



Operation and Maintenance Manual

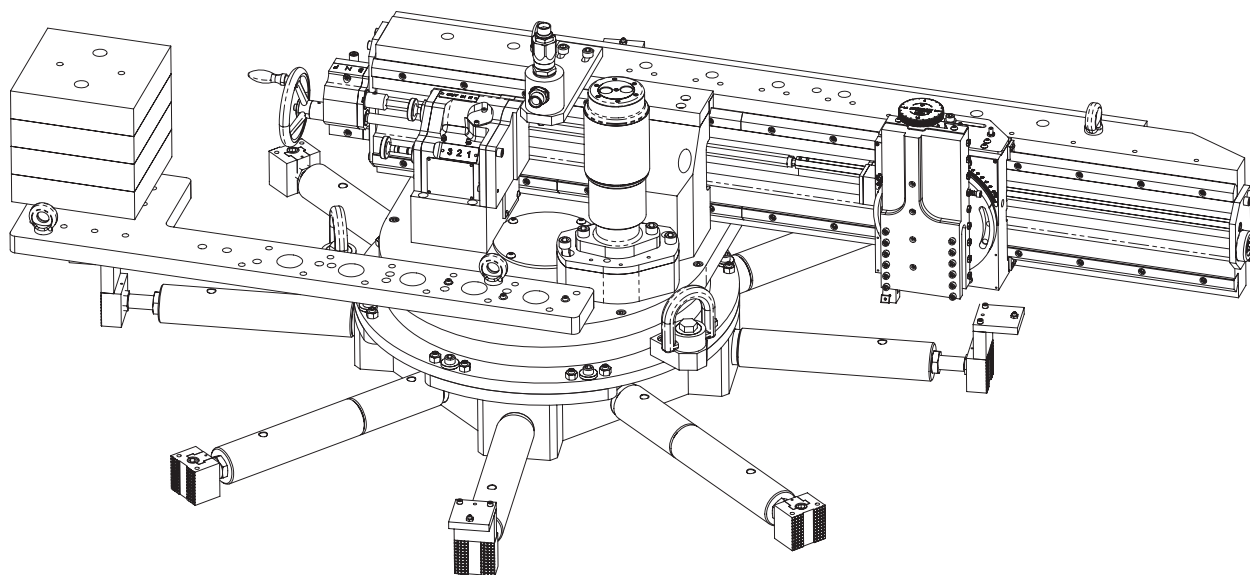
Enerpac MM2000i/ MM2000i-H **Flange Facing Machine (24-80" Internal Flange Facing Machine)**

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To reduce the risk of injury, user must read and understand this document before use.

ABOUT US

Enerpac is a global market leader in high pressure hydraulic tools, controlled force products, portable machining, on-site services and solutions for precise positioning of heavy loads. As a leading innovator with a 110-year legacy, Enerpac has helped move and maintain some of the largest structures on earth. When safety and precision matters, elite professionals in industries such as aerospace, infrastructure, manufacturing, mining, oil & gas and power generation rely on Enerpac for quality tools, services and solutions. For additional information, visit www.enerpac.com.



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WARRANTY

Refer to the Enerpac Global Warranty document for terms and conditions of the product warranty. Such warranty information can be found at www.enerpac.com.

NAMEPLATE

MIRAGE AN ENERPAC BRAND	MACHINE TYPE:	
MIRAGE MACHINES LTD	SERIAL NUMBER:	
8-10 ENTERPRISE WAY	YEAR OF MANUFACTURE:	
JUBILEE PARKWAY	SUPPLY:	
DERBY DE21 4BB	MAX SWP:	
UNITED KINGDOM	WEIGHT:	
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CE		

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1. Safety

Read all instructions carefully. Follow all recommended safety precautions to avoid personal injury as well as damage to the product and / or damage to other property. Enerpac cannot be responsible for any damage or injury from unsafe use, lack of maintenance, or incorrect operation. Do not remove warning labels, tags, or decals. In the event that any questions or concerns arise, contact Enerpac or a local Enerpac distributor for clarification.

Save these instructions for future use.

If you have never been trained on high-pressure hydraulic safety, consult your distributor or service center for information about Enerpac Hydraulic Safety Courses.

This manual follows a system of safety alert symbols, signals, words, and safety messages to warn the user of specific hazards. Failure to comply with these warnings could result in death or serious personal injury, as well as damage to the equipment or other property.



The Safety Alert Symbol appears throughout this manual. It is used to alert you to potential physical injury hazards. Pay close attention to Safety Alert Symbols and obey all safety messages that follow this symbol to avoid the possibility of death or serious injury.

Safety Alert Symbols are used in conjunction with certain Signal Words that call attention to safety messages or property damage messages and designate a degree or level of hazard seriousness. The Signal Words used in this manual are DANGER, WARNING, CAUTION, and NOTICE.

⚠ DANGER Indicates a hazardous situation that, if not avoided, will result in death or serious personal injury.

⚠ WARNING Indicates a hazardous situation that, if not avoided, could result in death or serious personal injury.

⚠ CAUTION Indicates a hazardous situation that, if not avoided, could result in minor or moderate personal injury.

NOTICE Indicates information considered important, but not hazard related (e.g. messages related to property damage). Please note that the Safety Alert Symbol will not be used with the signal word.

1.1 Safety Precautions

The manufacturer has made every effort to ensure that the information given in this Operation & Maintenance manual, and other publications relating to this machine is correct and understandable. However, it is acknowledged that there may be errors or omissions in this publication.

The company also reserves the right not to provide updates, corrections or amendments to this publication but will keep customers up to date with all changes that may affect the machine operation. Any updates which affect the safe use of the machine shall be communicated to the customer in a prompt and appropriate manner.

Mandatory Safety Signs

ISO 7010 SYMBOL	SAFETY DESCRIPTION
	EYE PROTECTION MUST BE WORN
	EAR PROTECTION MUST BE WORN
	HARD HATS MUST BE WORN
	PROTECTIVE GLOVES MUST BE WORN
	PROTECTIVE FOOTWEAR MUST BE WORN
	OVERALL MUST BE WORN
	MACHINE GUARDS MUST BE USED

1.1.1 Handling

Customers, users and operators of the machines must be aware of the nature of the equipment supplied.

Although inherently robust, the machine is a precision tool and may be damaged by poor handling, tipping and falling, inadequate transport arrangements over e.g. rough terrain, misuse by operators and use outside its design specification.

Such poor handling may result in either broken or damaged parts or disturbance to fine settings resulting in an inability to meet the specified machining tolerances and capabilities.

1.2 Safety Procedures

Detailed in this section is a list of good Health and Safety practices that the manufacturer advise users to adhere to. Due to the nature of portable machine tools, not every eventuality can be catered for and the following is not exhaustive, as such the manufacturer strongly advise that the user carries out their own risk assessments based on the machining and environment in which they intend to use the machinery.

Machine Hazards /signs

ISO 7010 SYMBOL	HAZARD DESCRIPTION
	DANGER HIGH VOLTAGE
	WARNING MOVING MACHINERY
	CAUTION MOVING MACHINERY
	WARNING KEEP HANDS CLEAR

1.2.1 Pre-Operational Safety Checks

1. Always read safety signs / labels.
2. Ensure no slip / trip hazards are present in workspaces and walkways.
3. Locate and ensure you are familiar with the operation of the ON / OFF starter and E-Stop (if fitted). Do not leave equipment on top of the machine.
4. Do not leave equipment on top of the machine
5. Ensure each tool is in good condition and securely mounted.
6. Secure / Remove loose items.
7. Faulty equipment must not be used.
Immediately report any suspect machinery.

1.2.2 Operational Safety Checks

1. Operator is fully conversant and trained in use of equipment.
2. Keep clear of moving machine parts.
3. Never leave the machine running unattended.
4. Follow correct clamping procedures - keep overhangs as small as possible and check work piece is secure.
5. Set the correct speed to suit the tool, the depth of cut and the material.
6. Before making adjustments and measurements or before cleaning swarf accumulations switch off and bring the machine to a complete standstill.

1.2.3 Housekeeping

1. Switch off the machine.
2. Remove milling cutters, drill attachments and tap attachments and store them safely (if applicable).
3. Leave the machine and work area in a safe, clean and tidy state.

1.2.4 Noise Emissions

1. If this machine is driven by hydraulic motors, then airborne noise emissions of the machine will not exceed 70 db (A). For the hydraulic power pack noise emissions please refer to the hydraulic power pack manual.
2. If this machine is driven by pneumatic (air) motors, then airborne noise emissions of the machine will exceed 70 db (A). **The ear protection must be worn!** The exact value can be found in the 'Pre-Use Functional Checklist' which is included in the document pack.

1.2.5 Potential Hazards



1. Sharp cutters. Use protective gloves when handling cutters.
2. Moving components – hair / clothing entanglement. Keep clear of hazard zone when the machine is in operation. See section 1.3.
3. Skin irritation. Overalls and gloves should be worn stop direct contact with swarf and lubricants.
4. Metal splinters and burrs. Wear gloves when handling the machine or any sharp object. Swarf should be removed with pliers as well as protective gloves.
5. Flying debris. Keep clear of hazard zone when the machine is in operation. Eye protection should be worn to prevent eye injuries.
6. Fumes. Continuous cutting of metal can create fumes, therefore the machine must be used in a well ventilated area.
7. Extreme Temperatures:
Heat. The cutting tool and its surrounding areas will become hot after continuous use. Gloves should be worn when handling these components.

Frost. The pneumatic motor can become cold when used extensively. Gloves should be used when handling this component.



Figure 1: Motor showing safety labels

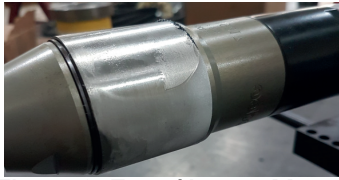


Figure 2: Frost/ ice on Motor

8. Fire or explosion. Machining aluminium, titanium, magnesium, graphite, or alkali metals can result in fire, explosion or noxious dust. If unsure, consult the manufacturer for guidance.
9. Trip hazards from hoses or other equipment at low level.
10. Hearing Loss. Use appropriate ear protection when in the vicinity of the machine in operation.

1.2.6 Foreseeable misuse

- Machining in other environments (temperature, materials, workpiece size) than what is specified in machine specification can cause damage to the machine and cause the injury.
- Do not use any other base leg extension combinations, other than what is specified in the base assembly drawings. Not enough thread engagement will have a severe effect on the stability of the machine and can cause damage to the machine and cause the injury.
- Do not use machine on poor quality and unstable workpiece (flange). The machine is clamped to the workpiece, so the workpiece structure provides the foundation and stability for the machine. If not adhered to, then this will have a severe effect on the stability of the machine and can cause damage to the machine and cause the injury.

1.2.7 Machine safety features

Pressure Regulator (Pneumatic)

The air lubrication unit comes with a pressure regulator. This limits the air pressure to 7Bar to ensure the air supply into the machine will not cause damage to the machine and its surrounding area.

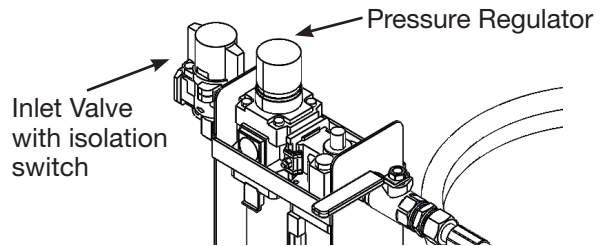


Figure 3: Air Lubrication Unit

Isolation Switch (Pneumatic)

The air lubrication unit also comes with an inlet valve with a lockable isolation switch.

The inlet valve has an indicator window to show its status;

SUP : Supply

EXH : Exhaust

To change the status of the valve, push down the handle then turn 90 degrees. Use the holes in the handle to lock the handle in position.

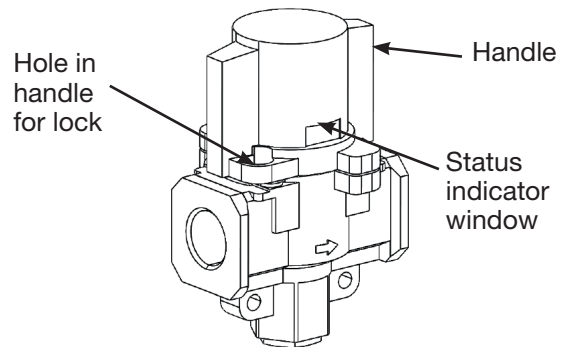


Figure 4: Inlet valve

Hold-to-Run Device (Pneumatic)

The machine is operated using a hold-to-run device which shall be located at a minimum of 2m away from the danger zone.

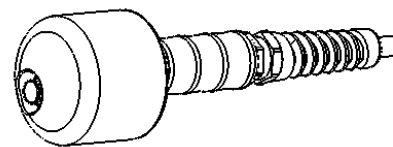


Figure 5: Hold-to-run control

Hold-to-Run Device (Hydraulic)

The hydraulic power units to be used with this machine should be supplied with a hand held control device (pendant) which shall be located at a minimum of 2m away from the danger zone.

1.3 Machine Hazard Zone

⚠ DANGER

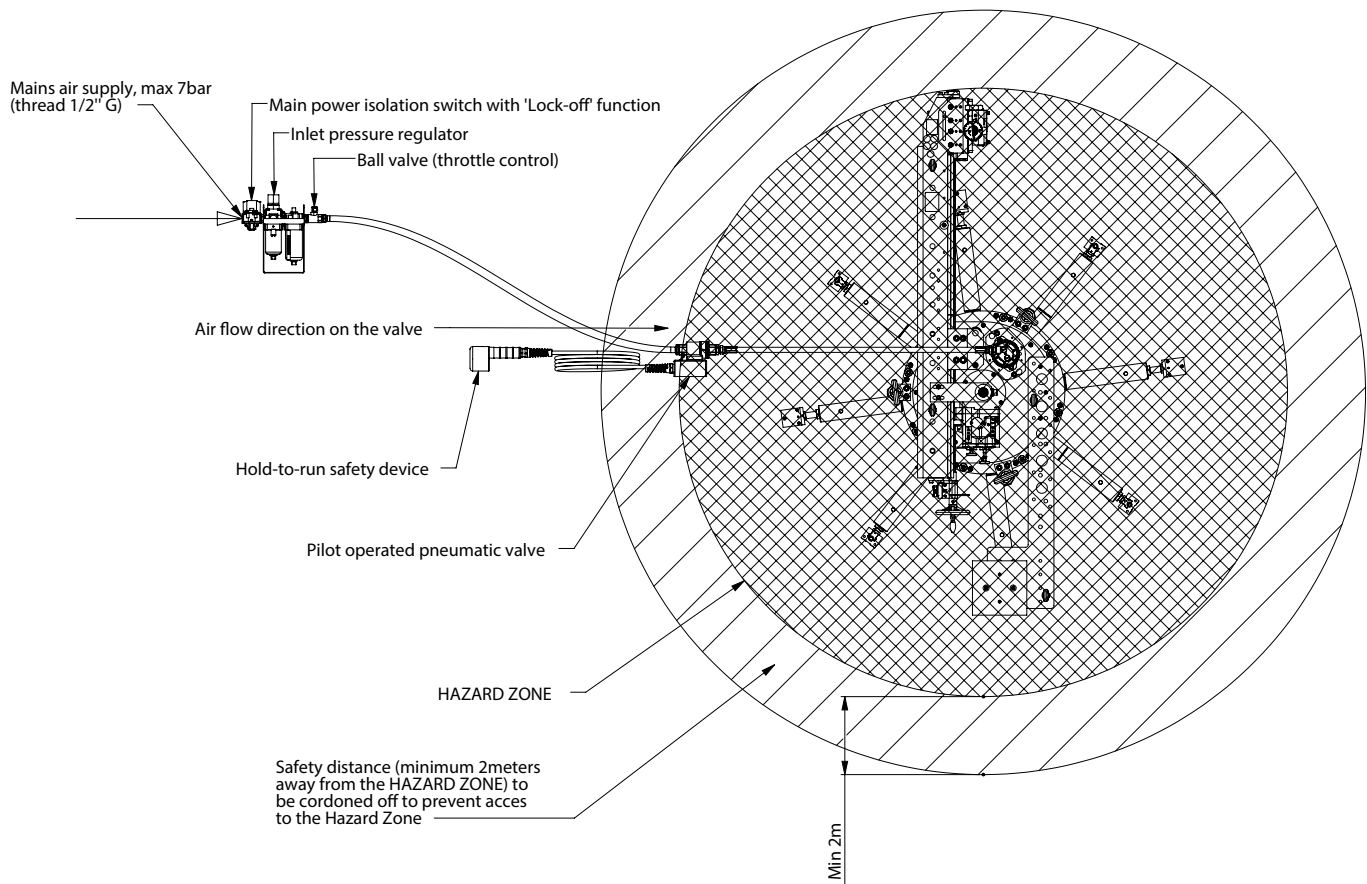


Figure 6: Supplied system layout drawing showing hazard area to be cordoned off

⚠ DANGER

The machine mains air valve must be switched off and locked off whilst performing the below tasks:

1. Setting up the machine into the work-piece.
2. Performing any maintenance, if necessary, before cut.
3. Cordoning off the area, a minimum 2m away from hazard zone.
4. All of the controls must be placed outside of the cordoned off zone.
5. Before switching the valve on, make sure there are no personnel in cordoned off zone.

After machines mains air valve is switched on:

1. Only the operator is allowed to enter cordoned off zone, if necessary.
2. Ball valve (throttle control) should be nearly closed in order to slowly start up the machine.
3. Operator to be outside of cordoned off zone and operate the machine by using the hold to run device.
4. Whilst the machine is running, no personnel including the operator, is allowed to enter the cordoned off zone under any circumstances.

* The same hazard zone applies for the **hydraulically** powered models. In this case, the controls will be a part of the hydraulic power pack. The controls should be placed outside of the hazard zone. (No Air lubrication kit or hold to run assemblies are supplied for hydraulic models)

1.4 Risk Assessment Checklist

The following checklist should not be taken as a comprehensive list of things to be vigilant for when installing and operating the MM2000i/MM2000i-H flange facing machine. However these checklists are typical of the types of risks the assembler and operator should be considering. Use these checklists as part of your risk assessment.

Figure 7: Risk Assessment Checklist before installation

	<u>Before Installation</u>
☐	I understand how this machine operates and identified the best placement for the controls, cabling, and the operator (having reviewed the manual and section 1 in particular).
☐	I removed or mitigated all identified risks (such as shearing, cutting, crushing, tripping, entanglement, or falling objects).
☐	I considered the need for personnel safety protection and guarding and installed any necessary guards, if supplied.
☐	I read the Machine Assembly instructions and took inventory.
☐	I created a lift plan, for each of the setup lifts required during the setup of the machine.
☐	I located the fall paths involved in lifting. Precautions have been taken to keep workers away from the identified fall path.
☐	I have noted all the warning labels on the machine.
☐	I considered and mitigated any other potential risks specific to the working environment.
☐	I have checked that all of the ram bolts are not damaged or corroded.

Figure 8: Risk Assessment Checklist after installation

	<u>After Installation</u>
☐	I checked that the machine is safely installed and the hazard zone is cordoned off as section 1.3. If the machine is installed at an elevated position, I checked that the machine is safeguarded against falling.
☐	I evaluated and mitigated the potential risks specific to the work environment.
☐	I checked that all affected personnel understand the hazard zone (section 1.3) and are outside of it.
☐	I followed the required Maintenance Intervals with the recommended lubricants in section 8.
☐	I checked that all affected personnel have the required personal protective equipment, as well as any site-required or regulatory equipment.
☐	I identified all possible pinch points, such as those caused by rotating parts, and informed the affected personnel, noting that no other personnel are allowed in the hazard zone unless the machine is isolated and locked off.
☐	I planned the safe guarding of any chips or swarf produced by the machining process.
☐	I considered that the tool tip cutter will be sharp and have planned adequate protection for handling.

2. Compliance Statement

2.1 EU Declaration of Conformity



Enerpac declares that this product fulfils all the relevant provisions of the directives and standards written on the declaration of conformity.

A copy of the EU and UK declaration of conformity is enclosed with each shipment of this product.

3. Features & Components

3.1 MM2000i Feature Diagram (Pneumatic)

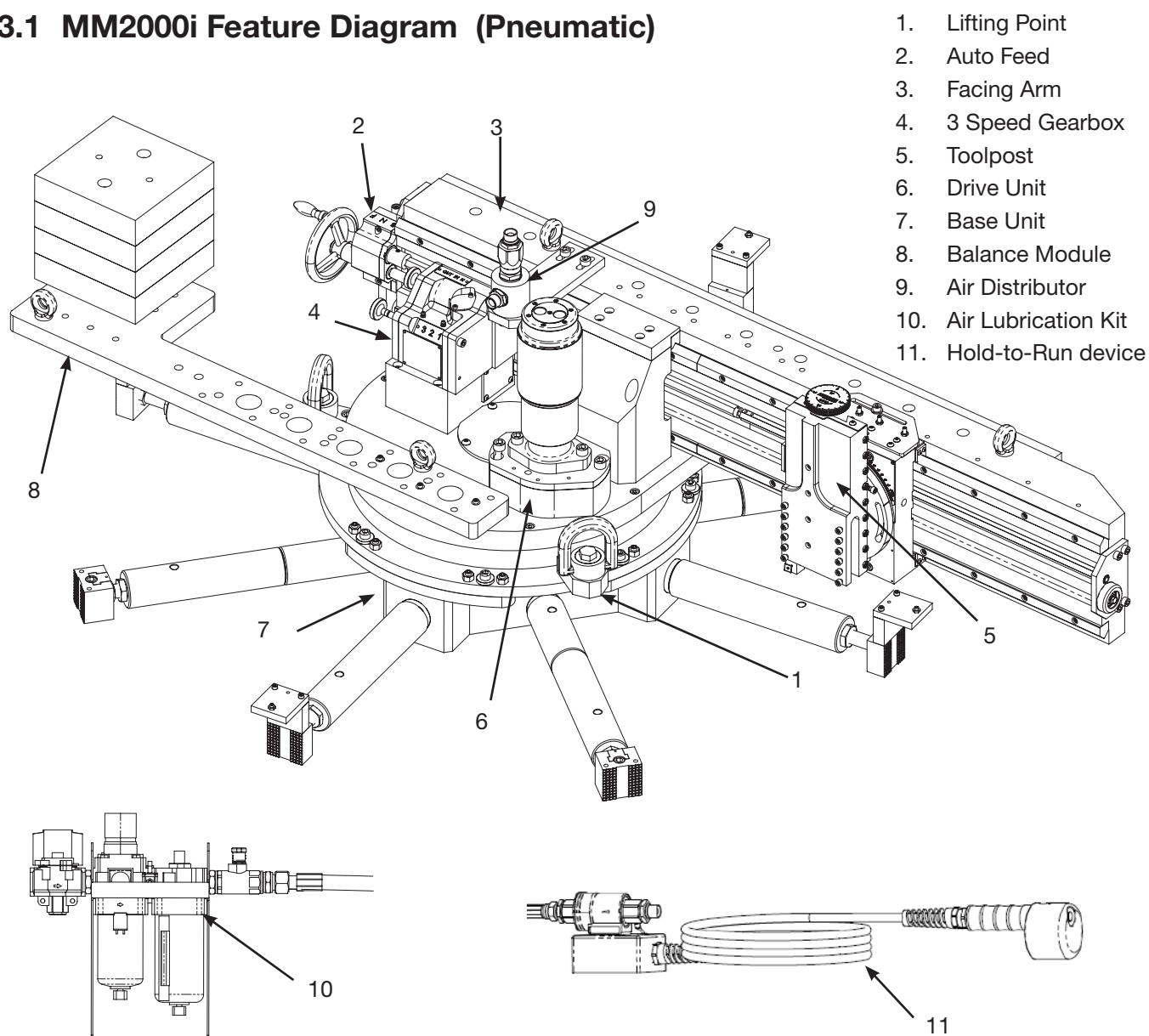


Figure 7: Major Features and Components of MM2000i - Flange Facing Machine (Pneumatic)

3.2 MM2000i-H Feature Diagram (Hydraulic)

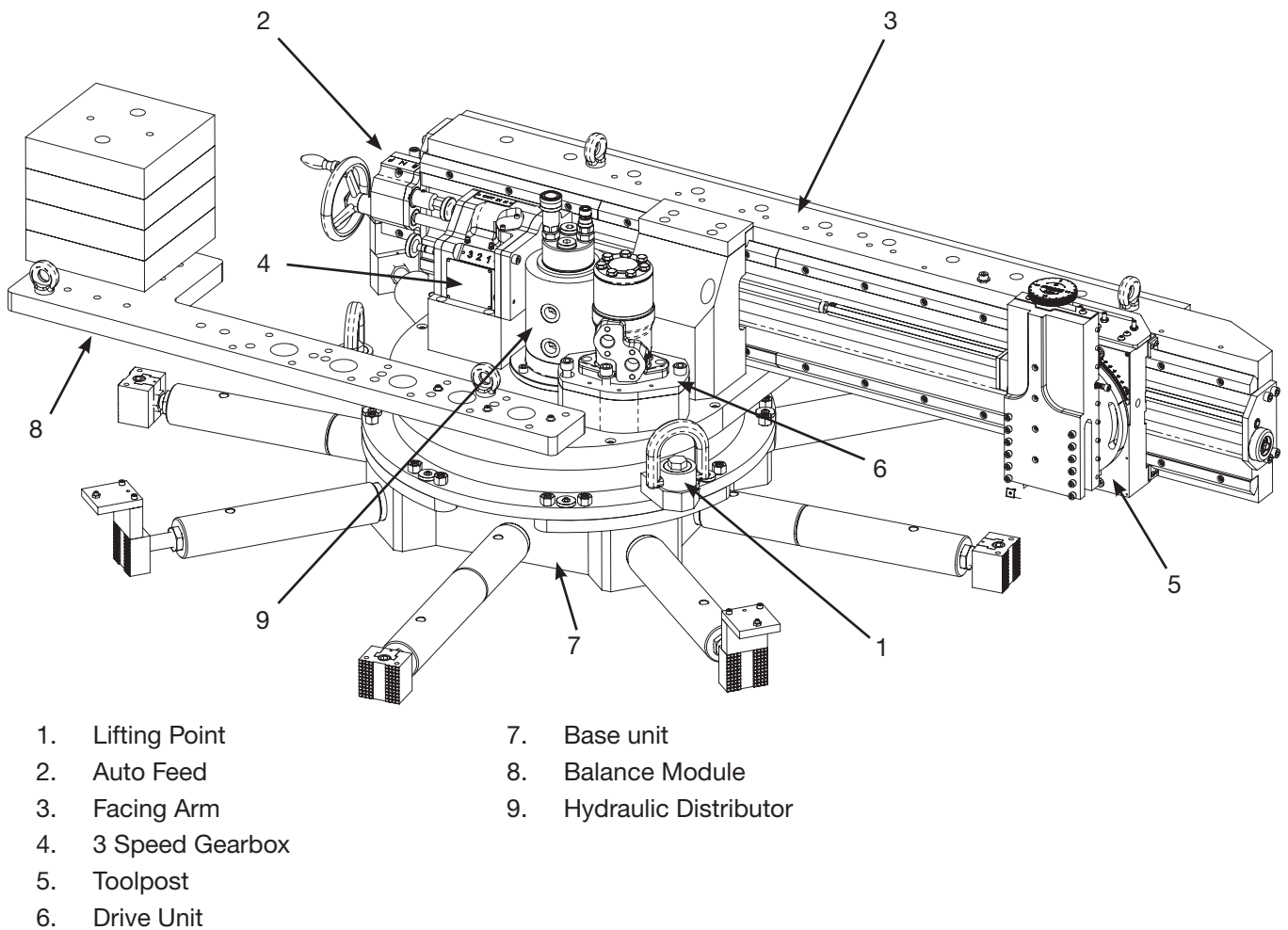


Figure 8: Major Features and Components of MM2000i - Flange Facing Machine (Hydraulic)

3.3 Machine Description

This machine has been designed for performing facing operations on flanges. It can be used for seal groove machining. The machine is manually fixed and levelled to the flange using the clamping Jaws. The machine motor rotates the toolpost assembly around the flange and by using fixed gears will produce continuous feed across the flange surface for groove gramophone finishes to ASME Standard.

3.4 Personnel

As a specialist portable machine the minimum standard for an operator is to be:

- The operator must be trained and conversant with the MM2000i / MM2000i-H.
- The operator to be able to identify the correct and incorrect use of static or portable machines.
- Comply with all local and internationally recognised safe use of powered machines.

4. Technical Product Data

4.1 MM2000i Dimensional Art

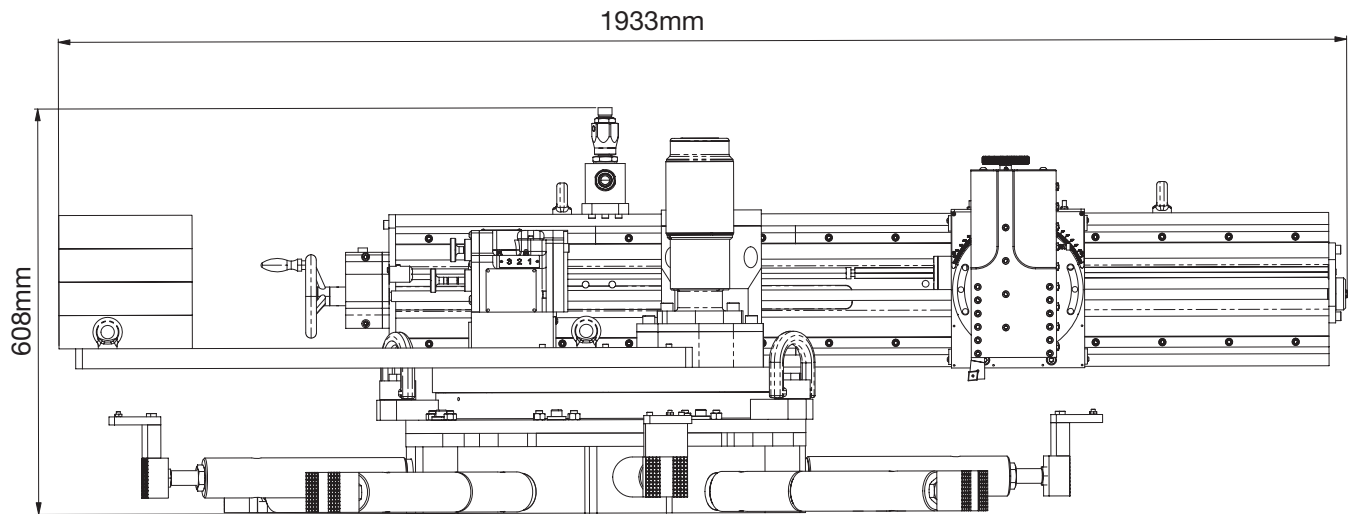


Figure 9: MM2000i-P-M Dimensions

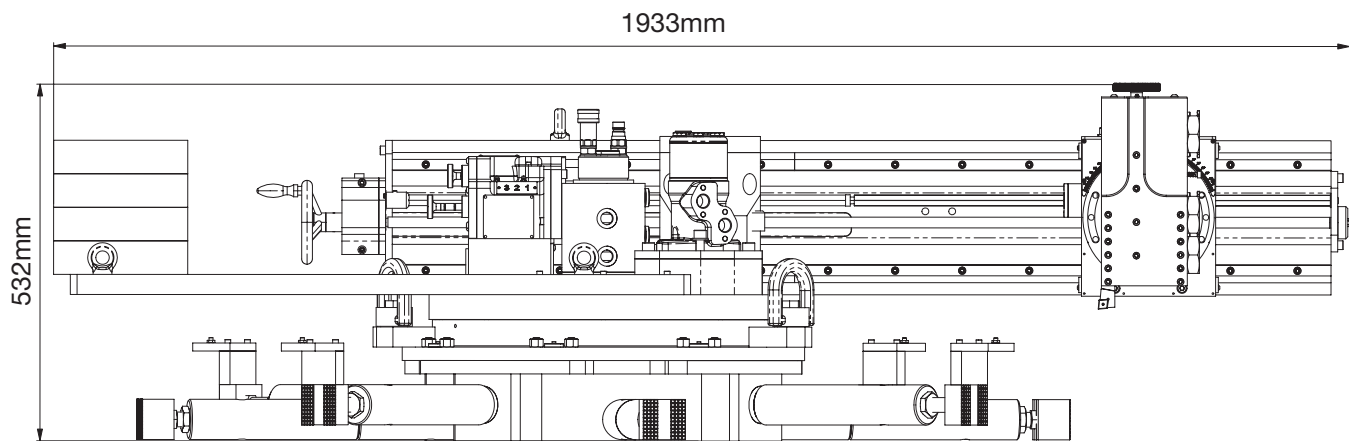


Figure 10: MM2000i-H-M Dimensions

4.2 MM2000i / MM2000i-H Technical Table

Description	Value			
	Pneumatic		Hydraulic	
Maximum Clamping diameter	1830mm	72"	1830mm	72"
Minimum Clamping diameter	604mm	23.8"	604mm	23.8"
Motor	3.0 kW @ 6 bar	4.0 hp @ 87 psi	4.0 kW @ 100 bar	5.4 hp @ 1450 psi
Maximum Facing diameter	2032mm	80"	2032mm	80"
Minimum Facing diameter	610mm	24"	610mm	24"
Maximum Swing Diameter	1691mm	66.5"	1691mm	66.5"
Minimum Swing Diameter	1535mm	60.4"	1535mm	60.4"
Toolpost Vertical Travel	100mm	4"	100mm	4"
R.P.M	Min. 5	Max. 16	Min. 5	Max. 12
Supply	2.89 m ³ /min @ 6 bar	102 ft ³ /min @ 87 psi	50 L/min @ 100 bar	11 Gpm (Imp) @ 1450 psi
Machine Weight (Machine & Base)	571kg	1259lb	580Kg	1279lb

5. Installation

5.1 Base Assembly Installation

⚠ WARNING

Before installation, visually inspect all ram bolts to ensure the threads are in good working condition.

1. Measure the inside diameter of the flange to be machined and ensure this is within the working parameters of the machine.
2. Select the required components for the base size (see section 9.26 table for 'Clamping arrangements for different diameters').



Note that the 4 opposing legs must have the same arrangement.

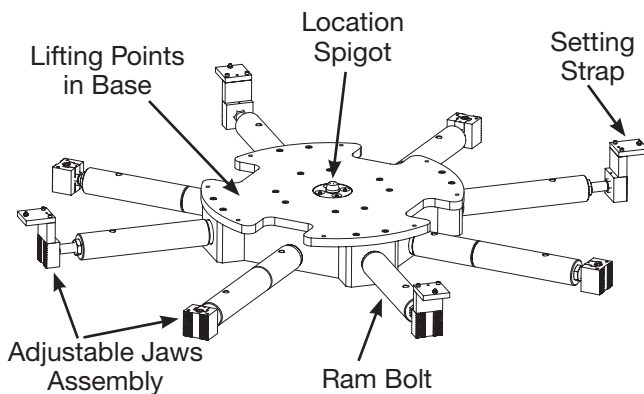


Figure 11: Base example assembly

3. Assemble the base components so that it measures 6mm (equally around its perimeter) below the bore mounting dimension. This is to be completed away from the work piece.



Note that the ram bolts on the extension legs can only be moved out a certain length to ensure that enough engagement remains between the leg and bolt. There is a groove on the leg to indicate allowable full extension length.

⚠ CAUTION

Do not unscrew the legs any further out once the groove is visible.

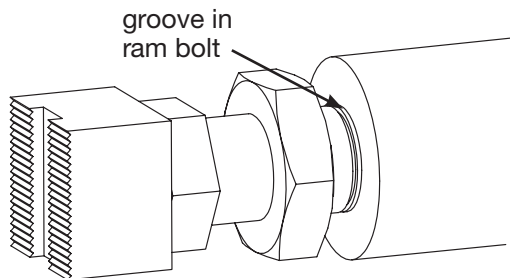


Figure 12: Ram bolt showing groove

4. Bolt the setting straps onto the fixed jaws.
5. Position the base into the flange bore. Check the centralisation by measurement and adjust

Using ram bolts as necessary. Lifting equipment and slings may need to be used to lift the base assembly to the work piece.

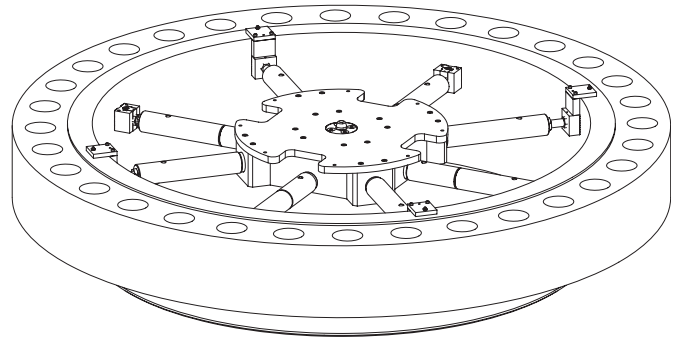


Figure 13: Setting straps on flange

6. Adjustments can be made by tightening and loosening opposing adjustable jaws, it is recommended that the setting straps are left in place until the base unit is fully installed.

⚠ CAUTION

Check that the walls of the work piece are able to withstand clamping forces without distortion. If the work piece is not able to withstand the forces, alternative means of clamping will be required. If not possible consult with the manufacturer for a custom resolution.

7. Once the base is correctly clamped to the workpiece, tighten the ram bolts to 200Nm. Then tighten the locking nut on the ram bolts to secure each leg.

Failure to correctly torque the bolts and also tighten lock nuts may result in the clamps becoming loose from vibration.

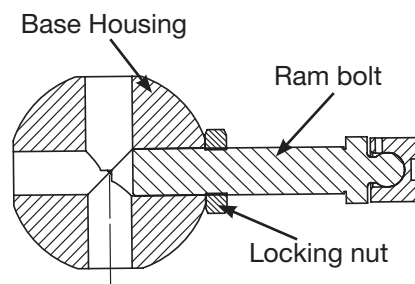


Figure 14: Leg Arrangement

8. When the base is secure to the work piece, remove the setting straps.

5.2 Machine installation

1. A central location spigot is provided for exact location of the machine, this is fixed to the centre of the machine base. See figure 11.
2. Ensure the Toolpost is fully retracted and the cutting tool has been removed.
3. Lift the machine carefully over the spigot and align bolt hole positions to avoid having to rotate the machine.
4. Lock the machine in position.
5. A magnetic base clock is provided in the tool kit to aid radial adjustment of the machine. This can be placed on the Toolpost and positioned onto the work piece.
6. Survey the flange and, if required, the adjustable bolts can be used to adjust the machine parallel with the flange.

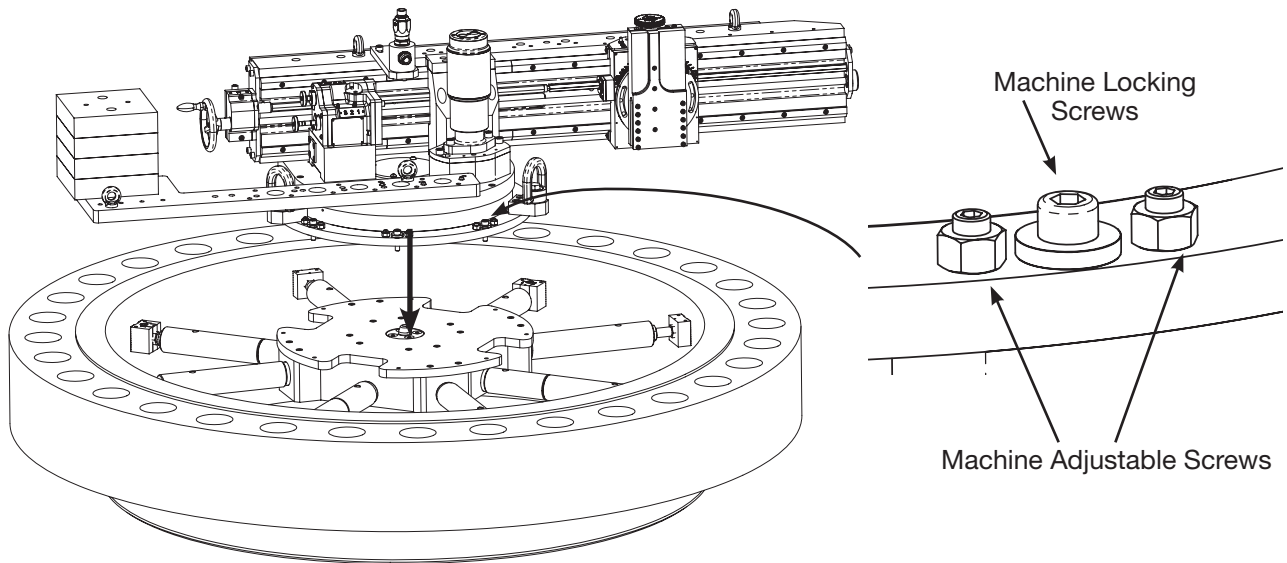


Figure 15: Machine Installation

5.3 Lifting

5.3.1 Lifting the Machine

1. Refer to Figure 16 and 17 for machine lifting points.
2. The machine and the base are supplied in two separate assemblies. Care should be taken, and adequate PPE should be worn, when lifting the two units.
3. Do not lift the machine with the base attached.
4.  When lifting the machine, only the labelled lifting points should be used.
5. RLP should be torqued to 60Nm.

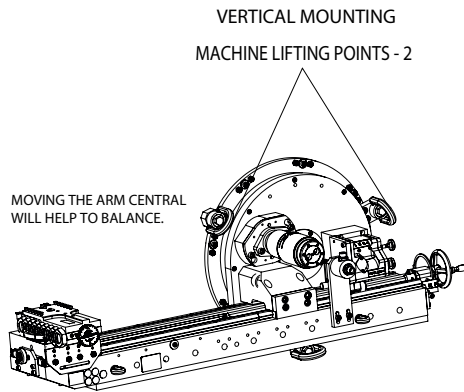


Figure 16: Vertical Lifting

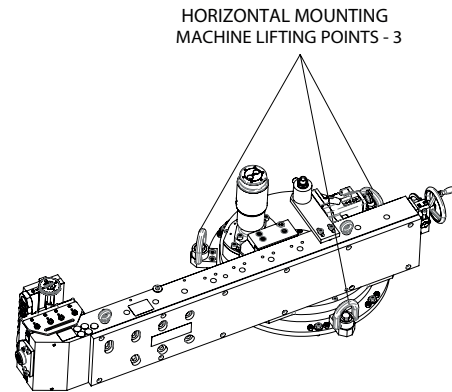


Figure 17: Horizontal Lifting

5.3.2 Lifting the Base (if legs are not attached)

The base is supplied with two M10 Lifting points. Each base should be lifted with 2 x M10 lifting points as shown.

The RLPs should be torqued to 15Nm.

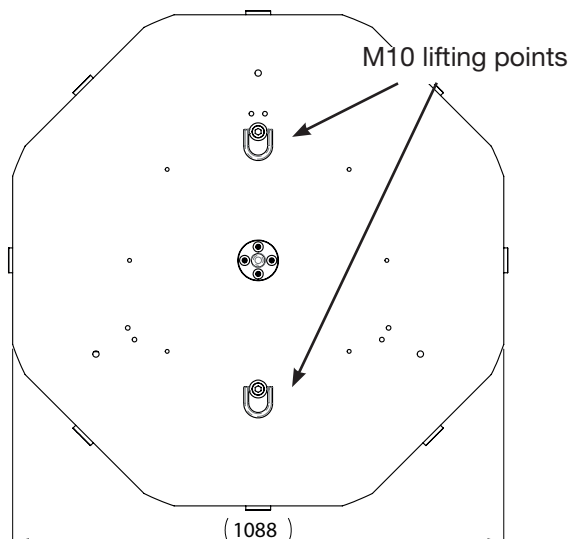


Figure 18: Base MM2000i-10a lifting points

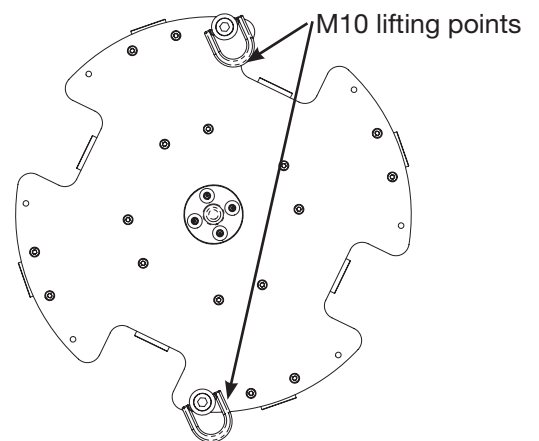


Figure 19: Base MM2000i-10b lifting points



Ensure the lifting eyes are removed before installing the machine.

6. Operation



NO MACHINE ADJUSTMENTS SHOULD BE MADE WHILE THE MACHINE IS IN OPERATION. TURN AND LOCK OFF THE ISOLATION VALVE ON THE POWER SUPPLY BEFORE MAKING ANY ADJUSTMENTS.

6.1 Connecting the machine to the power supply.

6.1.1 Pneumatic

Attach the 1/2" hose to the motor coupling adapter. The free end of the 1/2" hose should be attached to the pilot operated pneumatic valve from the hold to run unit.



Ensure the directional arrow is facing the correct orientation (Flow towards the motor).

Attach the 1/2" hose from the Air lubrication unit to the pilot operated pneumatic valve from the hold to run unit.

The air supply should be attached to the ALK inlet valve (1/2" G port).

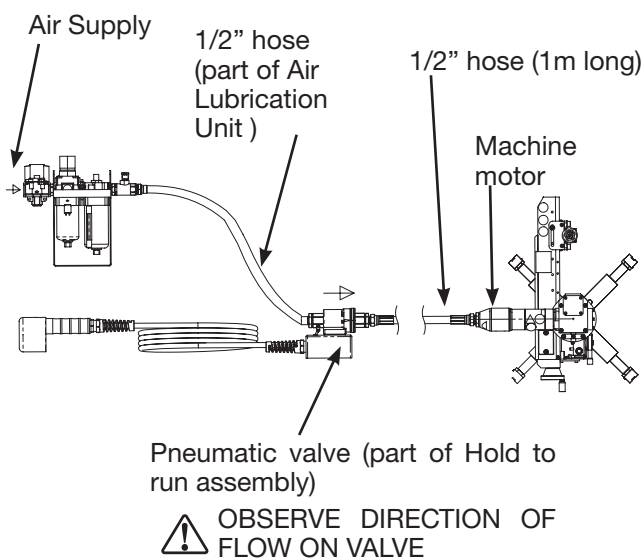


Figure 20: Pneumatic connection system diagram

Schematic diagrams are located in the appendix.

6.1.2 Hydraulic

The hydraulic supply from the power pack is connected to the inlet and outlet ports on the hydraulic distributor.

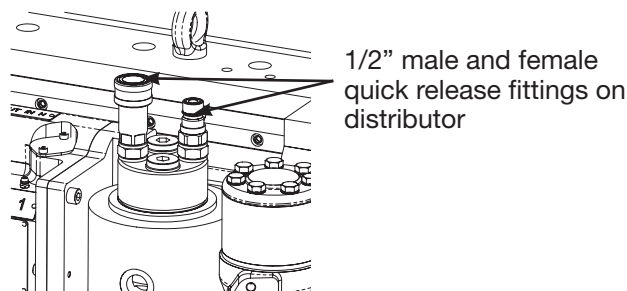


Figure 21: Hydraulic Connection diagram

6.1.3 Air Lubrication Unit (Pneumatic only)

The Pneumatic machine requires an Air Lubrication Kit to prevent damage to the machine. This unit is provided as part of the machine supply. For the part number and further details of this unit, please refer to the machine General Arrangement drawing.

6.2 Operating Hold-To-Run Device (Pneumatic only)

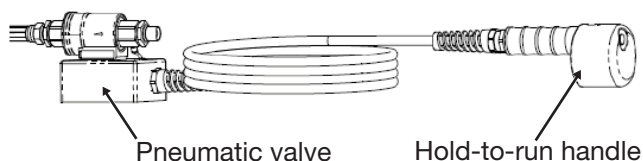


Figure 22: Hold-To-Run Assembly

WARNING When the machine has been fully set-up and connected to the power source, go through the safety checklist before beginning the cutting operation.

To operate the hold-to-run handle, first press on the anti accidental start button. Whilst holding this down, press down the 'hold-to-run' push button. The machine should now be running.

Release the anti accidental start button, but keep down the 'hold-to-run' push button to keep running the machine.

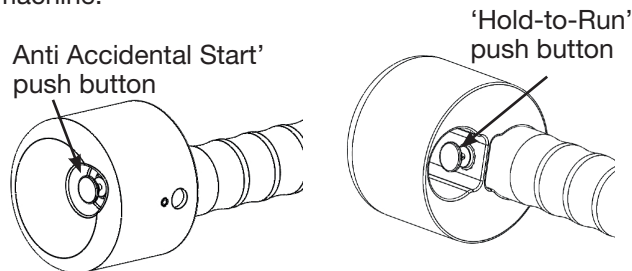


Figure 23: Hold-to-run handle

To stop the machine, and in case of emergency, release the button on the handle.

Hold-to-run device function summary:

Press 'Hold-to-run' button first, the machine **should not start**.

Press 'Anti Accidental Start' button first, the machine **should not start**.

Press 'Anti Accidental Start' button first, whilst holding this down, press 'Hold-to-Run' button, the machine **should start**.

Release 'Anti Accidental Start' button, the machine **should continue running** whilst holding down 'Hold-to-Run' button.

Release 'Hold-to-Run' button, the machine **should stop** immediately.

6.3 Restart Procedure

6.3.1 Pneumatic

If a power loss occurs during a cutting operation, follow the below procedure:

1. Release the button on the hold-to-run handle.
2. Lock off inlet isolation valve on the Lubrication unit.
3. Investigate power loss.
4. When power is available, re-assess safety, then once out of the cordoned off area, unlock the isolation switch on the inlet valve.
5. Re-start the machine by operating the hold-to-run device .

6.3.2 Hydraulic

If a power loss occurs during a cutting operation, follow the below procedure:

1. Refer to power pack user manual through-out the below steps.
2. Release the run button on the power pack.
3. Lock off inlet isolation valve on the power pack.
4. Investigate power loss.
5. When power is available, re-assess safety, then once out of the cordoned off area, unlock the isolation switch on the power pack.
6. Re-start the machine by operating the controls on the power pack.

6.4 Toolpost Setting

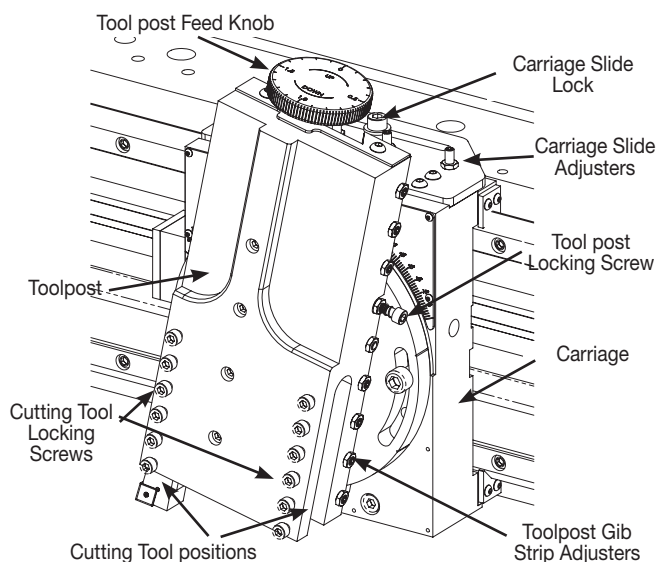


Figure 24: Toolpost Setting

Inserting the cutting tool

Install the tool provided in either of the tool slots and tighten – over tightening of the screws could result in thread or Toolpost damage.

Setting the Tool Post Angle

The angle of the Toolpost may be altered – loosen the 2 off screws as indicated and the Toolpost will swivel. Tighten the 2 off screws to lock at the required angle.



After setting up the toolpost, but before operation, the operator must, by hand, wind the carriage and toolpost to the minimum and maximum stroke on the arm to check for crashes.

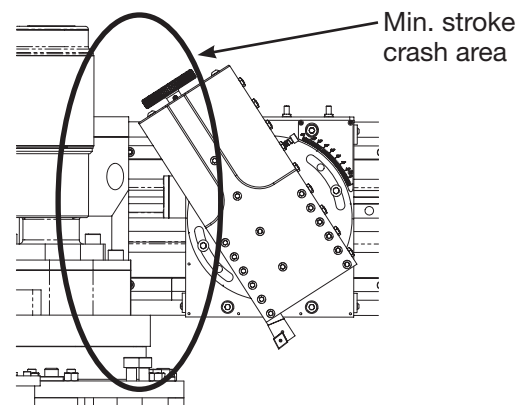


Figure 25: Tool post crash check

Setting the depth of cut

1. The Toolpost will feed approximately 2mm (0.078") per revolution. Accurate depth of cut setting is achieved by placing the magnetic clock on the Toolpost zero the dial on the flange face and then add depth of cut. To lock the cutting depth, tighten the 'Toolpost Locking Screw'.



When facing ensure the 'carriage slide lock' is removed. When boring ensure the lock is tightened to maintain a fixed carriage position.

6.5 Facing Feed Gear Selection

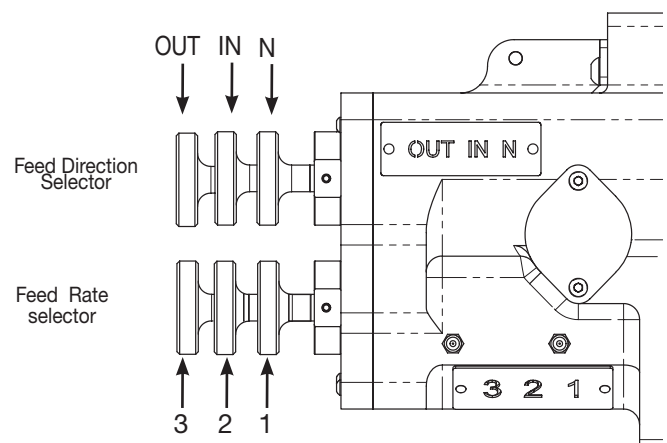


Figure 26: Feed Gear Selection

Feed Direction	Feed Gear	Feed Rate mm/rev	Feed Rate Grooves/ inch
Out	1	0.133	191
Out	2	0.208	122
Out	3	0.507	50
In	1	0.159	160
In	2	0.248	103
In	3	0.603	42

6.5.1 Selecting Feed Rate

1. Check feed rate table. (See appendix B3 Flange face surface finish)
2. Select required feed and push or pull feed selector to required position.

6.5.2 Selecting Feed Direction

1. Check required direction IN will traverse the tool towards centre – OUT will traverse the tool away from centre.
2. Select required direction and push or pull feed selector to required position.
3. The direction lever can be rotated to engage feed rate and direction gears and will not rotate when both are fully engaged.

6.6 Boring Feed Selection

For **FACING** push lever away from the surfacing arm whilst rotating the hand wheel located on the opposite end.

For **BORING** push lever towards the surfacing arm whilst rotating the Toolpost feed t-bar.

For conventional boring, the feed direction should be set to 'IN' for reverse boring, set the feed direction to 'OUT'.

Gear	mm per rev	Inch per rev
1	0.03	0.00118
2	0.06	0.00236
3	0.13	0.00511

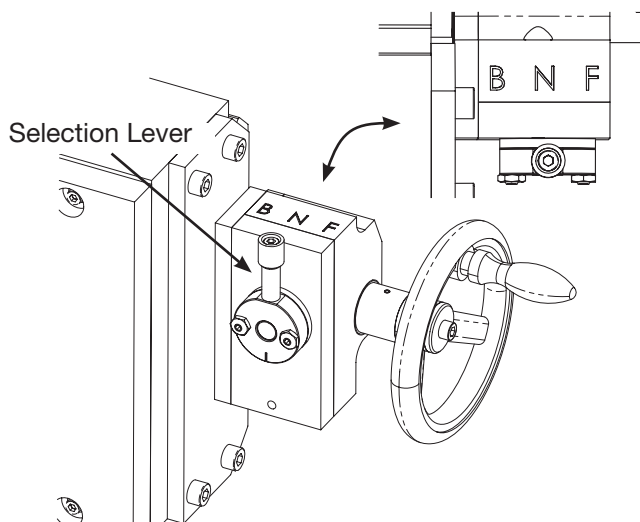


Figure 27: Selection Lever

NOTICE

When using the Toolpost in boring mode it is advisable to lock the carriage. The plate, screw and washer are provided to do this. It is also **important** to remember to remove the screw before using the machine in facing mode. Failure to do so could result in damage to the machine.

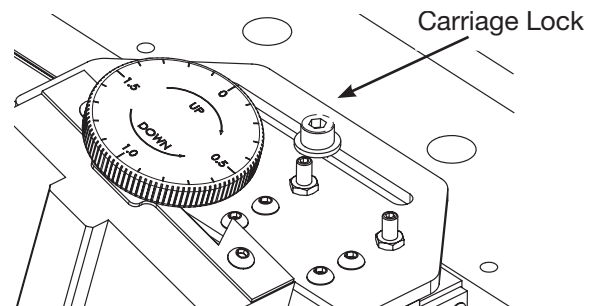


Figure 28: Carriage Lock

6.7 Surfacing Arm Setting

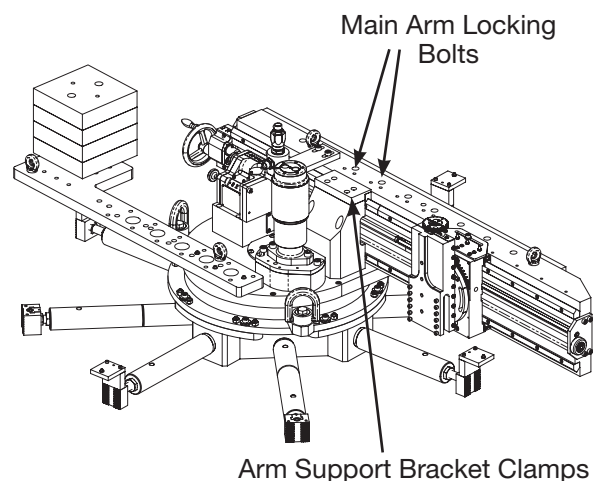


Figure 29: Surface arm position setting

1. Measure the flange face and place the machine in the horizontal plane. Remove the main drive to arm locking bolts.
2. Loosen the arm clamp plate screws in the arm support bracket and the arm should now slide. Slide to the required position.
3. To accurately locate the arm apply finger tight pressure to the main drive – arm locking bolts and then whilst supporting the arm weight tighten the clamp screws in order from 1 – 3 and then fully tighten the drive – arm locking bolts. This will ensure the arm is located correctly and is perpendicular to the rotation drive hub.

6.8 Machine Balancing

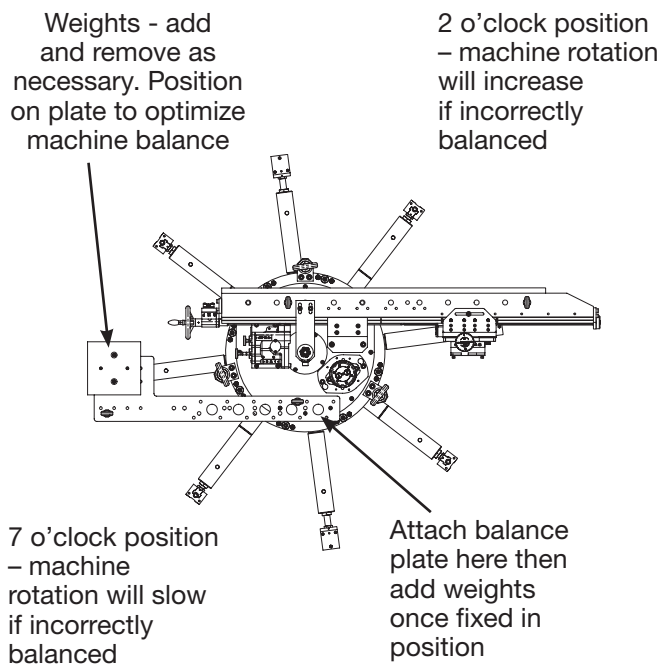


Figure 30: Machine Balancing

1. When machining in any angular position other than horizontal it is necessary to balance the machine. Attach the balance plate to the machine. Failure to balance the machine correctly will increase load on the drive components.
2. To obtain balanced rotation add or remove weights and move their position on the plate to obtain smooth rotation. There should be no increase or decrease in rotational speed. Pay particular attention to 7 o'clock and 2 o'clock positions as this will be where the weight shift will be greatest.
3. For more accurate balancing the motor can be removed and the machine swung by hand until it rotates at an even pace with no evidence of speed increase.

6.9 Clearing Blockages

When machining, a build up of swarf can occur. Periodic clearing of the swarf around the machine tool should be carried out to prevent any blockages.

CAUTION Wear protective gloves before commencing the below clearing procedure.

1. Release button on the hold-to-run handle.
2. Use a metal brush and pliers to remove swarf build-up.
3. Before re-starting the machine, re-assess safety, then once out of the cordoned off area start the hold to run device.

6.10 Machine Disassembly

To disassemble the machine follow the below procedure:

1. Switch off the inlet isolation valve before disconnecting the hoses from the machine. On the pneumatic model there should be 3 separate assemblies: the hold-to-run assembly, the lubrication unit assembly, and the machine/base assembly (still on the work piece).
2. The machine now needs to be disconnected from the base by loosening each of the eight machine bolts on the base. The arm assembly will need to be moved around in order to gain access to each bolt.
3. Once the bolts are loosened lift off the machine assembly using the base assembly. See Figure 15.
4. To safely remove the base assembly from the work piece, secure the setting straps back onto the base unit to ensure the base does not fall while loosening the ram bolts. The base can now be lifted out.

6.11 Recommended Lubricants.

The air lubricating unit uses AW32 hydraulic oil. For all other lubricants refer to the maintenance schedule tables for recommended lubricants.

7. Storage

Storing the machine in the original box will extend the longevity of the machine. Before storing make sure the machine is clean and dry. Pay particular attention to the V grooves in the rail. Grease the leadscrew and

slide ways (using WD40 or similar) before storing the machine.

Use the below images to assist with re-packing the machine.

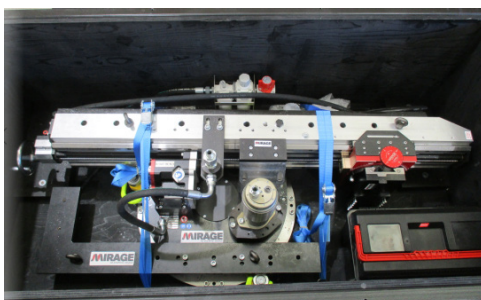


Figure 31: Storage box - machine

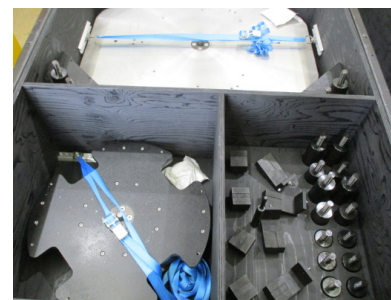


Figure 32: Storage Box - Base

8. Maintenance



NO MACHINE ADJUSTMENTS SHOULD BE MADE WHILE THE MACHINE IS IN OPERATION. TURN AND LOCK OFF THE ISOLATION VALVE ON THE POWER SUPPLY BEFORE MAKING ANY ADJUSTMENTS.

8.1 General Maintenance

General wear and tear items should be replaced with like for like components as per the machine general assembly drawings detailed in this manual. Failure to do so may result in a machine that is not fit for purpose and is outside the design intent it was supplied for. Items that require specific maintenance regimes and products will be detailed here in.

Time Period (of machine use)	Action	Recommended Lubricant
After every use	1. Clean all components and lightly oil	SAE 10 oil or WD40
	2. Check all components are present and stored correctly	
	3. Check tools and regrind or reorder inserts	
	4. Check and adjust gib strip and carriage	Reference corrective maintenance section
Weekly under use	1. Grease main hub bearings – 5 shots	00 EP Lithium semi fluid grease
	2. Grease gearbox – 2 shots	00 EP Lithium semi fluid grease
	3. Grease Toolpost rack	00 EP Lithium semi fluid grease
	4. Lightly oil slide ways	SAE 10 oil
	5. Clean and oil base components	SAE 10 oil

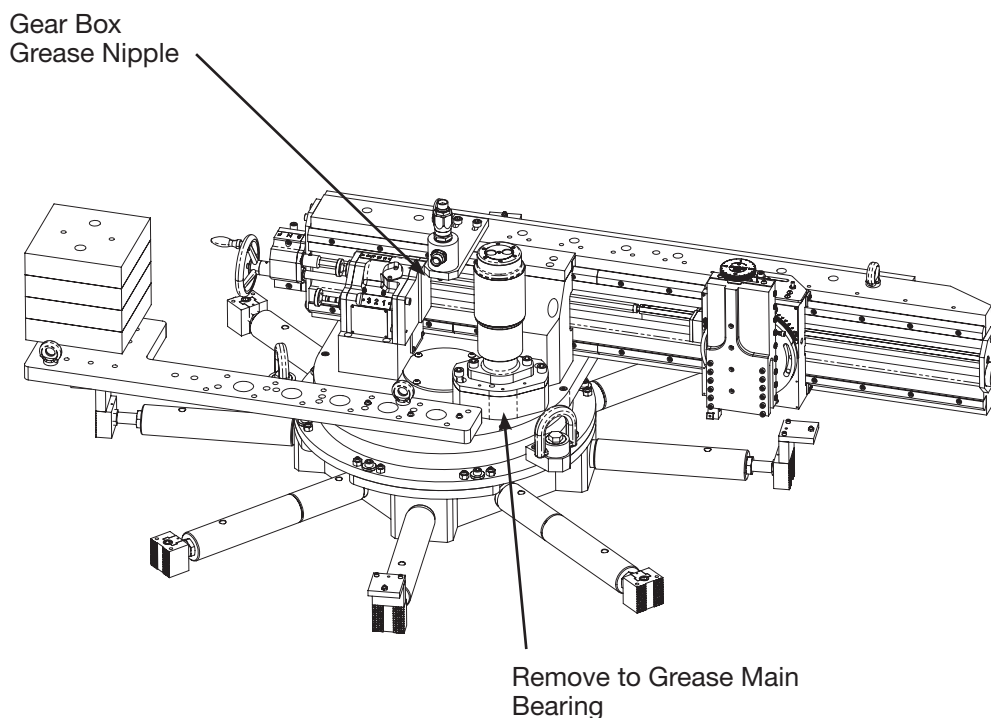


Figure 33: Grease Points During Maintenance

8.2 Safely maintaining hydraulic/pneumatic system

WARNING

- Never work on a hydraulic/pneumatic system unless fully trained.
- Carefully review the manuals before beginning work. Ask questions about anything you do not fully understand.
- Maintain a clean work area free of slipping hazards and debris.
- Use all required safety equipment.
- Always use safety glasses.
- Block, secure or lower to the ground components that may move, rotate or fall.
- Relieve system pressures. (Note: Some systems use accumulators that store pressure. Identify the system before working on it.)
- Use extreme caution when disconnecting lines. Severe burns from hot fluid can result.
- Use test equipment designed for higher pressures than the system being repaired. Use of gauges, lines, connectors, etc., designed for lower pressures can result in bursting or equipment damage. (Note: A good rule is to use equipment rated at twice what is expected. Example: For a 2500 psi system, use a 5000 psi gauge.)
- DO NOT USE HANDS OR FINGERS to find leaks. Fluid under high pressure can be injected into skin causing extreme injury and serious infection. "Note: High-pressure hydrocarbon injection injuries may produce substantial necrosis of underlying tissue despite an innocuous appearing external wound. These injuries often require extensive emergency surgical debridement and all injuries should be evaluated by a specialist in order to assess the extent of injury. Early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury."
- Clean up spills immediately. Hydraulic fluid is an oily substance which can cause slipping, falling and resulting injuries.
- Do not work under equipment/apparatus being supported by hydraulics. Stops, safety pins, etc. must be in place prior to beginning repairs.
- Review the Material Safety Data Sheets (MSDSs) for all chemicals used

8.3 Corrective Maintenance

8.3.1 Facing arm (Ref MM2000i-2)

- Remove the main arm bolts. Slacken off the adjuster screws in the arm support unit which clamps the surfacing arm perpendicular to the hub and remove clamping plate.
- Arm should then slide backwards to release
- Insert 2 x M16 eye bolts into arm, remove arm using vertical lift

The procedure for installation is the reverse of the removal ensuring that the PTO box (ref MM2000i-8) fits into the gearbox opening and it is in mesh with the output gear in the gearbox.

To check the correct installation - lift in the surfacing arm should be no more than 0.15mm (0.005").

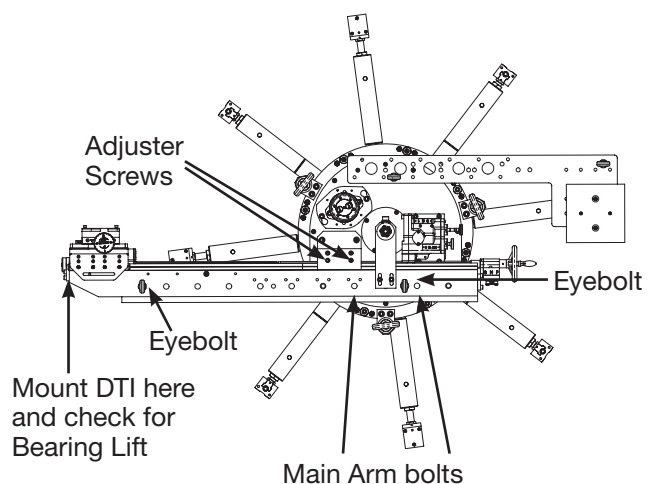


Figure 34: Machine components

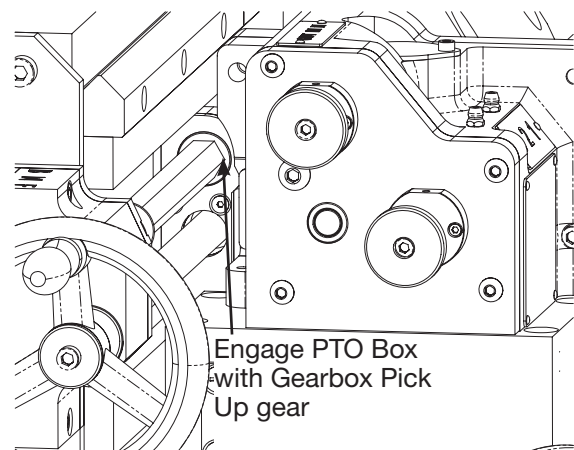


Figure 35: PTO Box and pick up gear

8.3.2 Toolpost gib strip (Ref MM1080IE-2)

- Slacken lock nuts on the gib strip adjusters and slacken grub screws.
- Working from one end adjust grub screws only when there is sufficient location on the slide way to prevent over tightening. To adjust tighten fully then back off one quarter of a turn and tighten the lock nut.
- Check the Toolpost movement along its stroke to ensure free sliding movement and no sideways movement.

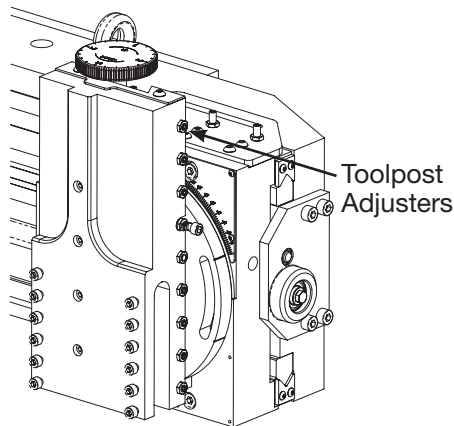


Figure 36: Tool Post

8.3.3 Slide way Carriage (ref MM2000i-2)

- Slacken lock nuts on the gib strip adjusters and slacken grub screws.
- Working with the hand wheel ensure the carriage will slide whilst tightening the grub screws and then use the lock nuts to fix the adjustment.

To check the correct installation – there should be no free play in the carriage slide assembly.

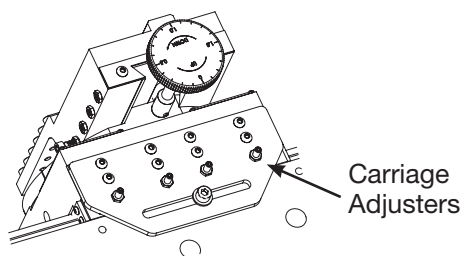


Figure 37: Carriage Adjusters

8.4 Changing the insert cutting tip.



When handling the insert make sure to use protective gloves.

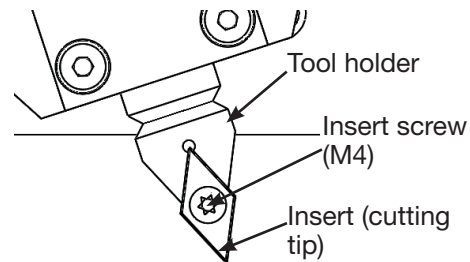


Figure 38: Insert and holder

The insert is attached to the tool holder by the screw. Ensure the screw is tight once the cutting tool insert has been changed.

8.5 Replacing Shear Pin in Pick Up Gear

1. Start by removing the complete gearbox and support assembly from the machine by unscrewing the four M8x80 screws in the MM2000i-3 assembly.
2. Remove the Bearing Cover (a.) by unscrewing the two M4x8 screws. Remove the circlip (b.), trapping ring (c.), locknut (d.), and lockwasher (e.)
3. Unscrew the four M6x80 bolts in the MM2000i-3 assembly and remove the MM1500i-20-002 gear by lifting the MM2000i-29 gearbox away.
4. Remove the shear pin and replace as necessary. Note that the pin out protrudes out through the hole on one side, and should not go into the keyway.
5. Re-assemble and attach the gearbox assembly to the machine using the reverse of the process detailed above.

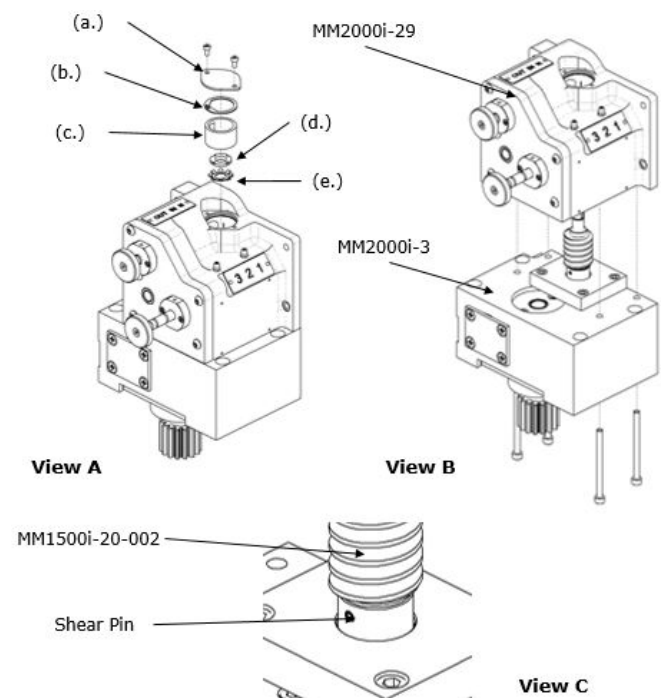
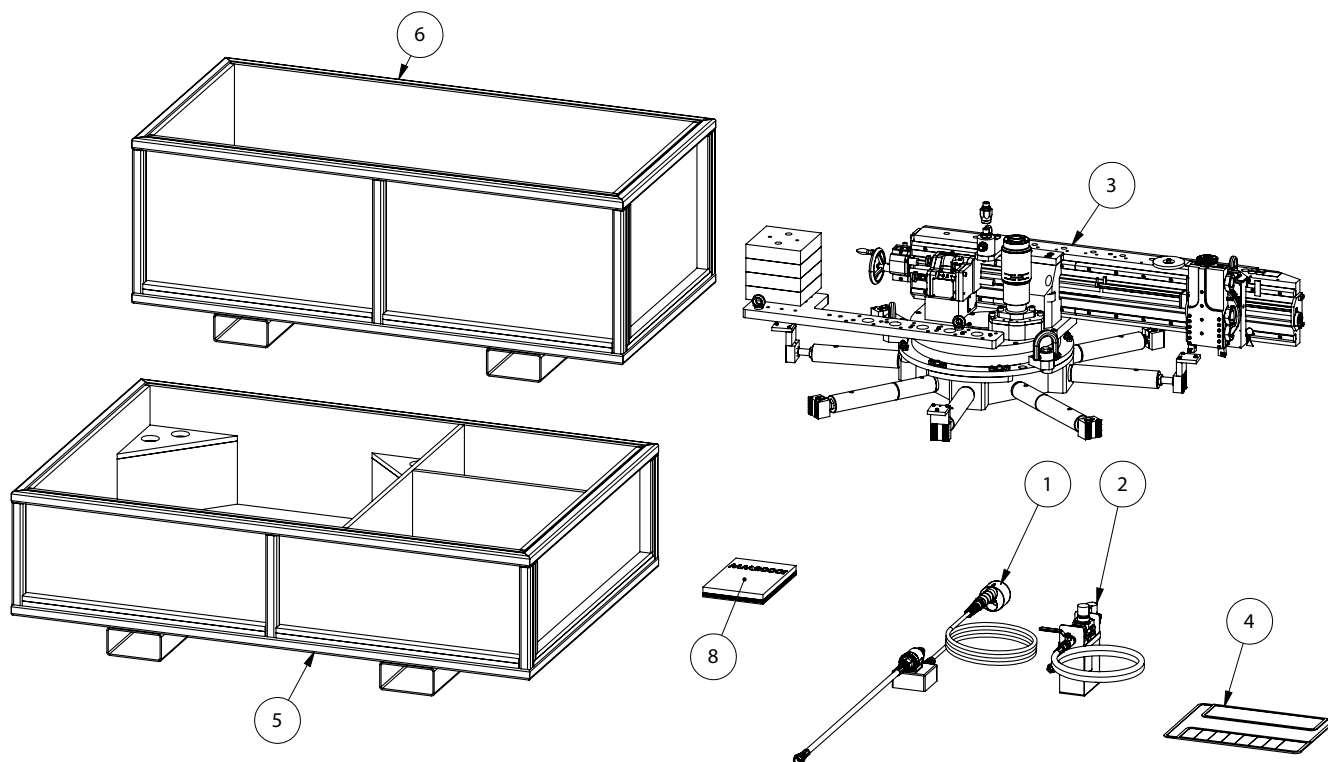


Figure 39: Gearbox images

9. Parts List

9.1 MM2000i Pneumatic Assembly (MM2000i, Revision G) Views

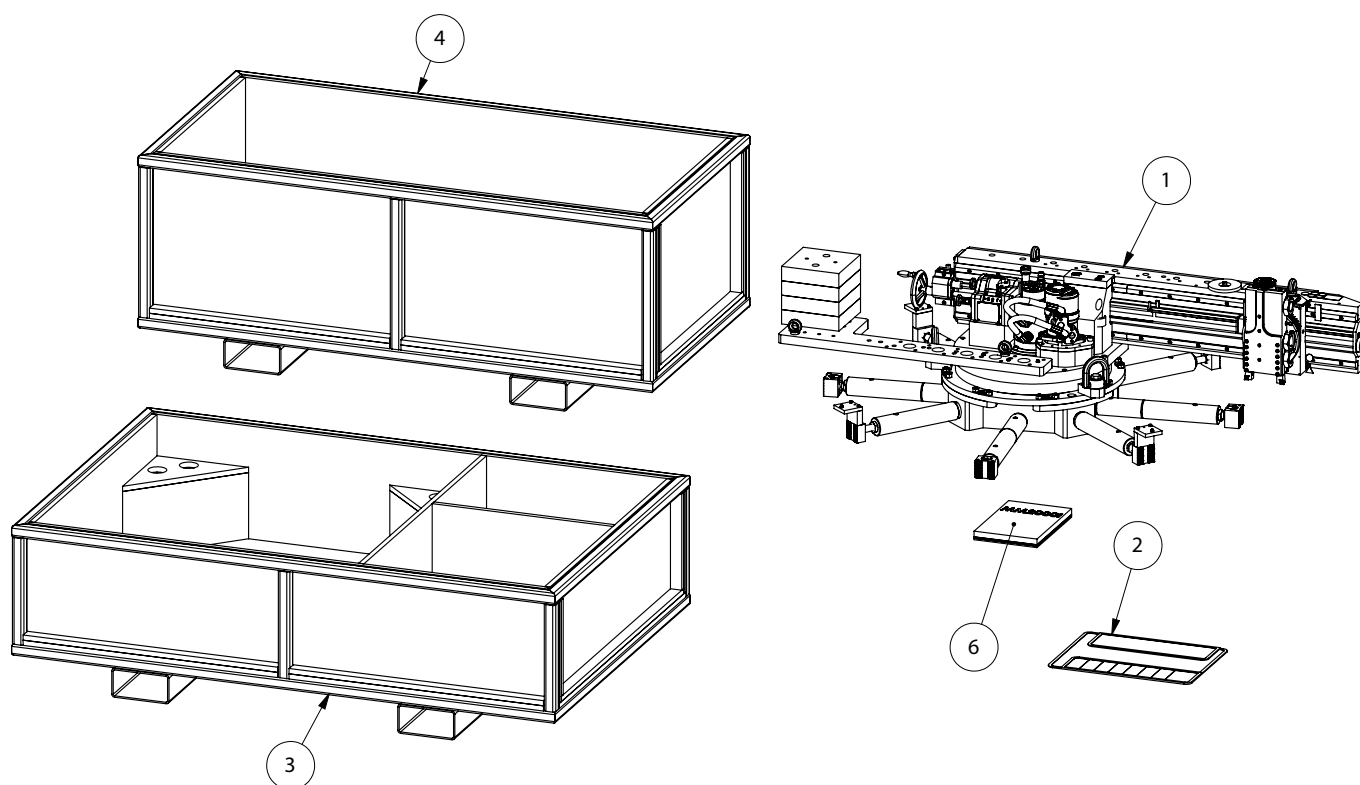


NOTES:
1. ITEM LOAD-STRAP-4.5M NOT SHOWN.

9.2 MM2000i Pneumatic Assembly (MM2000i, Revision G) Table of Parts

Item Number	Part Number	Description	QTY
1	DMH-PNEUMATIC	Pneumatic Dead Man's Handle	1
2	LARGE-ALK	Large Filter Lubricator Kit	1
3	MM2000i-P-M	Flange Facing (Pneumatic) Machine	1
4	MM2000i-TK	MM2000i Toolkit	1
5	MM2000i-BOX-001	MM2000i BOX FRAME	1
6	MM2000i-BOX-002	MM2000i BOX FRAME	1
7	LOAD-STRAP-4.5M	4.5M MACHINE LOAD STRAP	4
8	DOC-MM2000i	Document Pack for MM2000i	1

9.3 MM2000i-H Hydraulic Assembly (MM2000i-H, Revision J) Views



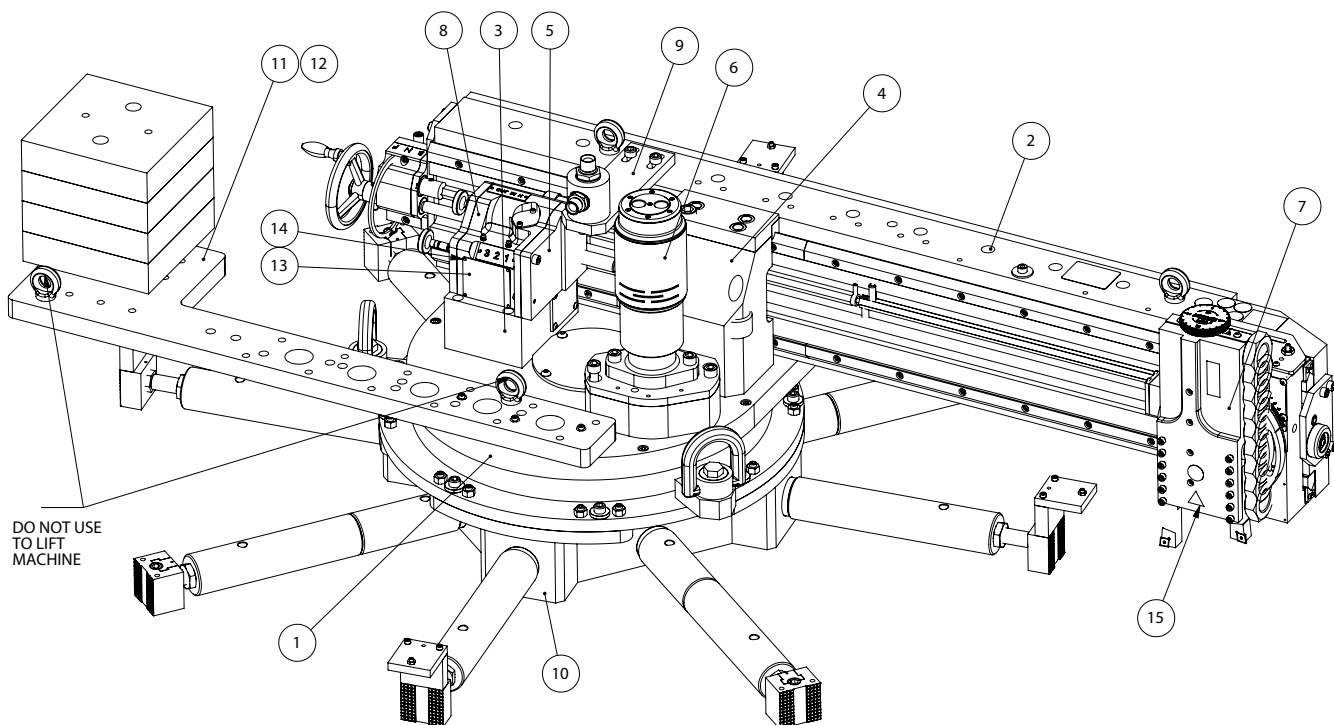
NOTES:
1. ITEM LOAD-STRAP-4.5M NOT SHOWN.

9.4 MM2000i-H Hydraulic Assembly (MM2000i-H, Revision J) Table of Parts

Item Number	Part Number	Description	QTY
1	MM2000i-H-M	FLANGE FACING (HYDRAULIC) MACHINE	1
2	MM2000i-TK	MM2000i TOOLKIT	1
3	MM2000i-BOX-001	MM2000i BOX FRAME	1
4	MM2000i-BOX-002	MM2000i BOX FRAME	1
5	LOAD-STRAP-4.5M	4.5M MACHINE LOAD STRAP	4
6	DOC-MM2000i-H	Document Pack for MM2000i-H	1

9.5 MM2000i Pneumatic Machine (MM2000i-P-M, Revision B) Views

Weight 580kg

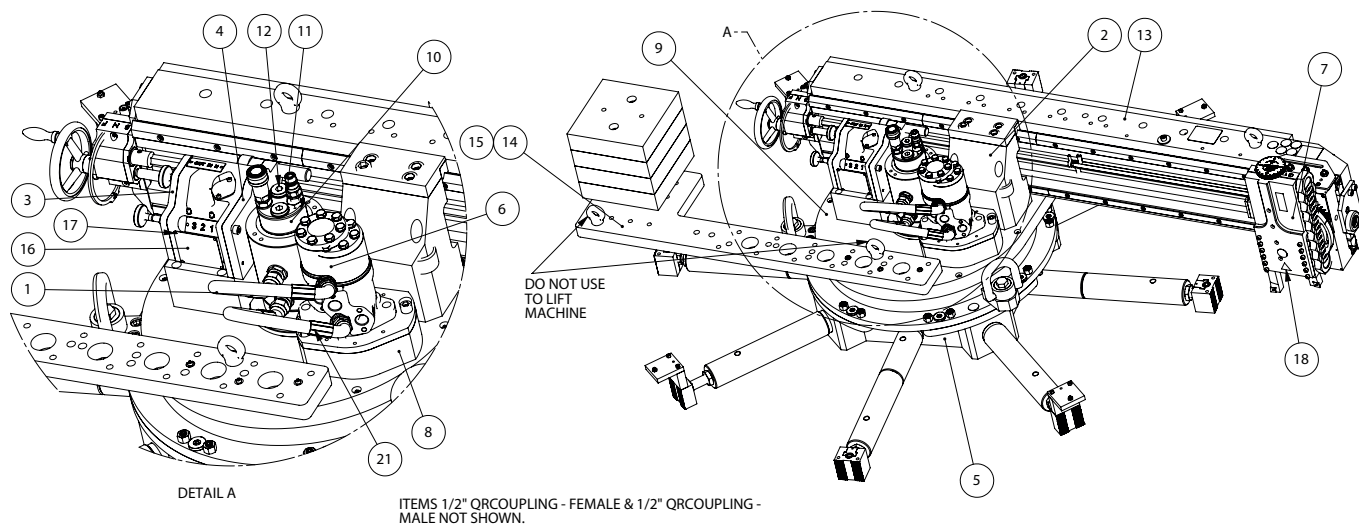


9.6 MM2000i Pneumatic Machine (MM2000i-P-M, Revision B) Table of Parts

Item Number	Part Number	Description	QTY
1	MM2000i-1	Drive Plate Assembly - Air	1
2	MM2000i-2	Facing Arm	1
3	MM2000i-3	Gearbox Support Unit	1
4	MM2000i-4	Arm Guide Support Assembly	1
5	MM2000i-8	Transfer Bulkhead	1
6	MM2000i-18	Drive Gear Unit - Pneumatic	1
7	MM1080IE-2	Toolpost Assembly	1
8	MM2000i-29	3 Speed Gearbox	1
9	MM1080IE-39	Air Distributor Assembly	1
10	MM2000i-10	Base Assembly	1
11	MM3000i-39	Counter Weight Assembly	1
12	NEGO147	Balance Weight	2
13	MM2000i-29-001	3 Speed Gearbox Legend	1
14	No 2 x 3/16"	Hammer Drive Screw	4
15	LABEL-PACK-6	Label Pack for MM2000i & MM3000i	1

9.7 MM2000i-H Hydraulic Machine (MM2000i-H-M, Revision B) Views

Weight 620kg

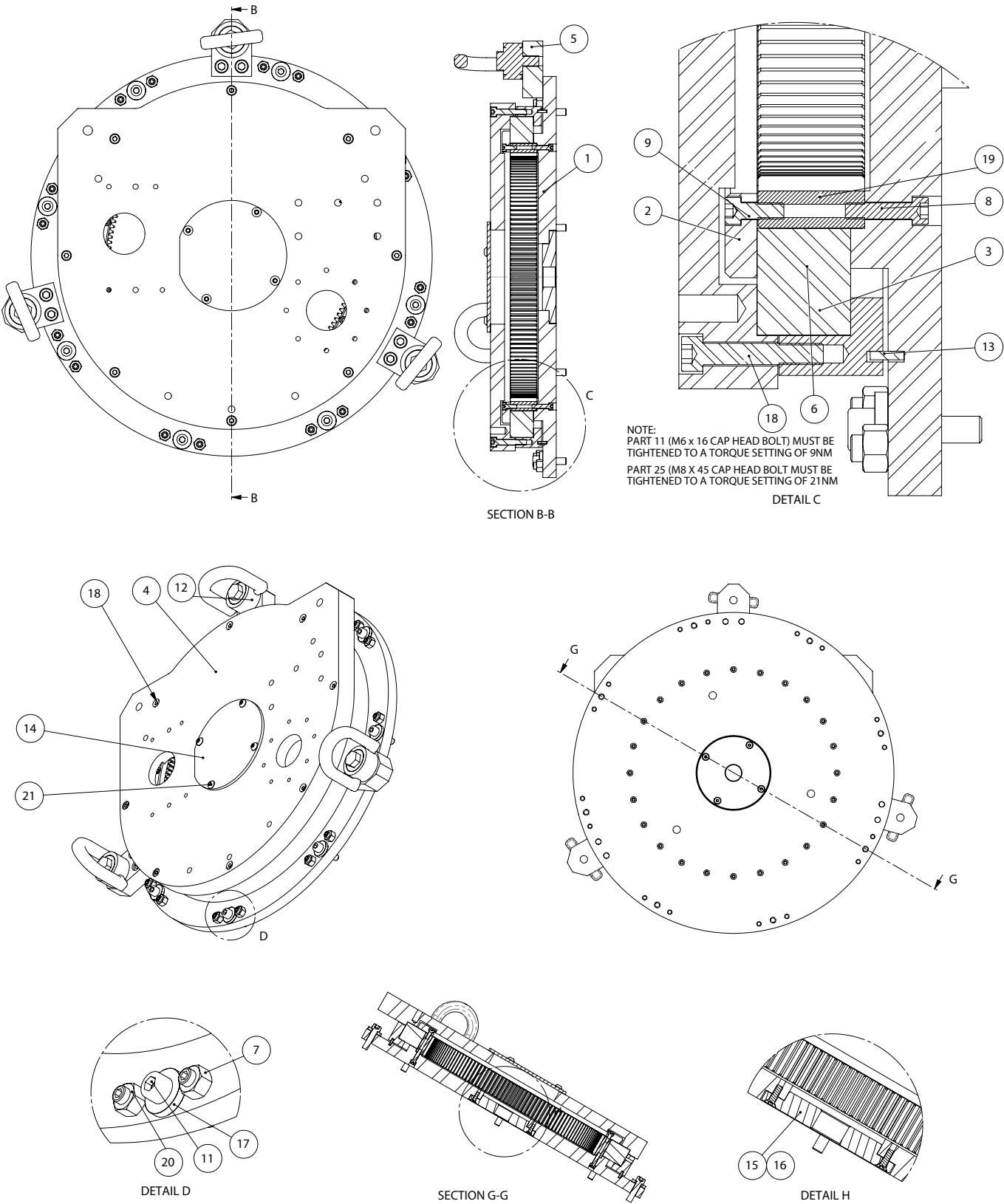


9.8 MM2000i-H Hydraulic Machine (MM2000i-H-M, Revision B) Table of Parts

Item Number	Part Number	Description	QTY
1	MM2000i-3	GEARBOX SUPPORT UNIT	1
2	MM2000i-4	arm guide support assembly	1
3	MM2000i-29	3 SPEED GEARBOX	1
4	MM2000i-8	TRANSFER BULKHEAD	1
5	MM2000i-10	BASE ASSEMBLY	1
6	151-0318	OMP 400	1
7	MM1080IE-2	TOOLPOST ASSEMBLY	1
8	MMI3000-5	drive gear unit - turning	1
9	MM2000i-1H	DRIVE PLATE ASSEMBLY	1
10	MM2000i-19	DISTRIBUTOR ASSEMBLY	1
11	DOWTY08	1/2" DOWTY WASHER	4
12	GN_749-g1_2-a	G1/2 GN 749 Threaded plugs NBR seal	4
13	MM2000i-2	FACING ARM	1
14	MM3000i-39	COUNTER WEIGHT ASSLY	1
15	NEG0147	BALANCE WEIGHT	2
16	MM2000i-29-001	3 SPEED GEARBOX LEGEND	1
17	No 2 x 3/16"	HAMMER DRIVE SCREW	4
18	LABEL-PACK-6	Label Pack for MM2000i & MM3000i	1
19	1/2" QRCOUPLING-FEMALE	1/2" QUICK RELEASE COUPLING FEMALE SET	1
20	1/2" QRCOUPLING-MALE	1/2" QUICK RELEASE COUPLING MALE SET	1
21	MM2000i-HHK	HYDRAULIC HOSES CONNECTING DRIVE TO DISTRIBUTOR	1

9.9 MM2000i Drive Plate Assembly - Air (MM2000i-1, Revision M) Views

Weight 135kg

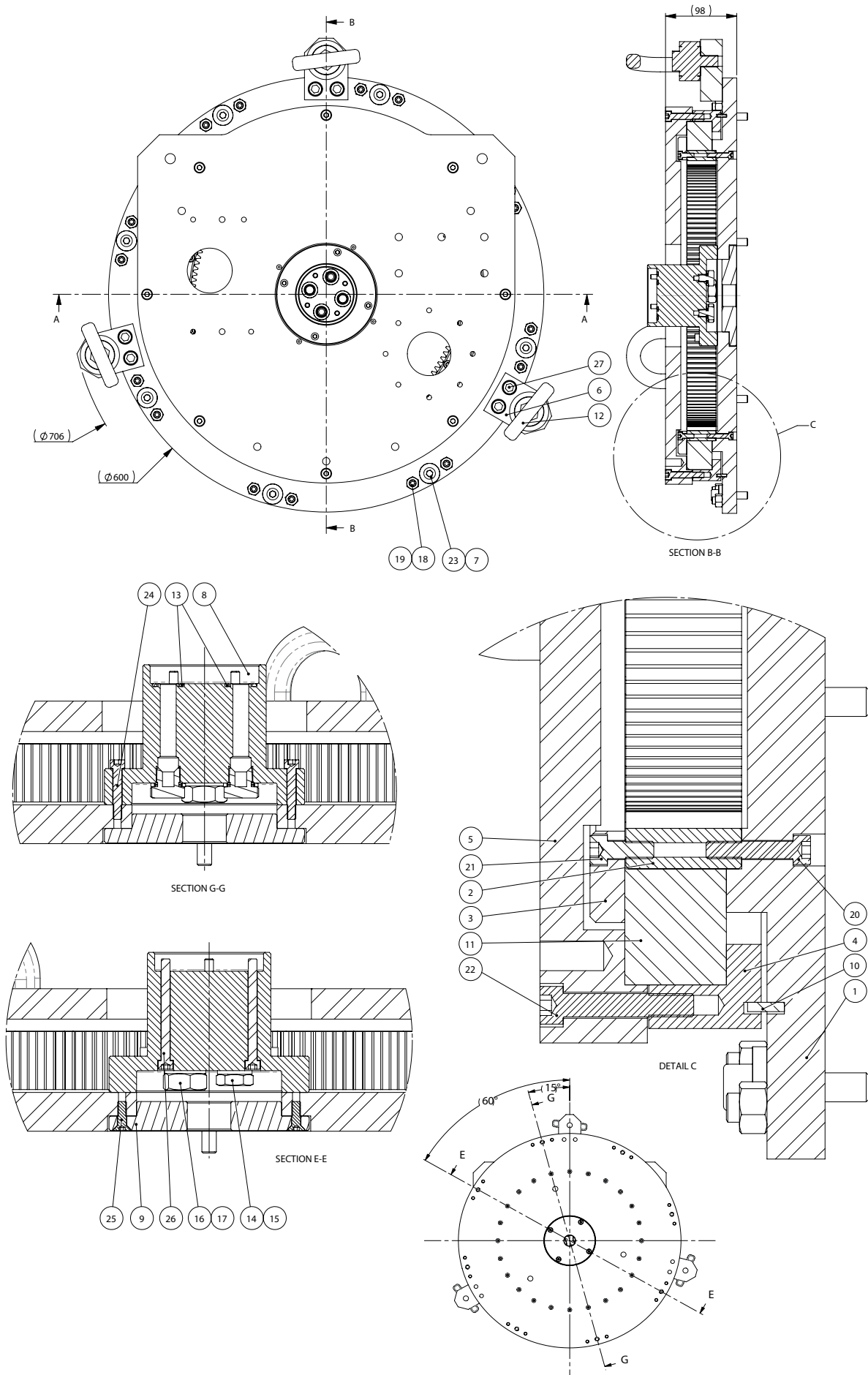


9.10 MM2000i Drive Plate Assembly - Air (MM2000i-1, Revision M) Table of Parts

Item Number	Part Number	Description	QTY
1	MM2000i-1-001	Base Plate	1
2	MM2000i-1-003	Bearing Trapping Ring	1
3	MM2000i-1-004	Bearing Outer Mounting Ring	1
4	MM2000i-1-005	Turntable	1
5	MM2000i-1-009	Lifting Plate	3
6	THK RB 40035 UU CCO	Cross Roller Bearing	1
7	M10	Hex Nut Grade C - BS EN 24034	16
8	M6 x 25	Hex Socket Head	24
9	M6 x 16	Hex Socket Head	24
10	M12 x 35	Hex Socket Head	6
11	M10 x 40	Hex Socket Head	8
12	RLP-M16-10	ROTATING LIFTING POINT	3
13	coil 3.18mm x 12.7	natural 66 nylon strip	1
14	MMI2000-1-010	BLANKING PLATE	1
15	SRB3000-H-5-003	LOCATION BUSH	1
16	M6 x 20	Hex Socket CTSK Head	4
17	MMI3000-1-007	Heavy Duty M10 washer	8
18	M8 x 45	Hex Socket Head - BS EN ISO 4762	8
19	MM2000i-1-002	144t internal gear	1
20	GN. 13984	M10 x 32 BTSS Grub Screw	16
21	M8 x 20	BUTTON HEAD SOCKET SCREW	4

9.11 MM2000i-H Drive Plate Assembly - Hydraulic (MM2000i-1H, Rev J) Views

Weight 137kg



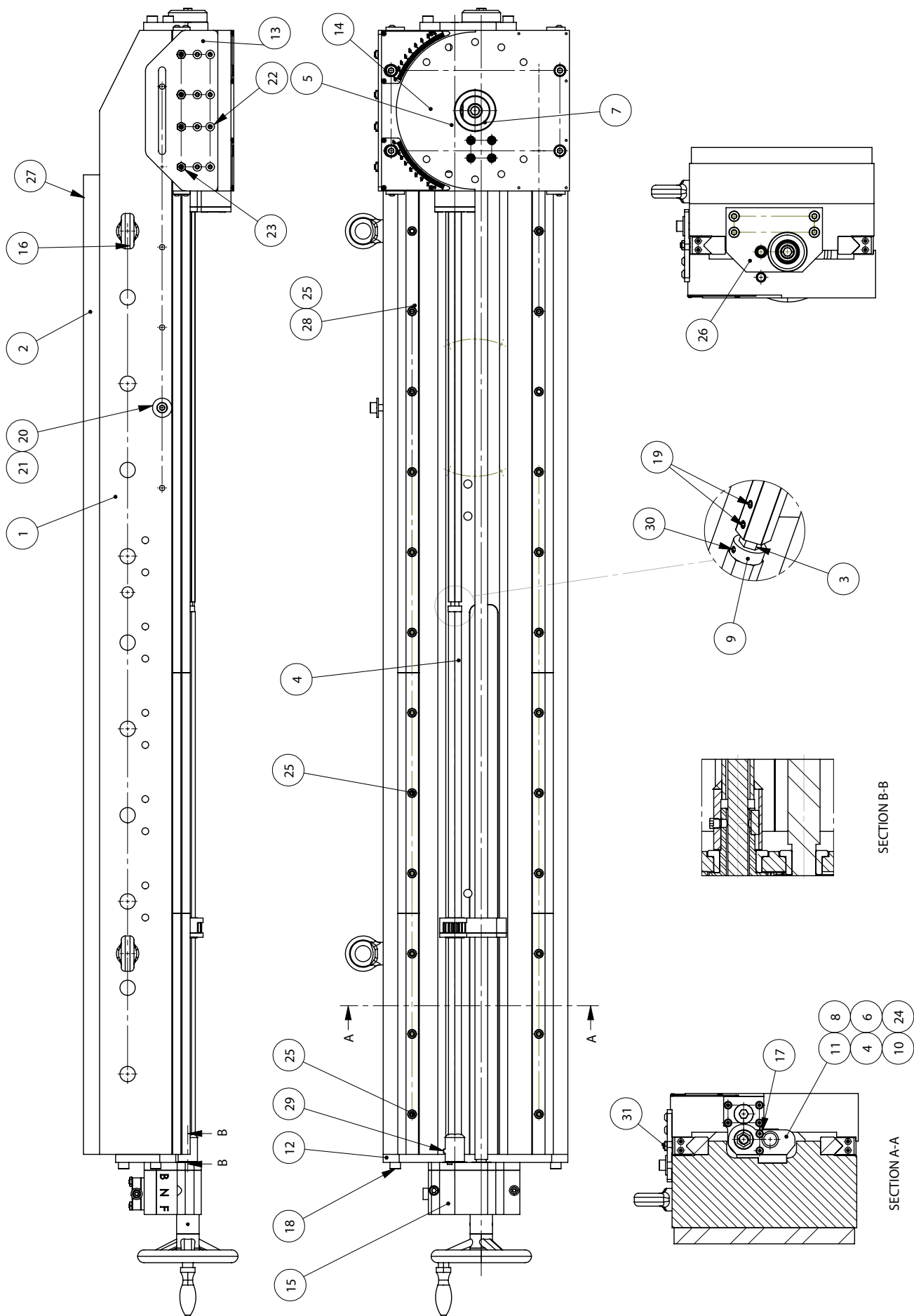
9.12 MM2000i-H Drive Plate Assembly - Hydraulic (MM2000i-1H, Revision J)

Table of Parts

Item Number	Part Number	Description	QTY
1	MM2000i-1-001	Base Plate	1
2	MM2000i-1-002	144t internal gear	1
3	MM2000i-1-003	bearing trapping ring	1
4	MM2000i-1-004	bearing outer mounting ring	1
5	MM2000i-1-005	turntable	1
6	MM2000i-1-009	lifting plate	3
7	MMI3000-1-007	Heavy Duty M10 washer	8
8	MM2000i-1-010	DISTRIBUTOR POST EXTENSION	1
9	SRB3000-H-5-003	LOCATION BUSH	1
10	coil 3.18mm x 12.7	natural 66 nylon strip	1
11	THK RB 40035 UU CCO	CROSS ROLLER BEARING	1
12	RLP-M16-10	ROTATING LIFTING POINT	3
13	ORAR00114-NBR	O-Ring Axial Static	4
14	AP-06	3/8" BSPP Male Plug	2
15	DOWTY 06	3/8" DOWTY WASHER	2
16	AP-08	1/2" BSPP Plug	2
17	D400 025 08	1/2" DOWTY WASHER	2
18	GN. 13984	M10 x 32 BTSS Grub Screw	16
19	M10	Hex Nut Grade C - BS EN 24034	16
20	M6 x 30	HEX SOCKET HEAD	24
21	M6 x 16	Hex Socket Head	24
22	M8 x 45	Hex Socket Head	8
23	M10 x 40	Hex Socket Head	8
24	M6 x 35	Hex Socket Head - BS EN ISO 4762	4
25	M6 x 20	Hex Socket CTSK Head	4
26	M6 x 70	Hex Socket Head - BS EN ISO 4762	4
27	M12 x 35	ISO 4762, SOCKET HEAD CAP SCREW, 12.9, BLACK OXIDE	6

9.13 MM2000-i/ MM2000i-H Facing Arm (MM2000i-2, Revision N) Views

Weight 145kg

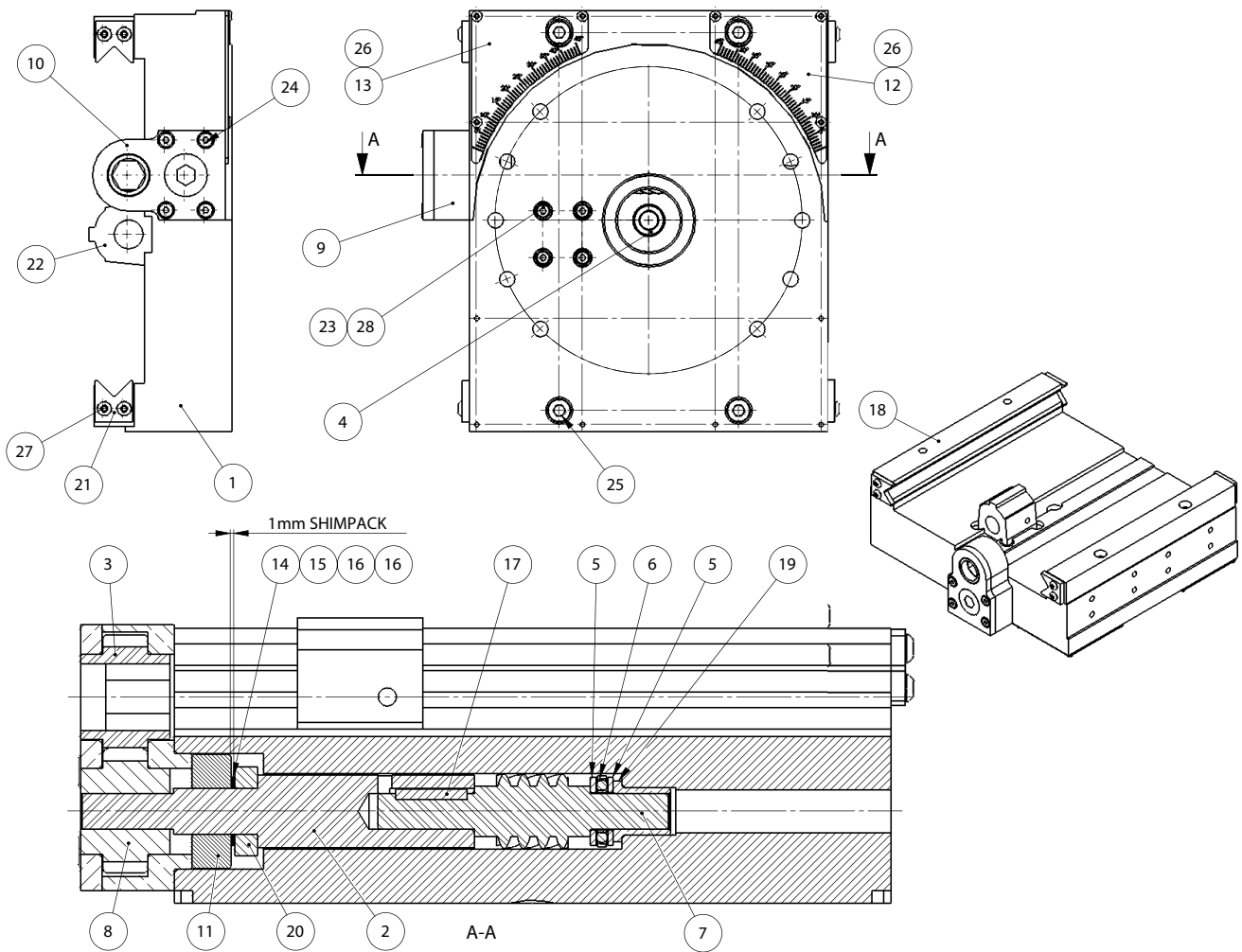


9.14 MM2000-i/ MM2000i-H Facing Arm (MM2000i-2, Revision N) Table of Parts

Item Number	Part Number	Description	QTY
1	MM2000i-2-001	Facing Arm	1
2	MM2000i-2-002	Backplate	1
3	MM2000i-2-003	1400 Arm Hex Bar	1
4	MM2000i-2-005	Toolpost Drive Coupling Shaft	1
5	MM2000i-2-006	Hex Drive Shaft	1
6	MM2000i-2-010	Wear Pad	1
7	MM2000i-2-009	Leadscrew	1
8	MMI 8306	20t Pick Up Gear	1
9	MMI 8347	End Stop	1
10	MMI 30327	PTO Gearbox Case	1
11	MMI 30328	PTO Gearbox Lid	1
12	MMIE 6348	Arm End Plate	1
13	MMIE 6350	Boring Plate	1
14	MM600IE-3	Power Carriage	1
15	MM1080IE-13	Selector Unit	1
16	M16 x 20	Eyebolt	2
17	M4 x 8	Socket Countersunk Head Screw	2
18	M8 x 25	Hex Socket Head	4
19		4 x 16 Spring Pin	2
20	M8	Washer - BS4320	1
21	M8 x 20	Hex Socket Head - BS EN ISO 4762	1
22	M6 X 16	Hex Socket Button Head	8
23	M6	Hex Thin Nut	4
24	M4 x 16	Hex Socket CTSK Head - BS EN ISO 10642	4
25	MMI8388A	modified M8 button head screw	28
26	MM2000i-27	END BEARING ASSEMBLY	1
27	M10X35SHCSA2SS	Hex Socket Head - BS EN ISO 4762	12
28	LWRPV 9 800	Vee Rail 9 Series	4
29	M5 x 5	Socket Set Screw Cone Point	1
30	M4 x 3	Socket Set Screw Flat Point	1
31	M6 x 12	Socket Set Screw Flat Point	4

9.15 MM2000i/MM2000i-H Power Carriage (MM600IE-3, Revision J) Views

Weight 9kg



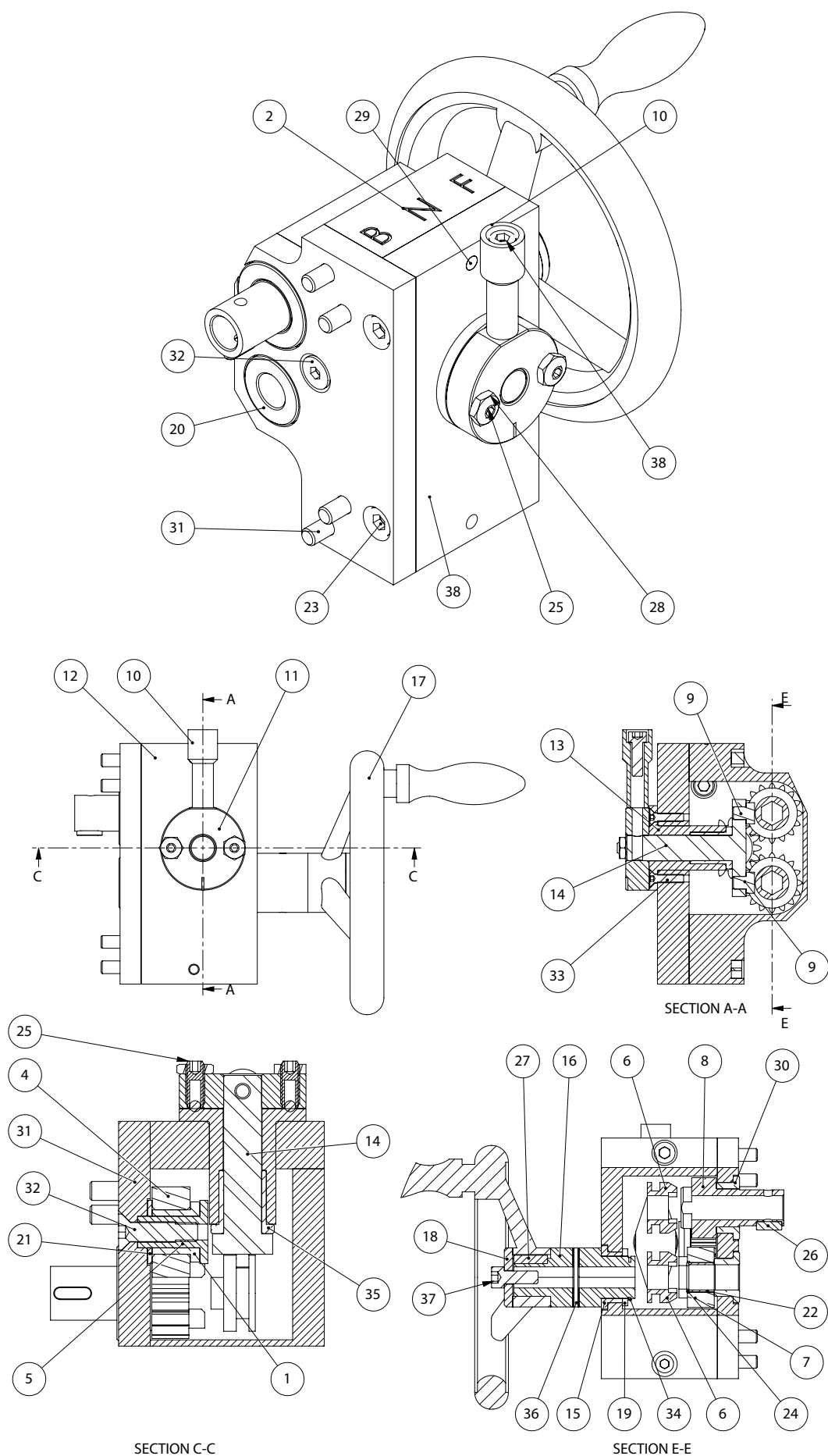
9.16 MM2000i/MM2000i-H Power Carriage (MM600IE-3, Revision J) Table of Parts

Item No.	Part Number	Description	QTY
1	MMIE 6340	CARRIAGE	1
2	MMIE 6342	PTO TRANSFER SHAFT	1
3	MMI 8306	20t PICK UP GEAR	1
4	MMI 8393 G	OILITE BUSH	1
5	MMI 8395 A	THRUST WASHER	2
6	MMI 8395B	Thrust bearing	1
7	MMI 30317	10T HELICAL GEAR TRANSFER SHAFT	1
8	MMI 30319	20t 16DP GEAR	1
9	MMI 30323	PTO GEARBOX CASE	1
10	MMI 30324	PTO GEARBOX CASE LID	1
11	MMI 30344	BEARING PRELOAD SPACER	1
12	MM600IE-3-001	R/H ANGLE LABEL	1
13	MM600IE-3-002	L/H ANGLE LABEL	1
14	CPS13x19x0.5	PRECISION SHIM	1

Item No.	Part Number	Description	QTY
15	CPS13x19x0.3	PRECISION SHIM	1
16	CPS13x19x0.1	PRECISION SHIM	2
17	KK3-20A	TYPE A KEY	1
18	MM600IE-3-003	'M' RAIL GUIDE	2
19	AMF101316	Flanged Oilite Bush	1
20	FT 1/2	THRUST BEARING	1
21	LWEARM9	WIPER	4
22	503-165-373-14	ballscrew nut	1
23	M4-BOLTRE-TAINER	M4 Bolt Retaining Washer	4
24	M5 x 30	Hex Socket Low Head	4
25	M8 x 60	Hex Socket Head	4
26	M3 x 6	Hex Socket Button Head	6
27	M4 x 10	Hex Socket Button Head - BS EN ISO 7380	8
28	M4 x 25	Hex Socket Head - BS EN ISO 4762	4

9.17 MM2000i/MM2000i-H Selector Unit (MM1080ie-13, Revision W) Views

Weight 3kg

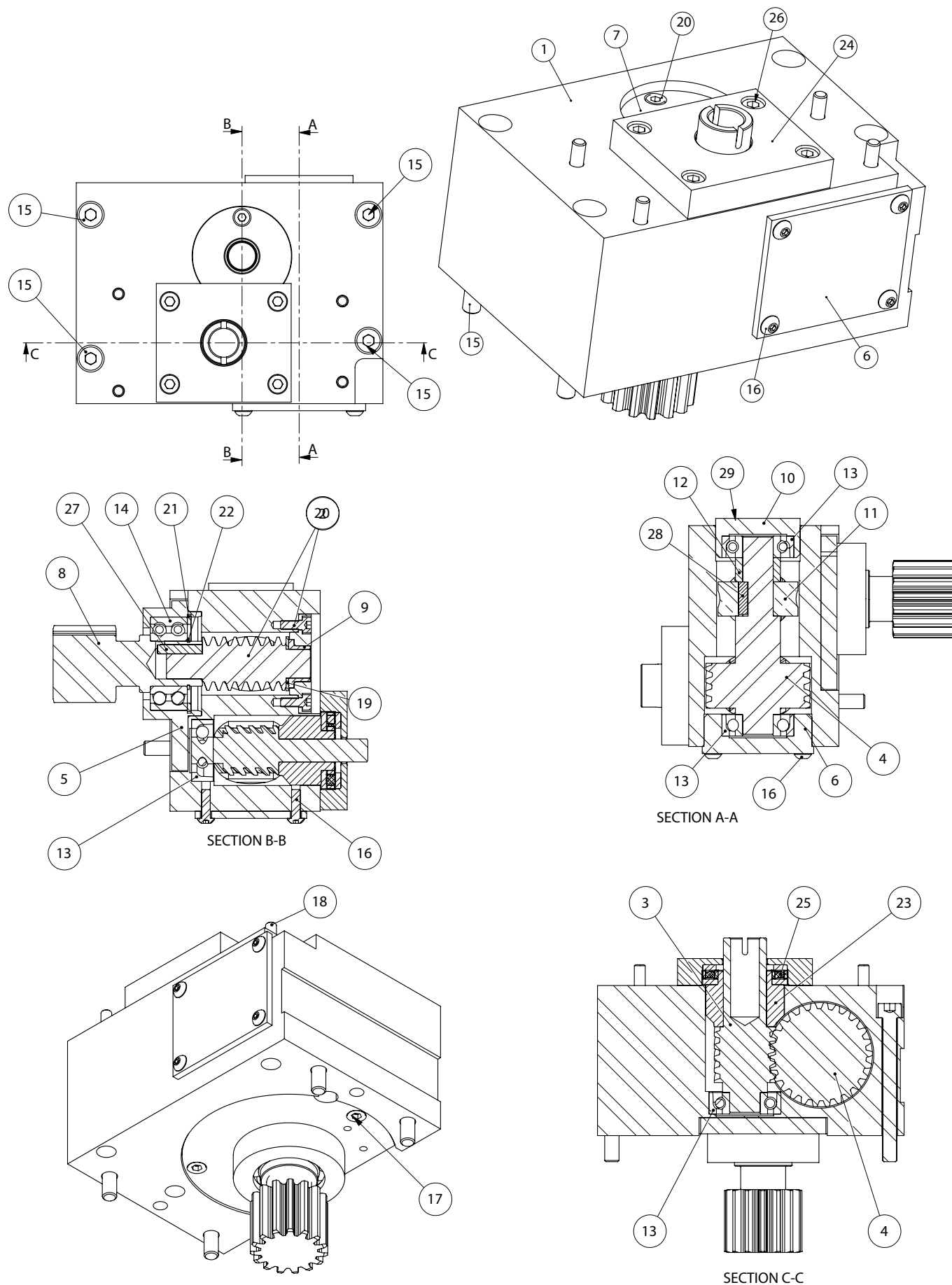


9.18MM2000i/MM2000i-H Selector Unit (MM1080ie-13, Revision W) Table of parts

Item Number	Part Number	Description	QTY
1	MM1080IE-13-001	Modified Flanged Oilite Bush	1
2	MMI 4346	GEARBOX COVER	1
3	MMI 4357	THUST PLATE	1
4	MMI 8216	16t REVERSE GEAR	1
5	MMI 8224	REVERSE SHAFT	1
6	MMI 8324	POWER SHAFT DOG	2
7	MMI 8325	16t GEAR	1
8	MMI 8326	16t gear on transfer shaft	1
9	MMI 8333	SELECTOR PIN	2
10	MMI 8235	GEAR SELECTOR HANDLE	1
11	MMI 8345	SURFACING ARM SELECTOR IDENT	1
12	MMI 30330	SELECTOR PLATE	1
13	MMI 30331	DRIVE IDENT HOUSING	1
14	MMI 30332	SELECTOR	1
15	MMI 30355	Modified Flanged Oilite Bush	1
16	MMI 30356	HANDWHEEL ADAPTOR	1
17	MMI 30357	handwheel	1
18	MMI 30358	CAPTIVE WASHER	1
19	MMI 30363	Captive washer	1
20	AMF121812	OILITE BUSH	1
21	WC08DU	DU THRUST WASHER	1
22	MB1212DU	DU BUSH	1
23	M6 x 20	Hex Socket Head	2
24	M2400 0120	Snap ring	1
25	31500.W0006	SPRING PLUNGER	2
26	KK4-12A	TYPE A KEY	1
27	KK4-16C	TYPE C KEY	1
28	M6 Nut	M6 Nut	2
29	M6 x 35	Hex Socket Head - BS EN ISO 4762	1
30	MMI3000-4-007	MODIFIED OILITE BUSH	1
31	M6 x 12	Hex Socket Head	4
32	M6 x 25	Hex Socket CTSK Head - BS EN ISO 10642	1
33	622034x16	M4X16 HEXAGON SOCKET COUNTERSUNK HEAD SCREW DIN 7991	2
34	Ø15	External Circlip	1
35	MM1080IE-13-002	Modified Flanged Oilite Bush	1
36	Ø3 x 28	Spring Pin (Slotted - LD)	1
37	M6 x 16	Hex Socket Head - BS EN ISO 4762	1
38	M5x0.8x20-SHCS-12.9-BZP	M5x0.8 GR 12.9-BZP Socket Head Cap Screw ISO 4762	2

9.19 MM2000i/ MM2000i-H Gearbox Support Unit (MM2000i-3, Revision J) Views

Weight 7kg



9.20 MM2000-i/ MM2000i-H Gearbox Support Unit (MM2000i-3, revision J)

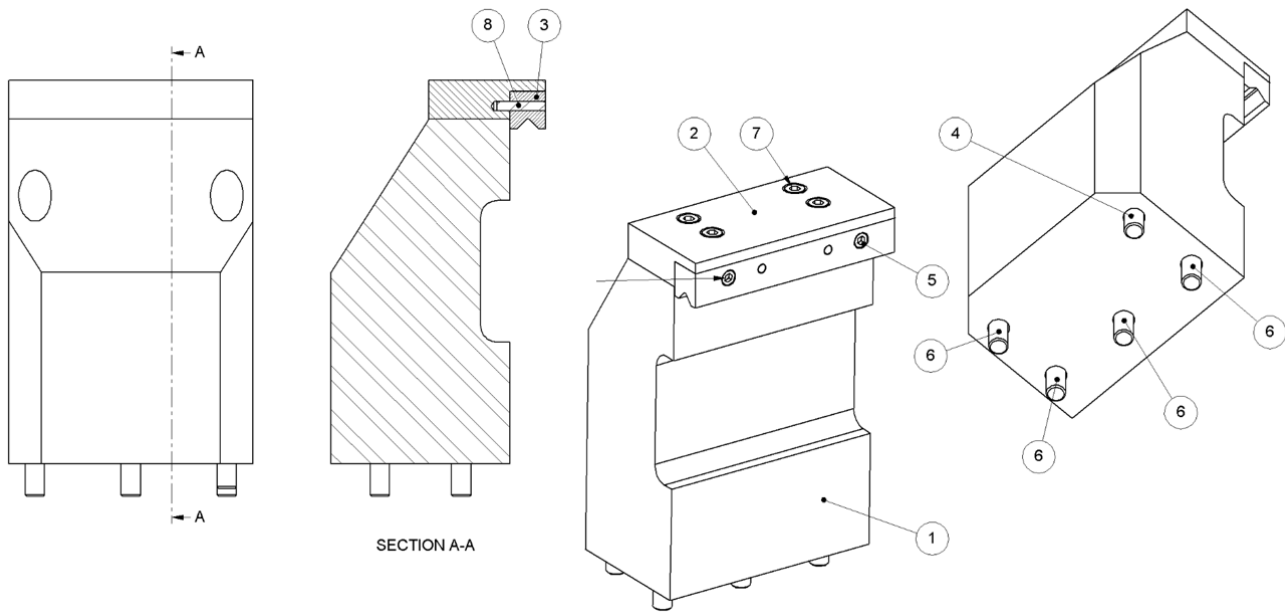
Table of Parts

Item Number	Part Number	Description	QTY
1	MM2000i-3-001	Gearbox Transfer Block	1
2	MM2000i-3-002	1 Start 12 DP Feed Worm R.H.	1
3	MM2000i-3-003	10t 12DP Cross Helical Gear R.H.	1
4	MM2000i-3-004	18t 12DP Cross Helical Gear R.H.	1
5	MM2000i-3-005	15t Pick Up Gear Support Cap	1
6	MM2000i-3-006	Bearing Cap	1
7	MM2000i-3-007	Worm Support	1
8	MM2000i-3-008	15t Pick Up Gear	1
9	MM2000i-3-009	Modified Oilite Bush AMF 162016	1
10	MM3000i-3-002	Bearing Cap	1
11	MMIE 6507	1 Start 18T 12 DP Wormwheel R.H.	1
12	MMIE 6511	Spacer	1
13	7203	Single Row Ang Con Brg	3
14	3205 2RS	double row ang con brg	1
15	M8 X 80	Hex Socket Head - BS EN ISO 4762	4
16	M5 x 16	Hex Socket Button Head	4
17	M6 x 12	Hex Socket Head - BS EN ISO 4762	3
18	M6 x 80	socket head cap screw	4
19	WC14DU	du thrust washer	1
20	M5 x 12	Hex Socket Head - BS EN ISO 4762	2
21	D1300 0520	INTERNAL CIRCLIP	1
22	D1400 0250	External Circlip	1
23	MM2000i-3-014	SPACER BOSS	1
24	MM2000i-3-015	BEARING HOUSING	1
25	81106 TN	CYLINDRICAL ROLLER THRUST BEARING	1
26	M6 x 16	Hex Socket Head - BS EN ISO 4762	4
27	KK5-25A	TYPE A KEY	1
28	KK5-18A	TYPE A KEY	1
29	M6X 16	CTSK FLAT HEAD CROSS RECESS SCREW BS EN ISO 7046-1 M6X16-Z-16N	4

9.21 MM2000-i/ MM2000i-H Arm Guide Support Assembly (MM2000i-4, Revision D)

Views

Weight 10kg



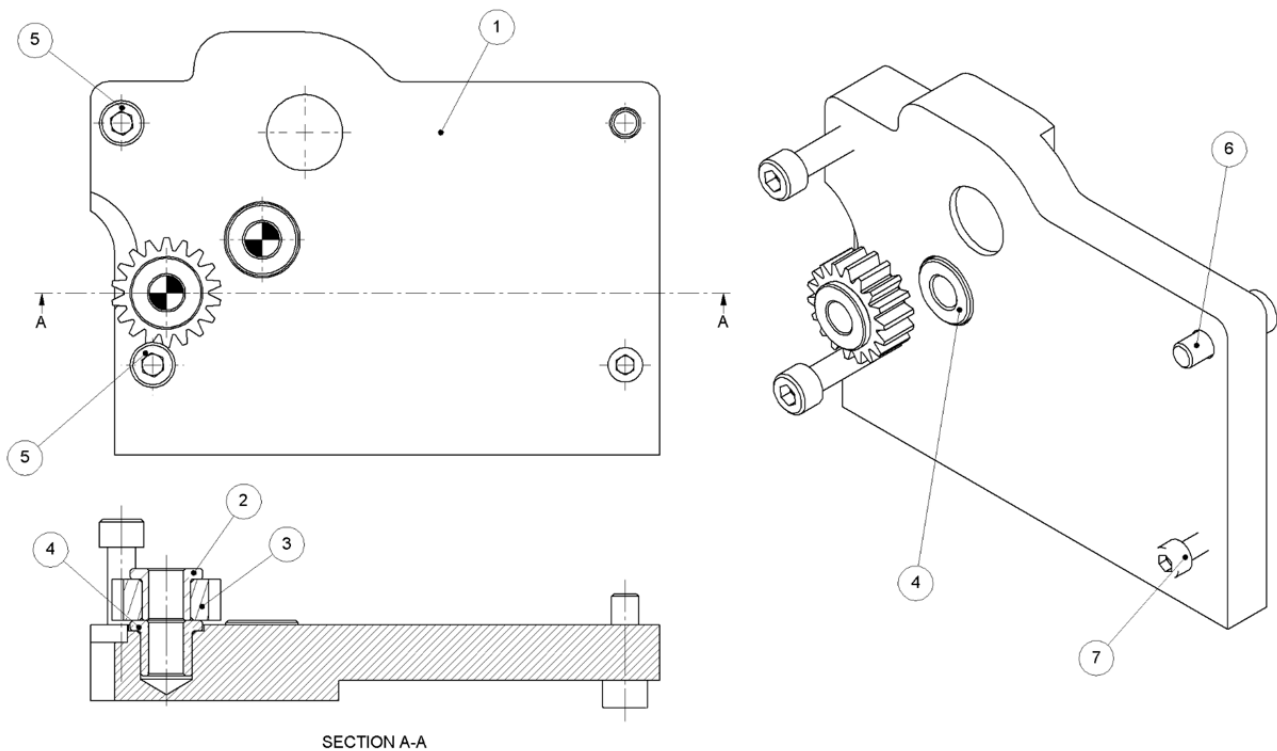
9.22 MM2000-i/ MM2000i-H Arm Guide Support Assembly (MM2000i-4, Revision D) Table of Parts

Item Number	Part Number	Description	QTY
1	MM2000i-4-001	Arm Guide Support Block	1
2	MM2000i-4-003	Guide Support Block	1
3	MM2000i-4-004	Rail Guide	1
4	M12 x 110	Socket Head Cap Screw	1
5	M6 x 25	Hex Socket Head	2
6	M12 x 120	Hex Socket Head	4
7	M8 x 30	Hex Socket Head - BS EN ISO 4762	4
8	6 x 30	Parallel Pin (Hard)	2

9.23 MM2000i/ MM2000i-H Transfer Bulkhead (MM2000i-8, Revision B)

Views

Weight1kg

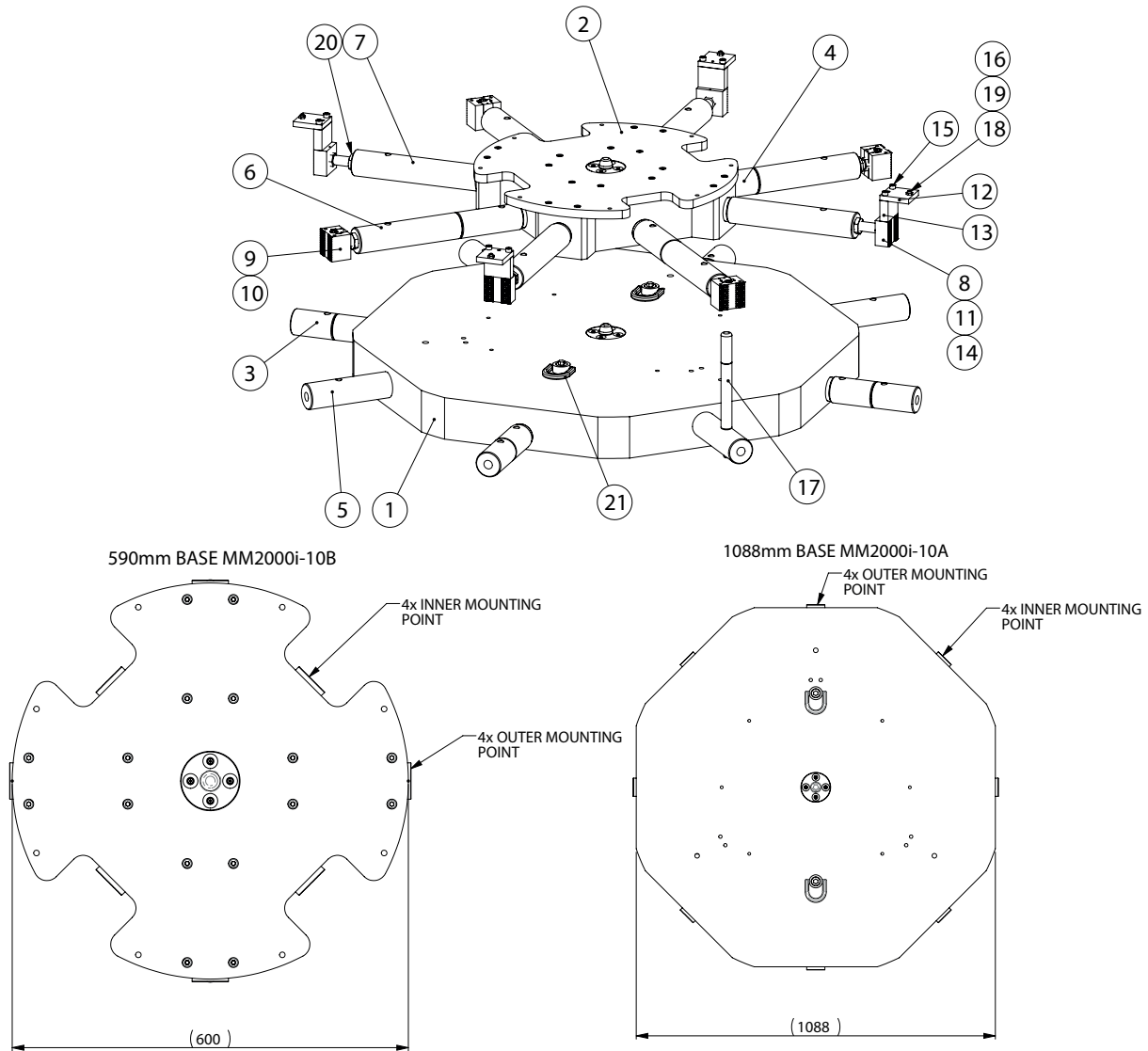


9.24 MM2000i/ MM2000i-H Transfer Bulkhead (MM2000i-8, Revision B) Table of Parts

Item Number	Part Number	Description	QTY
1	MM2000i-8-001	Bulkhead	1
2	MM860LT-2-007	Flanged Oilite Bush	1
3	MMI 8226	18t Output Gear	1
4	AMF101516	Flanged Oilite Bush	2
5	M8 x 35	Socket Head Cap Screw	2
6	M8 x 25	Hex Socket Head - BS EN ISO 4762	1
7	M6 x 25	Hex Socket Head - BS EN ISO 4762	1

9.25 MM2000i/ MM2000i-H Base Assembly (MM2000i-10, Revision E) Views

Weight 333kg



NOTES:
1. WHERE SPECIFIED IT IS RECOMMENDED THAT THE INNER AND OUTER MOUNTING POINTS ARE USED AT THE SAME TIME FOR MAXIMUM SECURING STRENGTH.

9.26 MM2000i/ MM2000i-H Base Assembly (MM2000i-10) Table of Parts

Item Number	Part Number	Description	QTY
1	MM2000i-10A	1088mm Base	1
2	MM2000i-10B	590mm Base Assembly	1
3	MM1500i-5-001	4" Extension	8
4	MM1500i-5-002	6" Extension	4
5	MM1500i-5-003	8" Extension	4
6	MM1500i-5-004	10" Extension	4
7	MM1500i-5-005	12" Extension	4
8	MM1500i-5-006	Plain Jaw Pad	4
9	MM1500i-5-008	Adjustable Jaw Assembly	4
10	MMI 8426	Small Ram Bolt	4
11	MMI 8427	Large Ram Bolt	4

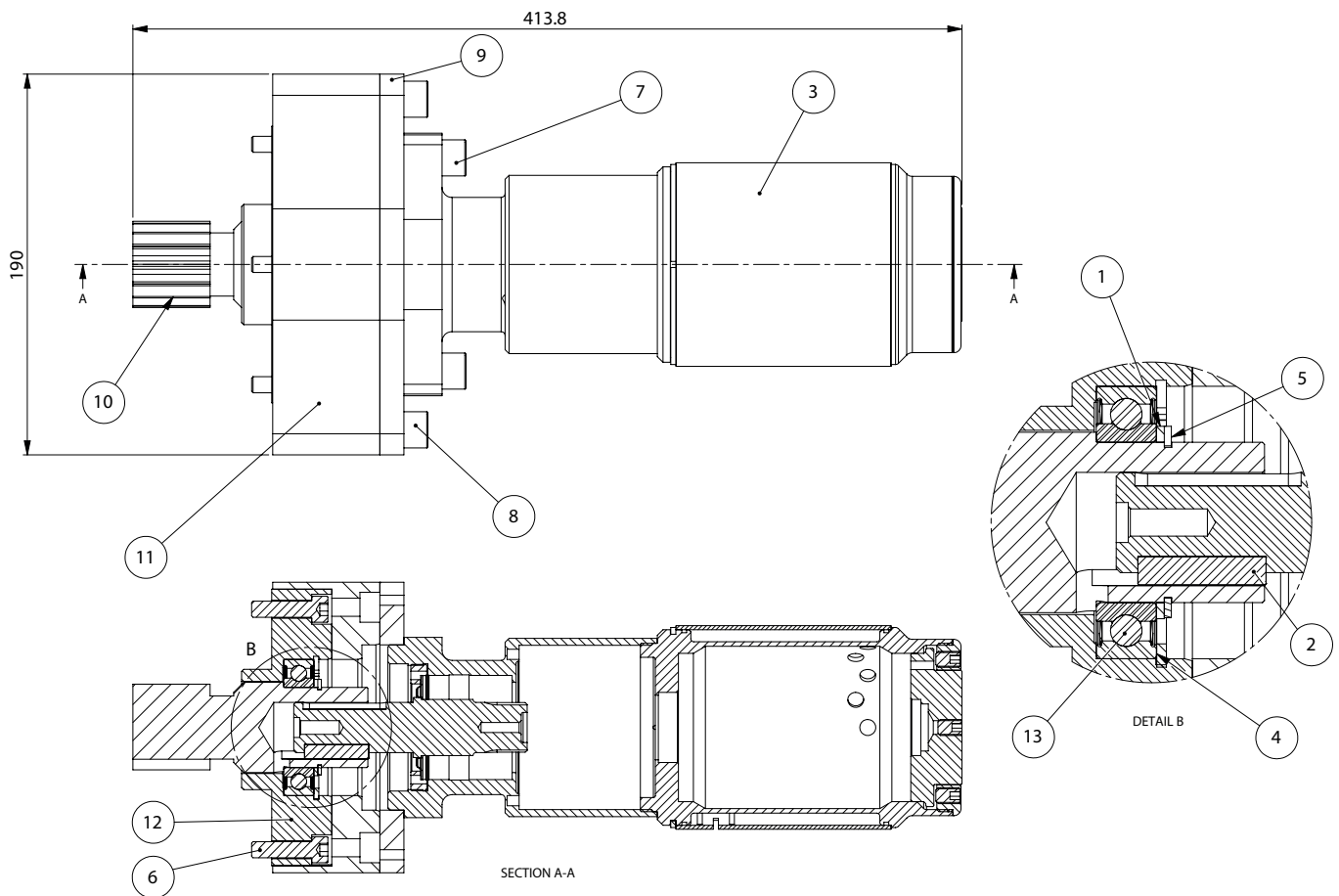
Item Number	Part Number	Description	QTY
12	MM1500i-5-009	Setting Strap Plate	4
13	MM2000i-10-001	Spacer Block	4
14	3150.W004	Spring Plunger	4
15	M8 x 80	Hex Socket Head - BS EN ISO 4762	8
16	M6 x 55	Hex Socket Head	4
17	MMI 18420	Tommy Bar	1
18	M8 x 20	Socket Set Screw Flat Point	4
19	M8	Hex Thin Nut Grade B - BS EN 24036	4
20	ISO 8675 Thin Nut M22 x 1.5 BZP	ISO 8675 Thin Nut M22x1.5	8
21	RLP-M10-10	ROTATING LIFTING POINT	2

Clamping Arrangements Table for MM2000i-10 Base Assembly

MAX CLAMPING Ø	MOUNTING POINTS	1088mm BASE MM2000i-10A	590mm BASE MM2000i-10B	MM1500i-5-001 4" EXTENSION	MM1500i-5-002 6" EXTENSION	MM1500i-5-003 8" EXTENSION	MM1500i-5-004 10" EXTENSION	MM1500i-5-005 12" EXTENSION	MMI 8427 LONG RAM BOLT	MMI 8426 SHORT RAM BOLT	MM1500i-5-006 PLAIN JAW PAD	MM1500i-5-008 ADJ. BLOCK
24"	OUTER		✓						✓			✓
	INNER											
26"	OUTER		✓						✓			✓
	INNER											
28"	OUTER		✓						✓	✓	✓	✓
	INNER											
30"	OUTER		✓						✓			✓
	INNER			✓						✓	✓	
32"	OUTER		✓						✓		✓	✓
	INNER			✓						✓		
34"	OUTER		✓						✓			✓
	INNER			✓						✓	✓	
36"	OUTER		✓	✓						✓	✓	
	INNER				✓				✓			✓
38"	OUTER		✓	✓						✓	✓	
	INNER				✓				✓			✓
40"	OUTER		✓	✓					✓		✓	
	INNER					✓				✓		✓
42"	OUTER		✓		✓					✓		✓
	INNER					✓			✓		✓	
44"	OUTER		✓		✓				✓		✓	
	INNER						✓			✓		✓
46"	OUTER		✓			✓				✓	✓	
	INNER						✓		✓			✓
48"	OUTER		✓			✓			✓		✓	
	INNER							✓		✓		✓
	OUTER	✓								✓	✓	
	INNER							✓	✓			✓
50"	OUTER		✓				✓			✓	✓	
	INNER	✓						✓	✓			✓
	OUTER								✓			✓
	INNER									✓		
52"	OUTER		✓					✓		✓	✓	
	INNER			✓		✓			✓			✓
54"	OUTER		✓			✓		✓		✓	✓	
	INNER				✓				✓			✓
55"	OUTER		✓					✓		✓		✓
	INNER				✓		✓		✓		✓	
56"	OUTER	✓		✓					✓		✓	✓
	INNER			✓						✓		
58"	OUTER	✓		✓					✓		✓	✓
	INNER			✓						✓		
60"	OUTER	✓		✓					✓		✓	✓
	INNER				✓					✓		
62"	OUTER	✓		✓					✓		✓	✓
	INNER				✓					✓		
64"	OUTER	✓			✓				✓		✓	✓
	INNER					✓				✓		
66"	OUTER	✓			✓				✓		✓	✓
	INNER					✓				✓		
68"	OUTER	✓				✓			✓			✓
	INNER						✓			✓	✓	
70"	OUTER	✓				✓			✓		✓	✓
	INNER						✓			✓		
72"	OUTER	✓					✓		✓		✓	✓
	INNER							✓		✓		

9.27 MM2000i Drive Gear Unit - Pneumatic (MM2000i-18, Revision A) Views

Weight 18kg

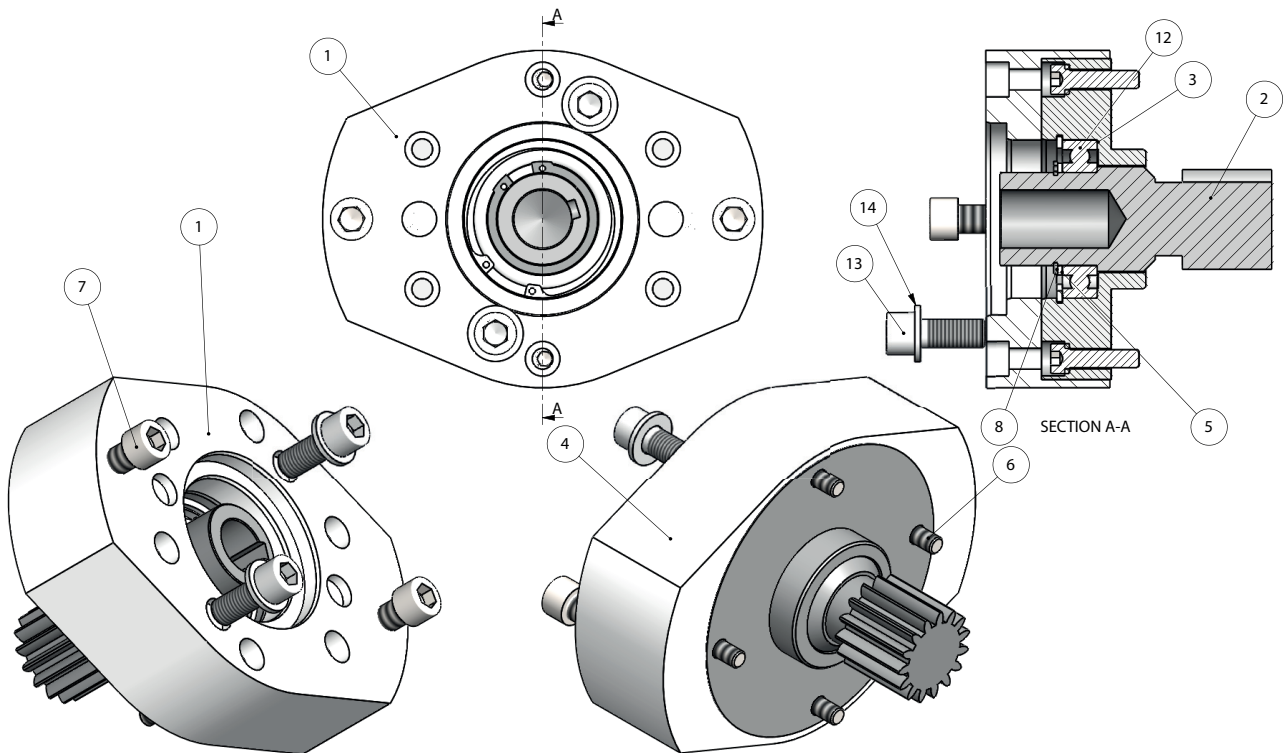


9.28 MM2000i Drive Gear Unit - Pneumatic (MM2000i-18, Revision A) Table of Parts

Item Number	Part Number	Description	QTY
1	MMIE601304	Washer	1
2	MM1080IE-35-003	Type A Key	1
3	MT30LT0145HCL4F	Air Motor	1
4	D1300 0680	Internal Circlip	1
5	D1400 0400	External Circlip	1
6	M8 x 30	Hex Socket Head	4
7	M12 x 30	Hex Socket Head	2
8	M12 x 35	Hex Socket Head	2
9	MM13000-5-002	QR Turning Flange	1
10	MM13000-5-003	15 Tooth Drive Gear	1
11	MM13000-5-005	Motor Mount Housing	1
12	MM13000-5-004	15t Gear Housing	1
13	6008-2RS	Radial Bearing	1

9.29 MMI3000-5 Drive Gear unit - Turning - Hydraulic (MMI3000-5, Revision D) Views

Weight 9kg

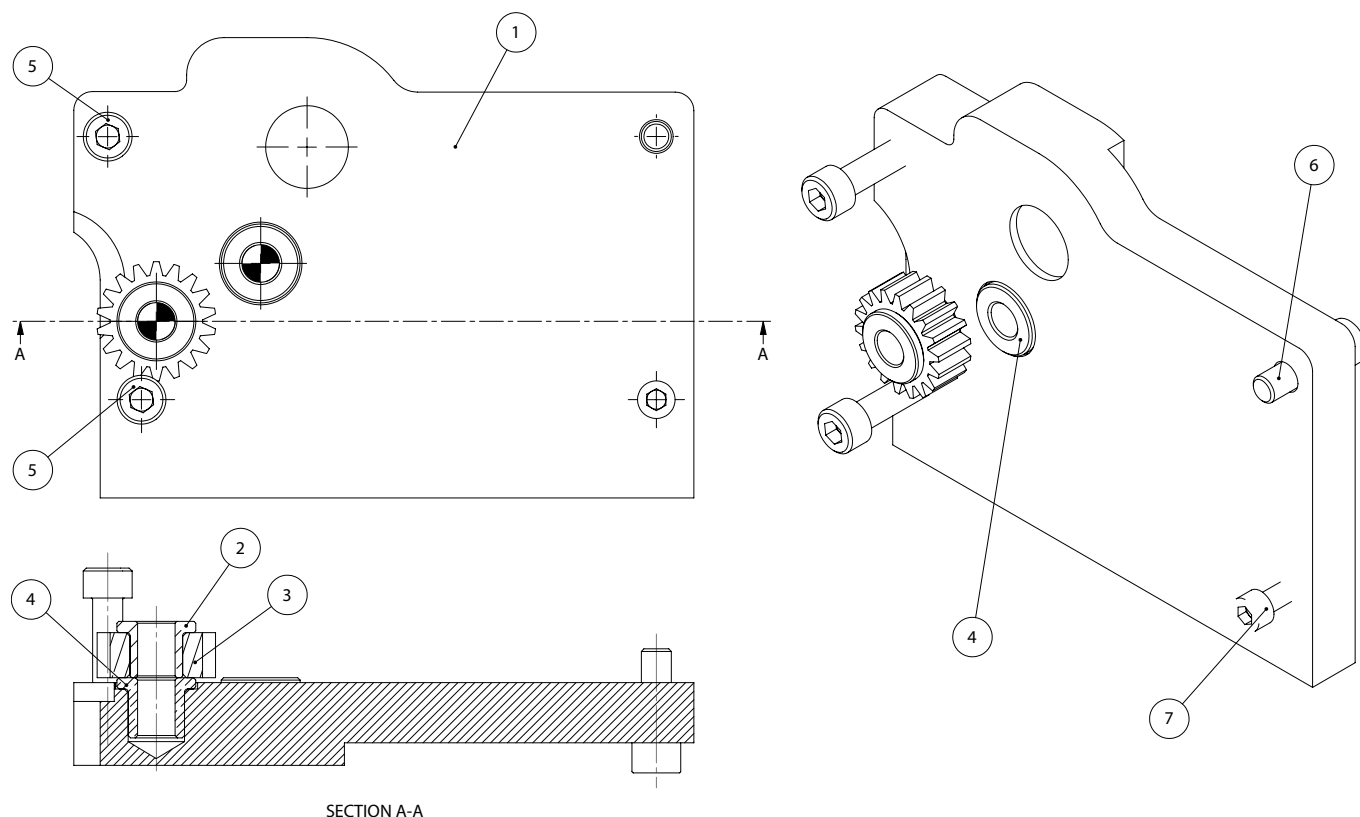


9.30 MM2000i-H Drive Gear Unit - Hydraulic (MMI3000-5, Revision D) Table of Parts

Item Number	Part Number	Description	QTY
1	MMI3000-5-002	QR Turning Flange	1
2	MMI3000-5-003	15 Tooth Drive Gear	1
3	MMI3000-5-004	15t Gear Housing	1
4	MMI3000-5-005	Motor Mount Housing	1
5	MMIE601304	Washer	1
6	M8 x 30	Hex Socket Head	4
7	M12 x 35	Hex Socket Head	2
8	D1400 0400	EXTERNAL CIRCLIP	1
9	D1300 0680	INTERNAL CIRCLIP	1
10	OMP160	151-0314	1
11	OMP 250	151-0316	1
12	6008-2RS	Deep Groove Ball Bearing - 40 x 68 x 15mm	1
13	M12 x 30	Hex Socket Head - BS EN ISO 4762	2
14	Bright washer BS 4320 - M12	WASHER (FORM A)	2

9.31 MM2000i/MM2000i-H Transfer Bulkhead (MM2000i-8, Revision B) Views

Weight 1kg



9.32 MM2000i/MM2000i-H Transfer Bulkhead (MM2000i-8, Revision B) Table of Parts

Item Number	Part Number	Description	QTY
1	MM2000I-8-001	BULKHEAD	1
2	MM860LT-2-007	Flanged Oilite Bush	1
3	MMI 8226	18t OUTPUT GEAR	1
4	AMF101516	Flanged Oilite Bush	2
5	M8 x 35	Socket Head Cap Screw	2
6	M8 x 25	Hex socket head	1
7	M6 x 25	Hex socket head	1

Weight 18kg



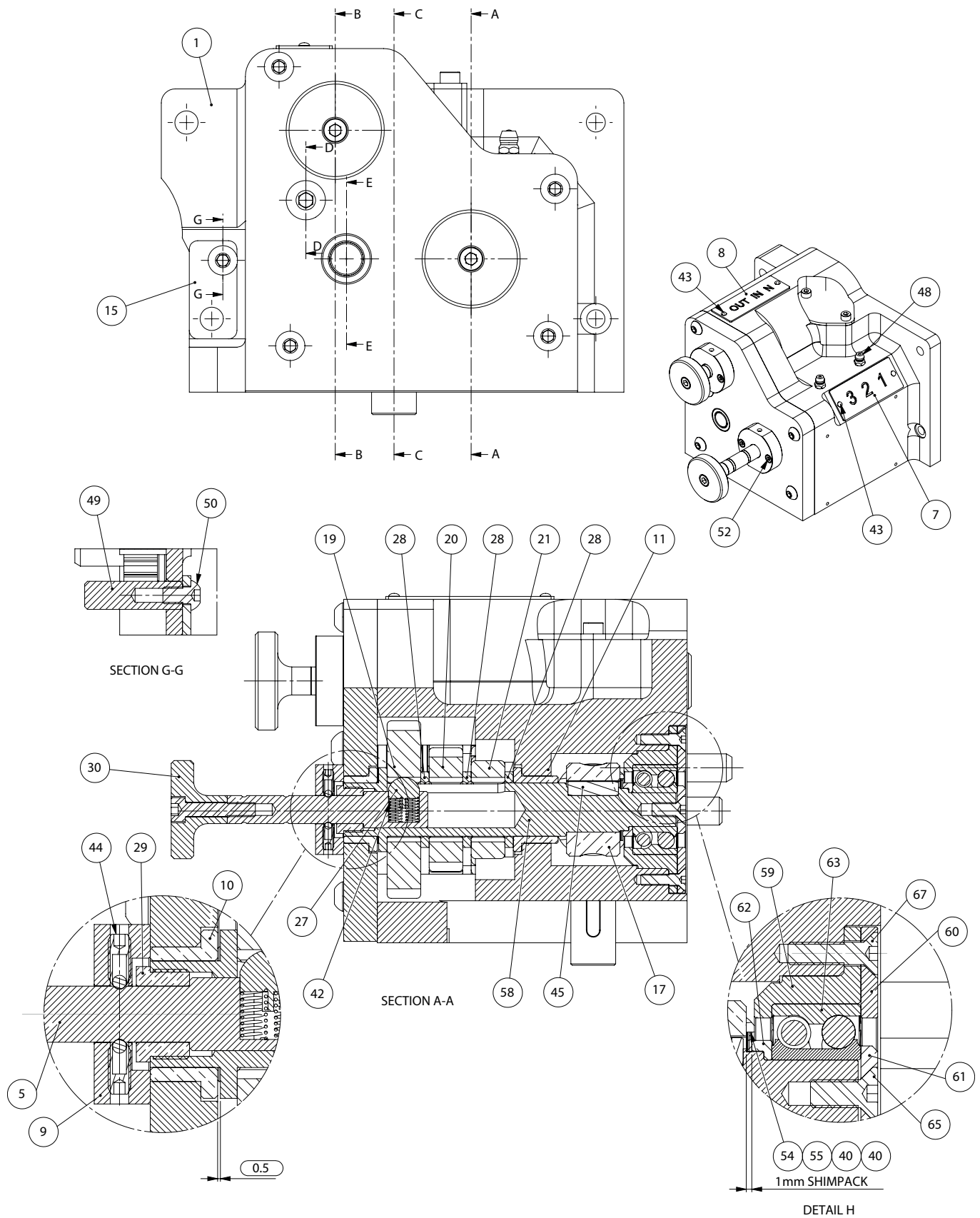
9.34 MM2000i/MM2000i-H Toolpost Assembly (MM1080IE-2, Revision K)

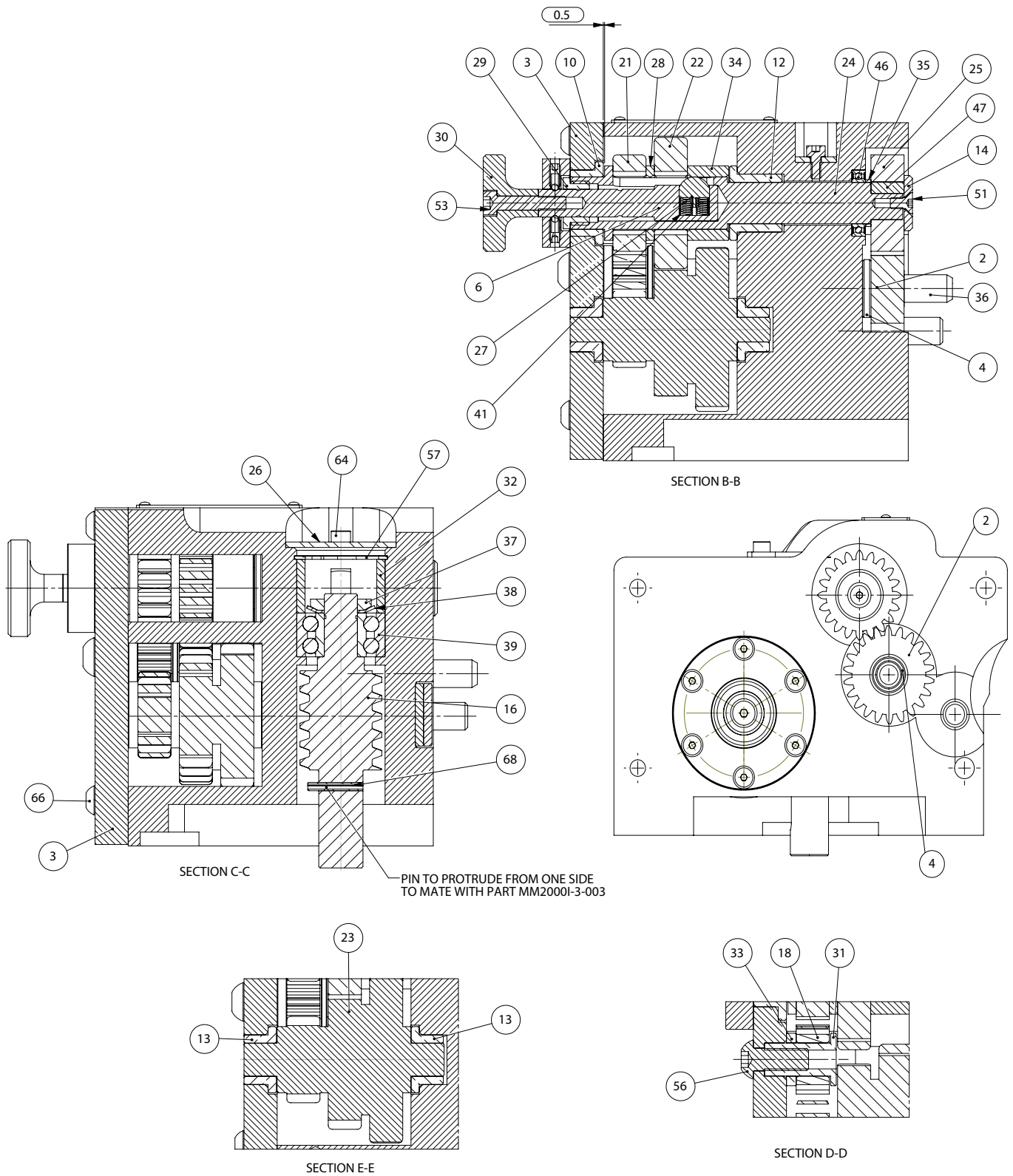
Table of Parts

Item Number	Part Number	Description	QTY
1	MMI 8312	Toolpost Feed Screw	1
2	MMI 8317	Rack	2
3	MMI 8335	10t Gear on Shaft	1
4	MMI 8352	Gear Spacer	1
5	MMI 8383	Toolholder & Handwheel Assembly	1
6	MMI 8395 A	Thrust Washer	4
7	MMI 8395 B	Thrust Bearing	2
8	MMI 30314	Toolpost	1
9	MMI 30315	Toolpost Swivel Plate	1
10	MMI 30318	18t Helical Gear	1
11	MMI 30321	End Plate	1
12	MMI 30322	Toolpost End Plate	1
13	MMI 30348	Toolpost Extension	1
14	MMI 30349	Toolpost Side Extension	1
15	MMI 30350	10 Helical Gear Toolpost Feed	1
16	MMI 30351	10 Helical Gear Draft Shaft	1
17	MMI 30353	Spacer	1
18	MMI 30354	GIB Strip	1
19	AMF 101316	Flanged Bush	1
20	3200-2RS	Double Row Ang Con Brg	1
21	D1300 0300	Internal Circlip	1
22	Ø3 x 16	Spring Pin (Slotted - HD)	1
23	KK3-15A	Type A Key	1
24	KK3-30A	Type A Key	1
25	M5 x 25	Hex Socket Head St St	4
26	M6	Thin Nut	8
27	M6 x 10	Hex Socket Button Head	2
28	M6 x 12	Hex Socket Button Head - BS EN ISO 7380	4
29	M6 x 20	Hex Socket Head - BS EN ISO 4762	22
30	M6 x 35	Socket Set Screw Cone Point	8
31	AMF 101310	OILITE BUSH	1
34	IND-106-2010K	PCLNL 2020K12 (LH)	1
35	IND-106-2000K	PCLNR 2020K12 (RH)	1
36	M4 x 5	Socket Set Screw Flat Point - BS 4168-2	1
37	34020.W0064	THRUST SCREW HEADED M6x30.8	1
38	LCM065D 11 M	COMPRESSION SPRING, OD 7.49 WIRE DIA 0.66, ZP	1

9.35 MM2000i/ MM2000i-H 3 Speed Gearbox (MM2000i-29, Revision F) Views

Weight 5kg





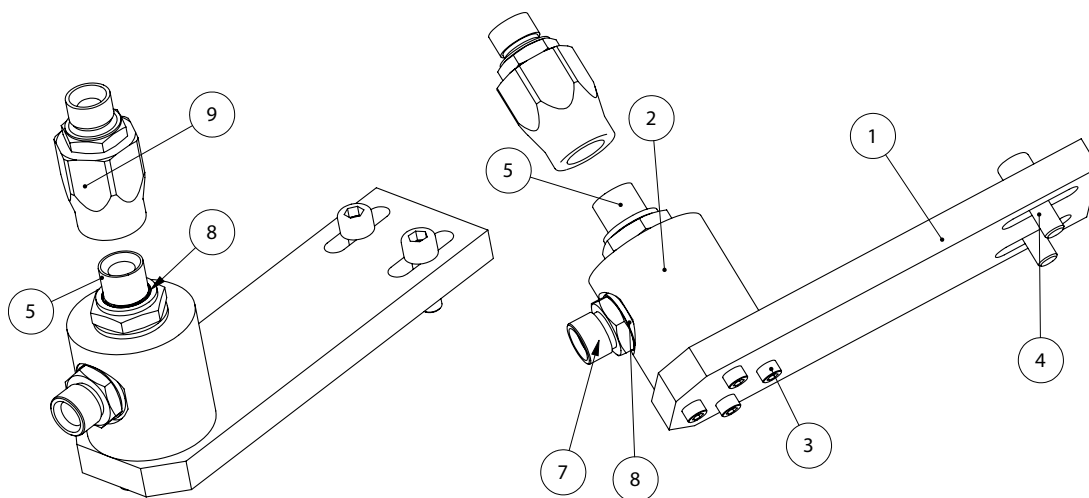
9.36 MM2000i/ MM2000i-H 3 Speed Gearbox (MM2000i-29, Revision F) Table of Parts

Item Number	Part Number	Description	QTY
1	MM860LT-2-002	Gearbox Housing	1
2	MM860LT-2-003	22t 16DP Gear	1
3	MM860LT-2-004	Gearbox Lid	1
4	MM860LT-2-007	Flanged Oilite Bush	1
5	MM860LT-2-008	Selector Shaft	1
6	MM860LT-2-010	Selector Shaft	1
7	MM860LT-2-013	Label - Speed	1
8	MM860LT-2-015	Label - Direction - MM3000i	1
9	MM860LT-2-016	RR Clip Housing	2
10	MM860LT-2-017	Oilite Bush	2
11	MM860LT-2-018	Oilite Bush	1
12	MM860LT-2-019	Oilite Bush	1
13	MM860LT-2-020	Oilite Bush	2
14	MM860LT-2-023	Captive Washer	1
15	MM860LT-2-004	Keeper Plate	1
16	MM1500i-20-002	1 Start 16 DP Worm	1
17	MM1500i-20-003	18t 16 DP 1 Start Wormwheel	1
18	MMI 2209	14t Idler Gear	1
19	MMI 7616	38t 16 DP Gear	1
20	MMI 7617	26t 16 DP Gear	1
21	MMI 7618	20t 16 DP Gear	2
22	MMI 7619	28t 16 DP Gear	1
23	MMI 7620	38t 30t 18t 16 DP Gear Stack	1
24	MMI 7623	FR Shaft	1
25	MMI 7625	20t 16 DP Output Gear	1
26	MMI 7627	Bearing Cover	1
27	MMI 7632	Selector Key	2
28	MMI 7634	Gear Spacer	4
29	MMI 7637	Selector End Cap	2
30	MMI 7638	Selector Knob	2
31	MMI 7639	Idler Post	1
32	MMI 7654	Bearing Trapping Ring	1
33	MMI 7657	Idler Washer	1
34	MMI 7680	Selector Key Parking Sleeve	1
35	MMI 7690	Gearbox Spacer	1
36	MMI 8265	Long Location Dowel	1
37	KM1	Locknut	1
38	MB1-OU	Lock Washer	1
39	3201-2RS	Double Row Ang Con Brg	1
40	CPS15x22x0.1	Precision Shim	2
41	5	Compression Spring	2
42	5	Compression Spring	2

Item Number	Part Number	Description	QTY
43	N0 2 x 3/16"	Hammer Drive Screw	4
44	3150.W004	Spring Plunger	4
45	KK5-18A	Rounded End Feather Key	1
46	61802-2RS	Single Row Deep Groove Ball Bearing	1
47	KK4-12C	Type C Key	1
48	M6	Straight Grease Nipple	2
49	Ø10 x 35	Extractable Dowel	1
50	M6 x 10	Hex Socket Button Head	1
51	M4 x 8	Socket Countersunk Head Screw	1
52	M3 x 12	Hex Socket Head	4
53	M5 x 25	Hex Socket Head St St	2
54	CPS15x22x0.5	Precision Shim	1
55	CPS15x22x0.3	Precision Shim	1
56	M8 x 20	Hex Socket Button Head	1
57	D1300-0320	DIN 472 Internal Circlip	1
58	MM1080IE-33-005	Selector Sleeve	1
59	MM1080IE-33-001	Bearing Housing	1
60	MM1080IE-33-002	Bearing Cap	1
61	MM1080IE-33-004	Retaining Washer	1
62	MM1080IE-33-003	End Float Spacer	1
63	3201-2RS	Angular Contact Bearing	1
64	M4 x 8	Hex Socket Head	2
65	M5 x 12	Hex Socket CTSK Head	1
66	M6 x 25	Hex Socket Button Head - BS EN ISO 7380	4
67	M4 x 16	Hex Socket CTSK Head - BS EN ISO 10642	6
68	Ø3 x 20	Spring Pin (Slotted - HD)	1

9.37 MM2000i Air Distributor Assembly (MM1080IE-39, revision G) Views

Weight 3.5kg

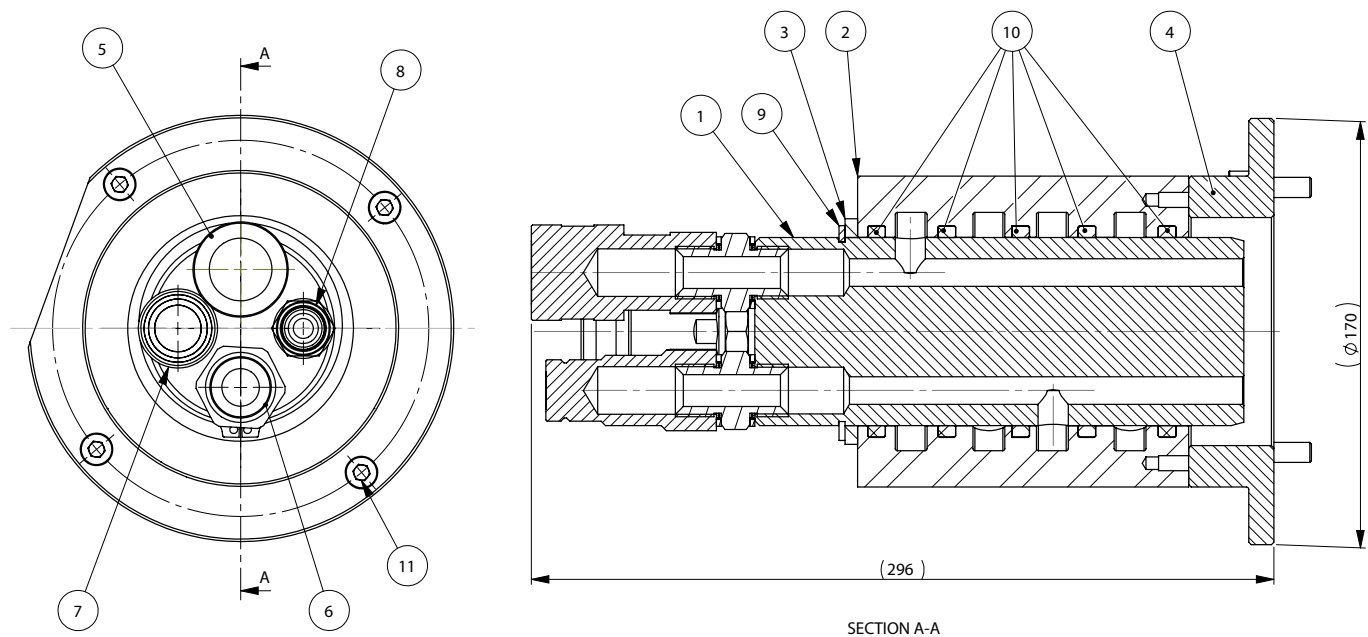


9.38 MM2000i Air Distributor Assembly (MM1080IE-39, Revision G) Table of Parts

Item Number	Part Number	Description	QTY
1	MM1080IE-39-002	Air Distributor Mounting Plate	1
2	MM1080IE-39-001	Air Distributor	1
3	M6 x 30	Hex Socket Head	4
4	M10 x 30	Hex Socket Head	2
5	1/2-3/4" MALE-MALE	3/4" BSPP Make x 1/2" BSPP Male	1
6	D400 027 12	3/4" Dowty Washer	1
7	BMBM 0808	BSP STRAIGHT MALE 1/2 -MALE 1/2	1
8	DOWTY08	1/2" Dowty Washer	3
9	HMFS08	BSP SWIVEL ADAPTOR 1/2"	1

9.39 MM2000i-H Distributor Assembly (MM2000i-19, Revision B) Views

Revision B

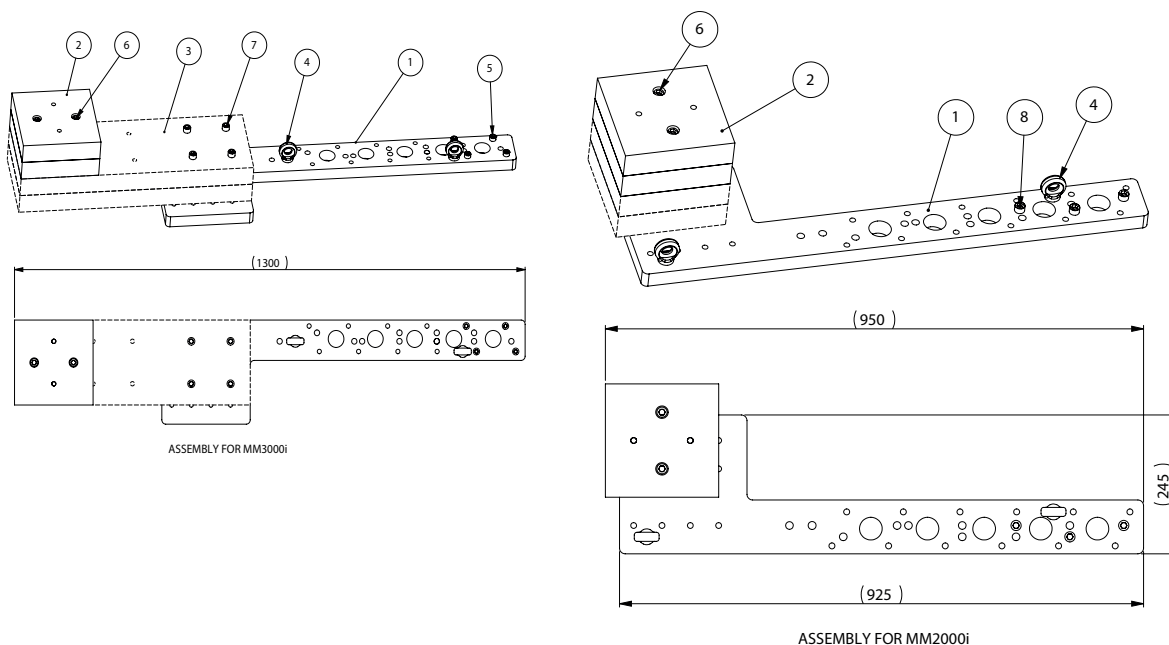


9.40 MM2000i-H Distributor Assembly (MM2000i-19, Revision B) Table of Parts

Item Number	Part Number	Description	QTY
1	SRB3000-H-9-001	DISTRIBUTOR POST	1
2	WP4300-1004	distributor	1
3	MMI30151	distributor washer	1
4	MM2000i-19-001	DISTRIBUTOR SPACER	1
5	1/2" QRCOUPPING-FEMALE	1/2" QUICK RELEASE COUPLING FEMALE	1
6	1/2" QRCOUPPING-MALE	1/2" QUICK RELEASE COUPLING MALE	1
7	3/8" QRCOUPPING-FEMALE	3/8" QUICK RELEASE COUPLING FEMALE	1
8	3/8" QRCOUPPING-MALE	3/8" QUICK RELEASE COUPLING MALE	1
9	D1400-0750	RETAINING RING	1
10	S/55403/0750/S	DOUBLE DELTA SEAL	5
11	M8 x 25	Hex Socket Head - BS EN ISO 4762	4
12	M6 x 35	Hex Socket Head	4
13	3/8" WASHER	DOWTY WASHER	4
14	1/2" WASHER	DOWTY WASHER	2
15	1/2" M-M CONNECTOR	MALE - MALE 1/2" CONNECTOR	2

9.41 MM2000i/MM2000i-H Counter weight Assembly (MM3000i-39, Revision B) Views

Weight 152kg

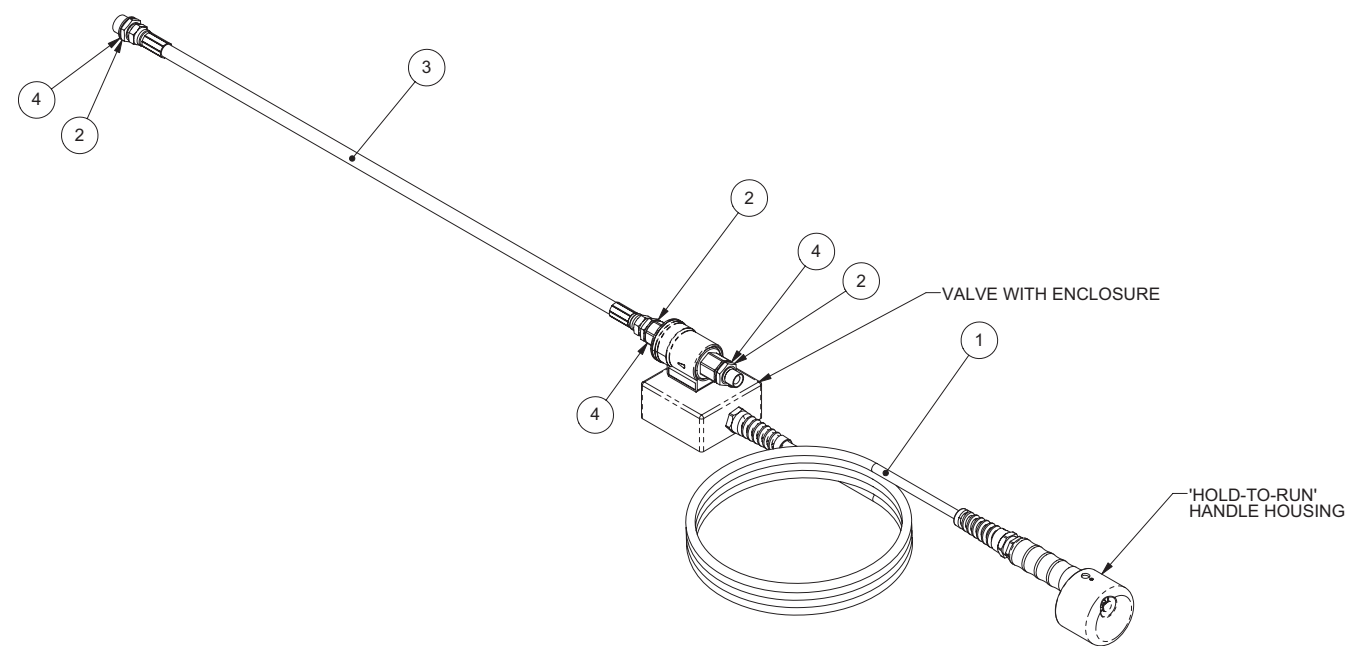


9.42 MM2000i/MM2000i-H Counter Weight Assembly (MM3000i-39, Revision B) Table of parts

Item Number	Part Number	Description	MM2000 QTY	MM3000 QTY
1	MM3000i-39-001	BALANCE PLATE	1	1
2	NEG0147	BALANCE WEIGHT	4	2
3	MMI3000-1-012	Balance plate	-	2
4	M16COLLARED-EYE-BOLT	EYEBOLT	2	2
5	CCZ1029028-1A	M10X40 GR12-9 SOCKET HEAD CAP SCREW COARSE ISO 4762 (BZP)	-	4
6	CCZ1243028-1A	SCREW-SHCS, FLAT, HEX, M12X1.75X80, STL/12.9, ZINC	8	4
7	CCZ1253028-1A	SCREW-SHCS, FLAT, HEX, M12X1.75X130, STL/12.9, ZINC	-	4
8	CCZ1229028-1A	SCREW-SHCS, FLAT, HEX, M12X1.75X40, STL/12.9, ZINC	3	-

For MM2000i and MM2000i-H machines use 'MM2000 QTY' column above.

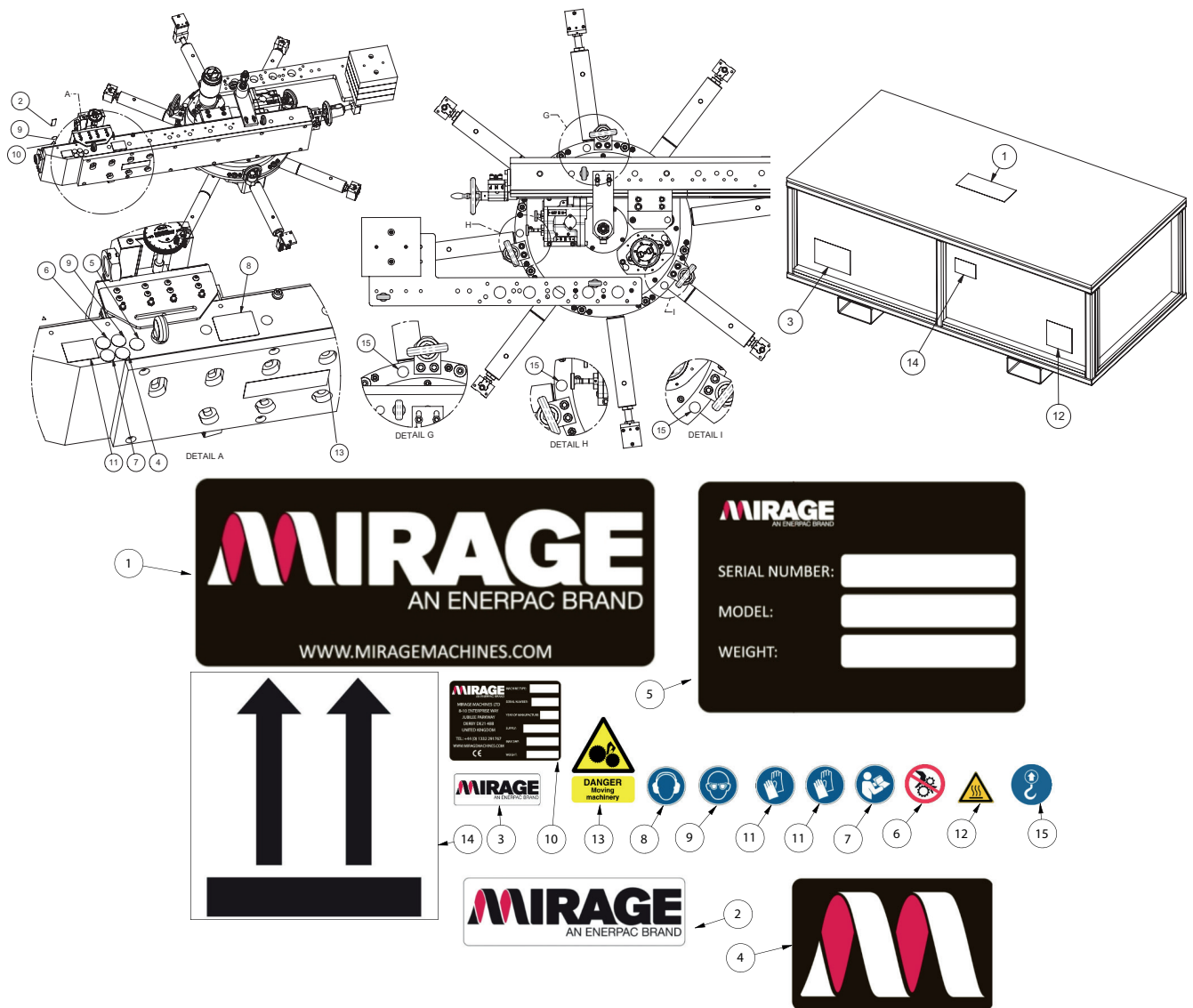
9.43 MM2000i Pneumatic Dead Man's Handle (DMH-Pneumatic, Revision D) Views



9.44 MM2000i Pneumatic Dead Man's Handle (DMH-Pneumatic, Revision D) Table of Parts

Item Number	Part Number	Description	QTY
1	DMH1	Dead Man's Handle	1
2	3/4" - 1/2" Adaptor M-M	3/4" BSPP Male x 1/2" BSPP Male Adaptor	3
3	1/2" Hose - 1000 F-F	1/2" x 1/2" BSPP Female-Female Hose	1
4	D400 027 12	3/4" Dowty Washer	3

9.45 Label Pack (LABEL-PACK-6, Revision A) Views



9.46 Label Pack (LABEL-PACK-4) Table of Parts

Item Number	Part Number	Description	QTY
1	LABEL-MM-001	Box Packaging Sticker with WEB address (285 x 116)	2
2	LABEL-MM-003	Machine Logo Sticker - Medium (148 x 45)	1
3	LABEL-MM-004	Machine Logo Sticker - Small (55 x 20)	1
4	LABEL-MM-005	Box Packaging 'M' Sticker (122 x 86)	2
5	LABEL-MM-007	Box Contents Sticker (210 x 148 - A5)	2
6	LABEL-MM-008	Prohibition Label "Fingers out - rotating machinery" ISO 7010 (Ø25)	1
7	LABEL-MM-009	Mandatory Label "Refer to instructions" ISO 7010 - M002 (Ø25)	1
8	LABEL-MM-020	Mandatory Label "Wear ear protection" ISO 7010 - M003 (Ø19)	1
9	LABEL-MM-021	Mandatory Label "Wear eye protection" ISO 7010 - M004 (Ø19)	1
10	LABEL-MM-033	CE Aluminium Label (70 x 50)	1
11	LABEL-MM-064	Mandatory Label "Wear protective gloves" ISO 7010 - M009 (Ø25)	2
12	LABEL-MM-065	Warning Label "Hot Surface" ISO 7010 - W017 (21.5 x 25)	1
13	LABEL-MM-066	Warning Label "Danger - Moving Machinery" (40 x 50)	1
14	LABEL-MM-087	Label 'This Way Up' (150 x 150)	2
15	LABEL-MM-088	Mandatory Safety Label: "Lift Point" ISO 3864-2	3

9.47 MM2000i / MM2000i-H Tool kit

Part Number	Description	QTY
DCGT11T304-PM2-WXN10	11 SEAT .4MM RAD INSERTS	10
KEN0903250K	1/2"SQX3" COBALT TOOLBIT	1
KEN1001060K	44 P20/P30 BRAZED TOOL	1
KEN5801270K	27MM BLACK OPEN ENDED SPANNER	1
KEN5822610K	10MM COMBINATION SPANNER	1
KEN5822770K	24MM COMBI SPANNER	1
KEN5930520K	POCKET PLAIN CHISEL ROLL	1
KEN5932320K	TOOLBOX WITH TOTE AND ORGANISER	1
KEN6015140K	14MM ALLEN KEY LONG ARM	1
KEN6025500K	BALL DRIVER L WRENCHES	1
KEN6026200K	10MM T-HANDLE BALL DRIVER	1
MAGNETIC-BACK-900928	MAGNETIC BACK - MITUTOYO 900928	1
MIT3253587E	MITUTOYO DIGIMATIC DIAL TEST INDICATOR 2046S 58MM DIA	1
SDJCL2020K11	LEFT HAND TOOLHOLDER FOR DC STYLE INSERTS	1
SDJCR2020K11	RIGHT HAND TOOLHOLDER FOR DC STYLE INSERTS	1
SDNCN1616H11	TOOL HOLDER: NEUTRAL	1
SPRINGPIN-3X28	SPRING PIN (SLOTTED - LD)	10

10. Troubleshooting



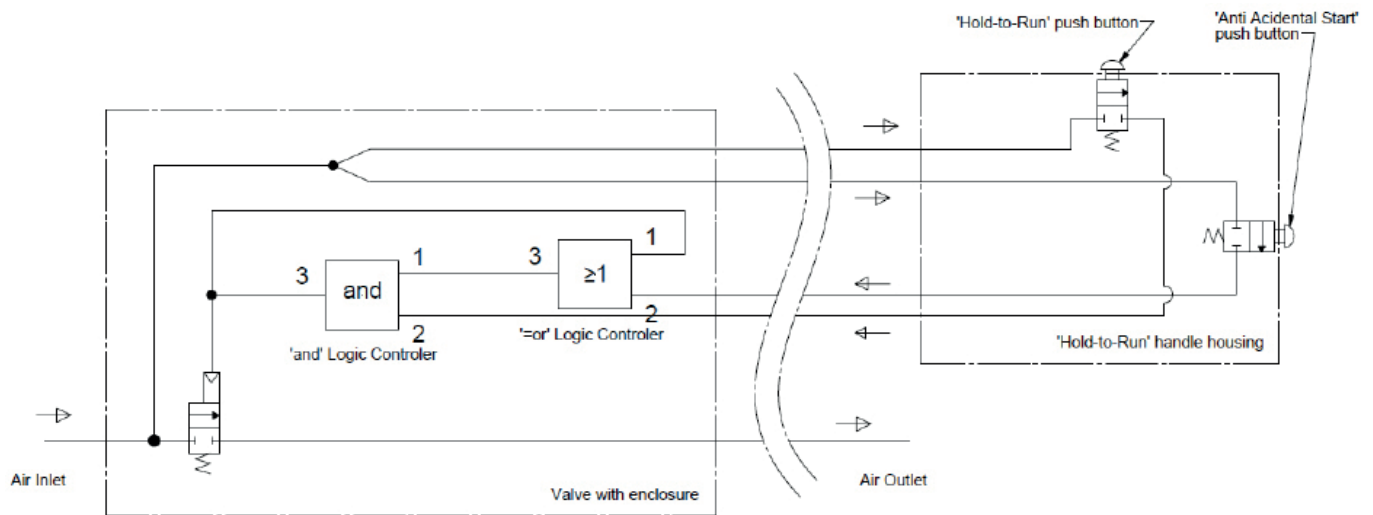
NO MACHINE ADJUSTMENTS SHOULD BE MADE WHILE THE MACHINE IS IN OPERATION. TURN AND LOCK OFF THE ISOLATION VALVE ON THE PNEUMATIC SUPPLY BEFORE MAKING ANY ADJUSTMENTS.

Symptom	Possible Cause	Corrective Action
The machine will not rotate	1. Supply not available	Check supply
	2. Supply is below the minimum required to operate the machine	Check supply
	3. Drive motor faulty	Remove motor and check operation
	4. Damage to drive gear train	Remove motor and check free rotation
	5. Faulty valve or emergency shut off operational	Check supply to motor
The machine does not traverse	1. The feed selector is not correctly positioned and the facing feed gears are not engaged	Check position
	2. The direction selector is in neutral or not correctly engaged – if both gears are engaged this should not rotate	Remove and check drive assembly operation
	3. Drive key problem	Remove and check gearbox assembly operation
	4. Carriage has been run off the lead screw	Check lead screw nut and screw are engaged
Poor surface finish on the face	1. Machine out of balance	Check balance
	2. Machine base incorrectly installed	Check installation
	3. Machine installation bolts not tightened	Check bolts
	4. Turning tool not ground correctly or worn	Check tool & replace
	5. Depth of cut too deep	Reduce depth of cut
	6. Too much play in Toolpost gib strip or carriage	Adjust Toolpost & carriage
	7. Too much play in main hub bearings	Adjust bearing dampers
	8. Worn drive motor	Check motor
	9. Poorly adjusted surfacing arm	Check and adjust
	10. General poor machine condition	Refer to the Enerpac

Appendix - Additional Reference Material

A Additional Schematic diagrams

A1 Hold-to-run schematic diagram



B Additional Technical Data

B1 Recommended general torque settings for fasteners

Thread Ø	Tensile Strength		Torque Setting	
	kN	lbs	Nm	in-lbs
M3	6.54	1470	2.1	19
M4	11.4	2560	4.6	41
M5	18.5	4160	9.5	85
M6	26.1	5870	16	140
M8	47.6	10700	39	350
M10	75.4	17000	77	680
M12	110	24700	135	1200
M14	150	33700	215	1900

Thread Ø	Tensile Strength		Torque Setting	
	kN	lbs	Nm	in-lbs
M16	204	45900	330	2900
M20	306	68800	650	5750
M22	374	83950	875	7725
M24	441	99100	1100	9700
M30	701	158000	2250	19900
M32	860	193500	3050	27000
M36	1020	229000	3850	34100

B2 Cutting feed and speed calculations

To find	Using	Metric		English	
Cutting speed	RPM, Dia	m/min	$V = \text{RPM} \times 0.00314 \times \text{Dia}$	Ft / min	$V = \text{RPM} \times \text{Dia} \times 3.82$
RPM	V, Dia	Revs/min	$\text{RPM} = \frac{V}{3.14 \times \text{Dia}} \times 1000$	Revs / min	$\text{RPM} = \frac{V}{3.82 \times \text{Dia}}$
Feed rate	RPM, FPT, NT	mm/min	$\text{FR} = \text{RPM} \times \text{FPT} \times \text{NT}$	Inches/min	$\text{FR} = \text{RPM} \times \text{FPT} \times \text{NT}$
Feed per Tooth	FR, RPM, NT	mm/tooth	$\text{FPT} = \frac{V}{\text{RPM} \times \text{NT}}$	Inches/tooth	$\text{FPT} = \frac{V}{\text{RPM} \times \text{NT}}$
Feed / Rev	RPM, FR	mm/Rev	$\text{FRR} = \text{FR} / \text{RPM}$	Inches/Rev	$\text{FRR} = \text{FR} / \text{RPM}$
Metal removal	DC, RC, FR	cm ³ /min	$\text{MR} = \text{DC} \times \text{RC} \times \text{FR} \times 1,000$	Inches ³ /min	$\text{MR} = \text{DC} \times \text{RC} \times \text{FR}$
Horse Power	MR, C, WC, PC	HP	$\text{HP} = \text{MR} \times \text{C} \times \text{WC} \times \text{PC} \times 0.015$	HP	$\text{HP} = \text{MR} \times \text{C} \times \text{WC} \times \text{PC}$

V = cutting speed (m/min or Ft/min)

Dia = Diameter of cutting tool

RPM = spindle revs /min

FPT = Feed per tooth (mm or Inches)

NT = Number of teeth

FR = Feed rate (mm/min or inches/min)

FRR = Feed rate per revolution

DC = axial depth of cut

RC = radial engagement of cut (mm or inches)

MR = Metal removal rate (cm³/min or inches³/min)

HP = horse power (estimate of the power required at the motor assumes 75% efficiency)

C = cutting edge constant (from table 1)

WC = wear constant (from table 2)

PC = power constant (from table 3)

Table 1 (Use FPT number in feed rate calculation to obtain cutting edge constant C)							
Feed in	C	Feed in	C	Feed mm	C	Feed mm	C
0.002	1.40	0.018	0.94	0.02	1.40	0.45	0.94
0.004	1.25	0.020	0.90	0.10	1.25	0.50	0.90
0.006	1.15	0.025	0.86	0.15	1.15	0.60	0.86
0.008	1.08	0.030	0.83	0.20	1.08	0.75	0.83
0.010	1.04	0.035	0.80	0.25	1.04	0.90	0.80
0.012	1.00	0.040	0.78	0.30	1.00	1.00	0.78
0.014	0.97	0.050	0.75	0.35	0.97	1.25	0.75
0.016	0.94	0.060	0.72	0.40	0.94	1.50	0.72

Table 2 (Determine the type of operation to obtain constant W)	
Type of operation	W
Turning – finishing cuts	1.00 – 1.10
Turning – roughing cuts	1.60 – 2.0
Milling – finishing cuts	1.10 – 1.25
Milling – Heavy metal removal face milling	1.30 – 1.60
Drilling – normal to hard to drill materials	1.30 – 1.50

Table 3 (Determine material to obtain constant PC)				
Material Type	Hardness - HB	Tensile Strength – n/mm ²	PC (inch)	PC (metric)
Plain carbon steels	<200	< 700	0.51 – 0.62	1.39 – 1.69
Free machining and stainless steels	< 260	< 850	0.74 – 0.92	2.02 – 2.51
Alloy steels	< 340	< 1200	0.80 – 1.00	2.18 – 2.73
High alloy steels and castings	< 450	< 1500	1.00 - 1.20	2.73 – 3.28
Aluminium		< 300	0.25 – 0.33	0.68 – 0.90
Cast iron	< 300		0.63 – 0.86	1.72 – 2.35
Stainless steel	< 340	< 1200	0.80 – 1.00	2.02 – 2.51
Heat resistant super alloys		< 1250	1.00 – 1.10	2.73 – 3.00

B3 Flange face surface finish

ANSI / ASME 16.5, 16.47, 16.42 - ISO 7005-1

Finish	Surface Finish	Feed Rate
RF - Stock finish	125-500 μ in	0.032"
	3.2-12.5 μ m	0.80mm
RF - Smooth	125-250 μ in	0.012"
	3.2-6.3 μ m	0.30mm
Hydrogen	79-125 μ in	0.008"
	2-3.2 μ m	0.20mm
RTJ	32-63 μ in	0.008"
	0.8-1.6 μ m	0.20mm

Micrometer μ m	Micro - inch μ in	Roughness Grade N	Roughness Grade ∇
12.5	500	N10	∇
6.3	250	N9	$\nabla\nabla$
3.2	125	N8	$\nabla\nabla$
1.6	63	N7	$\nabla\nabla$
0.8	32	N6	$\nabla\nabla\nabla$
0.4	16	N5	$\nabla\nabla\nabla\nabla$

NOTES

[illegible]

