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ROBOTICS

Arm - RX series 90B family

Instruction manual



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STÄUBLI

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CHAPTER 1

INTRODUCTION

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1.1. FOREWORD

The information contained in the present document is the property of **STÄUBLI** and it cannot be reproduced, in full or in part, without our prior written approval.

The specifications contained in the present document can be modified without notice. Although all necessary precautions have been taken to ensure that the information contained in this document is correct, **STÄUBLI** cannot be held responsible for any errors or omissions found in the illustrations, drawings and specifications contained in the said document.

If any difficulties are met with during operation or servicing of the robot that are not referred to in this document, or if further information is required, please contact the **STÄUBLI** After Sales Department, "Robot Division".

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1.1.1. OBJECTIVE OF THIS MANUAL

The objective of this manual is to provide information concerning the installation, operation and maintenance of **STÄUBLI** robots. It provides help for the persons working on the equipment, for reference purposes only. Indeed, in order to understand the present document and the use of **STÄUBLI** robots, it is necessary for staff to acquire the corresponding knowledge by following a "robots" training course as provided by **STÄUBLI**.

1.1.2. SPECIAL MESSAGES CONCERNING WARNINGS, ALERTS, AND INFORMATION

In this document, there are two formats for warnings and alerts. The messages contained in the boxes inform staff of the potential risks involved in carrying out an action.

These boxes are as follows (they are shown in decreasing order of importance):

Danger message



DANGER:

Instructions drawing the reader's attention to the risks of accidents that could lead to serious bodily harm if the steps shown are not complied with. In general, this type of indication describes the potential danger, its possible effects and the steps necessary to reduce the danger. It is essential to comply with the instructions to ensure personal safety.

Warning message

CAUTION:

Instructions drawing the reader's attention to the risks of material damage if the steps shown are not complied with. It is essential to comply with these instructions to ensure equipment reliability and performance levels.

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Notes
Paragraphs of the "note" type provide very important information to help the reader to understand a description or a procedure.

> **Note:**
> *Supplies further information, or underlines a point or an important procedure. This information must be memorized to make it easier to apply and ensure correct sequencing of the operations described.*

1.2. DEFINITION OF THE ELEMENTS AROUND THE ROBOT CELL

Person: general term identifying all individuals likely to come close to the **STÄUBLI** robot cell.

Staff: identifies the persons specifically employed and trained to install, operate, and service the **STÄUBLI** robot cell.

User: refers to the persons or the company responsible for operating the **STÄUBLI** robot cell.

Operator: refers to the person who starts or stops the robot, or controls its operation.

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1.3. REMINDER CONCERNING THE SAFETY STANDARDS

DANGER:

The robot is a fast moving machine. These movements can be dangerous. Always comply with the safety standards recommended for robot use and inform operators about the dangers faced.

The robot is a sub-assembly designed for integration in a robot cell. It has been designed and built to enable the "robot cell" unit to comply with regulatory provisions. Compliance of the robot cell is the responsibility of the prime contractor who very frequently is the owner.

The user must make sure that the staff programming, operating, maintaining or repairing the robot or the robot cell are correctly trained and show the skills necessary to carry out these tasks in full safety.

In France, for example, posters isued by the CRAM are available to remind operators of the safety rules applicable in the vicinity of robot stations.

The electrical equipment of the robot and the robot cell must comply with standard EN 60204-1.

The characteristics of the power supply and the grounding terminals must comply with the manufacturers' specifications.

The robot and its controller are designed to meet a "Category III" safety level.

Standards applicable
Installation of the robot must be planned in accordance with the standard instructions.

• ISO 10218-1, 2006	Robots for industrial environment - Safety
• EEC 98 / 37 "Machine Safety" Directive	European Directive
• Standard EN 292	General principles
• Standard EN 294	Safety distances
• Standard EN 418	Emergency stop equipment
• Standard EN 953	Protective elements
• Standard EN 954-1	Machine safety
• Standard EN 349	Minimum clearances
• Standard EN 1050	Risk assessment
• Standard EN 1088	Locking devices
• Standard EN 60204-1	Electrical equipment on machines
• Standard EN 999	Speed on approach towards the human body
• Standard EN 61 000-6-4	Electromagnetic compatibility - Emission
• Standard EN 61 000-6-2	Electromagnetic compatibility - Immunity
• Standard CEI 34-1	Electrical rotating machines

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1.4. SAFETY DIRECTIVES CONCERNING TO THE WORK ENVIRONMENT

1.4.1. ANALYSIS OF SAFETY AROUND THE ROBOT CELL

Safety must be taken into account for the robot cell from the design and development stage on.
Before planning the installation of the robot cell, it is necessary to study the following points:

- Plan the safety strategies that reduce risks to an acceptable level.
- Define the tasks required for the foreseeable applications and assess the access and/or approach requirements.
- Identify the sources of risks including the failures and the failure modes associated with each of the tasks. The risks can involve:
    - the cell itself
    - its association with other items of equipment
    - the interactions between persons and the cell.
- Assess and estimate the risks stemming from cell operation:
    - programming risks
    - operating risks
    - risks during use
    - maintenance risks for the robot cell.
- Select the protective methods:
    - use of protective devices
    - installation of signalling means
    - compliance with safe working procedures.

These points are taken from the standards applicable to robots.

Note:
This list is not exhaustive. Above all, it is necessary to comply with the standards in force in your country.



DANGER:

To ensure reliability and precision in the robot's movements, the robot cell environment must comply with the levels of disturbance set out in the safety standards.

1.4.2. RULES CONCERNING THE ROBOT'S WORK AREA

The controlled area or isolation area in which the robot moves must be determined using protective devices (protective elements).

Note:
Protective elements are devices protecting persons from a dangerous area. See the standards currently in force concerning safety for industrial handling equipment.



DANGER:

At the time of an emergency stop, the final position of the arm can never be determined precisely because of the kinetic energy involved. It is thus necessary to make sure that no persons or obstructions are present in the robot's work area when the arm is powered up.

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1.5. SAFETY DIRECTIVES CONCERNING TO STAFF PROTECTION

Stäubli robots work with computer controlled mechanisms, capable of moving at high speed and exerting considerable force. Like all robots and most industrial equipment, they must be controlled with great care by the user of the robot cell. All staff using **Stäubli** robots must be familiar with the warnings and recommendations given in this manual.

1.5.1. MECHANICAL AND ELECTRICAL DANGERS.

DANGER:

Disconnect all the electrical and pneumatic power supplies before carrying out any work on the controller or the arm.

To turn of power, set the CS8C main switch to the "0" position.

To prevent inadvertent during the service operation, the main switch must be locked in 0 position using a padlock whose key is to be kept by the person carrying out the service operation. The locked status must be shown by a sign. For example, put a "Do not operate" sign in place.

Before powering up the system, make sure that all the electrical protection systems have been fitted and that there is no risk of electric shocks.

Note:
When the main switch is set to 0, voltage remains present between the input terminals (mains supply filter) and the main switch input.

DANGER:

Each time the arm is powered on, keep one hand close to the "Emergency stop" button in order to be able to press it as quickly as possible in the event of a problem.

- Do not connect or disconnect components while the unit is under power. The connection between the controller and the robot arm can only be made if the controller has been switched off.
- The arm must not be loaded during maintenance operations.
- If unusual sounds or vibrations are noted on the robot arm, especially following a shock or some other incident, it is necessary to inspect the tool and gripper fastenings carefully and make diagnoses at low speed.

Note:
If a crash of the arm occurs, all safety components involved in the safety have to be checked carefully to verify they are still operating and not damaged: hard stop devices on the arm, electrical limit switches, calibration of the robot. Don't hesitate to call Stäubli service for any doubt.
Each time a calibration, adjustment or recovery procedure is done, the calibration of the arm has to be controlled carefully to verify that the robot is able to move in its expected angular range and not more. This verification has to be done at slow speed.

DANGER:

All persons are prohibited from remaining in the isolation area in which the robot arm operates. Certain robot working modes such as the "brake release" mode can lead to unforeseeable arm movements.

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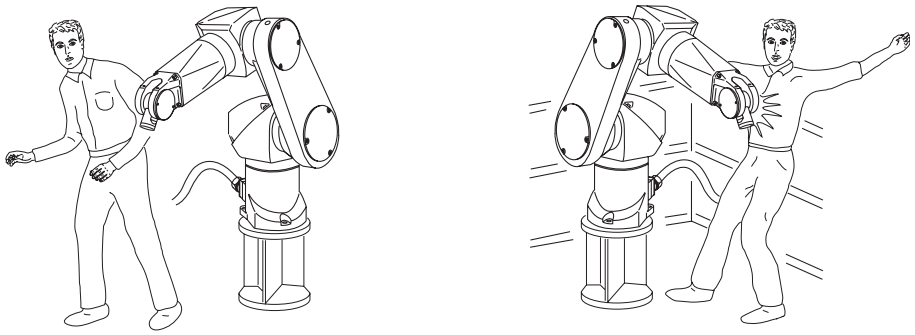


Figure 1.1

Following maintenance work, whether it involves mechanical, electrical, pneumatic or software operations, it is advisable to make sure that the robot functions correctly, first at low speed while the person stays outside the cell, and then under the normal conditions of use. In particular, make sure that all the protective and safety systems are correctly in place, and that calibration of the robot is correct.

1.5.2. ROBOT CELL SAFETY DEVICES

The safety devices must form an integral part of the design and installation of the robot cell. Operator training and compliance with the operating procedures constitute a major element in setting up the safety devices and systems.

Stäubli robots are equipped with various communication functions, helping the user to develop safety devices for the robot cell. These functions include the emergency stop circuits, the digital Input/Output lines, and the display system for error and warning messages (see the "Integration" chapter). When the system is used without the MCP, these messages/warnings can only be consulted via the application program.

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1.5.3. SAFETY DIRECTIVES CONCERNING TO PROTECTION OF THE EQUIPMENT

1.5.3.1. CONNECTIONS

- Before connecting the controller to the power supply, make sure that its nominal voltage does indeed correspond to the network voltage.
- When connecting the controller, use a cable whose cross-section corresponds to the power rating shown on the manufacturer's plate.
- Before removing or inserting an electronic component, switch off arm power and then switch off controller power and comply with the procedure.
- Take care to avoid blocking the air inlets and outlets for the controller airflow path.
- Never use the emergency stop to power down the arm under normal conditions of use.

1.5.3.2. INFORMATION ON ELECTROSTATIC DISCHARGES

What is an electrostatic discharge?

Everyone has felt the effects of static electricity on their clothes or when they touch a metal object, without being aware of the damage that can be done to electronic components by static electricity.

Our desire to integrate the notions of quality and reliability in our products makes it necessary to prevent electrostatic discharges from causing damage to them. This means that all the staff and login users must be informed.

Storage of a charge
An electric charge is created simply by combining a conductor, a dielectric and the ground (lowest reference potential, usually the ground in the case of an electrostatic charge).
Example: people, printed circuits, integrated circuits, components, conducting mats when separated from the ground by a dielectric.

Electrostatic discharges or ESD
Most people have experienced ESD by receiving an electric shock when walking on a carpet and touching a doorknob or when getting out of a car.
In most case, the following is true:
- To feel an ESD, a charge of at least 3500 V is required.
- To hear one, a charge of at least 5000 V is required.
- To see a spark, a charge of at least 10 000 V is required.

This shows that it is possible to develop charges of over 10 000 V before noticing an electrostatic discharge!

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Risks created by an electrostatic discharge

A high ESD voltage (several thousand volts) creates danger for electronic components. A semi-conductor must be handled carefully to prevent destruction by ESD. ESD are truly dangerous. It is estimated that they destroy only 10% of the components that they effect. The other 90% of components fall into the "deteriorated" category. A component may be damaged with simply 25% of the voltage required to destroy it.

These hidden faults can lead to problems that appear several days, weeks or even months after the incident. Components may also undergo a change in their operating characteristics. Initial tests are successfully passed but an intermittent error occurs under vibration or temperature constraints. The same components will pass the "on/off" test successfully, as carried out during repairs, but the problem will reappear again once on site.

Typical ESD voltages

SOURCE	LOW RELATIVE HUMIDITY 10 - 20%	AVERAGE RELATIVE HUMIDITY 40%	HIGH RELATIVE HUMIDITY 65 - 90%
Walking on carpet	35 kV	15 kV	1,5 kV
Walking on vinyl	12 kV	5 kV	0,3 kV
Working at the workstation	6 kV	2,5 kV	0,1 kV
Plastified instructions	7 kV	2,6 kV	0,6 kV
Polyethylene bags	20 kV	2 kV	1,2 kV
Cellular polyurethane	18 kV	11 kV	1,5 kV

CHARGE SOURCES	
Work surfaces	Packaging
Floors	Handling
Chairs	Assembly
Carriages	Cleaning
Clothes	Repairing

PARTS SENSITIVE TO STATIC CHARGES
Electronic cards Power supplies Encoders etc

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1.5.3.3. PREVENTION OF DAMAGE DUE TO ELECTROSTATIC DISCHARGES

It is essential to guard against electrostatic discharges during an intervention concerning electronic components, sub-assemblies and complete systems.

Elimination of the danger due to ESD requires a combined team effort. By complying with the following instructions, you can substantially reduce the potential damage caused by ESD and ensure long-term reliability for the robot.

- Inform the staff of the risks stemming from ESD.
- Know the critical zones sensitive to ESD.
- Know the rules and procedures to deal with ESD.
- Always carry components and boards in a tray to protect them from electrostatic charges.
- Always ground yourself before working on a workstation.
- Keep non-conducting equipment (static charge generators) away from components and boards.
- Use tools providing protection from ESD.

STÄUBLI workstation
To handle electronic cards, **STÄUBLI** workstations are given a grounded coating that dissipates static electricity. An anti-static bracelet is required to handle boards or electronic components.

Work zones
Remove objects that generate static electricity charges from the work area, such as:

- plastic cups
- polystyrene
- notebooks
- plastic files and document holders.

Printed circuits, boards and electronic components must be kept in anti-static bags.

Anti-static wrist strap
Use an electrostatic wrist strap connected to the frame of the controller or to the frame of the arm and the ground during all handling of boards or components. The wrist straps are supplied as part of the standard equipment for the robot.

> **CAUTION:**
> **Use an anti-static wrist strap and an anti-static mat connected to the controller for all work involving handling of boards or components.**

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CHAPTER 2

DESCRIPTION

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2.1. IDENTIFICATION

Manufacturer's plate on each robot.

There is a plate riveted on the controller and arm (see figure 2.1).

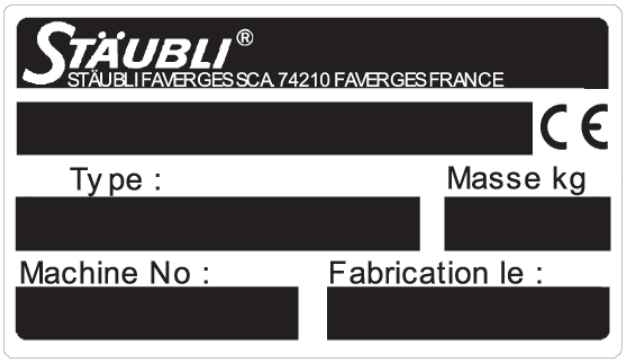


Figure 2.1

For all requests concerning information, replacement part orders, or requests for intervention, please state the type and the serial number of the machine concerned, as set out on the manufacturer's plate.

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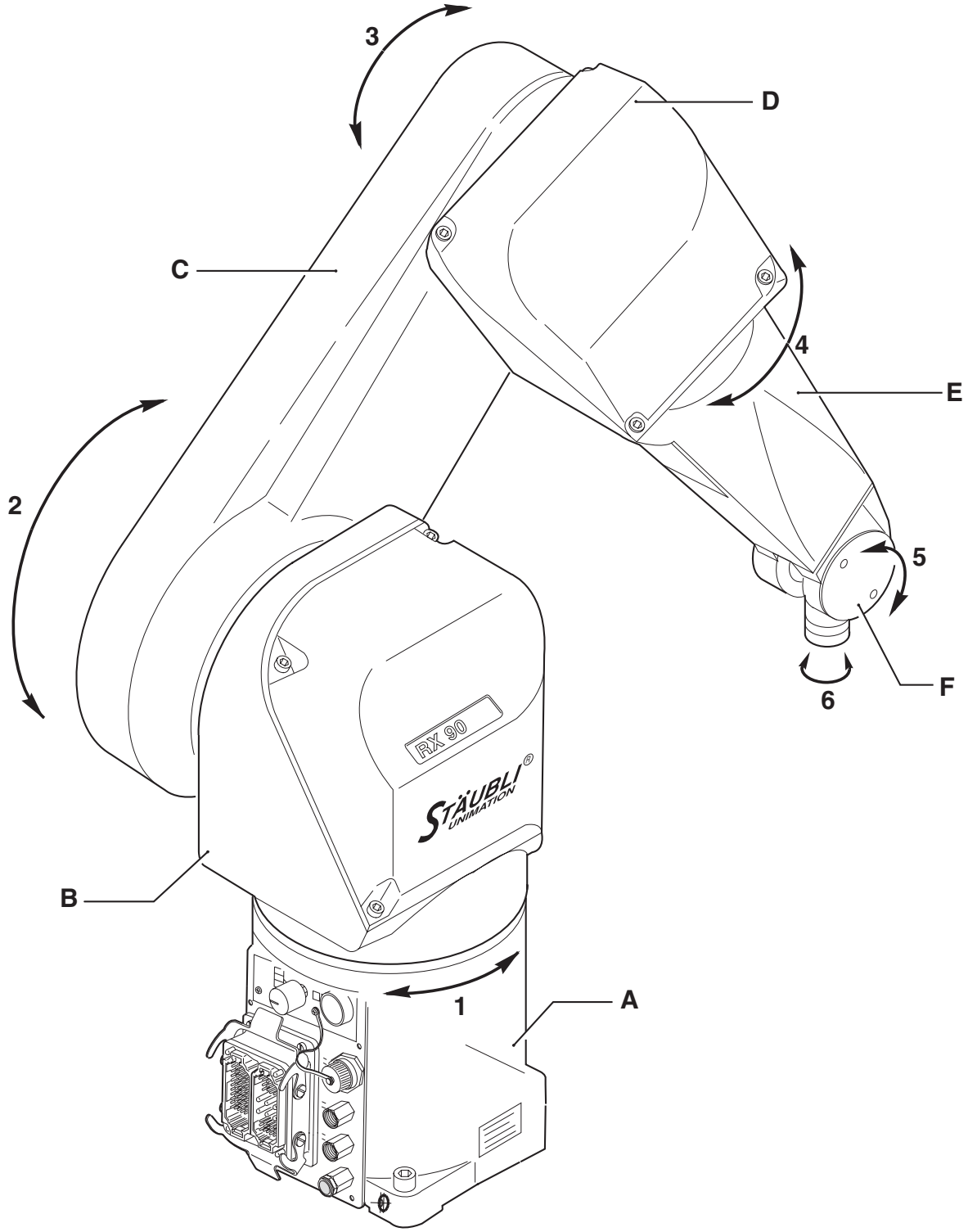


Figure 2.2

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2.2. GENERAL PRESENTATION

The arm consists of segments or members interconnected by joints **(figure 2.2).**

Each joint comprises an axis around which two members pivot.

The movements of the robot's joints are generated by brushless motors coupled to resolvers. Each of these motors is equipped with a parking brake.

This reliable, robust assembly is linked to an innovative counting system that provides data concerning the absolute position of the robot at all times.

The arm assembly is flexible and is able to perform a great variety of applications.

Example: Handling of loads, assembly, process, application of adhesive beads, control/check and clean room applications. This list is not exhaustive: for further information, please consult us.

The various elements of the robot's arm are: the base **(A)**, the shoulder **(B)**, the arm **(C)**, the elbow **(D)**, the forearm **(E)** and the wrist **(F) (figure 2.2).**

The robot arm assembly thus contains the motorization, brakes, motion transmission mechanisms, cable bundles, pneumatic and electric circuits for the user and the counterbalance system.

Of simple construction, the RX90B arm assembly consists of a rigid and encased structure (protection IP65 to standard NF EN 60529) to protect it against external aggressions. Its design is based on transmission modules: JCS (STÄUBLI Combined Joint) used on axis 1, 2, 3 and 4 **(figure 2.2).**

The wrist consists of axis 5 and 6 **(figure 2.2).**

Arm balance is performed by an integrated spring system. The arm has a built-in spring counterbalance system giving an attractive low weight system.

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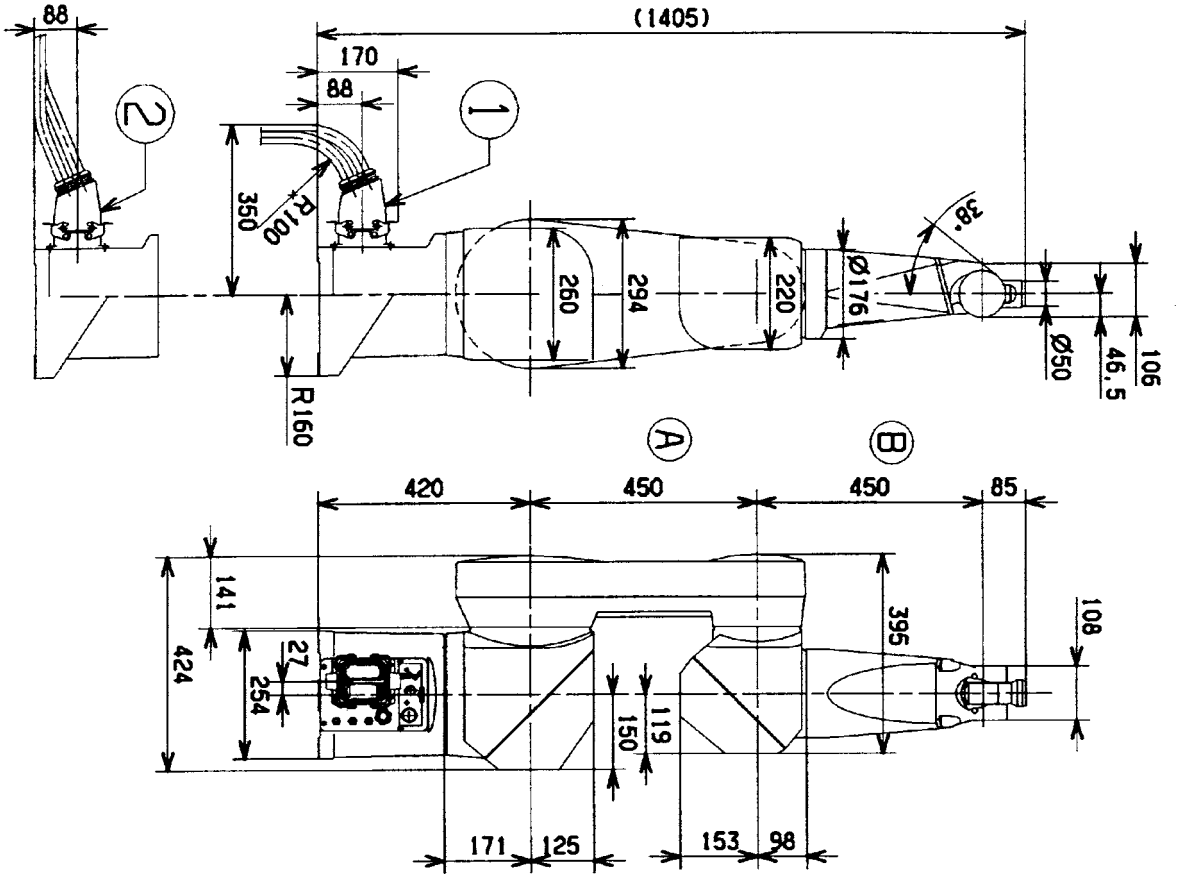


Figure 2.3

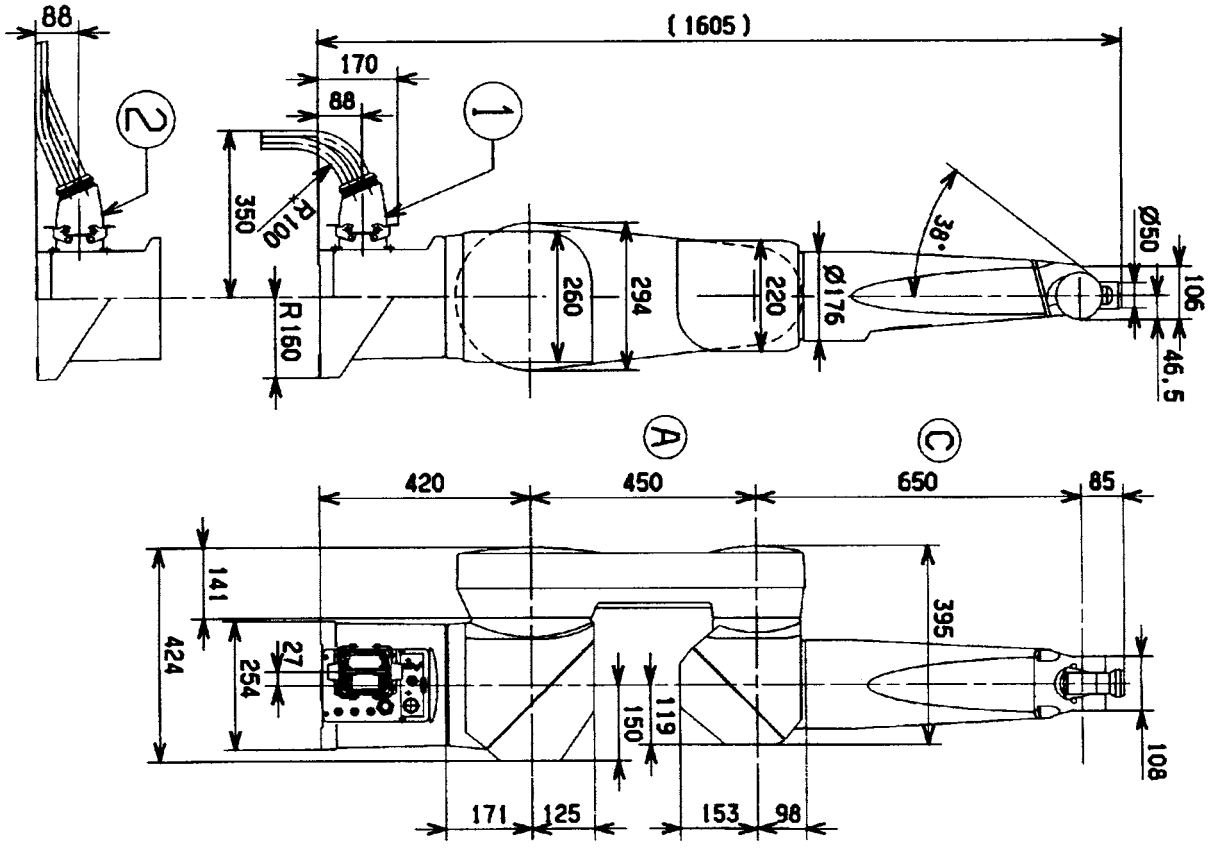


Figure 2.4

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2.3. DESIGNATION OF ROBOTS OF THE RX SERIES 90B FAMILY

RX	9	0	B		CR
(1)	(2)	(3)	(4)		(5)

(1) RX family arm

(2) Maximum reach between axes 2 and 5 expressed in decimeters:
dimension (A) + dimension (B)

(3) Number of active axes:
- 0 = 6 active axes.
- 5 = 5 active axis, geometry being conserved.

(4) RX family changed to "B".

(5) Upper case letters to indicate an option.
- L = extended forearm: dimension (A) + dimension (C) **(figure 2.4).**
- CR = clean room application.

These letters can be combined.
Example: LCR = extended forearm clean room application.

In the manual, the following terminology is used:

Standard arm: for arm with standard geometry **(figure 2.3).**

Long arm: for arm with different geometry where forearm is extended **(figure 2.4).**

5-axis arm: for arm with 5 active axis.

2.4. GENERAL CHARACTERISTICS

2.4.1. OVERALL DIMENSIONS **(figures 2.3 and 2.4)**

(1) Vertical cable outlet

(2) Horizontal cable outlet

2.4.2. WORK ENVIRONMENT

- Working temperature: + 5°C to + 40°C (according to standard(s) and/or directive(s): NF EN 60 204-1)

CAUTION:
It may be necessary to perform a warm-up cycle before nominal performances are obtained.

- Humidity: 30% to 95% max. non-condensing (according to standard(s) and/or directive(s): NF EN 60 204-1)
- Altitude: 2000 m max
- Vibrations: please consult us

Clean room application: Cleanliness class ISO 4 according to standard ISO 14644-1

CAUTION:
If the robot is used in dusty surroundings or in the presence of spattered liquids, we strongly recommend use of the pressurization system as described in chapter 2.11, page 45.

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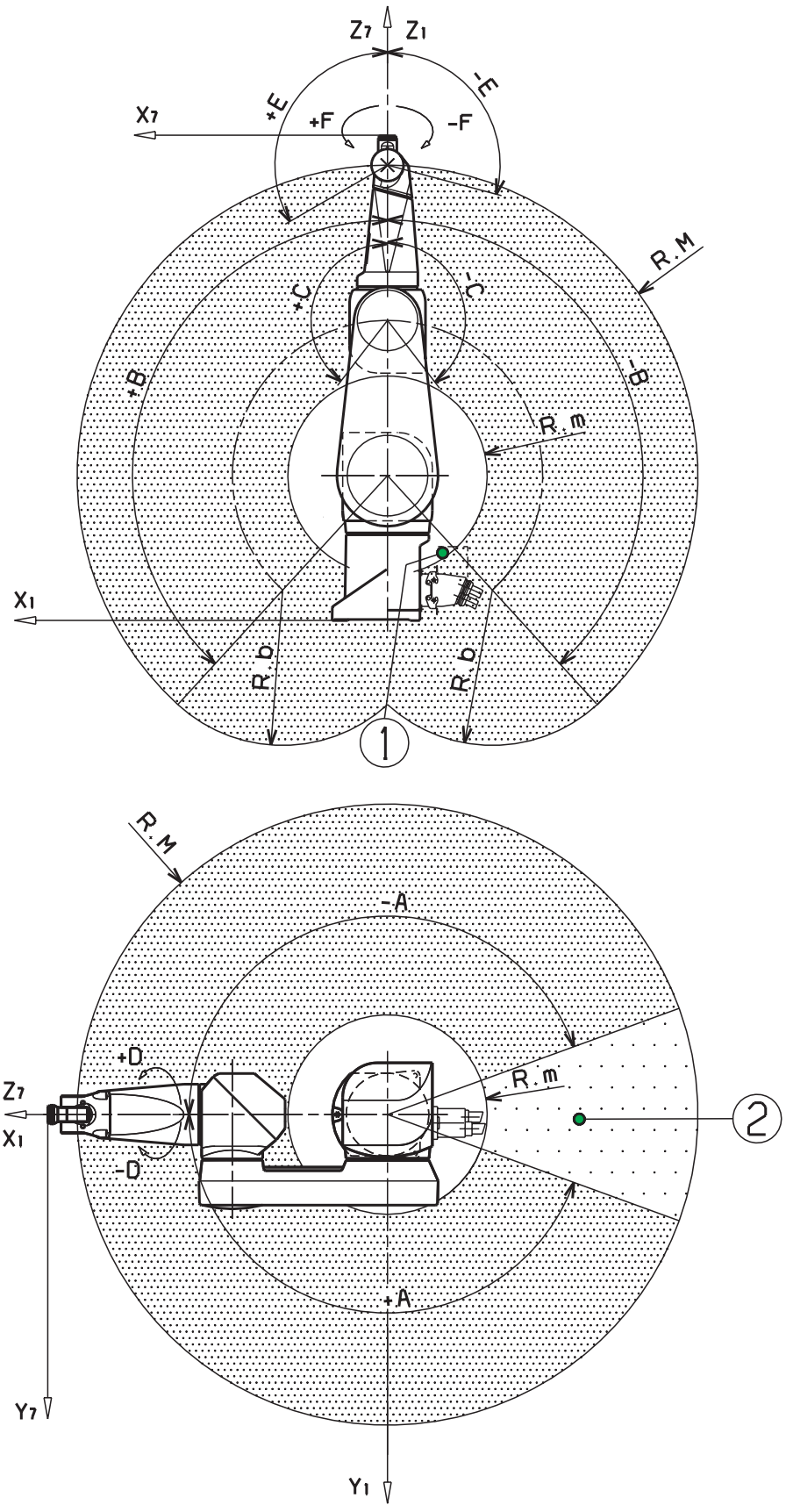


Figure 2.5

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2.4.3. WEIGHT

STANDARD ARM	LONG ARM	5-AXIS ARM	LONG 5-AXIS ARM
111 kg	113 kg	106 kg	107 kg

2.5. PERFORMANCE

See **figure 2.5**

(1) Brake release access area

(2) Area accessible in righty configuration

	STANDARD ARM	LONG ARM
Work envelope		
R.M max. reach between axis 2 and 5	900 mm	1100 mm
R.m min. reach between axis 2 and 5	289 mm	401 mm
R.b reach between axis 3 and 5	450 mm	650 mm
Maximum speed at load center of gravity	11 m/s	12.6 m/s
Repeatability at constant temperature	± 0.02 mm	± 0.025 mm

2.5.1. TORQUE LIMITS

	REFERENCE AXIS		
	AXIS 5 (Z_6)		AXIS 6 (Z_7)
Static torque (Nm)	24 (1)	14 (2)	10
Peak torque (Nm)	100 (1)	57 (2)	43

(1) If axis 6 torque = 0

(2) For maximum torque on axis 6

2.5.2. AMPLITUDE, SPEED AND RESOLUTION

Axis	1	2	3	4 (1)	5	6
Amplitude (°)	320	275	285	540	225	540 (2)
Working range distribution (°)	A ± 160	B ± 137.5	C ± 142.5	D ± 270	E +120 -105	F ± 270
Nominal speed (°/s)	236	200	286	401	320	580
Maximum speed (°/s)	356	356	296	409	800	1125 (3)
Angular resolution ($°.10^{-3}$)	0.87	0.87	0.72	1	1.95	2.75

(1) For 5-axis arms, axis 4 is fixed. Joint 5 corresponds to joint 4 and joint 6 to joint 5 of the software.

(2) Can be configured by software up to ±18 000°. See the "Software configuration" chapter in the "Controller" documentation.

(3) Without axis 5 interaction.

Low speed in manual mode: 250 mm/s at tool centre point and 45°/s on each axis.
Maximum Cartesian speed: 2 m/s

CAUTION:

In some arm configurations, the maximum joint speeds can be reached only if payloads and inertias are reduced.

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2.5.3. MODIFICATION OF AMPLITUDES

The arm is installed to obtain maximum angular amplitudes.

The amplitude of the joints can be voluntarily limited by the "software" (see chapter on programming). Also, the position of the mechanical travel limiters on axis 1, 2 and 3 and of the electrical travel limiters on joints 1 and 2 can be modified in a certain number of positions (for modification, please consult STÄUBLI).

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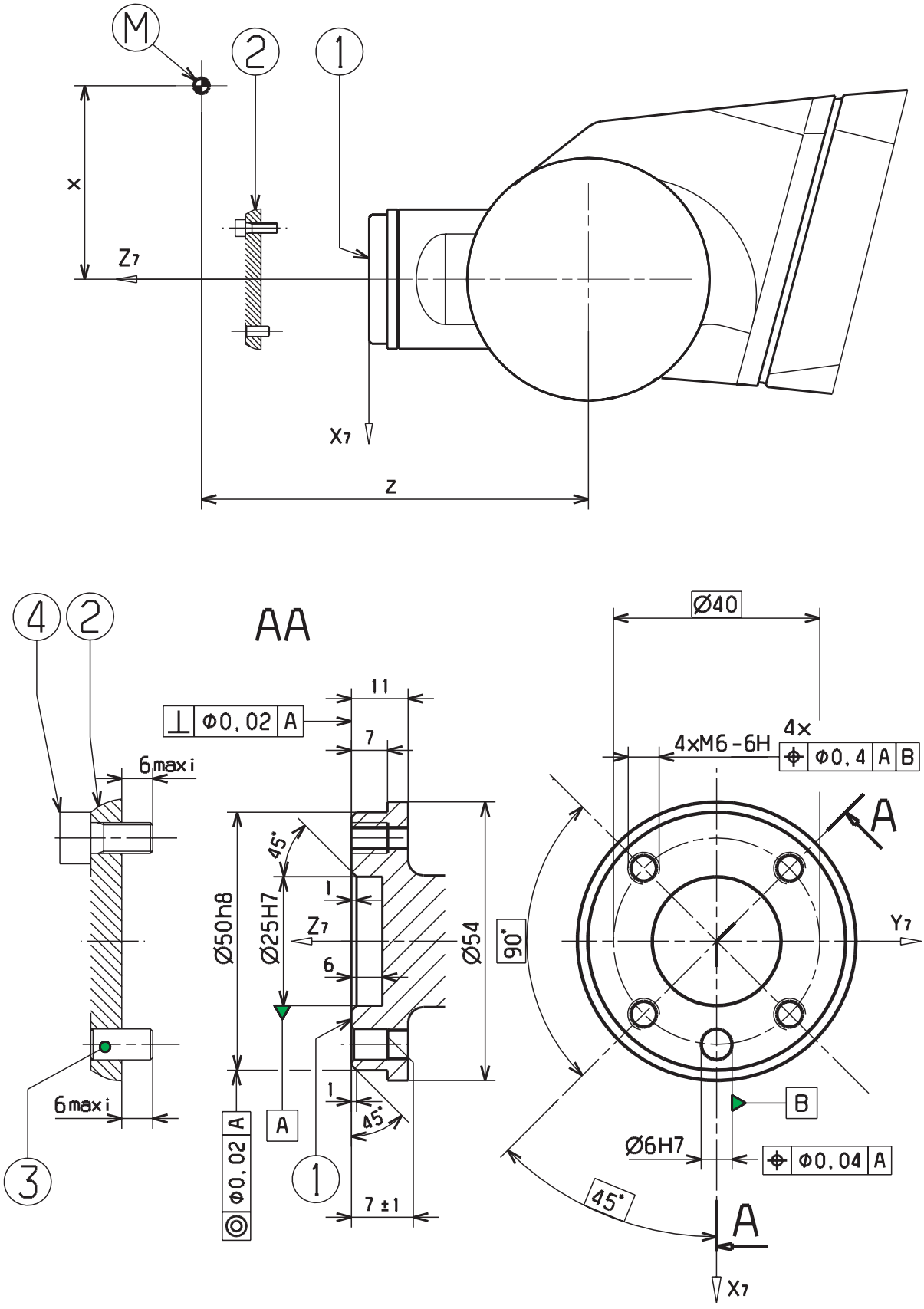


Figure 2.6

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2.6. LOAD CAPACITY – MECHANICAL INTERFACE

(1) Mechanical interface

(2) End-effector

The end-effector is not supplied with the robot arm assembly; its design depends on the robot's specific applications. All studies can be undertaken in cooperation with STÄUBLI to obtain optimum performance without exceeding the robot arm assembly load limits.

The end-effector is installed on the mechanical interface of the wrist, the dimensions of which are given on figure **2.6**.

Attachment by 4 M6 screws frame (4), Class 12-9, torque 16.7 Nm ± 1.2 Nm.

Indexing by pin frame (3), diameter 6.

Mechanical interface designation:
ISO 9409 - 1 - A40 as per Standard ISO 9409 - 1 : 1996 (F)
(except the localization of the 4 M6 threaded holes)

CAUTION:
Length of end-effector attaching screws is limited to avoid all interference with the wrist (figure 2.6).

2.6.1. LOAD CAPACITY **(figure 2.6)**

Load characteristics:

Load center of gravity position (M): z = 150 mm from centerline of joint 5 and x = 75 mm from centerline of joint 6 **(figure 2.6).**

Load capacity	**Standard arm**	**Long arm**
At nominal speed (1)	6 kg	3.5 kg
At reduced speed (1)	9 kg	6 kg
In some configurations (consult us)	12 kg	9 kg

(1) In all configurations and taking maximum inertias into account. See table below.

	NOMINAL INERTIAS (kg.m²)		**MAXIMAL INERTIAS (kg.m²) (2)**	
	STANDARD ARM	**LONG ARM**	**STANDARD ARM**	**LONG ARM**
For axis 5	0.135	0.080	0.675	0.400
For axis 6	0.034	0.020	0.170	0.100

(2) Under reduced speed and acceleration conditions:
For CS7B: SP60, ACC(8) 50, 50
For CS8: VEL = 60%, ACC = 30%, DEC = 30%

CAUTION:
The nominal values can be exceeded to a certain extent but imply a limitation to the speed and the acceleration of the arm. If these limits are to be exceeded, please consult STÄUBLI.

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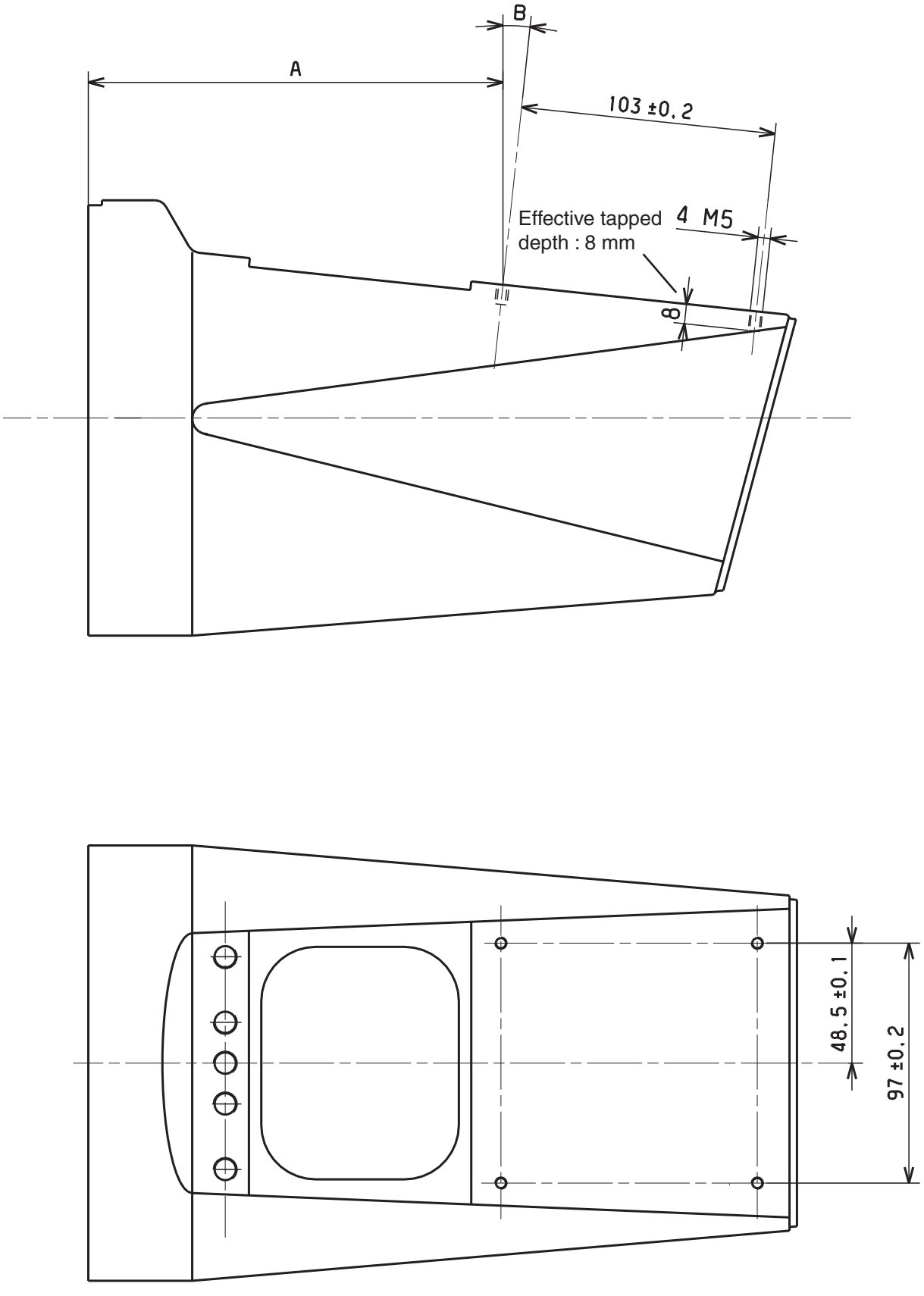


Figure 2.7

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2.6.2. ATTACHMENT OF ADDITIONAL LOAD ON FOREARM

An additional load can be attached to the forearm using 4 M5 screws; maximum torque is 7 Nm.

Position of 4 M5 tapped holes: See **figure 2.7**.

DIMENSIONS	STANDARD ARM	LONG ARM
A	167.5 ± 1 mm	272 ± 1 mm
B	6°	4.5°

CAUTION:

The additional load depends on nominal load (see next page). In all cases, do not exceed load characteristics.

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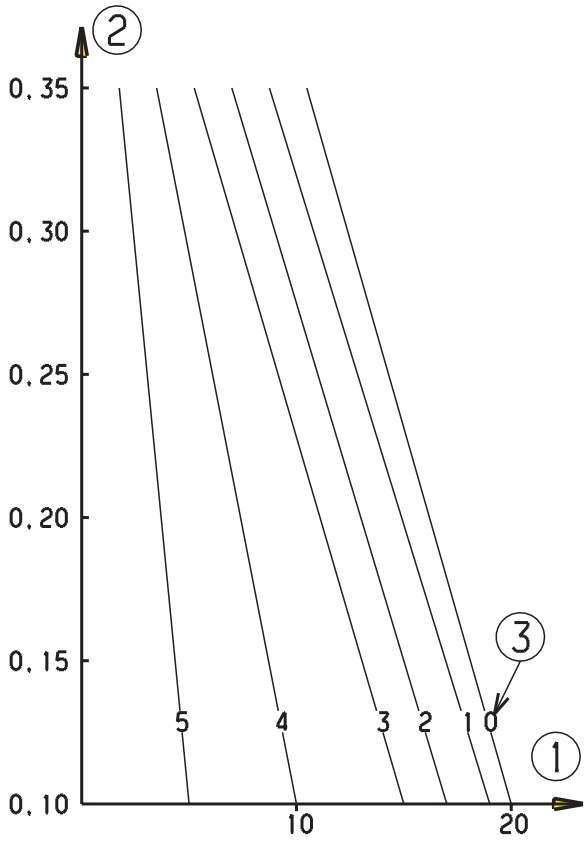


Figure 2.8

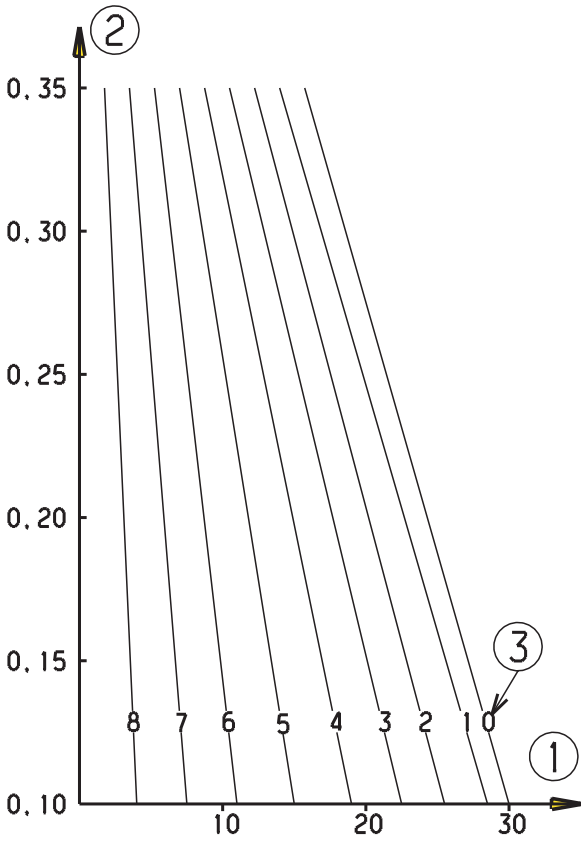


Figure 2.9

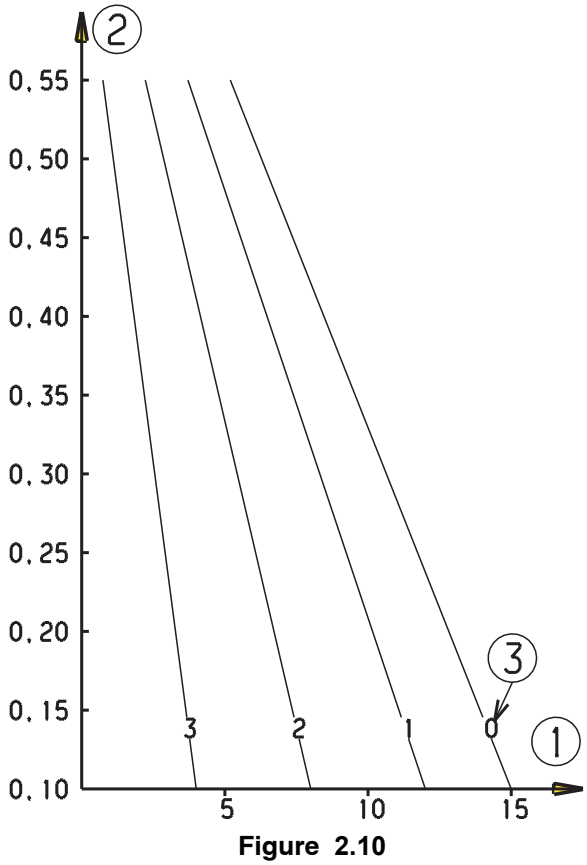


Figure 2.10

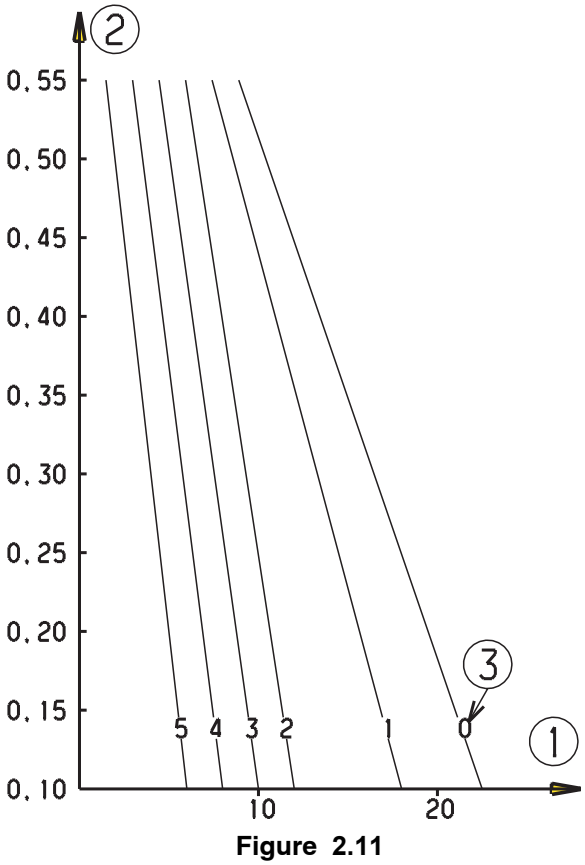


Figure 2.11

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2.6.3. ADDITIONAL LOAD DIAGRAMS

These diagrams can be used to determine the additional load which can be attached to the forearm depending on its center of gravity position from joint 3 and the load attached to the mechanical interface of the wrist.

(1) Additional load (kg)

(2) Additional load center of gravity position (m) from centerline of joint 3.
The additional load center of gravity position is at 0.25 m max. from the centerline of joint 4.

(3) Load attached to the mechanical interface of the wrist.
150 mm from centerline of joint 5 and 75 mm from centerline of joint 6.

Figure 2.8: For standard RX90B
Figure 2.9: For standard RX90B with reduced speeds (1)
Figure 2.10: For RX90B long arm
Figure 2.11: For RX90B long arm with reduced speeds (1)

(1) Reduced speeds:
For CS7B: SP60, ACC(8) 50, 50
For CS8: VEL = 60%, ACC = 30%, DEC = 30%

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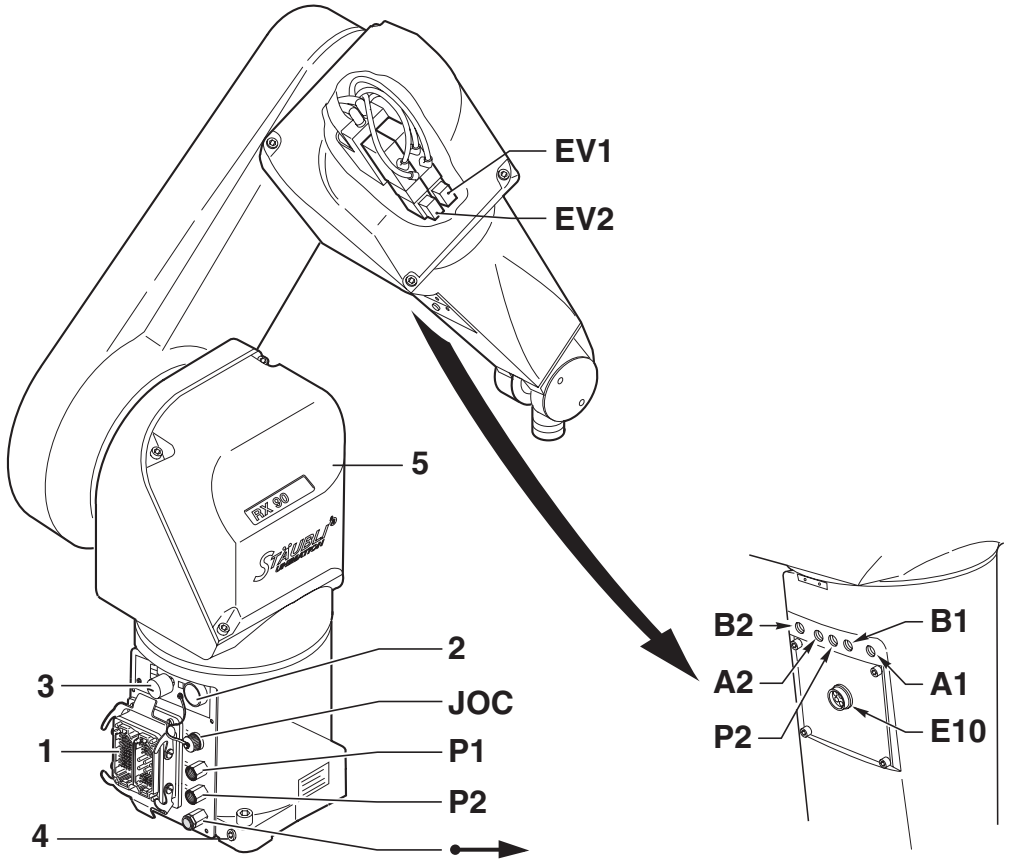


Figure 2.12

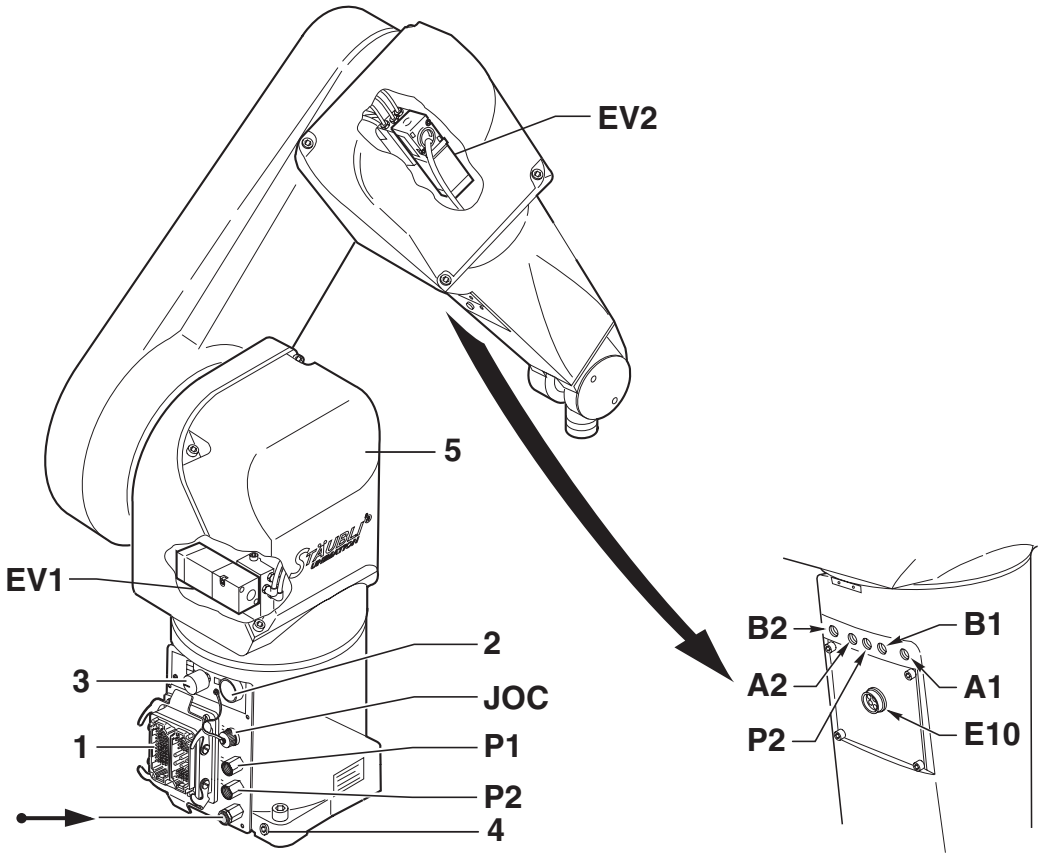


Figure 2.13

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2.7. USER CIRCUIT

The electric wiring of the arm is assembled into a harness including several cables supplying the motors (power, brakes, resolvers), the solenoid valves, the limit switches and user connector. These components are connected by means of removable connectors.

The harness also includes pneumatic hoses which supply air to the solenoid valves (**EV1** and **EV2**).

The robot also has a pressure source (**P2**) close to the tool clamp.

The outlets of the solenoid valves **EV1** and **EV2** are on the forearm:

- **A1** and **B1** for solenoid valve **EV1**.
- **A2** and **B2** for solenoid valve **EV2**.

Figure **2.12** is for all robots except the clean room application.

Figure **2.13** is for clean room application robots.

The wiring is inside the structure and routed through the centre of the joints. It is connected to the arm base on a plate which includes several electrical and pneumatic components such as:

Figures 2.12 and 2.13:

- Arm/**(1)** controller interconnection socket.
- R23 connector intended for the user for possible electrical connection of grip (**JOC**).

> **CAUTION:**
> **When a connector is plugged to E10, there may be a risk of collision with the cover (5) in some arm configurations.**

- Brake release selector **(3)**.
- Brake release pushbutton **(2)**.
- Compressed air network pneumatic (or vacuum) connections **P1** and **P2**.
- Pneumatic (or vacuum) exhaust muffler ⟶ .
- Arm ground connection **(4)**.

> **CAUTION:**
> **Do not add wires or cables to arm wiring as this may cause premature wear of the arm electrical wiring and lead to loss of the warranty.**

2.8. RELEASING JOINT BRAKE

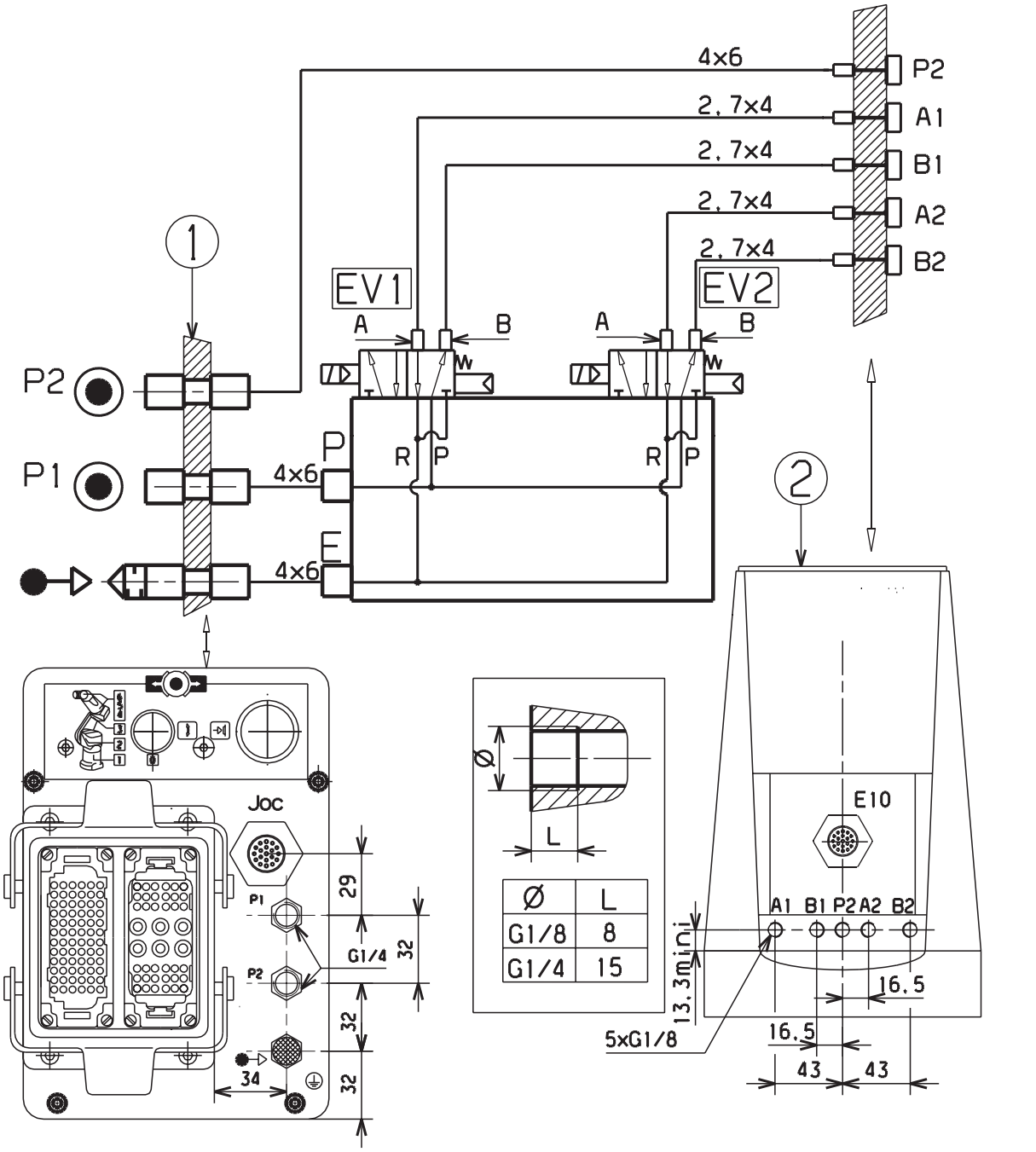
The controller must be connected to the power supply.

Place the brake release selector in position corresponding to the joint to be released.

> **CAUTION:**
> **Make sure that the arm and load relevant to this joint are suitably supported.**

Press the brake release pushbutton, the selected joint is totally free. When the pushbutton is released, the brakes will then be engaged and the corresponding joint locked.

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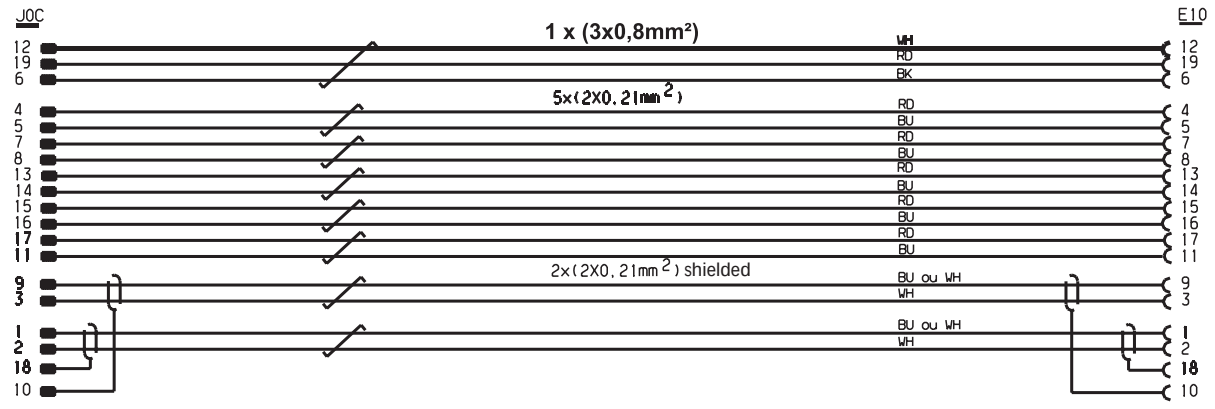


Figure 2.14

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2.9. PNEUMATIC AND ELECTRIC CIRCUITS (EXCEPT FOR CLEAN ROOM APPLICATION)

2.9.1. PNEUMATIC CIRCUIT

(1) Plate attached to base

(2) Forearm

Solenoid valves (EV1 and EV2):

- 5/2-way monostable.
- Electrically controlled (24 VDC).
- Working pressure: 1.5 to 7 bar.
- Flow coefficient Kv = 8.6.
- Clip-on connector.
- Overvoltage protective circuit and indicator diode.

Description (figure 2.14):

- The arm is connected to the compressed air network (7 bars max., lubricated or not) via the base **P1**.

> **CAUTION:**
> **The air must be filtered by a 10 µm filter.**

- There is a direct line between the base and the forearm (**P2**).
- The centralized solenoid valve exhaust is directed to the base and through a muffler ⟶ .

2.9.2. ELECTRIC CIRCUIT **(figure 2.14)**

The electrical circuit consists of:
- A male 19-contact socket at the bottom of the arm.
- A female 19-contact socket on the forearm.

These 19 contacts include 3 power contacts and 16 signal contacts.

- The 3 power contacts in each socket are connected by a 3-wire conductor with cross-section AWG18 (contacts 6-12-19).
- The 16 signal contacts in each socket are connected in the following way:
    - 2 shielded twisted pairs, cross-section AWG24 connecting contacts 3-9-10 and 1-2-18 in each socket.
    - 5 twisted pairs, cross-section AWG24 for the other contacts.

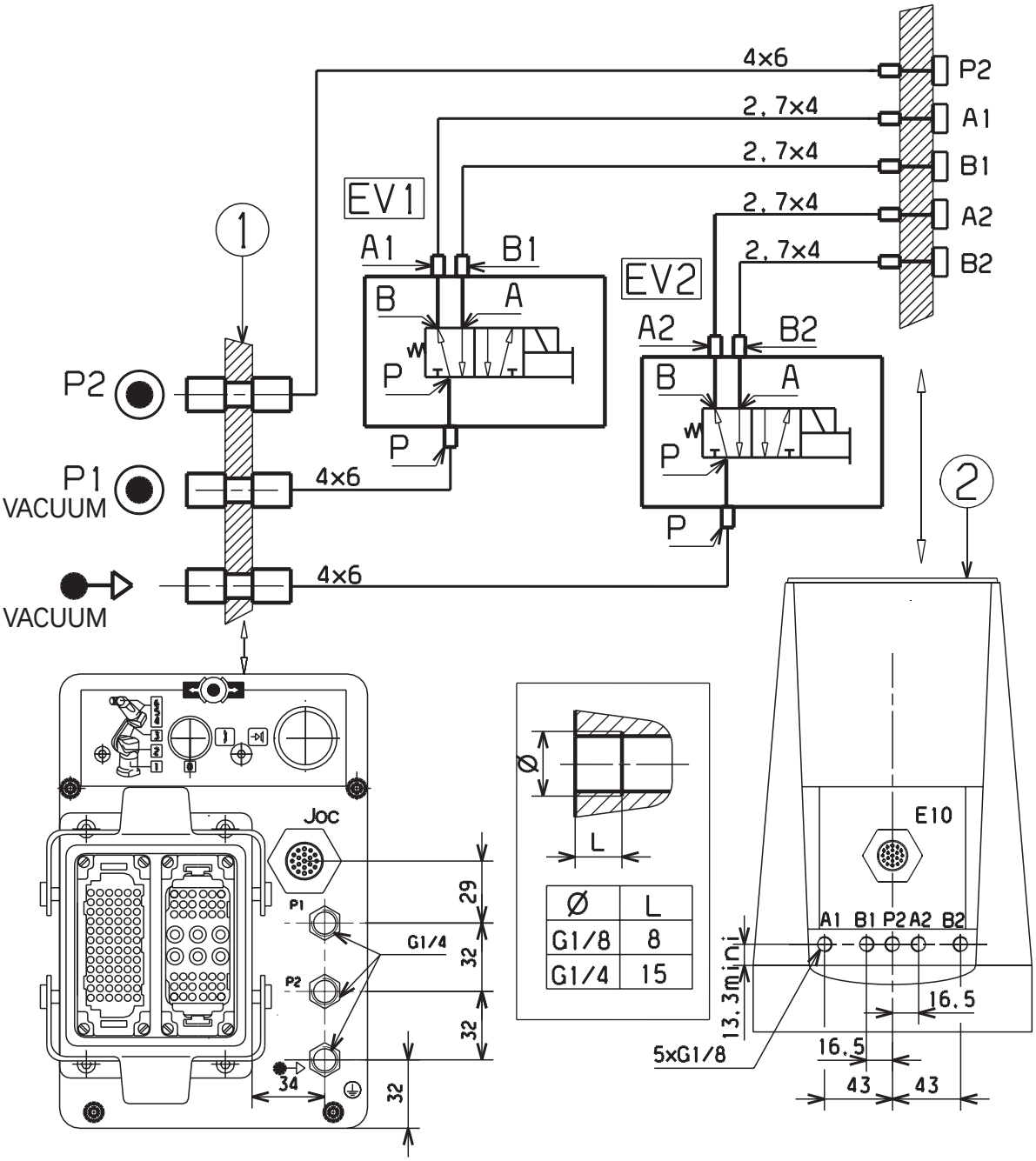
Supply voltage: 60 VDC - 25 VAC.

Permissible current:
- 3-wire conductor AWG18: 4.5 A per contact.
- Pairs and shielded pairs AWG24: 2 A per contact.

> **CAUTION:**
> **Do not use the shields as a conductive cable.**

- Connection to forearm (**E10**) by R23 elbow male cylindrical connector.
- Connection to base (**JOC**) by R23 straight female cylindrical connector.

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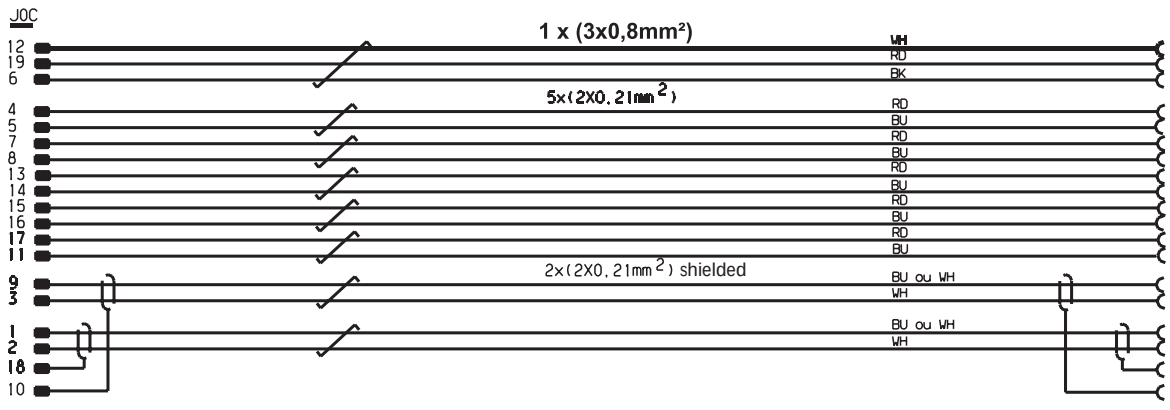


Figure 2.15

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2.10. PNEUMATIC AND ELECTRIC CIRCUITS CLEAN ROOM APPLICATION

2.10.1. PNEUMATIC CIRCUIT

(1) Plate attached to base

(2) Forearm

Solenoid valves (EV1 and EV2):

- 5/2-way monostable.
- Electrically controlled (24 VDC).
- Max. working pressure: vacuum only.
- Flow coefficient Kv = 5.72.
- Clip-on connector.

Description (figure 2.15):

- The arm is connected to the vacuum network via the base (**P1** and ⟶).
- There is a direct line between the base and the forearm (**P2**).
- Max. working pressure: vacuum only.
- There is no exhaust to the outside of the arm for the solenoid valves controlling the vacuum circuit.

> **CAUTION:**
> **Cleanliness of sucked in air must be equivalent to 5 µm filtered air.**

2.10.2. ELECTRIC CIRCUIT **(figure 2.15)**

The electrical circuit consists of:
- A male 19-contact socket at the bottom of the arm.
- A female 19-contact socket on the forearm.

These 19 contacts include 3 power contacts and 16 signal contacts.

- The 3 power contacts in each socket are connected by a 3-wire conductor with cross-section AWG18 (contacts 6-12-19).
- The 16 signal contacts in each socket are connected in the following way:
    - 2 shielded twisted pairs, cross-section AWG24 connecting contacts 3-9-10 and 1-2-18 in each socket.
    - 5 twisted pairs, cross-section AWG24 for the other contacts.

Supply voltage: 60 VDC - 25 VAC.

Permissible current:
- 3-wire conductor AWG18: 4.5 A per contact.
- Pairs and shielded pairs AWG24: 2 A per contact.

> **CAUTION:**
> **Do not use the shields as a conductive cable.**

- Connection to forearm (**E10**) by R23 elbow male cylindrical connector.
- Connection to base (**JOC**) by R23 straight female cylindrical connector.

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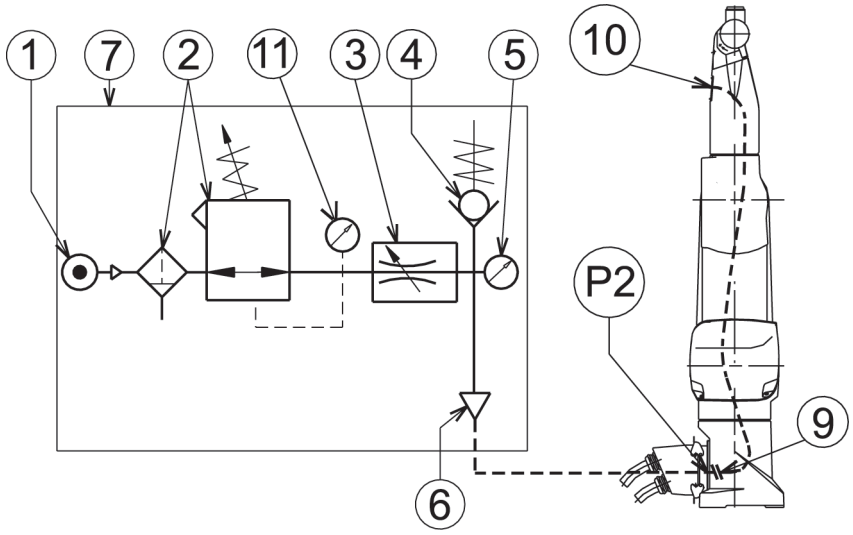


Figure 2.16

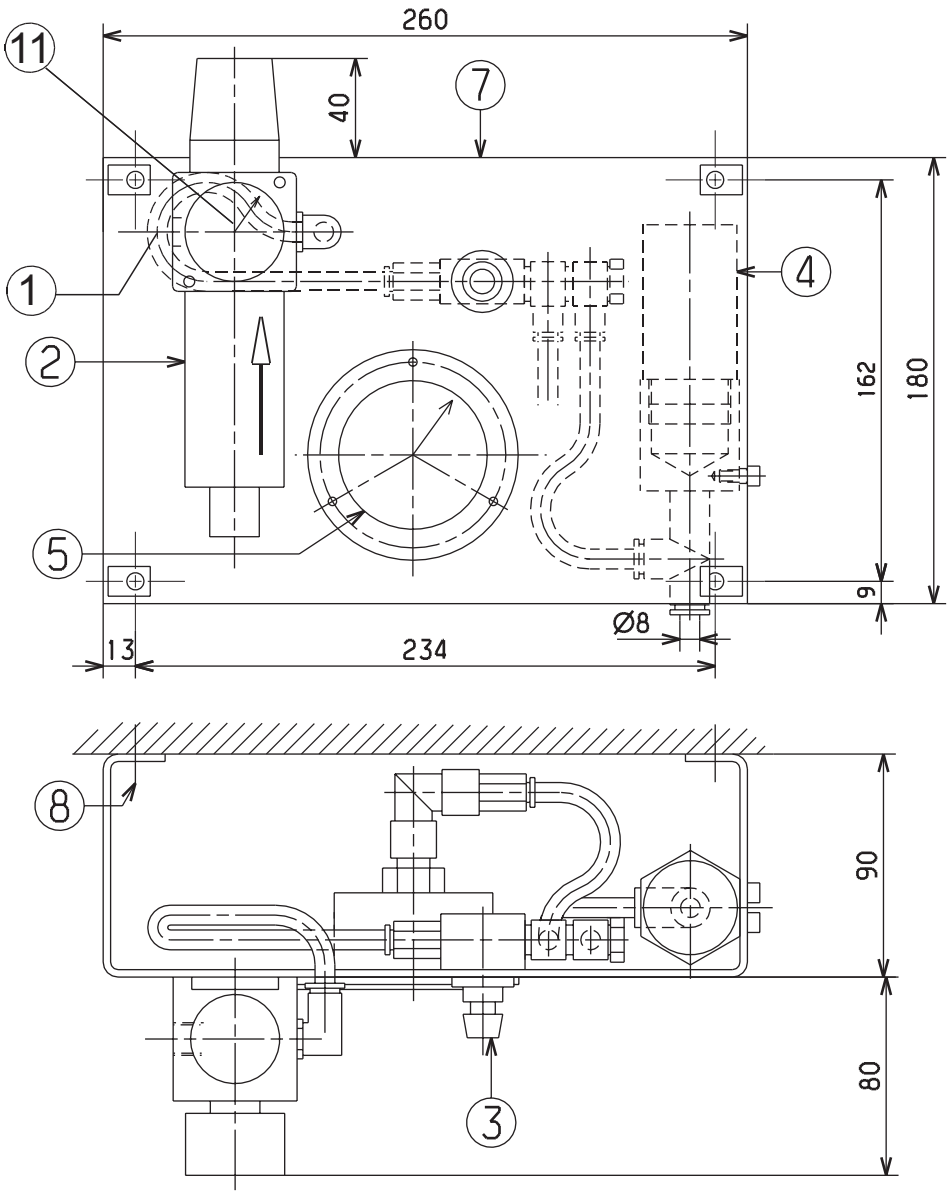


Figure 2.17

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2.11. PRESSURIZATION SYSTEM FOR DUSTY SURROUNDINGS OR SPATTERING WITH LIQUIDS

2.11.1. PURPOSE

For very severe applications in dusty surroundings or with spattered liquids, the objective is to keep the pressure inside the arm above atmospheric pressure in order to avoid migration of dust and liquids.

> **CAUTION:**
> **The overpressure must never exceed 20 mbar.**

2.11.2. INSTALLATION

a) Plate with pneumatic system P3:

- Use this fitting to connect the unit.

b) Plate without pneumatic system P3:

- If the hose **(P2)** between **(9)** and **(10)** is not used, cut the pipe **(P2)** at **(9)** and plug **(P2)** at **(10)**.
- If **(P2)** is used for another function, add a pressure sealed union to the connector mount (black plate at base of arm to which the electrical connector is attached).
- Attach the unit with 4 screws (Ø 6 max.) at item **(8)** (screws not supplied) to a rigid vertical wall in direction shown by arrow; the air inlet **(1)** being to the left of the regulator **(2)**.
- Provide for air inlet at **(1)**, this is a G1/4 tapped hole; the air pressure is 10 bar maximum. Before the pressure arrives at **(1)**, make sure that the regulator **(2)** is completely screwed out and that the valve **(3)** is completely screwed in. Before pressurizing the arm, also make sure that the arm is correctly connected and correctly sealed (covers closed, plugs in hoisting ring tapped hole, pipe connected at **(6)** and at **(9)**, etc.).
- Install a pipe with an outside Ø 8 between the unit (output **6**) and the arm (input **P2**). Provide a male G1/4 union for the pipe with an outside Ø 8. At **(P2)**, the hole is a G1/4 tapped hole for the complete RX range.
- Pressurize the arm.

  1) Slowly screw in the regulator. First adjust the pressure to 1 bar max. (pressure shown on pressure gage **11**).

     Note:
     *At this stage, the low pressure gage **(5)** must remain at 0 mbar.*

  2) Very slowly screw out the valve **(3)**; the value on the pressure gage **(5)** must increase progressively. When this value reaches 5 to 10 mbar and remains stable, adjustment is considered as correct.

> **CAUTION:**
> **An excessive value (above 40 mbar) will make the pressure gage (5) unusable.**

- If however the valve **(3)** is completely screwed out and it is impossible to reach 5 mbar, check that:

  a) The circuit is tight (unit, arm, pipe, etc.)

  b) The pressure gage **(5)** is not unserviceable (damaged by a pressure greater than 40 mbar).

If the 2 points a and b are correct, the pressure can be increased by means of the **(2)** regulator without however exceeding 2 bar.

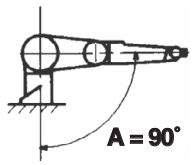
Note:
It is preferable for safety reasons (valve 4 opens between 15 and 25 mbars) and consumption reasons to work with minimum pressures (high and low pressures).

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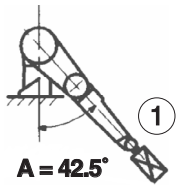
FLOOR CONFIGURATION	CEILING CONFIGURATION

1) Balanced position (joint 2 brake released) is as follows:

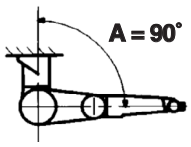
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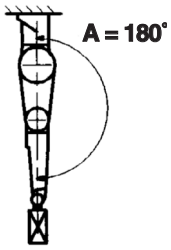
with nominal load:



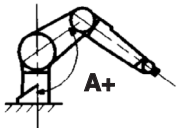
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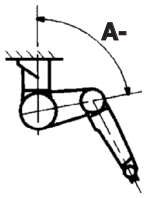


with nominal load:



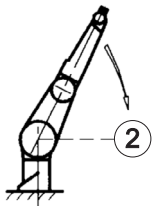
Rotating joint 3 modifies angle A:



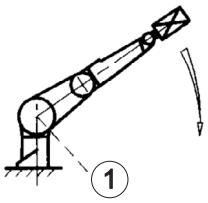


2) When arm is in a position other than balanced position, releasing joint 2 brake causes arm to return to balanced position.

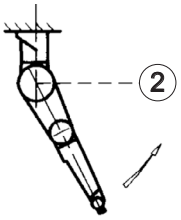
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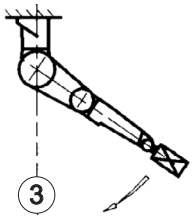
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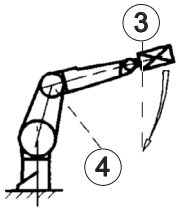


with nominal load:

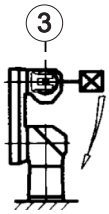


3) Releasing brakes of joints 3, 4, 5 and 6 (standard arm) or joints 3, 4 and 5 (5 axis arm) causes arm to move down whether loaded or not.

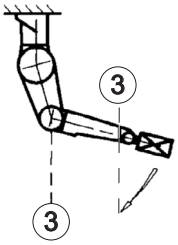
- Joints 3 and 5 (standard arm)
- Joints 3 and 4 (5 axis arm)



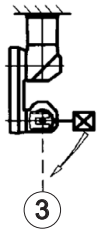
- Joints 4 and 6 (standard arm)
- Joint 5 (5 axis arm)



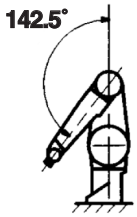
- Joints 3 and 5 (standard arm)
- Joints 3 and 4 (5 axis arm)

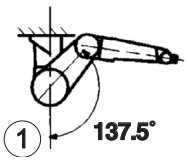


- Joints 4 and 6 (standard arm)
- Joint 5 (5 axis arm)



4) Before all operations on arm (especially for removal), springs must be released and arm placed in following position:





(1) against stop
(2) balanced position
(3) vertical
(4) position of axis 3

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2.12. SAFETY

The robot arm's energy is that accumulated by the springs.

Indeed, joint 2 is equipped with a spring balance system. Releasing joint 2 discharges the accumulated energy. This energy label is attached on the arm and must remain in place.

The brake release movements are described on the opposite page according to arm configuration (floor or ceiling).

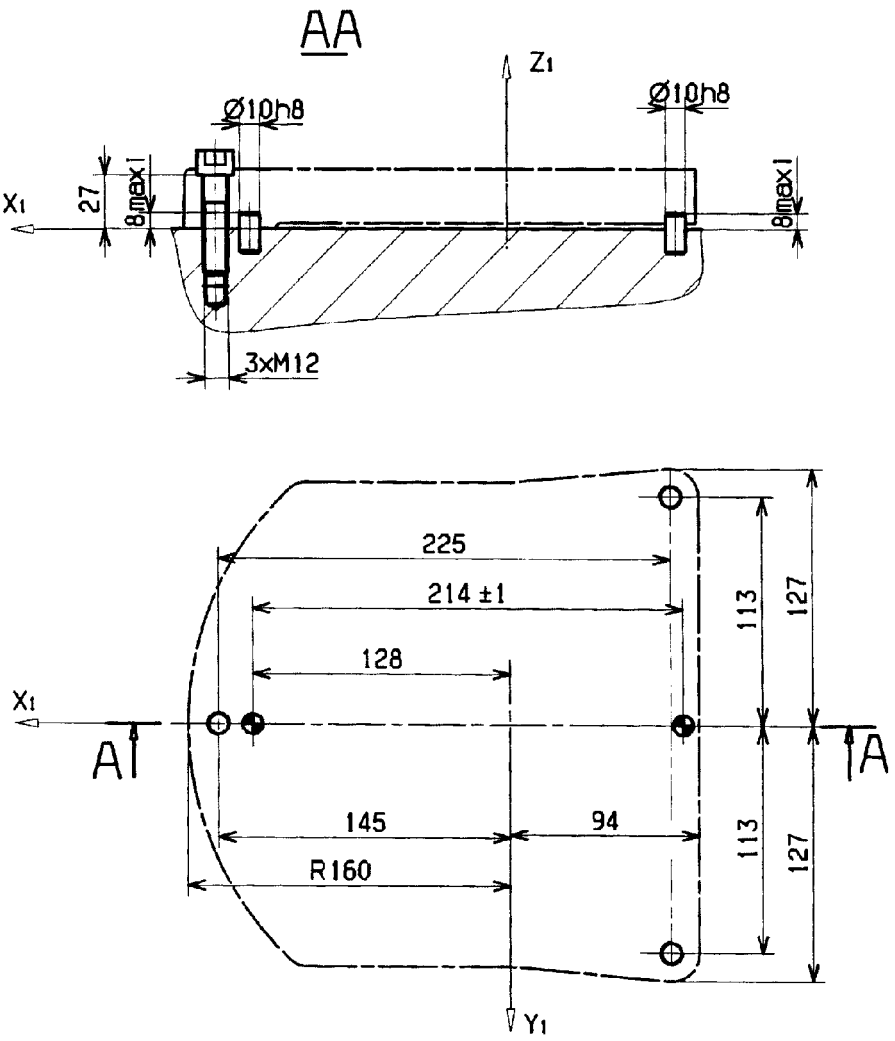
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CHAPTER 3

ON-SITE PREPARATION

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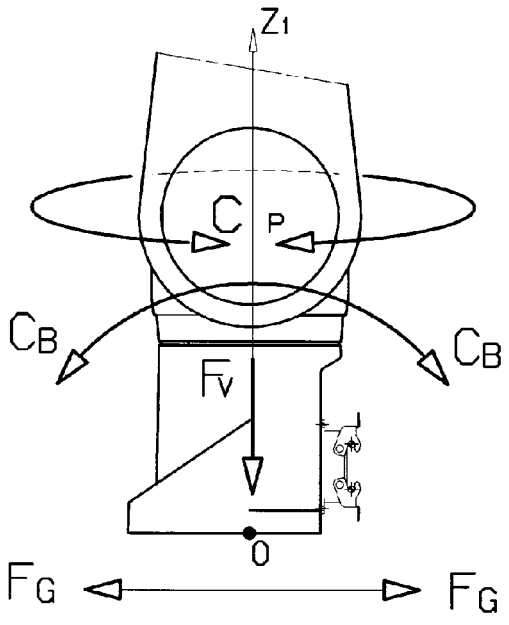


Figure 3.1

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3.1. WORKING SPACE

The user is responsible for performing all preparatory work required to complete the on-site installation of the robot. Working space must be sufficient, installation surface appropriate; the power supplies must be available (for the electric power supplies, see the characteristics of the controller).

DANGER:

The arm's working area must be surrounded by a closed safety enclosure in compliance with the country's safety legislation preventing personnel accessing the dangerous area.

International standard: ISO 10218-1, 2006.

European Directive: machine directive CEE 89-392.

DANGER:

There must be no obstacles within the robot work envelope.

3.2. ATTACHMENT (figure 3.1)

The robot arm can be installed vertically, base downwards (floor-mounted version) or base upwards (ceiling-mounted version). In all cases, it must be securely attached by 3 class 12.9 M12 hex. socket head screws.

Attachment surface shall be flat and metallic. A deformable support will greatly reduce robot's performance in speed and accuracy.

To dimension the support, take into account the maximum loads generated by the arm in motion at point 0 which are:

- F_V = 2232 N
- F_G = 1635 N
- C_B = 1700 Nm
- C_P = 747 Nm

Under following load conditions:

		LOAD POSITION (mm)	
	LOAD (kg)	AXIS 5	AXIS 6
Standard arm	6	150	75
Long arm	3.5		

The user can accurately position the robot by means of two 10h8 diameter centering pins.

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CHAPTER 4

INSTALLATION

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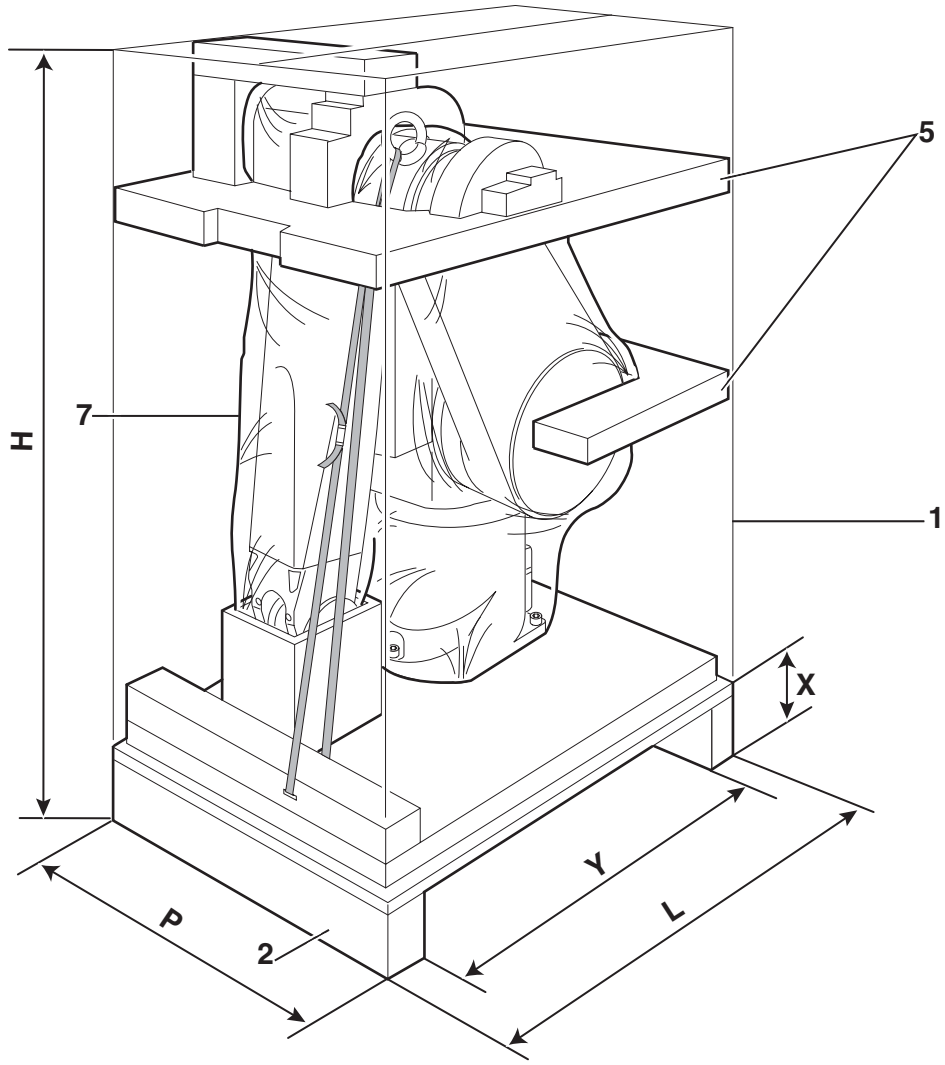


Figure 4.1

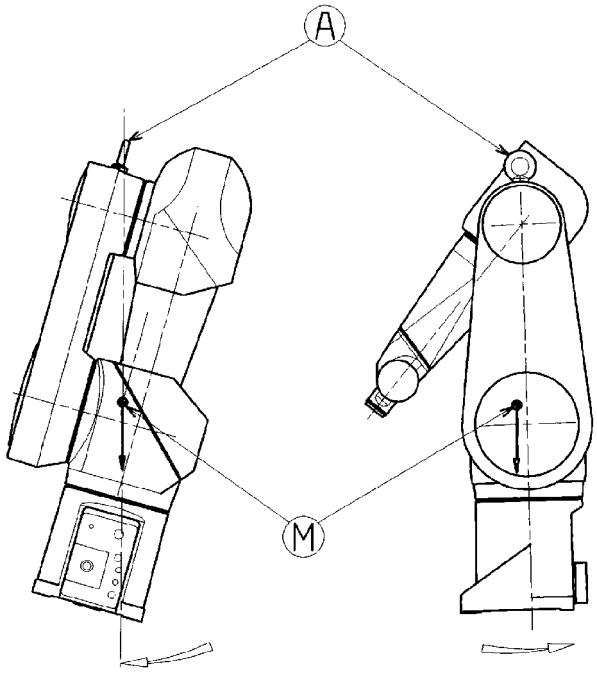


Figure 4.2

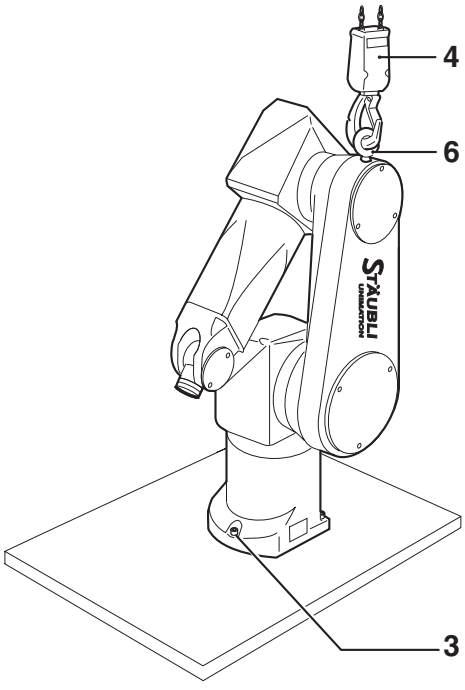


Figure 4.3

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4.1. ARM PACKAGING (figure 4.1)

Standard packaging:

Case **(1)**: L x H x D = 850 x 1210 x 640 mm
Gross weight:
- Standard arm:136 kg
- Long arm:137 kg

International packaging:

Case **(1)**: L x H x D = 935 x 1210 x 670 mm
Gross weight:
- Standard arm:175 kg
- Long arm:176 kg

The arm is packed in the vertical position. It is attached to the pallet **(2)** by 3 M12 bolts **(3)**.

Transport condition:
- Minimum temperature -20°C
- Maximum temperature +60°C

4.2. HANDLING OF PACKING (figure 4.1)

By pallet truck under base **(2)**.
- X = 100 mm
- Y = 700 mm

4.3. UNPACKING AND INSTALLATION OF THE ARM

CAUTION:
According to European Directive CEE 89-392, the hoisting ring's (6) threaded hole (M20) used for the robot hoisting is defined according to the ISO 262 standard.

- Move the packing case as near as possible to the installation site.
- Remove the cardboard packaging **(1)**, remove the packing material **(5)** and the plastic cover **(7)** **(figure 4.1)**.
- Pass the hook **(4)** of the hoist through the hoisting ring **(6)** and hold slightly tensioned to stop the arm from tipping **(figure 4.3)**.
- Remove the 3 M12 **(3)** bolts from the arm.
- Slowly raise the arm using the hoist.



DANGER:
The robot will swing when raised and moved (figure 4.2).

Ⓐ Attachment point

Ⓜ Center of gravity

CAUTION:
For ceiling-mounted version robots (balance springs of joint 2 released), do not rotate joint 2.

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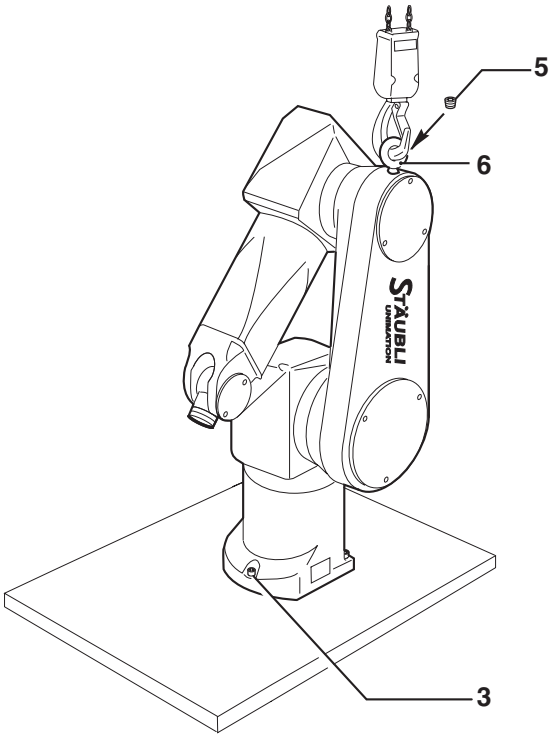


Figure 4.4

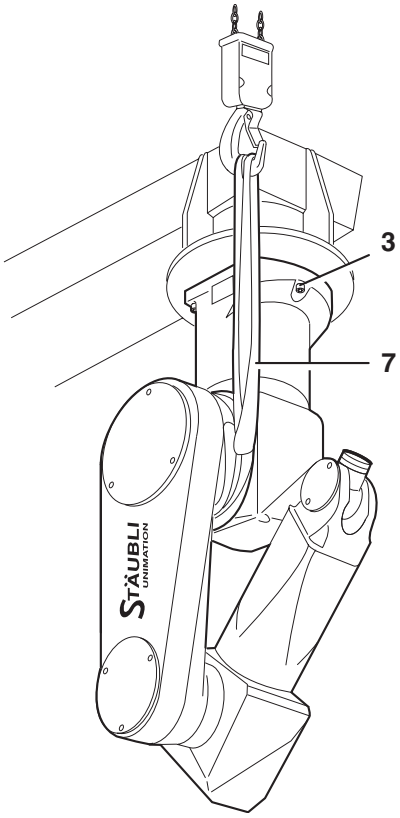


Figure 4.5

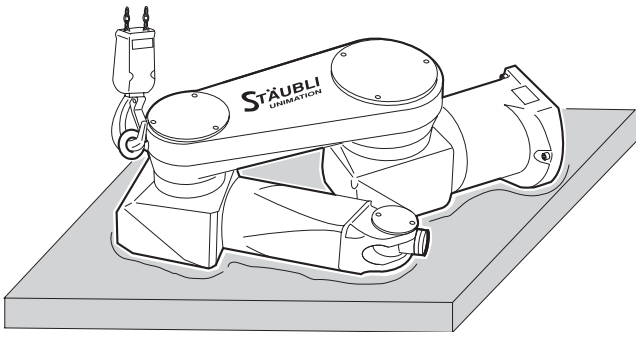


Figure 4.6

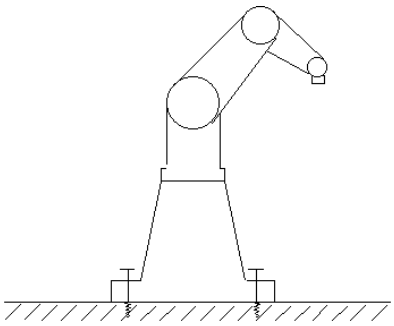


Figure 4.7

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4.4. INSTALLATION OF ARM

CAUTION:

The arm can be attached with the base downwards (floor-mounted version) or with base upwards (ceiling-mounted version). Caution: the balance system is installed in the factory for one OR the other of these versions. Conversion from a floor-mounted version to a ceiling-mounted version requires a mechanical operation on the balance system.

4.4.1. INSTALLATION OF ARM ON FLOOR **(figure 4.4)**

- Position the arm on the support at its final attachment points.
- Attach the arm with 3 class 12.9 M12 hex. socket head screws **(3)**, tightened to 132 Nm ± 9 Nm.
- Unscrew the hoisting ring **(6)** and install the plug **(5)**.

DANGER:

For safety reasons, hold the sling slightly tensioned until arm is securely attached to the floor.

4.4.2. INSTALLATION OF ARM ON CEILING

CAUTION:

Do not rotate joint 2.

- Carefully lay down the arm on a flexible support as shown on figure **4.6**.
- Place the fabric sling **(7)** around joint 2 as shown on figure **4.5**.

CAUTION:

500 kg fabric sling.

- Position the arm on the support at its final attachment points.
- Attach the arm with 3 class 12.9 M12 hex. socket head screws **(3)**, tightened to 132 Nm ± 9 Nm.
- Tension the springs for robots delivered in ceiling-mounted version using the tool supplied with the robot *(see chapter 4.5).*

DANGER:

For safety reasons, hold the sling slightly tensioned until arm is securely attached to the ceiling.

4.4.3. MOUNTING FLOOR QUALITY **(figure 4.7)**

The user has to make sure that the mechanical caracteristics of the floor and the means of fixture allow to hold up the maximum forces caused by the moving arm *(see chapter **3**).*

CAUTION:

The height of the robot support can strongly influence the forces on the floor.

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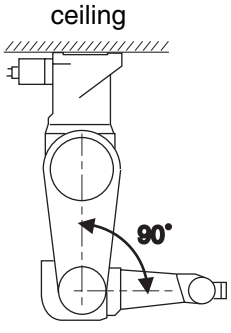


Figure 4.8

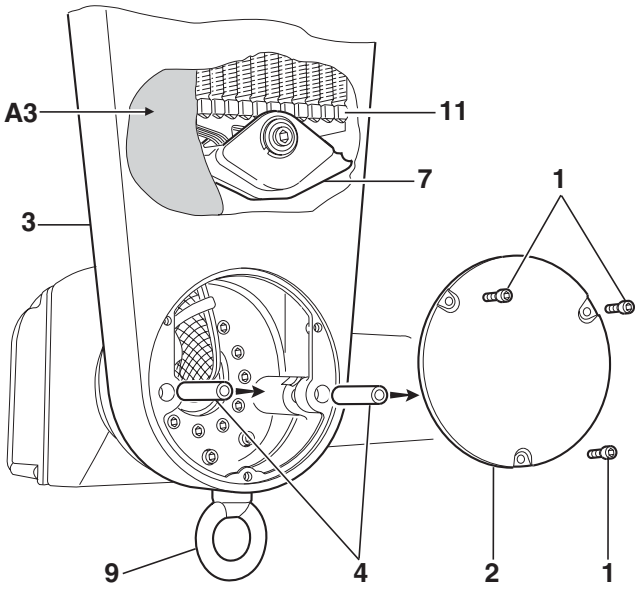


Figure 4.9

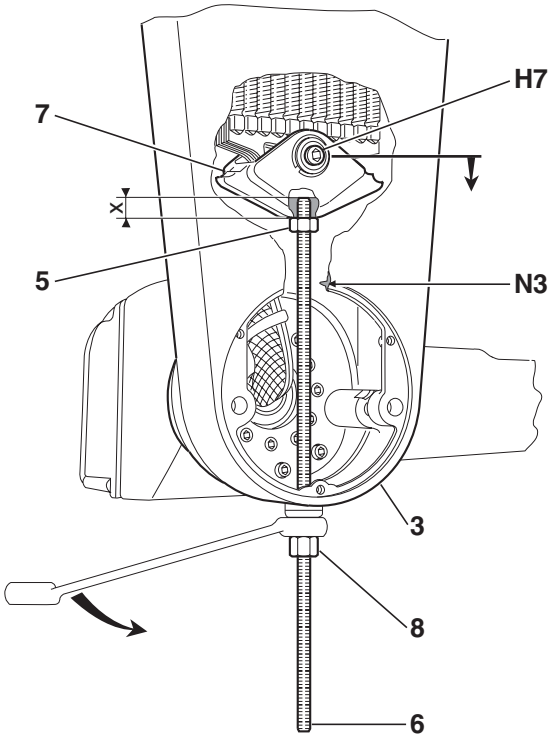


Figure 4.10

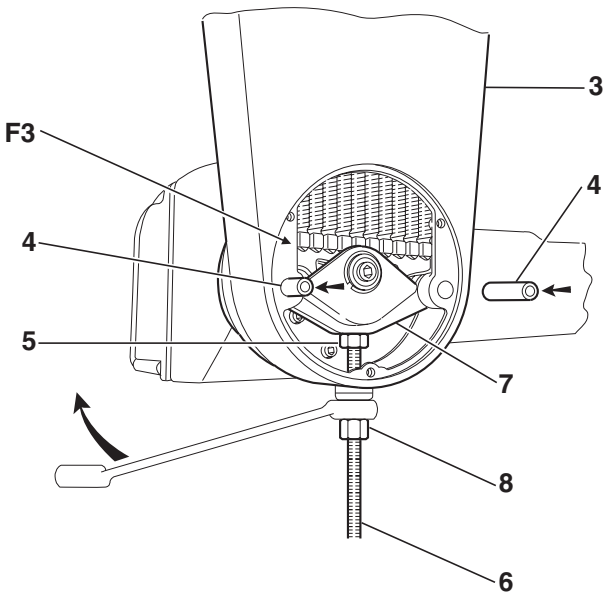


Figure 4.11

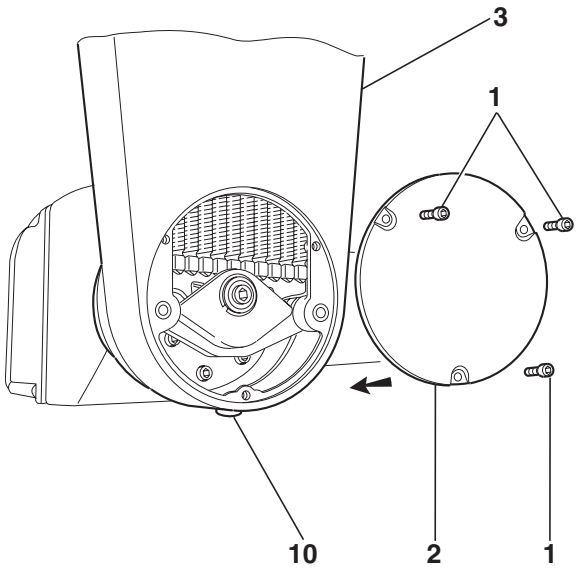


Figure 4.12

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4.5. SPRING TENSION

CAUTION:
The robot must be attached to the ceiling.
Do not rotate joint 2.

Figure 4.9

- Remove hoisting ring **(9)** from the arm.
- Unscrew the 4 M5 screws **(1)** attaching cover **(2)**.
- Remove cover **(2)** from arm **(3)**.
- Remove the 2 pins **(4)** from arm **(3)**.
- Remove foam **(A3)** wedging beam **(7)** against arm **(3)**.
- Check that beam **(7)** and its springs **(11)** are not jammed in arm **(3)**.
- Place the robot in position **(figure 4.8)**.

Figure 4.10

- Unscrew the M12 nut **(5)** from the M12 threaded rod **(6)**.
- Insert threaded rod **(6)** into arm **(3)** (polyamide washer in contact with arm).
- Screw nut **(5)** onto threaded rod **(6)**.
- Screw the end of threaded rod **(6)** into beam **(7)**.
  Grip length X = 15 mm ± 1 mm
- Tighten nut **(5)** against beam **(7)**.
- Using an 18 mm ring spanner (not supplied), tighten nut **(8)** until the pin holes of beam **(7)** coincide and pass beyond (± 1 mm) those on the arm.

Figure 4.11

- When beam **(7)** is in position, insert the pins **(4)** in arm **(3)** (pin threads on outside). The pins must be inside face **(F3)** of arm **(3)**.
- Unscrew nut **(8)** so that beam **(7)** bears on pins **(4)**.
- Unlock nut **(5)**.
- Unscrew threaded rod **(6)**.
- Unscrew the M12 nut **(5)** from the M12 threaded rod **(6)**.
- Remove threaded rod **(6)** from the arm.

Figure 4.12

- Install cover **(2)** on arm **(3)**.
- Tighten the 3 screws **(1)**.
- Install plug **(10)** in arm **(3)**.

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CHAPTER 5

INTERNAL VARIATIONS BETWEEN VARIOUS TYPES OF ARMS

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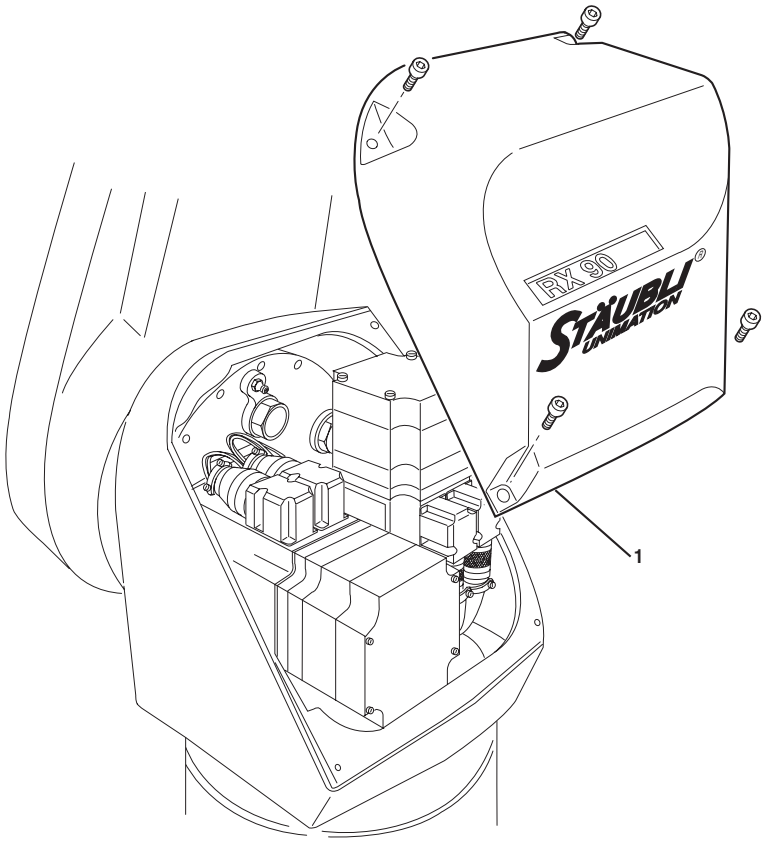


Figure 5.1

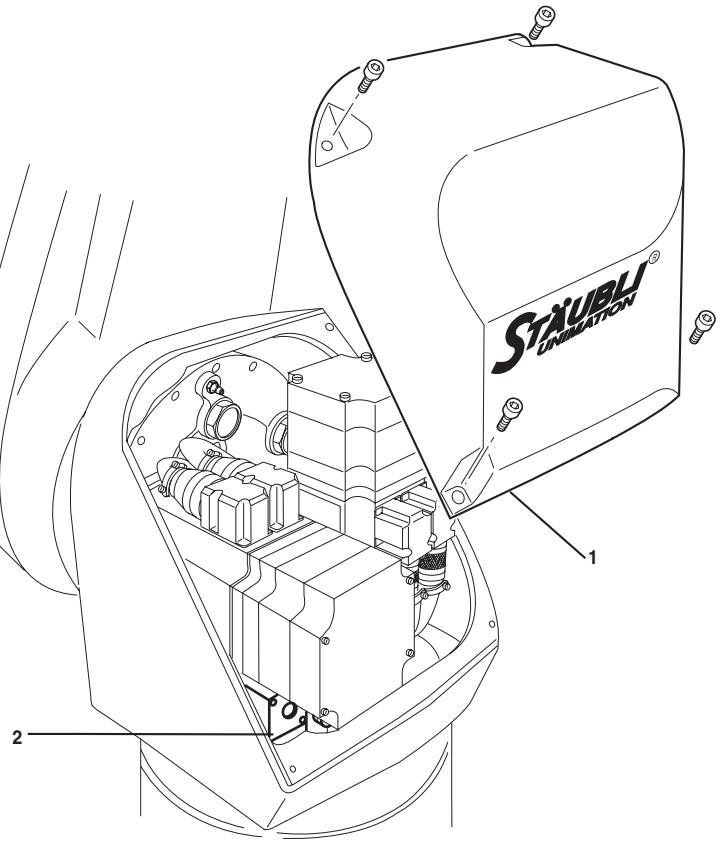


Figure 5.2

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5.1. PURPOSE OF THIS CHAPTER

This chapter shows the internal design variations between different types of arms.

These variations are detailed on the following pages.

Only the views of the standard version are shown in the following paragraphs.

Clean room arm

These variations concern the type of solenoid valves and their locations.

Two solenoid valves are placed at joints 3 and 4 in the standard arms.

For space reasons, one solenoid valve is attached to joints 3 and 4 and the other to joint 1 on the clean room arms.

5.2. JOINTS 1 AND 2

On the clean room arm, solenoid valve **(2)** is visible (bottom left) when cover **(1)** is removed.

Figure 5.1: Joints 1 and 2 standard arm

Figure 5.2: Joints 1 and 2 clean room arm

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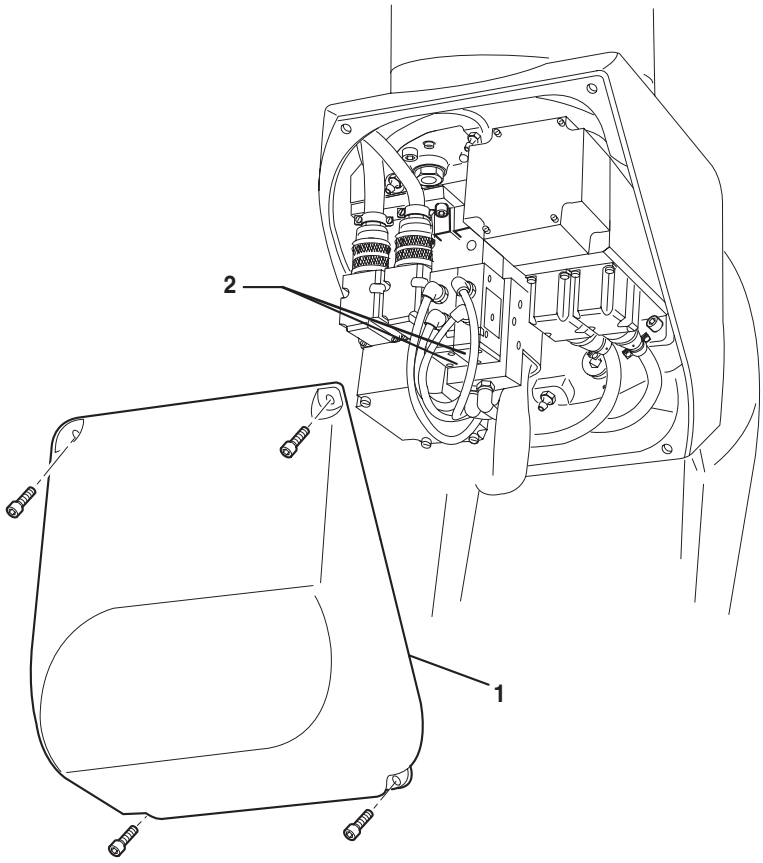


Figure 5.3

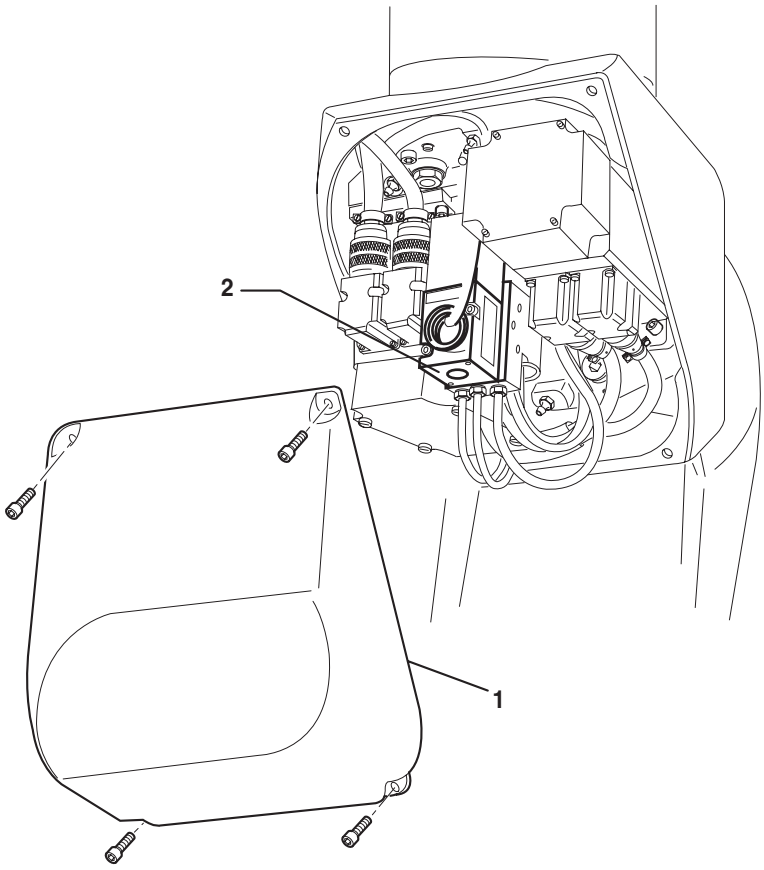


Figure 5.4

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5.3. JOINTS 3 AND 4

After removing cover **(1)**, the two solenoid valves **(2)** of the standard arm are replaced by a single solenoid valve **(2)** on the clean room arm.

Figure 5.3: Joints 3 and 4 standard arm.

Figure 5.4: Joints 3 and 4 clean room arm.

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CHAPTER 6

TRANSMISSION CASING OIL CHANGE

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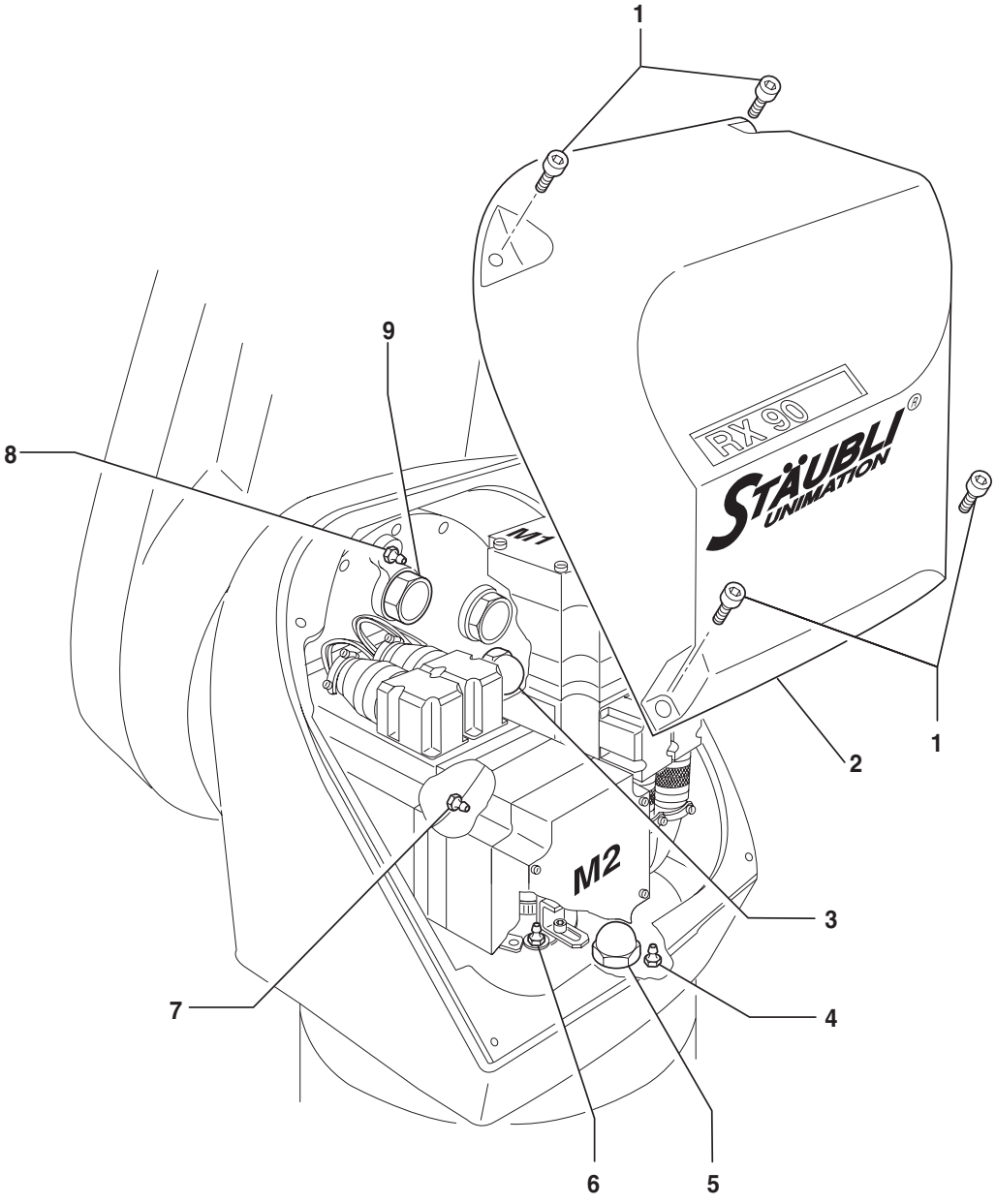


Figure 6.1

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CAUTION:
The figures in this chapter show the standard arm (see chapter 5 for variations).

6.1. JOINT 1 TRANSMISSION CASING (figure 6.1)

DANGER:
Follow the safety rules! See chapter 1.3.

- Unscrew the 4 M5 screws **(1)** attaching cover **(2)**.
- Remove shoulder cover **(2)**.
- Install a 6/8 pneumatic hose on drain screw **(6)** (drain screw **(4)** for ceiling-mounted version).
- Unscrew drain screws **(4) (6)** by approximately 2 turns.
- Using a pumping device, remove the oil from the casing via the hose.
- Top up with oil* via the hose (indicative quantity: 300 cm^3), ***see oil level: chapter 8.2.1.***
- Tighten drain screws **(4)** and **(6)** to 20 Nm ± 1.4 Nm.
- Disconnect the hose.
- Replace the joint on the cover **(2)**.See chapter 6.6.
- Install shoulder cover **(2)**.
- Tighten the 4 M5 screws **(1)** attaching the cover **(2)** to 5.7 Nm ± 0.4 Nm.

6.2. JOINT 2 TRANSMISSION CASING (figure 6.1)

DANGER:
Follow the safety rules! See chapter 1.3.

- Unscrew the 4 M5 screws **(1)** attaching cover **(2)**.
- Remove shoulder cover **(2)**.
- Install a 6/8 pneumatic hose on drain screw **(7)** (drain screw **(8)** for ceiling-mounted version).
- Unscrew drain screws **(7) (8)** by approximately 2 turns.
- Using a pumping device, remove the oil from the casing via the hose.
- Top up with oil* via the hose (indicative quantity: 170 cm^3), ***see oil level: chapter 8.2.1.***
- Tighten drain screws **(7)** and **(8)** to 20 Nm ± 1.4 Nm.
- Disconnect the hose.
- Replace the joint on the cover **(2)**.See chapter 6.6.
- Install shoulder cover **(2)**.
- Tighten the 4 M5 screws **(1)** attaching the cover **(2)** to 5.7 Nm ± 0.4 Nm.

(*) Recommended oil: see spare parts
oil levels: *See chapter 8.2.1.*

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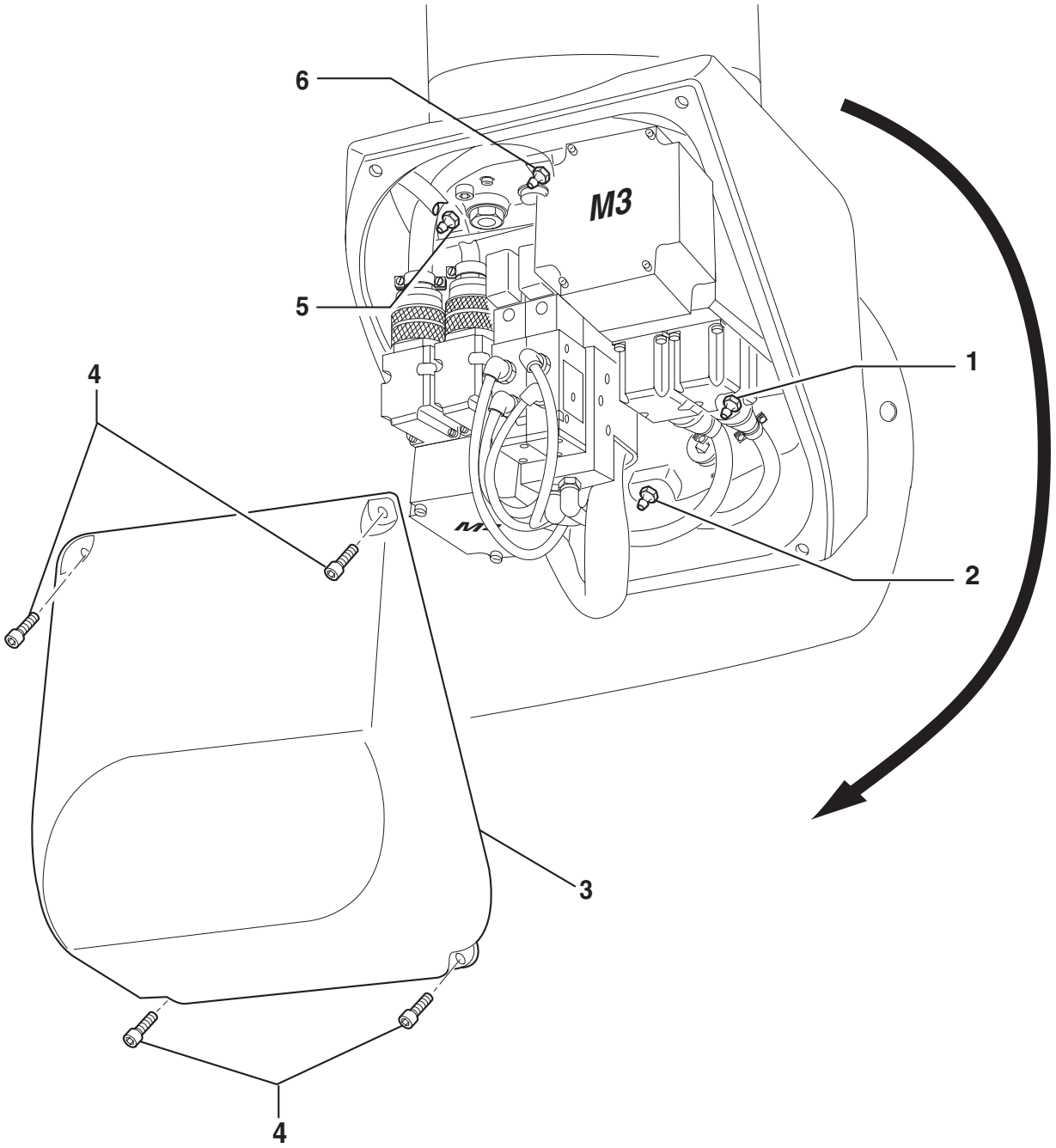


Figure 6.2

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6.3. JOINT 3 TRANSMISSION CASING (figure 6.2)

> **DANGER:**
> **Follow the safety rules! See chapter 1.3.**

- Set the arm in horizontal position.
- Set the forearm perpendicular to the arm, wrist on top.
- Unscrew the 4 M5 screws **(4)** attaching cover **(3)**.
- Remove elbow cover **(3)**.
- Install a 6/8 pneumatic hose on drain screw **(2)**.
- Unscrew drain screws **(2)** then **(1)** by approximately 2 turns.
- Using a pumping device, remove the oil from the casing via the hose.
- Top up with oil* via the hose (indicative quantity: 70 cm^3), ***see oil level: chapter 8.2.1.***
- Tighten drain screws **(1)** and **(2)** to 15 Nm ± 1 Nm.
- Disconnect the hose.
- Replace the joint on the cover **(3)**.See chapter 6.6.
- Install elbow cover **(3)**.
- Tighten the 4 M5 screws **(4)** to 5.7 Nm ± 0.4 Nm.

6.4. JOINT 4 TRANSMISSION CASING (figure 6.2)

> **DANGER:**
> **Follow the safety rules! See chapter 1.3.**

- Set the arm in horizontal position.
- Set the forearm perpendicular to the arm, wrist on top.
- Unscrew the 4 M5 screws **(4)** attaching cover **(3)**.
- Remove elbow cover **(3)**.
- Install a 6/8 pneumatic hose on drain screw **(6)**.
- Unscrew drain screws **(6)** then **(5)** by approximately 2 turns.
- Using a pumping device, remove the oil from the casing via the hose.
- Turn the forearm through 180° in direction shown by arrow, downwards.
- Top up with oil* via the hose (indicative quantity: 70 cm^3), ***see oil level: chapter 8.2.1.***
- Tighten drain screws **(5)** and **(6)** to 15 Nm ± 1 Nm.
- Disconnect the hose.
- Replace the joint on the cover **(3)**.See chapter 6.6.
- Install elbow cover **(3)**.
- Tighten the 4 M5 screws **(4)** to 5.7 Nm ± 0.4 Nm.

(*) Recommended oil: see spare parts
oil levels: *See chapter 8.2.1.*

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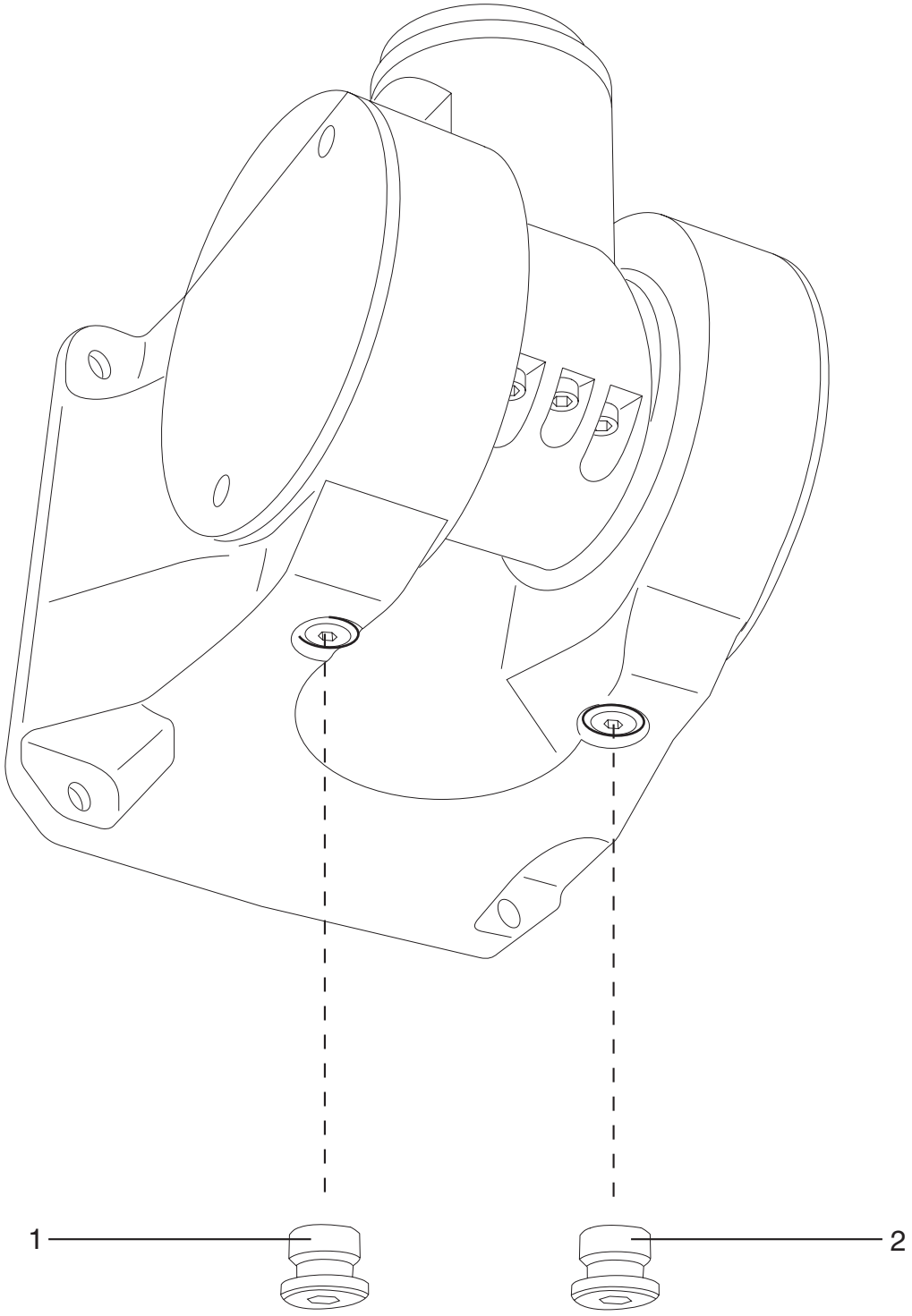


Figure 6.3

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6.5. TRANSMISSION CASING OF JOINTS 5 AND 6 (figure 6.3)

DANGER:
Follow the safety rules! See chapter 1.3.

- Turn the joints so that forearm is horizontal, plugs **(1)** and **(2)** facing downwards, joint 6 vertical, upwards.
- Unscrew plugs **(1)** and **(2)**.
- Wait approximately 10 minutes for oil to flow out.
- Turn the joints so that plugs **(1)** and **(2)** are facing upwards.

CAUTION:
As joint 4 has no mechanical stop, check, when turning plugs (1) and (2) upwards that joint 4 remains within its envelope.

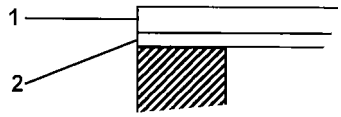
- Top up with oil* via holes of plugs **(1)** and **(2)** (indicative quantity: 180 cm^3), ***see oil level: chapter 8.2.1.***
- Tighten plugs **(1)** and **(2)** to 4 Nm ± 0.3 Nm.

(*) Recommended oil: see spare parts,
oil levels: See chapter 8.2.1.

6.6. PROCEDURE FOR REPLACING THE FLAT SEAL

The flat seal is made up of 2 sections:

- A section made of foam **(1)**,
- An adhesive section **(2)**.



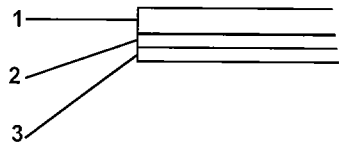
6.6.1. REMOVING THE SEAL

- To remove the flat seal, peel off a corner of the seal and pull it towards you.
  If the adhesive section **(2)** remains stuck to the cover, use "C" fluid (ethyl acetate) to remove it.
- Clean the surface, remove all paint and all other particles present on the surface, without scratching it.
- Clean the whole surface using "C" fluid (ethyl acetate).

6.6.2. FITTING A NEW SEAL

The new seal is made up of 3 sections:

- A section made of foam **(1)**,
- An adhesive section **(2)**,
- A protective paper covering the adhesive **(3)**.



- Remove the cut-out sections such as screw holes.
- Present the seal. Line the contour of the seal up with that of the surface.
- Apply the new seal to the surface. Remove a corner of the protective paper covering, apply that part to the surface, and then continue to remove the paper and put the seal into contact with the surface.

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CHAPTER 7

OPERATIONS ON MOTORS

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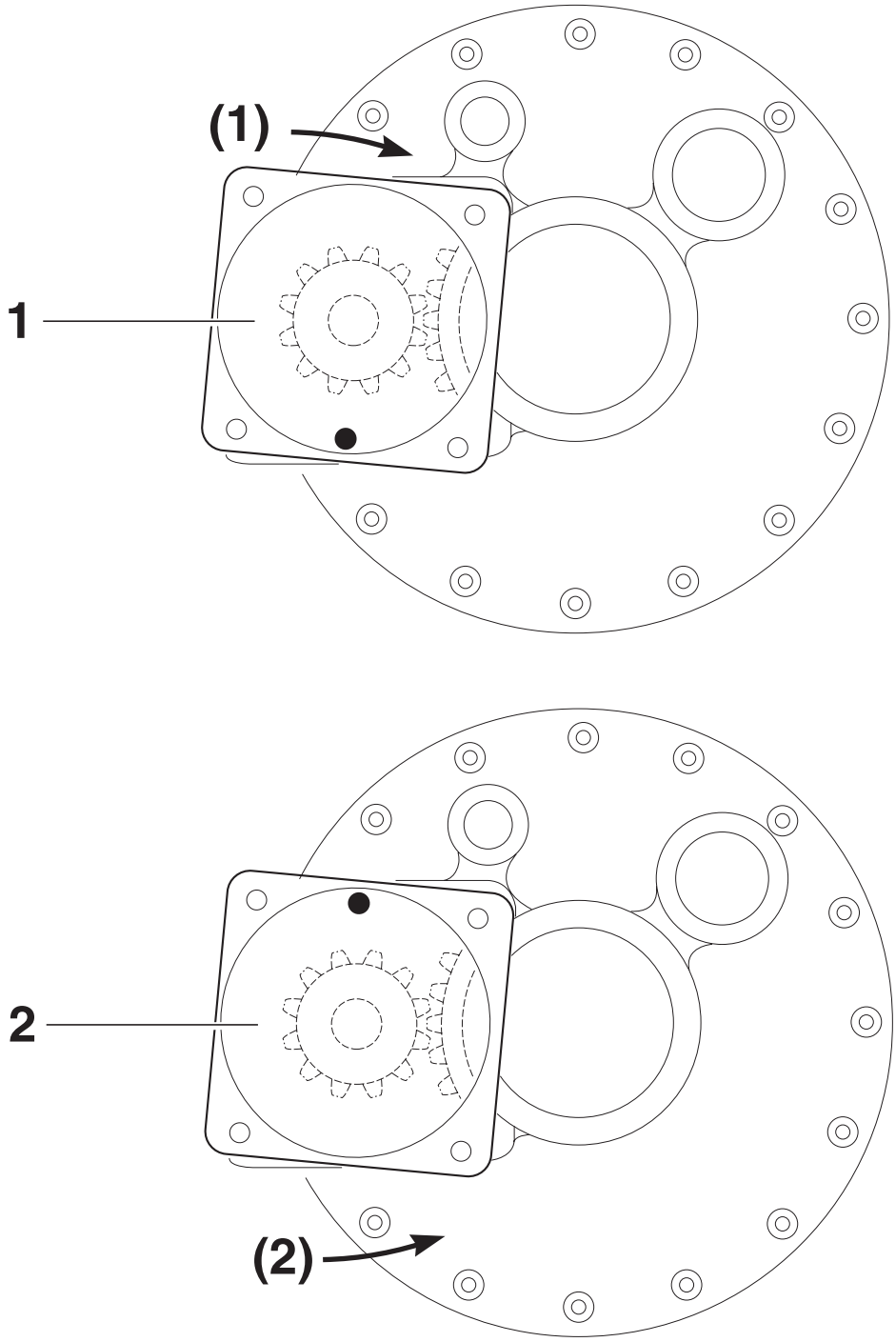


Figure 7.1

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DANGER:
Follow the safety rules! See chapter 1.3.

7.1. MOTOR PLAY ADJUSTMENT PROCEDURE

7.1.1. ACCESS TO MOTORS

The operations to be performed to access the motors are described in paragraph **7.2**.

7.1.2. JOINTS 1, 2, 3 AND 4

Motor play is adjusted by moving the motor gear wheel towards the crown gear of the JCS transmission module:

- Unscrew the 4 screws of the motor of the joint concerned by 1/4 to 1/2 of a turn.
- Axis 1, 2, 4: Push motor **(1)** clockwise (**figure 7.1**) to reduce play.
- Axis 3: Push motor **(2)** anticlockwise (**figure 7.1**) to reduce play.
- Progressively tighten the 4 motor screws, working diagonally.

CAUTION:
Do not hold the motor pressed against the crown gear when tightening its 4 attachment screws.

- Check adjustment by conducting the following "motor play check" procedure:

To check for play in a join:

- Release the brake of the joint concerned.
- Move the joint to both sides in movement direction.
- If there is play in the joint, a characteristic noise will be heard when direction of movement is reversed.

For the robot to work under the best conditions, transmission play must tend towards zero without this jamming the gearing or creating a friction point in the transmission or significant operating noise.

7.1.3. JOINTS 5 AND 6

Play of joints 5 and 6 must be adjusted in the factory or by a qualified technician.

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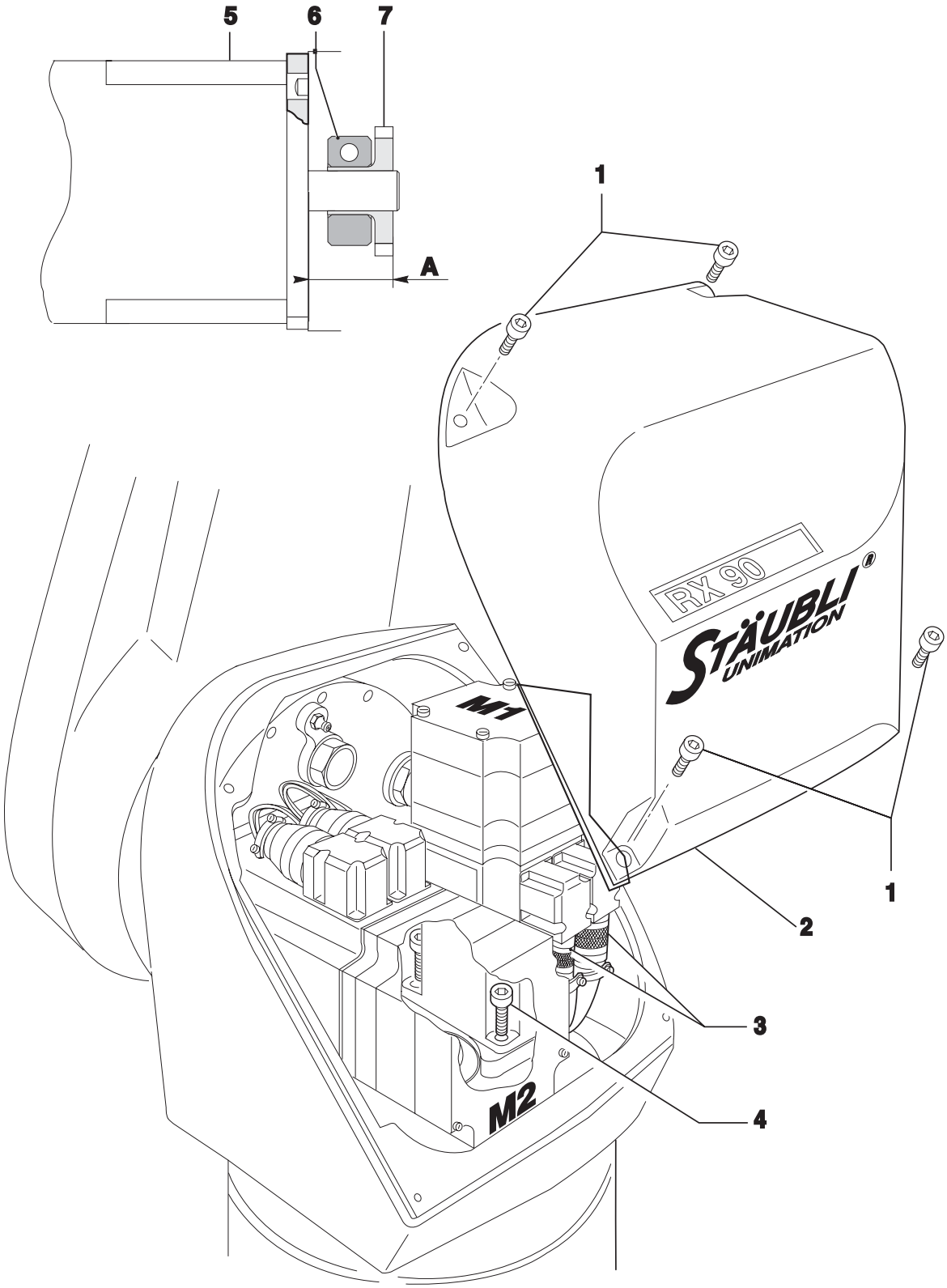


Figure 7.2

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7.2. REPLACEMENT OF A MOTOR

DANGER:

Follow the safety rules! See chapter 1.3.

Before carrying out any work on the motors, the DAPS board backup supply switch MUST be set to OFF (0).

If an item is replaced or joint transmission uncoupled, an arm adjustment procedure must be performed.

The figures in this chapter show the standard arm (see chapter 5 for variations).

7.2.1. JOINT 1 **(figure 7.2)**

- Align the joint position frames.
- Unscrew the 4 M5 screws **(1)** attaching cover **(2)**.
- Remove shoulder cover **(2)**.
- For ceiling-mounted version, drain the joint casing *(see paragraph 6.1).*
- Disconnect connectors **(3)** from motor M1.
- Unscrew the 4 M6 screws **(4)** attaching motor M1.
- Remove motor M1.

CAUTION:
- **Hold the joint in position.**
- **Check for good condition and positioning of the joint under the motor.**
- **Make sure that no impurities enter the joint JCS casing.**

Figure 7.2

- Untighten the M6 screw of bushing **(6)**.
- Remove gear wheel **(7)** from motor **(5)**.

On the new motor:

- Install the gear wheel **(7)** and bushing **(6)** assembly on motor **(5)**. Dimension (A) is 25 mm ± 0.1 mm.
- Tighten the M6 screw of bushing **(6)** to 16.7 Nm ± 1.2 Nm.
- Install motor M1 on joint 1 casing.

CAUTION:
- **Do not damage the joint under the motor.**
- **Correctly position motor M1 on the locating stud.**
- **Keep the joint frames aligned to within 1/2 of a tooth.**

- Install the 4 M6 screws **(4)** attaching motor M1, do not tighten down.
- Connect connectors **(3)** to motor M1.

- Perform the motor play adjustment procedure.
- Tighten the 4 M6 screws **(4)** attaching motor M2 to 16.7 Nm ± 1.2 Nm.
- Replace the joint on the cover **(2)**.See chapter 6.6.
- Install shoulder cover **(2)**.
- Tighten the 4 M5 screws **(1)** attaching the cover **(2)** to 5.7 Nm ± 0.4 Nm.

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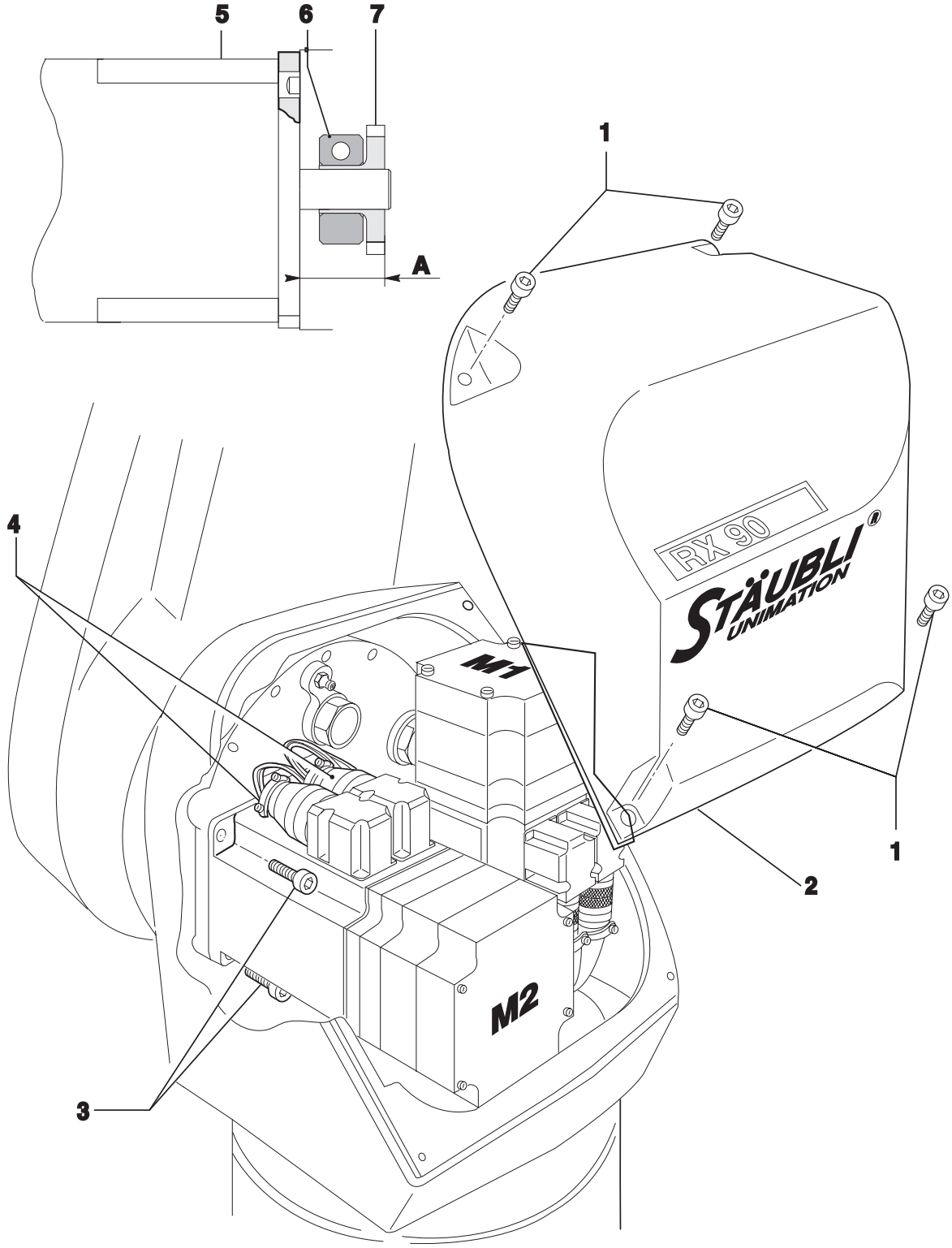


Figure 7.3

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7.2.2. JOINT 2 **(figure 7.3)**

DANGER:
Follow the safety rules! See chapter 1.3.

- Align the joint position frames.
- Unscrew the 4 M5 screws **(1)** attaching cover **(2)**.
- Remove shoulder cover **(2)**.
- Disconnect connectors **(4)** from motor M2.
- Unscrew the 4 M6 screws **(3)** attaching motor M2.
- Remove motor M2.

CAUTION:
- **Hold the joint in position.**
- **Check for good condition and positioning of the joint under the motor.**
- **Make sure that no impurities enter the joint JCS casing.**

Figure 7.3

- Untighten the M6 screw of bushing **(6)**.
- Remove gear wheel **(7)** from motor **(5)**.

On the new motor:

- Install the gear wheel **(7)** and bushing **(6)** assembly on motor **(5)**. Dimension (A) is 25 mm ± 0.1 mm.
- Tighten the M6 screw of bushing **(6)** to 16.7 Nm ± 1.2 Nm.
- Install motor M2 on joint 2 casing.

CAUTION:
- **Do not damage the joint under the motor.**
- **Correctly position motor M2 on the locating stud.**
- **Keep the joint frames aligned to within 1/2 of a tooth.**

- Install the 4 M6 screws **(3)** attaching motor M2, do not tighten down.
- Connect connectors **(4)** to motor M2.

- Perform the motor play adjustment procedure.
- Tighten the 4 M6 screws **(3)** attaching motor M2 to 16.7 Nm ± 1.2 Nm.
- Replace the joint on the cover **(2)**.See chapter 6.6.
- Install shoulder cover **(2)**.
- Tighten the 4 M5 screws **(1)** attaching the cover **(2)** to 5.7 Nm ± 0.4 Nm.

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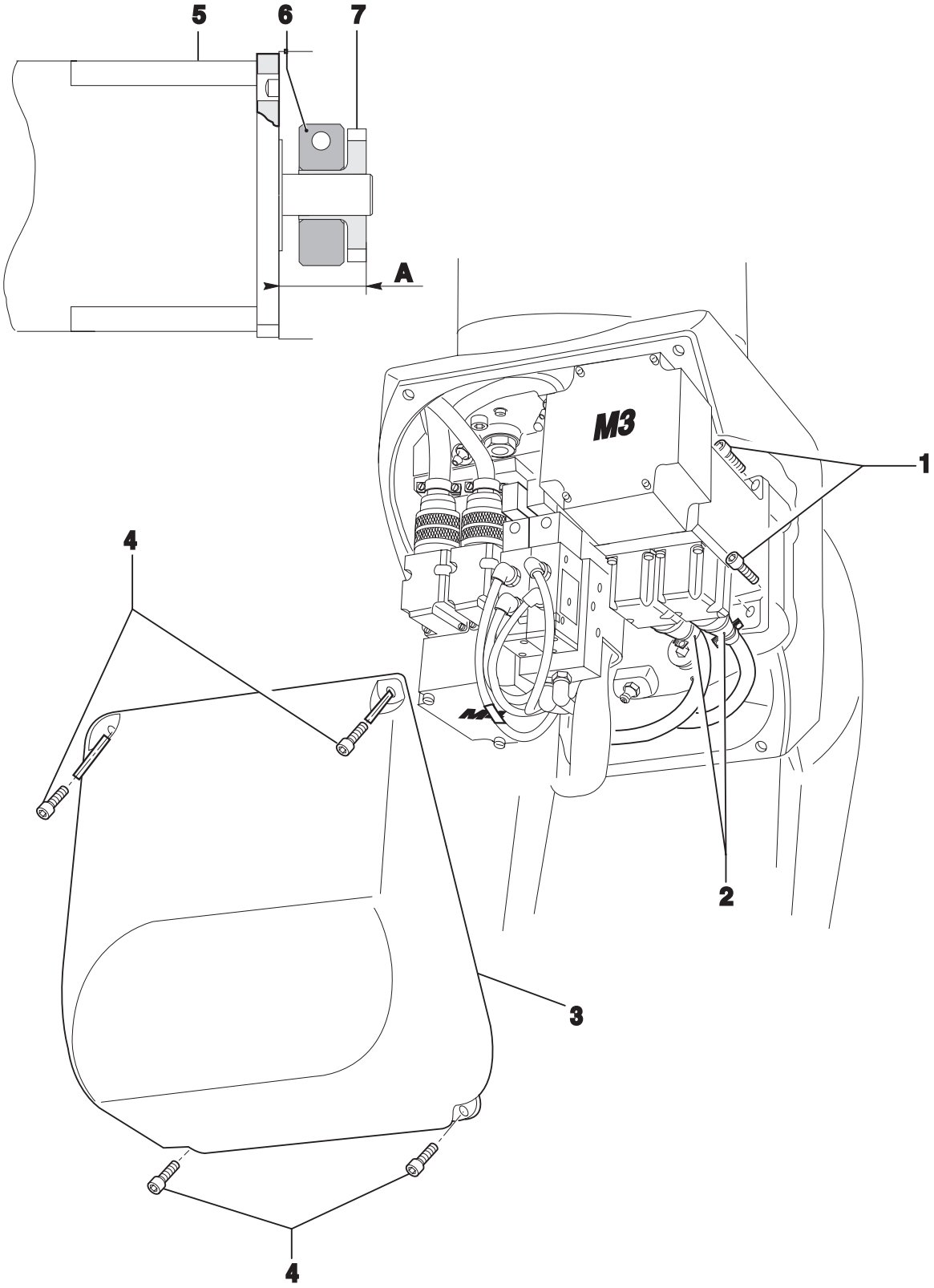


Figure 7.4

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7.2.3. JOINT 3 **(figure 7.4)**

DANGER:
Follow the safety rules! See chapter 1.3.

- Align the joint position frames.
- Unscrew the 4 M5 screws **(4)** attaching cover **(3)**.
- Remove elbow cover **(3)**.
- Disconnect connectors **(2)** from motor M3.
- Unscrew the 4 M5 screws **(1)** attaching motor M3.
- Remove motor M3.

CAUTION:
- **Hold the joint in position.**
- **Check for good condition and positioning of the joint under the motor.**
- **Make sure that no impurities enter the joint JCS casing.**

Figure 7.4

- Untighten the M6 screw of bushing **(6)**.
- Remove gear wheel **(7)** from motor **(5)**.

On the new motor:

- Install the gear wheel **(7)** and bushing **(6)** assembly on motor **(5)**. Dimension (A) is 23 mm ± 0.1 mm.
- Tighten the M6 screw of bushing **(6)** to 16.7 Nm ± 1.2 Nm.
- Install motor M3 on joint 3 casing.

CAUTION:
- **Do not damage the joint under the motor.**
- **Correctly position motor M3 on the locating stud.**
- **Keep the joint frames aligned to within 1/2 of a tooth.**

- Install the 4 M5 screws **(1)** attaching motor M3, do not tighten down.
- Connect connectors **(2)** to motor M3.

- Perform the motor play adjustment procedure.
- Tighten the 4 M5 screws **(1)** attaching motor M3 to 9.5 Nm ± 0.7 Nm.
- Replace the joint on the cover **(3)**.See chapter 6.6.
- Install elbow cover **(3)**.
- Tighten the 4 M5 screws **(4)** attaching the cover **(3)** to 5.7 Nm ± 0.4 Nm.

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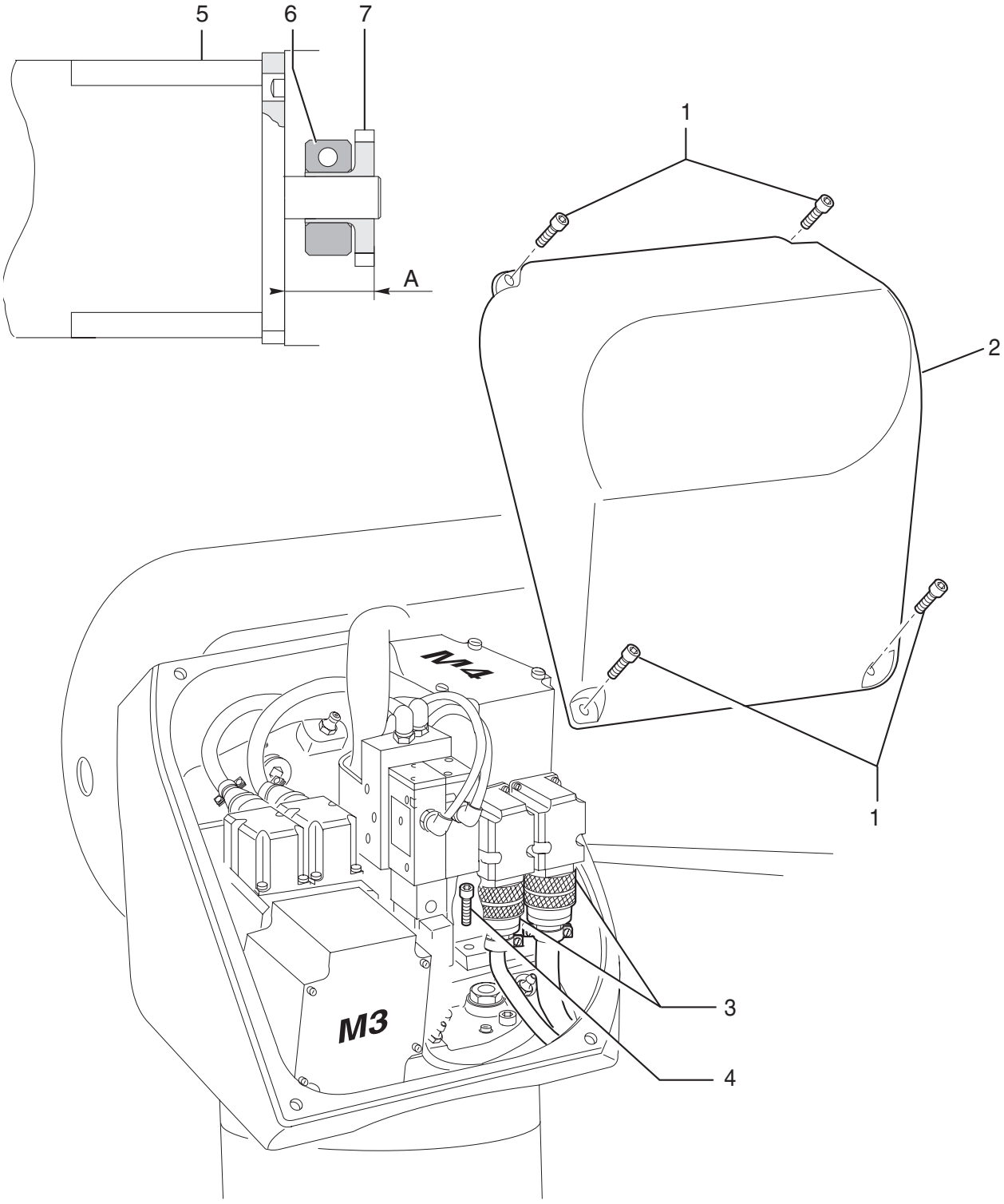


Figure 7.5

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7.2.4. JOINT 4 **(figure 7.5)**

DANGER:
Follow the safety rules! See chapter 1.3.

- Configure the robot arm:
  - Arm horizontal (joint 2),
  - Forearm vertical, wrist downwards,
  - Joint 4 frames aligned.
- Unscrew the 4 M5 screws **(1)** attaching cover **(2)**.
- Remove elbow cover **(2)**.
- Disconnect connectors **(3)** from motor M4.
- Unscrew the 4 M5 screws **(4)** attaching motor M4.
- Remove motor M4.

CAUTION:
- **Hold the joint in position.**
- **Check for good condition and positioning of the joint under the motor.**
- **Make sure that no impurities enter the joint JCS casing.**

Figure 7.5

- Untighten the M6 screw of bushing **(6)**.
- Remove gear wheel **(7)** from motor **(5)**.

On the new motor:

- Install the gear wheel **(7)** and bushing **(6)** assembly on motor **(5)**.
  Dimension (A) is 23 mm ± 0.1 mm.
- Tighten the M6 screw of bushing **(6)** to 16.7 Nm ± 1.2 Nm.
- Install motor M4 on joint 4 casing.

CAUTION:
- **Do not damage the joint under the motor.**
- **Correctly position motor M4 on the locating stud.**
- **Keep the joint frames aligned to within 1/2 of a tooth.**

- Install the 4 M5 screws **(4)** attaching motor M4, do not tighten down.
- Connect connectors **(3)** to motor M4.

- Perform the motor play adjustment procedure.
- Tighten the 4 M5 screws **(4)** attaching motor M4 to 9.5 Nm ± 0.7 Nm.
- Replace the joint on the cover **(2)**.See chapter 6.6.
- Install elbow cover **(2)**.
- Tighten the 4 M5 screws **(1)** attaching the cover **(2)** to 5.7 Nm ± 0.4 Nm.

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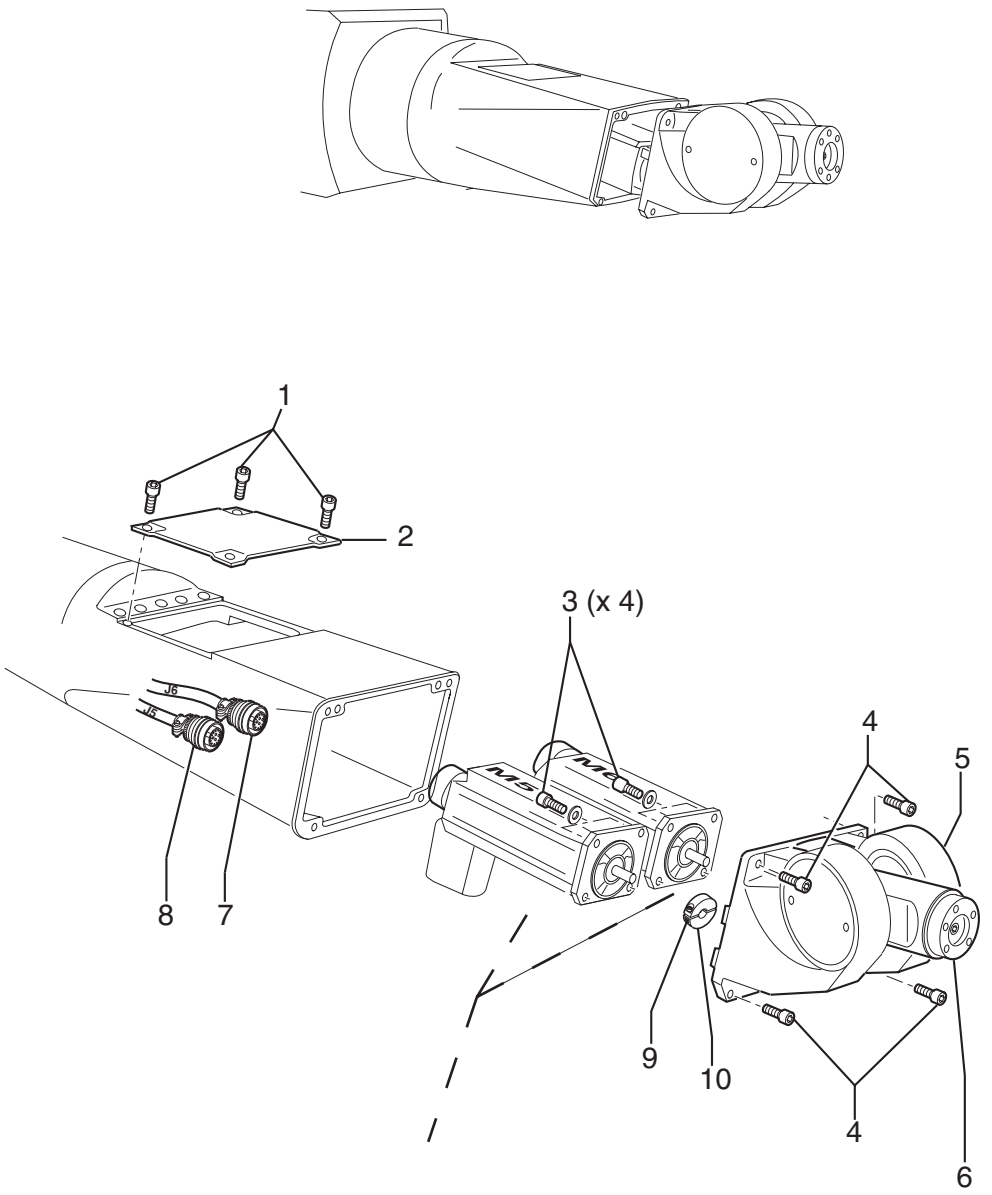


Figure 7.6

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7.2.5. JOINTS 5 AND 6 **(figure 7.6)**

DANGER:
Follow the safety rules! See chapter 1.3.

- Remove the end-effector installed on mechanical interface **(6)** of wrist **(5)**.
- Unscrew the 4 M5 screws **(1)** attaching cover **(2)**.
- Disconnect connectors **(7)** and **(8)** from motors M6/M5.
- Unscrew the 4 M5 screws **(4)** attaching wrist **(5)**.
- Remove the wrist/motor assembly according to procedure shown on **figure 7.6**.

Replacement of a motor

  - Unscrew the 4 M4 screws **(3)** attaching the motor.
  - Untighten the M5 screw **(9)** of bushing **(10)**.
  - Install the new motor.
  - Tighten the 4 M4 screws **(3)** attaching the motor to 4.8 Nm ± 0.30 Nm.
  - Tighten the M5 screw **(9)** of bushing **(10)** to 9.5 Nm ± 0.7 Nm.
- Reinstall the wrist/motor assembly working back through procedure shown on **figure 7.6**.
- Tighten the 4 M5 screws **(4)** attaching the wrist to 5.7 Nm ± 0.4 Nm.
- Install connectors **(7)** and **(8)** on motors M6 and M5.

CAUTION:
Check that connector frames correspond to motors.

- Replace the joint on the cover **(2)**.See chapter 6.6.
- Install cover **(2)**.
- Tighten the 4 M5 screws **(1)** to 5.7 Nm ± 0.4 Nm.

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CHAPTER 8

PREVENTIVE MAINTENANCE

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To keep the performance of the arm at an optimal level the arm requires preventive maintenance.

The maintenance operations must be carried out by persons who have followed the appropriate course given by STÄUBLI.

> **CAUTION:**
> **To ensure a correct seal, the joint must be replaced each time a cover is removed (see chapter 6.6).**

8.1. MAINTENANCE FREQUENCY

Every year:

- Check the general condition of the arm.
- Check oil levels for axis 1 to 6 (see chapter **8.2**).
- Check the condition of the harness (visible parts).
- Grease the balance system eccentric bearings (see chapter **8.3**).

After 20 000 hours:

- Change the oil* in joints 5 and 6 (see chapter **6**).

> **CAUTION:**
> **Consult STÄUBLI to define a preventive maintenance programme adapted to the use you make of the arm.**

After 40 000 hours:

- Change the oil* in all the joints.

> **CAUTION:**
> **Consult STÄUBLI to define a preventive maintenance programme adapted to the use you make of the arm.**

* Recommended oil: see spare parts

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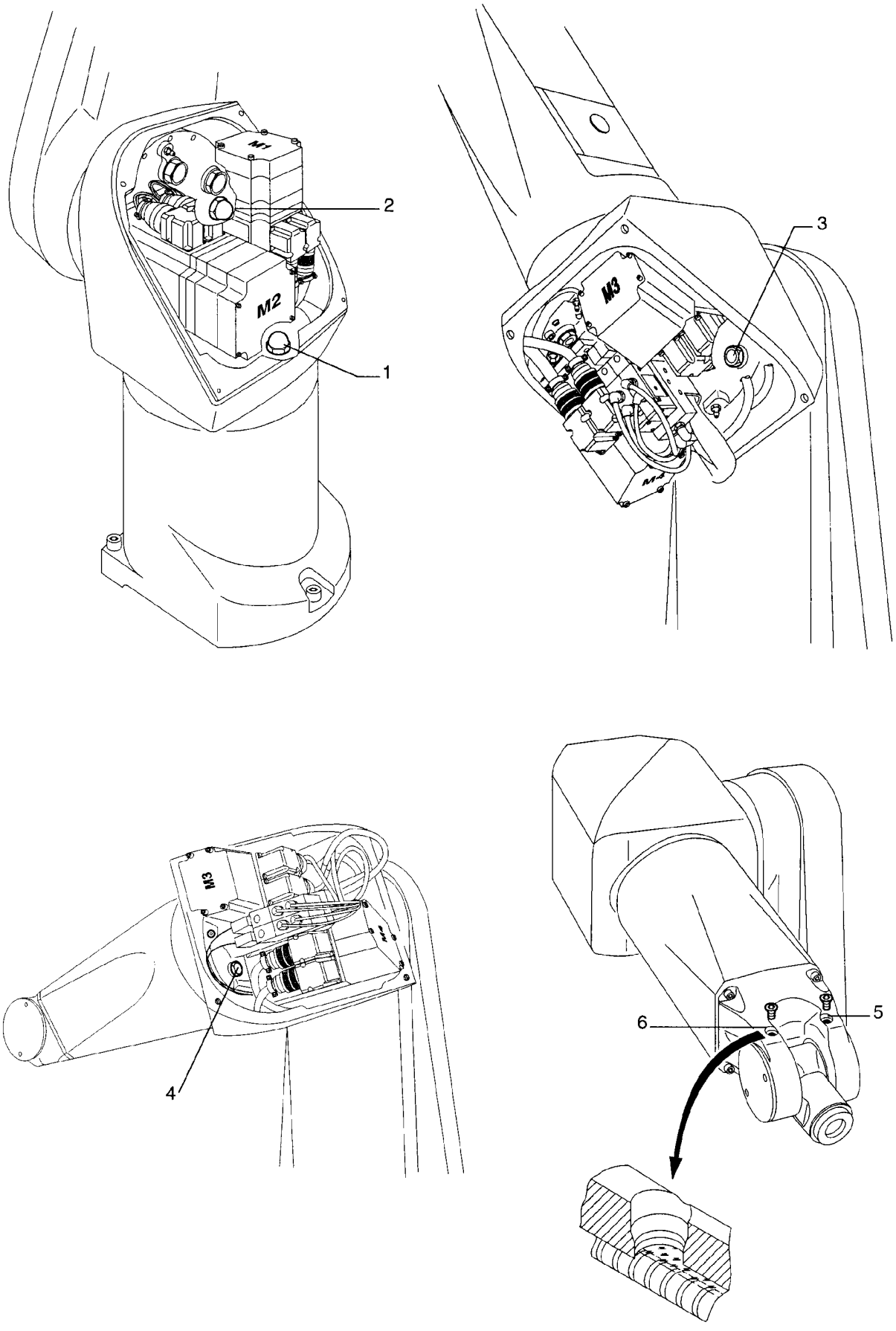


Figure 8.1

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8.2. CHECKING OIL LEVELS

8.2.1. ARM IN FLOOR-MOUNTED POSITION **(figure 8.1)**

8.2.1.1. ARTICULATION POSITIONS FOR LEVEL CHECKS

	POSITION						
Check	Joint 1	Joint 2		Joint 3		Joint 4	Joints 5/6
		CS7	CS8	CS7	CS8		
Joint 1	0°	-90°	0°	+90°	0°	0°	0°
Joint 2							
Joint 3				+50°	-40°		
Joint 4				-10°	-100°		
Joints 5/6				+195°	+105°		

8.2.1.2. LEVELS TO BE OBSERVED

With the robot in position specified above, the oil levels to be observed are as follows:
- Joint 1: Oil level flush with lower edge of toothed wheel visible via indicator **(1)**.
- Joint 2: Oil level in center of indicator **(2)** ± 2 mm.
- Joints 3 and 4: Oil level with the bottom of the Ø 5.5 hole after removing the plugs **(3)** and **(4)**.
- Joints 5 and 6: The oil level must touch the thread root of the worm screws (plugs removed) **(5)** and **(6)**.

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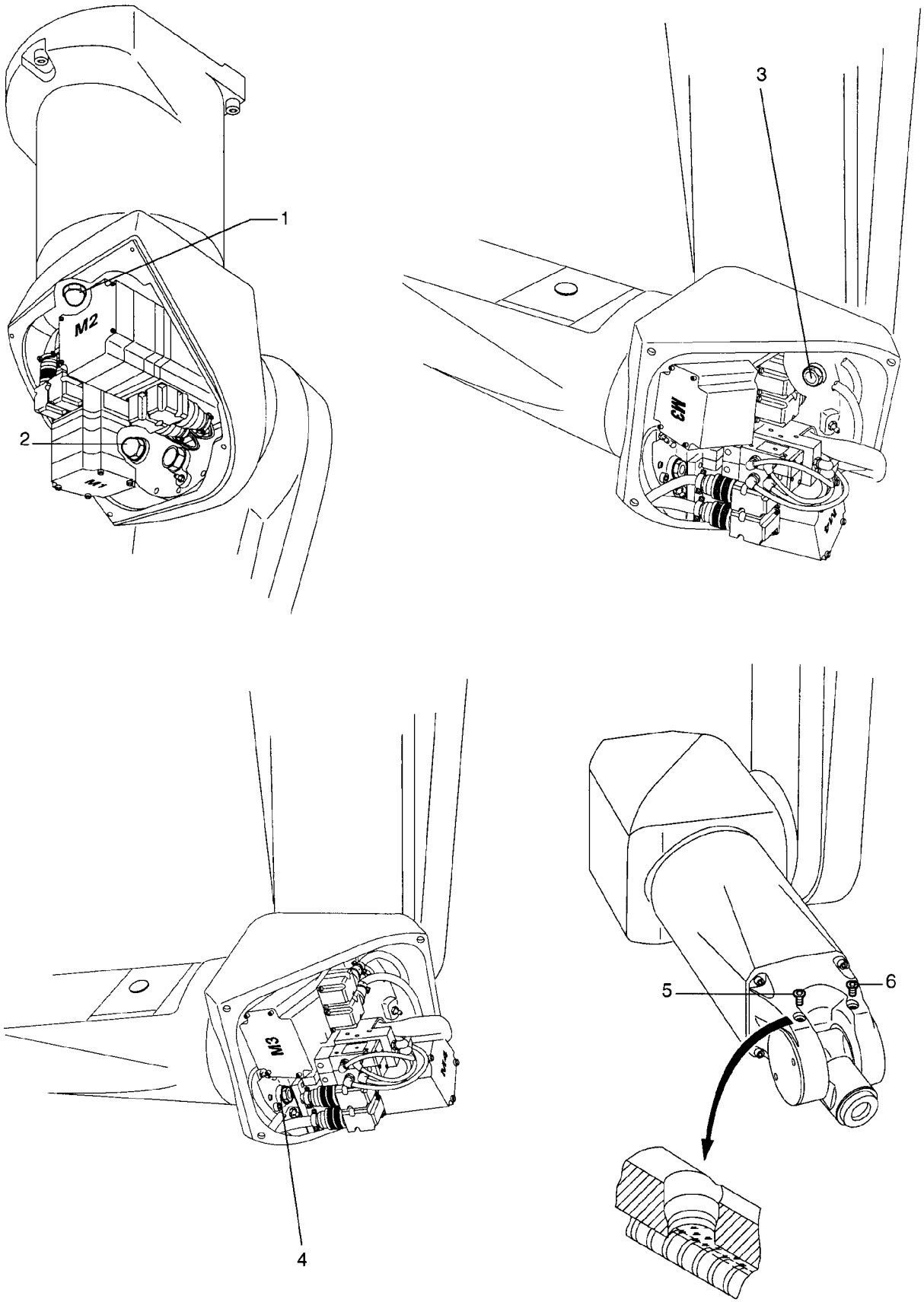


Figure 8.2

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8.2.2. ARM IN CEILING-MOUNTED POSITION **(figure 8.2)**

8.2.2.1. ARTICULATION POSITIONS FOR LEVEL CHECKS

	POSITION						
Check	Joint 1	Joint 2		Joint 3		Joint 4	Joints 5/6
		CS7	CS8	CS7	CS8		
Joint 1	0°	-90°	0°	+90°	0°	0°	0°
Joint 2							
Joint 3				+230°	+140°		
Joint 4				+170°	+80°		
Joints 5/6				+15°	-75°		

8.2.2.2. LEVELS TO BE OBSERVED

With the robot in position specified above, the oil levels to be observed are as follows:

- Joint 1: The indicator is filled with oil **(1)**.
- Joint 2: Oil level in center of indicator **(2)** ± 2 mm.
- Joints 3 and 4: Oil level with the bottom of the Ø 5.5 hole after removing the plugs **(3)** and **(4)**.
- Joints 5 and 6: The oil level must touch the thread root of the worm screws (plugs removed) **(5)** and **(6)**.

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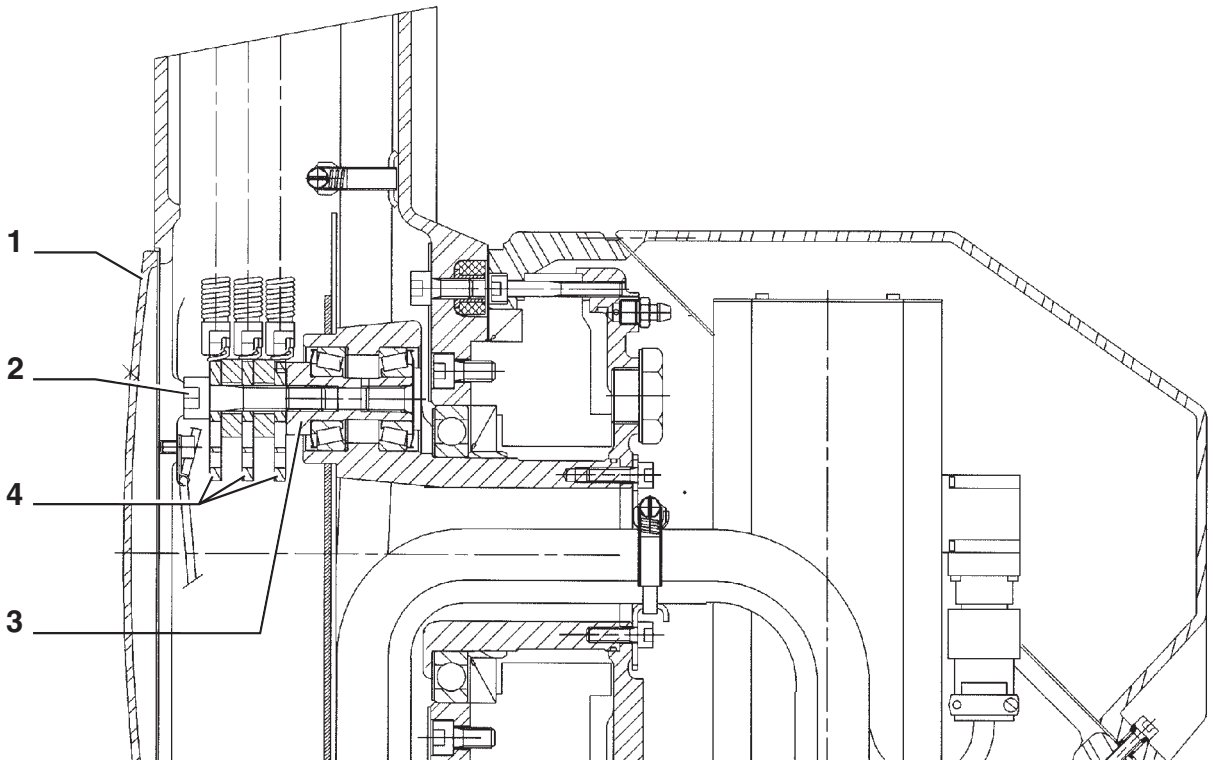


Figure 8.3

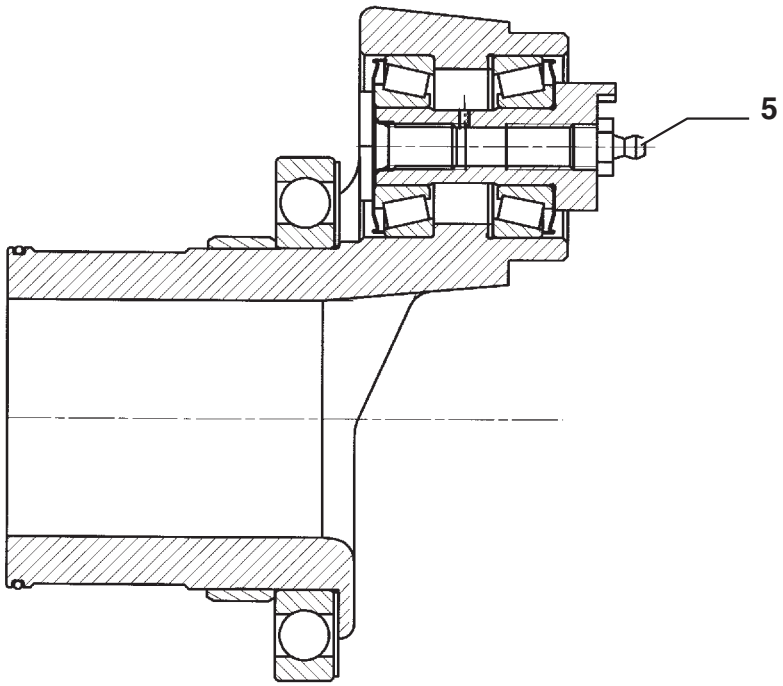


Figure 8.4

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8.3. GREASING OF THE BALANCE SYSTEM ECCENTRIC BEARINGS

DANGER:
Follow the safety rules! See chapter 1.3.
Use the kit (wedges + tools) dedicated to the spring tension.

Procedure (Procedure applicable both to floor-mounted arms and ceiling-mounted arms):

- Release the springs *(see* Ⓜ *next page).*
- See figures **8.3** and **8.4**.
    - Remove the cover **(1)**.
    - Wedge set of springs **(4)** to prevent rotation.
    - Unscrew the M10 screw **(2)** .
    - Remove the M10 screw and the washers from the set of springs **(4)**.
    - Move the set of springs **(4)** toward joint 3 to free the eccentric axle **(3)**.
    - **If the arm is attached to the ground**, place the beam (item **5** fig. **8.9**) on the 2 pins (item **7** - fig. **8.9**).
    - Screw the M10 grease nipple **(5)** onto the eccentric axle.
    - Grease with a grease gun (Shell Nerita HD2).
    - Wipe off surplus grease.
    - Remove the grease nipple **(5)**.
    - Remove the 2 pins (item **7** - fig. **8.9**) in order to release the beam (item **5** fig. **8.9**).
    - Install the set of springs on the joint **(3)** with the M10 screw **(2)** and the washers.

CAUTION:
Place joint stud in spring fastener groove.

- Wedge set of springs **(4)**.
- **Mandatory:** Torque M10 **(2)** screws ⇒ C = 77 Nm.
- Remove the shims.
- Tension springs *(see* Ⓜ *next page).*
- Attach the cover **(1)**.

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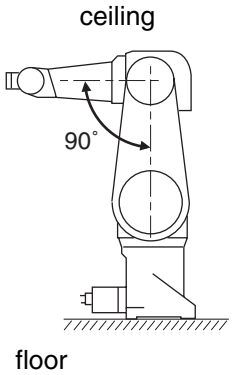


Figure 8.5

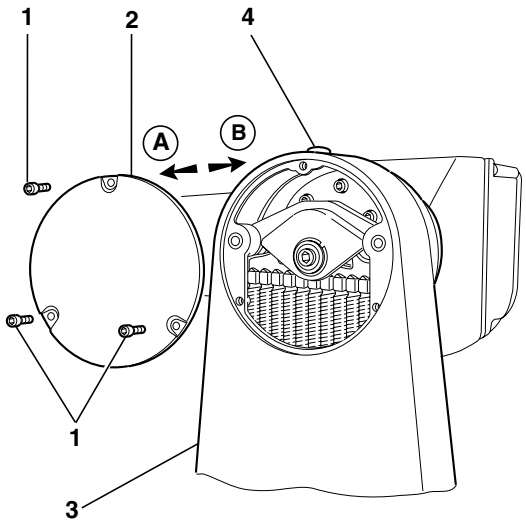


Figure 8.6

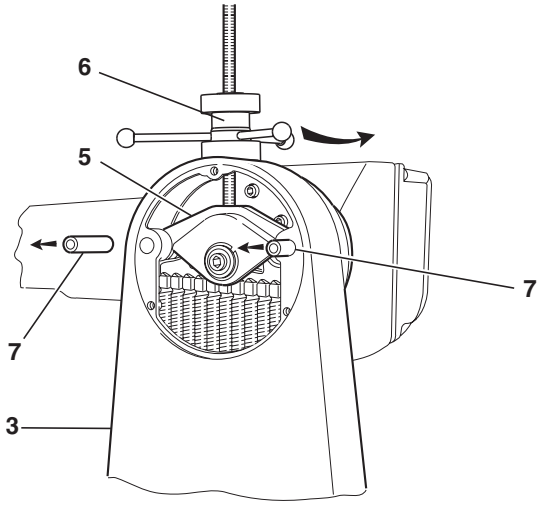


Figure 8.7

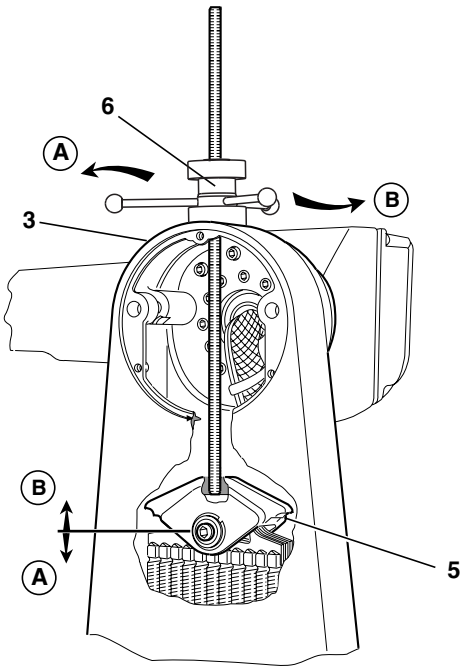


Figure 8.8

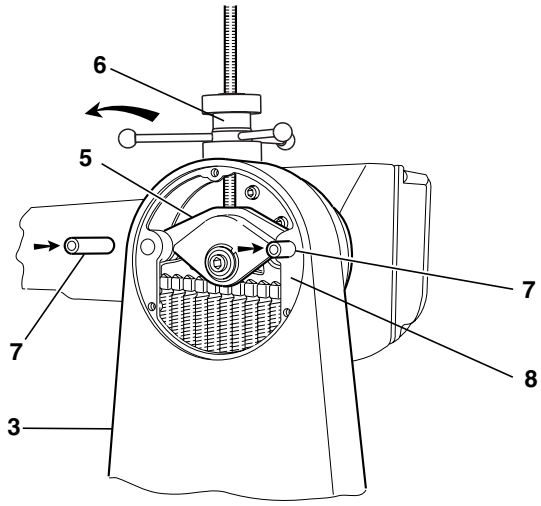


Figure 8.9

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Ⓜ **Release the springs:**

> **CAUTION:**
> **The angle between the arm and the forearm must be 90° (see figure 8.5).**

Figure 8.6

- Unscrew the 3 screws **(1)**.
- Remove cover **(2)** from arm **(3)**.
- Remove plug **(4)** from arm **(3)**.

Figure 8.7

- Insert the tool threaded rod **(6)** into arm **(3)** (polyamide washer in contact with arm).
- Screw and fasten the end of threaded rod **(6)** into beam **(5)**.
- Tighten the tool lever nut **(6)** until the pin holes **(7)** be free.
- Remove the 2 pins **(7)** from arm **(3)**.

Figure 8.8

Unscrew the tool lever nut **(6)** until the tension of springs be completely free.

Ⓜ **Set springs:**

> **CAUTION:**
> **The angle between the arm and the forearm must be 90° (see figure 8.5).**

Figure 8.8

- If the tool threaded rod **(6)** is not fixed to the beam **(5)**:
  - Insert the tool threaded rod **(6)** into arm **(3)** (polyamide washer in contact with arm).
  - Screw and fasten the end of threaded rod **(6)** into beam **(5)**.
- Tighten the **(6)** tool lever nut until the **(5)** beam pin bearing surfaces protrude beyond the **(3)** arm holes by 1 mm.

Figure 8.9

- When beam **(5)** is in position, insert the 2 pins **(7)** in arm **(3)** (pin threads on outside). The pins must be inside face **(8)** of arm **(3)**.
- Unscrew the tool lever nut **(6)** so that beam **(5)** bears on pins **(7)**.
- Disunite the tool threaded end **(6)** from the beam **(5)**.
- Remove tool **(6)** from the arm **(3)**.

Figure 8.6

- Install cover **(2)** on arm **(3)**.
- Tighten the 3 screws **(1)**.
- Install plug **(4)** in arm **(3)**.

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CHAPTER 9

RECOMMENDED SPARE PARTS

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- Mobil SHC 634 oil* (for wrist)
- Mobil SHC 639 oil* (for wrist) (Consult STÄUBLI)
- Mobil SHC 626 oil*
- Solenoid valve
- Pneumatic harness
- Motor of axis 1, 2, 3, 4, 5 and 6
- O-ring for motors of axis1, 2, 3 and 4
- Electrical harness
- Brake selection board
- Cover seal kit

* Maximum oil quantity

SHC 634 :	Wrist	180 cm^3
SHC 639 :	Wrist	180 cm^3
SHC 626 :	Axis 1, 2, 3, 4	610 cm^3

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