Chapter 3

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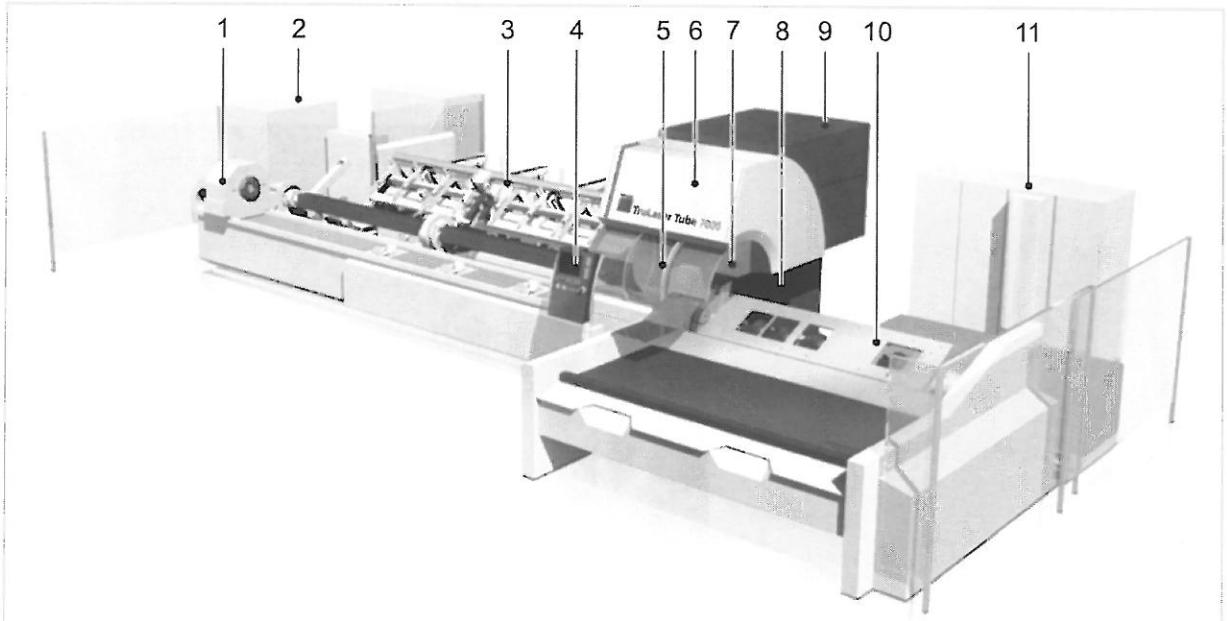
1. Assemblies of the machine



1	Feed station	5	Feed-through chuck	9	TruFlow laser
2	Compact dust extractor	6	Protective cover	10	Part removal station (movable unloading table, brush table)
3	LoadMaster Tube (optional)	7	Cutting head with lens	11	Modular switch cabinet
4	Control panel	8	Nameplate		

Modules of the TruLaser Tube 7000

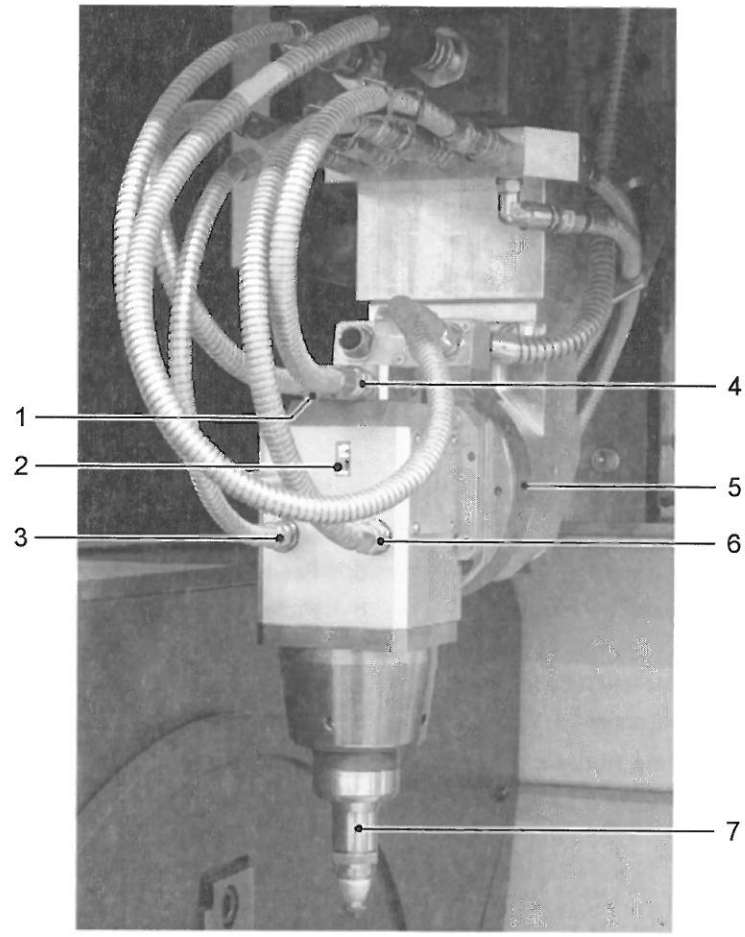
Fig. 53404

1.1 Nameplate and CE marking

The nameplate and the CE marking are located at the back of the machine on the machine frame.

1.2 Machining station

Lens cutting head with magnetic coupling



1	Water connection	5	Magnetic coupling
2	LED display	6	Cutting gas connection
3	Connection for beam guideway gas	7	Sensor body
4	Water connection		

Lens cutting head, focal length 155 mm Fig. 52871

Protection against damage

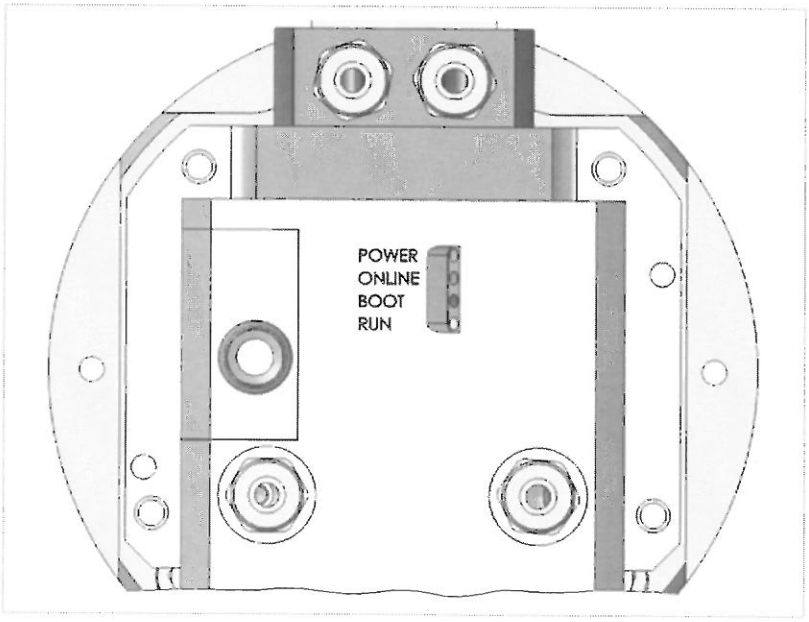
A general risk of collision between the lens cutting head and the tube exists in the machining station. The magnetic coupling cannot prevent collisions (usually caused by operating errors) but it can alleviate the effects.

A magnetic coupling is installed between the lens cutting head and Z slide. In the event of a collision between the lens cutting head and a tube, the head will be "thrown off" without however falling down. Even minor deflections of the head are displayed as error messages.

Displaying the operating status

The sensor system in the lens cutting head is provided with separate software which is checked and updated automatically if required when the optics are started-up. The software is made up of two components: the bootloader to load the software and the software program itself. The electronic system of the lens cutting head communicates with the height regulation system (ControlLine) of the machine using this software.

The current operating status of the sensor system is displayed using LEDs.



LED display

Fig. 51640

Display	Normal mode	Update	Error	Error	Error
POWER (green) **Power supply available**	Lights up	Lights up	Lights up	Lights up	Lights up
ONLINE (orange) **Connection to ControlLine active**	Lights up	Lights up	Off	Off	Off
BOOT (red) **Bootloader active**	Off	Lights up	Flashes	Off	Lights up
RUN (yellow) **Software program active**	Lights up	Flashes	Flashes	Off	Off
Measure			Faulty electronic system. Send the lens cutting head to TRUMPF for repair.		Communication with ControlLine interrupted. Contact the TRUMPF service department.

Operational status indicator of the sensor system

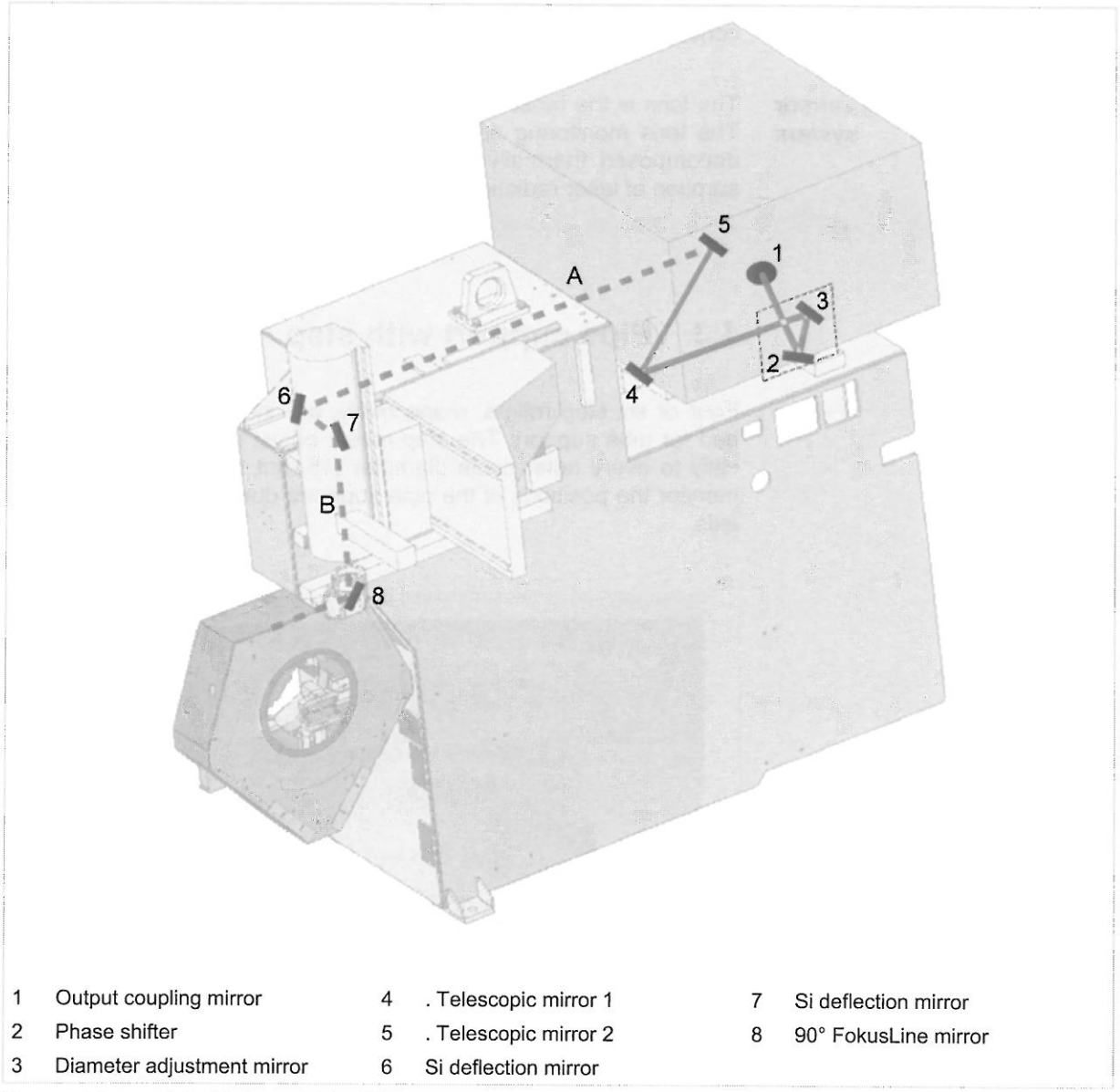
Tab. 3-1

Specifications

Cutting head with lens	F155 D40 R200
Focal length	F = 155 mm
Z axis joint offset/tool length (swivel radius in case of 1 mm nozzle distance)	200 mm
Weight (with yoke plate)	3.5 kg

Technical specifications of the lens cutting head Tab. 3-2

Beam guidance



1	Output coupling mirror	4	. Telescopic mirror 1	7	Si deflection mirror
2	Phase shifter	5	. Telescopic mirror 2	8	90° FokusLine mirror
3	Diameter adjustment mirror	6	Si deflection mirror		

Beam guideway at the TruLaser Tube 7000

Fig. 54291

Safety The laser beam is completely encapsulated on its way from the beam generator to the lens cutting head of the basic machine; this means that no laser radiation can escape and no fumes from the cutting process can infiltrate the beam guideway. After the invisible laser radiation has been released from the laser unit the beam runs over the beam bending mirror and the circular polarizer to the lens cutting head.

Focus position The automatic focus position adjustment FocusLine automatically adjusts the focus position to the type and thickness of the material.

Beam guideway ventilation

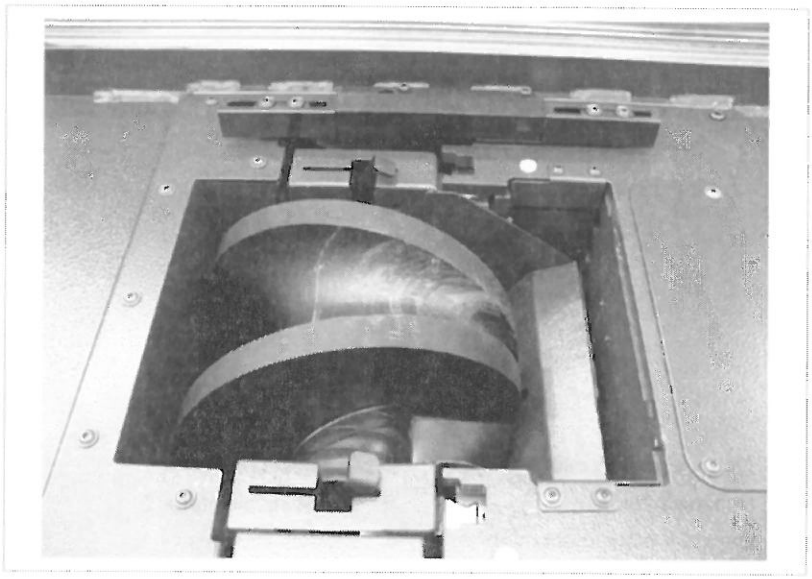
The entire beam guideway is ventilated with purified compressed air. Three filter inserts and a vacuum gauge guarantee that only oil-free and dust-free air can infiltrate the beam guideway with constant pressure.

Lens monitoring sensor system

The lens is the most heavily used component during laser cutting. The lens monitoring sensor system ensures that the lens is not decomposed thermally due to contamination and intensified absorption of laser radiation (only for machines with TruFlow 3600).

1.3 Pipe support with step rollers

Four or six step rollers, respectively, are installed in the machine bed for tube support. The step rollers adjust themselves automatically to every outer circle diameter (15 mm to 200 mm). Sensors monitor the positions of the pipe supports during travel along the X axis.



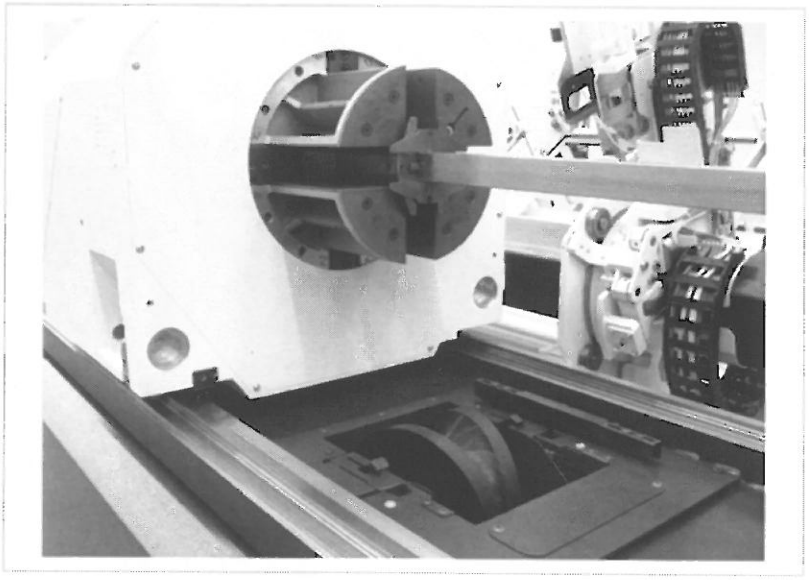
Step roller Fig. 57765

The most important functions:

- Automatic outer circle adaptation.
- The tube is supported as it is guided into the feed-through chuck.
- Tubes can be fed in sideways during processing.

1.4 Feed station and feed-through chuck

Feed station



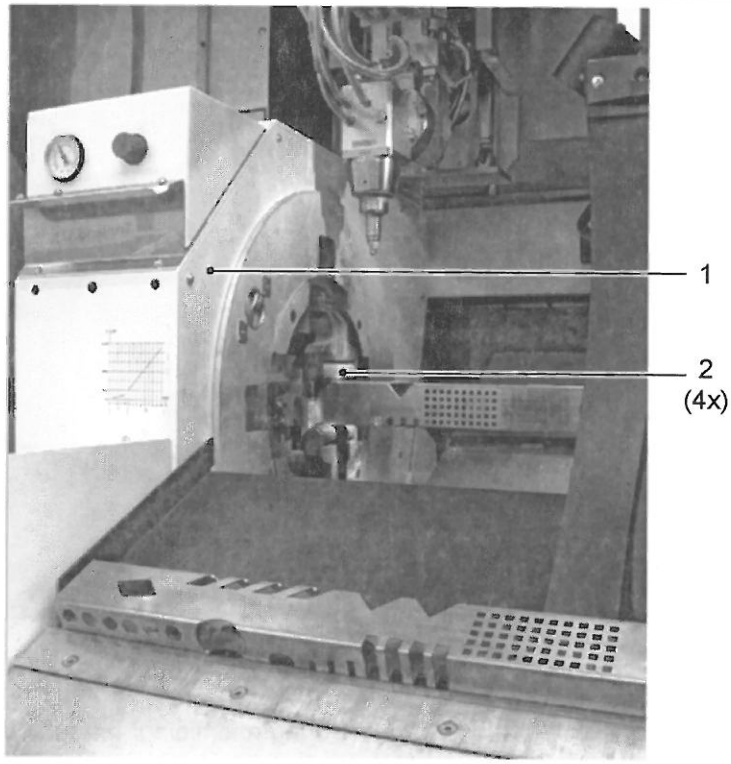
Feed station with a clamped tube Fig. 57766

During machining, the tube is moved from the feed station in X direction and rotated. The self-centering clamping jaws ensure the exact position of the tubes in order to enable precise machining. The lens cutting head executes movements only in Z and Y directions.

Clamping method

The collet chuck corresponds to a 4-jaw chuck, whereby 2 clamping jaws on each side opposite each other are actuated in synchronized fashion. The coupling of the jaw pairs is secured by synchronization rings. The collet chuck is actuated purely pneumatically with a maximum actuation pressure of 6 bar. The clamping force is generated by the pneumatic cylinders and guided to the clamping jaws through the lever aligned horizontally at the chuck level.

Feed-through chuck



1 Feed-through chuck 2 Roller jaws

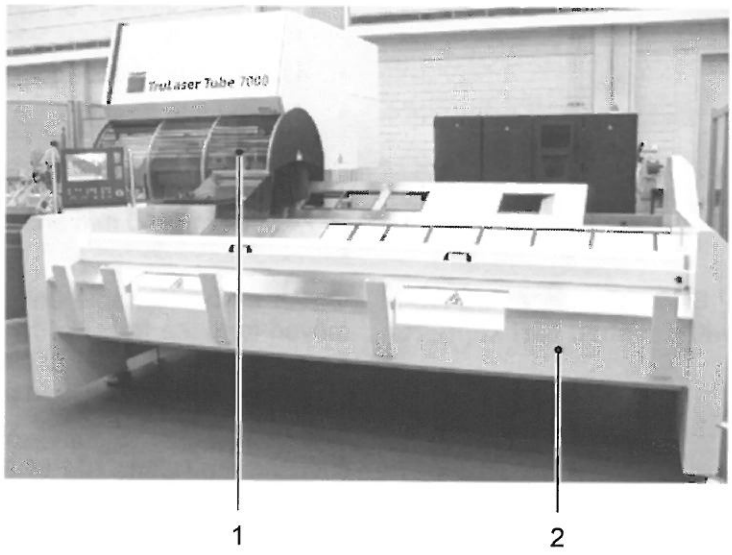
Feed-through chuck with clamped tube Fig. 57859

The feed-through chuck has no feed axis and is fixed rigidly in place in X direction. The tube held by the feed station is guided through the feed-through chuck in X direction during machining. The tube can be rotated around the X axis by means of the clamped roller jaws.

Rollers on the feed-through chuck are conical (towards the center) and they enable:

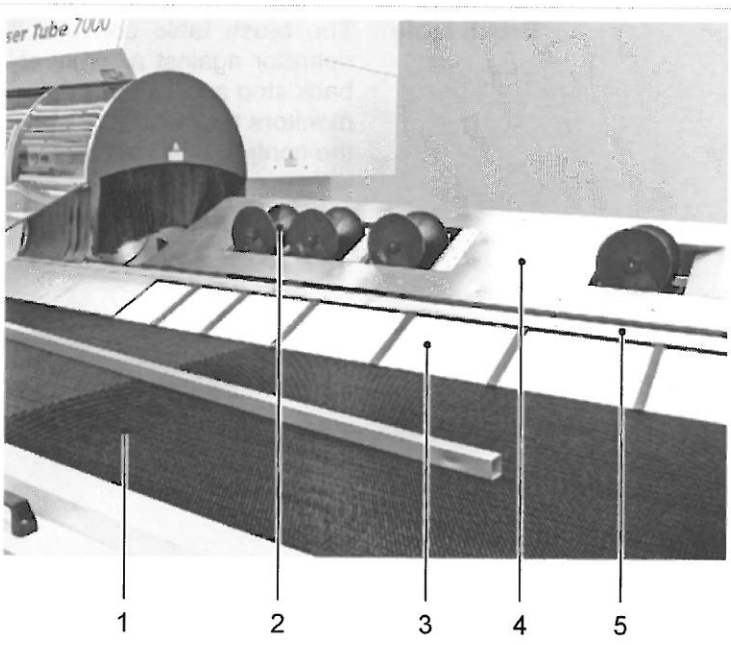
- Clamping in the corner radius area for square and rectangular tubes. Clamping takes place at eight points.
- Clamping at the correct position with tube tolerances (e.g. bulbous tubes).
- Central alignment of tubes.

1.5 Part removal station



1 Machining station
2 Part removal station

Part removal station TruLaser Tube 7000, front view Fig. 57767



1 Brush table
2 Finished part supports
3 Lifter stop at the front
4 Slewable unloading table
5 Front lifting rake with small parts sheet

TruLaser Tube 7000 part removal station, view from front Fig. 57852

Versions

The part removal station at the TruLaser Tube 7000 is comprised of the following components:

- Slewable unloading table with 4 or 7 finished part supports, respectively.
- Lifting rakes, front and rear (option), with small parts sheets.
- Brush table (front).

The part removal station of the TruLaser Tube 7000 is available in two versions: 3000 mm and 6000 mm (option).

Slewable unloading table with finished part supports

Owing to the slewable unloading table, finished parts can be removed from the front (in the direction of the brush table) and from the rear (optional). The table surface is covered with a structured sheet on which the finished parts rolled or slid.

The unloading table can also be moved in X direction, during which short finished parts (up to 300 mm) are supported during unloading. The disposal of the remaining tubes is also made possible.

During the machining, the tube lie on 4 or 7 finished part supports, respectively (depending on the version of the part removal station). The finished part supports guide longer tubes during the machining and permit them to be raised and lowered individually. The finished part supports hand over finished parts securely on the lifting rakes.

Brush table

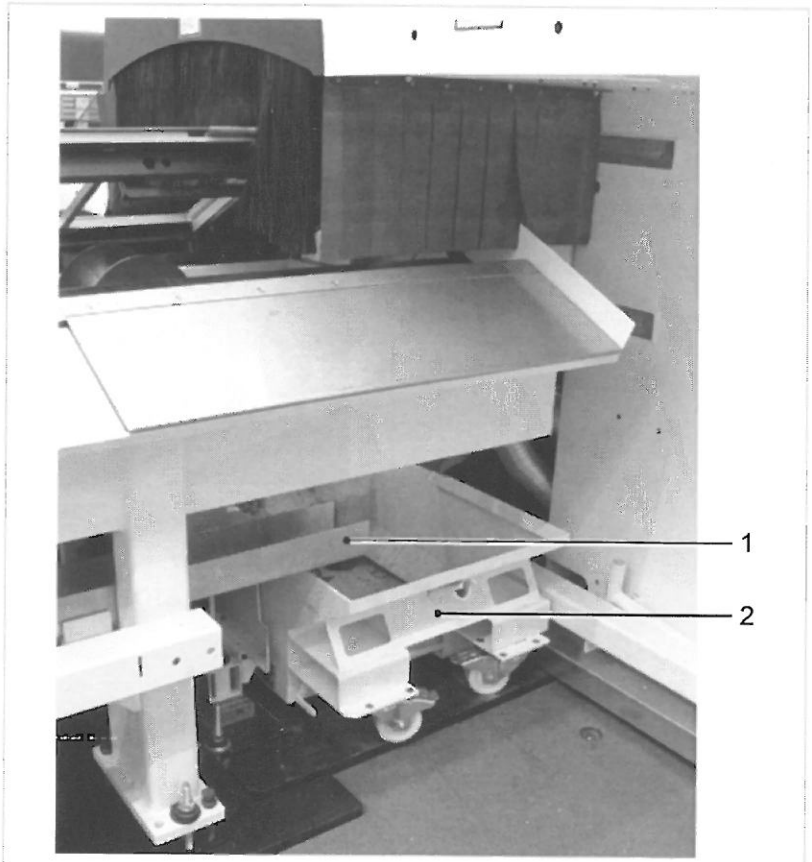
The brush table conveys the tubes at slow speed towards the operator against a removable back stop. The tubes collect at the back stop and can be removed from there manually. A light barrier monitors the degree of occupancy and reports a full brush table to the control. The next tube will still be cut off, the next one after that will be processed up to the parting cut. The back stop can be removed for the unloading of the cut tubes.

1.6 Scrap container / Waste conveyor belt (optional)

Scrap container

The scrap container is located below the machining station.

Cutting scraps which fall out during the machining of the tube will fall directly into the scrap container. Cutting scraps and small parts which fall during the transfer of the tube by the finished part supports are conveyed into the scrap container with the aid of scrap compactors at the front and the rear (option).

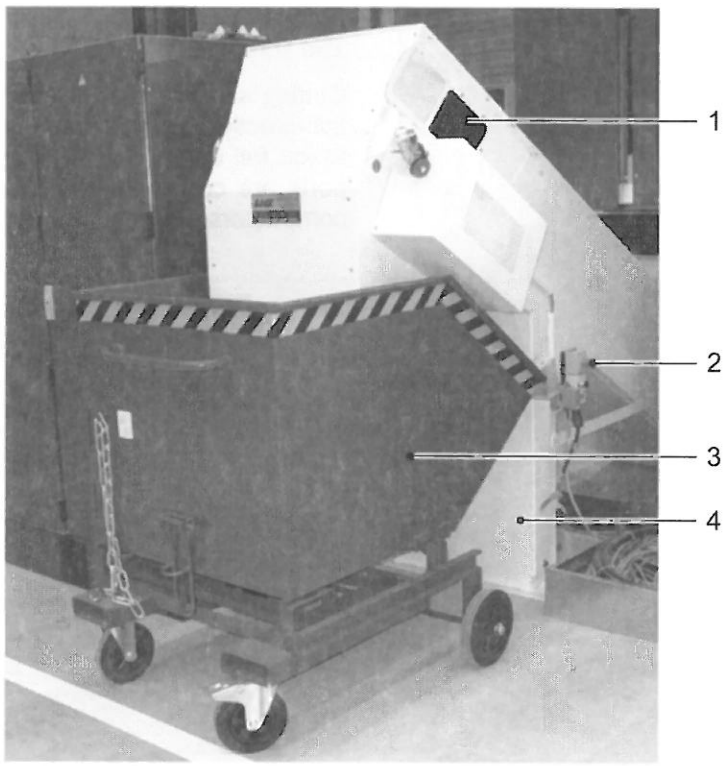


1 Scrap compactor at the rear (option)
2 Scrap container

Scrap container Fig. 57853

Waste conveyor belt (optional)

The waste conveyor belt starts automatically when cutting parts.



1	Viewing window	3	Scrap container
2	EMERGENCY STOP impact button	4	Sensor plate

Waste conveyor belt Fig. 56854

1.7 Control, operating panel

Open control system

The TruLaser Tube 7000 is equipped with a modern open control system – the Siemens SINUMERIK 840D SolutionLine. The user interface has been developed by TRUMPF and is based entirely on the requirements of the operator.

Proven operating concept

The operator should be able to enjoy working at the machine without any stress, and should feel comfortable while doing so. Operator guidance and design of the workplace were based on these considerations.

The user interface was designed for operational functionality and does not depend on the functional structure of the control system. Menu-assisted functions which follow the operator's procedures are provided for the desired action in each control area.

All the operating functions required for daily operations can be accessed directly. This allows the operating personnel to handle production without long training or knowledge of the entire range of functions of the control system.

Workplace ergonomics

The radiation-free TFT (thin film transistor) color display is the control system's visual interface, and offers a picture that is sharp and rich in contrast.

The operating keys have been grouped according to ergonomic and functional aspects.

Touchscreen

The touch-sensitive screen extends the key assignment options and can be operated easily and quickly.

Advanced diagnostics options

A new diagnostics concept is enable by the open control system. Malfunctions in the operational sequence are detected by the sensor assembly and can be displayed on the screen after being selected.

The error location is also displayed graphically if required. The measures required to eliminate the error are described in plain text.

Slewable control panel

The slewable operating panel is fastened to the machining station and can be positioned in the working area where the operator needs it.

Operation is made convenient by:

- Slewable towards the working range.
- USB interface for data exchange.
- Movable keyboard.

Machining station with control panel Fig. 57858

Quick access to data

The open control system provides new data transmission options. The standard control system has a USB interface. Another data transfer option is online data transfer via a network between the programming system and the machine:

- Simple handling.
- Quick data transfer.
- Reasonably priced due to the use of Windows standard network components
- Integration of the machine into an existing network.
- Access to different network drives from the machine.

1.8 Drives

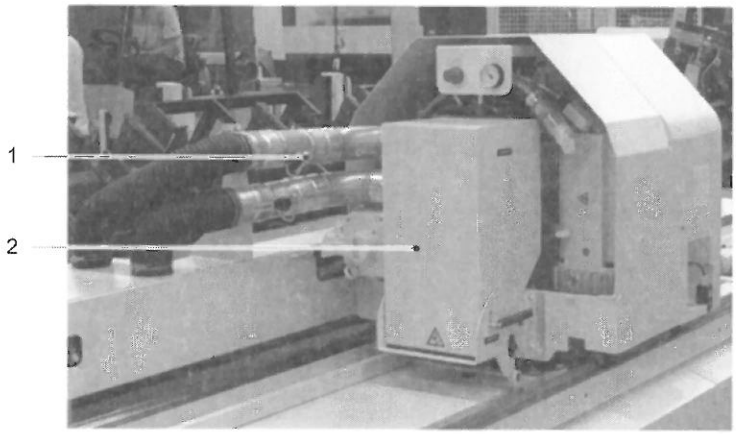
All drives are digital 3-phase current servomotors from Siemens.

The advantages of digital drives are:

- A long service life even in extreme temperatures.
- No maintenance due to permanent magnet control.

The flexible, modular drive system for demanding tasks

1.9 Suction system



1 Suction system 2 Collecting pans

Suction system at the feed station Fig. 54357

A compact dust extractor is located inside the feed station. The dusts and slags which arise are suctioned out through the inside of the tube. Coarse pieces of scrap and the slags are collected directly in the feed station in a collecting pan. When the feed station moves in reverse direction, the container is emptied into a separate receiver drawer at the end of the machine bed. Suction chambers are integrated underneath the machining station. The exhaust air is channeled through a tube system directly into the compact dust extractor.

Filter elements in the dust extractor are used to filter the exhaust gases produced during laser cutting. A continuous purging cycle provides optimal use of the filters' capacity.

Compact dust extractor with extinguisher (optional)

The compact dust extractor can be optionally equipped with a fire extinguisher.

1.10 LoadMaster Tube (optional)

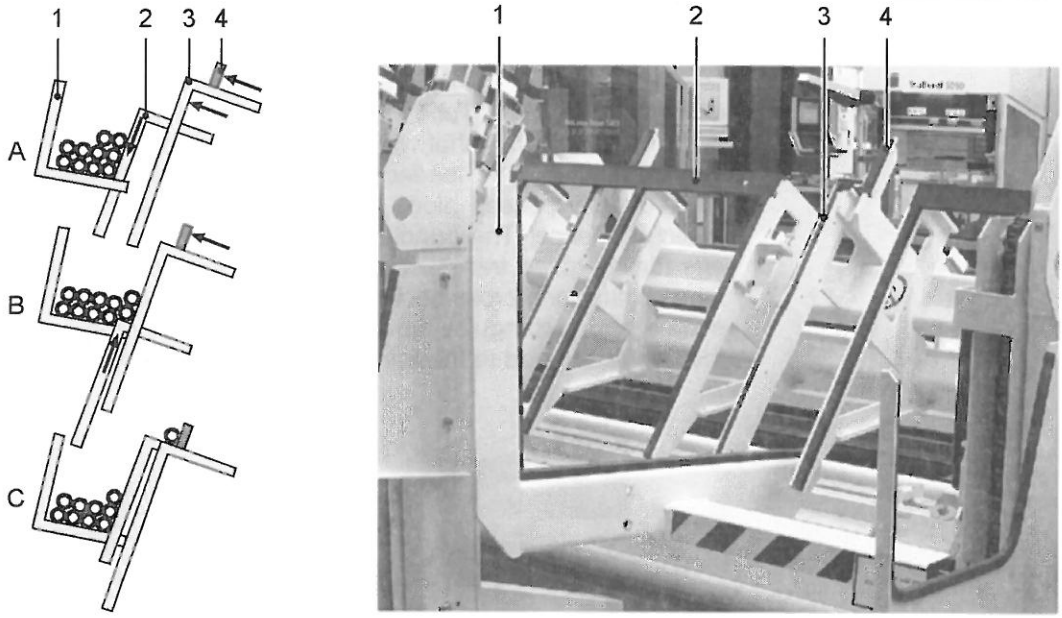
LoadMaster Tube (option) is a loading unit for the automatic loading of the TruLaser Tube 7000. The bundle support encompasses up to 4 t of raw material with a bundle cross-section of up to 600 mm x 600 mm. The loaded tubes are separated, measured and subsequently passed along to the machine in a completely automatic sequence. The bundle support can be moved in two positions for improved transport of the tubes. The lower position is for tubes with round cross-section and the upper position is for round, square and rectangular tubes. Lift sliders convey the tubes out of the bundle support to the transfer position of the grippers.

1 Tube bundle in the bundle adapter
2 Gripper
3 Lift slider

LoadMaster Tube (optional) Fig. 57854

Loading process LoadMaster Tube

The lift slider moves downward during the loading process (A). The tube setting and the tube stop are positioned on the outer circle diameter. One tube from the bundle adapter slides onto the lift slider (B). The lift slider conveys the tube upward to the transfer position. The tube rolls against the tube stop and can be taken up by the grippers (C).



1 Upright/bundle adapter
2 Lift slider
3 Tube setting
4 Tube stop

Loading process LoadMaster Tube

Fig. 53660

Measuring procedure

The slide gauge travels against the end of the tube. Sensor 1 is actuated by the impulse caused when the gauge impinges upon the tube and switches the drive over to reduced feed rate. The tube is moved at this reduced speed against the stop plate (zero point) which gives the release for measurement by means of an additional Sensor 3. The actual measuring procedure takes place by means of the measuring axis when, in addition to 3, Sensors 2 or 1 switch. After the measurement, the slide gauge moves back, causing the contact pressure to be reduced to approximately 2-3 kg. Afterwards, the grippers can take up the tube.

Manual conveyor path (optional)

If an order needs to be processed urgently, you can use the manual conveyor path (optional). In such a case, individual tubes are directly transported up to the tube setting using the conveyor path. Bundle support need not be emptied when doing so.

1 Upright (buffer)

2 Manual conveyor path, swivelled in

Fig. 57855

Anti-scratch bundle adapter (option)

The lift sliders of the bundle adapter can be covered with plastic material upon request in order to avoid scratches on the tubes.

1.11 TruFlow laser

A TRUMPF CO_2 laser is part of the standard equipment of the TruLaser Tube 7000. Three different laser types are available: TruFlow 2000, TruFlow 2700 and TruFlow 3600.

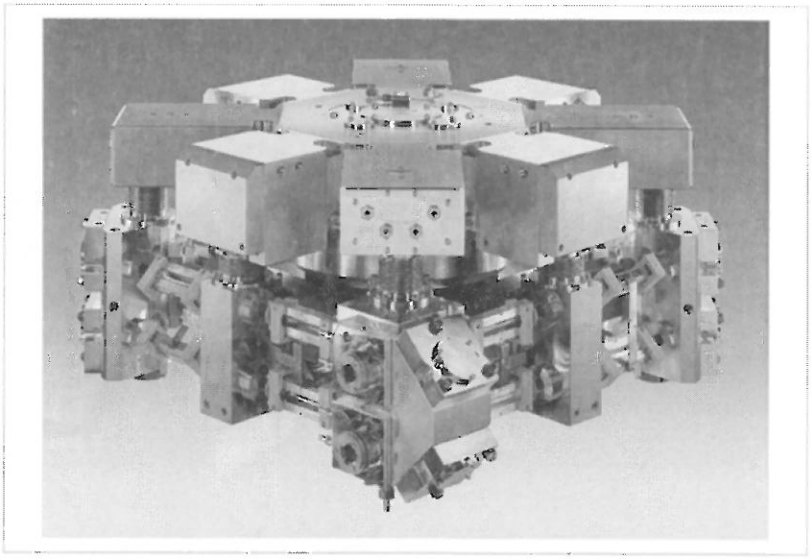


Fig. 44362

TruFlow lasers are excited by a high-frequency alternating current.

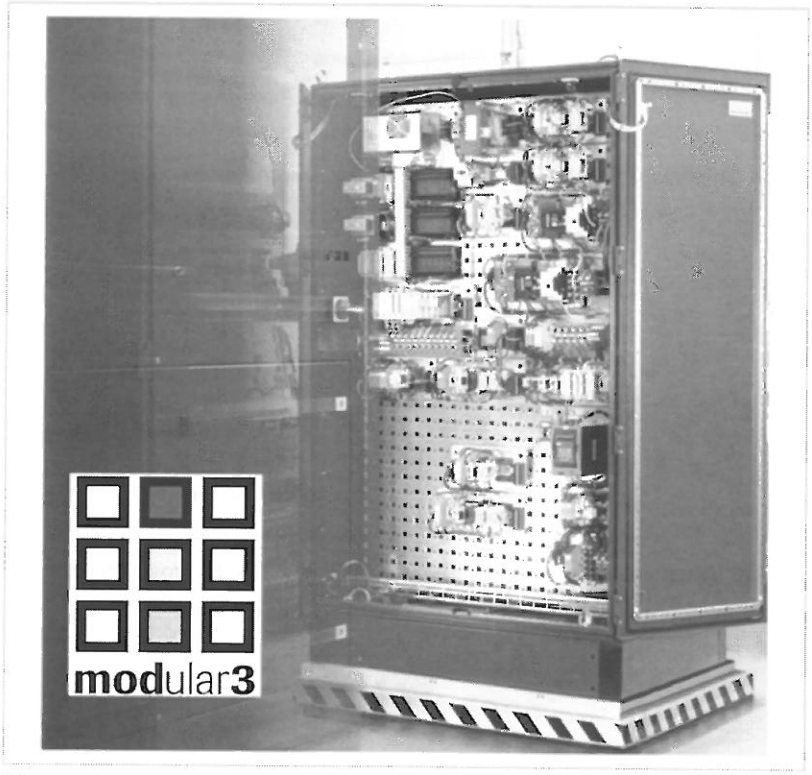
- Radio-frequency excitation ensures homogeneous gas discharge and excellent beam quality.
- Lower voltage is required for the excitation of the laser gas than when inputting the energy via a DC source. Result: lower CO_2 decomposition and hence reduced gas consumption.
- Since the electrodes are not directly connected to the laser medium and are therefore not exposed to gas discharge, there is no significant wear on the electrodes. In addition, electrode material cannot contaminate the resonator or the mirror. As a result, maintenance requirements and gas consumption are reduced.
- The laser output remains constant for years.

1.12 Modular switch cabinet

modular3 means

For the design and assembly of a switch cabinet, we are banking on the new concept: modular3.

- Using few, high-performance standard components.
- Standardized interfaces.
- Simple and safe assembly of components and sub-assemblies.



The modular switch cabinet Fig. 57294

Overview of advantages

- Reduction in wiring and component variants; therefore, less error potential.
- Clear arrangement of all modules.
- Quick finding of defective components.
- Easy and fast service.
- High system availability.

Thanks to the combination of electrical functions, even an untrained person can easily locate the source of an error. The error in a component is displayed on the control panel of the machine. The user or the service technician can easily replace the corresponding module with a new or tested module.

2. Technical data, axis designations

2.1 Technical data

TruLaser Tube 7000			
Working range	X axis	mm	6500 9200 (option) [1]
	Y axis	mm	320
	Z axis	mm	230
	A1 axis (feed-through chuck)	°	n x 360
	A2 axis (feed station)	°	n x 360
Tube dimensions	Max. raw material length	mm	6500 9200 (optional)[1]
	Min. raw material length	mm	2500
	Max. outer circle diameter	mm	200 250 (optional) [2]
	Min. outer circle diameter	mm	15
	Max. length of finished parts	mm	3000 6000 (option) [3]
	Min. remaining tube length	mm	120
	Max. material thickness	mm	8
Bundle dimensions	Maximum bundle cross-section	mm x mm	600 x 600
	Max. bundle weight	kg	4000
Material weights	Max. tool weight (raw material)	kg	150 225 (optional)[2]
	Max. tool weight (finished part)	kg/m	25 37.5 (optional)[2]
speeds	X axis	m/min	100
	Y axis	m/min	60
	Z axis	m/min	60
	A-axis	1/min °/s	150 900
Accuracy [4]	Positioning accuracy Pa	mm °	±0.2 ±0.015
	Average position range Ps	mm °	±0.06 ±0.005
	Smallest programmable increment	mm °	±0.01 ±0.001
Cutting head with lens	Focal length	mm	155
Control system:	SINUMERIK 840D sl		

TruLaser Tube 7000			
Space requirements [5]	Length	mm	16 000
	Width	mm	8 600
	Height	mm	3 300
Total weight[5]		kg	approx. 16 200

Technical data of the machine

Tab. 3-3

1 For a machine bed with 9 m.

2 Extended clamping range up to 250 mm.

3 For a part removal station with 6 m.

4 The maximum possible precision on the workpiece depends, among other factors, on the type of workpiece, its pretreatment, the sheet size, and its position in the working area. In accordance with VDI/DGQ 3441. Measurement length 1 m.

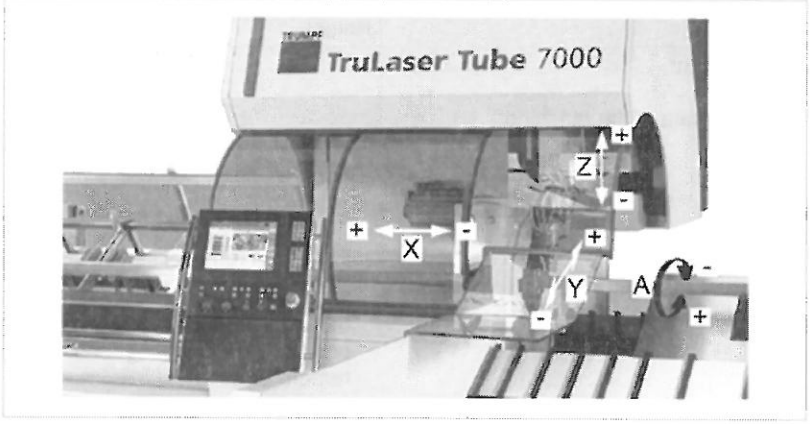
5 Machine including laser, LoadMaster Tube, part removal station 3 m.

Laser	TruFlow 2000	TruFlow 2700.	TruFlow 3600
Max. laser power in W (programmable in 1% increments)	2000	2700	3600
Power density distribution (beam mode)	TEM_{00}	TEM_{00}	TEM_{00}
Max. material thickness in mm			
Mild steel	8	8	8
Stainless steel	4	5	6
Aluminium	3	4	5
Laser gas consumption in l/h			
CO_2	1	1	1
N_2	6	6	6
He	13	13	13
Cutting gas consumption			
O_2	Dependent on application		
N_2	Dependent on application		
Lens monitoring sensor system	-	-	yes

Technical data for the TruFlow laser

Tab. 3-4

2.2 Axis directions



Axis directions Fig. 53591

The machine has four axes.

Axis name	Direction of movement
X axis	Horizontal movement axis for the feed station.
Y axis	Horizontal movement axis for the lens cutting head.
Z axis	Vertical movement axis for the lens cutting head.
A-axis	Rotary axis around the X-axis, whereby the feed station as well as the feed-through chuck actively rotate the tube.

Tab. 3-5

3. SeamLine Tube (optional)

Non-contact weld seam detection

The SeamLine Tube sensor system is used for the visual detection of visible tube welding seams. The sensor system measures the presence of a welding seam, depending on the rotational position of the tube.

The measurement and the corresponding operating process can be carried out either online or offline.

The sensor system operates:

- Without contact.
- Fast
- Reliably
- And has a high optical resolution.

Measuring procedure

A high-resolution CCD camera scans the surface of the workpiece by means of the reflected light method. Bent fluorescent tubes illuminate the surface evenly, enabling flexible adaptation to different tube materials and diameters.

Hardware

The hardware includes:

- CCD camera.
- Image processing computer.
- Touchscreen monitor integrated into the control panel.
- Lighting unit (bent fluorescent tubes).

Software

The software of the seam detector allows:

- Online evaluation of image data and presentation of the measurement results.
- Visualization and simple operation on the LCD TFT touchscreen.
- Remote diagnostics and software updates via modem.
- Automatic selection of configuration using NC control.
- Visualization of measurement results.
- Parameters with online help.