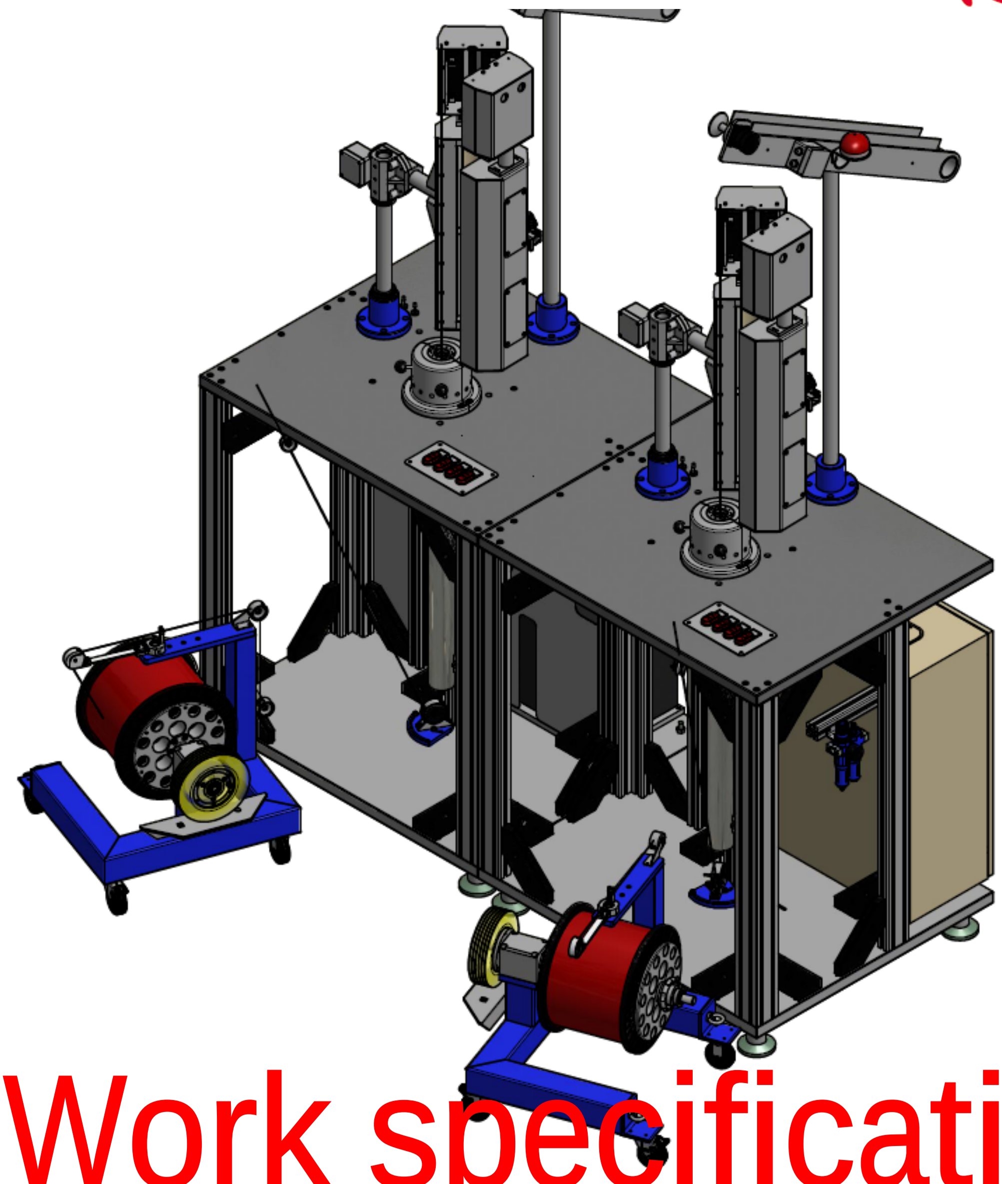
11 / 2015



Work specification spiral production

Work specification spiral production

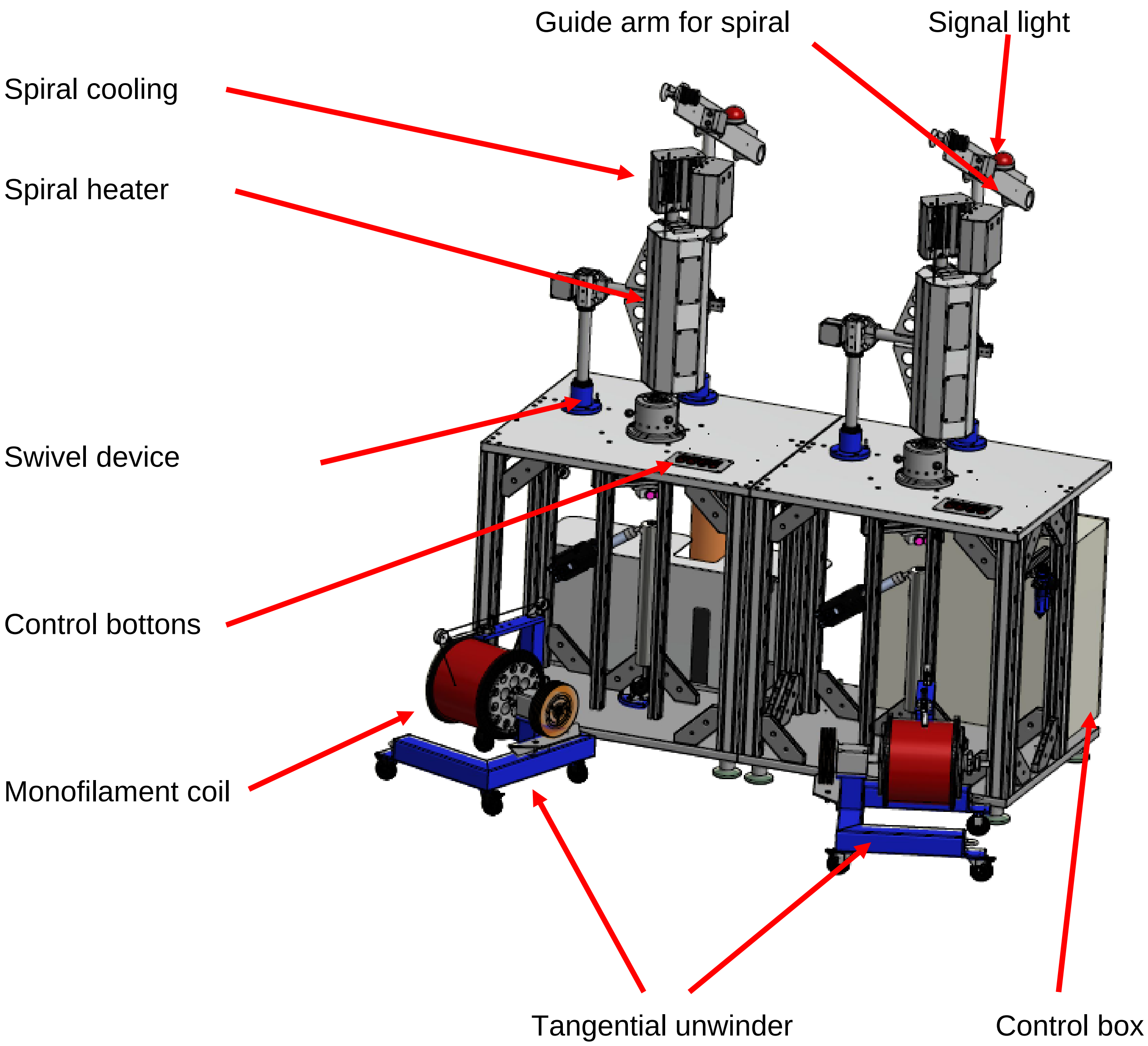
Index

Work specification spiral production

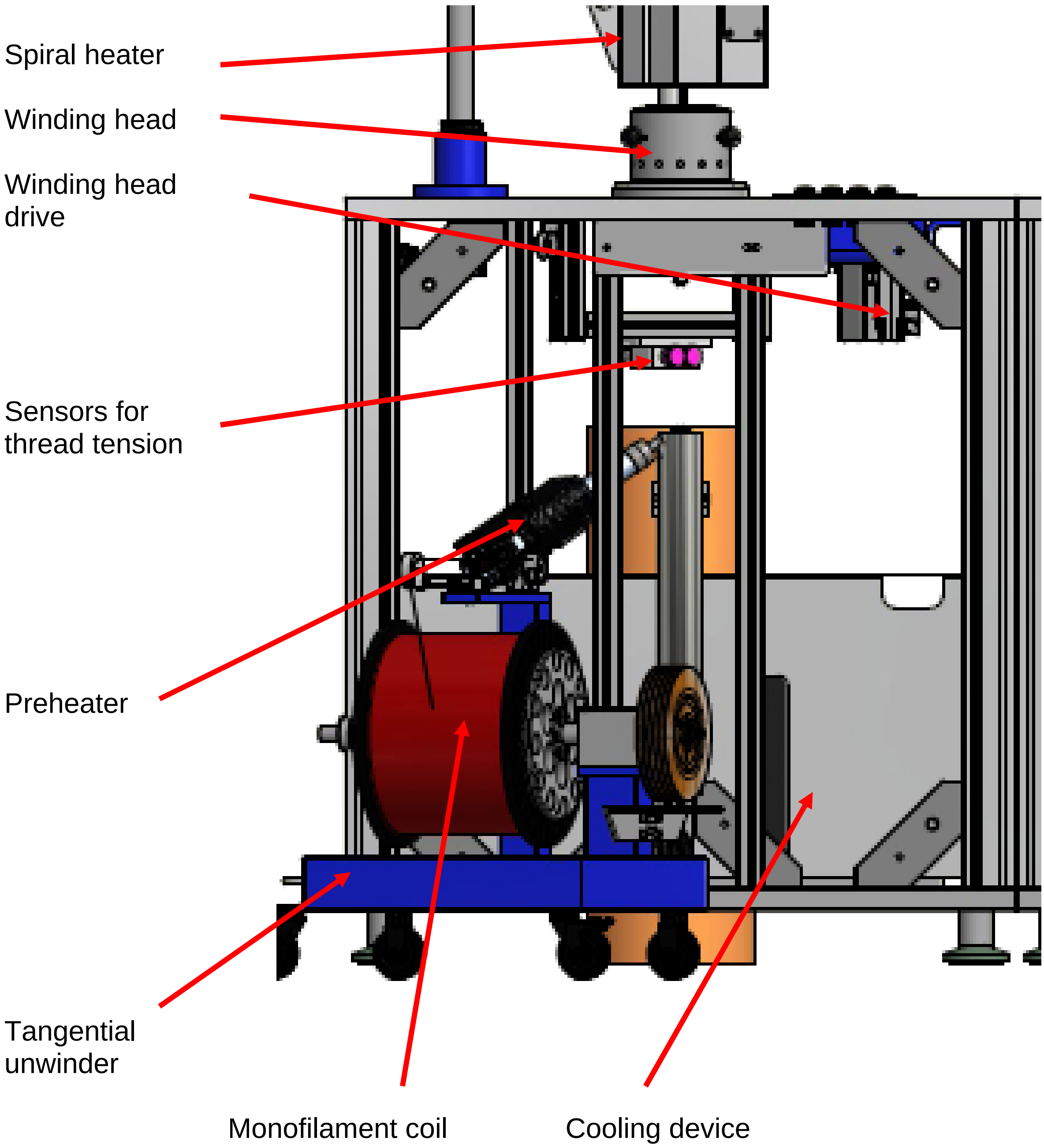
1.0 Layout of the spiral machine

The spiral machine produces spirals for the manufacture of spiral sleeves. Round monofilaments made from various plastic types with various diameters (e.g. PET, PPS, PA, etc.) are used as source material.
Monofilament will also be referred to in the following as ***thread*** or ***spiral wire***.

Complete machine overview



Interior view (left side of the machine)

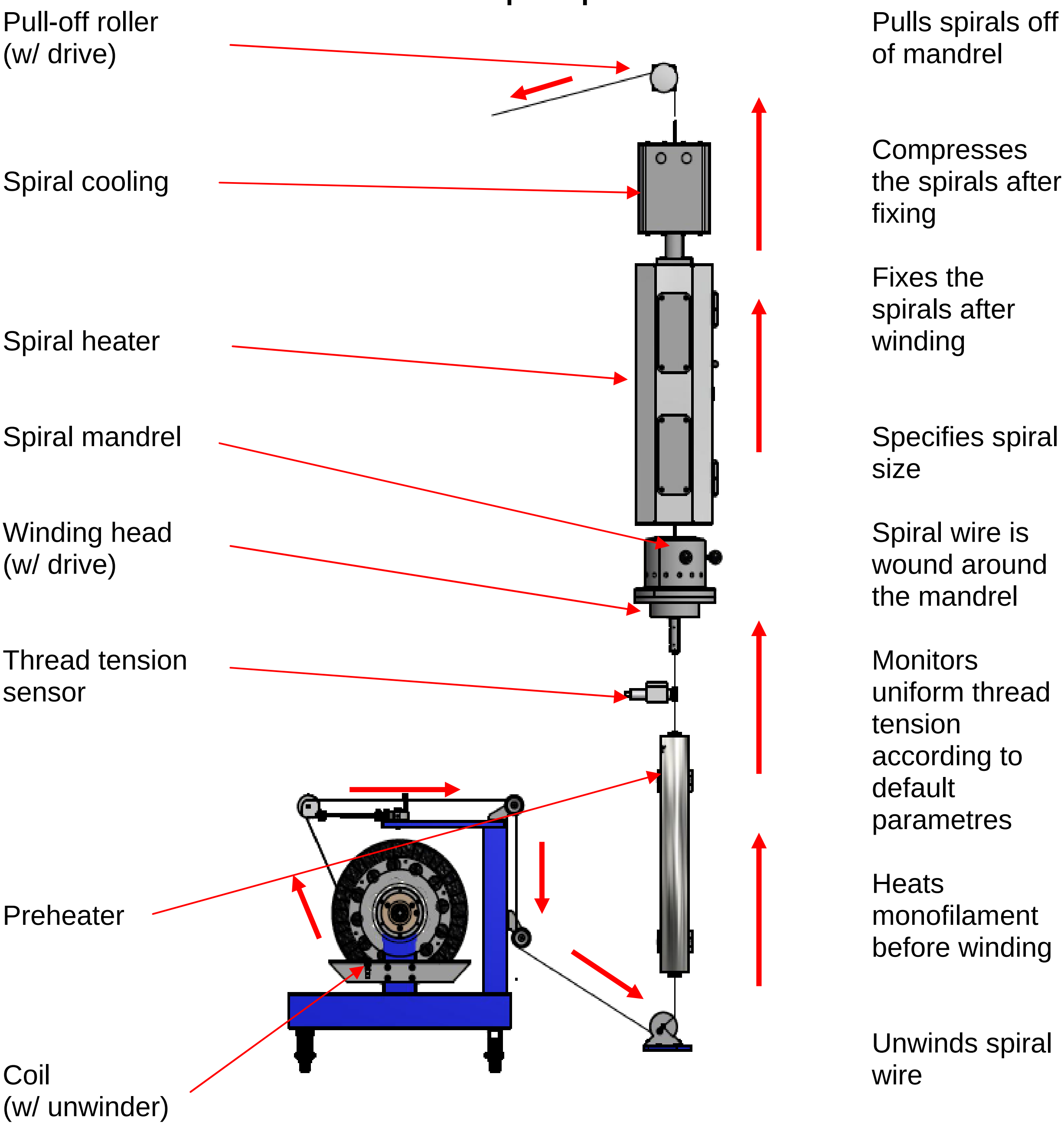


2.0 Functioning of the spiral machine and process flow

2.1 Overview and terms

The explanations of the following terms are listed in the order of the monofilament/spiral flow through the machine i.e. from bottom to top.

Functional principle



The high-performance spiral machine essentially consists of two independently operating spindles, allowing for the production of monofilament spirals with round cross-sections. Spirals can be simultaneously wound to the left and right.

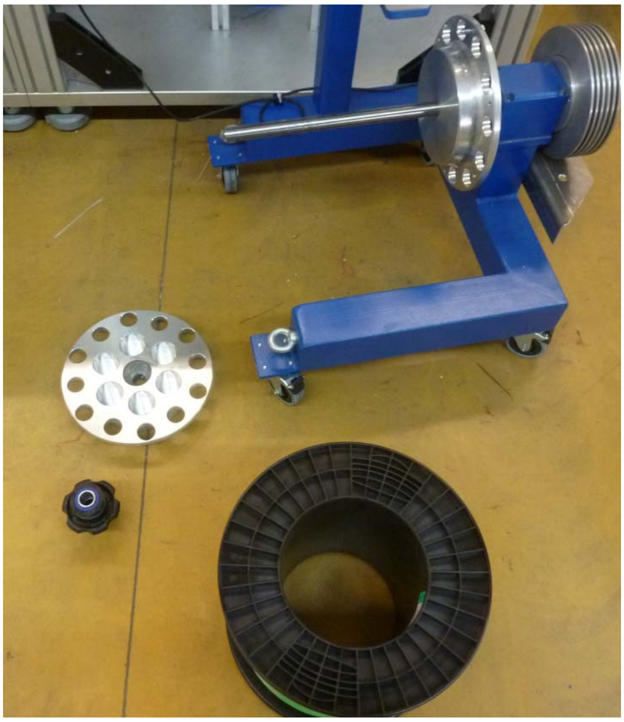
High performance spiral machine
with independently operating right and left spindles

2.1.1 Coil

All monofilaments are processed on a K335 coil. The maximum winding of the coil is between 7kg and 10kg depending on the shape and diameter of the wire.

2.1.2 Tangential unwinder

The tangential unwinder serves the uptake of the coil. During the winding process, it guides the spiral wire from the coil (2.1.1) through the various guides and rollers to the spiral preheater (2.1.3).
Working with the wire tension sensor (2.1.4), it also ensures consistent, uniform tension of the spiral wire. In other words, the tangential unwinder also acts as a brake.



2.1.3 Spiral preheater

The spiral wire is preheated in the spiral preheater. The temperature is set, monitored and controlled using the controls depending on the material to be processed.
After exiting the preheater, the thread continues on to the thread tension sensors (2.1.4).

2.1.4 Thread tension sensors

Using the thread tension sensors, the controls constantly adjust the current thread tension with the parameter values specified in the controls and regulates it via the tangential unwinder. Depending on the material to be processed, there are two measuring ranges:

1= up to 10 N
2= up to 60N

2.1.5 Winding head

The spiral wire enters the winding head from below where it is wound around the spiral mandrel (2.1.6). The process speed is set with the drive. Depending on the diameter of the spiral wire, rotational speeds of up to 7,500 rpm are possible.

2.1.6 Spiral mandrel

Depending on the type of spiral wire used (dimensions and material) and the predetermined spiral dimensions, spiral mandrels with various dimensions can be used. The spiral wire wound around the mandrel through the winding head “spirals” up to the mandrel with each rotation. The length of the mandrel passes through the heater to just below the pull-off roller at the top of the machine. All mandrels included with this machine have uniform intakes, making them easily interchangeable.

2.1.7 Heater

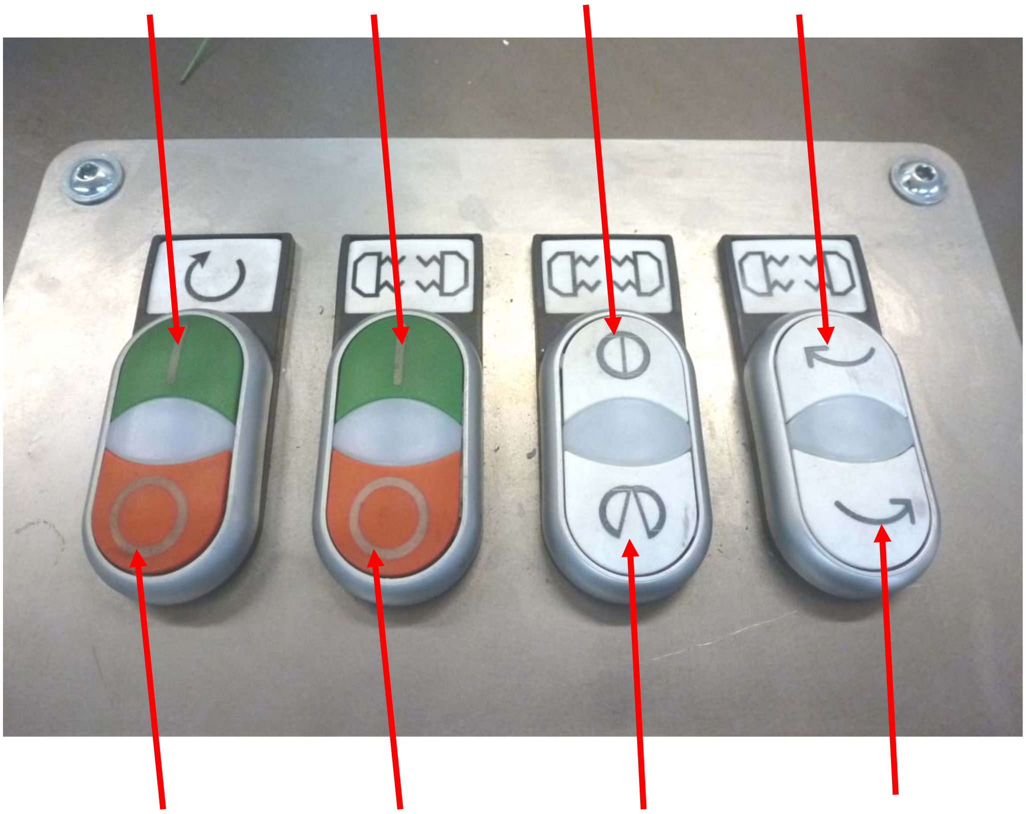
The spiral that traverses the mandrel is fixed in the heater. Heating the spirals prevents them from twisting or uncoiling when leaving the mandrel.
The two-part heater housing contains ceramic infrared heating elements. The controls monitor the temperature in the heater via two thermocouples. If necessary, the controls regulate the temperature in the heater.
The heater is preheated before the process begins. When the target temperature is reached, the winding process can be started. The target temperature is set in the process parameters.
The idling heater (closed and swung backwards) is then pneumatically opened (image 01) and pneumatically turned to the spiral mandrel where it is closed again (2). The heater now surrounds the spiral mandrel with the spiral feeding in from below during the winding process. The heater's motion sequence is controlled manually with the button on top of the machine.

Heater image 1

Heater image 2

2.1.8 Control panel

A control panel is located on both sides of the machine.
These are only used to carry out the machine's basic functions.



2.1.9 Spiral cooling

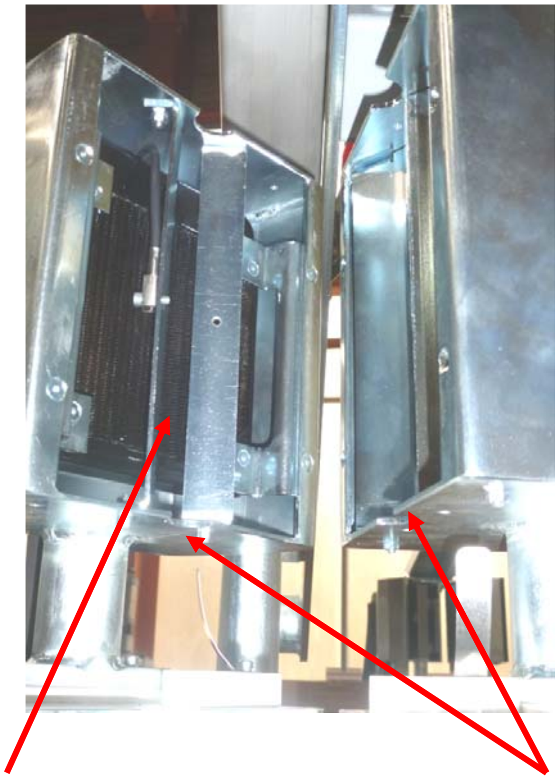
The spiral cooling primarily consists of three main components

01 = Two-part cooling housing

02 = Heat exchanger / thermocouple

03 = Cooling device

The heat exchanger and the thermocouple are built into the cooling housing.
The cooling is used to compress the wound spirals before they are passed into the cans (2.1.11). The housing is directly mounted onto the heater.



(02) Heat exchanger (01) Two-part cooling housing

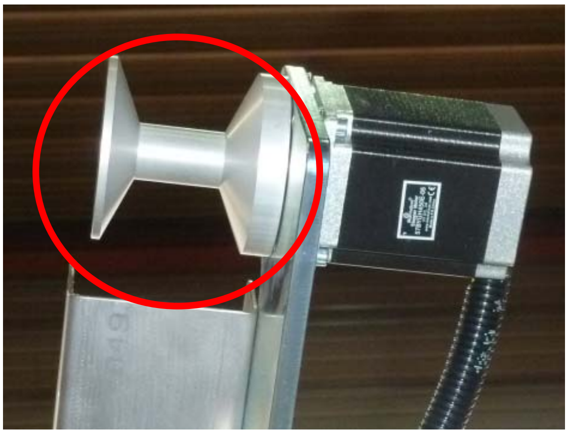
The cooling device (03) is located on the left side of the spiral machine and is mounted onto the floor plate next to the control box.
A cooling unit supplies two heat exchangers with coolant via insulated lines.

(03) Rear view of cooling unit

Coolant reservoir

2.1.10 Pull-off roller

The driven pull-off roller is located above the upper end of the winding mandrel. Depending on the process speed and pre-set pull-off value (mm/rev), the roller “pulls” the spiral up from the spiral mandrel and from there, the spiral moves down into a spiral can via a downward sloping guiding track (“slide”). The spiral can also be wound 1x to 2x around the pull-off roller in order to increase the tensile force.



2.1.11 Spiral can

“Cans” are placed behind the spiral machine to collect the spirals as they exit the machine.
The size of the plastic piping cans is selected to fit the amount of spirals coming off of a 7/10 kg coil.
The tops of the cans are fitted with slots into which the ends of the spirals are hooked.
In order to connect a spiral sleeve, the spirals are processed directly from the cans.

2.2 Description of the controls with push button and switching functions

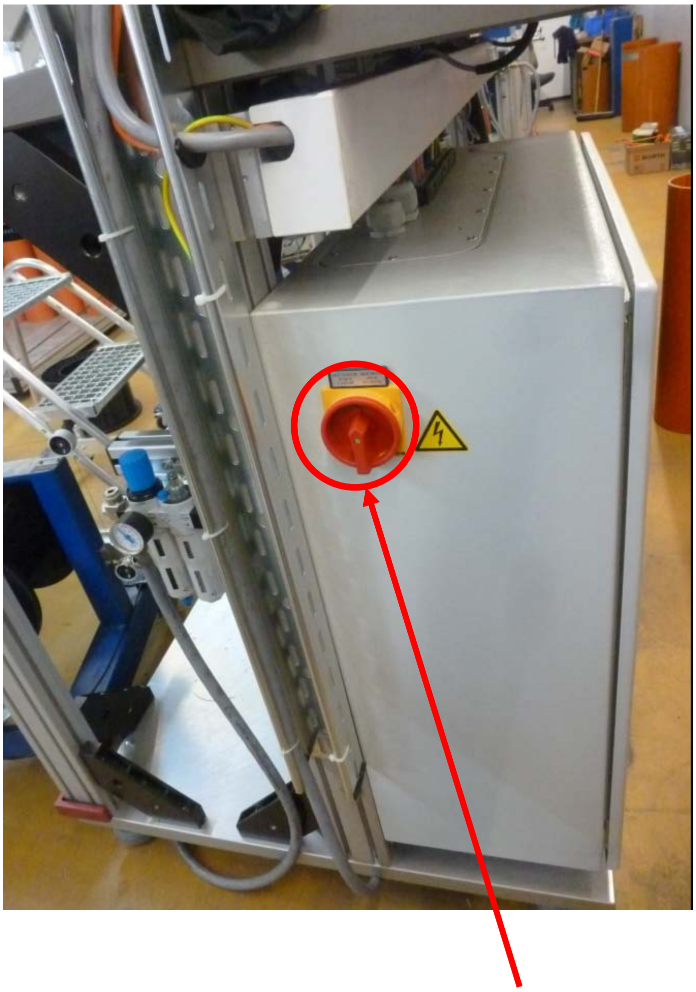
Several spiral machines are monitored via a control centre (server) and programmed via one central touch panel. A few buttons for starting the spindle and operating the heater – separate for each spindle – are located on the machine itself. All remaining functions – in particular the input and monitoring of parameter values – are controlled exclusively via the central touchscreen.
The corresponding station (machine with two spindles) is selected on the start menu (image 3.2.4.1).
All necessary parameters for this machine, depending on the spiral type to be manufactured, can now be read separately for each spindle, defined or changed on the following menu screen.

All important machine functions along with the current parameter values are displayed on the clearly laid out control menu screens in the respective menu areas.

Touch panel for operating spiral machines

2.2.1 Turning on the machine

After the machine is turned on with the main switch (located on the right side of the control box), the machine's internal operating system will boot up. Pushbuttons (2.1.8) can now be used to turn the heater on in order to use the machine set-up time for heating.



Main switch

2.2.2 Selecting the machine

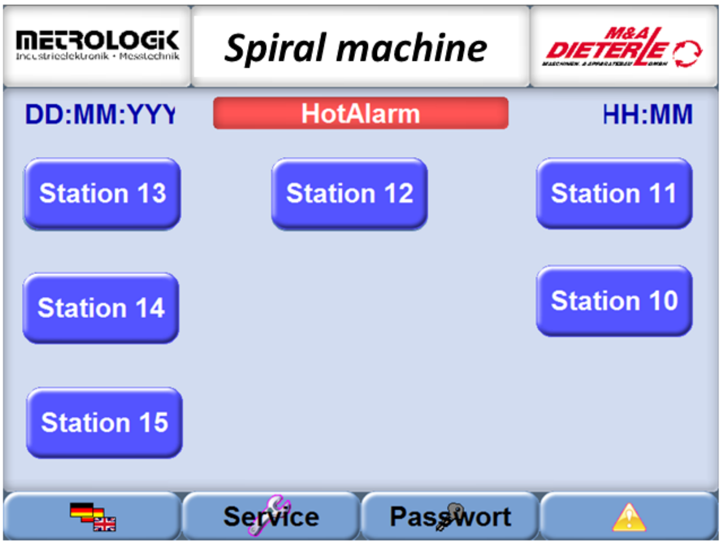
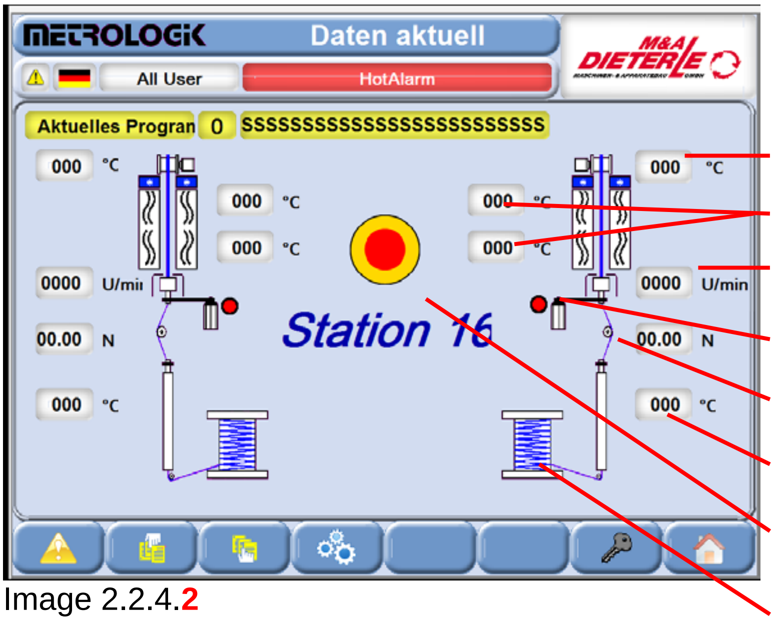
Each machine is displayed with a button on the central touch panel's start menu (image 2.2.4.1). After selecting the desired machine, its current actual values are displayed for both spindles (image 2.2.4.2).

2.2.3 Determining the spiral wire profile and winding direction

From the window with the actual values, the selected machine can be reached via the *parameter* button (gear icon) on the selection window (image 2.2.4.3). The rotating/winding direction for the respective spindle is selected here.

2.2.4 Input of production parameters

From the window with the actual values, the parameter window (fig. 2.2.3.4) for the selected machine can be reached via the *Parameter* button (gear icon). Here, the process parameters can either be pre-set or adjusted to requirements during the process.

Menu screen	Procedure
 Image 2.2.4.**1**	Select station / machine
 Image 2.2.4.**2** 🟢 = component functioning properly 🔴 = component defect	Display of process parameters and operating conditions *actual values* Cooling temperature Heater temperature Winding head speed Winding head drive Thread tension sensor Thread temperature Emergency stop activated Tangential unwinder

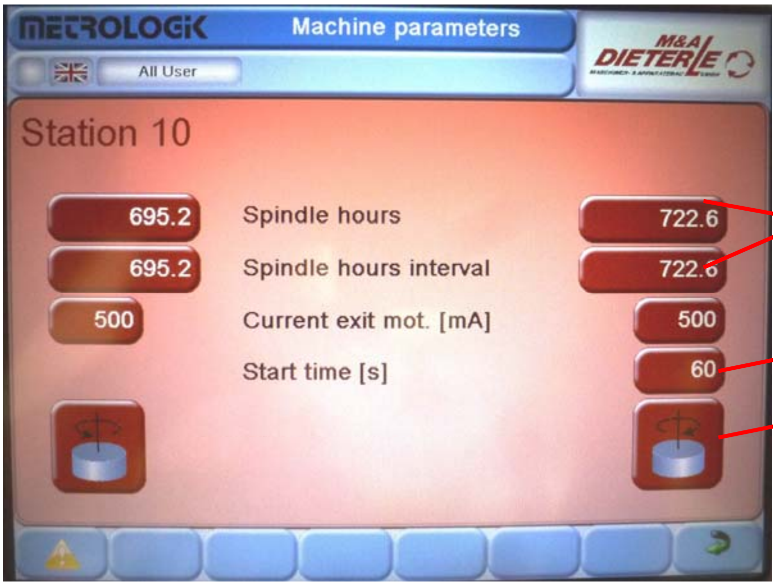
<table>
<tr><th>Menu screen</th><th>Procedure</th></tr>
<tr><td>


Image 2.2.4.3
</td><td>
The displayed spindle hours are for informational purposes

The start time is a fixed value

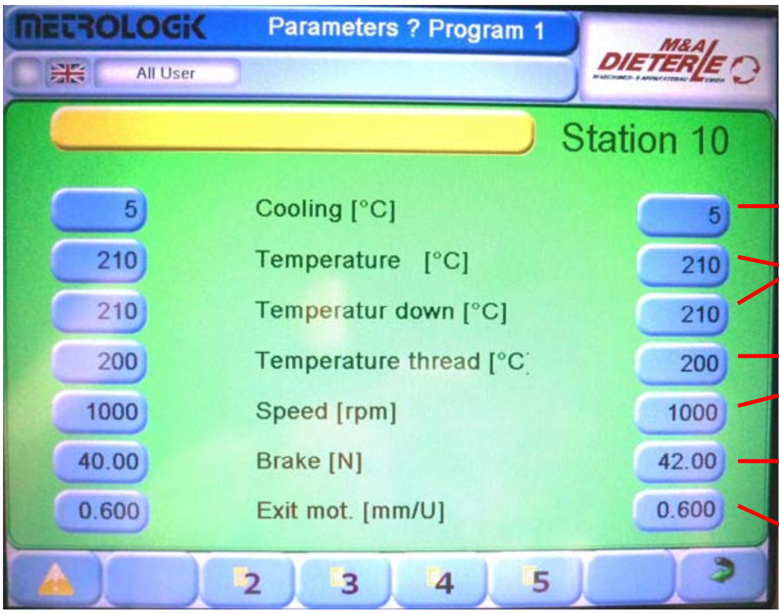
Select rotation direction
</td></tr>
<tr><td>


Image 2.2.4.4
</td><td>
Input of process parameters TARGET values

Cooling temperature

Heater temperature

Preheater temperature**
Winding head speed

Tangential unwinder

Pull-off roller

** value not identical with thread temperature!
</td></tr>
</table>

2.3 Setting up / adjusting machines and process start (operation sequence)

According to the planned process (*round or flat* spirals), different procedures are required when setting up and programming. The respective sequences are described in the following steps.

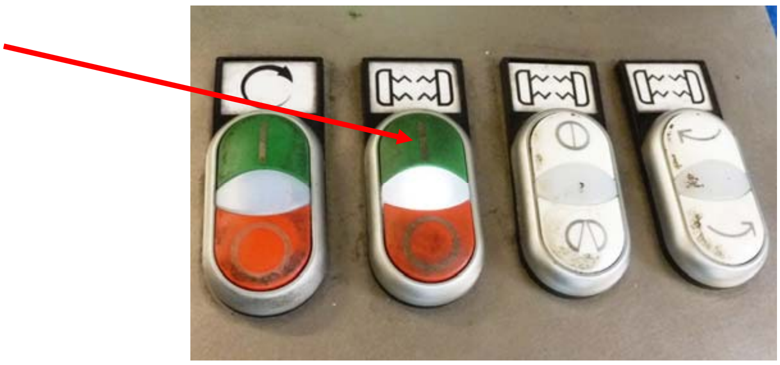
<u>*Initial situation:*</u> *machine is switched off.*
no coil mounted.

2.3.1 Preparatory work on the machine

Turn on machine with main switch.

The machine controls will now turn on independently.

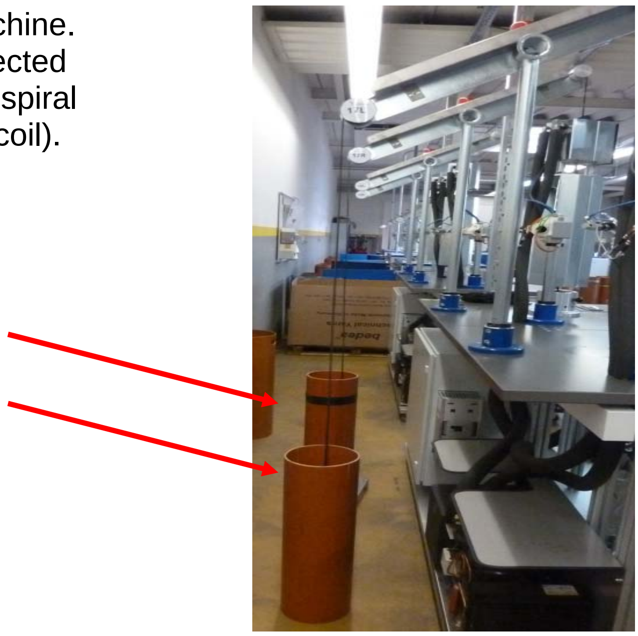
Turn on heater



Prepare tools:

- Scissors
- Brush
- Allen key

Place spiral cans behind the machine. Select size according to the expected spiral quanity (depending on the spiral size and the winding type of the coil).



2.3.2 Change spiral mandrel

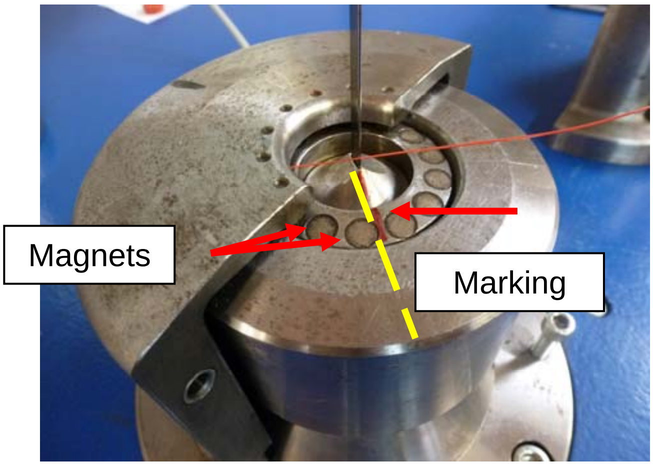
This procedure is only necessary for changing the spiral size or monofilament.

Long, 3mm and 6mm Allen keys are required for changing the spiral mandrel.

The two screws on the front cover of the winding head are loosened with the 6mm Allen key.

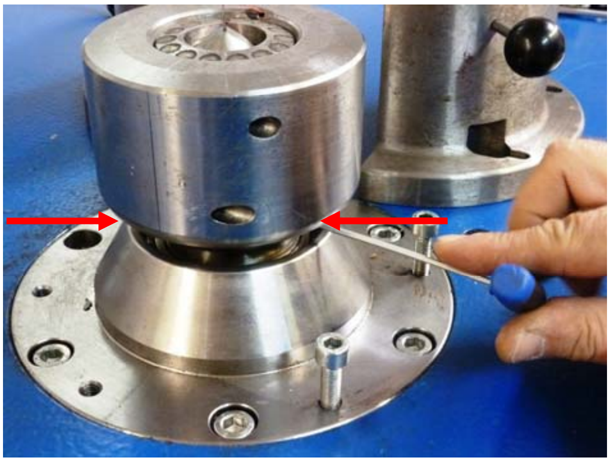
The housing half can now be removed at the front and set aside.

The mandrel is then twisted until two magnets become visible on the left side between the narrow side of the mandrel and the housing. A pen is then used to make a colour marking, as shown on the right.



The mounting screws on the rear housing half are unscrewed and can then be removed.

On the hub of the winding head, the two clamping screws located opposite one another for the mandrel intake are removed with the 3mm Allen key.

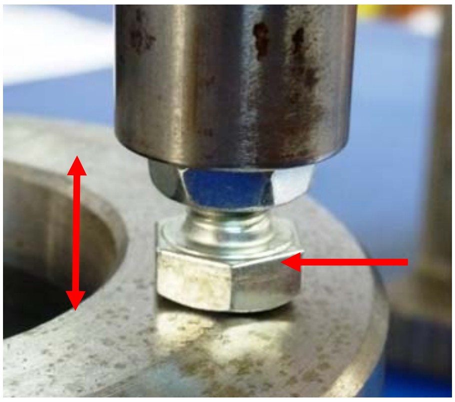


The intake with the mandrel can now be pulled out from above.

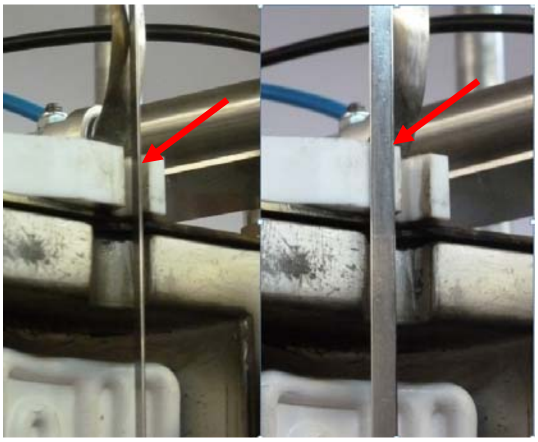
After loosening the clamping screws with the 4mm Allen key, the mandrel can be removed from the intake.

To insert the new mandrel, follow the reverse order of this process. When inserting into the intake, the narrow side of the mandrel must again face the marking.
Due to the narrow fit tolerance, the intake slides into the winding head by itself.

If it becomes necessary to correct the height, the intake must again be removed from the winding head and the height must be readjusted on the adjusting screw.



The two covers of the winding head can subsequently be remounted.
It should be noted that the alignment of the marking for the mandrel is the same as the position for disassembly.
If the mandrel is twisted, it will be in the wrong position when closing the heater, which will prevent it from closing correctly.



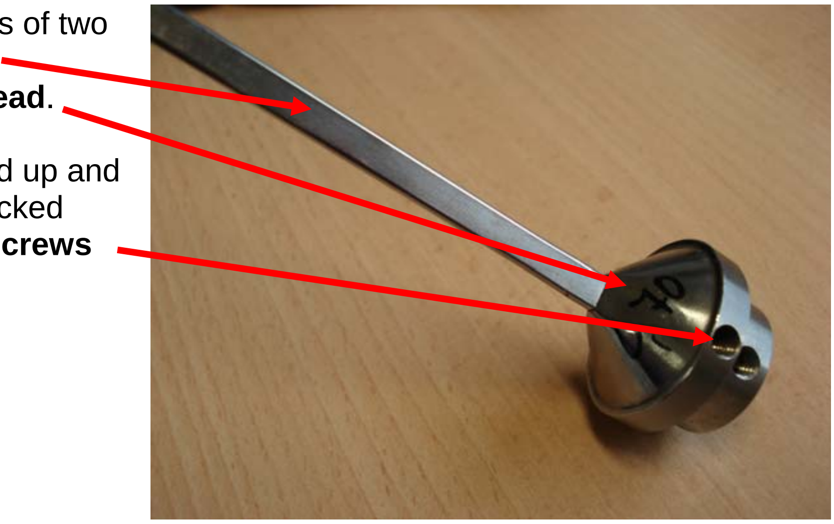
Correct Mandrel on marking | **Incorrect** Mandrel twisted

2.3.3 Adjusting the spiral mandrel

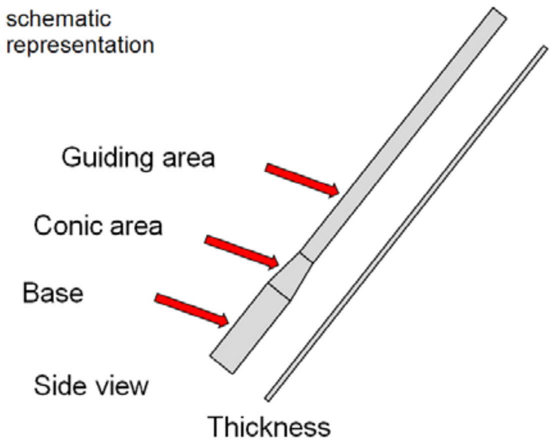
The spiral mandrel is generally only adjusted if a new mandrel is being used for the first time or if it is meant to produce another spiral size.

The spiral mandrel consists of two parts: the **mandrel itself** and the **head**.

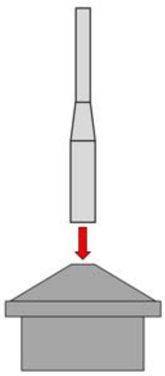
The mandrel can be moved up and down in the head and is locked into position with two **set screws** using an Allen screw.



From a side view, the mandrel can be divided into three sections:

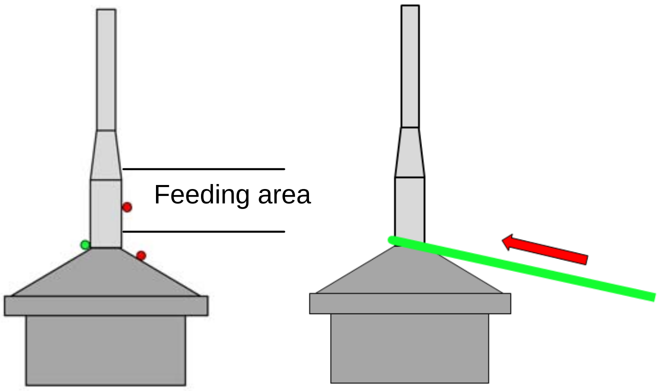


The height-adjustability allows for, …



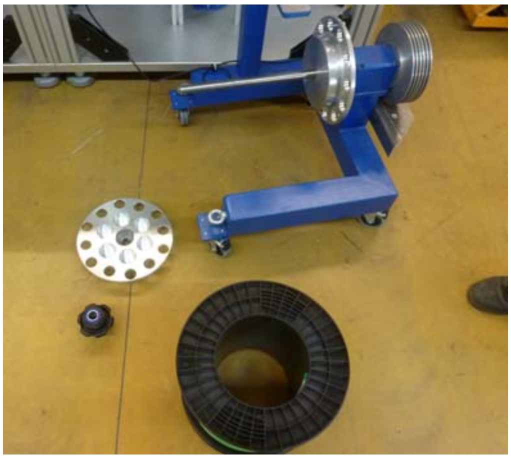
… the spiral wire running on the mandrel to hit a specific location on the mandrel during the winding process: the (ideal) winding point, shown in green on the schematic diagram. If the point at which the spiral wire meets the mandrel is too high or too low on the mandrel (shown in red), the resulting spiral will have irregularities or the thread could snap.

Round profile
For round profiles, the mandrel is fixed so that 8-10mm of the mandrel base is visible as a feeding area. The exact measurement of the feeding area must be checked or determined with a test run. The winding point here is on the bottom end of the feeding area just above the head.

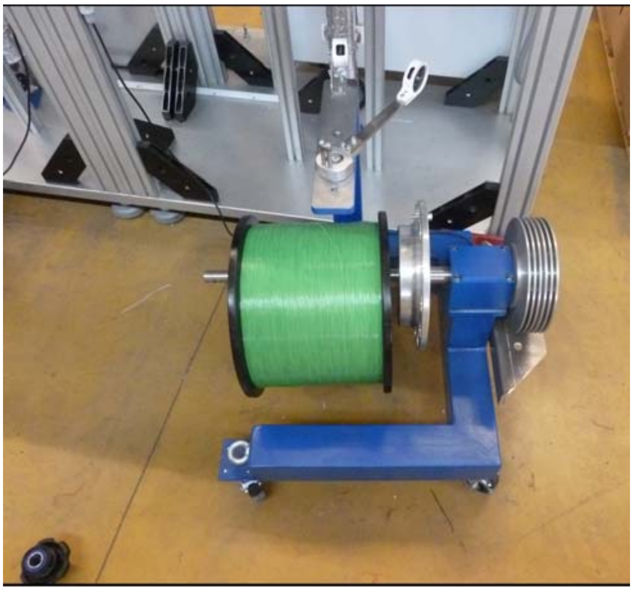


2.3.4 Inserting the coil

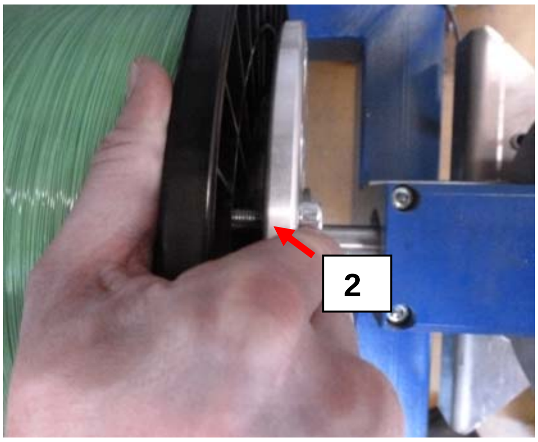
Make sure that the coil/coil intake is clean.



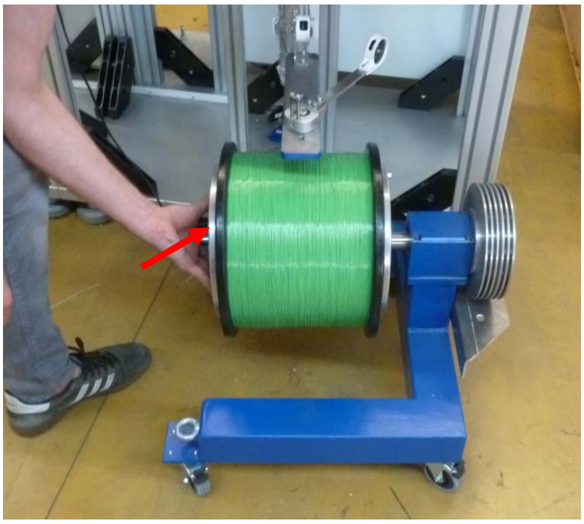
Place the coil on the tangential unwinder while paying attention to the pull-off direction!



Secure the coil with the driving pin (2).



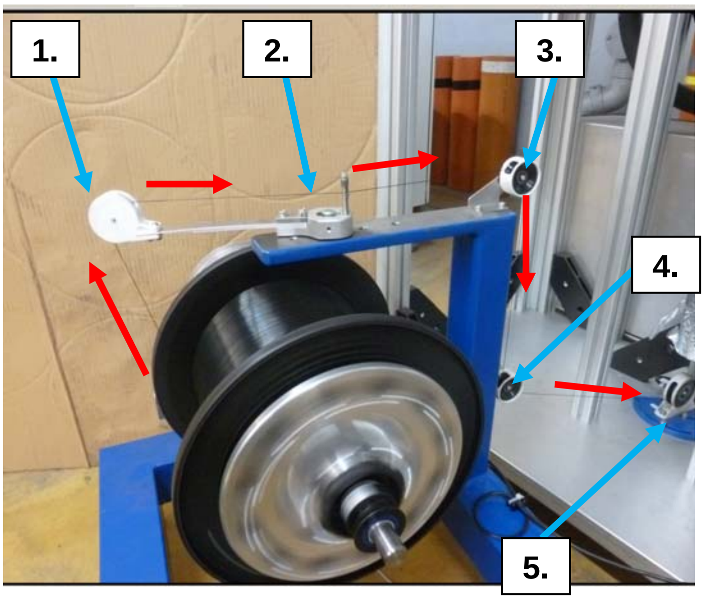
Place the flange in front on the shaft and in the coil.



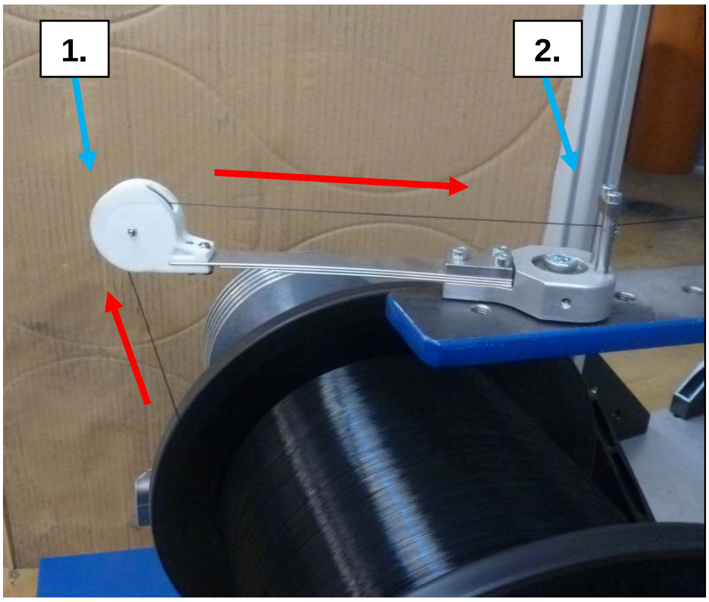
Stick the clamping cone onto the shaft and push until it stops against the front flange, then tighten.

2.3.5 Feeding the monofilament into the machine

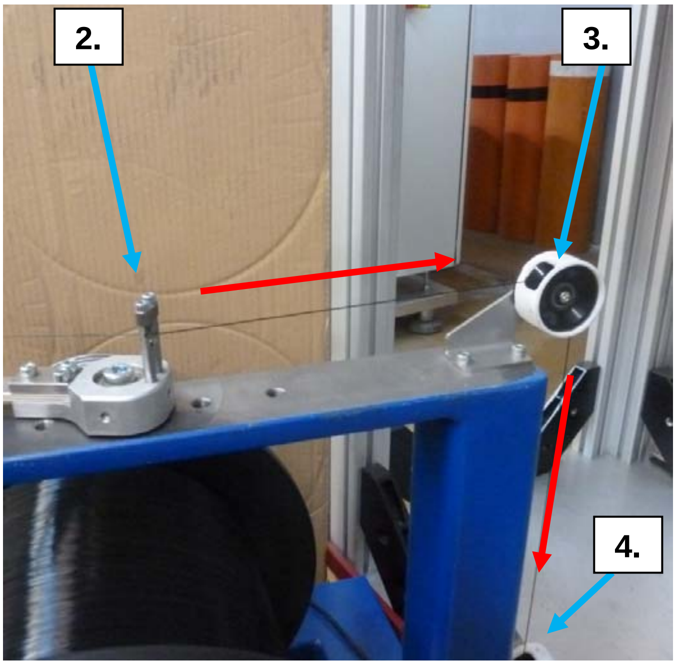
Overview
Guide the thread from the tangential unwinder to the machine



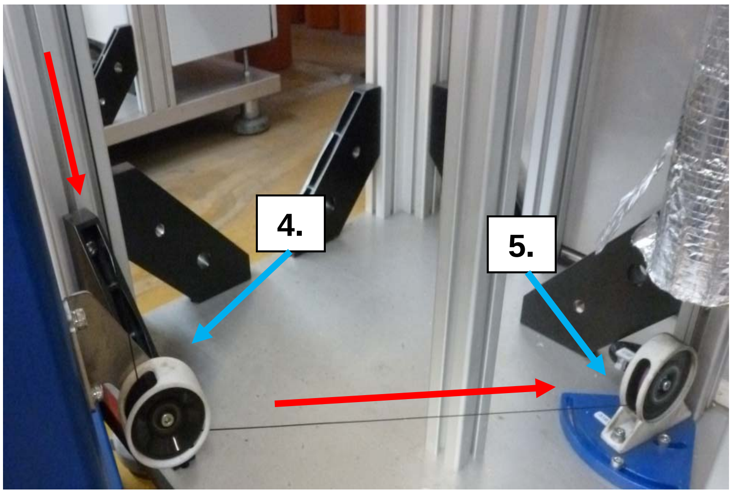
Step 1
Pull the thread from the coil and through the front deflection roller (pos. 1) in the direction of the two guide pins (pos. 2).



Step 2
Guide the thread through the two deflecting pins (pos. 2) toward the deflection roller (pos. 3) and then through the deflection roller (pos. 3) down to the deflection roller (pos. 4).

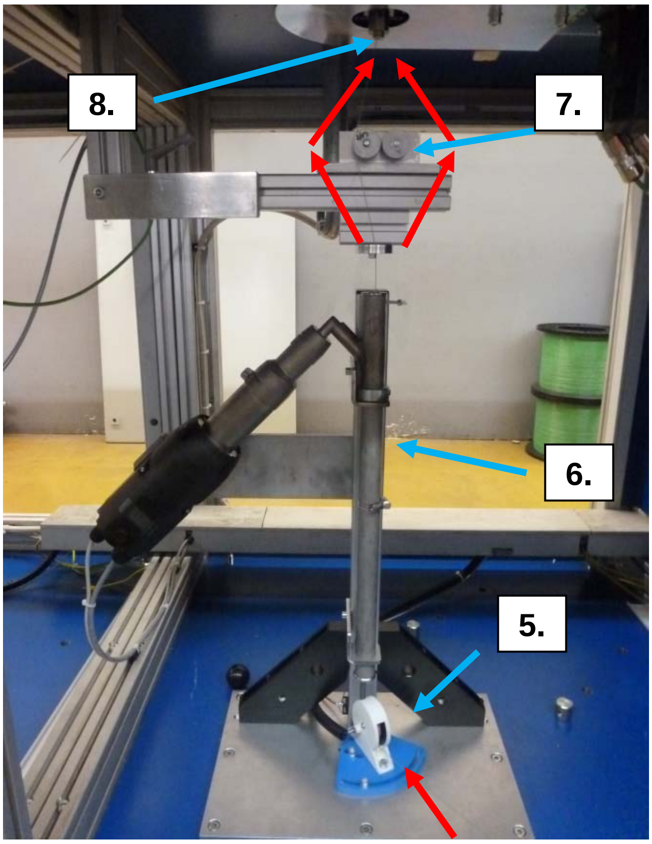


Step 3
The thread is guided forward through the deflection roller (Pos.4)
("*this location is the transition from the tangential unwinder to the machine,")*
diagonally to the deflection roller (pos. 5).



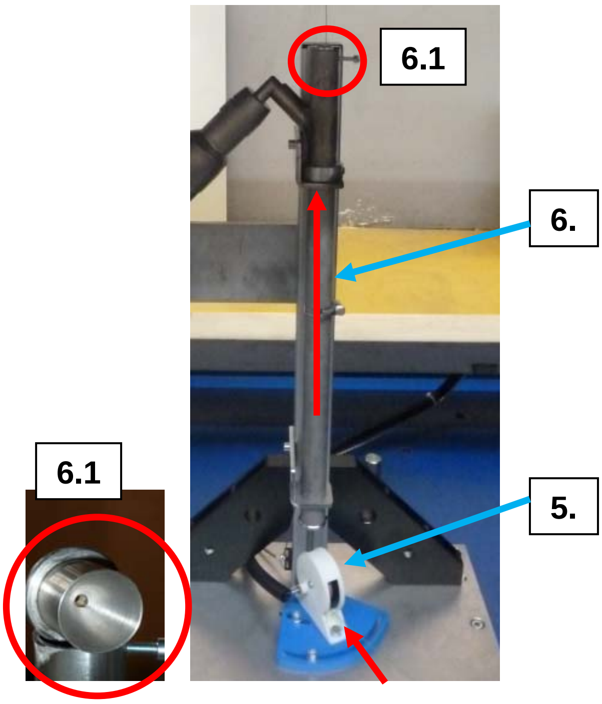
Overview
The course of the thread in the machine
The thread tension sensor can be mounted above or below the profile depending on the machine type.

Attention! Overstressing by incorrect course of the thread can destroy the thread tension sensors. Usage as regulated in the operation procedure



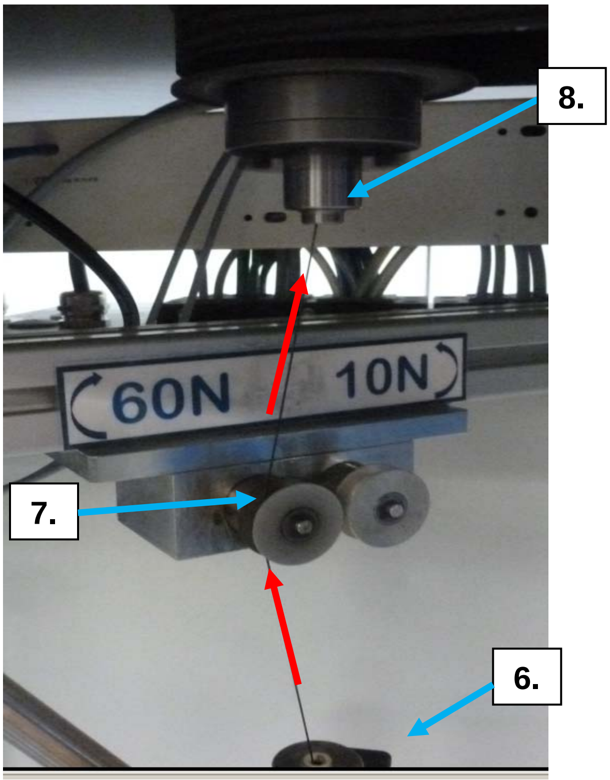
Step 4
The thread is pulled through the deflection roller (pos. 5) to the preheater (pos. 6).
In order to facilitate the thread's exit, the lid (pos. 6.1) of the preheater can be loosened with a thumbscrew and removed

Please note: the thread must also be guided through the lid (6.1)



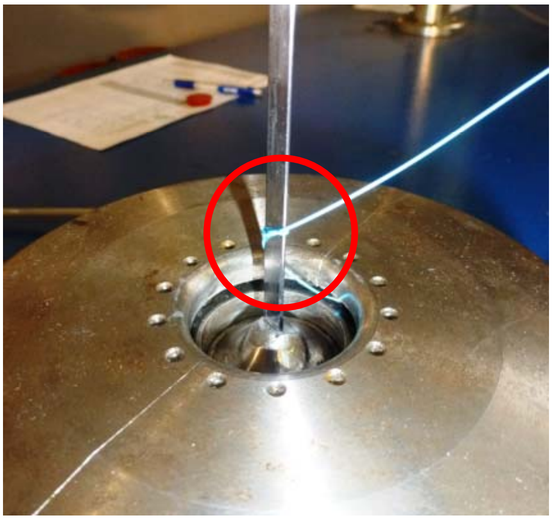
Step 5
After the thread has exited the preheater (pos.6), it is guided over the thread tension sensor roller (pos. 7) to the winding head (pos. 8).
The measuring range of the sensor is selected according to material and/or spiral.
(10N or 60N)

Attention! Overstressing by incorrect course of the thread can destroy the thread tension sensors. Usage as regulated in the operation procedure



Thread leaves the winding head for the spiral mandrel.

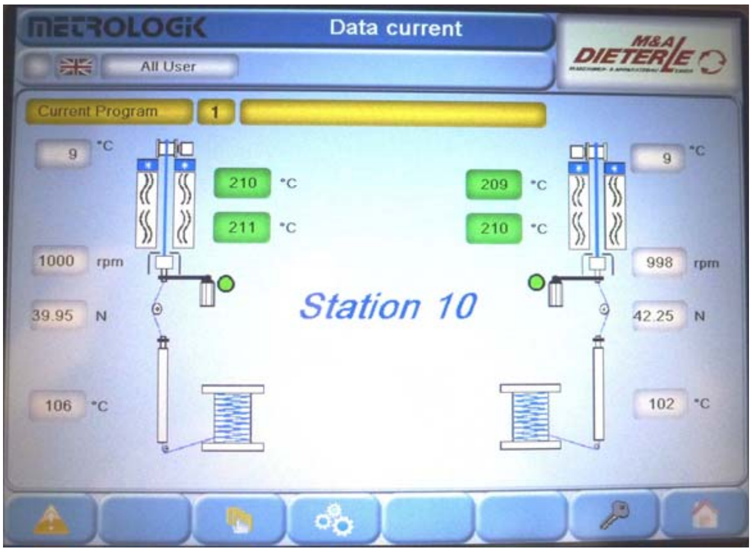
The thread is now tied onto the spiral mandrel. Continue to pay attention to the **winding direction**!



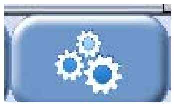
The machine is now ready for the winding process. The manufacturing parameters can now be selected according to spiral type and size using the central touchscreen at the controls.

Selecting the machine / station
(example here is machine 10)

>>> Display of current actual values for the two spindles of the selected machine.

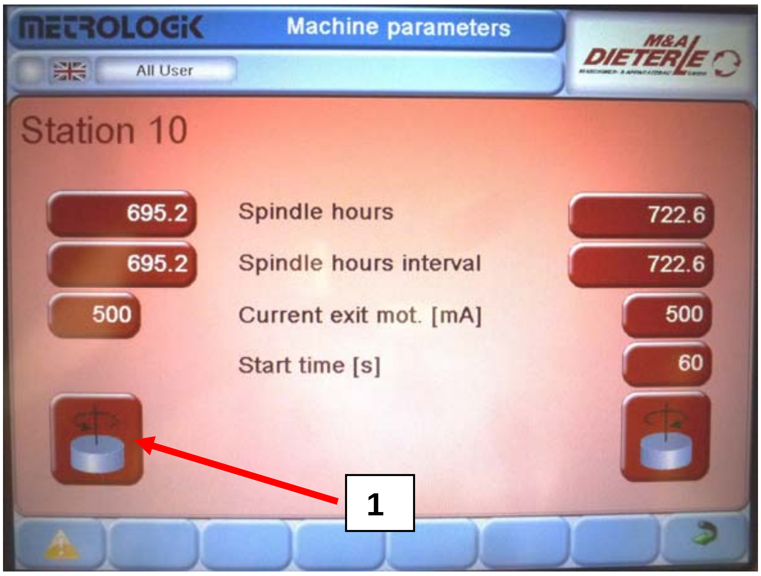


Press “process” button (gear symbol).



>>> The pre-selection window for the machine can be used (according to machine preparation) to select the corresponding spindle with button 1 and its **rotational direction – LEFT or RIGHT**

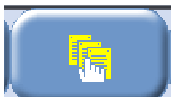
(e.g. here: left spindle rotation direction LEFT.)



The values shown in the number fields are only for informational purposes; they cannot be changed.

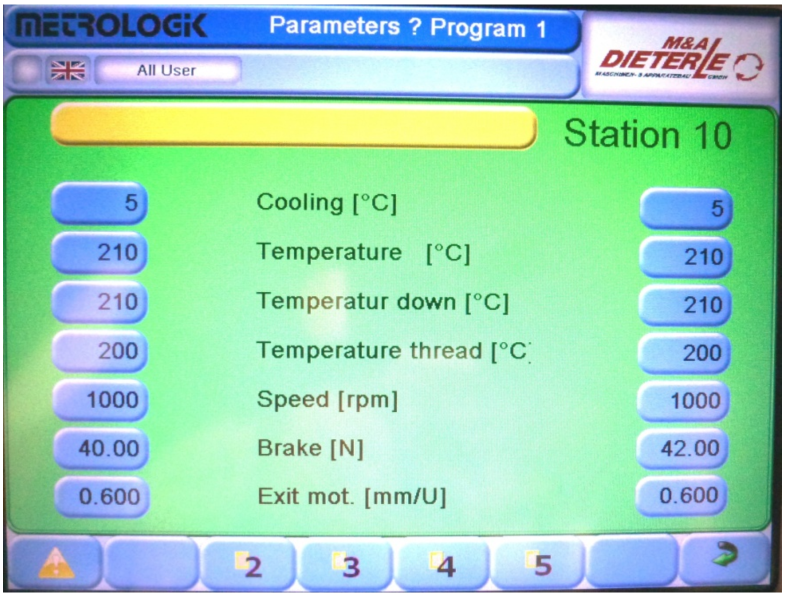
Use the button “back” to return to the actual values display.

From here, the input window for the process parameters can be reached with the button “edit.”



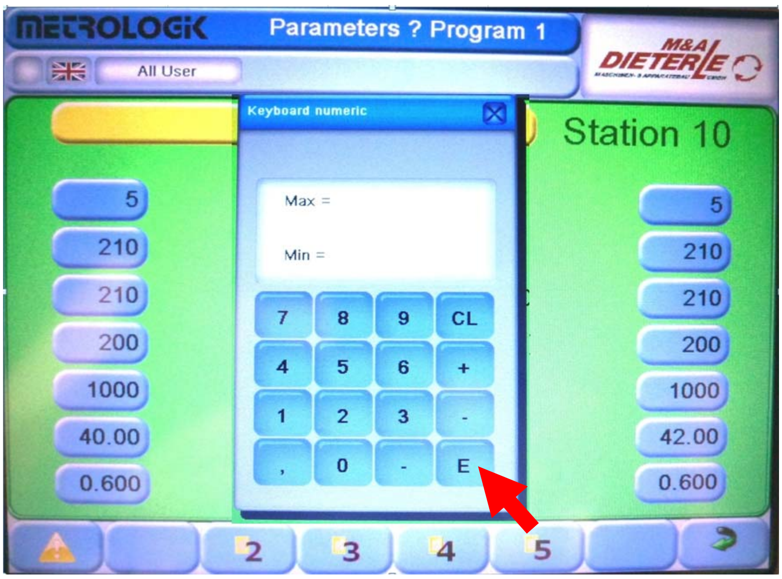
Default values, depending on spiral type and size, can be entered here:

- Cooling temperature
- Heater temperature (up/down)
- Preheater temperature
- Spindle rotation speed
- Brake
- Outlet

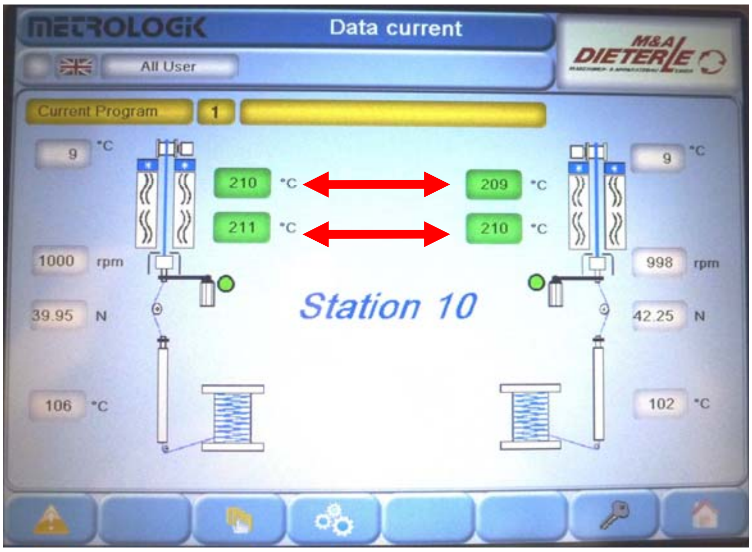


Input and changes can be made using a number pad, which appears by typing in the corresponding display field.

Values entered are accepted (arrow) using the enter button “E”.

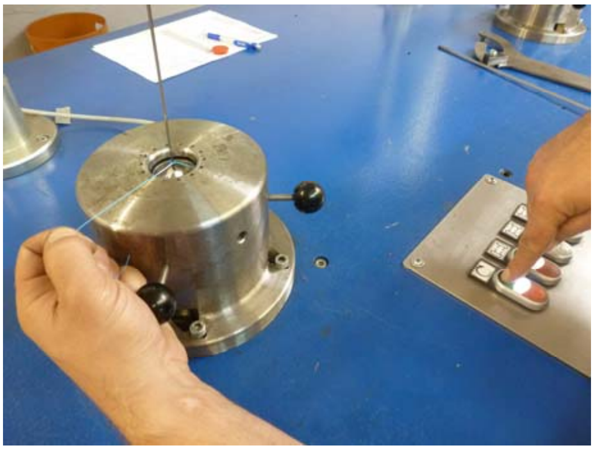


Once the heater has reached the TARGET value (see window ACTUAL value), the spindle can

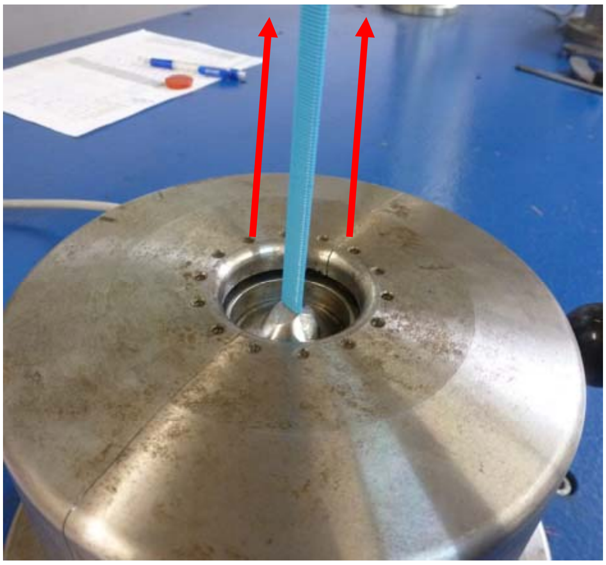


… be started by pressing the green START button on top of the machine.

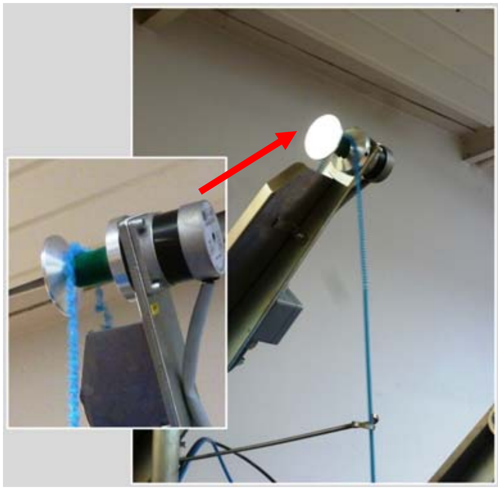
When the spindle starts running, the tied spiral wire must be secured with two fingers during the first rotation to prevent it from winding onto the mandrel.



During the start-up phase, the wound spirals – as needed according to spiral type – must be lightly pushed up onto the mandrel by hand to avoid tangling and a resulting tear in the thread. Then the spiral must move upward on the mandrel by itself. If this is not the case, the process parameter is not correct (see also 2.5).



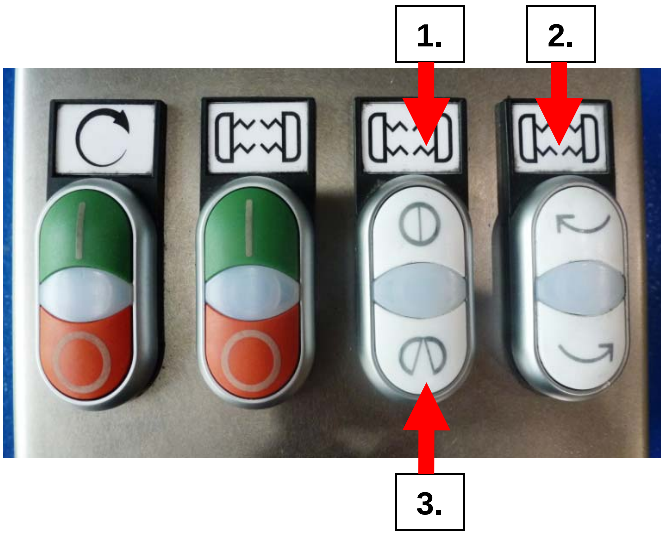
Once the wound spiral reaches the upper end of the mandrel, it is placed on the guiding track via the pull-off roller.



Once the TARGET rotational speed has been reached (see window ACTUAL values), the heater can be

- opened (1)
- turned to the spiral mandrel (2) and
- closed. (3)

with the corresponding buttons.



2.4 Monitoring of winding process

The dimensions of the spirals must be regularly checked during the first few minutes of the winding process. If needed, the process parameters (as described in 2.5.1) must be corrected. The spirals, which are wound until the desired dimensions are reached, are not suitable for sleeve production.
Once the desired size has been reached, the spirals are guided to the provided cans. At this point, measurements in half-hour intervals are sufficient – one-hour intervals if the machine is warmed up.

The winding process runs automatically. If a disturbance occurs (e.g. a thread tear) or the coil is empty, the machine will shut off automatically, the red light on the spiral guiding arm will illuminate and an acoustic signal can be activated.

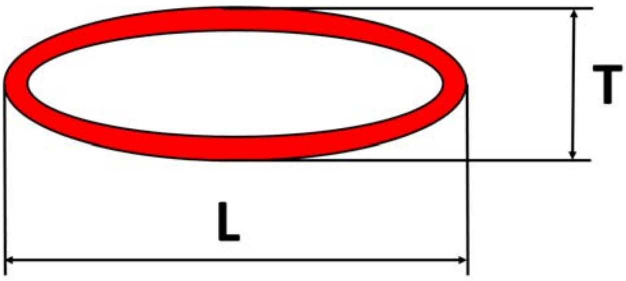
When turning the machine off, the heater is automatically opened and the turned into inactive position.

2.5 Possible irregularities, causes and remedies

Definition of spiral dimensions"

L = length of spiral

T = thickness of spiral



Error	Cause	Remedy
2.5.1		
Spiral size irregularities:		
Size L too large	Thread tension too low	Increase process parameter *brake*. for **PET** in intervals of 0.5 N for **PPS** in intervals of 0.2 – 0.3 N

Size L too small	Thread tension too high	Reduce process parameter *brake* For **PET** in intervals of 0.5 N For **PPS** in intervals of 0.2 – 0.3 N
Size T too large	Heater temperature too high	Reduce process parameter *temperature up / down* In intervals of 5°C.
Size T too small	Heater temperature too low	Increase process parameter *temperature up / down* In intervals of 5°C.
Error	**Cause**	**Remedy**
2.5.2		
Spiral shape irregularities:		
 Irregularities	Mandrel not properly positioned (too high/ too low) Thread tension too low Temperature too high	Readjust mandrel (see 2.3.2) Increase process parameter *brake*. For **PET** in intervals of 0.5 N For **PPS** in intervals of 0.2 – 0.3 N (see also 2.2.3.4) Reduce process parameter *temperature up / down* in intervals of 5°C. (see also 2.2.3.4)

3.0 Calibrating the thread tension sensors

1. Prepare calibration weights

One small and one large calibrating weight with approx. 5,000 g or 500 g and a hook at the top are needed for calibrating the thread tension sensors, as shown in image 1.

The 500g weight is for calibrating the 10N sensors and the 5,000g weight is for the 60N sensors.

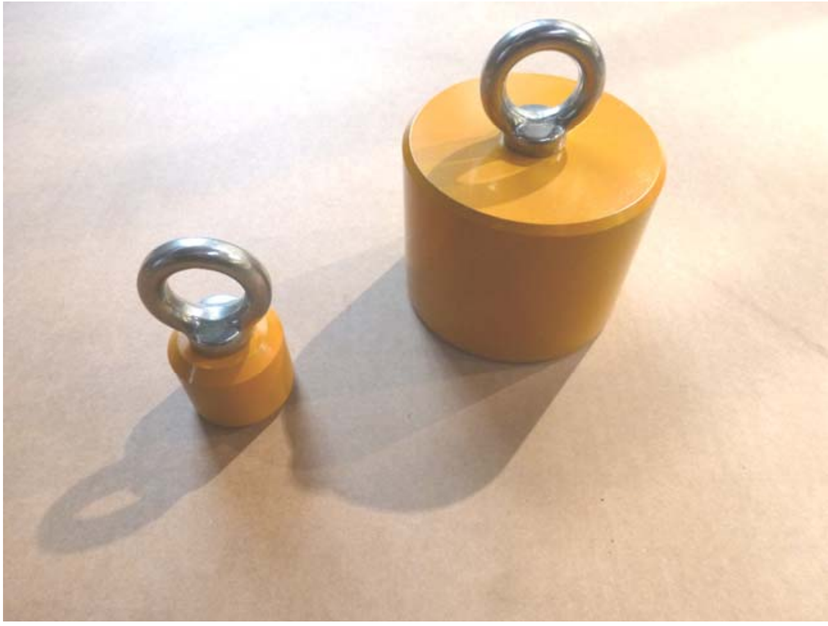


Image 1

Calibration weights

2. Calling up the control window for calibration

The spiral machine's selection window can be found above the SERVICE button located at the bottom of the touchscreen. Select the desired machine by pressing the corresponding button. This will open a window (image 2) in which all further steps are processed as described below.

3. Determine calibration weights in the controls

The exact weight of the small and large calibration weights must first be determined and entered into the data fields shown on image 2:
By pressing the numeric field, a window opens with a numeric keypad for entering the value. Finish entering by pressing the “enter button”.

The values labelled “thread tension 1” refer to the 10N sensor and “thread tension 2” refers to the 60N sensor.

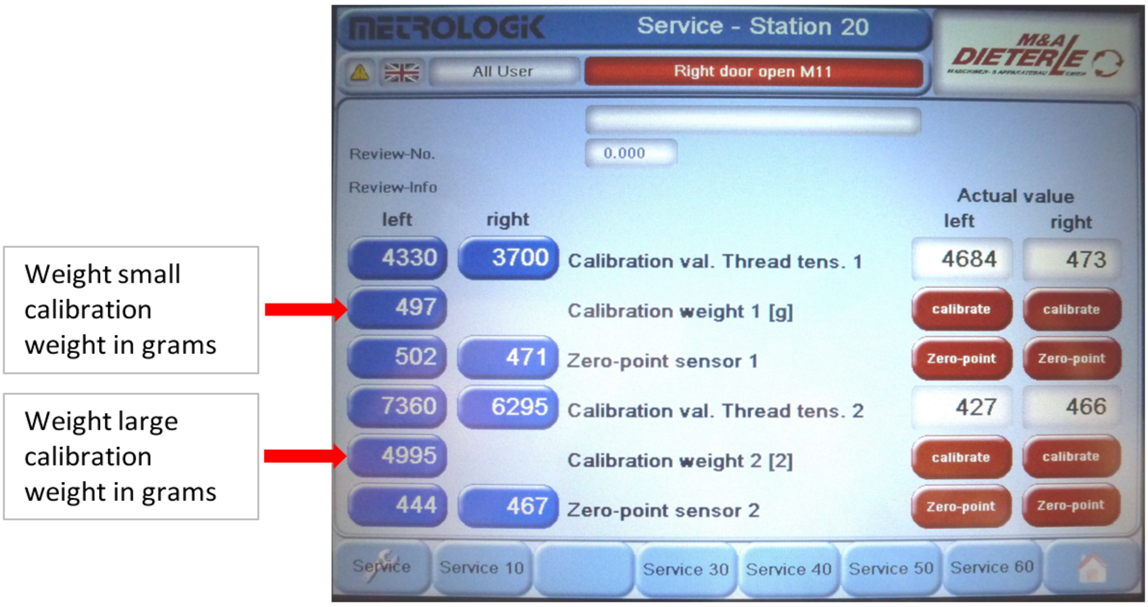


Image 2

Determining calibration weight in the controls

4. Zero point of the thread tension sensors

For unloaded sensors, the zero values (not equal to “0”!) are initially determined in the controls.
Example:
Zero value for the 10N sensor of the left spindle (see image 3).
By pressing the button, the value displayed in the corresponding data field (actual values / left) is transferred to the right side of the display.

The values for the other sensors are now recorded sequentially in the same way.

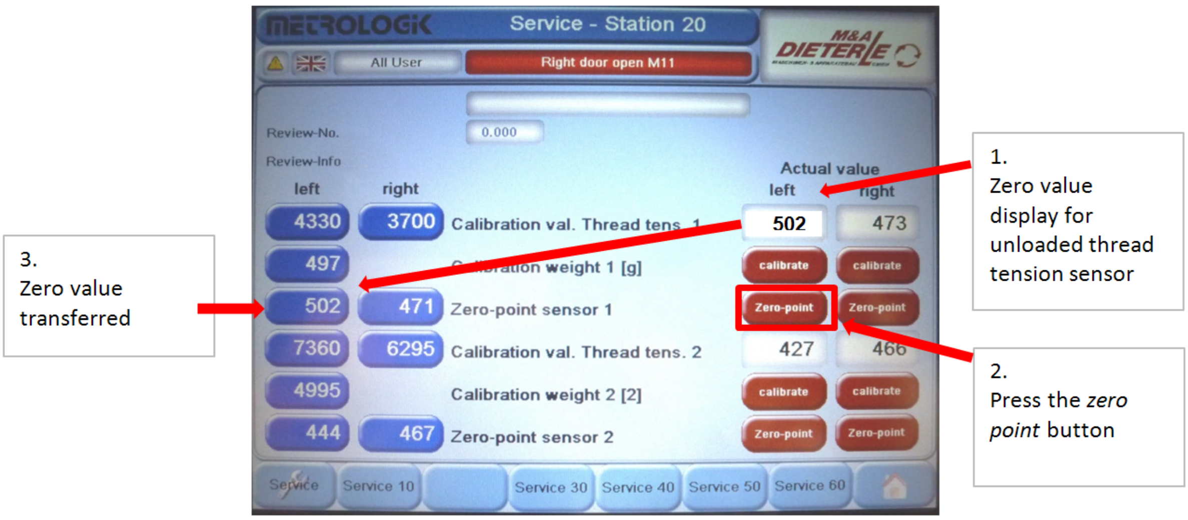


Image 3

Set sensors to “0”

5. Feed in spiral thread

Feed the spiral thread into the machine as described in chapter 2.3.5 and tie it to the spiral mandrel (image 4).
Insert the spiral thread between the deflection roller ① and the outer plate roller and guide it above the deflection roller ② mounted under the machine table plate.
Now the spiral wire is cut approx. 0.5m underneath the deflection roller and tied into a knot.

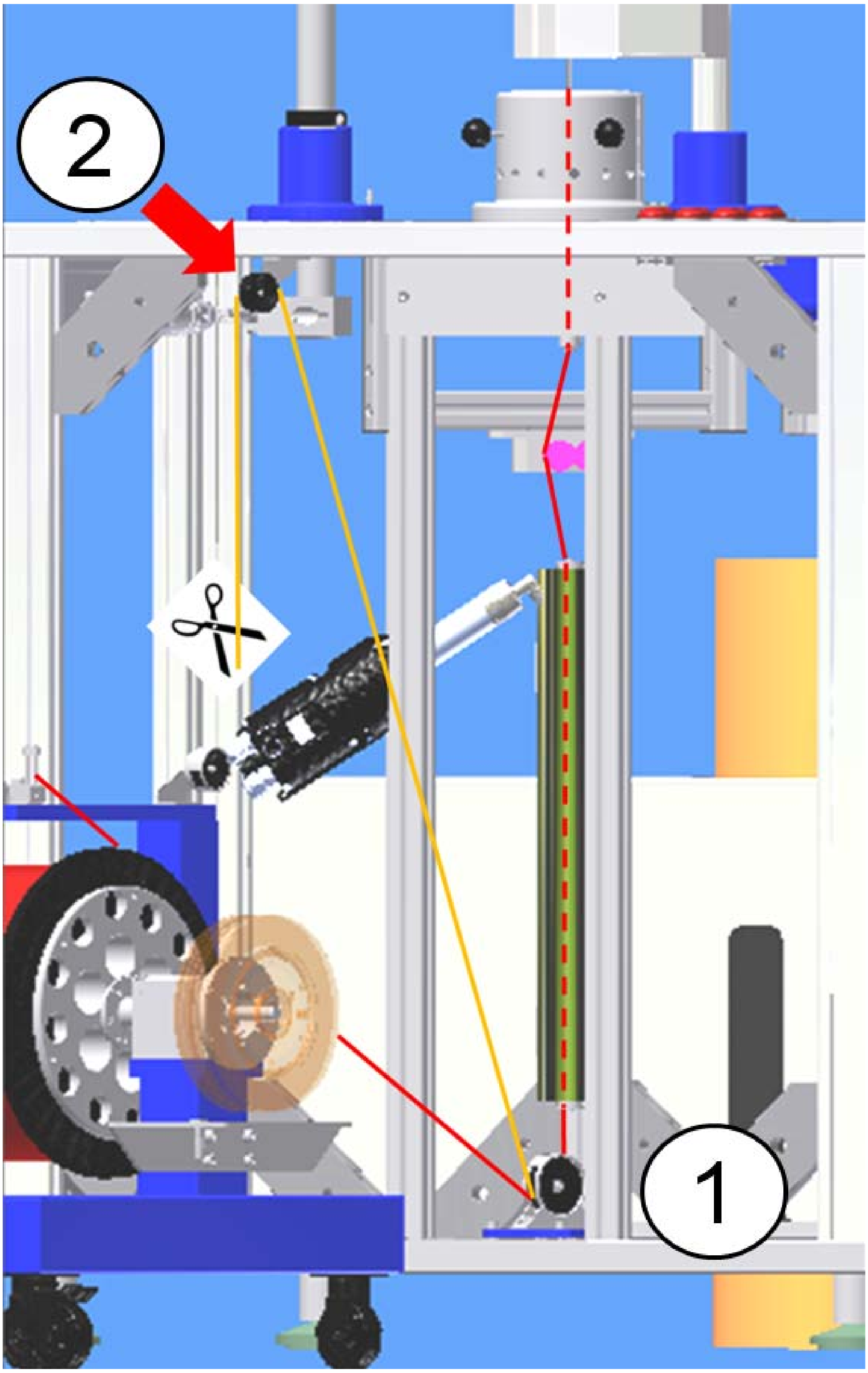


Image 4

Process for calibrating spiral wire

6. Test setup

First, the 10N sensor is calibrated with the smaller weight. The weight is also hung in the prepared knot in the spiral wire. Now the spiral wire has to touch the exterior of the roller of the respective sensor, as shown in image 3. The weight must not swing during calibration; if it does, no single value will be available as a basis.

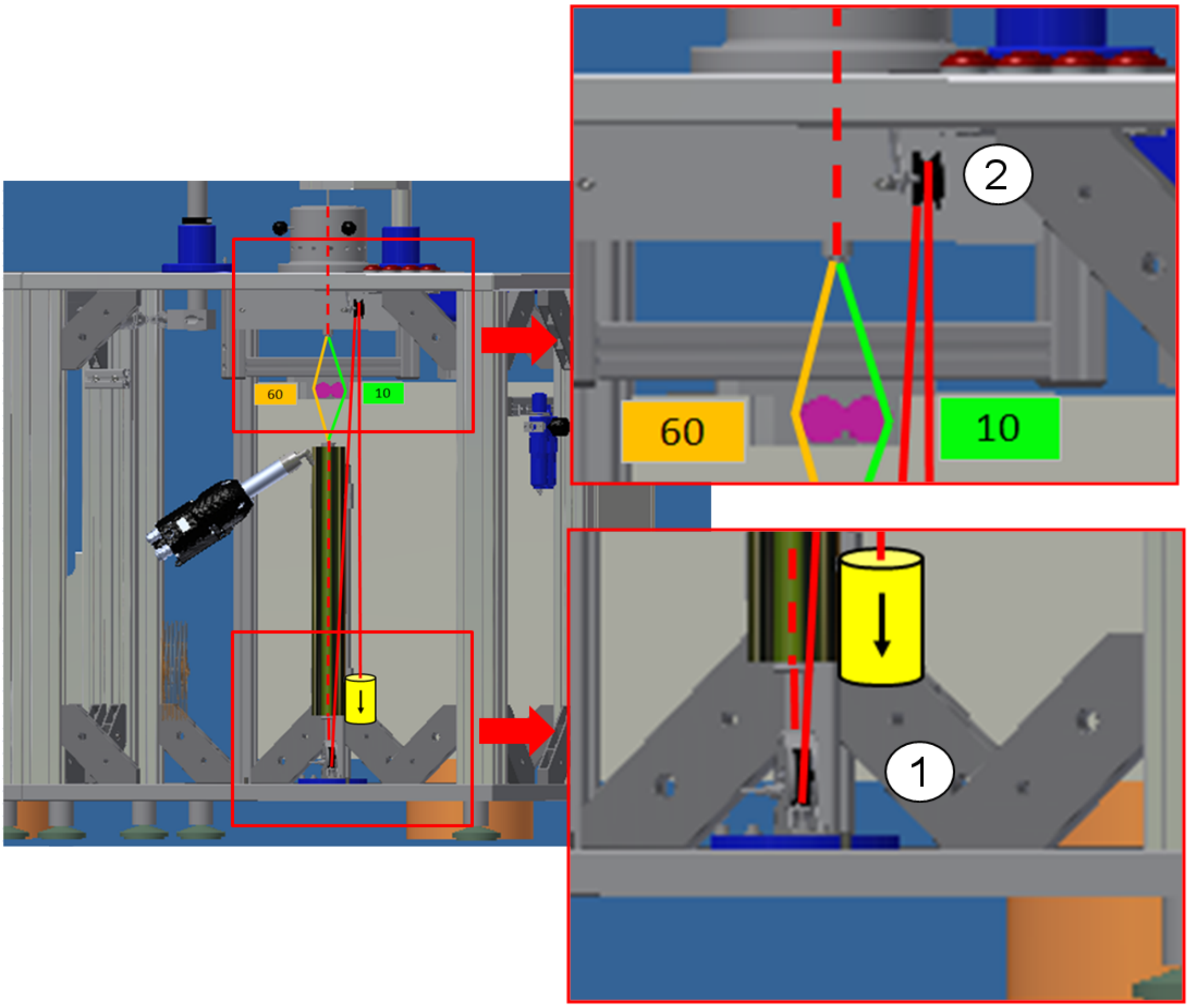


Image 5

Test setup for sensor calibration

7. Calibration

First, the corresponding machine (station) is selected in the controls in the *Service* window (image 6).
In the window “Service - Station 00” on the left, the target values and on the right, the actual values of both sensors are displayed for each spindle.

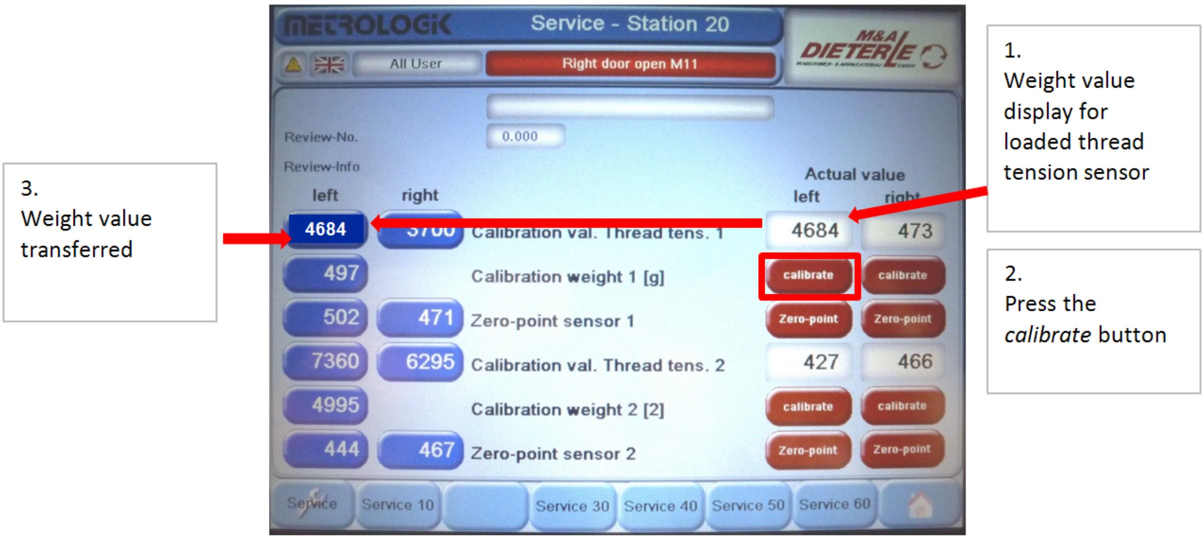


Image 6

Calibration of 10N sensor on the left spindle

In the blue data field (actual values) of the 10N sensor currently loaded with the calibration weight, its weight value is now displayed. This value does not correspond with the weight of the calibrating weight in grams! By pressing the *calibrate* button, the value displayed on the right is transferred to the data field on the left.

Now the weight can be replaced by the large test weight and the spiral wire can be guided outside over the roller of the 60N sensor. The second sensor is now calibrated in the same manner (thread tension 2).