



OPERATION MANUAL

VS-1 SP / VS-2 SP XL

Super Precision Turret Milling Machine



Operation and Maintenance Manual

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1 Safety

This manual covers the safe operation and maintenance of the MACH VS-1 SP and VS-2 SP XL vertical turret milling machines. Keep it beside the machine, or somewhere the operator can reach it easily, so that the machine is always used safely and efficiently.

■ WARNING

Even a well-designed machine can cause a serious accident if it is operated incorrectly. Take every precaution when you use this machine.

1.1 About this manual

- A machine that is properly managed and maintained lasts longer and is less likely to cause an accident.
- Every operator must fully understand and follow the safety rules, safe working methods and operating instructions in this manual, to avoid injury and damage to the machine.
- This manual cannot cover every situation at every customer's site. Operators must use their own knowledge to prevent any hazard that may arise in their particular circumstances.
- If an accident does happen, analyse its cause so that it cannot happen again.
- MACH Machine Tools welcomes comments and suggestions on these safety guidelines and on the machines.
- MACH Machine Tools accepts no liability for accidents or damage that follow any change to the machine's circuits, structure or parts made without its authorisation.
- All figures in this manual are for reference only. They are not to scale and do not show exact detail.
- MACH Machine Tools reserves the right to change the design, operation and construction of its machines without notice.
- When the machine is delivered, check that the reference number in this manual matches the number on the machine.

1.2 Warranty and delivery check

- New machines carry a one-year warranty from MACH Machine Tools. Faults arising in normal use are repaired free of charge. Damage caused by incorrect operation is not covered.
- When the machine arrives, check all accessories against the accessory list. Report anything missing or damaged to MACH Machine Tools or your MACH dealer.
- Quote the machine number whenever you contact MACH Machine Tools or your dealer for service.

1.3 General safety precautions

- Machine metal workpieces only. Never machine wood, or flammable or toxic materials.
- Only personnel who have received special training, and who fully understand the machine's characteristics, dimensions and safety rules, may operate or maintain the machine.
- Employers must send their operators on safety training.
- Employers must tell operators about every hazardous operation they know of.
- Always read this manual before you operate the machine. When you operate or maintain the machine, always follow the warning labels on it.
- Keep all doors and guards properly closed, except when you are making an adjustment or alignment.
- Do not move, change or clean the workpiece while the spindle is running or an operation is in progress.
- Know where the stop and emergency stop buttons are, so that you can react at once to a sudden hazard.
- Always wear safety goggles, safety shoes and a mouth cover (dust mask).
- Do not wear gloves, loose clothing, a necktie or long sleeves while the machine is operating.
- Wear a hard hat, or tie up your hair if it is long.
- Keep the area around the machine and the worktable clean. Clear away all obstructions and chips.
- Wear gloves when you load or unload a workpiece. Use a lifting device to move any object over 30kg.
- Do not use machine tools during machine operations.
- Switch off the power before any maintenance. Use only suitable tools.
- Make sure the workpiece is secured before machining, using a suitable fixture where needed. Leave clearance between the cutting tool and the workpiece to avoid a collision.
- Do not leave the machine once the spindle motor is started. If you must leave, switch off the power.
- Place nothing on top of the machine except workpieces and tools.
- After the power is switched off, never use your hand or any object to stop the spindle or tool. Let it come to rest by itself.
- Do not use compressed air to clean the machine.
- Do not modify the machine to take extra-large workpieces or tools.
- Keep everyone except the operator away from the machine. Do not lean against the machine.

1.4 Electrical safety

- Never maintain or inspect the electrical equipment unless you are a qualified technician.
- Never bypass the interlock circuit.
- Before you inspect the circuit, follow the related warning labels.
- When you inspect the circuit, use a suitable tester to confirm that the circuit is open (dead).
- Never modify the circuit without prior authorisation from MACH Machine Tools.
- Make sure all electrical equipment is properly earthed.
- Remove metal watches, rings, necklaces and spectacles before you repair or maintain electrical equipment. Put up a warning sign so that nobody switches the power on by accident.

1.5 Safe operation and care

- Keep the cutting tool well away from the workpiece when you start or stop the machine.
- If the machine breaks down, stop using it and have it repaired at once.
- Stop the machine before you inspect the workpiece.
- Keep the spindle clean and lubricated. Do not place tools on the worktable, to preserve the accuracy and finish of its surface.
- Use a brush to clear away metal chips.

1.6 Safety labels and safety features

The following warnings appear on the machine as labels or are built into its design. Obey them at all times.

■ WARNING

Do not put your hand on the table, and do not take hold of the workpiece, until the spindle has completely stopped. Label on the machine: CAUTION: DO NOT TOUCH TOOL WHILE SPINDLE IS RUNNING.

■ WARNING

Switch off the spindle power when you change tools. Label on the machine: CAUTION: DO NOT TOUCH TOOL WHILE SPINDLE IS RUNNING.

■ CAUTION

Before and after you use the elevating handle, check that the clutch gear is fully separated by the safety spring (Figure 1-1). Label on the machine: CAUTION: DISENGAGE THE CLUTCH OF ELEVATING HANDLE BEFORE TURN ON & OFF THE SWITCH.

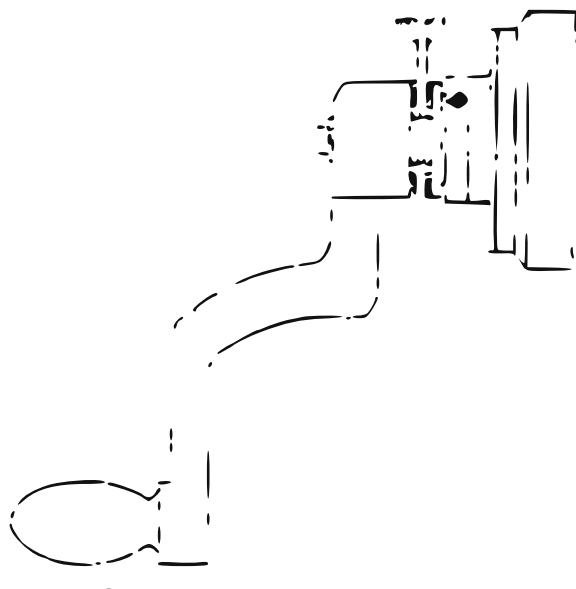


Figure 1-1: Elevating handle with the clutch disengaged

■ **WARNING**

Parts that carry electricity are marked with a warning label. Switch off the power before you dismantle them.

NOTE The machine has a safety interlock: when the electrical cabinet door is opened, the power is switched off automatically.

2 Specifications

This chapter gives the specifications, load limits and overall dimensions of both models. Where a value applies to one model only, it appears in that model's column.

2.1 Machine specifications

Table 2-1: Machine specifications (unit: mm)

Item	VS-1 SP	VS-2 SP XL
Working area of table	1067 x 230	1370x250
Manual table travel (X/Y/Z)	762/305/406	870/410/450
Auto. table travel (X/Y/Z)	700/305/406	780/410/450
Distance between spindle and table surface	0 - 440	
Spindle taper	NST#30 or R8 (NST#40 special specified)	NST#30 or R8 (NST#40 special specified)
Spindle speed r.p.m.	70 - 4200 (60Hz) / 50 - 3500 (50Hz)	70 - 4200 (60Hz) / 50 - 3500 (50Hz)
Quill travel	127	127
Feed area (per spindle revolution)	0.04/0.08/0.14	0.04/0.08/0.14
Distance between the column and the spindle, tilted in 45°	0 - 285	—
Distance between the column and the spindle centreline, 90°	171 - 482	180 - 680
Distance between the column and the spindle, tilted out 45°	228 - 533	—
Ram travel	457	500
Angle of rotation of ram	360°	360°
Motor	3HP 3-PH	3HP 3-PH
Net weight	950	1500

NOTE Longitudinal length is the distance measured with the table extended longitudinally across the saddle.

NOTE Specifications are subject to confirmation. Check any critical value with MACH Machine Tools before you rely on it.

2.2 Maximum loads and cutting capacity

Do not exceed the following recommended maximum loads.

Table 2-2: Maximum load on the table

Model	Loading weight (kg)
VS-1 SP	140
VS-2 SP XL	160

Table 2-3: Maximum cutting capacity (unit: mm)

Model	Face milling Ø	Drilling Ø
VS-1 SP	76.2 (3")	16 (5/8")
VS-2 SP XL	76.2 (3")	16 (5/8")

NOTE Cutting capacities are for S45C (medium-carbon steel).

2.3 Machine dimensions

Table 2-4 gives the dimensions marked A to G in Figure 2-1.

Table 2-4: Machine dimensions (unit: mm)

Dimension	VS-1 SP	VS-2 SP XL
A	2046	2262
B	1620	2120
C	1468	1840
D	0 - 455 (0 - 440)	70 - 540 (0 - 510)
E	13 - 285 (0 - 285)	-----
F	137 - 435 (171 - 482)	140 - 650 (190 - 685)
G	228 - 533	116 - 760 (180 - 680)

NOTE Where a cell holds two values, the value in brackets is printed beneath the first in the original drawing data. Confirm which applies to your machine with MACH Machine Tools.

■ CAUTION

Leave a safety clearance of 500mm around the machine, to avoid the danger caused by overcrowding.

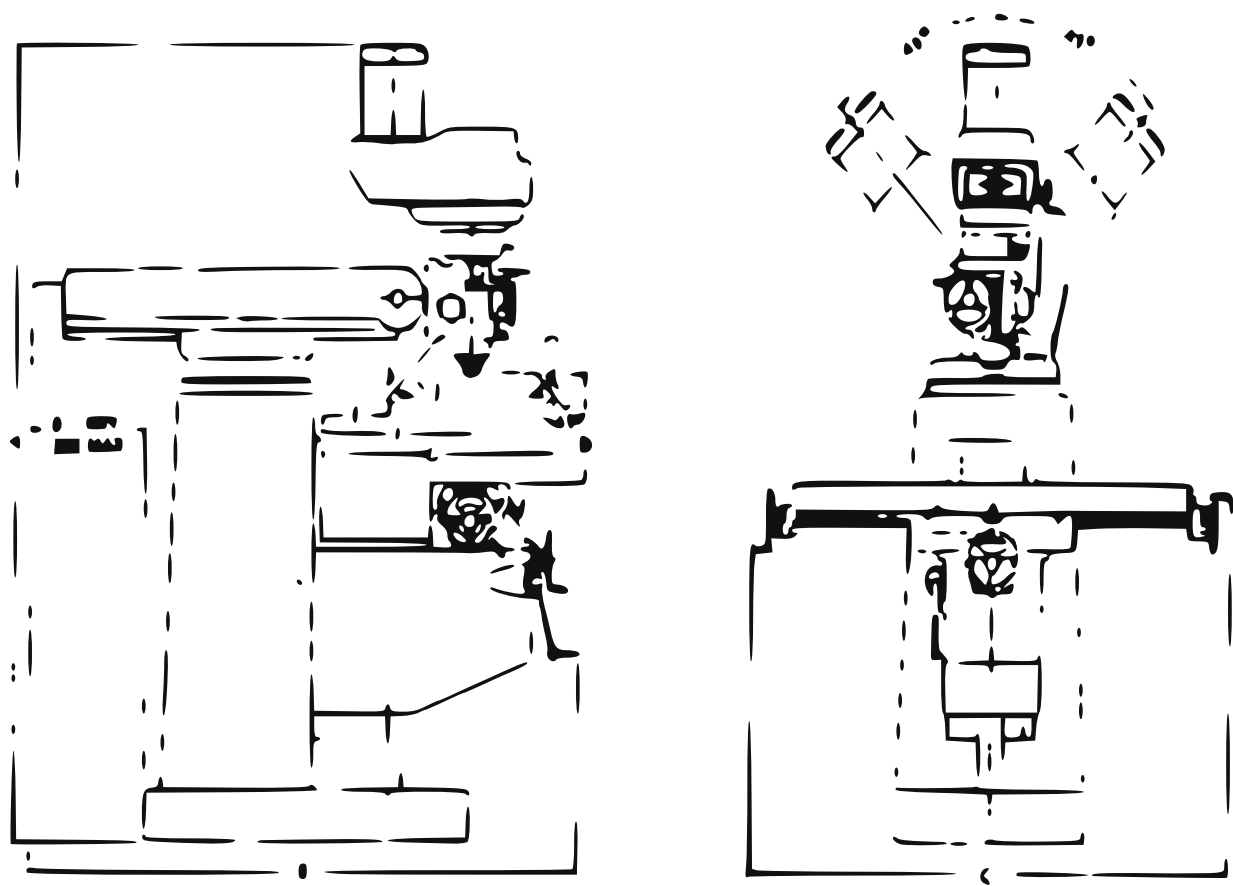


Figure 2-1: Machine outline, side and front elevations

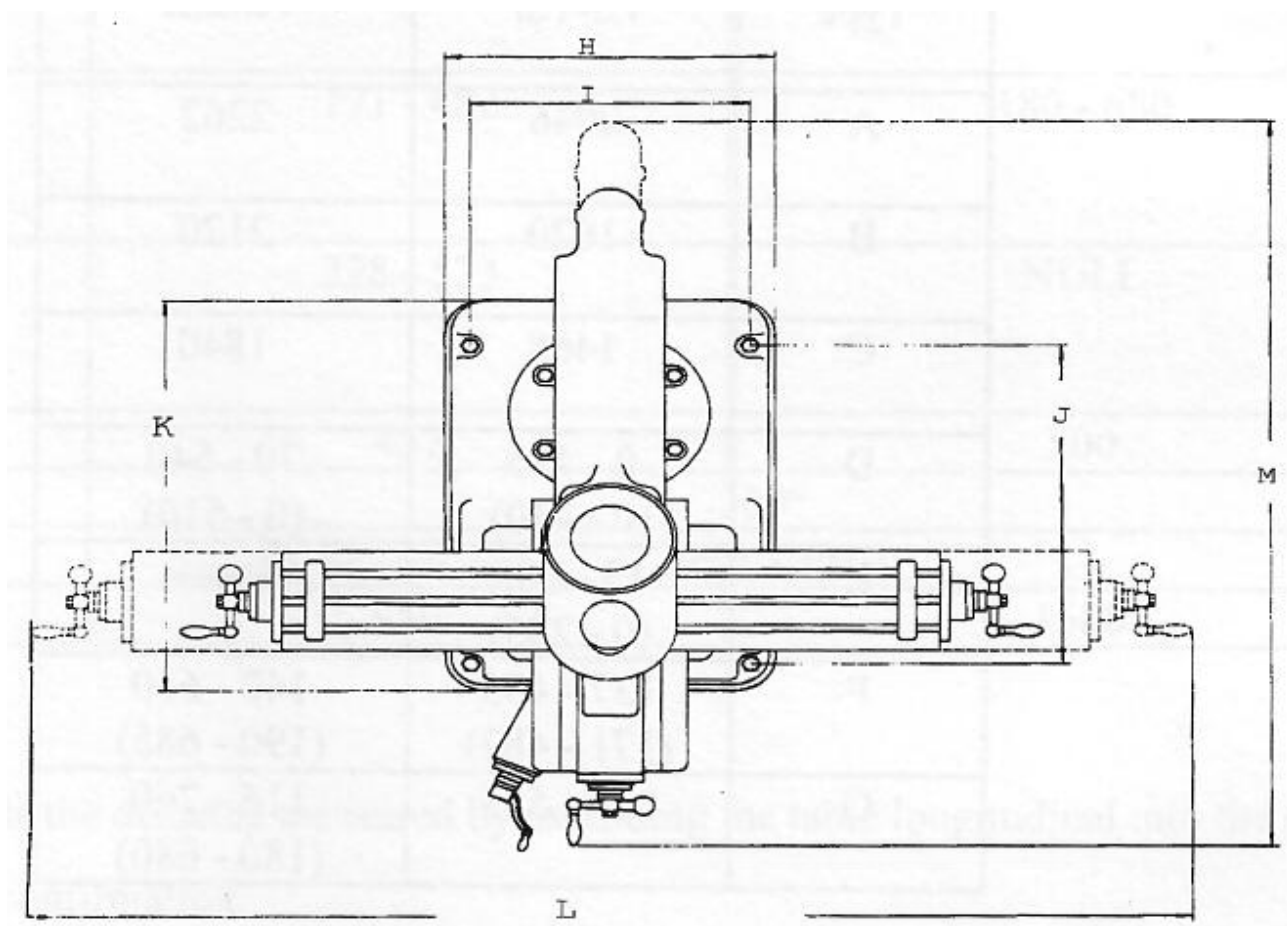


Figure 2-2: Machine outline, plan view

NOTE Dimensions H to M in Figure 2-2 have no values in the original data.

3 Installation

3.1 Transport and unpacking

- Transport the machine on its crate or pallet so that it is protected from moisture. If the machine is damaged by moisture, contact your MACH dealer or the forwarding agent.
- After unpacking, check that all accessories and tools are present and intact. If not, contact your MACH dealer.
- Before unpacking, the crated machine can be moved by forklift (Figure 3-1) or lifted by reinforced cable (Figure 3-2).
- After unpacking, do not move any sliding surface until its rust-preventive oil has been cleaned off and the surface has been lubricated.
- When you lift the crate by reinforced cable, strictly follow the instructions marked on the side of the crate.

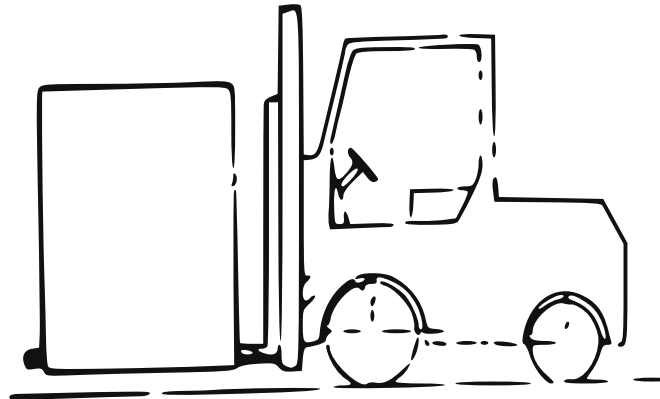


Figure 3-1: Moving the crated machine by forklift

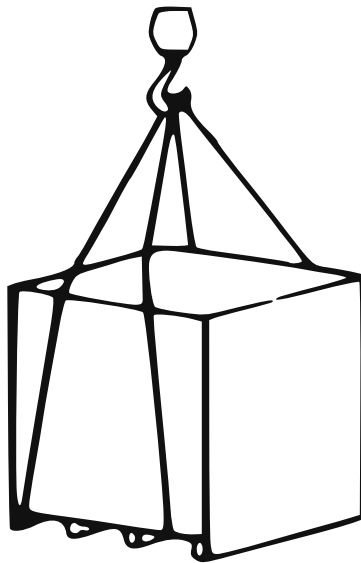


Figure 3-2: Lifting the crated machine by reinforced cable

3.2 Lifting with a hoist

- The safe working load of the hoist must be greater than the machine weight (see Table 2-1).
- Lift the machine with a reinforced cable (Figure 3-4) or with the eye bolt (Figure 3-3).
- Use the hoist's lowest speed to raise the machine.
- Keep the machine balanced throughout the lift.
- Protect the machine from the cable with soft rags or card.
- Do not lift the machine too high. The best height keeps the machine base approximately 10cm above the ground.
- Always make sure the ram is tightly clamped while lifting (Figure 3-3).

■ WARNING

Keep a safe distance from the machine while it is being lifted. Nobody may enter the area within at least 2m of the machine.

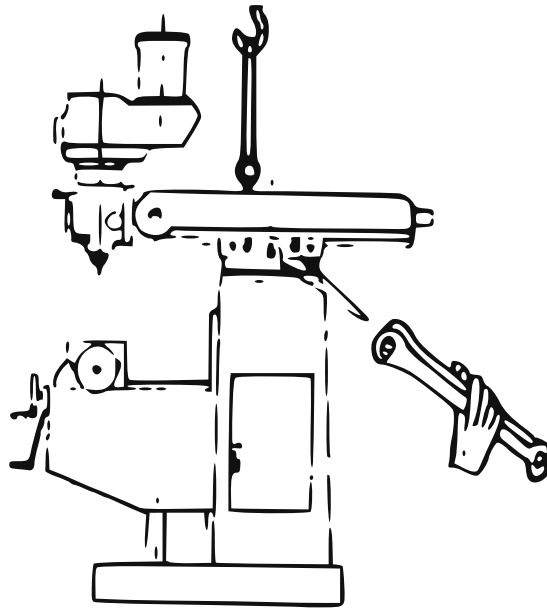


Figure 3-3: Lifting by the eye bolt; clamp the ram tight before lifting

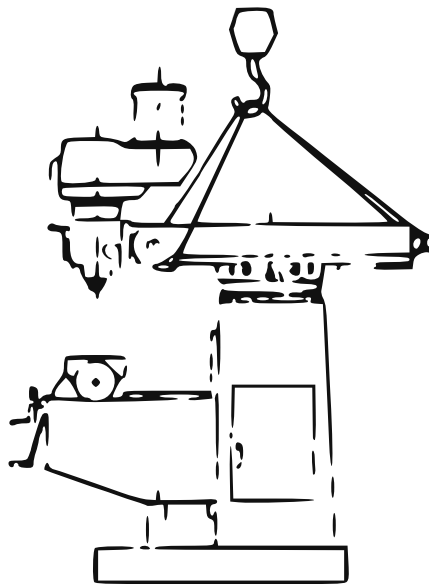


Figure 3-4: Lifting the unpacked machine by reinforced cable

3.3 Moving with a forklift

If no hoist is available, move the machine with a forklift (Figure 3-5).

- You do not need to remove the bottom of the wooden crate when you use a forklift. Set the machine down carefully and avoid any impact, so that its accuracy is not affected.
- Watch the centre of gravity to keep the machine balanced.
- The forklift's capacity must be greater than the machine's total weight.
- Only a qualified driver may drive the forklift.

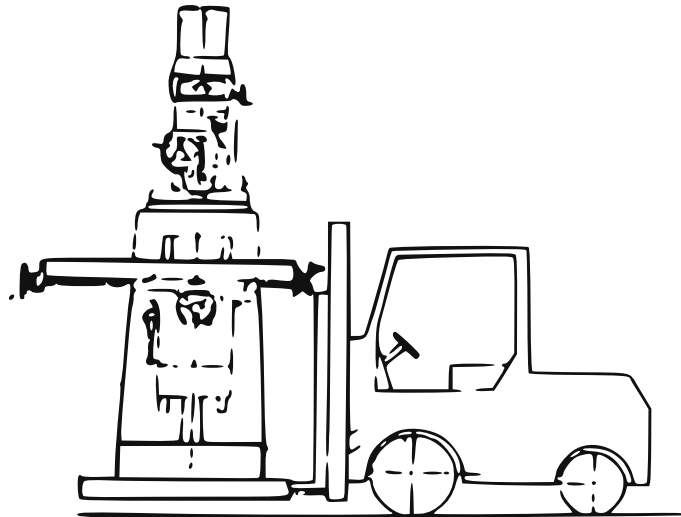


Figure 3-5: Moving the unpacked machine by forklift

3.4 Position

- Refer to 2.3 for the floor area the machine needs.
- Do not place the machine beside machines that vibrate heavily, such as presses.
- Leave enough space between the machine and other machines or walls for cleaning, maintenance and opening the doors.
- Leave at least 500mm for table travel.

3.5 Foundation

Lay a foundation of 15cm of concrete, and leave enough space for levelling the machine. Do not use a wooden foundation. When you install the machine on an upper floor, take the floor's maximum load into account.

3.6 Cleaning

- 1 Clean the rust-preventive grease from the metal surfaces with paraffin.
- 2 Wipe the surfaces with a clean rag.
- 3 Lubricate the surfaces with clean lubricant.

3.7 Levelling the machine

- 1 Clean the worktable.
- 2 Place two precision levels on the table, one along each axis (Figure 3-6). If you have only one level, check each direction in turn, repeatedly.
- 3 Before levelling, fit nut 2 onto levelling bolt 1 so that the nut is close to the bolt head (Figure 3-7).
- 4 Place the four levelling pads 3 under the levelling-bolt holes in the base.
- 5 Screw the four levelling bolts into the holes with an open-ended spanner until each reaches the centre of its pad.
- 6 Turn the levelling bolts clockwise to raise the machine approximately 5mm.
- 7 Level the machine.

NOTE Check a newly installed machine weekly. Once the foundation has settled, you can reduce this to twice a year.

NOTE Light machines have no levelling bolts. Place them on a flat, stable, non-slip foundation.

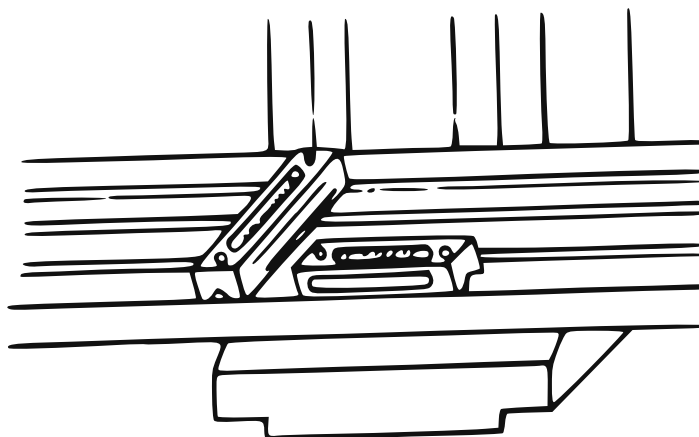


Figure 3-6: Precision levels on the worktable

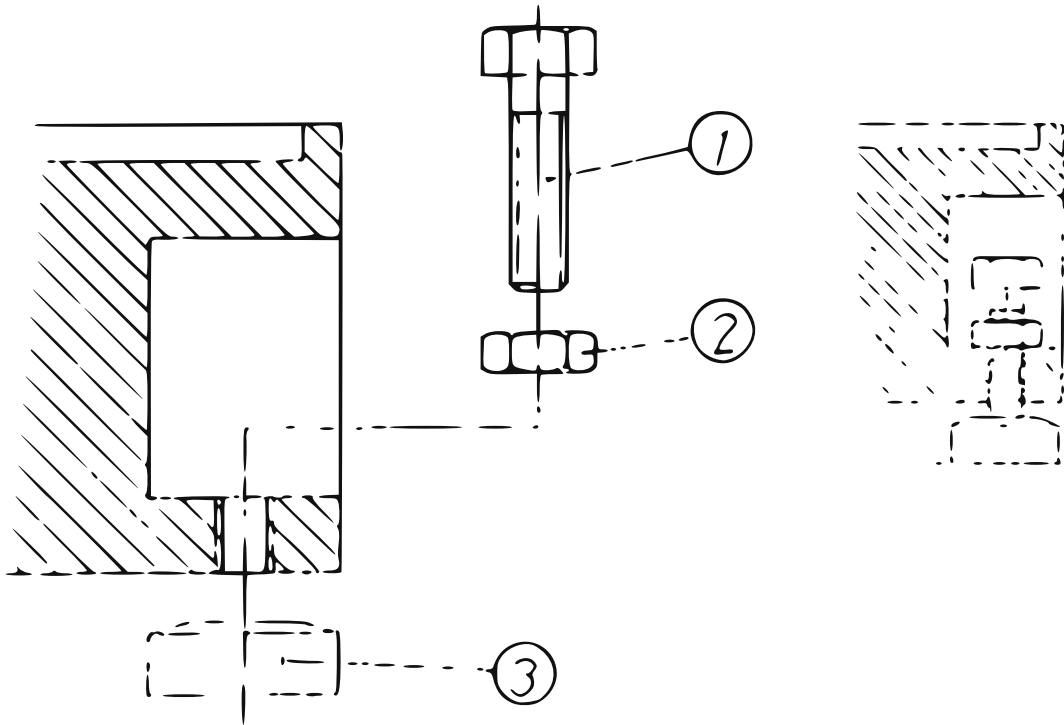


Figure 3-7: Levelling bolt arrangement

3.8 Squaring the spindle to the table

Use this procedure to set the spindle square (vertical) to the table. See also 5.5.

■ WARNING

Do not loosen the head bolts and nuts fully, or the head may tilt suddenly.

- 1 Loosen the three head bolts and the four head nuts, but not fully.
- 2 Refer to the MACH precision inspection table for the accuracy required.
- 3 Loosen the four head bolts so that the head can be turned with the spanner (supplied in the toolbox).
- 4 Align the head to the required accuracy, then tighten the two nuts diagonally opposite head nut 3.
- 5 Loosen bolt 2 and align it to the required accuracy, then tighten the three head bolts 1.
- 6 Check with a dial indicator that the spindle is square to the table within the required accuracy.
- 7 Tighten all four head bolts.

3.9 Electrical connection and direction of rotation

3.9.1 Power connection

- Check that the motor voltage matches the supply voltage. If it does not, call a technician to correct it.
- Make sure the wires are screwed tightly to the switch.
- Make sure the machine is earthed.

■ WARNING

Always switch off the power before you connect or change any wires.

3.9.2 Testing the direction of rotation

- 1 Switch on the power and turn the motor switch to ON.
 - 2 Check the direction of spindle rotation. Seen from the front of the machine, the spindle must turn clockwise.
 - 3 If it turns the wrong way, switch off the power and swap two of the supply wires to change the phase sequence.
- Use the same method to check the coolant pump and the step-up motor.
 - Do not fit any tools during the test.
 - Make sure everything is normal before you switch on the power.

4 Controls

4.1 Machine parts

Figure 4-1 names the main parts of the machine.

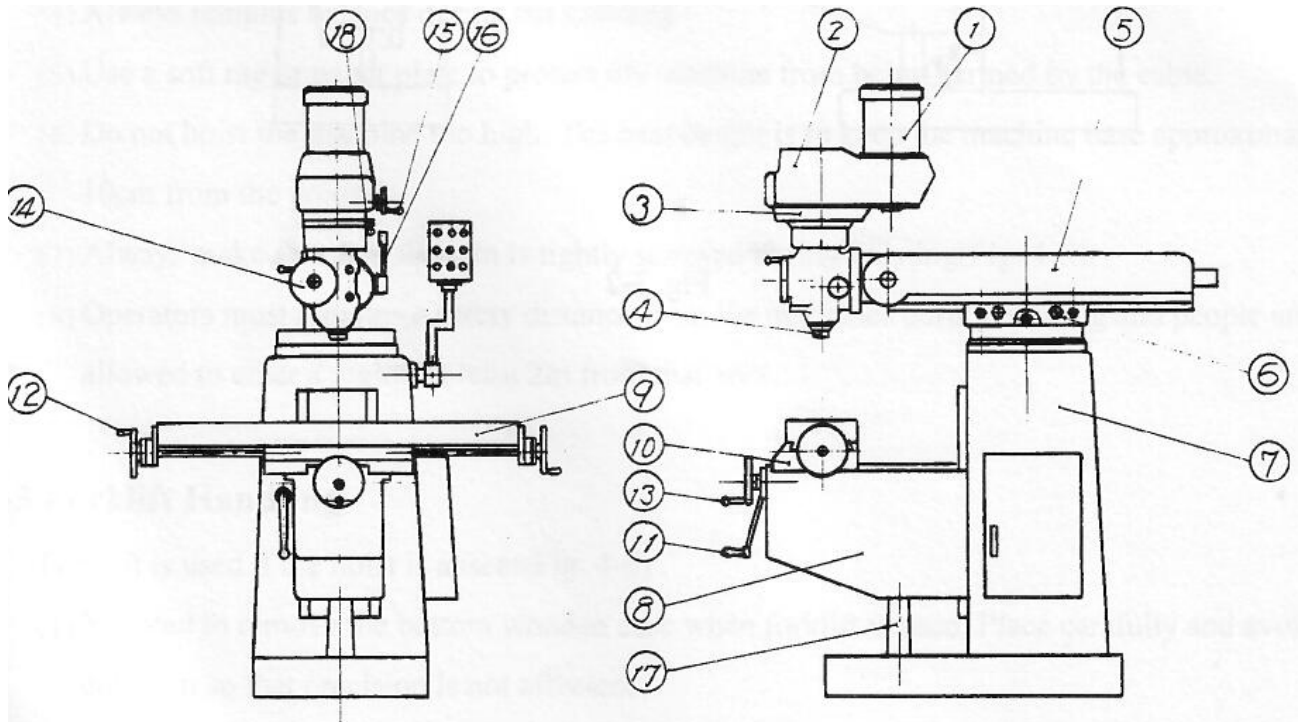


Figure 4-1: Machine parts

4.2 Axis directions

- X: the table moves left and right (east to west).
- Y: the table moves back and forward (north to south).
- Z: the knee moves up and down.

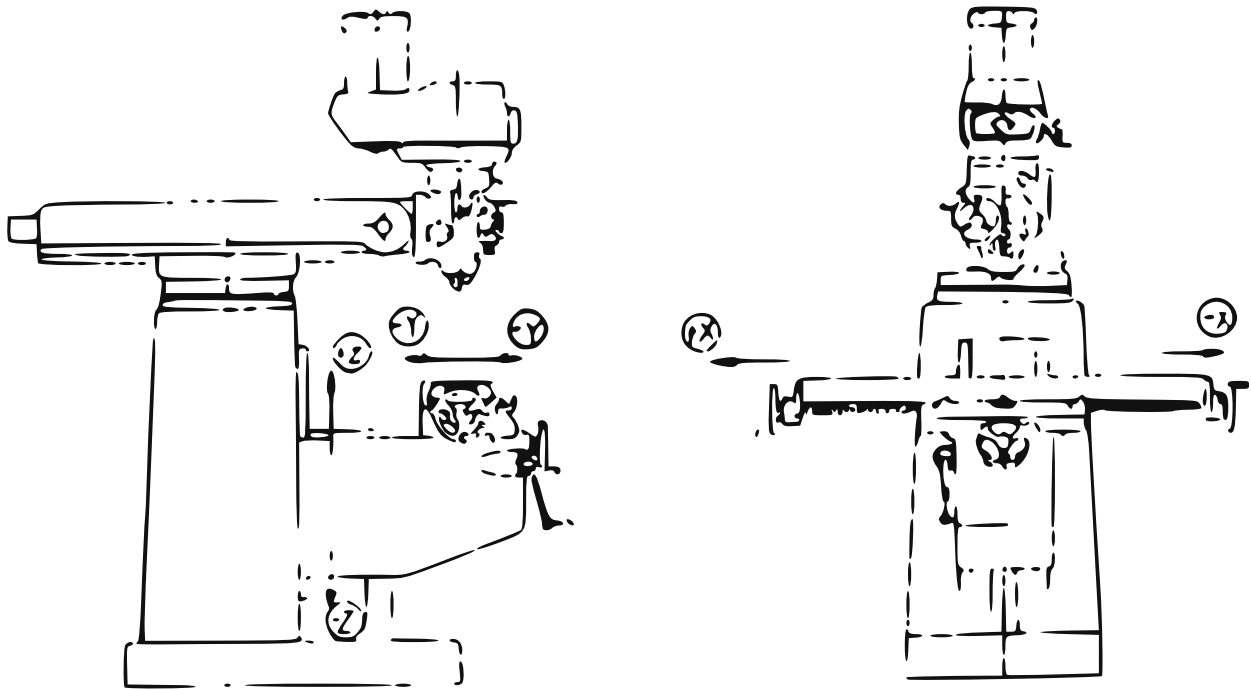


Figure 4-2: Axis directions

4.3 Head control panel

The control panel is on the front of the head (see Figure 5-1).

4.3.1 Power button

Press to switch on. The lamp inside the button lights when the power is on. The button is also used to reset an alarm (ALM) on the frequency changer (FC).

■ CAUTION

Make sure the spindle switch is in the centre (off) position before you press the power button.

4.3.2 Emergency stop button

If anything goes wrong while the machine is running, press the emergency stop button to shut the machine down immediately.

4.3.3 RPM display

Shows the actual spindle speed while the machine is running. The maximum is 5000rpm.

4.3.4 Spindle switch

- Centre: off.
- Position marked with the clockwise-arrow symbol: spindle runs clockwise (CW).
- Position marked with the anticlockwise-arrow symbol: spindle runs anticlockwise (CCW).

4.3.5 RPM control

Turn the knob to set the spindle to the speed you want (see 5.4.2).

4.3.6 Coolant pump switch

- Turn right to switch the coolant pump on.
- Turn left to switch it off.

5 Operation

5.1 Spindle brake

- 1 Switch off the power.
- 2 Wait 3 to 5 seconds for the spindle to slow down.
- 3 Pull the brake handle (A) down.

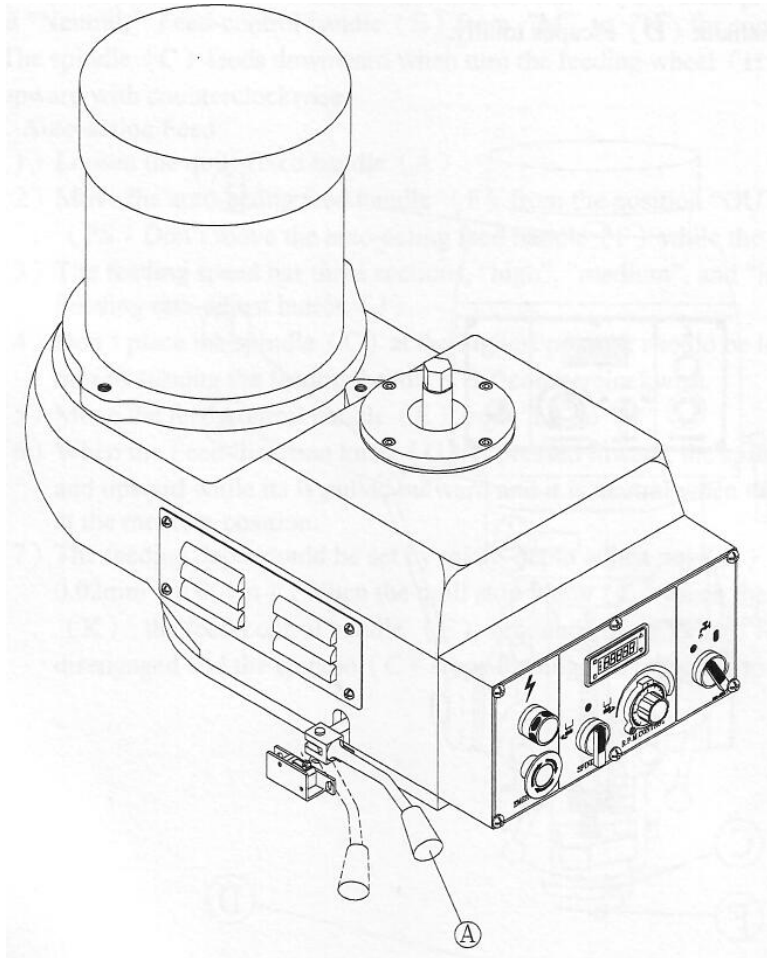


Figure 5-1: Upper head, showing the control panel and brake handle

5.2 Loading and unloading the cutting tool

■ CAUTION

Switch off the spindle power before you change tools.

The drawbar (B) has a right-hand thread.

5.2.1 Loading a tool

- 1 Move the speed handle (E) back to the LOW position.
- 2 Turn the spindle feed handle (A) clockwise to raise the spindle to its highest position.
- 3 Insert the tool shank (D) into the taper bore of the spindle (C), with the slot in the shank aligned with the stop block (F) in the spindle.
- 4 Turn the drawbar handle (B) clockwise until the shank (D) is fully engaged in the spindle bore (C).
- 5 Tighten the drawbar handle (B) clockwise.

5.2.2 Unloading a tool

- 1 Turn the drawbar handle (B) 3 to 5 turns anticlockwise.
- 2 Tap the drawbar handle (B) lightly with a soft hammer. The shank (D) is released from the spindle bore (C).
- 3 Keep turning the drawbar handle (B) anticlockwise until the shank (D) comes fully free.

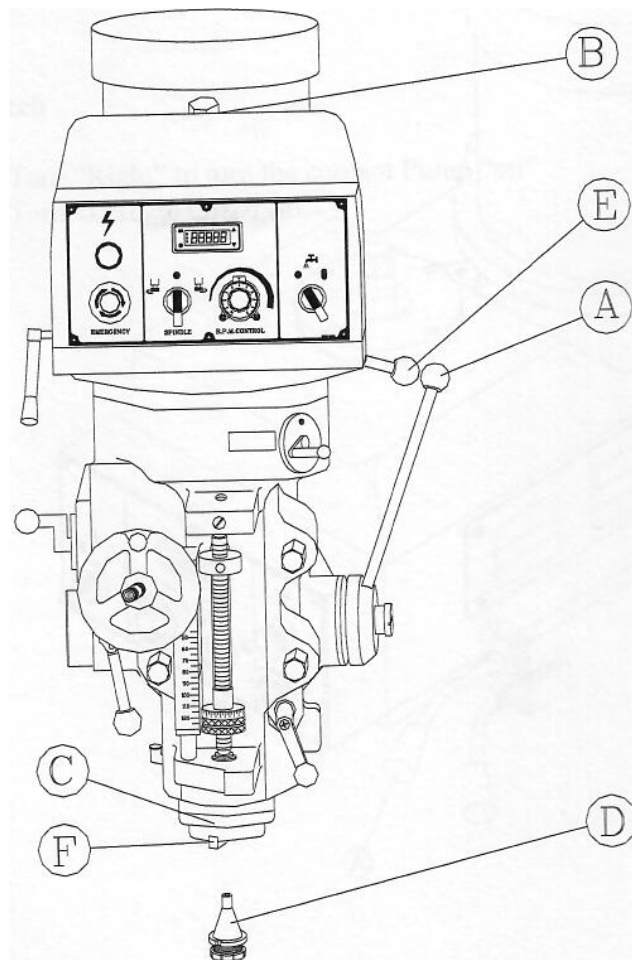


Figure 5-2: Tool loading and unloading

5.3 Quill feed

Letters in this section refer to Figure 5-3.

5.3.1 Manual fast feed

- 1 Loosen the quill lock handle (A).
- 2 Turn the handle (B) clockwise to raise the spindle (C), or anticlockwise to lower it.
 - Set the depth with the micro-depth adjusting nut (K).
 - The handle set (D) has 12 engagement positions, so you can fit it in the most convenient position.
 - For fast manual feed, the feed-control handle (E) must be in the M position.

5.3.2 Manual fine feed

- 1 Loosen the quill lock handle (A).
- 2 Turn the automatic feed handle (F) forward to the OUT position.
- 3 Set the feed-direction knob (G) to neutral.
- 4 Move the feed-control handle (E) from M to N to engage the quill clutch.
- 5 Turn the fine-feed handwheel (H) clockwise to feed the spindle (C) down, or anticlockwise to feed it up.

5.3.3 Automatic feed

■ CAUTION

Do not move the automatic feed handle (F) while the spindle is running.

- 1 Loosen the quill lock handle (A).
- 2 Move the automatic feed handle (F) backward from OUT to IN.
- 3 Select the feed rate (high, medium or low) with the feed-rate selector (J).
- 4 Do not leave the spindle (C) at its highest point. Lower it by about 5 to 10mm by turning the feed handle (B) anticlockwise.
- 5 Move the feed-control handle (E) from M to N.
- 6 Set the feed direction with the feed-direction knob (G): push it in to feed the spindle down, pull it out to feed up. The middle position is neutral.
- 7 Set the feed depth with the micro-depth adjusting nut (K). Each graduation is 0.02mm (0.001in).

When the quill stop block (L) reaches the micro-depth adjusting nut (K), the feed-control handle (E) trips back from N to M. The quill clutch disengages, the spindle (C) stops feeding and returns to its starting position.

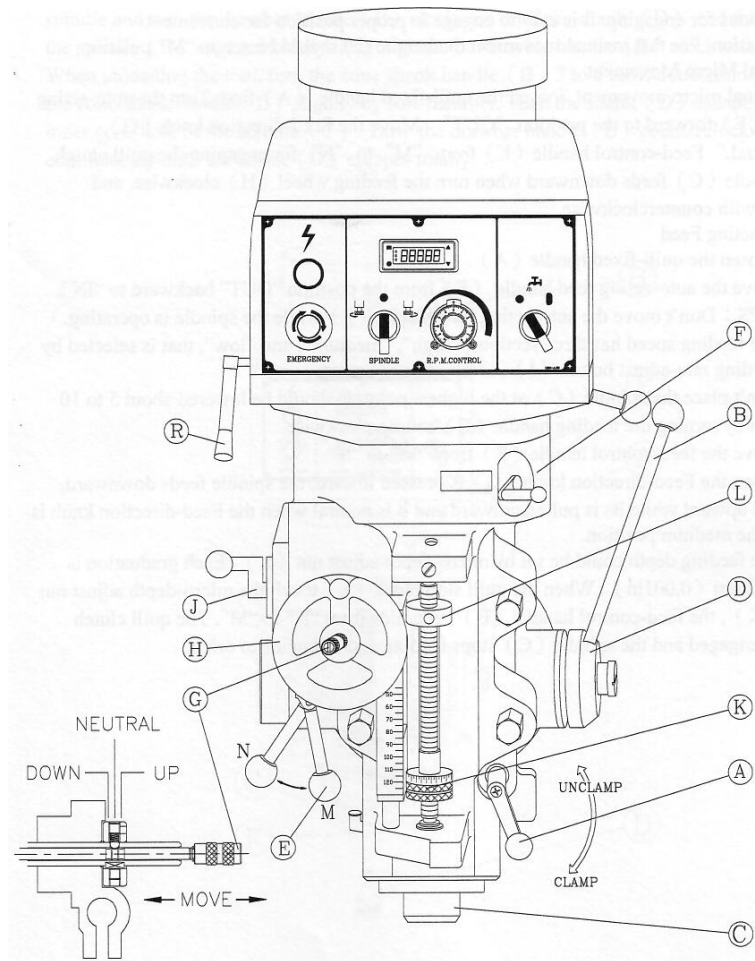


Figure 5-3: Quill feed controls

5.4 Spindle speed

5.4.1 High and low speed range

Select the speed range with the speed handle (P) (Figure 5-4):

- FRONT position: HIGH.
- MIDDLE position: NEUTRAL.
- BACK position: LOW.

■ CAUTION

Switch off the power and wait for the spindle to stop fully before you change the speed range.

To change from HIGH to LOW:

- 1 Turn the speed handle (P) anticlockwise to the back.
- 2 At the same time, turn the spindle (C) slightly with your left hand so that the spindle gears mesh with the back gears.

To change from LOW to HIGH:

- 1 Brake the front pulley with the brake handle (R) (see 5.1).

- 2 Turn the speed handle (P) clockwise to the front, turning the spindle (C) slightly. A click tells you the clutch has engaged.

■ CAUTION

The spindle runs in opposite directions in HIGH and LOW. It must run clockwise when cutting. If the spindle runs anticlockwise in LOW, change its direction with the spindle switch so that it runs clockwise.

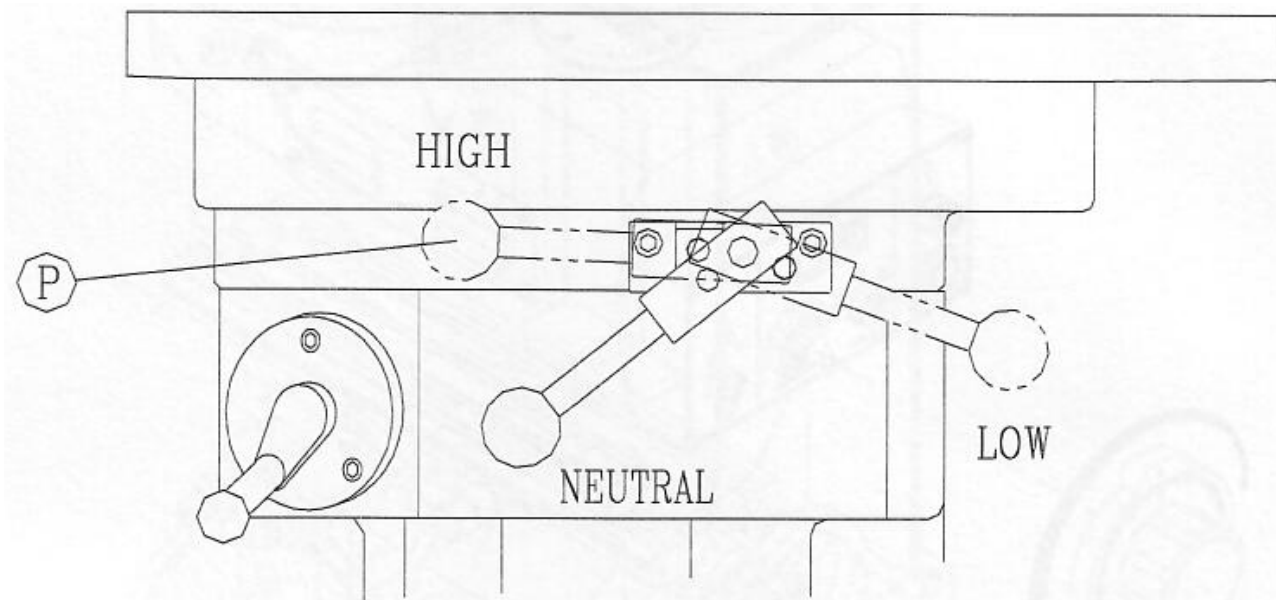


Figure 5-4: High/low speed handle positions

5.4.2 Variable speed

Set the spindle speed with the RPM control knob on the control panel (Figure 5-5).

- 1 Leave the power on while you change the speed. You can adjust the speed only while the spindle is running.
- 2 Turn the knob clockwise to increase the spindle speed, or anticlockwise to reduce it gradually. Read the speed on the RPM display.

■ CAUTION

Change the spindle speed gradually, to avoid damaging the machine.

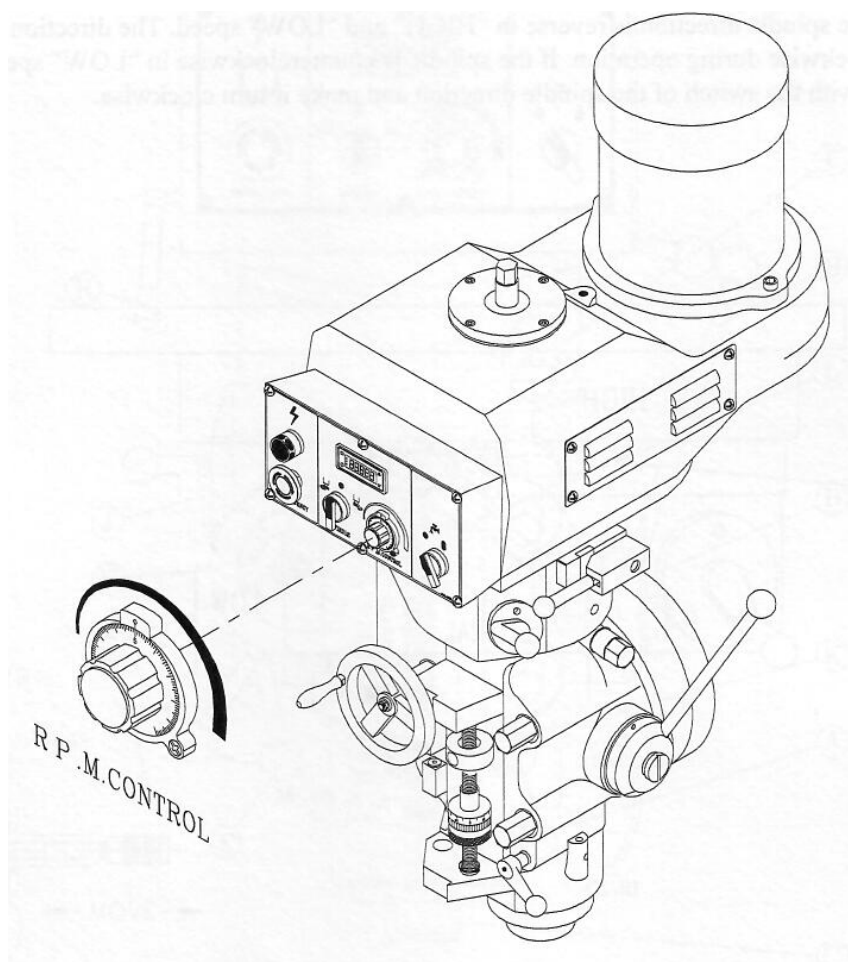


Figure 5-5: RPM control knob

5.5 Swivelling and tilting the head

■ WARNING

Before you swivel or tilt the head, switch off the power and wait for the spindle to stop fully.

5.5.1 Swivelling the head left or right

- 1 Loosen the four head nuts (A).
- 2 Turn the cross worm shaft (B): anticlockwise swivels the head to the right, clockwise swivels it to the left. Read the angle on the angle scale.
- 3 When the head reaches the required angle, tighten the four nuts (A).

5.5.2 Tilting the head forward or backward

- 1 Loosen the three head bolts (C).
- 2 Turn the longitudinal worm shaft (D) anticlockwise to tilt the head backward, or clockwise to tilt it forward, to the required angle. Read the angle on the angle scale.
- 3 Tighten the three head bolts (C).

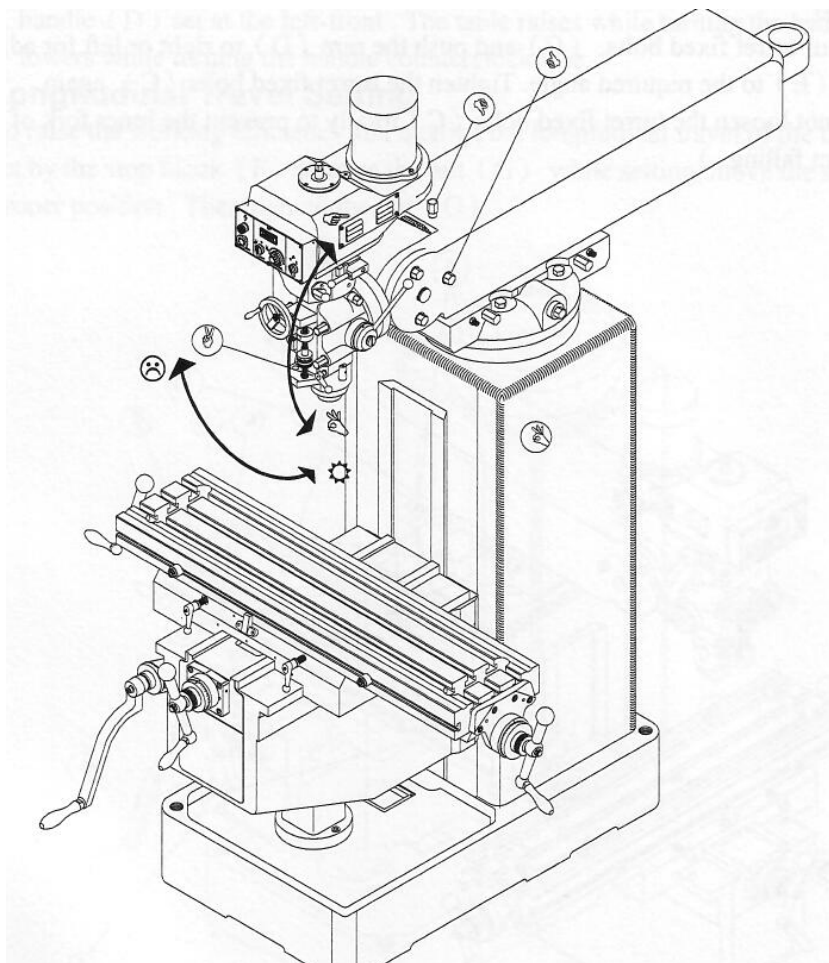


Figure 5-6: Head swivel and tilt

5.6 Moving and swivelling the ram

■ WARNING

Switch off the power before you move or swivel the ram.

5.6.1 Moving the ram

- 1 Loosen the two ram clamp bolts (A).
- 2 Turn the ram pinion (B) with a spanner: anticlockwise moves the ram forward, clockwise moves it back.
- 3 When the ram is in the required position, tighten the ram clamp bolts (A).

5.6.2 Swivelling the ram

■ CAUTION

Do not loosen the turret bolts (C) fully, or the inner fork of the turret may fall.

- 1 Loosen the four turret bolts (C).
- 2 Push the ram (D) to the right or left to set the turret (E) to the required angle.
- 3 Tighten the turret bolts (C) again.

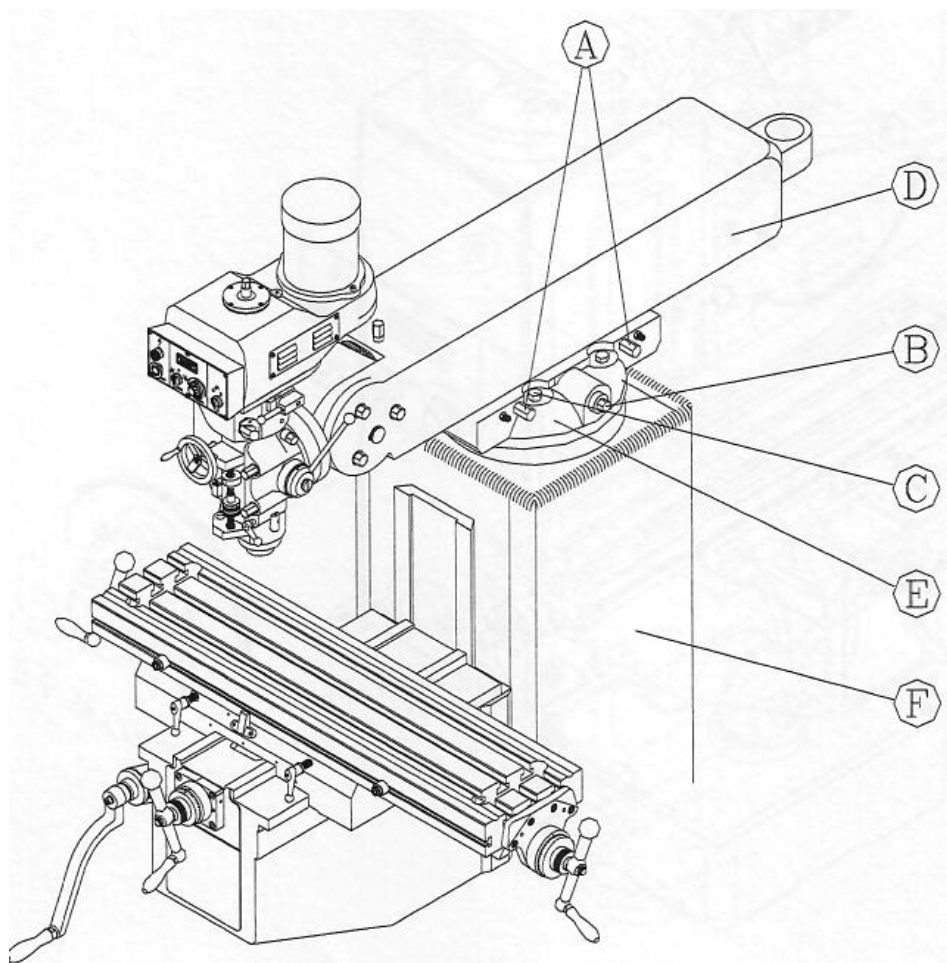


Figure 5-7: Ram movement and swivel

5.7 Table, saddle and knee feeds

Letters in 5.7 and 5.8 refer to Figure 5-8.

5.7.1 Longitudinal feed

The handles at both ends of the table move the table longitudinally.

- Right-end handle (A): turn clockwise to move the table left, anticlockwise to move it right.
- Left-end handwheel (B): the directions are the reverse of the right-end handle.

5.7.2 Cross feed

The handle (C) at the front of the table moves the table in and out. Turn it clockwise to move the table back, anticlockwise to move it forward.

5.7.3 Vertical feed

The elevating handle (D) at the left front raises and lowers the knee. Turn it clockwise to raise the table, anticlockwise to lower it.

5.8 Setting the longitudinal travel stops

To improve working efficiency and quality, you can limit the longitudinal travel of the table (E) with the stop block (F).

- 1 Loosen the nut (G).
- 2 Move the stop block (F) to the required position.
- 3 Tighten the nut (G).

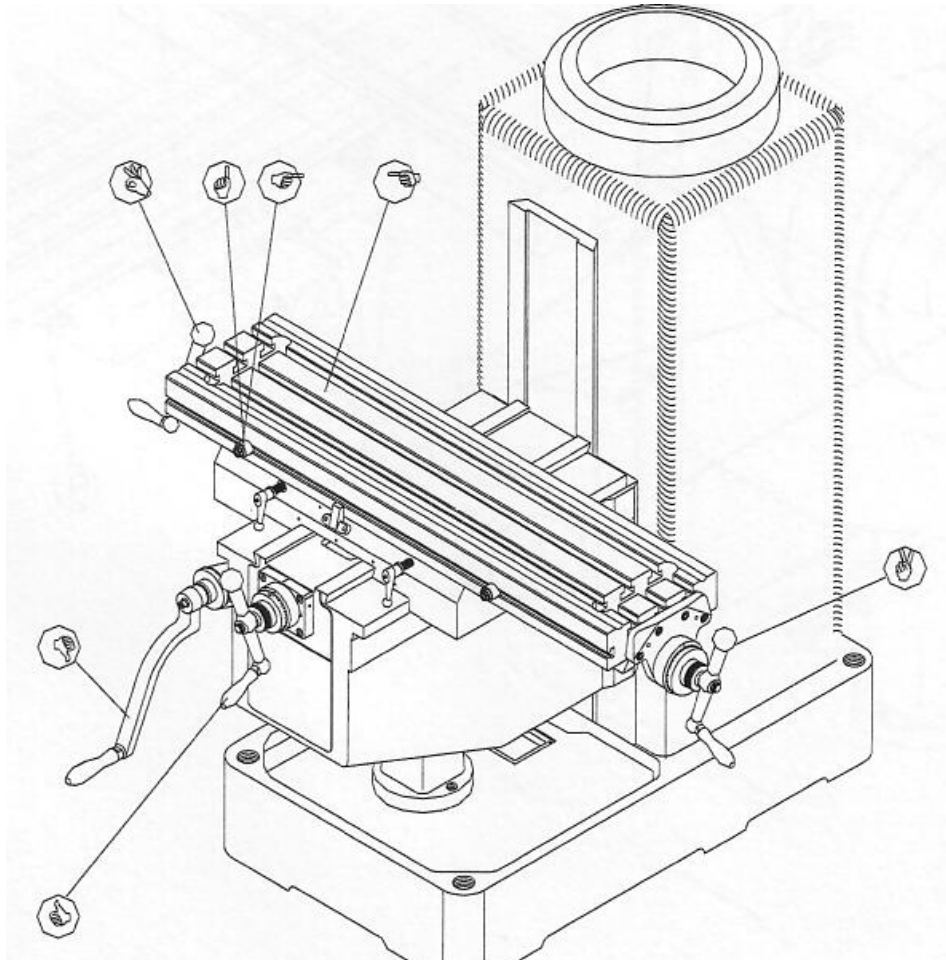


Figure 5-8: Table, saddle and knee feed controls

5.9 Resetting the dial to zero

- 1 Loosen the nut (A).
- 2 Turn the dial ring (B) to its zero (origin) position.
- 3 Tighten the nut (A) again.

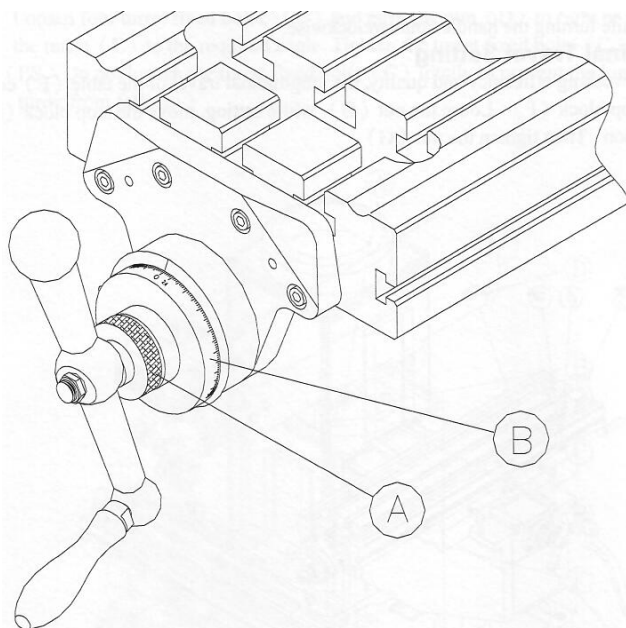


Figure 5-9: Handwheel dial zero reset

5.10 Locking the table, saddle and knee

- 1 Tighten the lock handle (A) to lock the table.
- 2 Tighten the lock handle (B) to lock the saddle.
- 3 Tighten the lock handle (C) to lock the knee.

NOTE Turn the lock handles (A), (B) and (C) clockwise to tighten and anticlockwise to loosen.

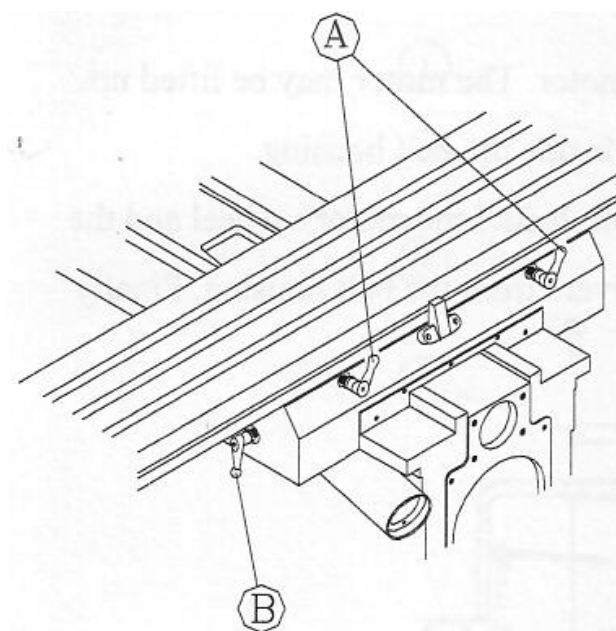


Figure 5-10: Table and saddle locks

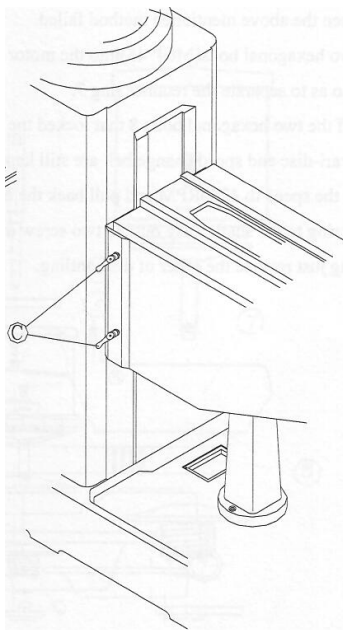


Figure 5-11: Knee locks

6 Lubrication

6.1 Head lubrication

Table 6-1: Head lubrication

No.	Lubricants	Qty	Time	Position
1	KUO_KUANG R 68 / ESSO FEBIS K53	FULL	Twice Daily	Head stock Matching Quill Holes
2	VACTRA #2 SHELL / TONNA 33	FULL	Once Daily	
3	KUO_KUANG R 68	FULL	3 Daily	Quill and Head stock internal holes.
4				
5				

NOTE Equivalent lubricants may be used. Check with MACH Machine Tools if you are unsure.

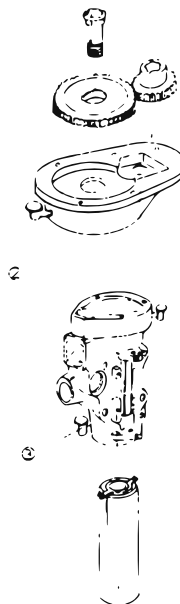


Figure 6-1: Head lubrication points

6.2 Machine body lubrication

- Position: the table, saddle, knee, slideways and leadscrews are lubricated by the hand pump on the left side of the knee.
- Method: 3 to 5 times daily, pulling the pump handle twice each time.
- Before operation each day, check that the oil in the hand pump is up to the level mark.

Recommended lubricants:

- KUO KUANG R68
- GULFWAY 52
- VACTRA 2

- ESSO FBIS K-53
- SHELL TONNA 33

7 Maintenance

If the machine is not properly maintained and operated over a long period, its service life is greatly reduced, workpiece quality suffers and efficiency falls. Every operator must know how to handle the machine and how to maintain it correctly.

■ WARNING

Switch off and isolate the power before any maintenance work.

7.1 Daily maintenance

- 1 Check that the oil in the hand pump is up to the level mark.
- 2 Lubricate the specified points before operation (see Chapter 6).
- 3 Run the machine idle for three to five minutes each day before operation.
- 4 At the end of the day, clean the worktable and remove any unfinished workpiece. Apply a little lubricant.
- 5 At the end of each day, loosen all lock levers, move all sliding parts to a suitable position and remove the cutter.
- 6 At the end of each day, if the head has been tilted, return it to its normal position.

7.2 Monthly maintenance

- Check that all slideway clamps work normally. If a slideway does not slide smoothly: (a) pump oil with the hand pump; (b) check for and remove dust from the sliding surfaces.
- Check that the backlash between each leadscrew and its nut is normal. If it does not meet the quality requirement: (a) adjust it as described in 7.8.
- Check that the quill lock and each slideway lock work normally. If the quill lock is worn or engages loosely: (a) replace the lock lever.

7.3 Quarterly maintenance

- Check that the brake and belts work normally. If braking is abnormal: (a) see 7.6, and replace the brake block or other parts in good time. If the speed change belt or timing belt is abnormal: (b) see 7.5 and 7.7, and replace the belt.
- Check the level of the worktable and the setting of the head. If the squareness of the head to the table does not meet the requirement: (a) realign it as described in 3.8; (b) during alignment, do not loosen the head bolts and nuts fully.
- Test the machine again against the test chart.
- Change the lubricating oil quarterly. Fill with new oil only after the old oil has been completely cleaned out.
- Replace any worn parts.

7.4 Removing the motor

Numbers refer to Figure 7-1.

- 1 Start the motor and turn the speed switch 1 to the centre position of 60-4200RPM.
- 2 Disconnect the motor power supply and remove the wire clamp plate and the reversing switch.
- 3 Remove the three socket-head bolts under the motor pulley cover.
- 4 Insert two screwdrivers into the two holes between the motor pulley cover and the belt housing, and push down to free the motor pulley cover 2.
- 5 If that does not free it, place a screwdriver in the speed change spring pieces 4 to free the motor pulley cover.
- 6 Screw two hexagon bolts (M64*45) into the motor vari-disc 5 to compress the speed change spring, so that the retainer ring 7 can be separated.
- 7 Remove the two hexagon bolts 8 that secure the motor, and lift the motor off. The motor vari-disc and the speed change belt stay inside the belt housing.
- 8 Change the speed to 4200RPM and pull back the belt.
- 9 Fit the motor pulley and the retainer ring to the shaft.
- 10 Remove the two screwdrivers from the belt housing.
- 11 To refit the motor, reverse the removal order.

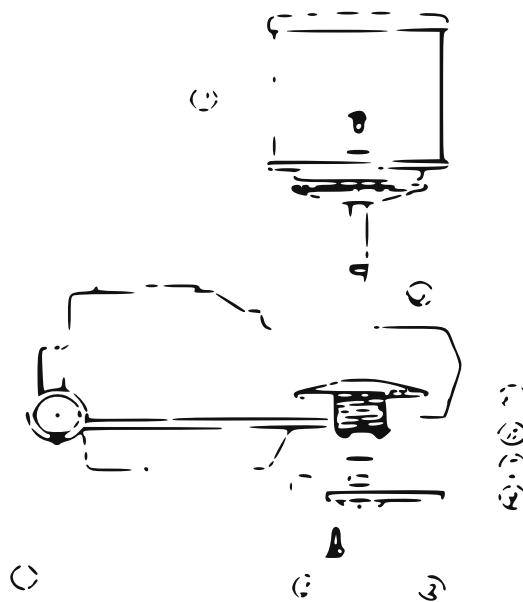


Figure 7-1: Motor removal

7.5 Replacing the speed change belt

Numbers refer to Figure 7-2.

- 1 Remove the motor (see 7.4).
- 2 Remove the drawbar 1.
- 3 Remove the four socket-head bolts 2, and use two of them to lift off the bearing housing 3.

- 4 From the top, remove the two socket-head bolts 4 and take off the bolt sleeves 5.
- 5 Remove the six socket-head bolts 6 under the gear housing to remove the upper belt housing 7.
- 6 Replace the speed change belt 8, then reassemble the machine in reverse order.

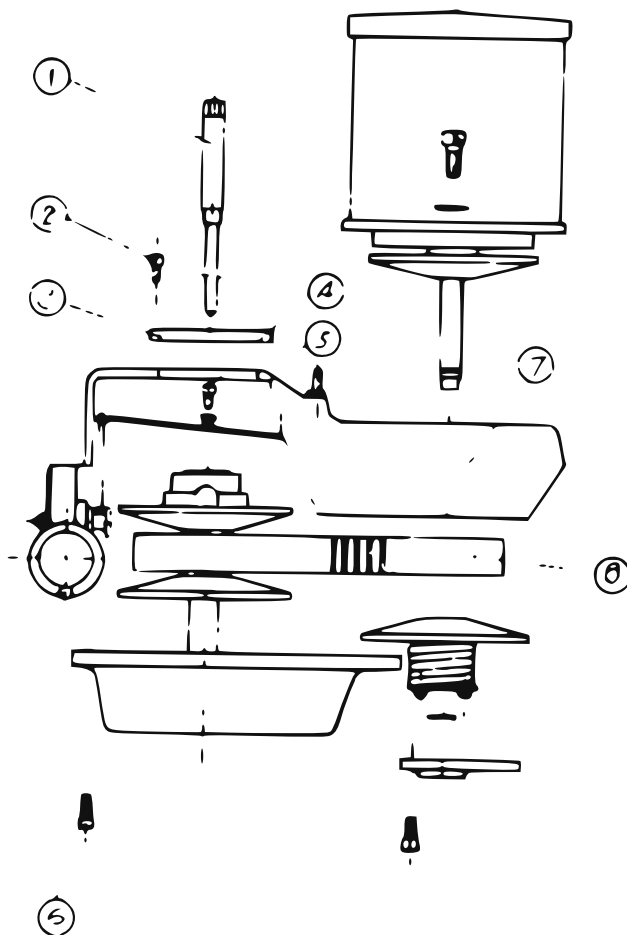


Figure 7-2: Speed change belt replacement

7.6 Replacing the brake block

Numbers refer to Figure 7-3 unless stated otherwise.

- 1 Remove the motor (see 7.4).
- 2 Remove the upper belt housing (see 7.5).
- 3 Referring to Figure 7-4, remove the gear housing 1 and the four hexagon bolts 2.
- 4 Remove the socket-head bolt 1 of the two bearing housings, and remove the front vari-disc assembly 2.
- 5 Replace the brake block 3.
- 6 Reassemble the machine in reverse order.

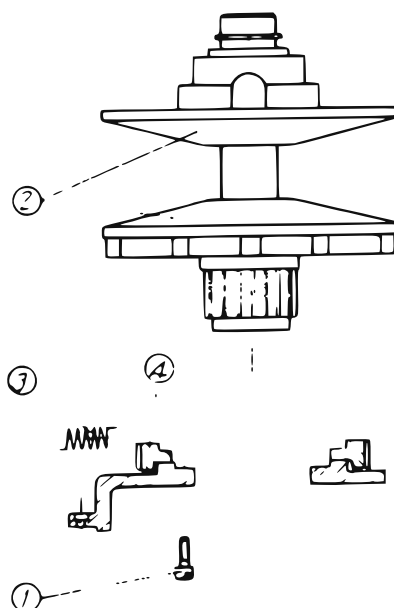


Figure 7-3: Brake block replacement

7.7 Replacing the timing belt

- 1 Remove the motor (see 7.4).
- 2 Remove the upper belt housing (see 7.5).
- 3 Replace the timing belt.
- 4 Reassemble the machine in reverse order.

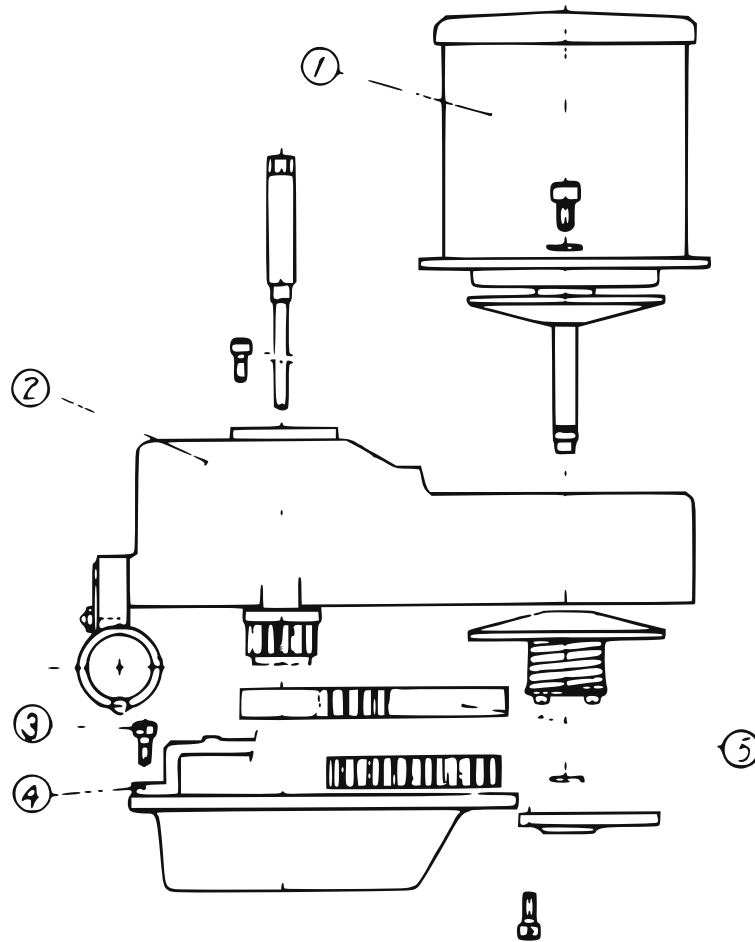


Figure 7-4: Timing belt replacement

7.8 Adjusting leadscrew backlash

Over time, wear opens up clearance between each leadscrew and its nut. Adjust the nut to keep the correct preload between the nut and the leadscrew.

7.8.1 Cross leadscrew

Numbers refer to Figure 7-5.

- 1 Turn the crank 1 anticlockwise to move the saddle to the front of the knee.
- 2 Remove the two dowel pins 3 from the front bearing bracket 2, and remove the four socket-head cap screws 4.
- 3 Support the cross feed bearing bracket 2 and turn the crank 1 clockwise, so that the bracket moves away from the knee. The gap must be longer than the adjusting tool (Figure 7-6).
- 4 Insert the larger end of the adjusting tool into the knee and turn the locking nut 5 one turn anticlockwise.
- 5 Reverse the adjusting tool and insert the smaller end into the knee. Turn the nut 6 clockwise and tighten it.
- 6 Turn the crank clockwise and anticlockwise, and check that the backlash on the dial is approximately 3-4 graduations (0.06mm-0.08mm or 0.003"-0.004").

- 7 Tighten the locking nut 5.
- 8 Turn the leadscrew anticlockwise into the knee until the front bearing bracket seats against the knee.
- 9 Fit the two dowel pins 3 and tighten the four cap screws 4 of the bearing bracket.

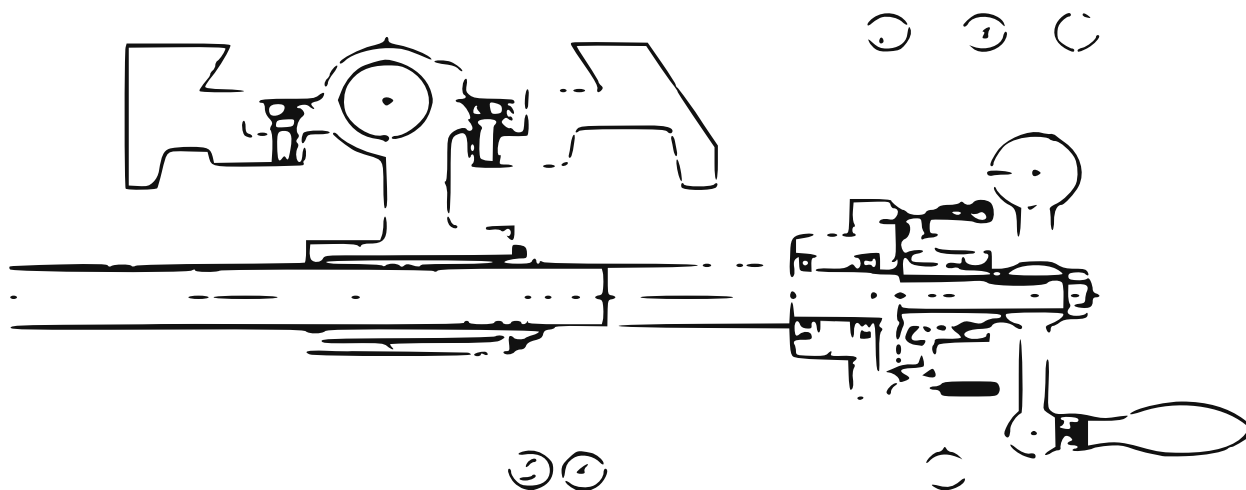


Figure 7-5: Cross leadscrew



Figure 7-6: Backlash adjusting tool

7.8.2 Longitudinal leadscrew

Numbers refer to Figure 7-7.

- 1 Move the worktable to the centre of the saddle.
- 2 Insert the large end of the adjusting tool (Figure 7-6) into the left side of the saddle, and turn the locking nut 1 one turn anticlockwise.
- 3 Reverse the adjusting tool, insert the small end in the same position, and turn the leadscrew adjusting nut 2 clockwise.
- 4 Turn the crank 3 slightly clockwise and anticlockwise, and check that the backlash on the dial is approximately 3 to 4 graduations (0.6-0.8mm or 0.003'-0.004").
- 5 Tighten the locking nut again.

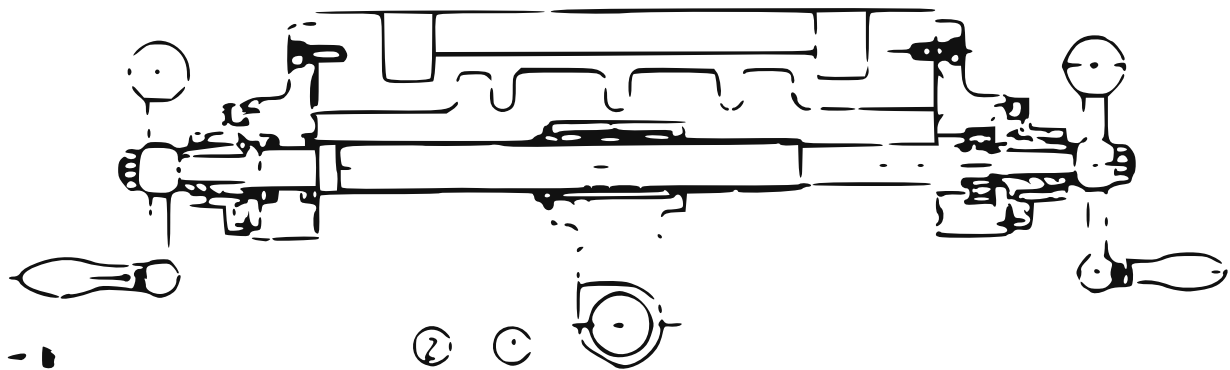


Figure 7-7: Longitudinal leadscrew

7.9 Adjusting the gibs

Long-term movement between the slideways and gibs wears the gibs and opens up clearance. Adjust the gibs to keep the slideways accurate.

7.9.1 Worktable gib

Numbers refer to Figure 7-8.

- 1 Loosen the lock lever 1.
- 2 Clean the slideway and apply lubricant.
- 3 Adjust the gib screws 2 at both ends of the saddle with a screwdriver.

Adjustment technique:

- 1 If the crank (Figure 7-7, 3) feels too loose, slightly loosen the gib adjusting screw on the right side of the saddle.
- 2 Tighten the gib adjusting screw on the left side.
- 3 Turn the crank again to check that the tightness is correct.
- 4 If it is not, loosen the left gib adjusting screw and tighten the right one.
- 5 Repeat until the worktable slides satisfactorily.

NOTE Replace a gib that is excessively worn.

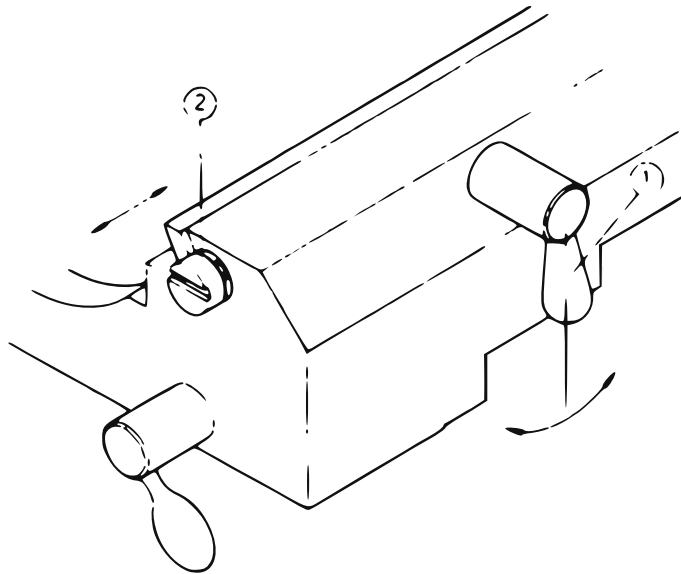


Figure 7-8: Worktable gib

7.9.2 Saddle gib

The saddle gib sits between the left side of the saddle and the knee dovetail. Numbers refer to Figure 7-9.

- 1 Loosen the saddle lock bolt 1.
- 2 Move the saddle to the front of the knee.
- 3 Remove the saddle wiper holder 2.
- 4 Clean the slideway and apply lubricant.
- 5 Adjust the saddle gib screw 3 with a screwdriver.
- 6 Use the same method as for the worktable gib (7.9.1).
- 7 Refit and secure the wiper holder 2 on the saddle.

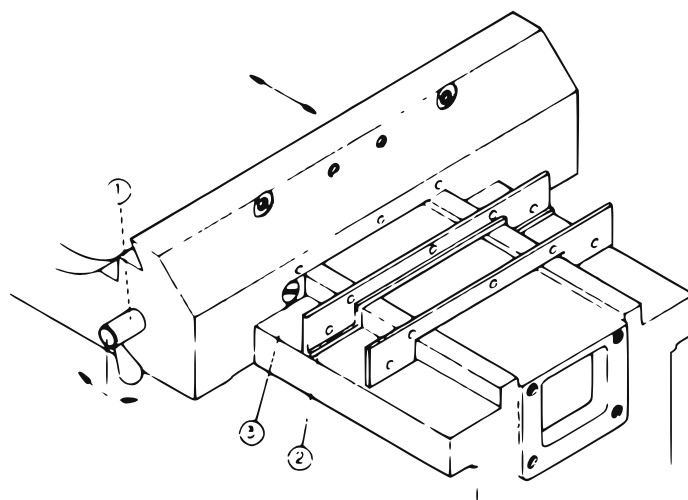


Figure 7-9: Saddle gib

7.9.3 Knee gib

The knee gib sits between the left side of the knee and the column dovetail. Numbers refer to Figure 7-10.

- 1 Loosen the knee clamp lever 1.
- 2 Remove the wiper holder 2.
- 3 Clean the slideway and apply lubricant.
- 4 Raise the knee to its highest position.
- 5 Adjust the knee gib screw 3 with a screwdriver.
- 6 Use the same method as for the worktable gib (7.9.1).
- 7 Refit and secure the wiper holder 2.

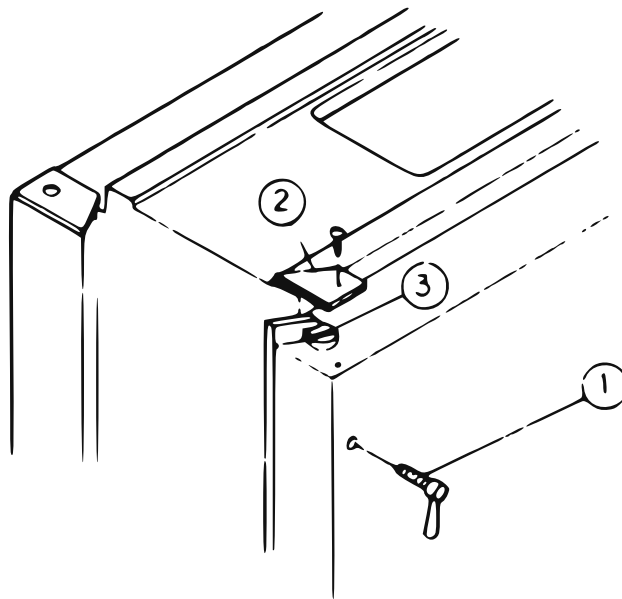


Figure 7-10: Knee gib

7.9.4 Ram gib

The ram gib sits between the ram and the turret dovetail. If the ram slides too tightly or too loosely, adjust it with the gib bolts. Numbers refer to Figure 7-11.

- 1 Loosen the ram lock lever 1.
- 2 Clean the slideway and apply lubricant.
- 3 Turn the nut 2 on the gib bolt.
- 4 Tighten or loosen the gib bolt 3 with a screwdriver until the ram moves smoothly.
- 5 Tighten the nut 2 firmly.

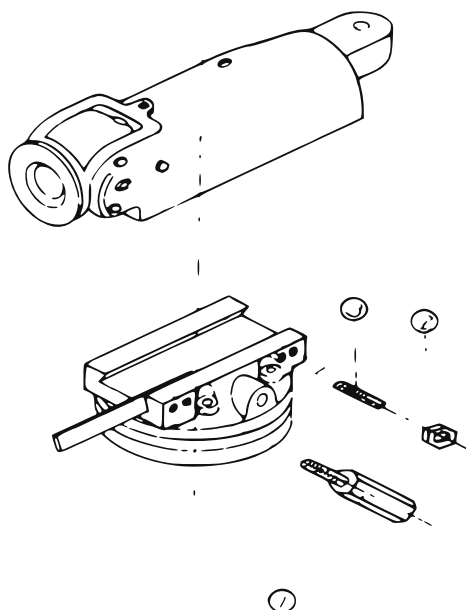


Figure 7-11: Ram gib

7.10 Replacing the collet aligning screw (R8 spindle only)

Numbers refer to Figure 7-12.

- 1 Before you start, draw a line across the quill 1 and its nose piece 2 with a marker pencil.
- 2 Loosen the nose piece set screw 3.
- 3 Remove the nose piece 2 with a hook spanner.
- 4 Remove the collet aligning screw 4 with a hexagon key of suitable length, and replace it.
- 5 Screw the nose piece 2 back on tightly until it lines up with the marked line.
- 6 Tighten the nose piece set screw 3.

NOTE To set the new collet aligning screw, a collet must be in the quill. Tighten the collet aligning screw 4 until it touches the bottom of the collet keyway, then back it off by approximately 1/4 turn. This leaves 0.25mm (0.01") of play so that the shank can be fitted and removed easily.

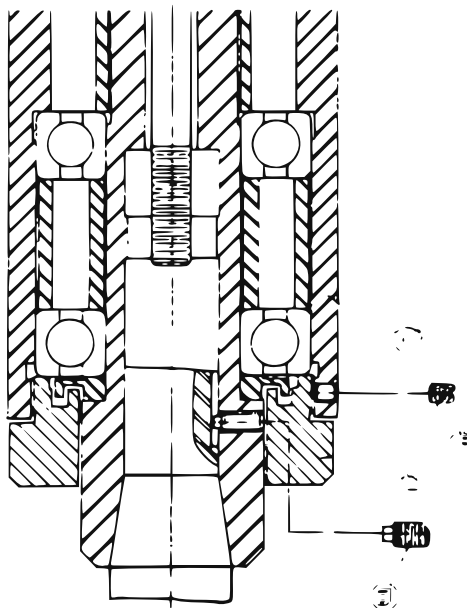


Figure 7-12: Collet aligning screw

8 Electrical

■ WARNING

Only a qualified electrician may work on the electrical system. Switch off and isolate the power, and confirm the circuit is dead, before you open the electrical cabinet.

The machine's electrical system is shown on two drawings: the power circuit (drawing SP-EVS-A11, Figure 8-1) and the control circuit (drawing SP-EVS-A2C, Figure 8-2). Both drawings are dated 2020.02.10. Circuits marked OPTION are fitted only when the option is supplied.

8.1 Power circuit

Mains input	L1, L2, L3 via main switch SW1 and noise filter
Main fuses F1X3	3 x 25A
Main contactor	KM0
Spindle drive	Inverter V1000 YASKAWA, driving spindle motor M1
Speed potentiometer VR1	2K Ω (to inverter +V, A1, AC)
Spindle direction PA1	S1 SPINDLE FOR. / S2 SPINDLE REV.
Start/reset	KA3 to inverter S4 START/RESET
Digital meter (RPM display)	Inverter AM / AC
Coolant pump motor M2 (OPTION)	Contactors MS2, overload OL2 1.7A~2.6A
Up/down motor M3 (OPTION)	Reversing contactors MS3 / MS4, overload OL3 2.8-4.2A
Emergency stop	XPS-AF emergency stop safety module; dual-channel EMG button (S11-S12, S21-S22); START button 34 with KM0 feedback contact (S33-S39); outputs KA1, KA2

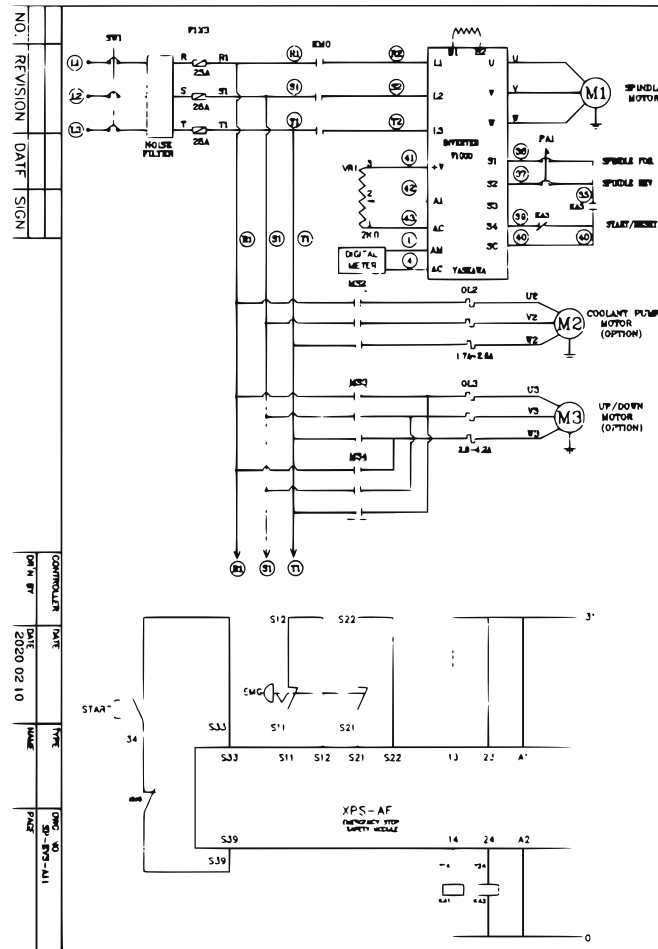


Figure 8-1: Power circuit and emergency stop (drawing SP-EVS-A11)

8.2 Control circuit

Control transformer TR2	400VA; primary via F3 3A, 220V tap (TO:S4) and 415V tap
Secondary	0V, 24V, 28V, 110V
24V circuit	WORK LAMP
F4 2A circuit	KM0 MACHINE READY (via KA1, KA2); PL READY LAMP
F5 4A circuit (110V)	KA3 SPINDLE READY (PA1 SPD FOR / SPD REV, START, LS1 spindle brake and spindle guard); KM1 COOLANT PUMP (OPTION, PA2, OL2); KM2 Z AXIS UP and KM3 Z AXIS DOWN (OPTION, LS2 Z-SAFE, PB3/PB4, LS3 UP/LS4 DOWN, interlocked, OL3)
Outputs on 110A	POWER OUT SOCKET (via KM0); POWER DRAW BAR (via inverter MC/MA)
F6 4A circuit	LUB LUBRICATION PUMP (OPTION), SPINDLE FAN, EXHAUST FAN (via KM0)
Spindle RPM display	Terminals 1, 4 to inverter AM / AC; terminals 5, 6 via KA4; supply 0V / 24V via bridge rectifier
Spindle L-G sensor	Drives relay KA4

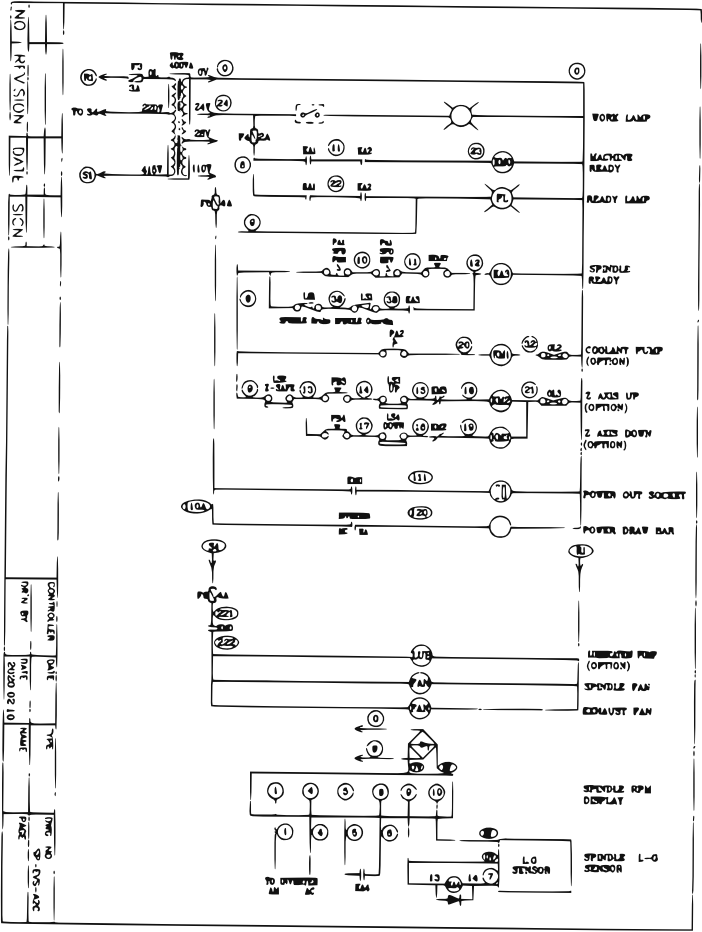


Figure 8-2: Control circuit (drawing SP-EVS-A2C)



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