

# ***HM-2000 EVO***

**Instruction Manual  
English (EN)**

**Headmaster  
Workstation**



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## 1 Safety Regulations



Observe local regulations when making any electrical installations. We suggest the installation of an external main switch with an integrated fuse near the machine. For this electric installation, contact your local electrician / expert!

We would like to draw your attention to some dangers which may occur. You should therefore read the following instructions carefully and proceed accordingly.

- ⚡ It is prohibited to run the workbench in moist, dusty or explosive environment! There is a danger of a short circuit!
- ⚡ The workbench must not be operated with an opened boardsheet!
- ⚡ Clamping device rotating 300 degrees only!
- ⚡ The isolation of the flexible drive shaft and all visible cables have to be checked regularly.
- ⚡ Overpasting or bridging of the handle switch is dangerous!
- ⚡ Safety Goggles have to be worn while using the unit!  
With long hair, either a head covering must be worn or the hair must be bound up!
- ⚡ The rotating spindle on the vario drive unit poses a risk of injury.
- ⚡ The clamping device must be cautiously clamped and released on both sides. There is a risk of squeezing by incorrect working!
- ⚡ Avoid suck in of dirt or liquids!
- ⚡ Inspect the suction line and filter for soiling and defects regularly!
- ⚡ When polluted, clean the suction line and replace the filter!
- ⚡ Switch off the vacuum pump when it is not in use!
- ⚡ Power must be disconnected prior to any electrical work or repair operations!
- ⚡ Repair operations may only be performed by the local Mira representative or by the manufacturer!
- ⚡ Use only genuine MIRA spare parts that are listed in the respective operating instructions!
- ⚡ Avoid all contact with the electrical circuits of the machine! => Risk of electrocution!
- ⚡ Modifications of the electronic components may have serious consequences!

### Earthing of the workstation

To minimize shock hazard, the drive must be connected to an electrical ground. Earthing equipment must be connected to the protective earthing conductor of the power supply!

### Do not use in explosive environment!

Operation of this machine in the presence of inflammable gases, fumes or dust may cause an ignition of this environment and has to be prevented.

### CAUTION!

1. It is not permitted to operate the machine in dusty surroundings as there is a risk of fire resulting from the overheating of small particles.
2. To avoid shock hazards do not expose this machine to moisture, rain or dew as this may cause an electrical short between mains and controls.
3. Installation, adjustment and service of this device must be made by qualified personal only. Works or repairs on electrical parts of the device is very dangerous because of the high voltages the circuit is working with. These high voltages are capable of causing death and are present even after disconnecting mains. Before starting servicing and repairs it is essential to disconnect any mains.
4. It is not permitted to work on the outputs if the power supply is switched on, even if the connected motor is not activated or the drive is interlocked.
5. Operation of this machine without a mechanical switch and a fuse in the supplying wiring is not permitted.
6. Do not attempt internal service or adjustment unless another person, capable of disconnecting mains and rendering first aid, is present.
7. This machine should never be used as a safety device or for realizing an emergency function. A malfunction of the connected motor even with switched on mains cannot be prevented.
8. Do not touch the electrical parts of the devices. During operation the electrical parts are carrying dangerous voltages and might lead to death. In addition, the machine can be damaged if the electrical circuit is touched, as a result of static discharge effects.
9. To prevent additional hazards, do not make modifications or installation of substitute parts. Before any modification, installation of substitute parts or additions are made, ask for the authorization of the manufacturer (Minelli Corporation).

## 2 Elementary safety-advice

### Advices in the instruction manual

- The knowledge of the Basic safety advices and safety regulation are basic conditions for the design to security using of this machine in cooperation with the “Safety Regulations” on page 3.
- The instruction manual contains the core of the important advices, to use this machine in a safe condition.
- The instruction manual, especially the safety advices, must be considered by all users, who work on this machine.
- Beyond that it must be paid attention to the locally valid regulations and the compliance of the accident control.

### Responsibility of the operator

Operation on this machine and its controls is only allowed, if the employees

- will be introduced to the basic advices for working safety and accident control. They must also be instructed to the machine applications as well.
- have read and understood the safety advices and warning indications in the instruction manual

The operator should regularly control the safety -conscious work of the employees.

### Responsibility of the employees

The employees, who work on the machine, have to oblige to the following principles:

- that they pay attention to the basic safety advices of work safety and accident control.
- that they have read and understood the safety advices and warning notices in the instruction manual.

### Risk in using the machine

The machine HM2000-EVO has been developed according to state of the art technology and was constructed by the accepted safety-related regulations. However, it is possible by using the machine, that there could appear some risks for employees / third party, especially if the machine is misused and operated not accordingly to the MIRA instruction manual. Only utilise the machine:

- for designated use.
- in safety-related good condition.

Breakdowns must be corrected immediately!

### Designated utilisation

The MIRA HM-2000 EVO machines are exclusively designed for clamping and machining cylinder-heads from combustion engines (Diesel and Gasoline). Another- or beyond going utilisation is not intended and permitted. The Minelli Corporation will not be rendered liable for damages which evolve from improper machine-use. The following references belong to a conventional use as well:

- to pay attention to every advice from the instruction manual.
- to observe the maintenance rate and service work schedules.
- to work and operate according to locally valid regulations and the compliance of the accident control.
- to use only genuine MIRATOOL spare parts for maintenance and repair servicing.

## Warranty and liability

Warranty matters are described in MIRA's terms of sales and return policy conditions and are an integral part of any sales contract between MIRA and the customer. Warranty- and liability by people and material assets are void, if they had one or more of the following causations:

- Non-designated use of the machine
- Incorrect mounting, launching, using and servicing of the machine
- Operation of the machine with damaged safety-devices or incorrect and missing mounting of the safety- and protective gears
- Non-observance of the advices in the instruction manual with regard to the transport, storage, assembling, launching, operating and servicing of the machine
- Independent constructive manipulations of the machine
- Independent manipulation of the HM-2000 EVO (for example: removing of safety labels, controls, safety- and protection shields)
- Manipulation and removing of the original MIRA type plate
- Bad monitoring of machine parts which are wearout and in dire need of maintenance
- Improper servicing, repairs and maintenance work
- Emergencies by external-material influence and "force-majeure" situations

## Symbol- and advice description

The following descriptions and icons will be used for risks and dangerous situations:



**Warning notice – Generally danger:** Indicates a potentially dangerous situation, which can induce low to severe injuries up to death, if they will be ignored.



**Warning notice – Danger of electrocution:** Indicates a dangerous situation, which can induce electrical shocks, severe burns up to electrocution, if they will be ignored.



**Warning notice – Crushing hazard:** Indicates a potentially dangerous situation, which can induce low to severe constant injuries, if they will be ignored.



**Info-notice:** Indicates Informations and/or additions, which are important for the appropriate use of the machine and its functionality.



**Application-notice:** Indicates accessories and further application-features of the machine.

## Organisational provisions

- The operator must prepare the required safety-equipment / gears.
- All safety-devices must be checked in regular intervalls.

## Protection-apparates

- Before launching the machine, all protection-devices must be installed and tested correctly.
- Protection-devices may only be removed
  - after shutdown and
  - coverage against re-launching of the machine
- By mounting additional machine parts, the dismantled protection gears must be installed in a correct and designated manner. The operator has to make sure all protective shields and gears are installed again in the correct order and fully functionally.

### **Informative safety provisions**

- The instruction manual must be kept by the machine at all times.
- Additional to the instruction manual, there must be paid attention to the general and local regulations of the accident- and pollution control.
- All safety- and warning symbols on the machine have to be kept in good condition.

### **Training of the users**

- Only introduced and trained employees are permitted to work on the machine.
- The user competence must be clearly appointed for the mounting, launching, handling, servicing and repairing of the machine.
- Beginners / trainees may only work on the machine under the attendance of an experienced employee or operator.

### **Machine- and apparate electricis**

- Do NOT consider any alterations and manipulations on the motor control unit or the control box of the Vario Drive. Manipulation on the machine / device wiring are strictly prohibited.
- Only introduced and trained employees are permitted to operate the Vario Drive. CAUTION => Pay attention to rotative machine parts and tools!

### **Safety provisions in the standard mode**

- All protection-devices must be absolute functioning, if the machine is in operation.
- Before switching-on the machine, there must be paid attention that nobody is exposed to the risks by starting the machine.
- The machine should be checked for external damages and safety-device functioning (EMERGENCY-Push button) on every working shift.

### **Risks of electricity and electrocution**

- The work on electrical power supplies must be done by an expert (Certified Electrician)
- The electrical equipment of the machine must be checked in constant intervals. (crippled cords and damaged cable strands, defective Controls etc.)
- The boardsheet has to be closed at all times, especially during operation!
- Repairs and servicing on hot wires / cables is strictly prohibited => contact MIRATOOL Service
- By permanent Non-use of the machine - remove the power cord from the main socket.

### **Especially danger areas**

- If the clamping-device is not tightened enough or fully loosened, there is a risk of rotating. This can be dangerous for squeezing of fingers, hands and arms. If necessary, lock and/or unlock the clamping device with the help from a second party.
- Make sure that the machine will be secured against accidental switch-on!
- General risk of clamping and squeezing by setting and clamping the cylinder-heads. Tighten securely the clamping plate and the clamping device against loosening.
- The vario drive and the respective valve seat refacing units contain rotating machine parts, who are a demanding risk for (long) hair, hands and fingers. Wear suitable safety equipment (e.g. hairnet etc.).

### **Leaking of hazardous dust and vapours**

- During the refacing of the valve seats, metal dust, particles and vapours from the cutting oil can occur. They can irritate and injure the lungs and the eyes. Wear suitable safety equipment (e.g. protection goggles, mask etc.). Ensure enough ventilation on the workstation. Special safety precaution, for example: eyeflushing device.

### Service and repairs, troubleshooting

- Arrange the prescribed setting-, servicing- and maintenance work to the appointed deadlines.
- Informing the responsible employees of the machine about imminent servicing and repairs.
- All of the machine pre- or after switched machine parts and operating mediums, e.g. pressurised air, must be ensured against accidentally re-launching.
- By all servicing-, checking- and repairing works, the machine must be switched off from the main supply and the main switch must be locked against unexpected re-launching
  - Lock and strip of the key from the main switch, if it is possible.
  - Add a shield or an information-sign on to the machine, that the machine may not can be switched on.
- Great assemblies must be carefully mounted and ensured on lifting gears. Only use inspected lifting gears according to the local regulations!
- Check loosened screw fittings for straight fixation.
- After finishing the service work, the safety devices of the machine must be checked and verified

### Constructive modifications on the machine

- Without written authorisation by the manufacturer Minelli Corp. (MIRA), there's no right to add components and/or making some modifications to the machine. This is also valid for welding on supporting assemblies.
- All constructive modifications require a written confirmation from the Minelli Corp. (MIRA)
- Machine parts in poor condition have to be replaced by original MIRA spare parts only!
- Only use original genuine MIRA spare and wearing parts.
  - By spare parts of an unknown third party and/or other supplier, there is no guarantee, that those parts are constructed for the required operational demands and safety factors.

### Cleaning of the machine and disposal of wastes

- Used stuff and materials must be disposed correctly, especially:
  - working on lubrication systems- and devices
  - waste from cleaning with solvents and cleaners
- The machine must be cleaned in constant intervals, with a dryflannel and the least of machine- or industry cleaner. => See maintenance rate!
- Further cleaning per grade of using and grade of pollution of the machine.
- The packaging material of the HM-2000 EVO, after delivering, must be disposed correctly in the respective waste containers and/or according to the local waste- and environmental legislations!

### Noise emission of the machine

- The noise pressure level, going out from this machine, by maximum spindle rotation of the Vario Drive, amounts to 70dB(A). The constant noise level amounts to approx. 40dB(A) (quietly environment).
- Based on the local environment, there is a possibility of a higher noise pressure level. This can cause noise deafness. In this case, the employees must be wearing protection devices (e.g. hearing protection, Oro-pax etc.).

### Safety advices for transportation

- By transportation, secure all moving parts from the machine against loosening.
- The machine must be protected against damages from transportation. If necessary, the machine has to be packed in completely.
- By transportation, the machine must be always secured with inspected tension belts and other tensioning mean, to avoid injuries and damages on employees and machine.
- To leveling up the machine with lifting equipment, the respective safety regulations must be observed. There is a risk of an accident by non-observance! MINELLI Corp will not be rendered liable for damages which evolve from improper machine levelling and handling.



### 3 Copyright ©

The exclusive copyright of this instruction manual remains in the hands of the MINELLI Corporation (MIRA).

This instruction manual is appointed to the operator and the corresponding employees.

**Minelli Corporation  
MIRA Division  
Mattenstrasse 3  
8330 Pfäffikon ZH  
Switzerland**

For the provided technical documentation see the authorised person in chapter „Declaration of conformity“ on page 10.

## 4 Non-liability

The HM-2000 EVO workstation may only be operated according to the instruction manual. The manufacturer refuses to accept any liability for accidents and damages caused by incorrect operation and non-designated use. He also refuses any liability for alienated use of the machine.

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## 5 Warranty

In case of manufacturing or material defects Minelli Corporation will replace the defective part or parts at no charge within 12 months after the date of final purchase. No further claims can be covered under the warranty. Defective parts must be returned along with proof of purchase. Warranty does not cover any subsequent damage caused by these defective parts. Warranty does not cover non-designated handling, the use of incorrect electronic parts or deliberate damage, nor does it cover shipping and packing costs.

**6 Declaration of conformity**

**MINELLI®**

Minelli AG  
 Mattenstrasse 3  
 CH-8330 Pfäffikon ZH  
 Schweiz / Switzerland  
 www.minelli.ch  
 sales@minelli.ch

**Konformitätserklärung**  
*Déclaration de conformité*  
**Declaration of conformity**  
**Dichiarazione di Conformità**

**Wir/Nous /We/Noi,**

**Minelli AG**  
**Mattenstrasse 3**  
**CH-8330 Pfäffikon ZH**

**erklären in alleiniger Verantwortung, dass das Produkt**

*déclarons de notre seule responsabilité que le produit*

bearing sole responsibility, hereby declare that the product

dichiariamo sotto la nostra sola e completa responsabilità che il prodotto

**Beschreibung des Produkts**

HM-2000 EVO Aufpannsystem für Zylinderköpfe

**Description du produit**

HM-2000 EVO Système de serrage pour culasses

**Description of product**

HM-2000 EVO Clamping system for cylinderheads

**Descrizione del Prodotto**

HM-2000 EVO Sistema di bloccaggio testate

**Typenreihe/ Série type/ Type Series/ Serie Tipo**

0518

**auf das sich diese Erklärung bezieht, mit der/den folgenden Norm(en) oder normativen Dokumenten übereinstimmt:**

*auquel se rapporte la présente déclaration est conforme aux normes ou aux documents normatifs suivants:*

referred to by this declaration is in conformity with the following standards or normative documents:

riferente a questa dichiarazione è conforme alle seguenti regole e normative:

**Bestimmungen der Richtlinie**

*Désignation de la directive*

Provisions of the directive

Denominazione della Direttiva

**Titel und/oder Nummer sowie Ausgabedatum der Norm(en)**

*Titre et/ou numéro ainsi que date d'émission de la/des norme(s)*

Title and/or number and date of issue of the standard(s)

Titolo e/o numero e data di promulgazione della norma

**2006/42/EG: Maschinenrichtlinie**

*2006/42/CE: Directive sur les machines*

2006/42/EC: Machinery directive

2006/42/CE: Direttiva Macchine

SN EN 1037+A1: 2008-07

SN EN ISO 13849-1: 2016-05

DIN EN ISO 12100: 2011-03

**2014/30/EU: EG-EMV Richtlinie**

*2014/30/UE: Directive CEM*

2014/30/EU: EMC directive

2014/30/UE: Direttiva CEM

SN EN 60204-1: 2006-06

SN EN 60269-1+A1+A2: 2015-05

DIN EN 61800-3: 2012-09

DIN EN 55011: 2018-05

**2014/35/EU: Niederspannungsrichtlinie**

*2014/35/UE: Directive basse tension*

2014/35/EU: Low voltage directive

2014/35/UE: Direttiva bassa tensione

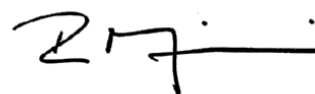
**Ort und Datum**

*Lieu et date*

Place and date

Luogo e Data

Pfäffikon ZH, 20.07.2023



Reto Minelli (CEO/Geschäftsführer)

*L'administrateur délégué*

General Manager

Amministratore delegato

# HM-2000 EVO

The HM-2000 EVO contains the newly constructed clamping system AV-2000 EVO and represents the all new generation of MIRA headmaster workstations. The state of the art developed Vario Drive and Multivac units are modularly integrated in the headmaster workstation and can be easily retrofitted into the system afterwards.

## 7 Positioning

To establish the HM-2000 EVO, it is necessary to provide a clean and bright working base with a power supply. About 1,7 x 1,3m should be provided as a platform as well as at least 2,0m ceiling height. The floor loading for the HM-2000 EVO amounts to 320kg (706lbs).

## 8 Levelling

The HM-2000 EVO has to be established absolutely steadfast and firmly to guarantee an appropriate and solid handling. Thus, the four mounting feet can be levelled individually with an open-end wrench (size 24) by rotating cw or ccw to the required level. The levelling range amounts to 70mm in overall.

There can be used a spirit level, laid alongside to the clamping plate, for an exact and even levelling of the workstation. The four mounting feet can be secured with the lock nut as soon as the levelling is completed.

## 9 Power network

### 9.1 220-240VAC / 50-60Hz

This is the standardised power network for operation in the following countries: **Switzerland, EU, UK, Africa, Russia, Australia, Asia and parts of Latin America.**

=> The Vario Drive and Multivac can be connected directly to the pre-installed multiple socket and therefore to the local 230VAC power network.

### 9.2 100-125VAC / 50-60Hz

For operation in the following countries: **USA, Japan, Central America und parts of Latin America**, the use of an external voltage transformer is required. The voltage transformer **provides** the required **220-240VAC / 50-60Hz** electricity from the local 100-125VAC power network.

=> The voltage transformer will be connected to the multiple socket. On the output of the voltage transformer, the Vario Drive and Multivac can be directly operated with 230VAC. The voltage transformer will be delivered as an additional device. See also chapter 12.11.

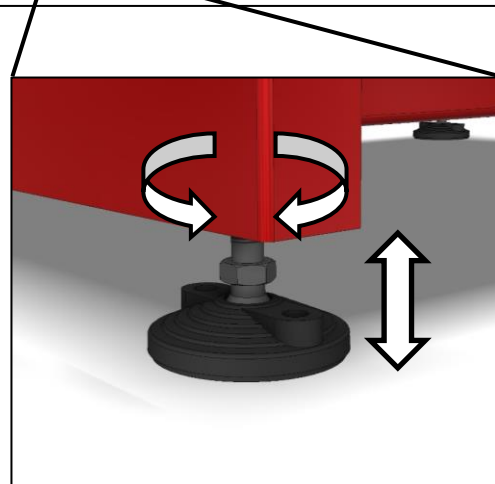


Fig. 1 - Levelling of the HM-2000 EVO

### 10 Connections and type plate

The pre-installed multiple socket is located on the rear side of the HM-2000 EVO. The VGX-21 valve seat refacing unit can be connected alongside with the Vario Drive and Multivac unit to the multiple socket. For operation in a 110VAC power network, an external voltage transformer will be connected to the multiple socket. This ensures that the Vario Drive and Multivac are operated with the required 230VAC power network. Up to 8 devices can be connected to the multiple socket. The type plate is located on the rear side of the HM-2000 EVO on the right corner. => Manipulation and removing of the type plate are not allowed. The original specifications on the type plate (serial-no., fabrication-no. and technical specifics) must be in readable condition if service repairs and warranty is required.

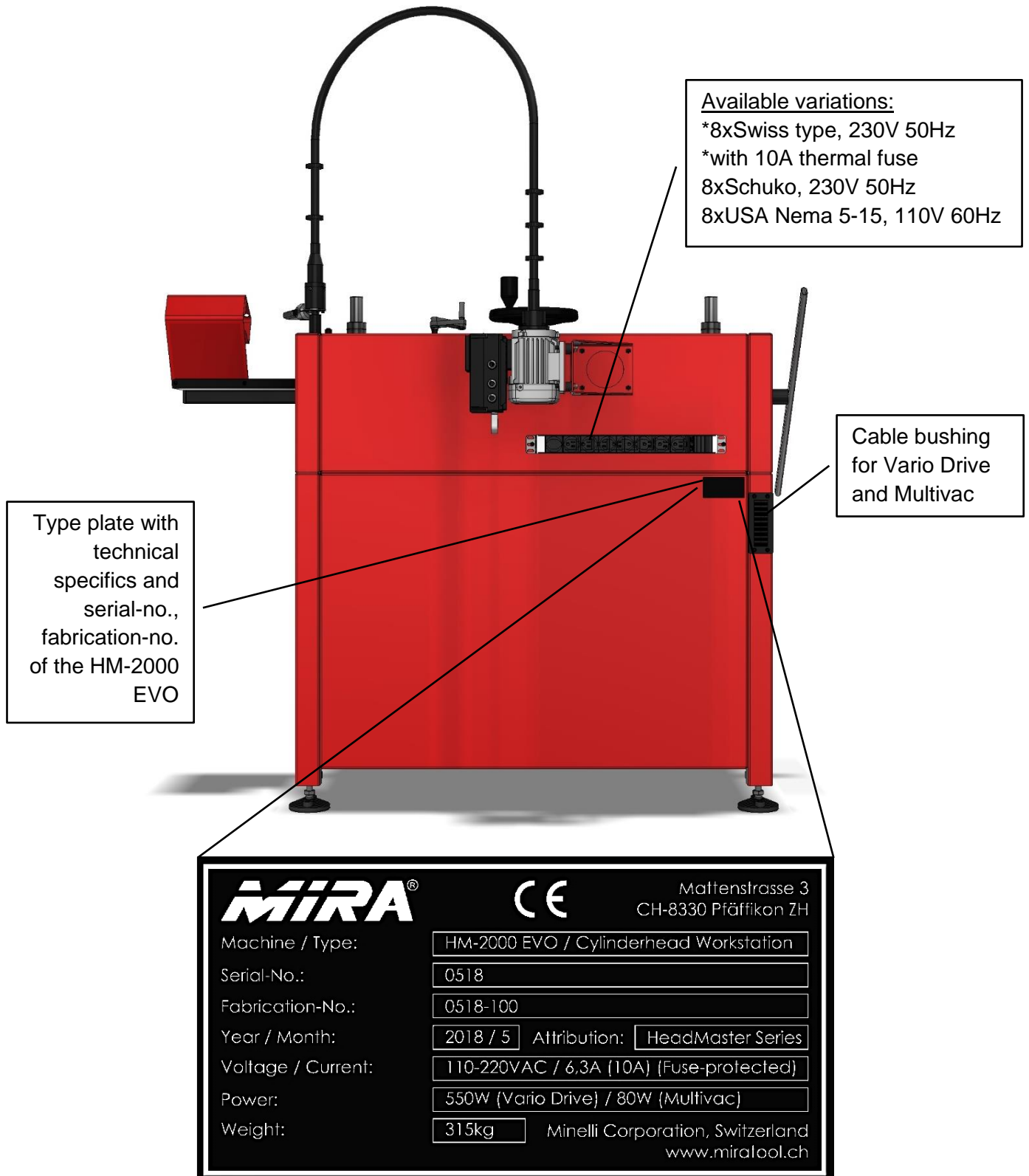
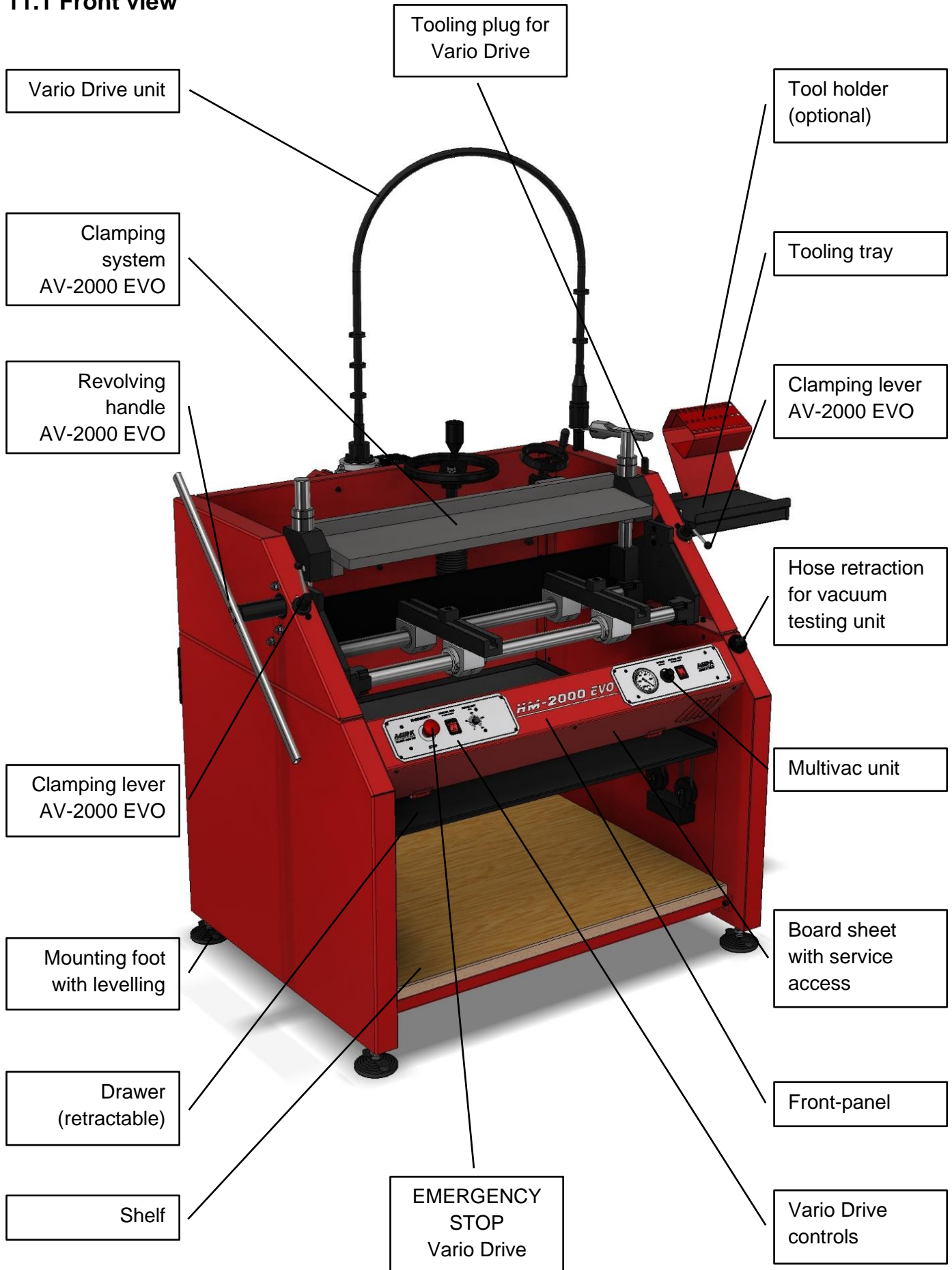


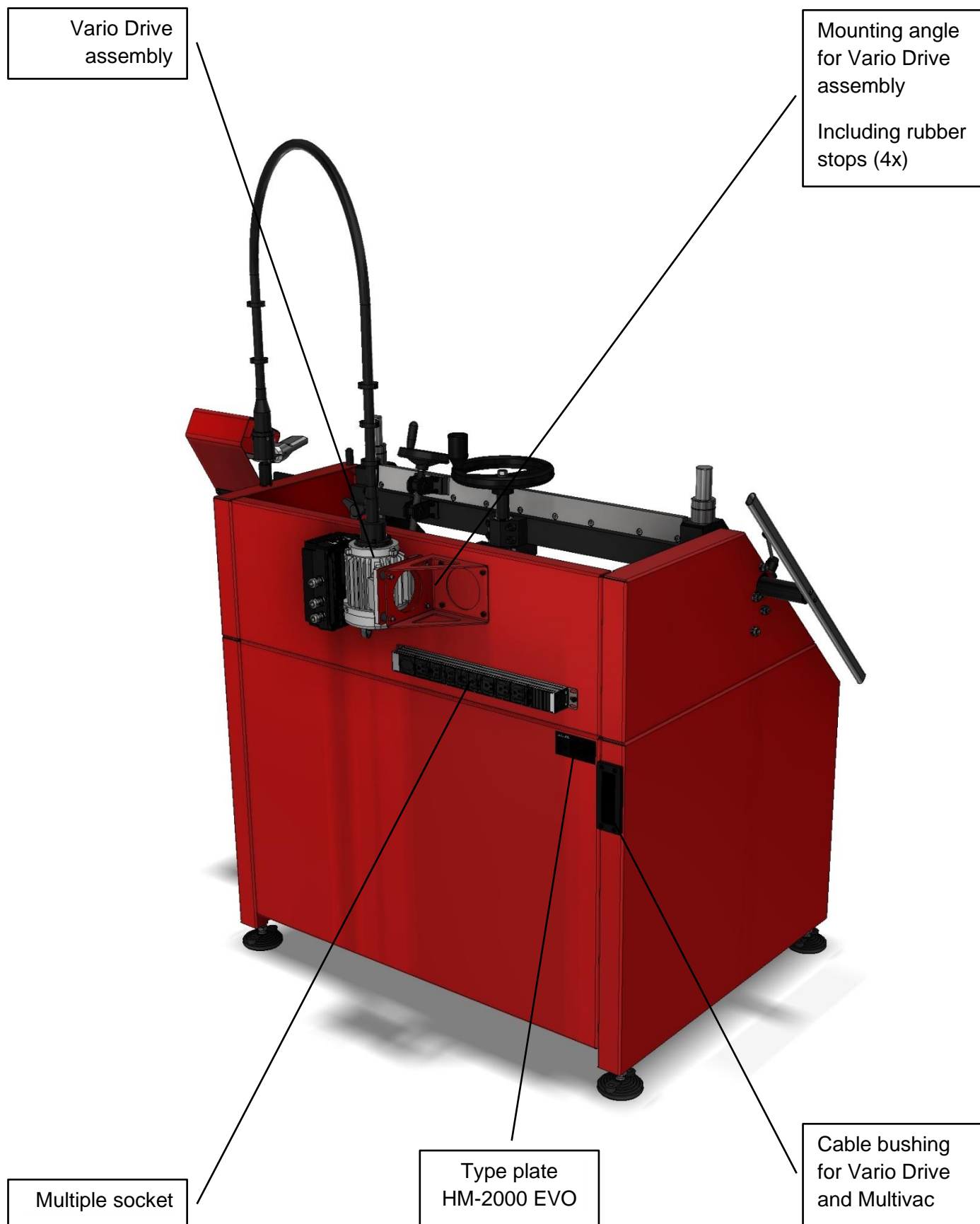
Fig. 2 - Type plate HM-2000 EVO

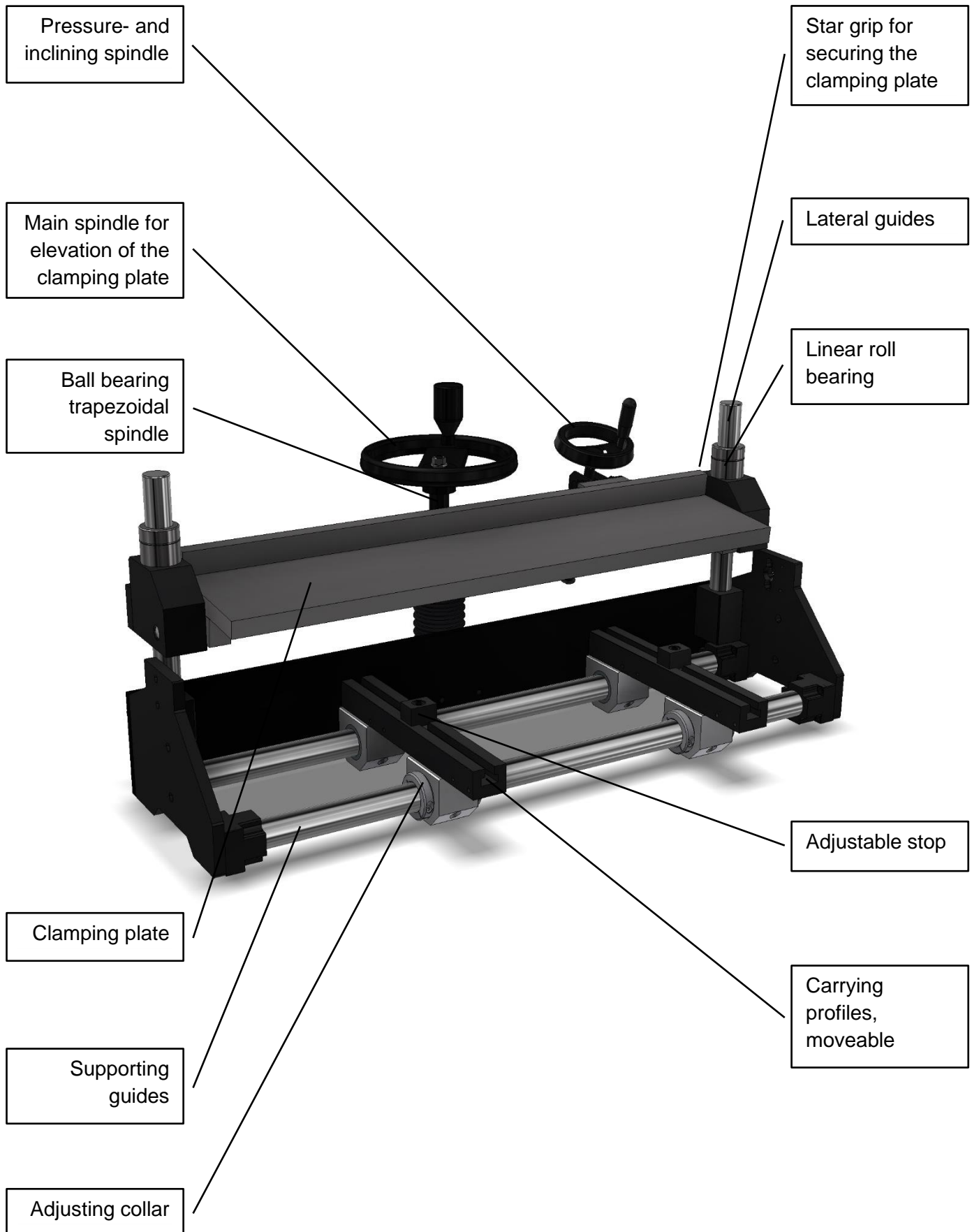
**11 Machine parts**

**11.1 Front view**



**11.2 Rear view**



**11.3 AV-2000 EVO**



11.4 Controls Multivac and Vario Drive

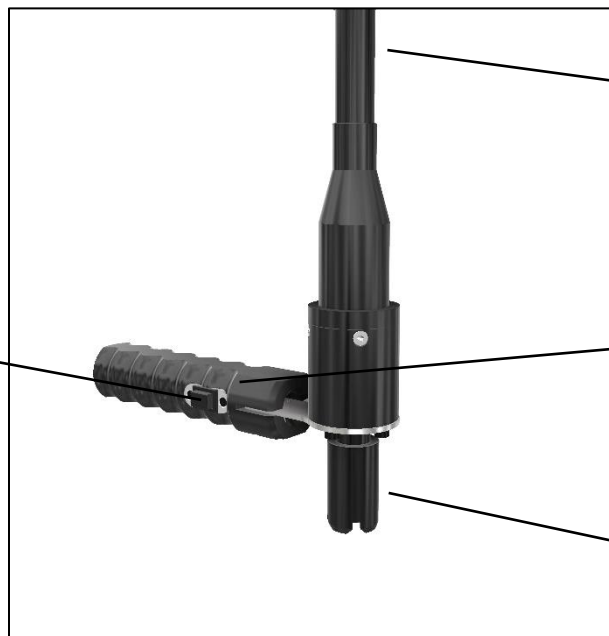


Fig. 5 - Vario Drive controls

EMERGENCY STOP Vario Drive

Rotation speed control (RPM)

ON-OFF Vario Drive



Flexible shaft

Switch key button

Hand grip Vario Drive

Vacuum setting

Driving pin to VGX-21 device

Vacuum indication

ON-OFF Vacuum pump

Fig. 4 - Vario Drive hand grip with switch-key button

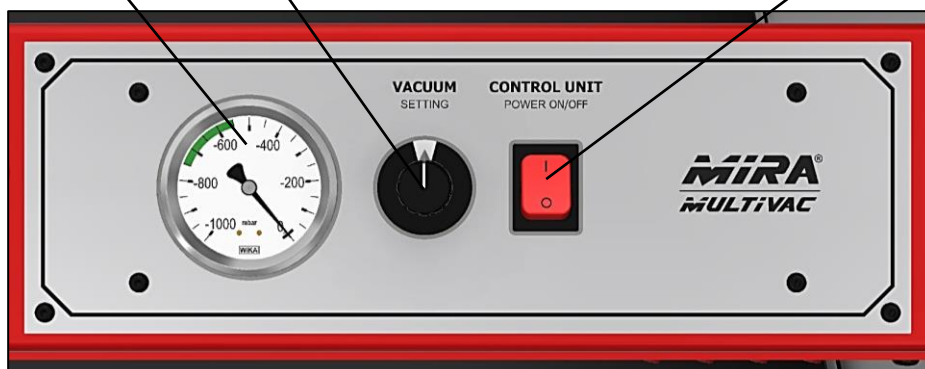


Fig. 3 - Multivac controls

## 12 Installation of the equipment

The installation of the equipment can be divided into mounting of the Vario Drive and Multivac. The VGX-21 unit is not fixly integrated in the HM-2000 EVO and therefore must be connected as an external device to the multiple socket of the workstation.

The multiple socket provides, including Multivac and Vario Drive connection, up to 6 connections for external devices and additional equipment.



**Pay attention! The use of an external voltage transformer is required if the installed Vario Drive and Multivac are operated in a 110VAC power network!**

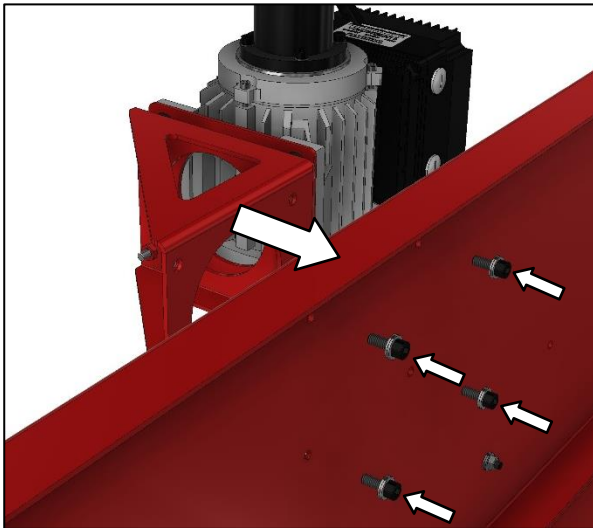


Fig. 6 - Installation of the Vario Drive assembly

### 12.1 Vario Drive

The Vario Drive assembly will be mounted on the rear side of the HM-2000 EVO. The assembly will be provided in a separate transport packagin (inside of the HM-2000 EVO handling case). The separate Vario Drive assembly packaging includes the following:

- 1x Drive assembly with motor and frequency transformer
- 1x Mounting angle with fastening material
- 4x Rubber stops
- 4x Inhex screw
- 4x Nordlock lock washer



#### **ATTENTION!**

**It is necessary to carry out this setup work with 2 persons. Risk of an accident and severe material damage by incorrect handling!**

The Vario Drive assembly will be delivered pre-installed with the mounting angle and four rubber stops. The pre-installed assembly can be mounted corresponding to the figure above. It can be secured with the 4 inhex screws / 4 Nordlock lock washer from the inside of the rear sheet panel.

## 12.2 Connecting the Vario Drive and Multivac

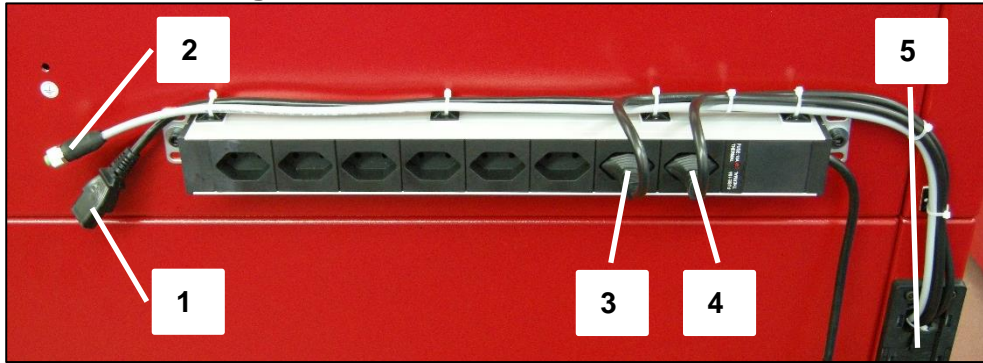


Fig. 7 - Fixly provided multiple socket with power cables

- No.1 => Power cable with C13 coupling to Vario Drive assembly
- No.2 => Potentiometer cable female to Vario Drive assembly
- No.3 => Multivac power cable 230VAC
- No.4 => Vario Drive control box power cable 230VAC
- No.5 => Cable bushing

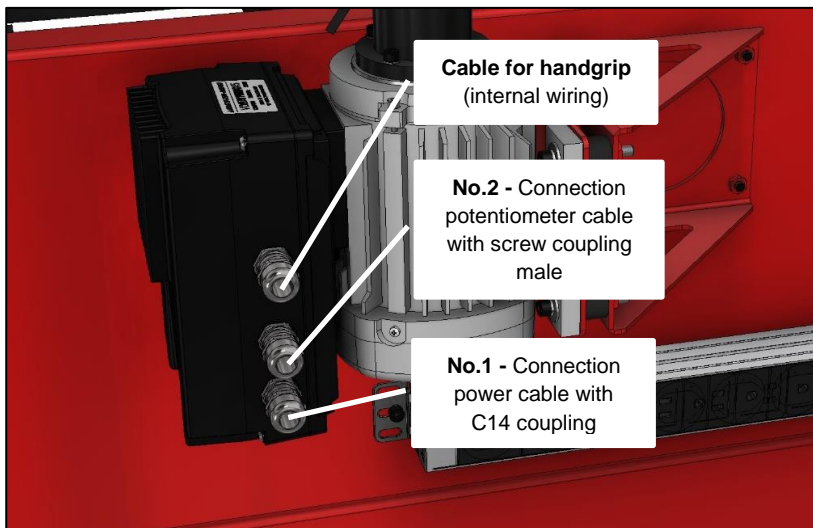


Fig. 8 - Connection of the Vario Drive assembly

The two connection leads for the Vario Drive assembly are pre-installed above the multiple socket and can be connected directly. The potentiometer cable (M12 socket) can be connected to the central supply line (M12 plug) of the Vario Drive assembly. The power cable (C13 coupling) can be connected to the lowermost supply line (C14 coupling) of the Vario Drive assembly.



### **ATTENTION!**

The Vario Drive and Multivac units must be connected in a de-energised mode. Isolate the workstation from the power network and secure it against unintended re-powering!

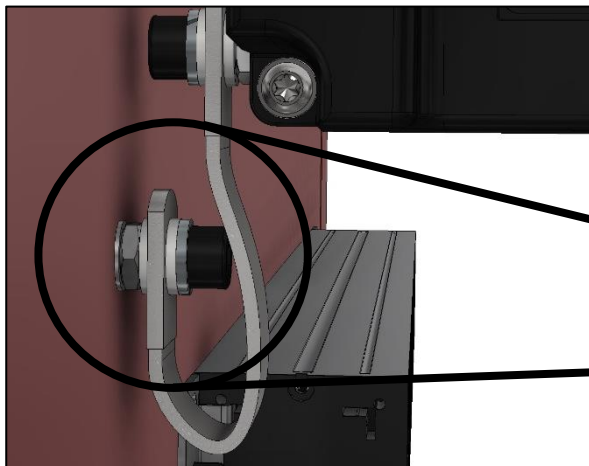


Fig. 9 - Earthing of the Vario Drive assembly

## 12.3 Electrical earthing

The earthing assembly is pre-installed on the frequency transformer of the Vario Drive assembly. After mounting the Vario Drive assembly, the earthing must be secured against the rear sheet panel of the HM-2000 EVO. => installation by the customer.



The earthing can be mounted corresponding to the figure beside. It can be attached on the rear sheet panel of the HM-2000 EVO with the provided mounting material. Secure the earthing from the inside of the rear sheet panel with a hex nut and a lock washer.



Fig. 10 - Vario Drive control box

### 12.4 Control Box Vario Drive

The associated control box for operating the Vario Drive unit is firmly mounted inside the front panel of the HM-2000 EVO and ready for use. The power supply for the Vario Drive will be provided through the pre-installed multiple socket of the HM-2000 EVO workstation. Otherwise, through the external voltage transformer if operating in a 110VAC power network.



**ATTENTION!**

The pre-wired control box should not be removed from the front panel and therefore should not be opened. The front panel, board sheet and the wiring should not be removed unless there is the need of replacing a fuse!

### 12.5 Fuse Control Box Vario Drive

The Vario Drive control box is secured with **two 6,3A fuses** on the power supply side. In case of replacing the fuses, please follow the steps below:



**ATTENTION!**

The Vario Drive and Multivac units must be connected in a de-energised mode! Isolate the workstation from the power network and secure it against unintended re-powering!

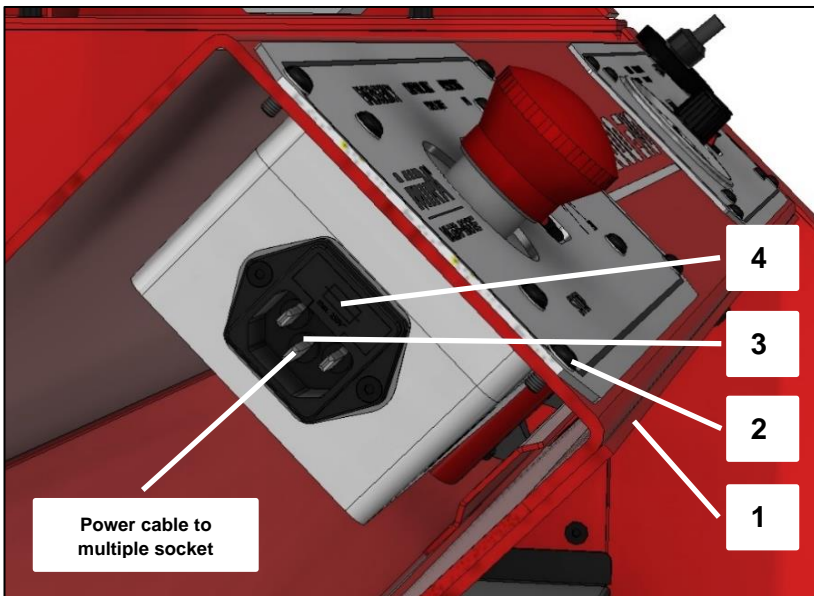


Fig. 11 - Power supply and fuse location of the Vario Drive control box

1. Remove the 6 pan head screws as well as the board sheet carefully.
2. Remove the outer pan head screws and pull out the front panel with the Vario Drive control box.
3. Remove the power cable on the left side completely.
4. Draw-out the fuse bin and replace the respective fuses. (max. 2pcs).

Order-No: **1ESI6300**

(Range of use **110-230VAC 50-60Hz**)

Afterwards, the Vario Drive control box can be installed again and the board sheet can be fixed with the respective pan head screws. Connect the HM-2000 EVO workstation to the power network and launch it for operational use.



Fig. 12 - Multivac unit

### 12.6 Multivac

The Multivac vacuumtesting unit is firmly mounted inside the front panel (on the right) of the HM-2000 EVO and ready for use. The power supply for the Multivac will be provided through the pre-installed multiple socket of the HM-2000 EVO workstation. Otherwise, through the external voltage transformer if operating in a 110VAC power network.



**ATTENTION!**

The pre-wired Multivac should not be removed from the front panel and therefore should not be opened. The front panel, board sheet and the wiring should not be removed unless there is the need of replacing a fuse!

### 12.7 Fuse Multivac

The Multivac is secured with a **0,63A fuse** on the power supply side. In case of replacing the fuse, please follow the steps below:



**ATTENTION!**

The Vario Drive and Multivac units must be connected in a de-energised mode! Isolate the workstation from the power network and secure it against unintended re-powering!



Fig. 13 - Removing the Multivac

1. Remove the 6 pan head screws as well as the board sheet carefully.
2. Remove the outer pan head screws and pull out the front panel with the Multivac unit.
3. Remove the power cable on the left side completely.
4. Draw-out the fuse bin and replace the respective fuse. (max. 1pc).

Order-No: **1ESI0630**  
(Range of use **230VAC 50Hz**)

Afterwards, the Multivac unit can be installed again and the board sheet can be fixed with the respective pan head screws. Connect the HM-2000 EVO workstation to the power network and launch it for operational use.

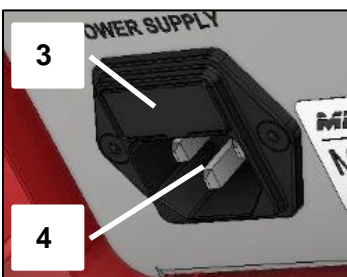


Fig. 14 - Fuse exchange Multivac



Fig. 15 - Multivac adaptor

### 12.8 Multivac adaptor

The Multivac adaptors are provided in 5 different diameters as included accessories of the Multivac unit. The required adaptor can be plugged on the end of the vacuum hose of the hose retraction.



If there appears a problem with the plug-on of the respective adaptor, use Vaseline® to slightly grease the end of the vacuum hose.

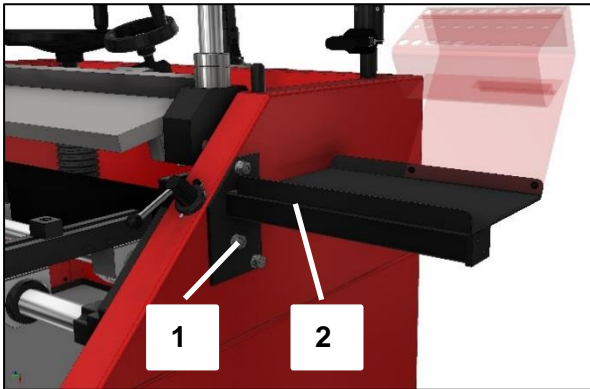


Fig. 16 - Installation of the tooling tray

### 12.9 Tooling tray

Follow the steps below to mount the provided tooling tray for the HM-2000 EVO workstation:

1. Lose the four M10 - hex nuts on the right side and remove them completely with all the mounting materials.
2. Mount the tooling tray corresponding to the picture beside and install the mounting material in the following order:  
4x washers => 4x spring washers => 4x hex nuts



The M10 hex nuts must be tightened with a torque wrench => 55Nm tightening torque.

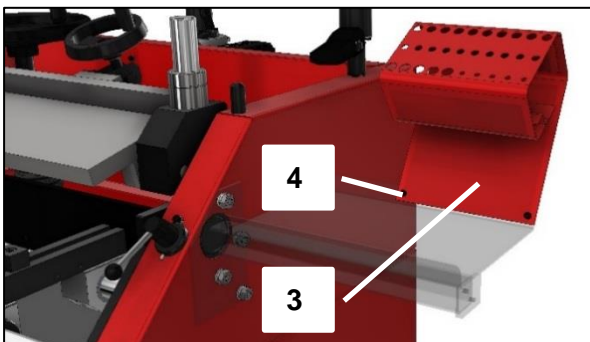


Fig. 17 - Installation of the tool holder

### 12.10 Tool holder (optional)

The optional tool holder can be installed on top of the tooling tray as following:

3. The tool holder will be positioned on the tooling tray (hole pattern) corresponding to the picture beside.
4. Insert the two M5x10 inhex screws from the front side and install the mounting material from the other side in the following order:  
2x washers => 2x spring washers => 2x hex nuts



The M5 hex nuts and M5 inhex screws should be tightened with a torque wrench => 6,5Nm tightening torque.



Fig. 18 - Fixation of the tool holder

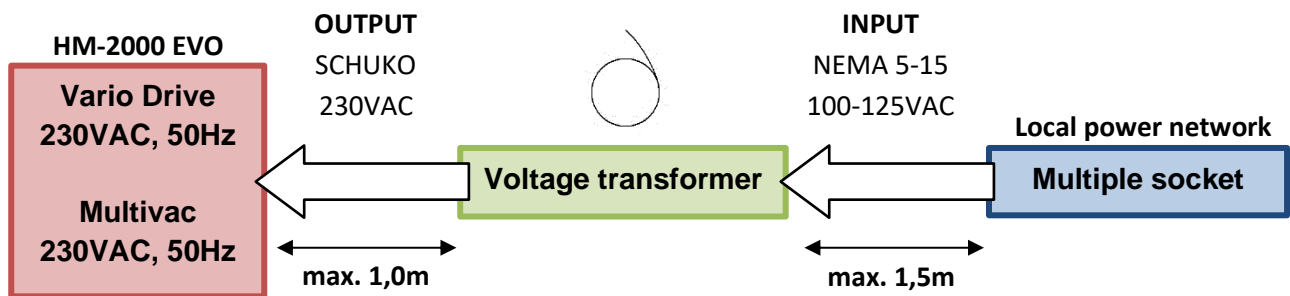
**12.11 Voltage transformer 100VAC ⇔ 230VAC**

**Only for countries with 100-125VAC power network!**

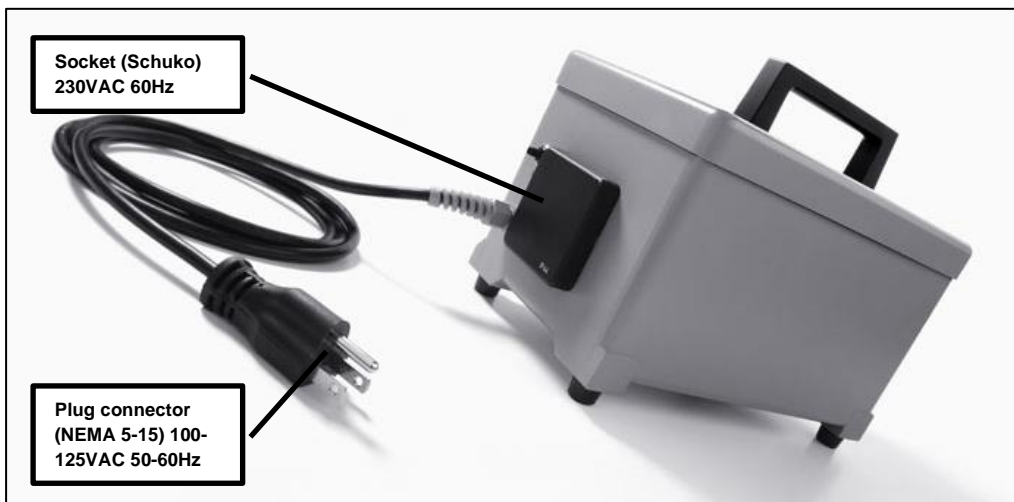
The operation of the Vario Drive and Multivac in a 100-125VAC power network requires a pre-connected, external voltage transformer. This device transfers the existing voltage of 100-125VAC into the required 230VAC power network for operational functionality of the pre-installed devices.

The power cable of the Vario Drive and Multivac (Schuko plug) must be connected directly to the output (Schuko socket) of the external voltage transformer. The voltage transformer will be connected to the local power network (Nema 5-15 plug) via pre-installed multiple socket.

The voltage transformer unit must be positioned in a **dry environment** and must not be exposed to mechanical vibrations. It is recommended to position the voltage transformer on the ground behind the HM-2000 EVO workstation. The connection distance **should not extent 1,0-1,5m**.



- Operating the HM-2000 EVO workstation (incl. Vario Drive and Multivac) without voltage transformer is allowed **ONLY** in a 230VAC, 50-60Hz power network!
- The voltage transformer has to be connected in a de-energised mode!
- Do not connect any 110VAC devices directly to the external voltage transformer! These electrical devices (working lamps, measuring devices etc.) will be destroyed by applying higher voltages (<230VAC). Imminent fire hazard through electrical overload.
- The voltage transformer must not be opened in any case. Imminent danger of electrocution and short-circuit fault!
- To lead away the emerging heat energy from the voltage transformer and preventing heat accumulation, the provided working base should be selected sufficient enough.
- Non-observance of these regulations can lead to hazardous electrical shocks, electrocution and material damage as well!



Order-No.:  
**1KTR00425**

Fig. 19 - External voltage transformer

### 13 Cylinder head clamping device

The following chapter introduces the operation of the clamping device AV-2000 EVO. Furthermore, all the general handling features will be explained, to guarantee a proper and secure clamping of the respective cylinder head.

However, it is recommended to contact the manufacturer MINELLI CORPORATION, if there is a problem with the clamping of the respective cylinder head. Please get in contact via [sales@minelli.ch](mailto:sales@minelli.ch).

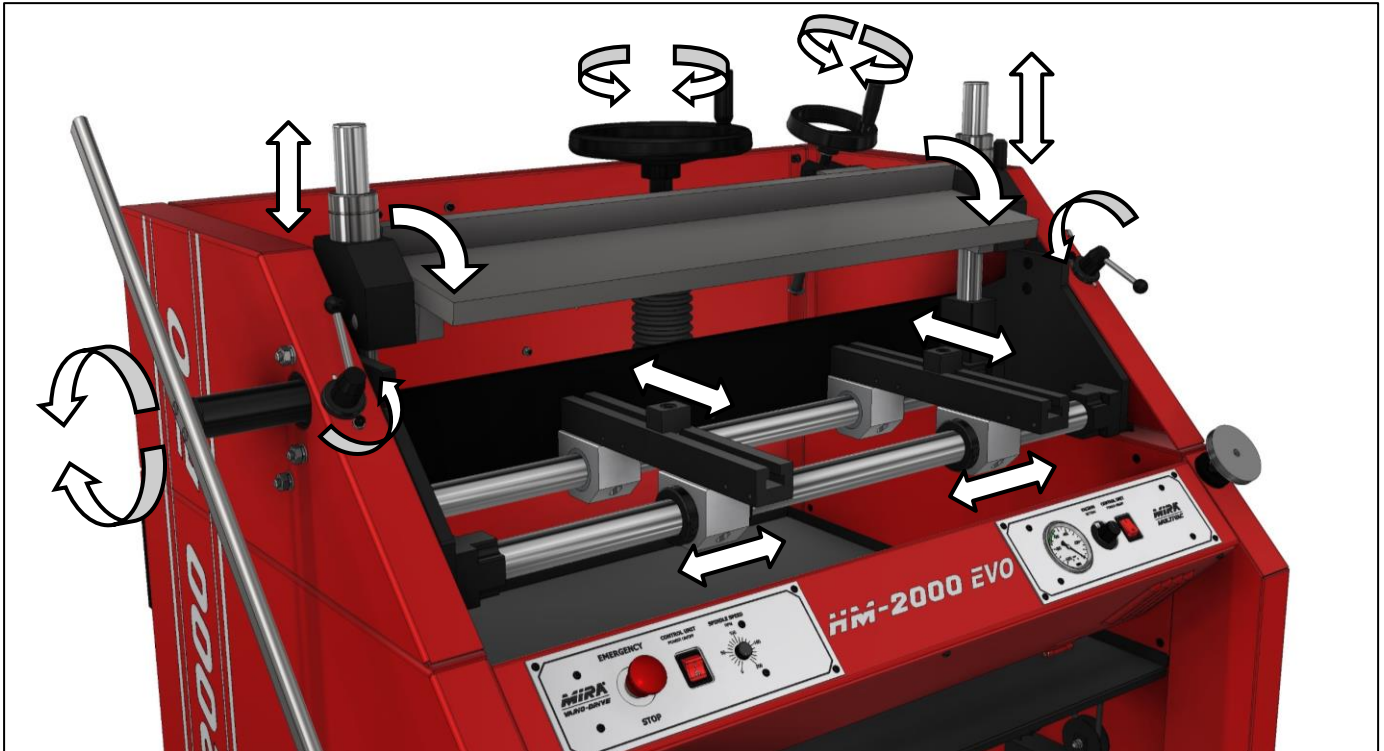


Fig. 20 - Positioning and adjusting of the AV-2000 EVO



**ATTENTION!**

The following setup work and clamping handling should be carried out carefully! There is an imminent hazard of crushing and shearing-off arms, fingers and hands if the clamping device will used improperly!



The maximum weight-load amounts to 100kg (220,5 lbs) and must not be exceeded by any means!

Loosening and revolving of the AV-2000 EVO should be carried out very carefully! There is a risk of injury by shift of emphasis! Careful shifting of the cylinder head!

In order to ensure a secure and firm clamping of the cylinder head, the following steps have to be carried out:



Fig. 21 - Revolving of the AV-2000 EVO

1. In order to avoid the cylinder head from slipping during the clamping process, the carrying profiles have to be set approximately horizontal

Loose the clamping lever on the right side. Then, hold the revolving handle with the left hand and carefully loose the clamping lever on the left side with the right hand. Firmly hold the revolving handle with both hands to safely revolve the clamping device. Tighten both clamping levers again (left side first, then right side) to secure the clamping device.



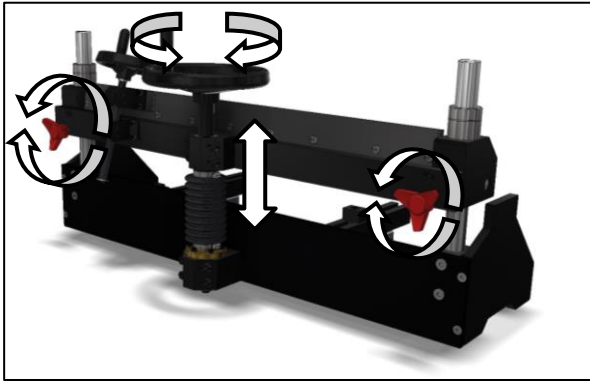


Fig. 22 - Loosening the star grips and elevating unit

- Both star grips (red) on the rear side of the clamping device have to be loosened completely, to provide the elevation of the clamping plate through the main spindle.

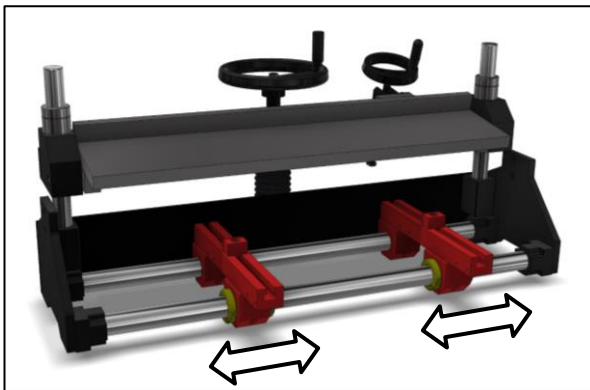


Fig. 23 - Setting the carrying profiles

- Loose the adjustment collars (yellow) to position the carrying profiles on the supporting guides. The carrying profiles (red) should be positioned approximately symmetrical (not unilateral) on the supporting guides to provide the widest possible carrying surface.



Ensure that the carrying profiles are not colliding with any protrusive valve guides and dowel pins and, as far as possible, are in contact with a machined area of the cylinder head.

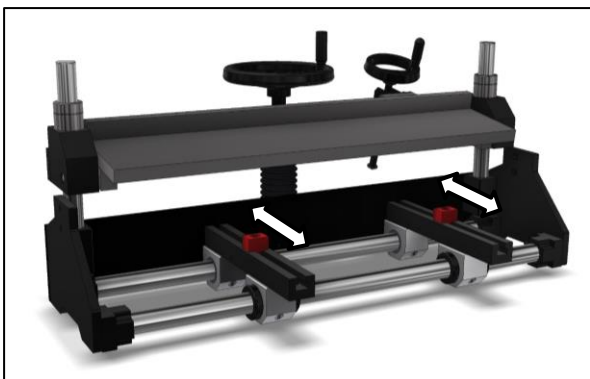


Fig. 24 - Setting the stops on the carrying profiles

- Put the cylinder head on the carrying profiles and loose the adjustable stops (red) located on the carrying profiles. Adjust the stops to ensure a parallel and nearby position of the valve seats to the edge of the clamping plate. This allows a neat refacing of the respective valve seats.



The size ratio for the respective tool-heads and formtools, for refacing with the VGX-21, have to be included as well.

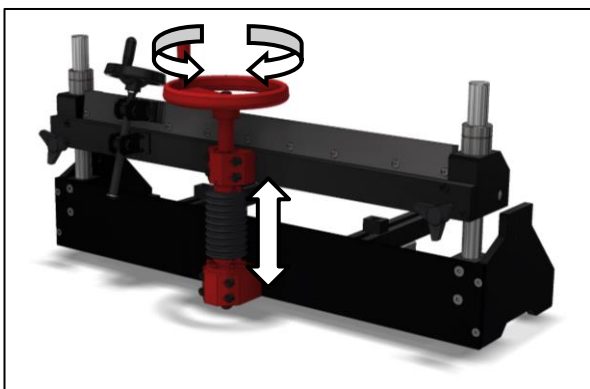


Fig. 25 - Elevating the clamping plate with the main spindle

- The clamping plate can be lowered down through rotating the main spindle (red). Lower down the clamping plate until there is a distance of approximately 1cm between the surface of the cylinderhead and the edge of the clamping plate.

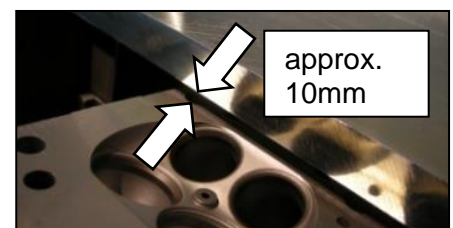


Fig. 26 - Distance of the clamping plate

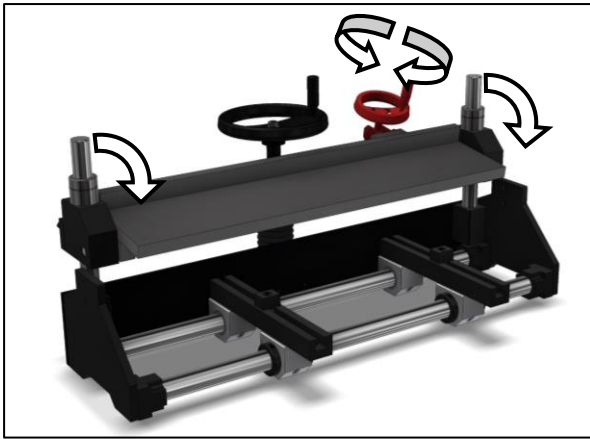


Fig. 27 - Pressure- and inclining spindle

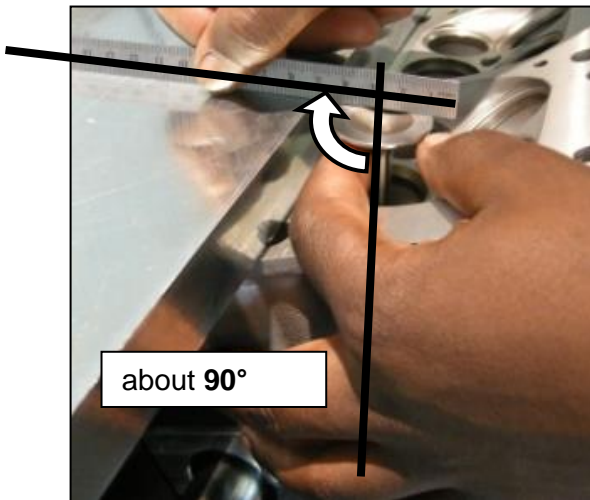


Fig. 28 - Setting with valve stem guide

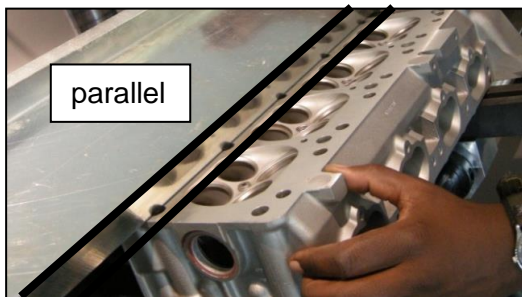


Fig. 29 - Parallelism to clamping plate

6. Ensure if the valve seats are in a parallel and nearby position to the edge of the clamping plate. Select a suitable valve and insert it in the valve stem guide. Then turn, with the pressure- and inclining spindle (red), the clamping plate nearly even to the valve head, allowing a 90° angle to the valve stem guide.
7. Lower down the clamping plate evenly on to the cylinder head surface using the main spindle. The clamping plate should rest completely and well-set on the cylinder head surface.
8. Tighten both star-grips on the rear side of the AV-2000 EVO clamping device firmly.
9. Tighten the clamping plate carefully but firmly on to the cylinder head surface using the pressure- and inclining spindle.
10. Check if the cylinder head is firmly clamped down and can not be moved under the expected operating load.



**If it is still possible to move the cylinder head:**

- Repeat the clamping process
- For single cylinder heads (made of grey cast iron), e.g. for truck motors, the clamping force achieved may be insufficient in certain circumstances => provide additional clamping pressure to the pressure- and inclining spindle.
- Use a suitable rubber sheet (anti-slip) between clamping plate and cylinder head surface as a further measure.

If the cylinder head is perfectly secured, revolve the clamping device in order to bring the clamping plate into a horizontal position presenting an ideal working table for the valve seat refacing unit. In this position tighten the AV-2000 EVO clamping device firmly with both clamping levers (left and right).



**ATTENTION!**

Depending on the respective cylinder head, the adjusting stops on the carrying profiles have to be positioned in the front- or rear side of the cylinder head. Properly positioned adjusting stops are preventing any slipping from the cylinder head when the clamping plate has to be released in an inclined position of the AV-2000 EVO clamping device. => Risk of injury if these indications will be ignored.



Furthermore, the adjusting stops are simplifying the clamping process on similar cylinder heads, because the clamping position is given and adjusted from the first cylinder head.

### 13.1 Example for the clamping of a cylinder head

The cylinder head in the **left picture** is supported insufficiently. The clamping force is not divided evenly on the cylinder head surface and cannot guarantee a secure clamping of the cylinder head. It is not recommended to operate any valve seat refacing on this cylinder head setting.

The cylinder head setting in the **right picture** shows the exact same cylinder head on a correctly expanded supporting. The clamping force can be divided evenly on the cylinder head surface. This setting guarantees a secure clamping of the cylinder head as required for any precise valve seat refacing.

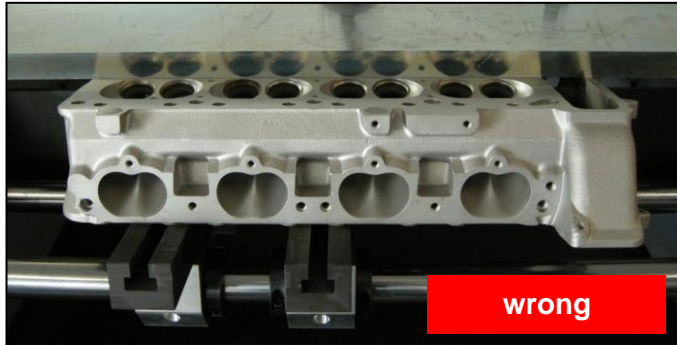


Fig. 31 - Irregular and uneven clamping of cylinder head

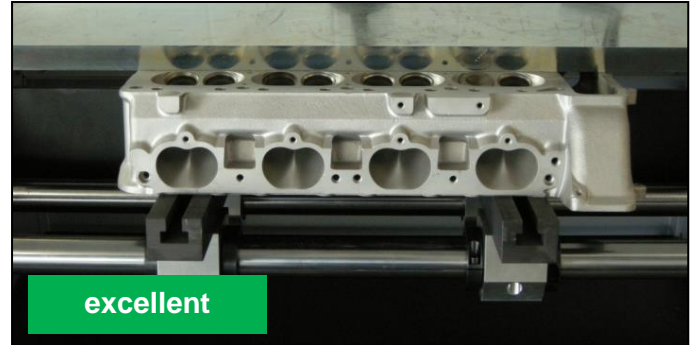


Fig. 30 - Regular and even clamping of cylinder head

## 14 Operation

### 14.1 Vario Drive handling

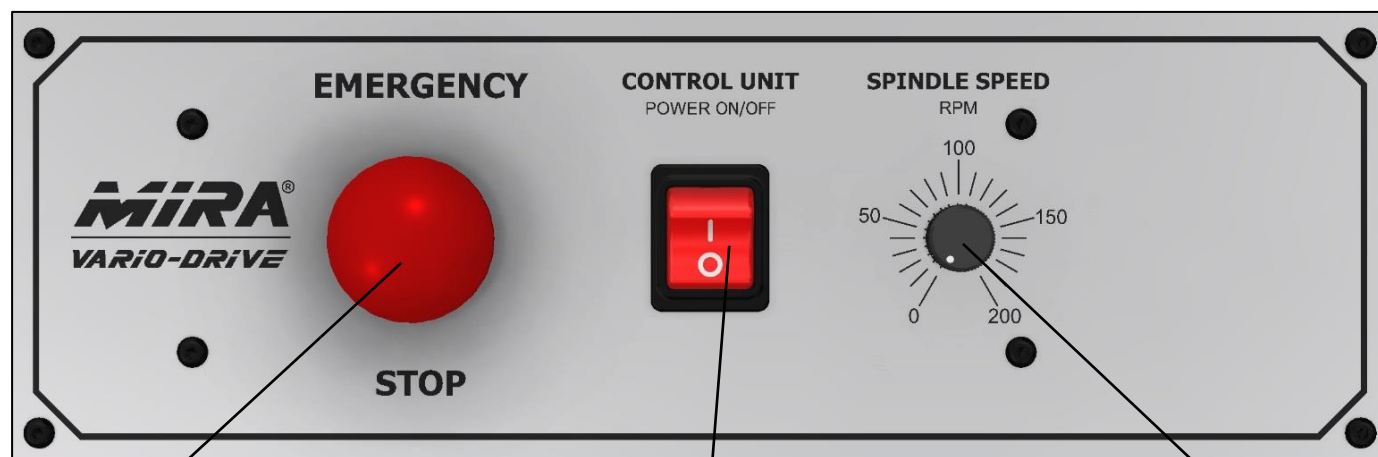


Fig. 32 - Vario Drive front plate with controls

EMERGENCY  
STOP  
Vario Drive

ON-OFF  
Vario Drive

Spindle speed  
0-200min<sup>-1</sup>

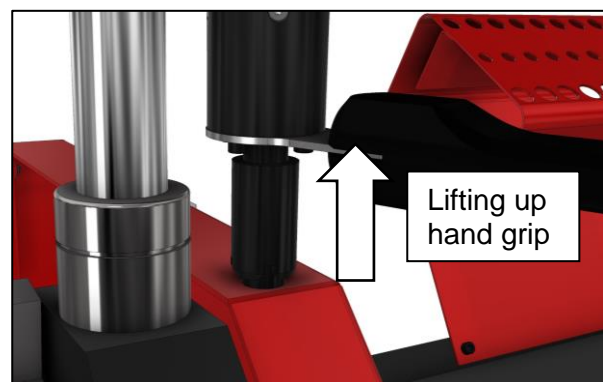


Fig. 33 - Tooling plug for Vario Drive hand grip

The Vario Drive unit will be activated through switching the ON/OFF switch to position 1 on the front plate (active mode is indicated with red illumination). The Vario Drive hand grip is, by default, inserted on the tooling plug of the right side wall of the HM-2000 EVO workstation. The hand grip can be lifted up from the tooling plug and, for operation, inserted on the adaptor of the VGX-21.

**Important:** The EMERGENCY STOP interrupts all electric circuits of the Vario Drive unit and stops the driving pin from any further rotating. Turn the push button clockwise to release and reset the EMERGENCY STOP.

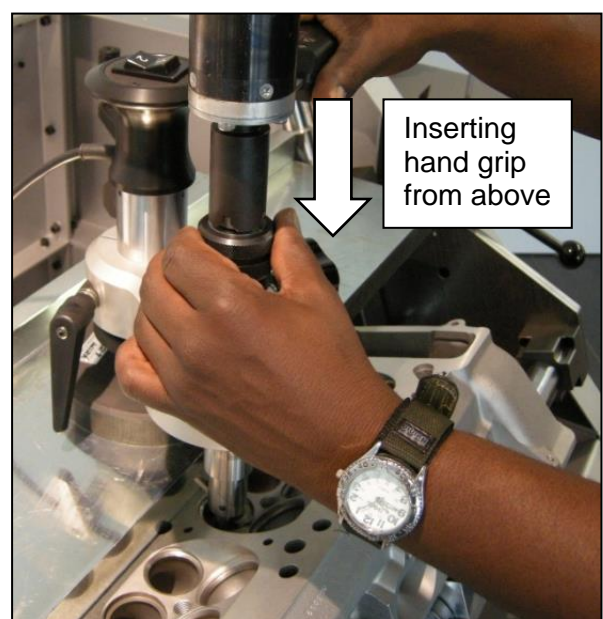


Fig. 34 - Inserting on VGX-21

The required spindle speed can be set on the potentiometer in a range between 0-200min<sup>-1</sup>. Rule of thumb: high speed for small diameters and low speed for large diameters.



**ATTENTION!**

**Do not use the Vario Drive for driving other devices and tools at all! Risk of injury through rotative tools! Beware of the rotating driving pin of the Vario Drive hand grip!**

**Attention:** The rotation of the driving pin begins / stops with a short delay after pressing down / releasing the switch key button on the Vario Drive hand grip!



Handling and valve seat processing with the VGX-21 as well as tool settings can be reviewed in the respective instruction manual.

Set the spindle speed and then the main switch to position 0 after finishing operations (=>Vario Drive power-off)

14.2 Multivac handling

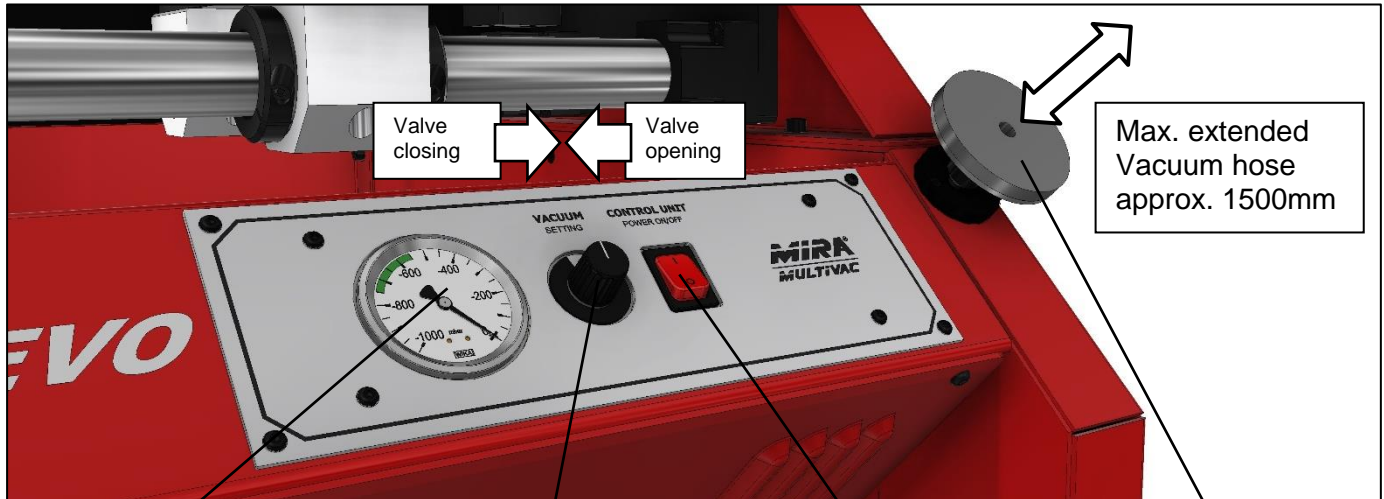


Fig. 35 - Multivac vacuum testing unit

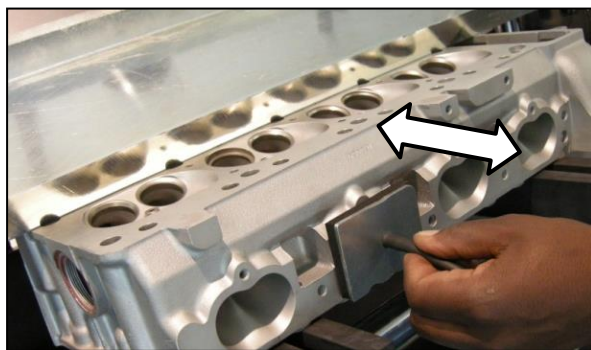
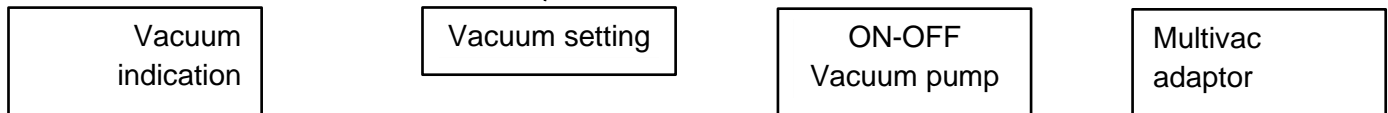


Fig. 36 - Multivac adaptor during leak testing

The leak test with the integrated Multivac vacuum testing unit is taking place after the complete refacing of the valve seats.

For a leak test after the valve seat refacing, it is sufficient enough to insert the clean valves into the valve stem guide and let them rest on their dead weight. The clearance of the valve stem guide will be causing an insignificant loss during the leak test.



**Pay attention**

**Avoid sucking in dirt and liquids. If the vacuum pump is polluted, it is possible that the testing vacuum cannot be accomplished anymore.**

**Testing surfaces have to be cleaned properly before applying any Multivac adaptor. Keep the adaptors in a clean and proper condition!**

**Do not bend the vacuum hose during operation and leak testing.**

1. Select the required diameter-size for the adaptor (corresponding to cylinder head) and apply the adaptor on to the vacuum hose of the hose retraction of the HM-2000 EVO workstation.
2. Switch the ON/OFF switch of the Multivac unit to position 1. => vacuum pump ON!
3. Turn the knob of the vacuum setting clockwise until the arrow is in the white sector of the setting indication and the knob cannot be turned any further. (Thus, the vacuum valve will be closed and the testing vacuum can be established)
4. Pull out the selected adaptor with the vacuum hose from the hose retraction and apply the adaptor on to the testing area of the cylinder head.
5. Testing vacuum will be established and indicated => the reference range of the vacuum is green.
6. Turn the knob of the vacuum setting anti-clockwise. (The vacuum valve opens = vacuum is falling).
7. Take off the adaptor from the testing area and retract the vacuum hose.
8. Switch the ON/OFF switch to position 0. => vacuum pump OFF!

If the leak test is continuing after step 7, turn the knob of the vacuum setting clockwise to re-establish the vacuum for the next testing area. Repeat steps until the cylinder head is tested completely.

## 15 Troubleshooting

The following check questions are designed to help you eliminating possible sources of faults.

### 15.1 Start-up

1. Is the power supply connected properly?
2. Are all plugs connected correctly?
3. Are there any loose contacts?
4. Is the frequency transformer functioning correctly?
5. Is the multiple socket functioning? => thermal fuse?
6. Is the emergency stop on the front panel activated? If yes, restore it.
7. Is the Vario Drive switch at the front panel in the ON position?

### 15.2 Preparations

1. Is the cylinder head at the right angle of the valve stem to the clamping plate?
2. Are the carrying profiles parallel and in contact with the cylinder head?

### 15.3 Leak testing

1. Is the vacuum hose polluted with dirt?
2. Are the hoses installed properly?
3. Are the cables connected properly to the vacuum pump?
4. Is the vacuum pump defective?
5. Is the vacuum adjusting defective?
6. Has the clearance from the valve to the valve stem guide been checked, according to the engine manufacturer's recommendation?
7. Is the valve seat clean?

**16 Spare parts**

**16.1 HM-2000 EVO Page 31**

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**16.2 AV-2000 EVO Page 33**

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**16.3 Pressure- and pivot spindle / Main spindle Page 34**

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**16.4 Hose retraction Page 35**

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**16.5 Vario Drive Page 36**

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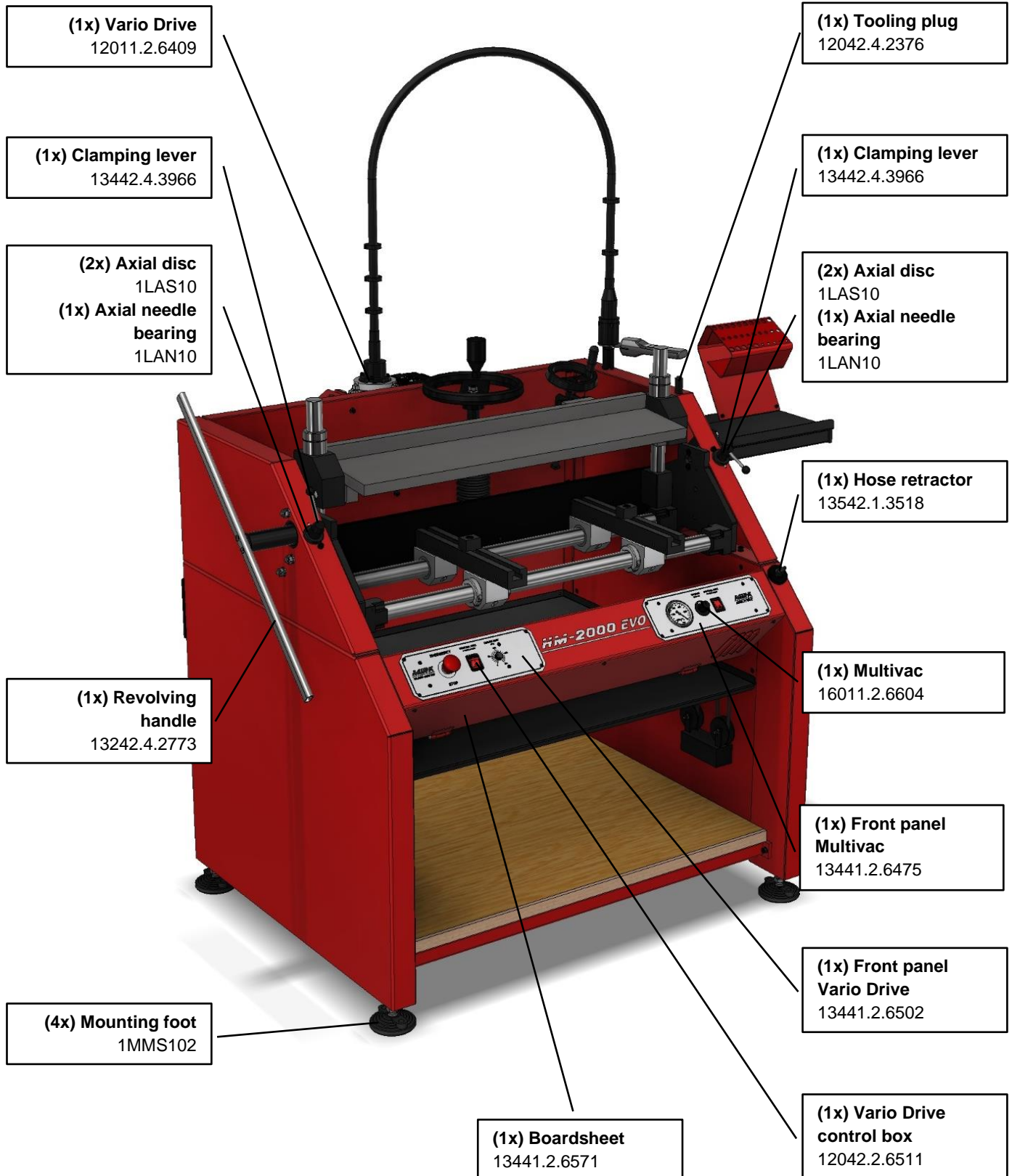
**16.6 Multivac Page 37**

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**16.1 HM-2000 EVO**

From Fabrication-No.: HM-102      Serial-No.: 0518

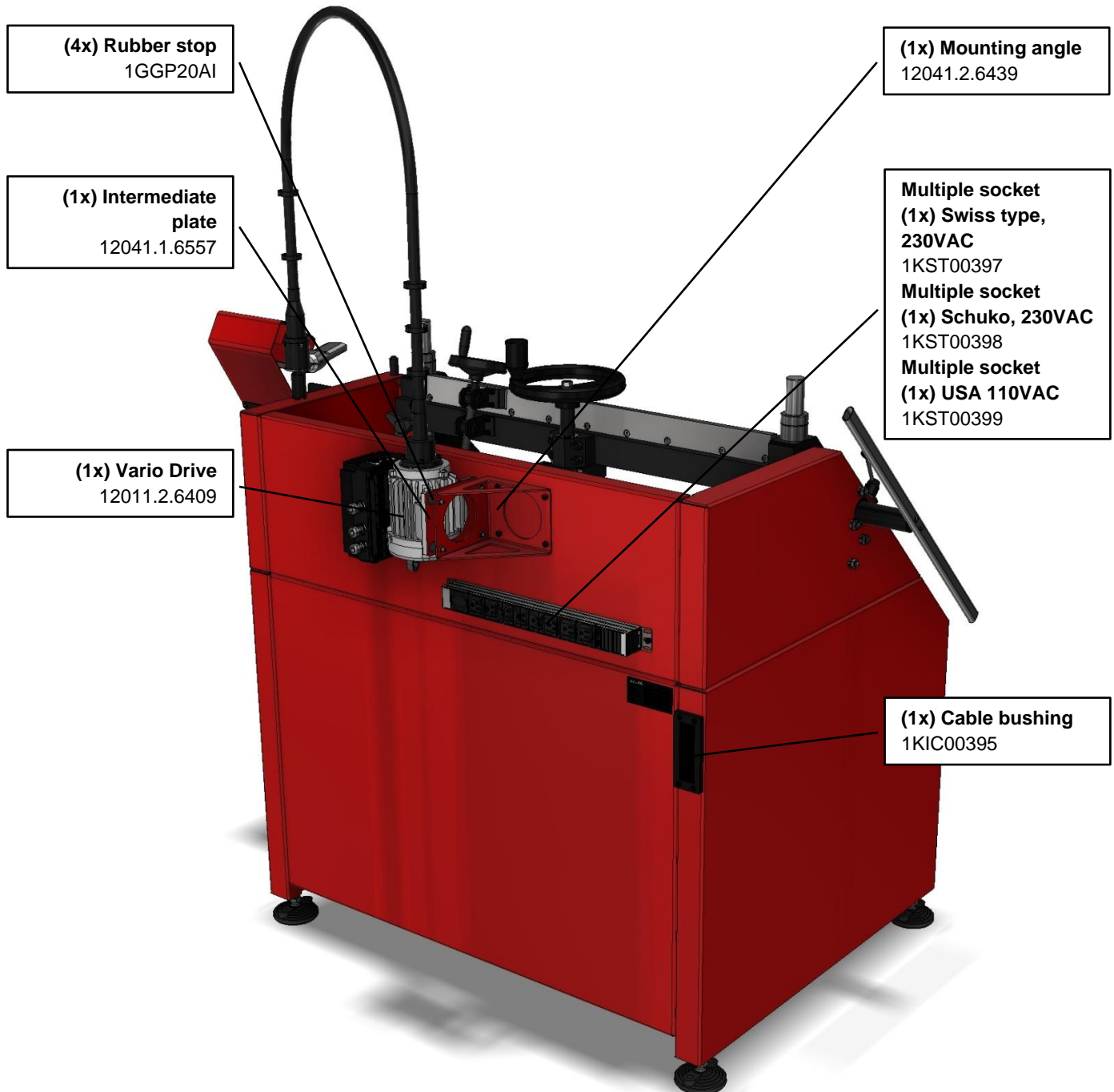
When ordering spare parts, the serial- and fabrication number must always be indicated.





From Fabrication-No.: HM-102      Serial-No.: 0518

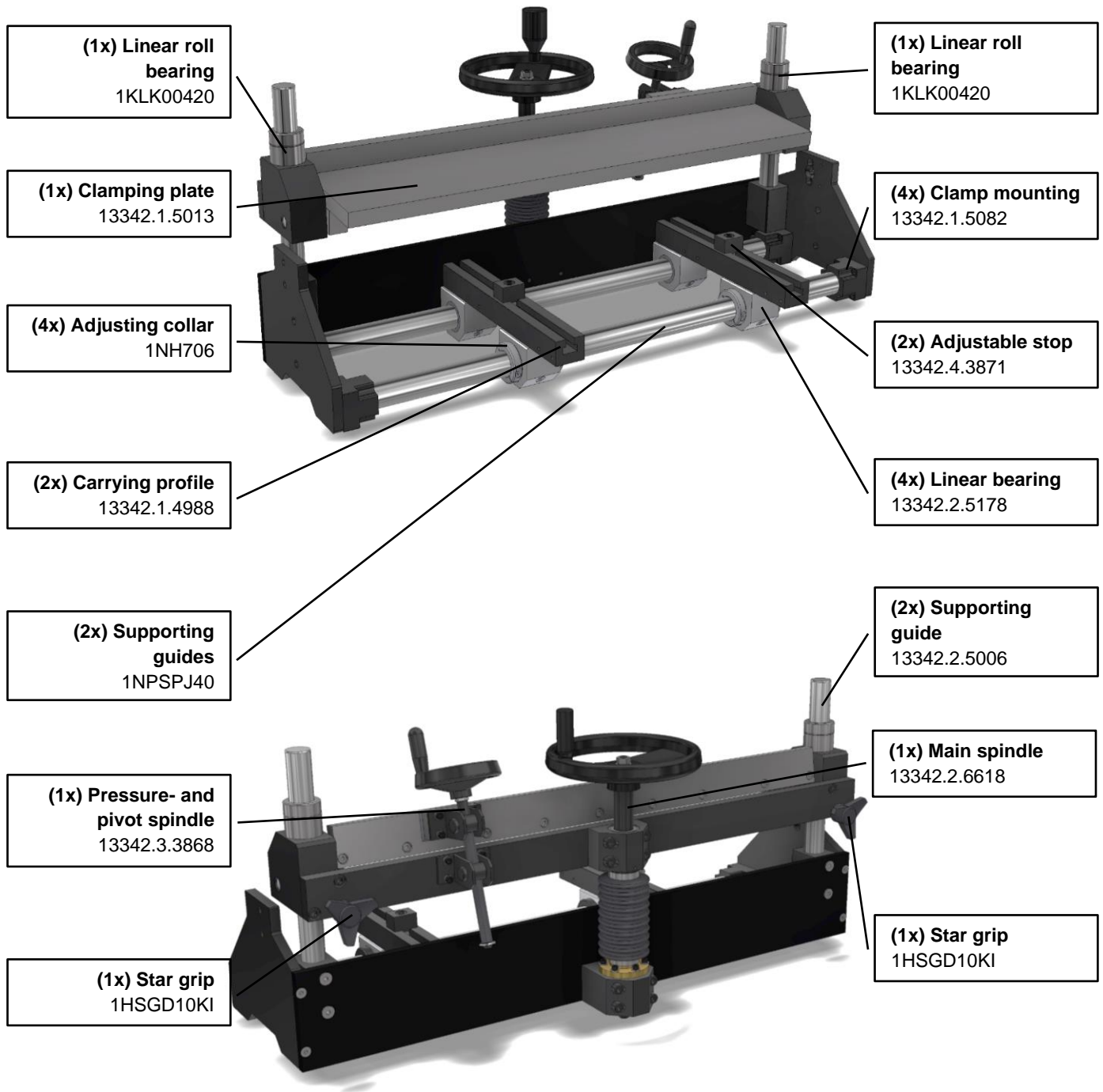
When ordering spare parts, the serial- and fabrication number must always be indicated.



**16.2 AV-2000 EVO**

From Fabrication-No.: HM-102      Serial-No.: 0518

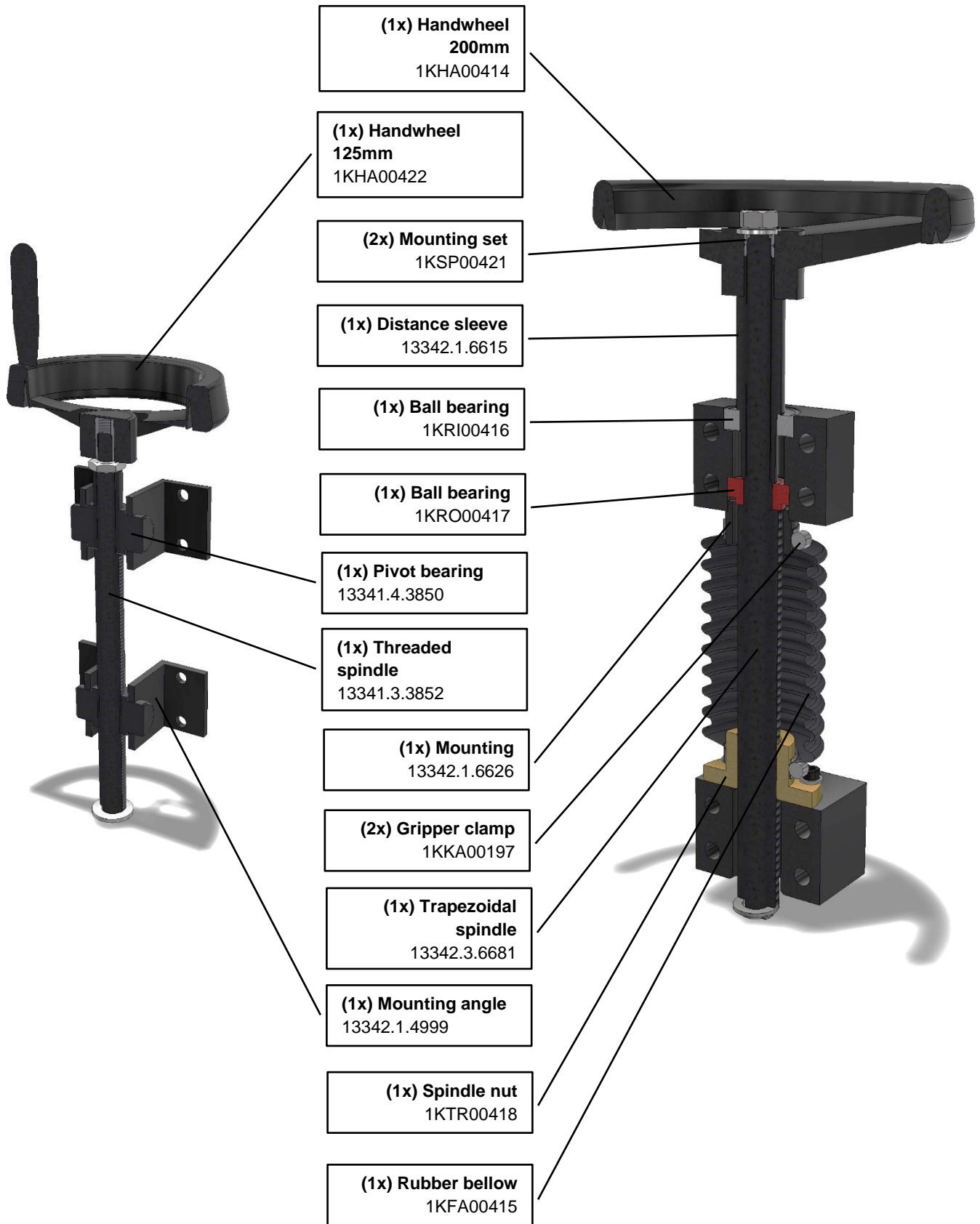
When ordering spare parts, the serial- and fabrication number must always be indicated.



**16.3 Pressure- and pivot spindle / Main spindle**

From Fabrication-No.: HM-102      Serial-No.: 0518

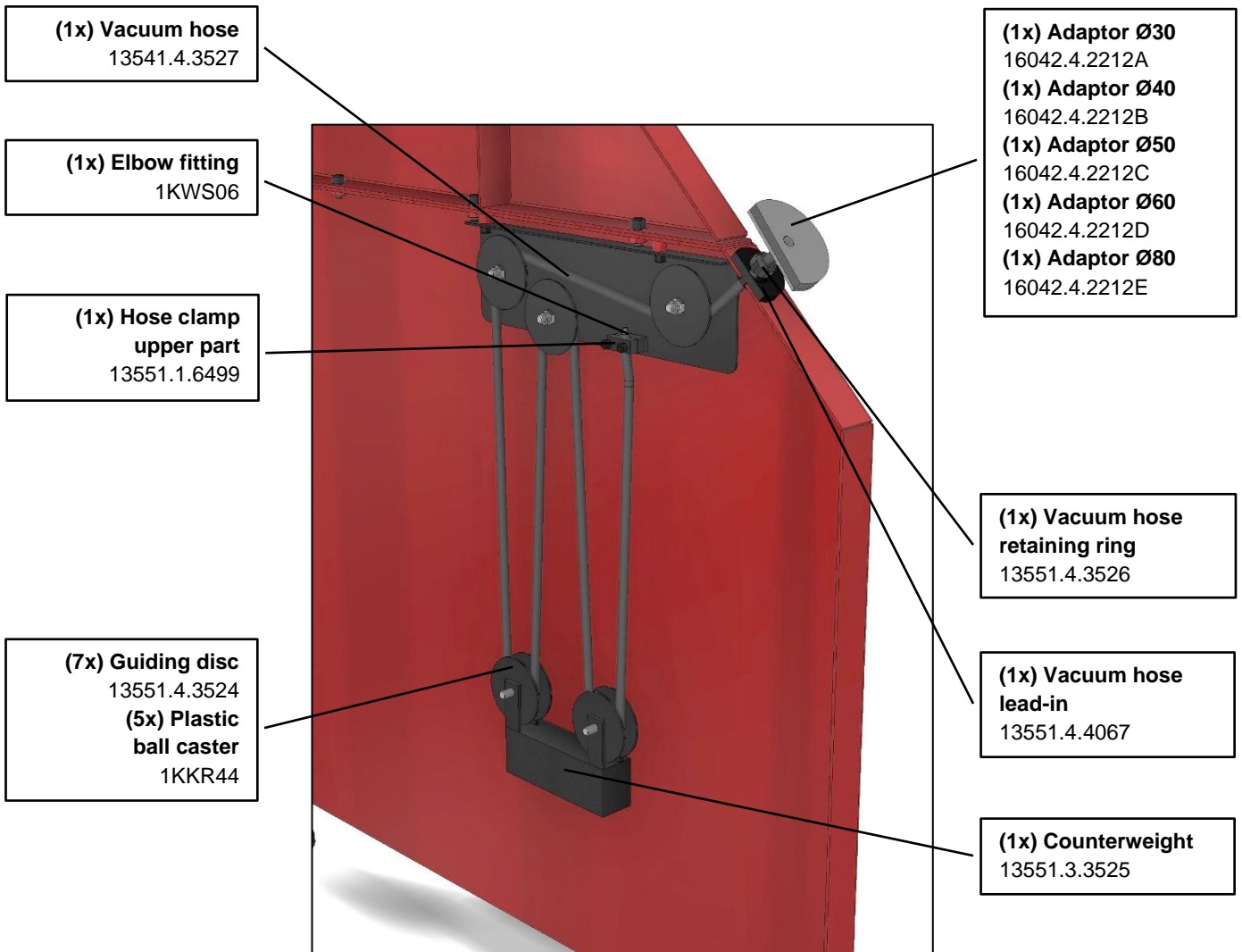
When ordering spare parts, the serial- and fabrication number must always be indicated.



**16.4 Hose retraction**

From Fabrication-No.: HM-102      Serial-No.: 0518

When ordering spare parts, the serial- and fabrication number must always be indicated.

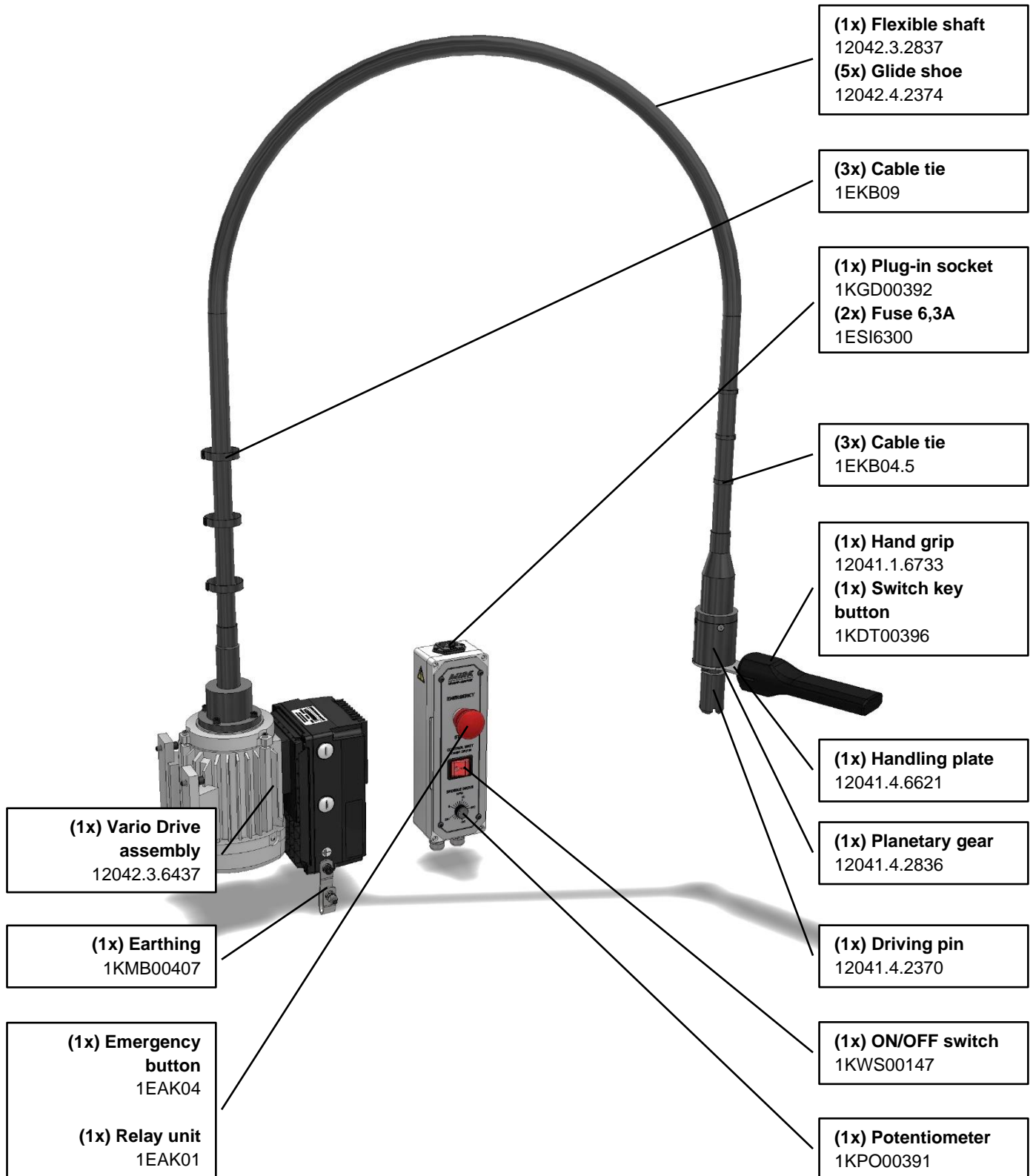


**16.5 Vario Drive**

From Fabrication-No.: VD-102

Serial-No.: 0318

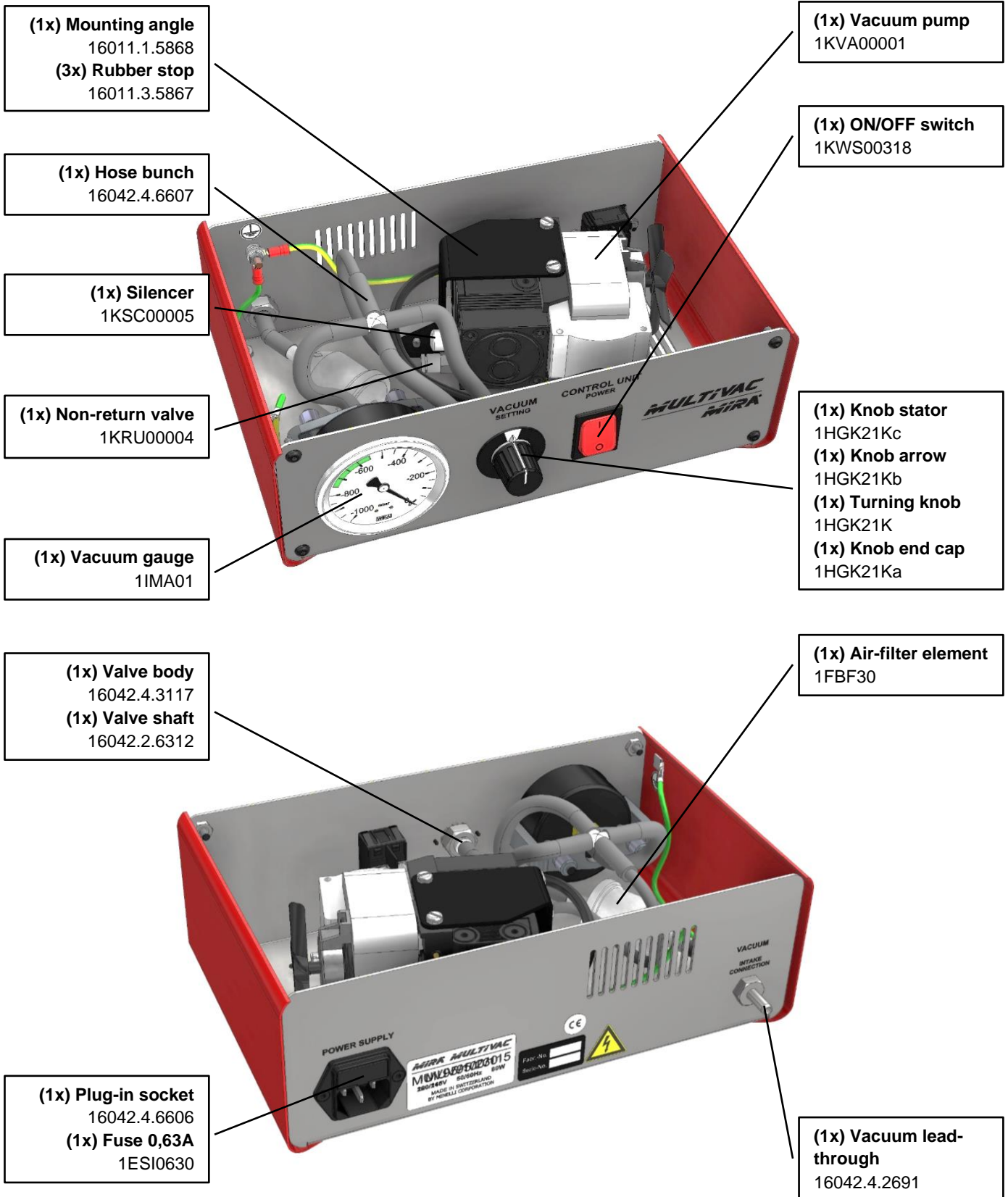
When ordering spare parts, the serial- and fabrication number must always be indicated.



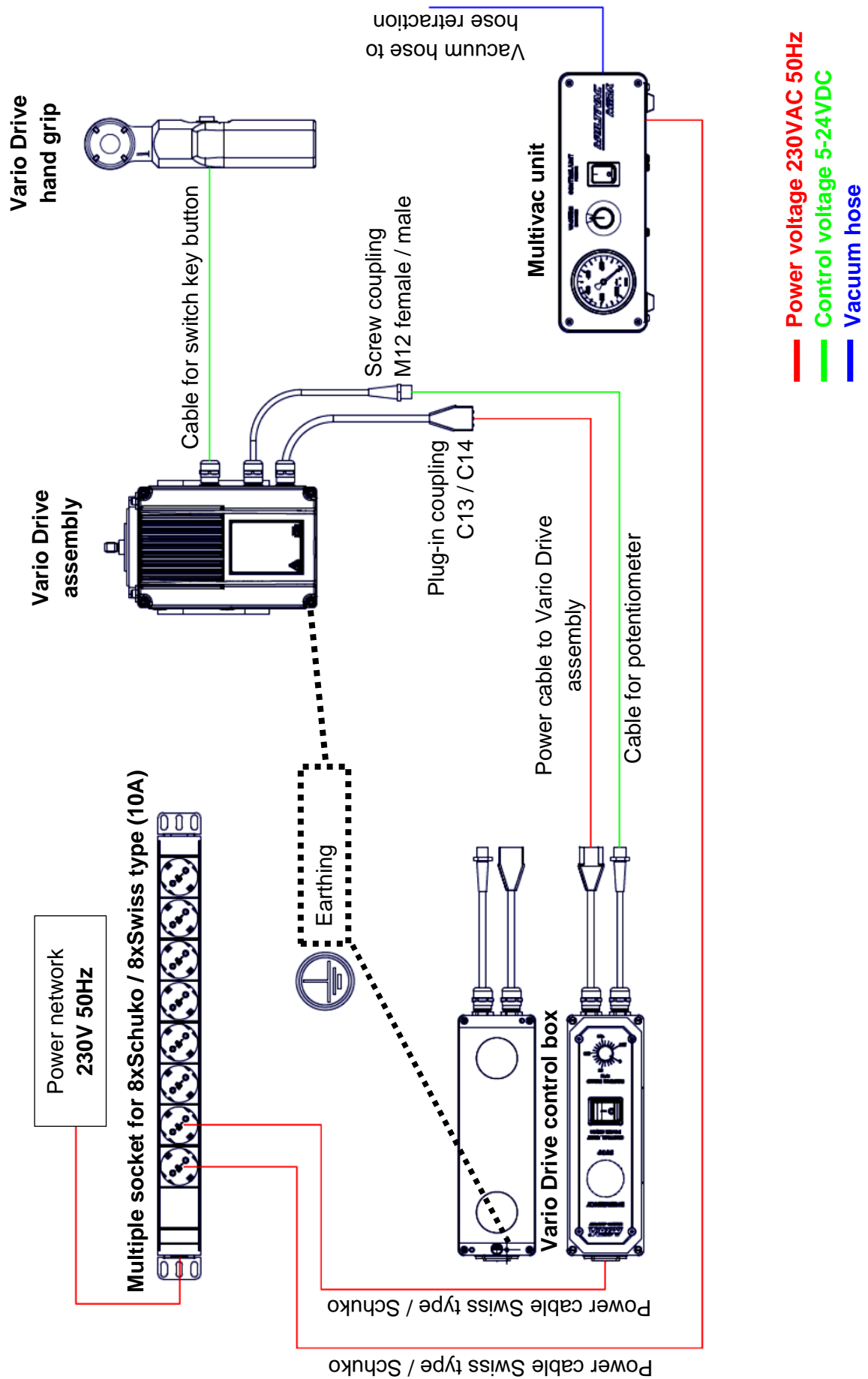
**16.6 Multivac**

From Fabrication-No.: MUV-102      Serial-No.: 0318

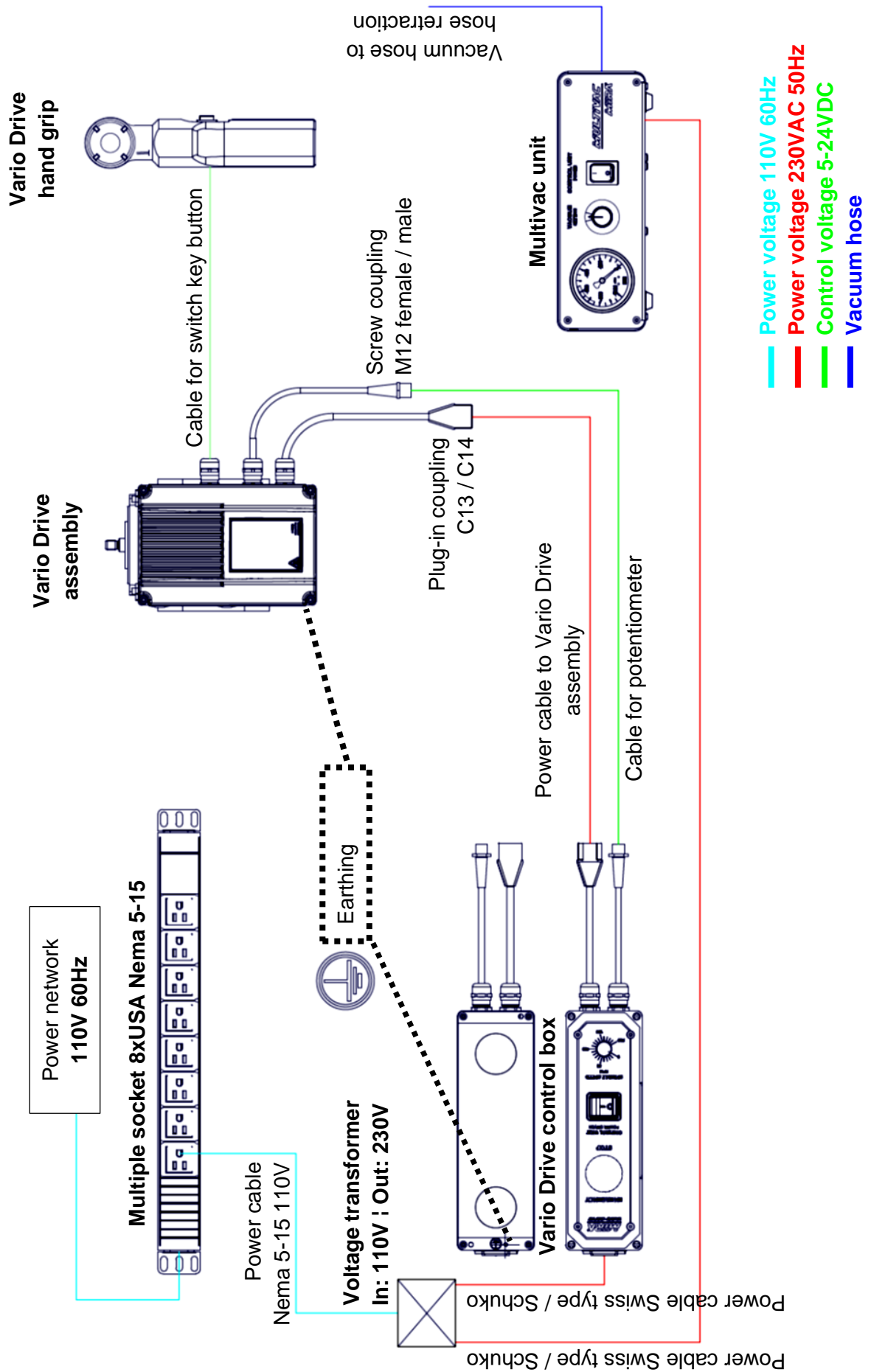
When ordering spare parts, the serial- and fabrication number must always be indicated.



17 Schematic diagramm 230VAC



18 Schematic diagramm 110VAC





## 19 Maintenance

Servicing and maintenance can be held at a minimum if the HM-2000 EVO will be operated properly and without any modifications. The use of warm water and a cleaning cloth are recommended for cleaning the anodised and powder-coated surfaces. Do not use any abrasive cleanser (acid, base, wire wool etc.) for surface cleaning.

It is recommended to carry out cleaning of metallic dust and cuttings on a weekly basis. The cleaning rate can be increased to a daily interval if pollution is higher than anticipated.

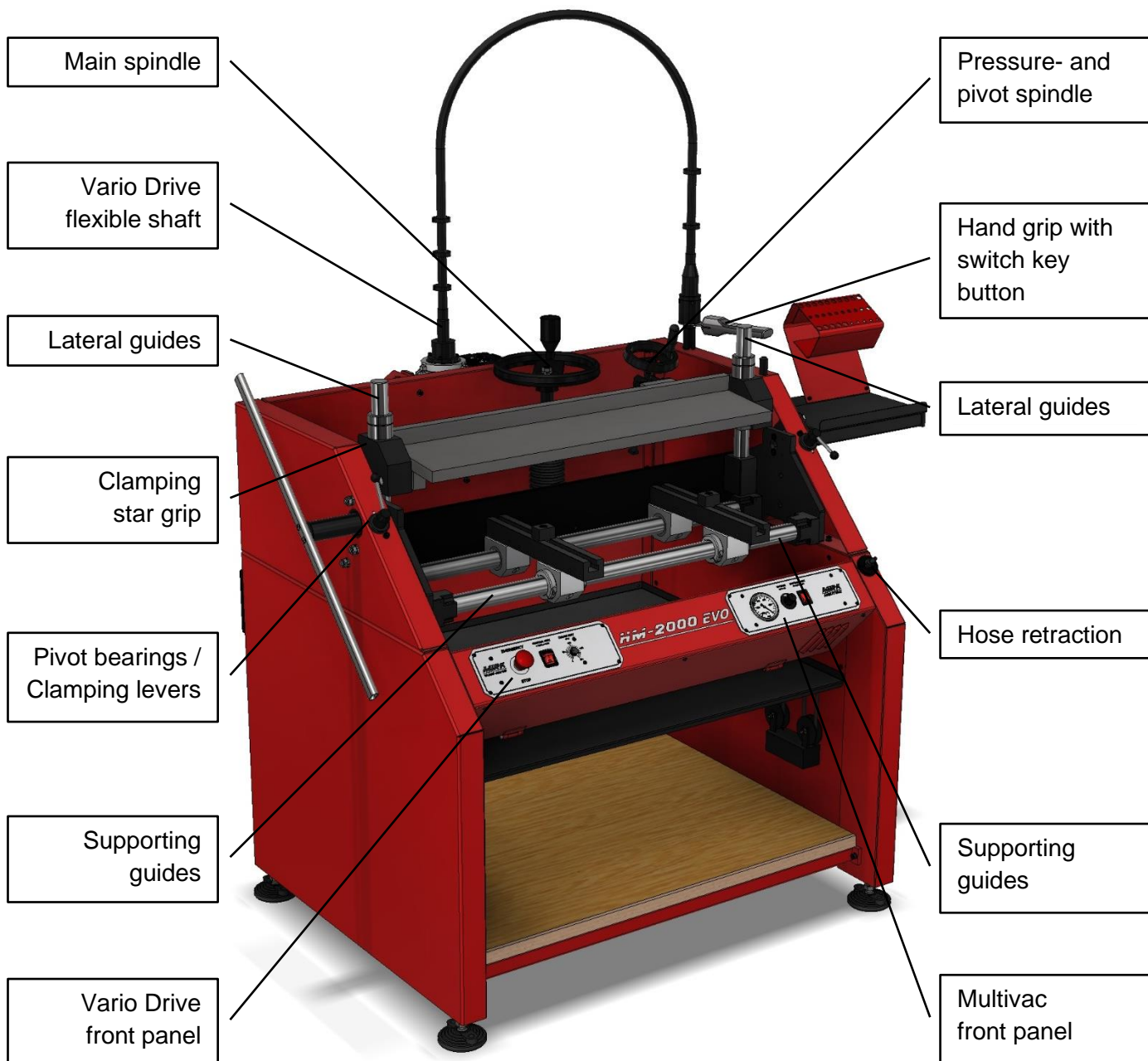


The HM-2000 EVO workstation must not be cleaned with pressurised air because of raising metallic dust into the ambient air, where it can be absorbed from the human respiratory system or can irritate the eyes. Furthermore - by cleaning with pressurised air, it is possible to damage the ball bearings and guide elements of the AV-2000 EVO clamping system.



For replacing any fuse of the HM-2000 EVO workstation, please review chapter 12.5 on page 19 and chapter 12.7 on page 20.

The following parts and assembly groups should be considered especially for the maintenance:



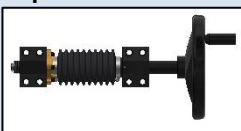
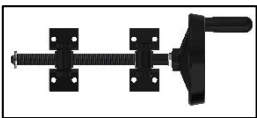


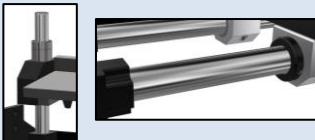
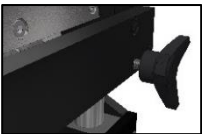




**MAINTENANCE RATE**

(Increase, if pollution is higher than anticipated)

**Weekly**

**Monthly**

**Annually**

	<b>Weekly</b>	<b>Monthly</b>	<b>Annually</b>
<p><b>Main spindle</b></p> 	In case of pollution: cleaning of the hand wheel with a slightly wet cloth	Greasing the visible parts of the trapezoidal spindle with <b>Panolin® LT Grease 00</b> and a respective brush.	Checking the rubber bellow if damaged and replacement as needed. <b>Order-No.: 1KFA00415</b>
<p><b>Pressure- and pivot spindle</b></p> 	In case of pollution: cleaning of the hand wheel with a slightly wet cloth	Greasing the visible parts of the metric threaded spindle with <b>Panolin® LT Grease 00</b> and a respective brush.	/
<p><b>Vario Drive flexible shaft</b></p> 	/	Checking the flexible shaft and connection leads for external damages.	Replacing defective and damaged cable ties as needed.
<p><b>Hand grip with switch key</b></p> 	In case of pollution: cleaning of the hand grip with a clean brush and a slightly wet cloth	Checking the driving pin for damages. Using rust protection against initial corrosion.	Checking switch key for correct functionality. <b>Contacting manufacturer if switch key is defective</b>
<p><b>Lateral guides Supporting guides</b></p> 	In case of pollution: Cleaning the bearing surface with a clean cloth. Slightly greasing the bearing surface with ball bearing grease in total length or total height.	Checking the adjusting collars for movability.	Checking the moveability of the carrying profiles in total bearing length. Checking the elevation of the clamping plate in total bearing height.
<p><b>Clamping star grip</b></p> 	/	Checking the star grips for damages and secure fixation. Checking clamping functionality with tightening and losing the star grips.	/
<p><b>Hose retraction</b></p> 	/	Drawing out the vacuum hose in its total length (approx. 1500mm) and checking for damages. => do not bend the vacuum hose!	/
<p><b>Pivot bearings Clamping levers</b></p> 	/	Checking the clamping functionality and revolving of the AV-2000 EVO. max. pivot is 300°.	Checking the clamping lever for damages and secure fixation. Using rust protection for the black finished pivot bearings and swivels.
<p><b>Vario Drive front panel</b></p> 	In case of pollution: Cleaning of the front panel with a clean soft cloth. Do not use abrasive cleanser!	Checking control elements for correct functioning.  Checking the Emergency function in operation and checking of the reset.	Replacing as needed <b>Contacting manufacturer if control elements are defective or damaged</b>
<p><b>Multivac front panel</b></p> 	In case of pollution: Cleaning of the front panel with a clean soft cloth. Do not use abrasive cleanser!	Checking control elements for correct functioning. Checking of the vacuum adjustment in operation by using the turning knob.	Replacing as needed <b>Contacting manufacturer if control elements are defective or damaged</b>

**20 Special accessories**



MIRATOOL devices and tooling equipment are available on the original [MIRATOOL Webshop](#).

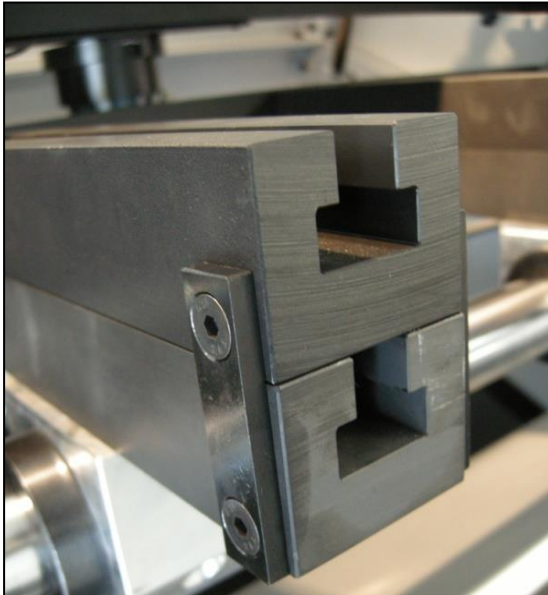


**20.1 Working lamp 230VAC**

The working lamp can be installed as an additional illumination for the HM-2000 EVO workstation. Thanks to the flexible headlamp and magnetic base, it is possible to place the working lamp on the desired position in the workstation. With integrated ON-OFF switch. Connected directly to the multiple socket of the HM-2000 EVO workstation. Otherwise, the working lamp must be connected to the output of the external voltage transformer if it is operated in a 110VAC power network. Type power cable: **Schuko, 230VAC, 50Hz**

Description	Quantity	Order-No.
Working lamp 230VAC	1 pc(s).	1KML00424

Fig. 37 - Working lamp



**20.2 Additional carrying profiles**

Smaller cylinder-heads can be clamped on a higher level with additional carrying profiles. Thus, a solid and secure cylinder head clamping of any smaller cylinder head will be guaranteed.

In order to install the additional carrying profile, the adjustable stops on each carrying profile (left and right) have to be removed completely. Then, the additional carrying profiles can be mounted directly on top. The removed adjusting stops can be installed again and positioned for the respective cylinder head.

Description	Quantity	Order-No.
Carrying profiles	2 pc(s).	13342.1.4988

**Individual carrying- and clamping profiles on request!**

Fig. 38 - Additional carrying profiles



**20.3 Tool holder**

The optional tool holder provides additional space for pilots, screw drivers, flex hone brushes etc. Delivered with the required mounting material, the tool holder will be mounted directly on the tooling tray (see chapter 12.10 on page 21).

Description	Quantity	Order-No.
Tool holder	1 pc(s).	13032.3.2809

Fig. 39 - Tool holder

## 21 Technical data

The following specifications are in context with the HM-2000 EVO and its subsystems AV-2000 EVO, Vario Drive and Multivac vacuumtesting unit. Specifications for other devices (VGX-21) and equipment can be reviewed in the respective instruction manuals.

### HM-2000 EVO workstation

<i>Dimensions without Vario Drive:</i>	<b>1650 x 960 x 1300mm (Width*Depth*Height)</b>
<i>Dimensions with Vario Drive:</i>	<b>1650 x 1100 x 1800mm (Width*Depth*Height)</b>
<i>Total weight:</i>	<b>320kg (706 lbs)</b>
<i>Levelling range of mounting foot:</i>	<b>70mm (+/- 35mm)</b>
<i>Power supply:</i>	<b>230VAC, 50Hz / 110VAC, 60Hz</b>
<i>Fuse (multiple socket):</i>	<b>max. 10A (only Swiss type)</b>
<i>Type of multiple socket:</i>	<b>Schuko (EU) / Swiss type / USA (Nema 5-15)</b>

### AV-2000 EVO

<i>Pivot of the clamping system (installed in workstation):</i>	<b>90° (±45°)</b>
<i>Setting range for clamping plate:</i>	<b>150mm</b>
<i>Setting range for pressure- and pivot spindle:</i>	<b>0-45°</b>
<i>Setting range for carrying profiles:</i>	<b>710mm</b>
<i>Main spindle:</i>	<b>Ø28x5mm, ball bearing trapezoidal spindle</b>
<i>Pressure- and pivot spindle:</i>	<b>M16x2mm, metrical threaded spindle</b>
<i>Type of lateral guides:</i>	<b>Ø35mm grinded, linear roll bearing</b>
<i>Type of supporting guides:</i>	<b>Ø40mm grinded, linear roll bearing</b>

### VARIO DRIVE

<i>Operating range with flexible shaft:</i>	<b>600mm in Radius</b>
<i>Rotational-speed range:</i>	<b>0-200min<sup>-1</sup></b>
<i>Power supply:</i>	<b>230VAC, 50Hz</b>
<i>Type power cable:</i>	<b>Schuko (EU) / Swiss type (CH)</b>
<i>Output - control box:</i>	<b>1x230VAC 50Hz / 1x24VDC</b>
<i>Nominal power:</i>	<b>550W</b>
<i>Fuse:</i>	<b>2x6,3A (parallel)</b>
<i>Type of switch for the hand grip:</i>	<b>4-pole, switch key button OFF-(ON)</b>
<i>Type rotary potentiometer:</i>	<b>10kΩ Cermet, linear±20%, IP67</b>

### MULTIVAC vacuumtesting unit

<i>Range of vacuum testing:</i>	<b>-550 to -750mbar (max.-800mbar)</b>
<i>Max. length of vacuum hose:</i>	<b>1500mm, completely extended</b>
<i>Power supply:</i>	<b>230VAC, 50Hz</b>
<i>Type power cable:</i>	<b>Schuko (EU) / Swiss type (CH)</b>
<i>Nominal power:</i>	<b>80W</b>
<i>Fuse:</i>	<b>1x0.63A (230VAC)</b>



**Notes**

Lined area for notes, consisting of multiple horizontal lines.



**Notes**

Lined area for notes, consisting of multiple horizontal lines.



**Notes**

Lined area for notes, consisting of multiple horizontal lines.



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Manufacturer and worldwide distributor:

MINELLI CORPORATION  
Mattenstrasse 3  
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Switzerland

[www.miratool.ch](http://www.miratool.ch)

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