Mazak

MAINTENANCE MANUAL FOR

VERTICAL QUALITY CENTER VQC-30/50

SERIAL NUMBER 73368

EQUIPMENT MAZATROL

CONTENTS

1. Overview

1-1 Introduction

This maintenance manual describes the following for operators of VQC 30/50 and for maintenance service personnel:

1) Requirements ranging from the installation of the machine to its trial run.
2) Requirements for operating the machine normally in an optimum working condition for a daily job.
3) Requirements for replacing parts with spares.
4) Requirements for locating causes of trouble, if any, and for recovering the original performance.

Trouble in a machining center assumes a wide diversity of forms. In the event of a problem that may not be covered by the instructions given herein, contact our sales office nearest to you.

1-2 SAFETY PRECAUTIONS

This machine is provided with a number of safety devices to protect personnel and equipment from injury and damage. Operators should not, however, rely solely upon these safety devices but should operate the machine after fully understanding what special precautions to take by reading the following remarks thoroughly.

(1) Basic Operating Practices

DANGER:

1) Some control panels, transformers, motors, junction boxes and other parts have high-voltage terminals, these should not be touched, or a severe electric shock will be sustained.
2) Do not touch a switch with wet hands. This, too, can produce an electric shock.

WARNING:

1) The emergency stop push-button switch location should be well known so that it can be operated at any time without having to look for it.
2) Before replacing a fuse, switch off the machine.
3) Provide sufficient working space to avoid hazardous falls.
4) Water or oil can make floors slippery and hazardous. To prevent accidents all floors should be dry and clean.
5) Before operating switches, always check that they are the right ones.
6) Never touch a switch accidentally.
7) Work benches near the machine must be strong enough to prevent accidents. Articles should be prevented from slipping off the bench surface.
8) If a job is to be done by two or more persons, coordinating signals should be given at each step of the operation. Unless a signal is given and acknowledged, the next step should not be taken.

CAUTION:

1) In the event of power failure, turn off the main circuit breaker immediately.
2) Use the recommended hydraulic oils, lubricants and grease or acceptable equivalents.
3) Replacement fuses should have the proper current ratings.
4) Protect the NC unit, operating panel, electric control panel, etc. from shocks, since this could cause a failure or malfunction.
5) Do not change parameters, volumes and other electrical settings unnecessarily. If such changes are unavoidable, record the values prior to the change so that they can be returned to their original settings if necessary.
6) Do not soil, scratch or remove the caution plate. Should it become illegible or be missing, order another caution plate from the supplier specifying the part number shown at the lower right of the plate.

(2) Before Switching On:

DANGER:

Cables, cords or electric wires whose insulation is damaged can produce current leaks and electric shocks. Before using these, check their condition.

WARNING:

1) Be sure the instruction manual and the programming manual are fully understood. Every function and operating procedure should completely clear.
2) Use safety shoes which are not damaged by oil, safety goggles with side covers, safe clothes and other safety protection.
3) Close all NC unit, operating panel and electric control panel doors and covers.

CAUTION:

1) The power cable from the factory feeder switch to the machine main circuit breaker should have a sufficient sectional area to handle the electric power used.
2) Cables which must be laid on the floor must be protected against chips so that short-circuits will not occur.
3) Before first operating the machine after unpacking or keeping the machine idle for a long period (several days or more), each sliding part must be freshly lubricated. To do so, push and release the pump button several times until the oil seeps out on the sliding parts. The pump button has a return spring, so do not force it to return.
4) Oil reservoirs should be filled to indicated levels. Check and add oil, if necessary.
5) For lubricating points, oil brands and appropriate levels, see the various instruction plates.
6) Switches and levers should operate smoothly. Check that they do.
7) When switching the machine on, put the factory feeder switch, the machine main circuit breaker and the power switch on the operating panel to the ON position in the order.
8) Check the coolant level, and add coolant, if necessary.

(3) After Control Power Switch Has been Turned On

CAUTION:

When the power switch on the operating panel is ON as described in 7 above, the READY lamp should also be on; check that it is.

(4) Routine Inspections

WARNING:

When checking belt tensions, do not get your fingers caught between the belt and pulley.

CAUTION:

1) Check pressure gages for proper readings.
2) Check motors, gear boxes and other parts for abnormal noises.
3) Check the motor lubrication, and sliding parts for evidence of proper lubrication.
4) Check safety covers and safety devices for proper operation.
5) Check belt tensions. Replace any set of belts that has become stretched with a fresh matching set (for L/M).

(5) Warm Up

CAUTION:

1) Warm up the machine, especially the spindle and feed shaft by running them for 10 to 20 minutes at about half or one-third the maximum speed in the automatic operation mode.

2) This automatic operation program should cause each machine component to operate. At the same time, check their operations.
3) Be particularly careful to warm up the spindle which can turn above 4000 rpms.

If the machine is used for actual machining immediately after being started, following a long idle period, sliding parts may be worn due to lack of oil. Also, thermal expansion of the machine components can jeopardize machining accuracy. To prevent this condition, always warm the machine up.

(6) Preparations

WARNING:
1) Tooling should conform to the machine specifications, dimensions and types.
2) Seriously worn tools can cause injuries. Replace all such tools with new ones beforehand.
3) The work area should be adequately lighted to facilitate safety checks.
4) Tools and other items around the machine or equipment should be stored to ensure good footing and clear aisles.
5) Tools or any items must not be placed on the headstock, turret, cover and similar places (for L/M).
6) If the center holes of heavy cylindrical workpiece are too small, the workpieces can jump out when loaded. Be careful about center holes and angles (for L/M).

CAUTION:
1) Too lengths should be within specified tolerances to prevent interference.
2) After installing a tool, make a trial run.

(7) Operation

WARNING:
1) Do not work with long hair that can be caught by the machine. Tie it up at the back, out of the way.
2) Do not operate switches with gloves on. This could cause malfunctions, etc.
3) Whenever a heavy workpiece must be moved, two or more persons should always work together if there is any risk involved.
4) Only trained, qualified workers should operate forklift trucks, cranes or similar equipment and apply slings.
5) Whenever operating a forklift truck, crane or similar equipment, special care should be taken to prevent collisions and damage to surroundings.
6) Wire ropes or slings should be strong enough to handle the loads to be lifted and should conform to the mandatory provisions.
7) Grip workpieces securely.
8) Stop the machine before adjusting the coolant nozzle at the tip.
9) Never touch a turning workpiece or spindle with bare hands or in any other way.
10) To remove a workpiece from the machine other than by a pallet changer, stop the tool and provide plenty of distance between the workpiece and the tool (for M/C).
11) While a workpiece is turning, do not wipe it off or remove chips with a cloth or by hand. Always stop the machine first and then use a brush and a sweeper (for M/C).
12) Do not operate the machine with safety front and chuck covers removed (for L/M)
13) Use a hrush to remove chips from the tool tip-not bare hands (for L/M)
14) Stop the machine whenever installing or removing a tool (for L/M).
15) Whenever machining magnesium alloy parts, wear a protective mask (for L/M).

CAUTION:
1) During automatic operation, never open the machine door.
2) When performing heavy-duty machining, carefully prevent chips from being accumulated since hot chips can catch fire.

(8) To Interrupt Machining

WARNING:
When leaving the machine temporarily after completing a job, turn off the power switch on the operation panel, and the main circuit breaker.

(9) Completing a Job

CAUTION:
1) Always clean the machine or equipment. Remove and dispose of chips and clean cover windows, etc.
2) Do not clean the machine or equipment, before it has stopped.
3) Return each machine component to its initial condition.
4) Check wipers for breakage. Replace broken wipers.
5) Check coolants, hydraulic oils and lubricants for contamination. Change them if they are seriously contaminated.
6) Check coolant, hydraulic oil and lubricant levels. Add, if necessary.
7) Clean the oil pan filter.
8) Before leaving the machine at the end of the shift, turn off the power switch on the operating panel, machine main circuit breaker and factory feeder switch in that order.

(10) Safety Devices

1) Front cover, rear cover and coolant cover
2) X- and Z-axis overtravel limit switches
3) Chuck barrier, tail barrier and tool barrier (NC software)
4) Stored stroke limit (NC software)
5) Emergency stop push-button switch

(11) Maintenance Operation Preparations

1) Do not proceed to any maintenance operation unless instructed to do so by the foreman.
2) Replacement parts, consumables (packing, oil seals, O-rings, bearing, oil and grease etc.) should be arranged in advance.
3) Prepare to record preventive and corrective maintenance operations.

CAUTION:
1) Thoroughly read and understand the safety precautions in the instruction manual.
2) Thoroughly read the whole maintenance manual and fully understand the principles, construction and precautions involved.

(12) Maintenance Operation

DANGER:

1) Those not engaged in the maintenance work should not operate the main circuit breaker or the control power ON switch on the operating panel. For this purpose, "Do not Touch the Switch, Maintenance Operation in Progress!" or similar wording should be indicated on such switches and at any other appropriates locations. Such indication should be secured by a semi-permanent means in the reading direction.
2) With the machine turned on, any maintenance operation can be dangerous. In principle, the main circuit breaker should be turned off throughout the operation.

WARNING:

1) The electrical maintenance should be done by a qualified person or by others competent to do the job. Keep close contact with the responsible person. Do not decide by yourself.
2) Overtravel limit and proximity switches and interlock mechanisms including functional parts should not be removed or modified.
3) When working at a height, use steps or ladders which are maintained and controlled daily for safety.
4) Fuses, cables, etc. made by qualified manufacturers should be employed.

(13) Until Operation is Begun after Maintenance

WARNING:

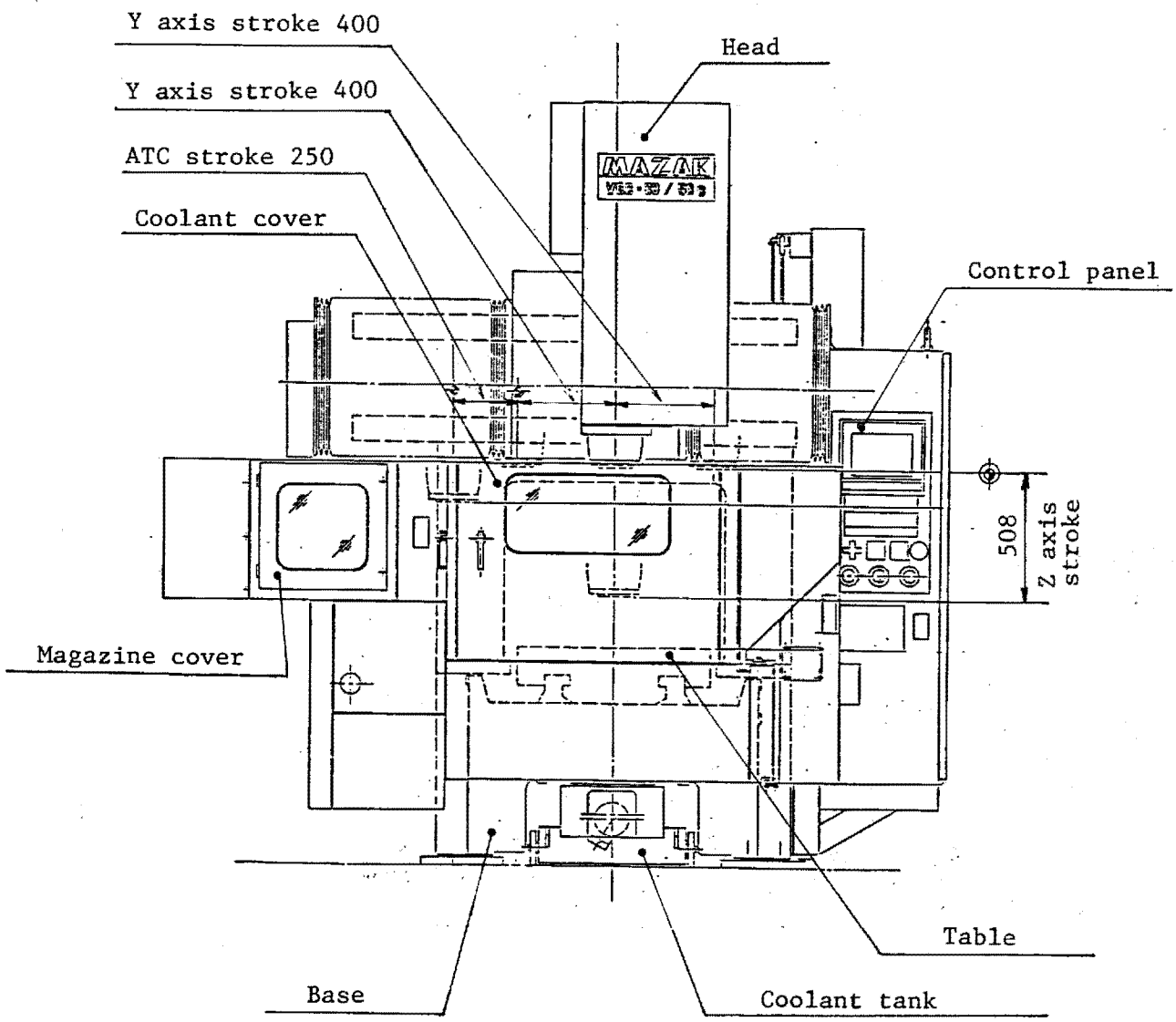
1) Arrange things in order around the section to receive the maintenance, including working environments. Wipe water and oil off parts and provide safe working environments.
2) All parts and waste oils should be removed by the operator and placed far enough away from the machine to be safe.

CAUTION:

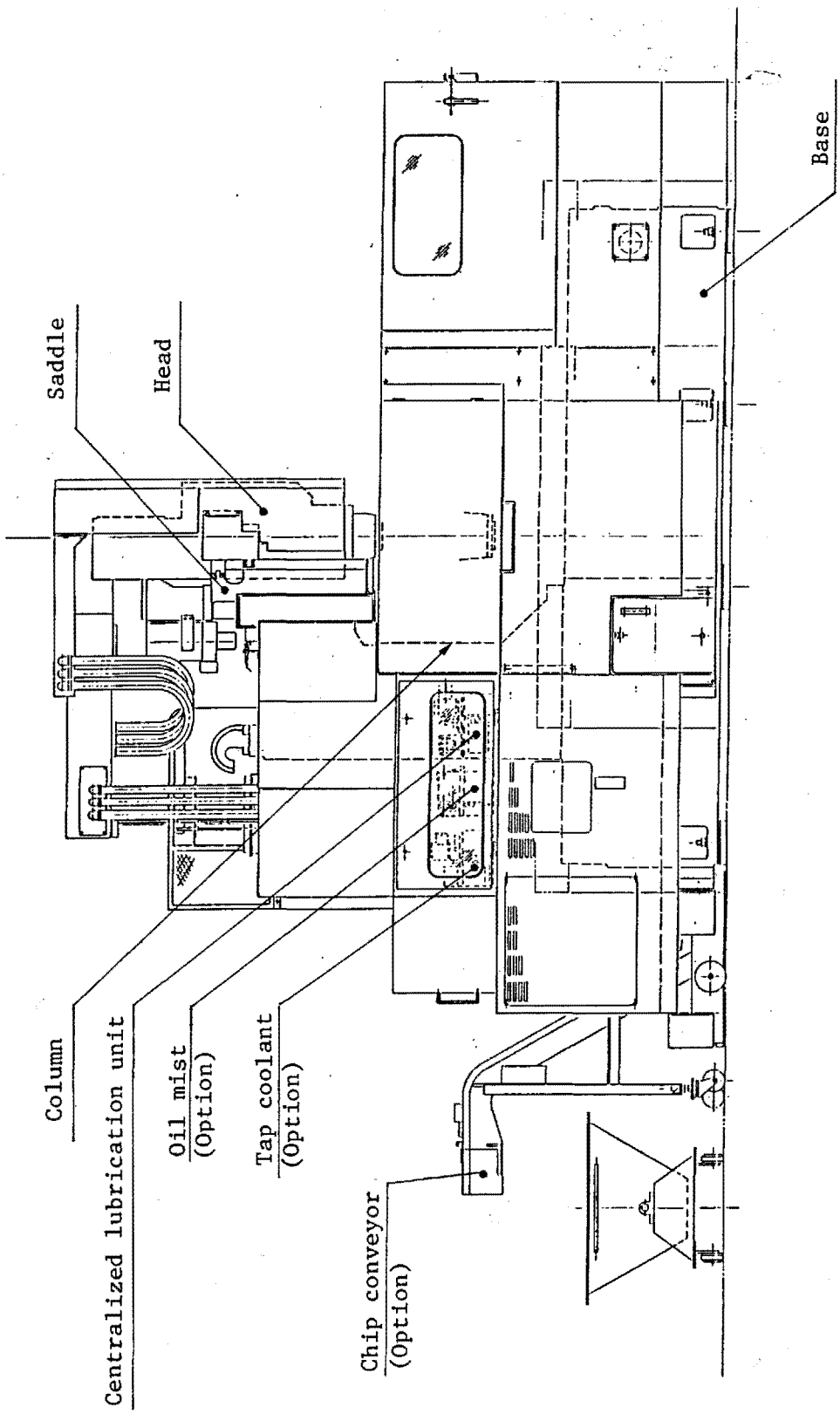
1) The maintenance person should check that the machine operates safely.
2) Maintenance and inspection data should be recorded and kept for reference.

1-3 Designation of Component Units in VQC

A and B type(Standard)



B type(Standard)



1-4 Preventive Maintenance

1) Preventive Maintenance

In preventive maintenance, cleanliness is a very important factor. Dust, moisture, oil, smoke, mist, etc., accelerate the corrosion of electrical contacts which operate intermittently. To carry out a maintenance plan efficiently, prepare a time schedule and observe it strictly. Even if the maintenance plan should interfere with a production schedule, giving priority to the former will prolong the life of the machine and controls. Any maintenance operation that has been performed, especially in relation to controls, should be recorded. These records will be helpful in knowing the life of every part and what replacement parts should be kept in stock.

Following maintenance plan is a general approach to preventive maintenance of our numerical controllers.
Ignore any items that may not apply to your machine. For any particulars that may not be given specifically, follow general maintenance procedures.

NOTE: TO BE SAFE, KEEP ALL ELECTRICAL EQUIPMENT DOORS CLOSED, UNLESS IT IS NECESSARY TO OPEN THESE FOR AN ELECTRICAL MAINTENANCE OPERATION, REPAIR, ETC.
IT IS NOT RECOMMENDED TO USE COMPRESSED AIR TO CLEAN THE MACHINE. COMPRESSED AIR MAY FORCE DIRT AND DUST INTO BEARINGS AND SLIDING SURFACES UNDER SOME CONDITIONS.
APPLY ONLY THOSE LUBRICANTS THAT ARE RECOMMENDED BY YAMAZAKI. APPLY NO EQUIVALENTS.

2) Daily Maintenance Items

(1) Remove chips, dirt and dust from the table, base, etc.
(2) Wipe oils, cutting fluids and chips from the machine surfaces.
(3) Remove everything from sliding surfaces which are not covered.
(4) Clean all sliding surface covers.
(5) Wipe exposed portions of feed screws. To remove dust and chips from such portions, flush them with a light oil or the like.
(6) Clean the feed cover.
(7) Clean all exposed limit switches and surfaces around them.
(8) Clean all electrical parts carefully.
(9) Check the central lubrication tank and the head for oil level. Keep the recommended lubricants at appropriate levels.
(10) Make certain that tools are changed in place.
(11) Make certain that the water in the air filter bowl is draining properly.
(12) Check pressure gages. Hydraulic unit ..... 70 kg/cm^2 (995.61 PSI)
(13) Visually check the machine and the hydraulic unit for possible oil leakage. Take appropriate action, if necessary.
(14) Check cutting fluid hoses and tanks. Remove any obstacle from inside of them.
(15) Make certain that all pilot lamps on the control pendant, etc., are flashing properly.

3) Weekly maintenance inspection items

(1) Conduct daily maintenance inspections.
(2) Check the spindle tip. tool holder and other fittings for possible burring, cracking or damage, and clean around the spindle.

(3) Check the hydraulic unit for oil level. Add an appropriate amount of recommended hydraulic oil, if necessary.
(4) Check each axis at its zero point.

4) Monthly maintenance inspection items

(1) Conduct weekly maintenance inspections.
(2) Clean off the high-voltage switchboard and the control panel inside.
(3) Check the table and the base for level and make certain that the jack bolts and nuts are tight.
(4) Check slide gibs settings and adjust, if necessary.
(5) Flush out the air filter and replace it, if necessary.
Do not apply a thinner or the like to flush the air filter.
(6) Check couplings, sleeves and bolts in the hydraulic unit for possible looseness or abrasion.
(7) Clean slidingsurface wipers and replace them, if necessary.
(8) Check solenoids and limit switches to make certain that they operate properly.
(9) Clean the in-line filter in the hydraulic unit.
(10) Check electric wire connecting terminals for possible looseness or disconnection.
(11) Make certain that interlocks and timers operate properly.
Check relays for appropriate contacting pressure. Clean relay contacts, and adjust them, if necessary.
(12) Drain the cutting fluid and flush out.
Replace the fluid.
(13) Make certain that the NC unit operates properly.

5) Semi-annual Maintenance Inspection Items

(1) Conduct weekly maintenance and monthly maintenance inspections.
(2) Clean the NC unit, high voltage switchboard and machine.

(3) Change the hydraulic oil in the hydraulic unit and the lubricant in the head. Also clean the insides of the tanks.
(4) Clean all motors.
(5) Check motors for possible bearing noise. Replace bearings, if necessary.
(6) Check the machine for alignment.
(7) Visually check all electrical parts and relay panels.
(8) Make certain that the voltmeter reads the appropriate voltage. Adjust or replace the voltmeter, if necessary.
(9) Flush out lubrication pumps and add lubricants required by manufaturers' instructions
(10) Clean the central lubricant filter and the head lubricant filter.
(11) Check that a test program runs perfectly.
(12) Measure any backlash in the NC drive shaft and adjust for it.
(13) Check the brushes in the axial feed servo motors.

2. From Installation to Trial Run

2-1 Environment

When installing a machine tool, avoid a location as follows:

1) Where the machine tool is exposed to the direct sunlight and/or near to a heat source, etc.
Ambient temperature during operation: 0° thru 45°C

2) Where the humidity is considerably flactuating and/or it is highly humid;
Normally 75% and below in relative humdity.
A higher humidity would deteriorate insulation and might accelerate the deterioration of parts. Though special dehumidification is not required, avoid locating the mahcine tool at a place apt to be humid.

3) Avoid using the machine tool under such environments as to be especially dustful and/or to have a vaporous organic corrosive gas highly concentrated.

4) Where there is a vibration source in the surroundings.

5) Soft and weak ground

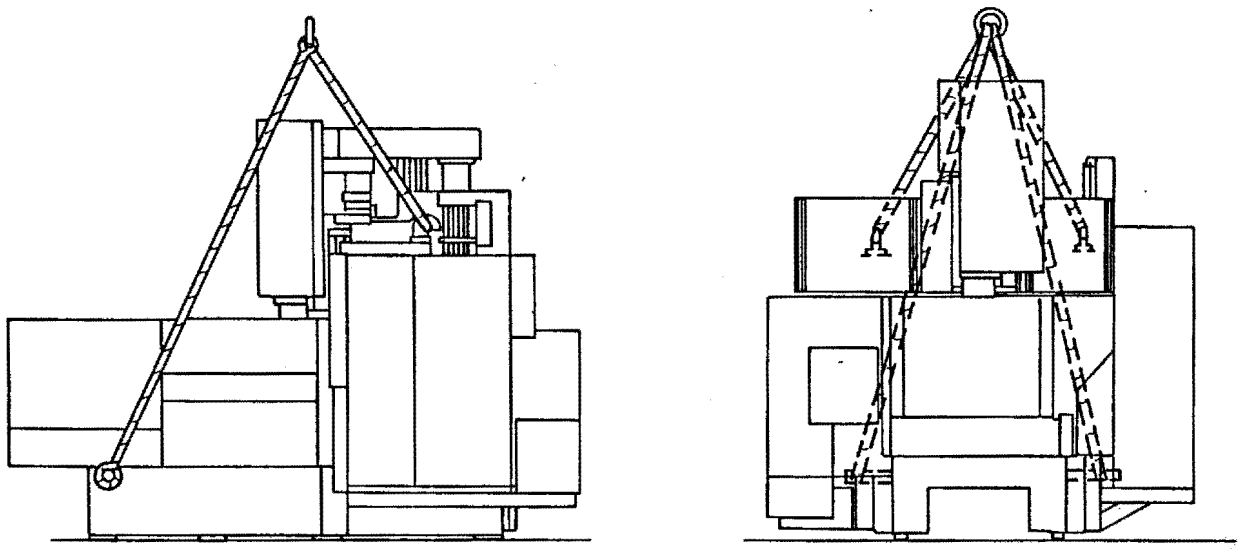
Notes: o If the machine tool is inevitably located near to a vibration source, it is necessary to take such action as to provide an anti-vibration ditch or the like.
o If the machine tool is installed on a soft and weak ground, the bearing power of the soil should be reinforced by piling or the like so as to prevent a subsidence or inclination of the land on which the machine tool is to be installed.

2-2 Installation Procedure

2-2-1 Transportation and Lifting

Machine weight

B Type : 8500 kgf (18739.1 lb)



o Use waste cloths, etc., to prevent damage to those portions on the body, where the wire rope touches.

Lift the machine as illustrated on the preceding page. In this case, however, always:

1) Locate the head at a low place and the table and the saddle at the center.
2) For lifting, use suitable wire ropes.
3) When lifting the machine, be careful to prevent the cable from contacting with any weak portion of the machine. Using cloths or wooden blocks protects such machine portions which the sling may touch.
4) Use utmost care to prevent slings from touching the piping or hydraulic equipment, NC unit, control panel, hydraulic unit, etc.
5) Make certain that hydraulic tanks, drain ports, etc. are closed to prevent leakage of cutting fluids, etc.
6) When transporting the machine using rollers, use utmost care to avoid jarring it.

2-2-2 Installation

The life of a machine tool is entirely dependent upon its proper installation. The present machine has high accuracy guide surfaces, so its improper installation would result in failure to achieve proper performance. Certain users may have had trouble in obtaining required performance of a machine tool justpurchased. In the long run, such trouble is usually attributable to installation problems. Thus, if the machine is installed in the absolutely same conditions as it has been assembled, machining can be done with high accuracy.

Installation Procedure:

1) Move the machine to its location.
2) Place the anchor plate according to the foundation drawing.
3) With the machine lifted, set the anchor bolts to the threaded portions on the base and lower the machine.
4) After leveling, tighten all hexagon nuts.

2-2-3 Cleaning

A rust inhibitor has been applied to the machined portions (not coated portions) to protect them against rusting. After completion of the installation, remove the rust inhibitor by wiping with waste cloths soaked in an abluent oil. After cleaning, apply a thin layer of the specified lubricant to sliding surfaces.

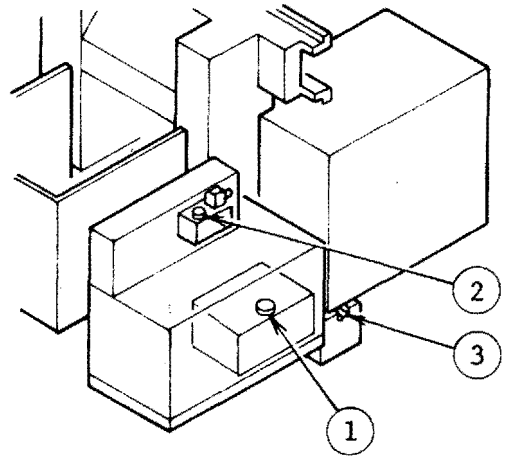
When removing the rust inhibitor, use extreme care to prevent any detergent from getting onto the spindle V-belt, the X-, Y- and Z-axis and the timing belt of the magazine.

NOTE: When cleaning, be careful not to let the abluent oil enter the wipers.

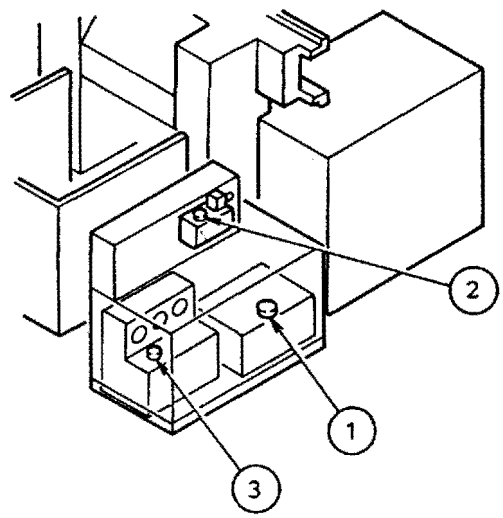
3. LUBRICATION AND COOLANT SUPPLY

3-1 Lubrication Chart

Oil Supply



(5.000 rpm)



(3.150 rpm Cooling coil heat specifications)

The lubrication period is decided on the basis of 8 hours operation a day.

Recommended Oils and Change Cycles

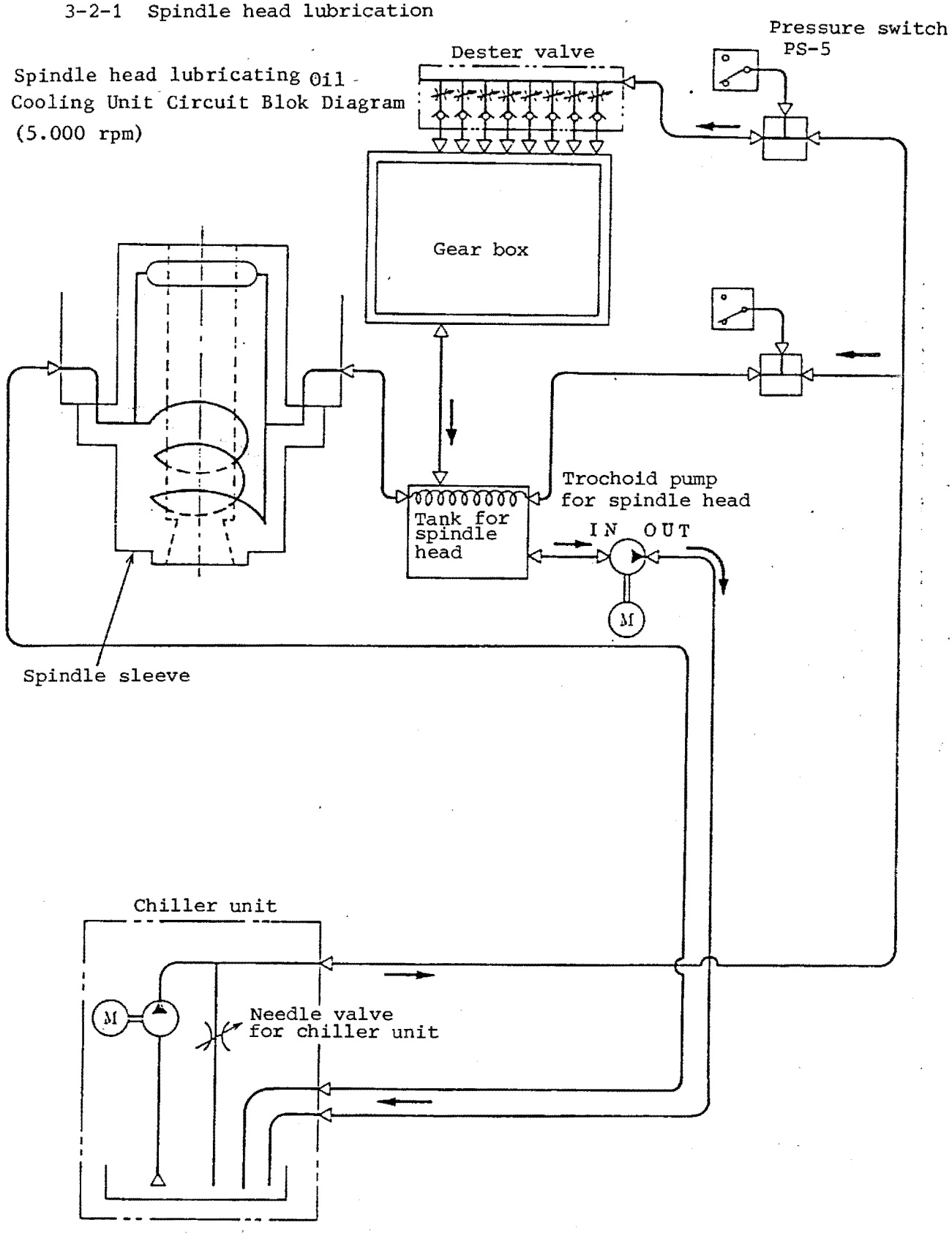
NO.	LUBRICATING POINT	Q'TY	RECOMMENDED OIL	REMARKS
1	Hydraulic Power Unit	40 ℓ (10.1 gal) 65 ℓ * (17.17 gal) with 2 P/C	UNI POWER SQ32 (ESSO) TELLUS OIL C32 (SHELL) DTE 24 (MOBIL)	Exchange oil every 6 months, then clean the filter.
2	Slide Way Ball Screw	3ℓ (0.8 gal)	FEBIS K68 (ESSO) VACTRA No. 2 (MOBIL) TONNA OIL T68 (SHELL) VG 68 (ISO GRADE)	Automatic lubrication Supply oil upon occasion. Clean the filter every year.
3	Head Stock	45 ℓ (11.9 gal)	SPINESSO 10 (ESSO) DTE 21 (MOBIL) TELLUS OIL C10 (SHELL)	Automatic lubrication Exchange oil every 6 months, then clean the filter.

* Option

3-2 Lubrication Mecanisms and Inspection

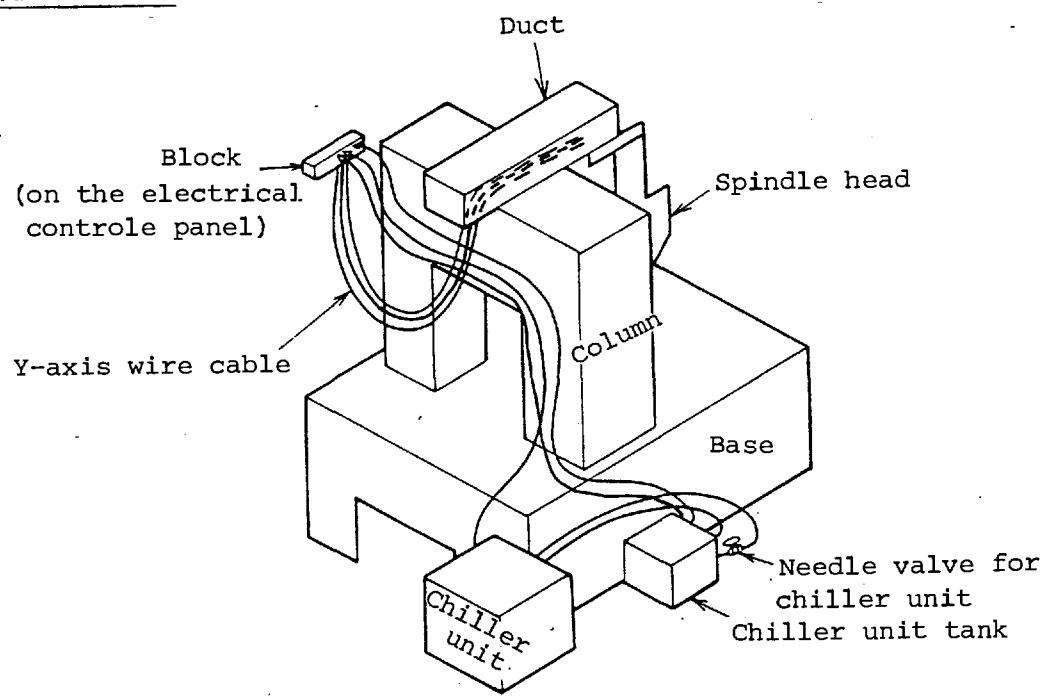
3-2-1 Spindle head lubrication

Spindle head lubricating Oil Cooling Unit Circuit Blok Diagram (5.000 rpm)

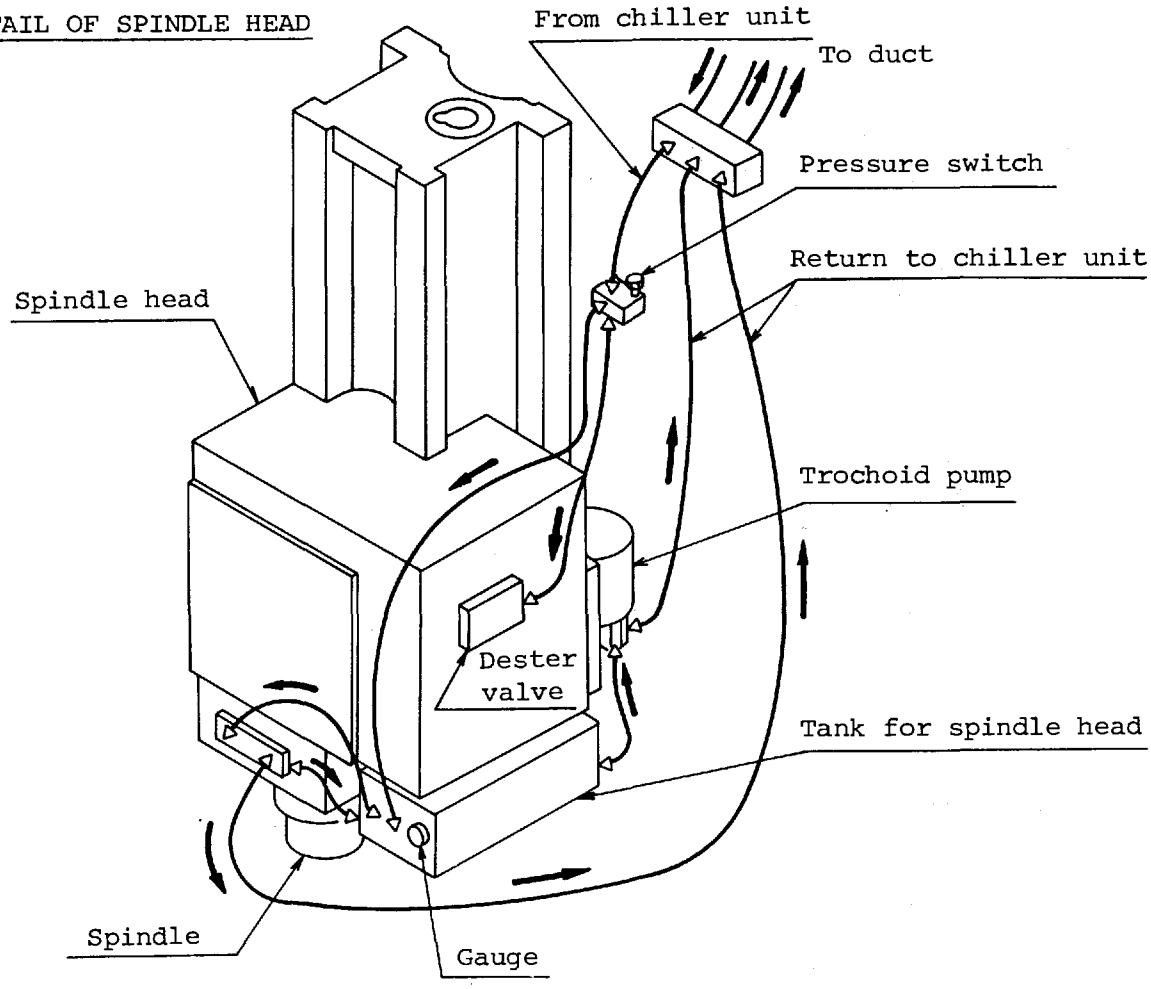


(5.000 rpm)

OVERALL VIEW



DETAIL OF SPINDLE HEAD



The present machine is provided with a spindle head chiller unit as a standaard accessory. The block diagram is given on page 3-2.

The lubricant which comes from the chiller unit reaches the head block through the Y-axis wire cable, duct and X-axis wire cable.

At the head block, the lubricant is routed through two circuits; one lubricates the gear box and the other cools the spindle sleeve. The block has a pressure switch, which operates to give an alarm if the part lubrication has a pressure of 0.3 kg/cm^2 (4.27 PSI) or less due to a system failure.

The oil lubricating the gear box uses a dester valve to lubricate and cool the gears and bearings in the gear box and finally enters the head tank. The oil flow to every part is regulated by a dester valve.

The lubricant after returning to the tank is pumped to another tank in the chiller unit by a trochoid pump.

The oil to the spindle sleeve flows through the radiator in the heat tank, and then returns to the chiller tank after cooling the sleeve.

The oil which returned to the chiller unit tank is returned to the head after being cooled in the chiller. (The oil is partially returned to the chiller unit tank.)

NOTE: The chiller unit tank needle valve and the head dester valve were properly adjusted before shipment. Do not adjust any of them unless necessary.

(1) Refilling the head lubricant:

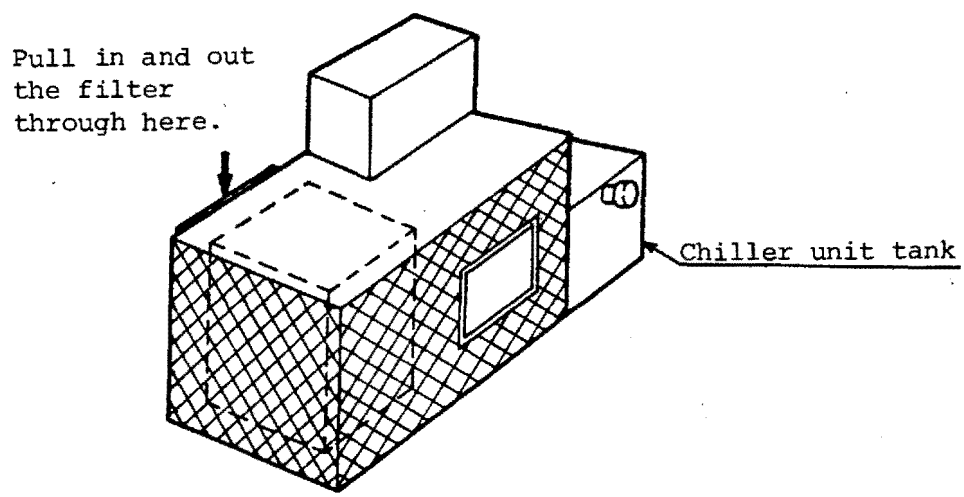
To refill the head lubricant, replenish the chiller unit tank with the recommended lubricant. Avoid directly supplying the head with the lubricant. The level gauge on the side of the head tank is to indicate an excessive amount of lubricant in the head. Therefore, the proper level of the lubricant while the machine is in operation should be a little below the center line.

(2) Cleaning the filter:

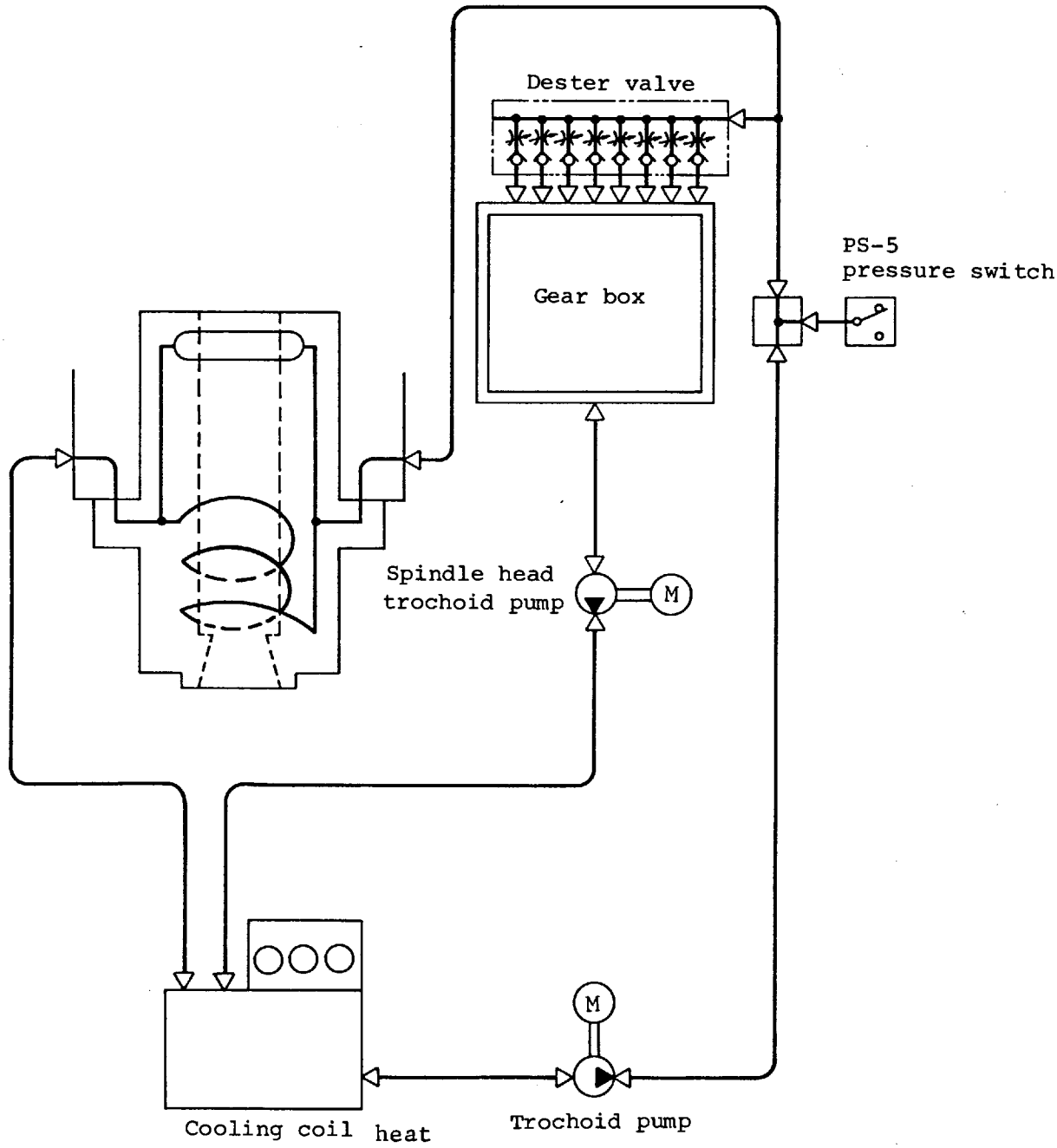
The chiller unit tank has a suction filter. If this filter is clogged, the oil cannot flow smoothly, and may result in a failure. It is necessary, therefore, to clean it periodically.

To clean it, uncover the tank.

An air filter is also provided at the chiller air intake. To make the chiller perform efficiently, it is necessay to clean the air filter from time to time.

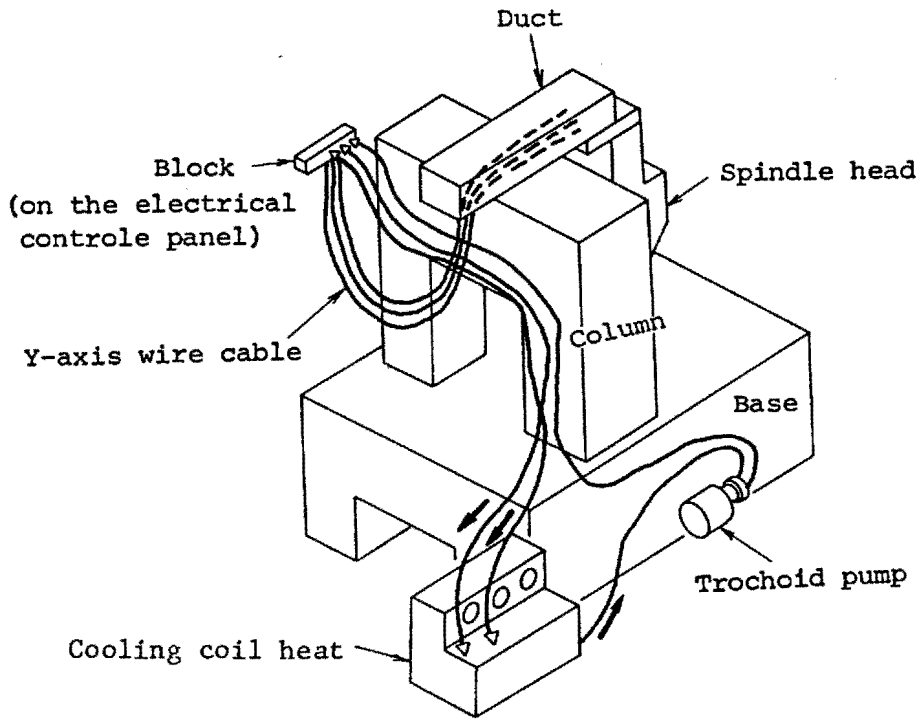


Spindle Head Lubricating Oil Cooling Unit Circuit Block Diagram
(3,150 rpm and Cooling Coil Heat specifications)

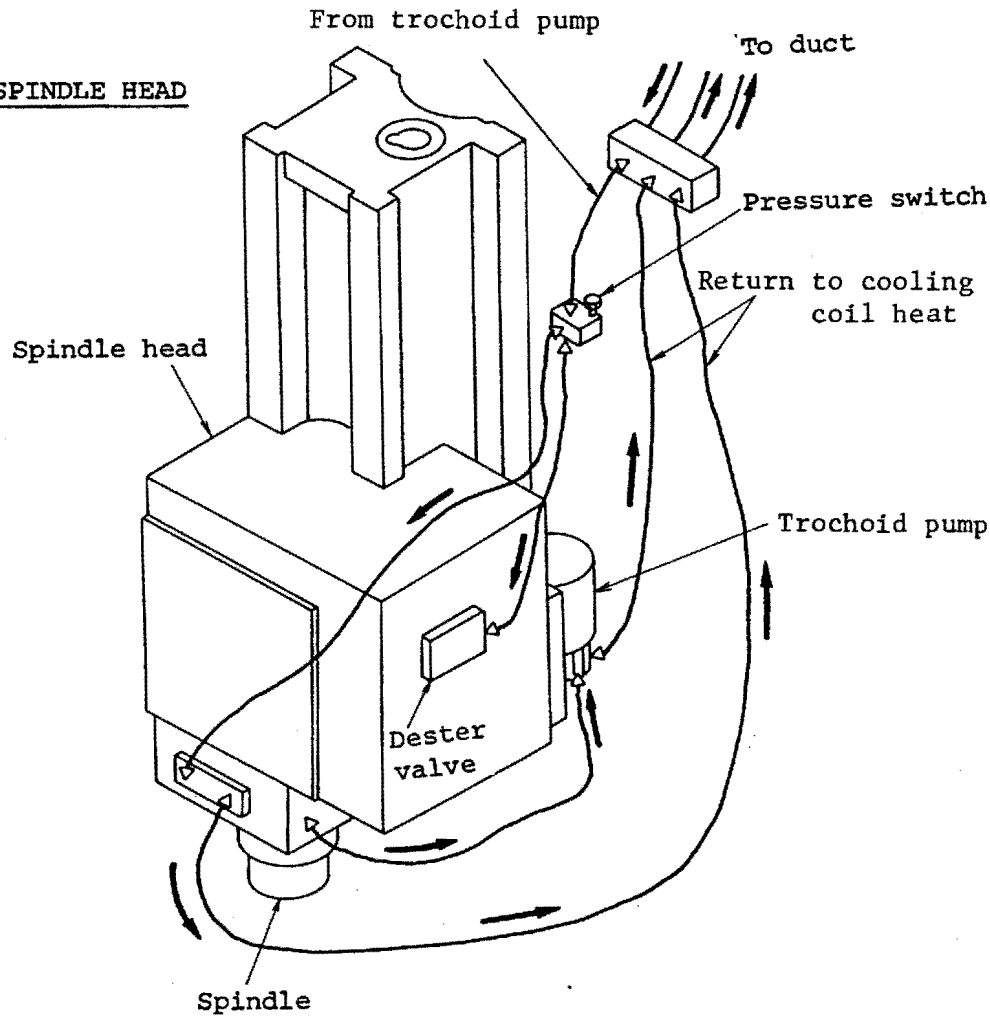


(3.150 rpm Cooling coil heat specifications)

OVERALL VIEW



DETAIL OF SPINDLE HEAD



The present machine is provided with a spindle head lubricating oil cooling unit as a standard accessory. The block diagram is given on page 3-5-1.

The lubricant which comes from the cooling coil reaches the head block through the Y-axis wire cable, duct and X-axis wire cable.

At the head block, the lubricant is routed through two circuits; one lubricates the gear box and the other cools the spindle sleeve. The block has a pressure switch, which operates to give an alarm if the part lubrication has a pressure of 0.3 kg/cm^2 or less due to a system failure.
(4.27 PSI)

The oil lubricating the gear box uses a dester valve to lubricate and cool the gears and bearings in the gear box and uses a trochoid pump to return to the cooling coil tank. The oil flow to every part is regulated by a dester valve.

The oil to the spindle sleeve returns to the tank under the cooling coil after cooling the sleeve.

The oil which returned to the tank under the cooling coil and is fed to the head after being cooled in the cooling coil.

NOTE: The head dester valve were properly adjusted before shipment. Do not tamper with it unless necessary.

(1) Refilling the head lubricant:

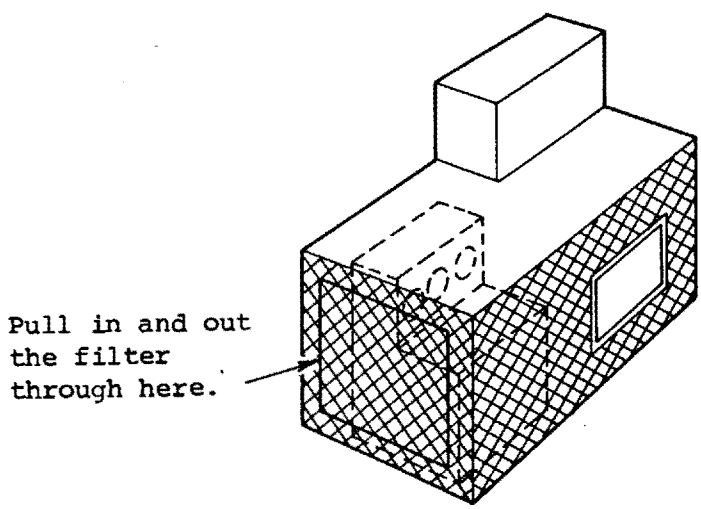
To refill the head lubricant, replenish the tank attached to the cooling coil with the recommended lubricant. Avoid directly supplying the head with the lubricant.

(2) Cleaning the filter:

The cooling coil tank has a suction filter. If this filter is clogged, the oil cannot flow smoothly, and may result in a failure. It is necessary, therefore, to clean it periodically. For the first year clean it once every three months, later on once every year.

To clean it, remove the flange of pump oil filler port, and take out the filter.

An air filter is also provided at the tank air intake. To make the cooling coil perform efficiently, it is necessary to clean the air filter from time to time.

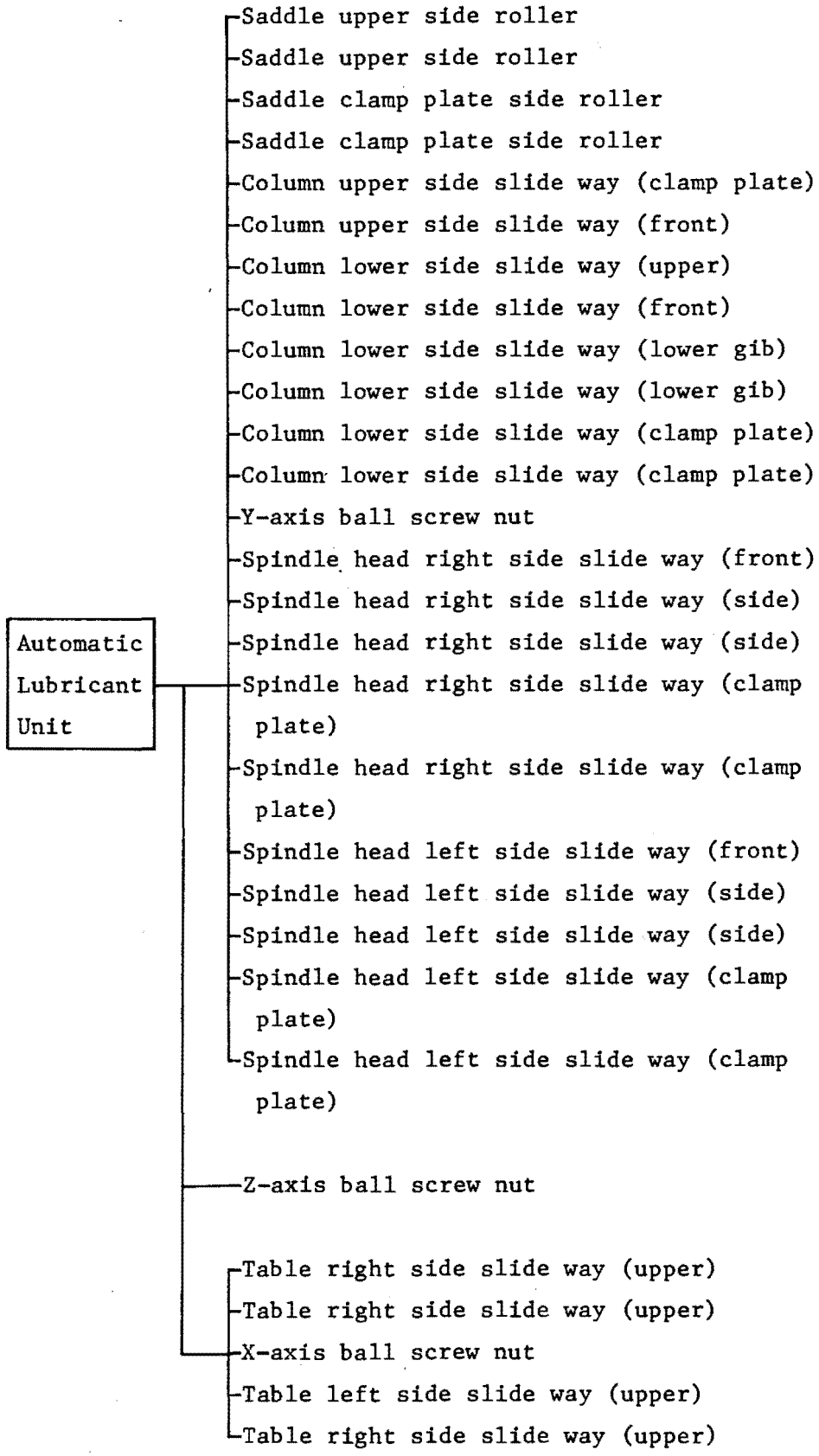


3-2-2 Lubricating sliding surfaces, ball screws, drive shafts and ATC section

Sliding surfaces and ball screws/nuts in shafting are lubricated by the automatic central control lubricator. The oil fed to every part to be lubricated is kept in a constant amount with the MO type constant flow valve provided in each part.

A flowmeter provided at the discharge port of the tank checks the lubricant for normal flow. If the lubricant is not supplied properly due to a drop of oil level, pump failure, etc., the MACHINE FAIL alarm lamp on the control panel will come on.

1) Lubrication System

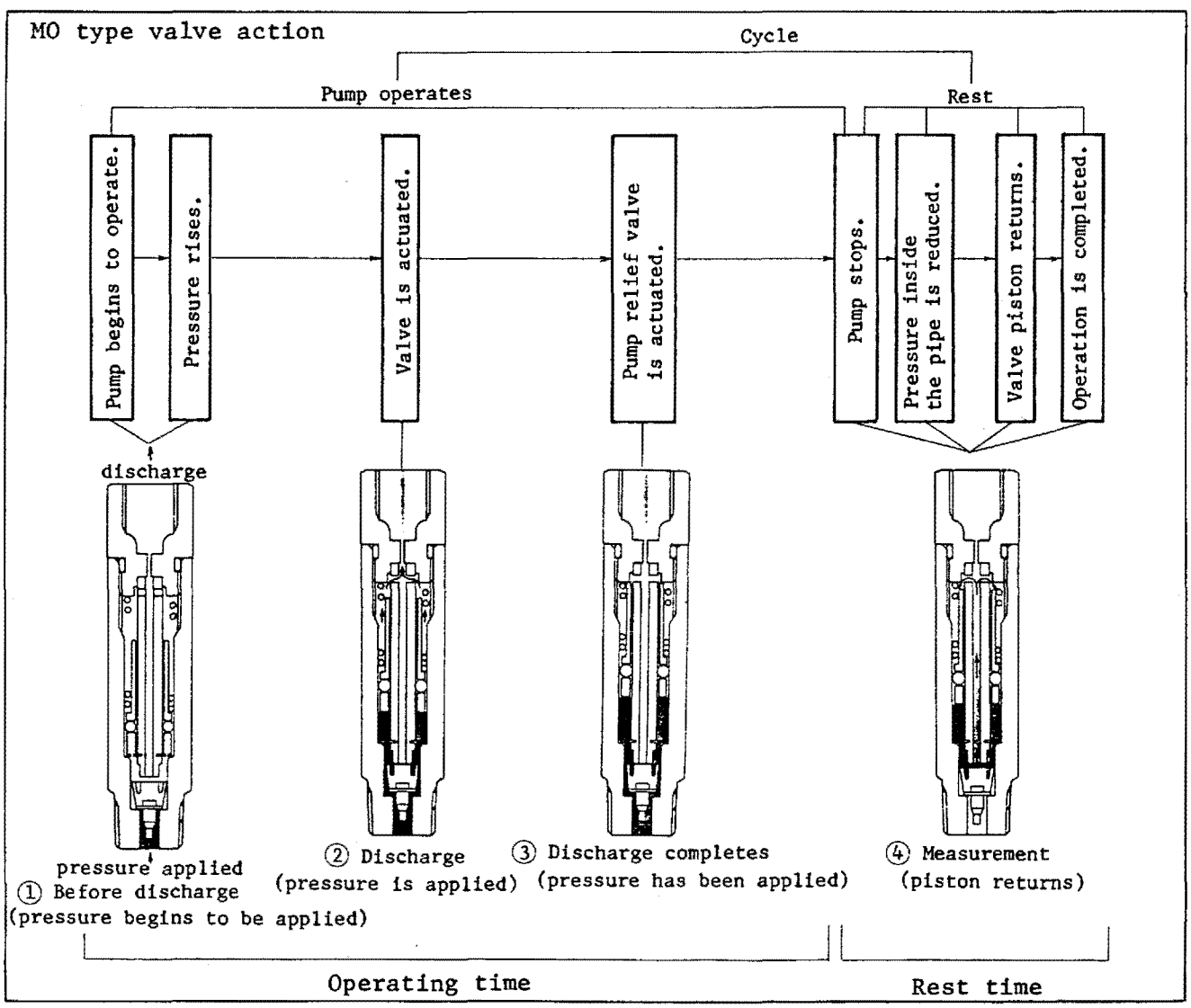


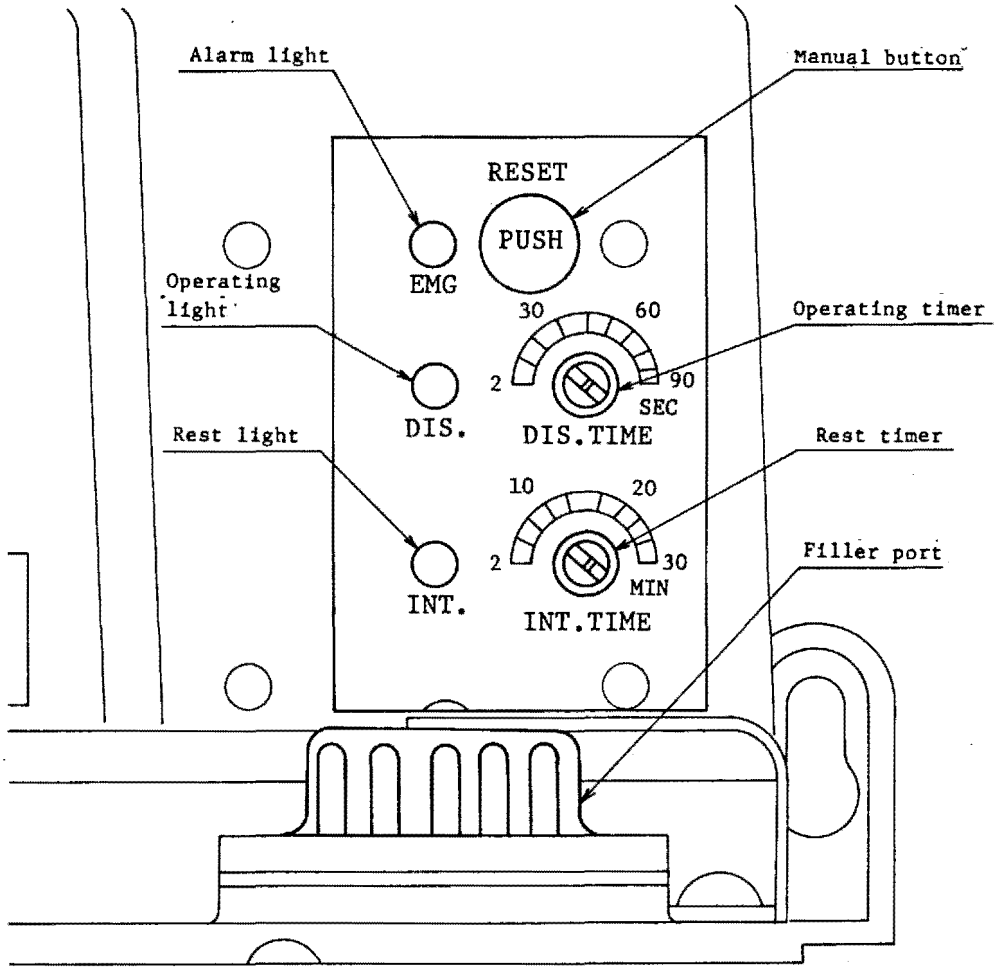
2) Intermittent interval adjustment

The automatic lubrication pump intermittent interval was adjusted at the factory to provide the optimum discharge. However, the intermittent interval for the operating time (DIS. TIME) or the rest time (INT. TIME) can be adjusted between 2 and 90 sec. or 2 and 30 min., respectively, if necessary.

Turn the timer key on the front of the pump to the desired setting with a screwdriver.

The operating timer and the interval timer were present to 30 sec. and 6.5 min., respectively, before shipment.





Operating time: after the pump begins to operate, lubricant flows into the lower part of the MO type valve and the pump relief valve is actuated until the pump stops.

Rest time: the spring inside the MO type valve returns until the pump begins to operate again.

3) Inspecting and cleaning the lubricator:

a) Before daily operation make certain that all parts are lubricated. Should any part run short of the oil, the oil may be leaking in the piping system.

b) With the four screws on the top of the unit removed, the suction filter in the automatic intermittent lubrication pump may be taken out. Clean the suction filter at least once a year. When the fuse in the unit is blown due to clogged suction filter, clean the suction filter.

c) Periodically inspect the tank for the presence of dirt, dust and water and clean inside the tank whenever necessary.

4) Automatic intermittent lubricator failures and remedial action

Cause	Action
o No oil from the pump.	
. Pump motor turning in the wrong direction.	Immediately reverse the motor direction.
. Lubrication tank oil level too low.	Add a recommended oil to a specified level (up to the pump flange face).
. Suction filter clogged.	Flush or replace filter. Replace oil with new supply, if necessary.
. Internal piping clogged (collapse, twist, disconnection, etc.)	Replace piping.
. Oil too viscous to be pumped.	Apply an oil with a recommended viscosity.
. Inlet check valve stuck and open.	Remove and clean.
. Outlet check valve stuck and open.	Remove and clean.
o Pump does not create pressure.	
. No oil from the pump for reasons mentioned above.	Take action by turns as described above.
. Check valve seat packing defective.	Replace.
. V-ring worn out in the interior of piston cylinder.	Replace.
o Plunger does not operate.	
. Speed reduction mechanism has ruptured due to an initial reverse run.	Replace.
. Cam defective	Replace.
. Motor defective.	Replace.
. Worm wheel gear worn out.	Replace.

3-3 Checking the Cutting Fluid Unit

3-3-1 Cutting fluid unit

The cutting fluid goes from the cutting fluid tank in the lower part of the base by the coolant pump (trochoid pump). Three individually-changeable nozzles are provided and their respective discharge directions marked. At this time, the flow rate may be also changed by regulating the cock in the nozzle block.

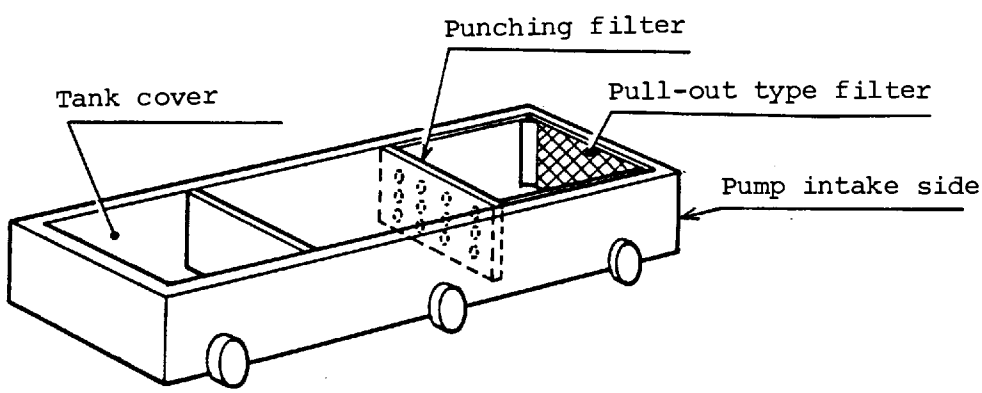
The tank configuration varies depending on whether or not the spiral conveyor and/or the chip conveyor are provided.
The system, moreover, differs depenidng on whether or not the oil hole and spindle thru are provided.

3-3-2 Checking the cutting fluid unit

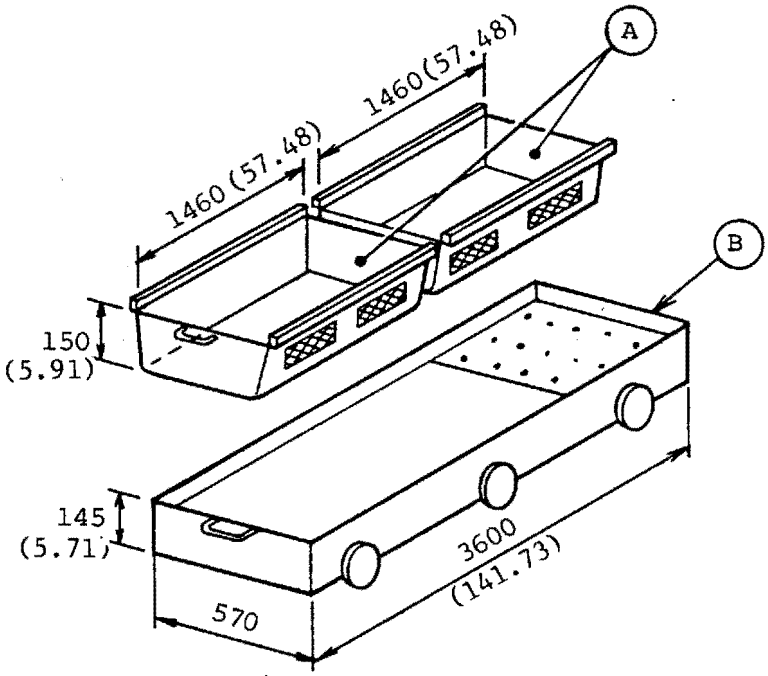
1) Supplying the cutting fluid
   Whenever the cutting fluid is lower than the lower limit on the level gage, add cutting fluid.

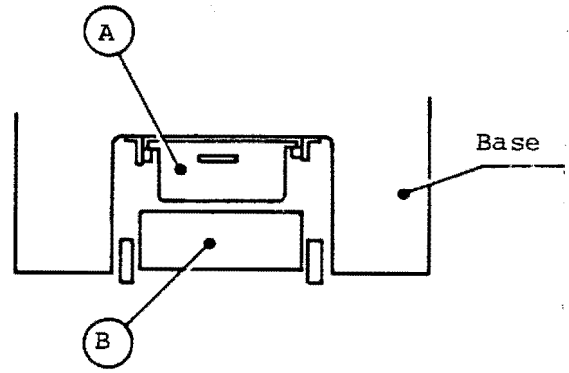
2) Clearing chips
   To clear chips from the machine, pull out Bucket (A) or (D).
   Clean the bucket from time to time.

3) Cleaning the filter
   A pull-out type filter is provided on the pump intake side of the tank while a punching filter is located at the cutting fluid drain cock (in both types).

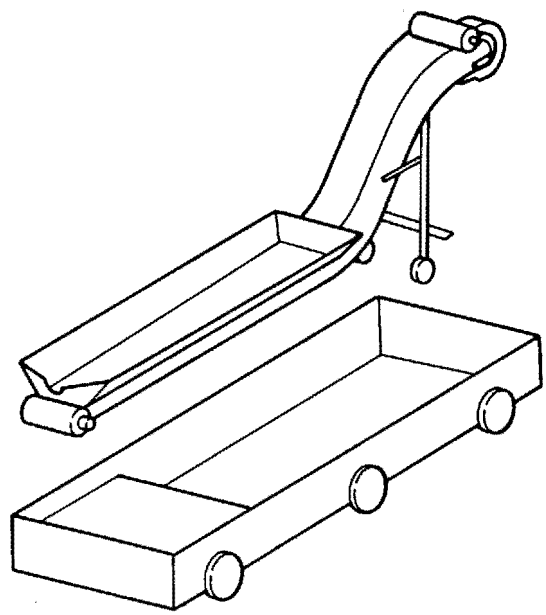


o Chip pan(standard)

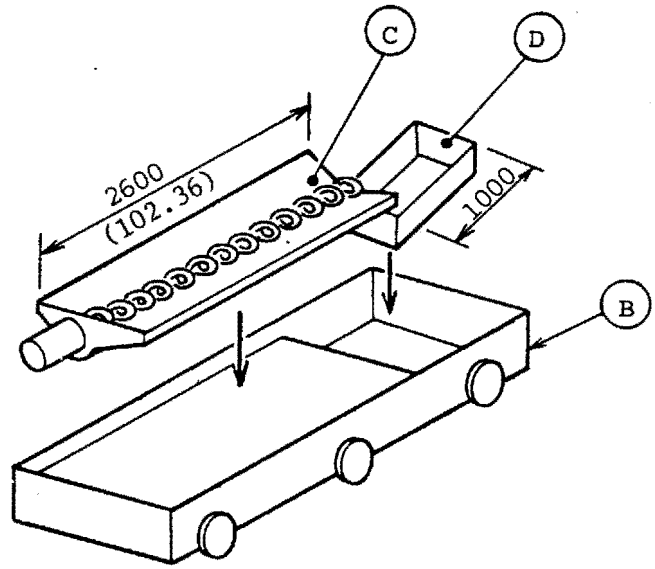




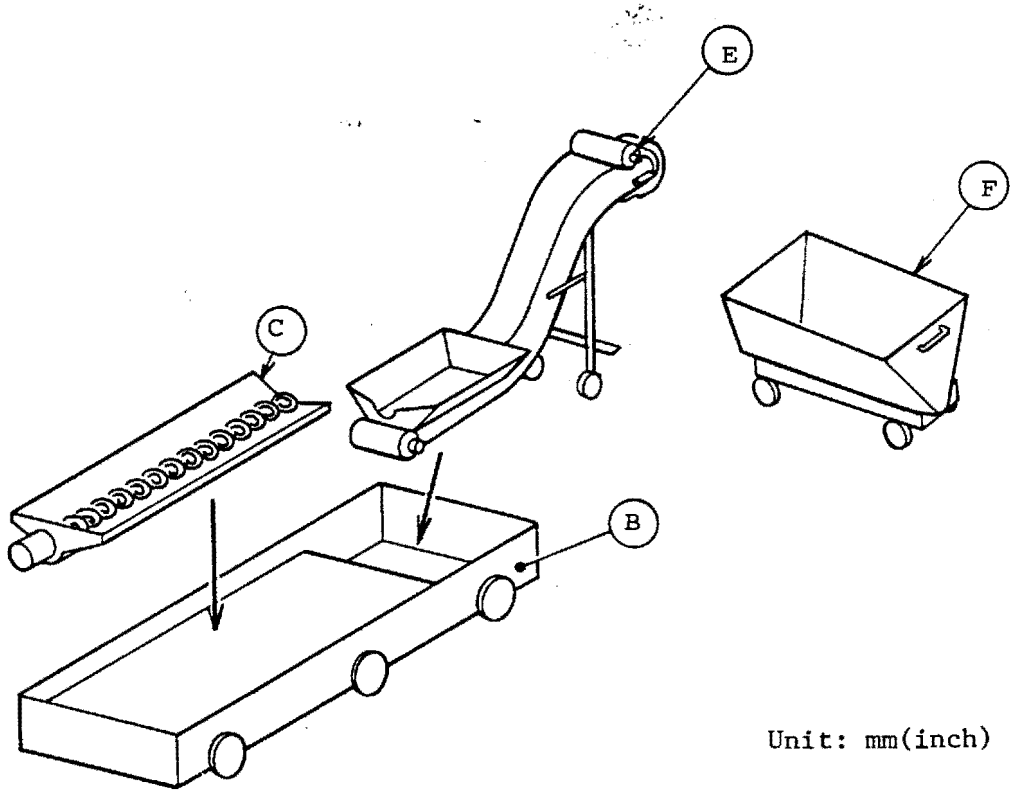
o With chip conveyor(A type,option)



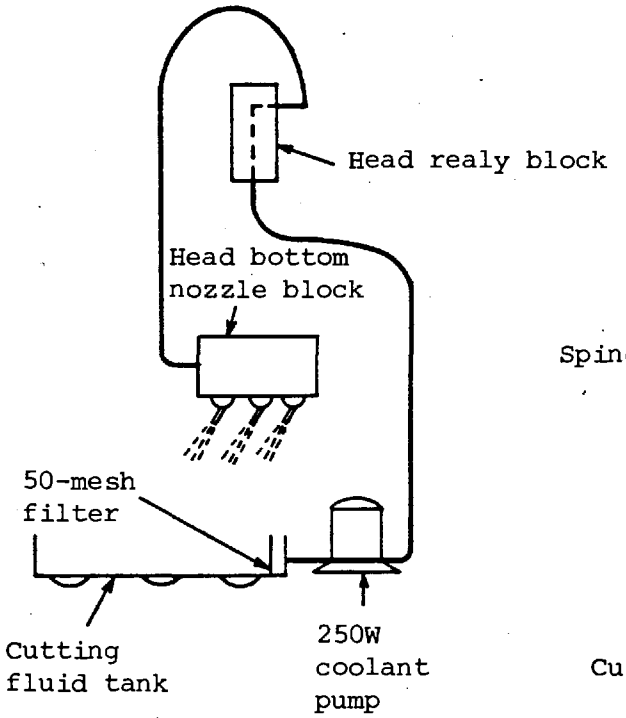
o With spiral conveyor(B type,option)



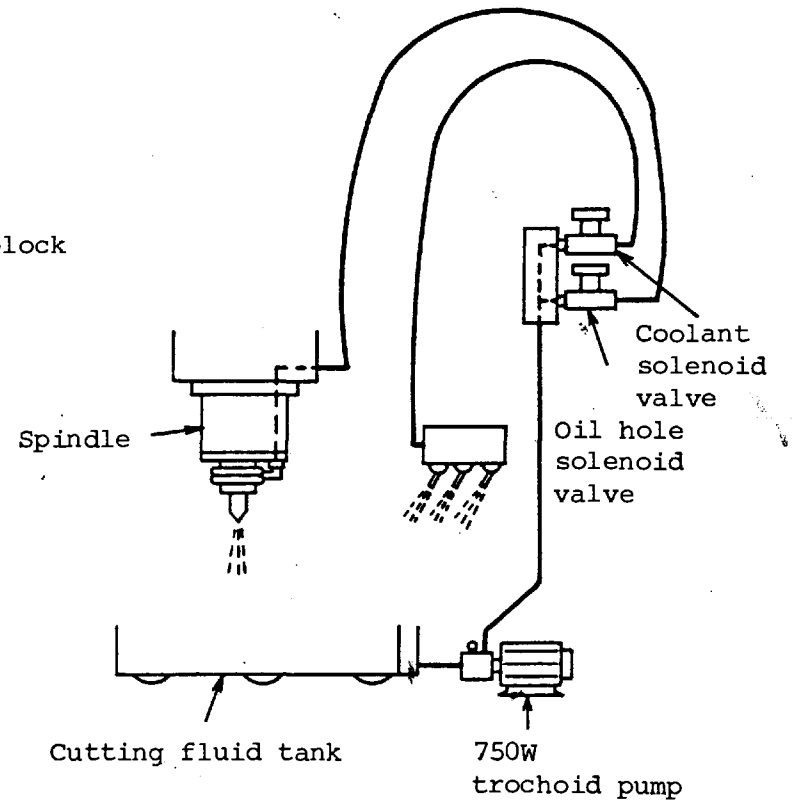
o With spiral conveyor and chip conveyor(B type,option)



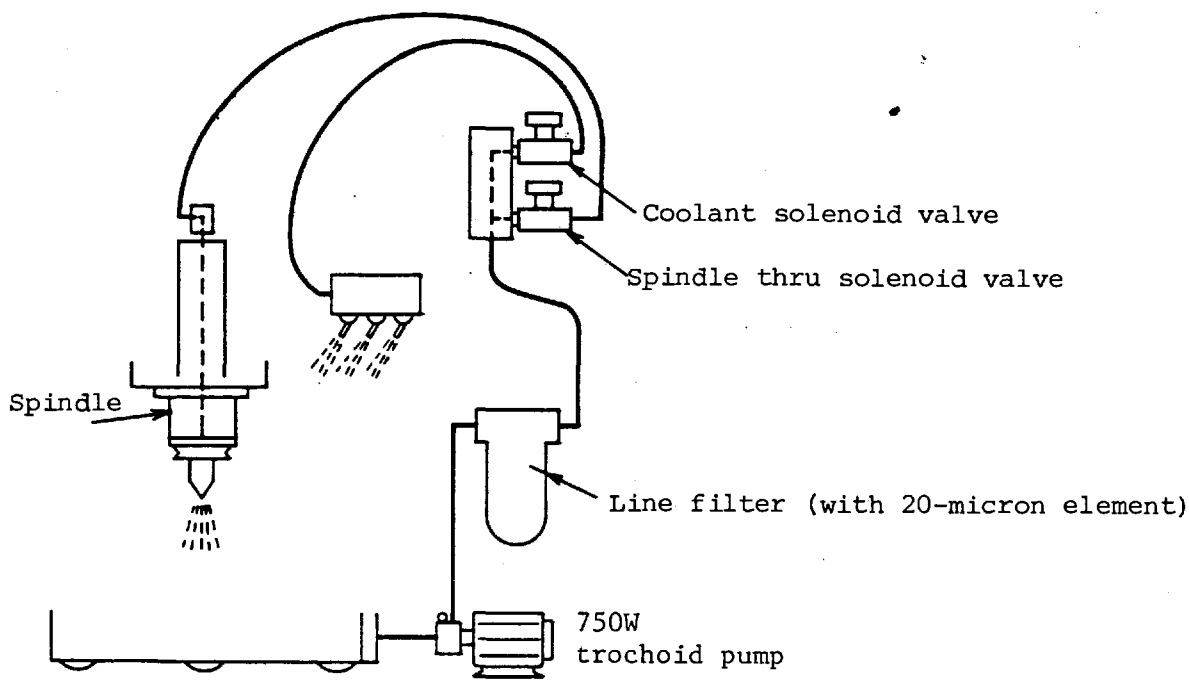
Unit: mm(inch)



(A) Standard Type



(B) With Oil Hole Unit



(C) With Spindle thru

Clean the filter once a day or from time to time depending on the amount of chips produced. When cleaning the tank, clean the punching filter, too.

For the machine with the spindle thru, the line filter with a 20-micron element is located just outside the pump discharge port. This filter should also be cleaned once a day.

Any filter that is clogged will reduce the discharge and may damage the pump. Clean from time to time.

4) Cleaning the tank

When the discharged cutting fluid has a higher content of impurities and when the cutting fluid is changed, clean the cutting fluid tank.

Drain the cutting fluid through the tank drain port and pull out the required part on the pump side of the tank. Clear away the chips on the tank cover as well.

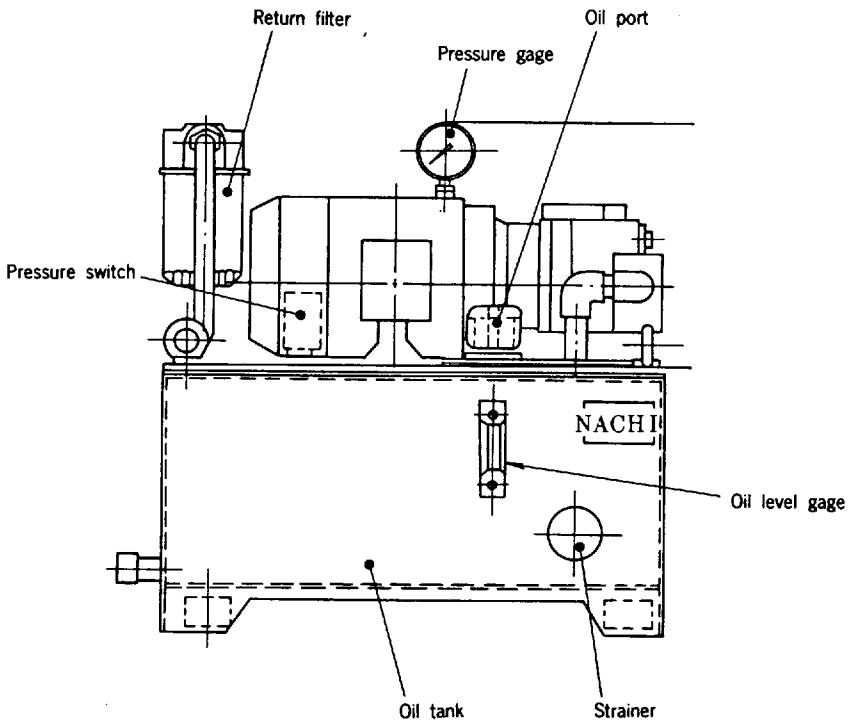
NOTE: When removing the coolant pump hose from the tank, close the lever cock between the tank and the hose carefully to prevent the water from the tank from spilling.

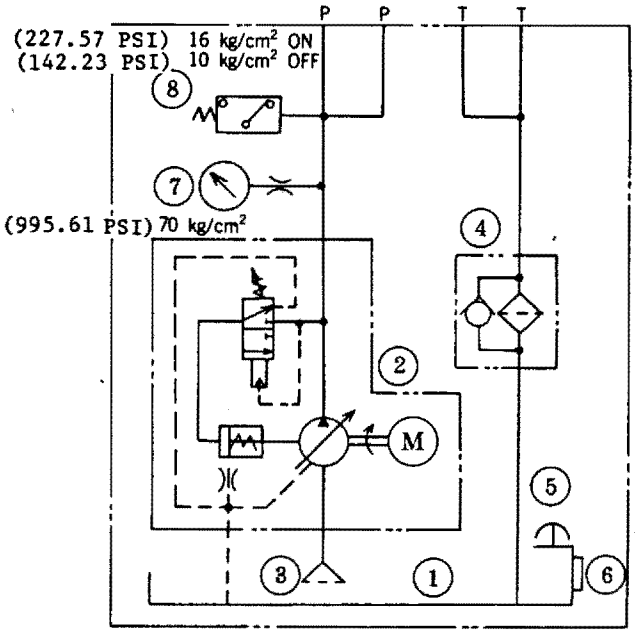
In the normal operation, the cock should be kept opened.

4. Hydraulic System

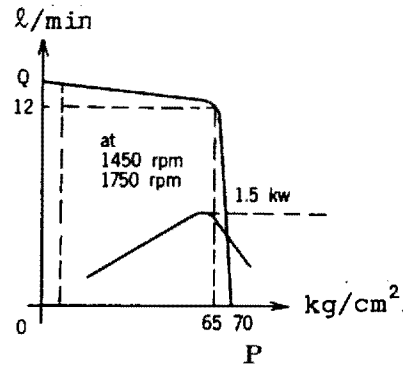
4-1 Hydraulic Unit

4-1-1 Construction and features (Standard)





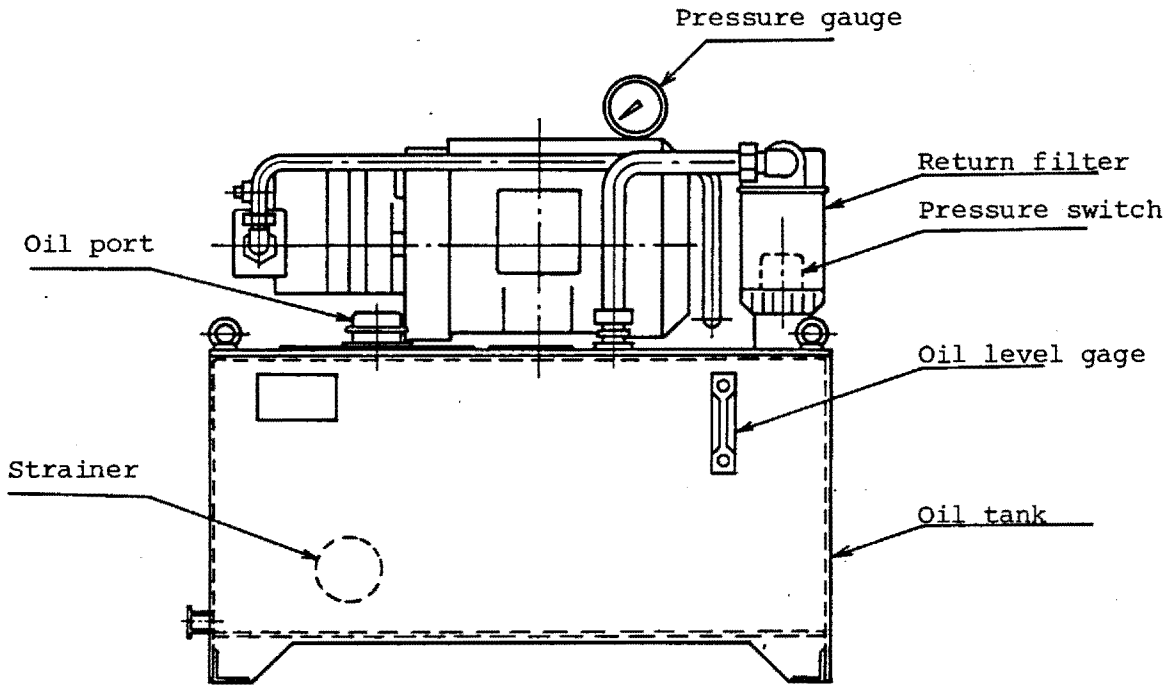
Hydraulic unit



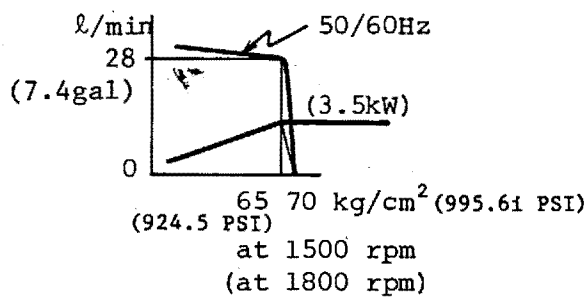
Performance curve of the Pump

8	Pressure switch	SPS-8T-P C-20	1	Sanwa Electric
7	Pressure gage	AVU 1/4xø60x150K (ø2.36 in x 330.69 lb)	1	NAGANO KEIKI
6	Oil level gage	ø6 x 80 (ø0.24 x 3.15 in)	1	
5	Oil port	MSA-C30T	1	MASUDA SEISAKUSHO
4	Return filter	CF-0610 μ	1	TAISEI KOGYO
3	Strainer	MST-06 150 mesh	1	MASUDA SEISAKUSHO
2	UNI pump	UPV-IA-16NI-1.5A-4-10	1	
1	Oil tank	40 Lit (8.8 gal)	1	
Item No.	Designation	Model	Q'ty	Remarks

(With 2 PC)



Performance curve of the pump



at 1500 rpm
(at 1800 rpm)

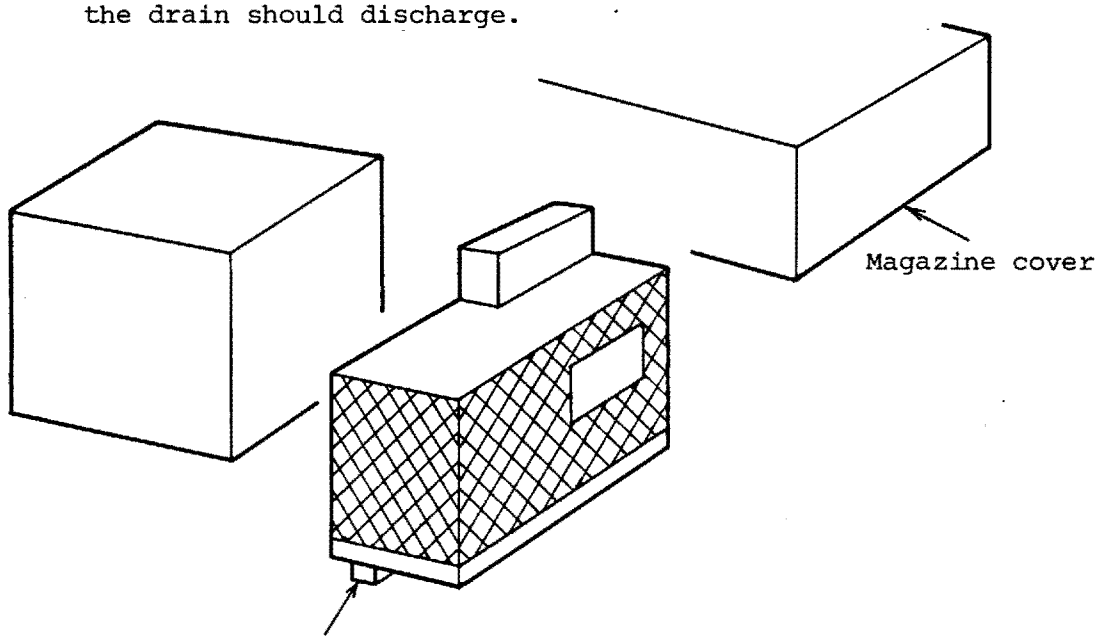
Item No.	Designation	Model	Q'ty	Remarks
8	Pressure switch	SPS-8T-P C-20	1	Sanwa Electric
7	Pressure gage	44743104450	1	ASAHI KEIKI
6	Oil level gage	ø6 x 80 L (ø 0.24 in x 17.6 gal)	1	
5	Oil port	FA-50	1	TAISEI KOGYO
4	Return filter	CF-0610 μ	1	TAISEI KOGYO
3	Strainer	MST-06 150 mesh	1	MASUDA SEISAKUSHO
2	UNI pump	UPV-1A-19NI-2.2-4-2408	1	
1	Oil tank	63 Lit (13.86 gal)	1	

4-1-2 Filter

To filter the hydraulic oil, the present machine has a filter in the circuit through which the oil is returned to the tank. This filter has a bypass circuit. When the filter is clogged, the hydraulic oil will not pass through it but returns directly to the tank. It is necessary, therefore, to replace the filter periodically. Replacement should be done half-yearly. This cartridge filter is easily replaceable.

4-1-3 Drain

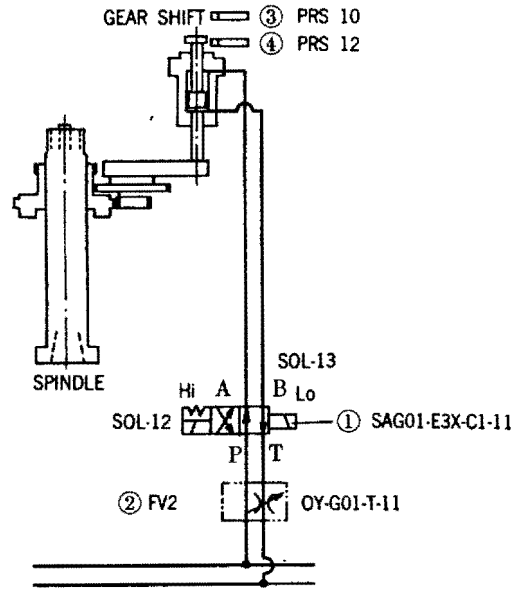
The drain in the hydraulic unit is connected by a pipe between the tank port and the rear of the present machine. From here, the drain should discharge.



4-2 Spindle Head Gear

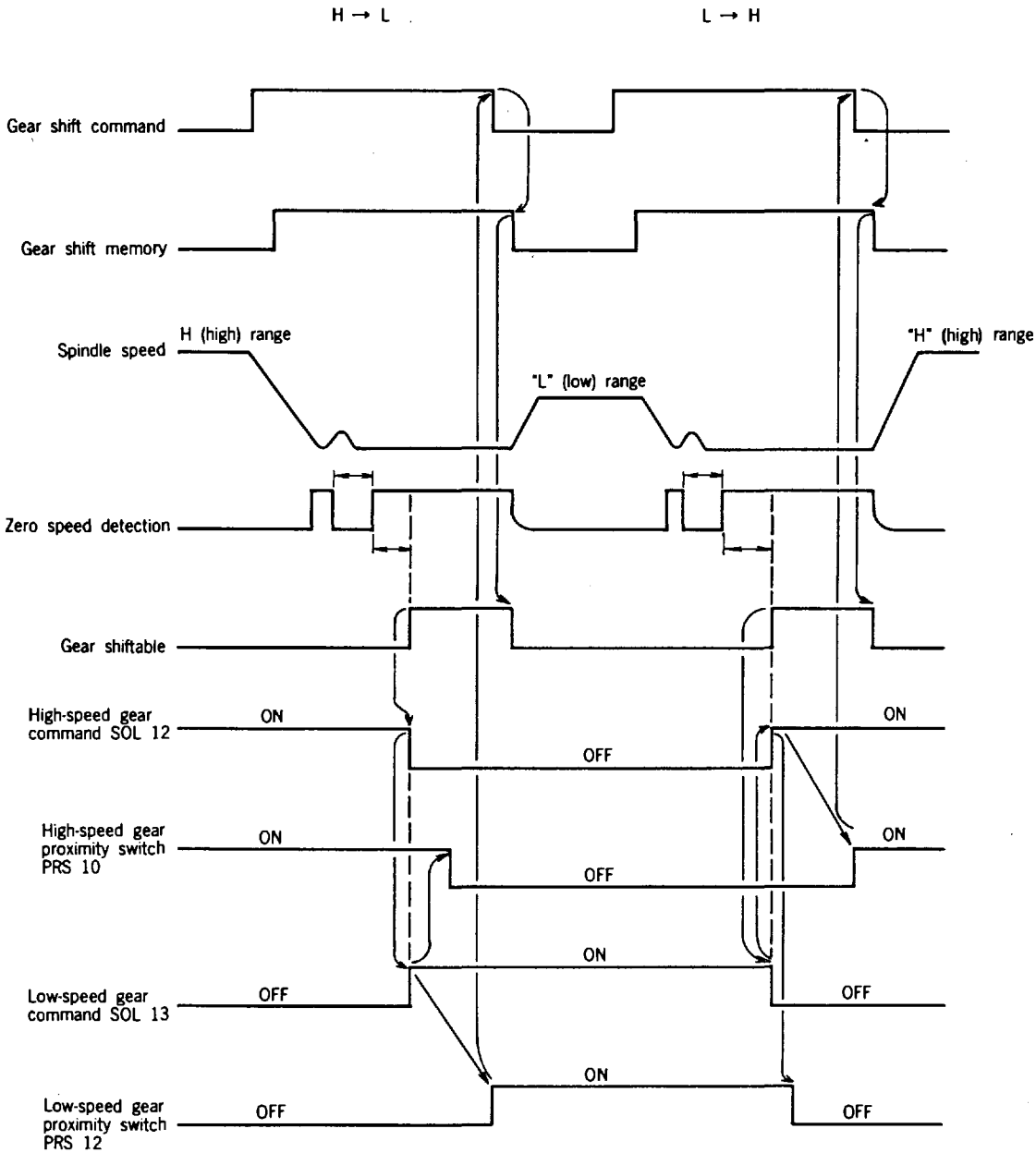
When the spindle speed is changed from low speed to high, or the reverse, the spindle head gear is shifted.

4-2-1 Hydraulic circuit diagram, parts and switches



No.	Designation	Model No.	Q'ty	Manufacturers	Application
①	Solenoid valve	SA-G01-E3X-C1-11	1	FUJIKOSHI	High-low shift
②	Flow regulator	OY-G01-T-11	1	FUJIKOSHI	High-low shift and speed regulation
③	Proximity switch	FL1-2D6-E3	1	YAMATAKA	High speed position check
④	Proximity switch	FL1-2D6-E3	1	YAMATAKE	Low speed position check

4-2-2 Gear shifting sequence



1) Shifting the gear from high to low speed:

(1) The gear shift command alters the spindle motor speed to gear shift speed.
(2) Once the gear shift speed has been attained, the solenoid of the high-speed solenoid valve is turned off, while that of the low-speed solenoid valve is turned on. Then, the shifter moves to the low-speed position.
(3) While the shifter is moving, the high-speed proximity switch turns off.
(4) When the shifter arrives at the low-speed position, the low-speed proximity switch turns on. Thus, the spindle motor will run so that the spindle will turn with the speed changed from the gear shifting speed to another speed specified by the S code.

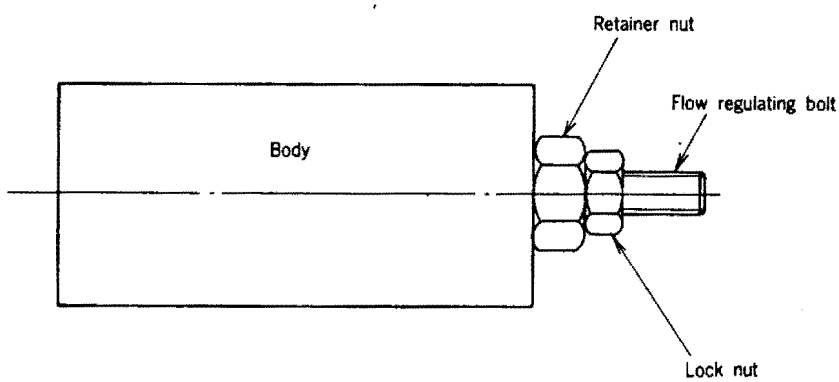
2) Gear shift sequence from low to high speed:

(1) The gear shift command converts the spindle motor speed to gear shift speed.
(2) Once the gear shift speed has been attained, the solenoide of the low-speed solenoid valve is turned off, while that of the high-speed solenoid valve is turned on. Thus, the shifter moves toward the high-speed position.
(3) While the shifter is moving, the low-speed proximity switch turns off.
(4) When the shifter arrives at the high speed position, the high-speed proximity switch turns on. Thus, the spindle motor will run so that the spindle will turn with the speed changed from the gear shifting speed to another speed specified by the S code.

4-2-3 Adjusting the gear shifting speed:
The gear shifting speed has been adjusted to an appropriate level before shipment from factory. Should the gear shifting speed be raised from theleveladjusted in the factory, to reduce the gear shifting time, the shift gear may collide with the spindle gear when shifted, possibly damaging the gearing, so use utmost care when adjusting the gear shifting speed.

The gear shifting speed is adjusted by regulating a flow control valve in the flow regulator.

Procedure for adjusting the gear shifting speed:



Flow Regulator
(OY-G01-T-11)

(1) Loosen lock nut.
(2) Insert an L wrench into the end of flow regulating bolt.
(3) Turn L wrench clockwise and the gear shifting speed will decrease.
Turning L wrench counterclockwise will increase the gear shifting speed.
(4) After completion of gear shifting speed adjustment, tighten lock nut.

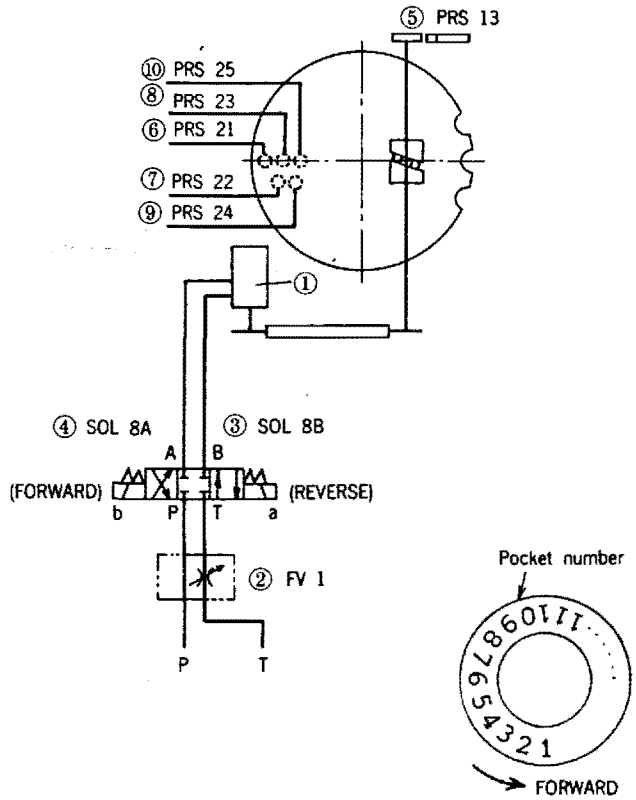
NOTE: Gear shifting speed set upon shipment from factory:
High pressure side low pressure side1.5 sec.

4-2-4 Flow regulator clogged
If the flow regulator is clogged, the gear shifting speed may decrease. In the long run, the gear may not shift. In such a case, clean the flow regulator using the following procedure:

(1) Switch off the hydraulic unit.
(2) Turn the retainer nut (See the illustration given on the preceding page.) counterclockwise. And remove the retainer.
(3) Remove any foreign matter which may be sticking to the retainer tip, throttle and interior of the body.
(4) After removing the foreign matter clogging the regulator, screw in the retainer up to the same position as before.

4-3 Magazine Turn

4-3-1 Hydraulic circuit diagram and arrangement of hydraulic parts and switches



FORWARD: Turn causing an increase in pocket number
REVERSE: Turn causing a decrease in pocket number

No.	Designation	Model No.	Q'ty	Manufacturers	Application
①	ORB mark motor	ORB-M26-2P	1	NIPPON OIL PUMP	To turn and drive the magazine
②	Flow regulator valve	OY-G01-T-11	1	FUJIKOSHI	To adjust the magazine turn speed
③	Solenoid valve	SA-G01-C5-C1-11	1	FUJIKOSHI	Magazine CW
④					Magazine CCW
⑤	Proximity switch	FL1-2D6-E3	1	YAMATAKE	To make certain of magazine in position
⑥	"	FL1-2D6-E3	1	YAMATAKE	To make certain of tool command 2^0
⑦	"	FL1-2D6-E3	1	YAMATAKE	To make certain of tool command 2^1
⑧	"	FL1-2D6-E3	1	YAMATAKE	To make certain of tool command 2^2
⑨	"	FL1-2D6-E3	1	YAMATAKE	To make certain of tool command 2^3
⑩	Proximity switch	FL1-2D6-E3	1	YAMATAKE	To make certain of tool command 2^4 or 10.

4-3-2 Adjusting the magazine turn speed:

The magazine turn speed has been adjusted to an appropriate level before shipment from factory, so do not adjust it unnecessarily.

If necessary, adjust the flow control valve in the flow regulator. To operate the flow regulator, follow the same procedure as that for gear shifting.

NOTE: Magazine turn time per pocket set upon shipment from factory: 0.6 sec. (To be set, without tools)

Magazine tool numbers are read by five proximity switches, PRS-21 thru PRS-25.

PRS-21	$2^0=1$
-22	$2^1=2$
-23	$2^2=4$
-24	$2^3=8$
-25	$2^4=16$

For T09, as an example, PRS-21 and -24 will turn on with

$$9 = 2^0 + 2^3 = 1 + 8$$

For T14, PRS-22, -23 and -24 will turn on, with

$$14 = 2^1 + 2^2 + 2^3 = 2 + 4 + 8$$

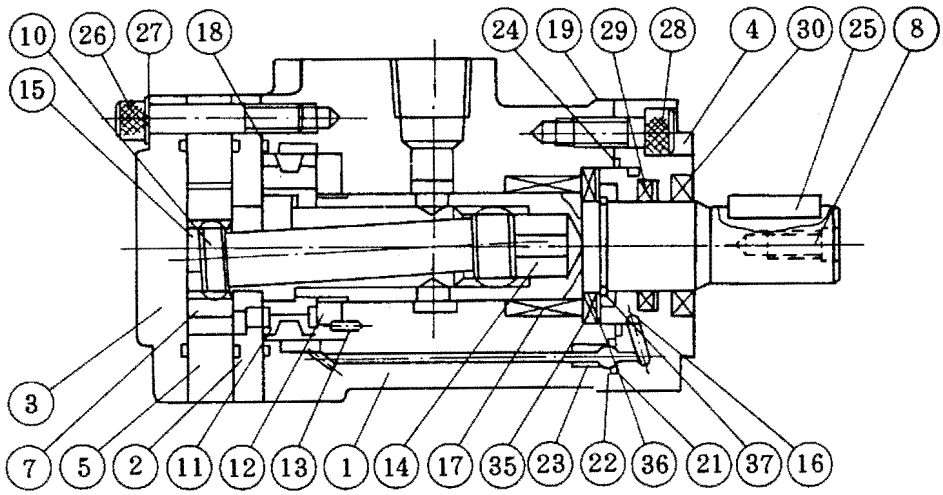
Tool Codes vs. ON/OFF Conditions of Tool Number Check Proximity Switches

Switch / Tool	PRS-21	PRS-22	PRS-23	PRS-24	PRS-25
	Tool command 2^0	Tool command 2^1	Tool command 2^2	Tool command 2^3	Tool command 2^4
T01	O	X	X	X	X
T02	X	O	X	X	X
T03	O	O	X	X	X
T04	X	X	O	X	X
T05	O	X	O	X	X
T06	X	O	O	X	X
T07	O	O	O	X	X
T08	X	X	X	O	X
T09	O	X	X	O	X
T10	X	O	X	O	X
T11	O	O	X	O	X
T12	X	X	O	O	X
T13	O	X	O	O	X
T14	X	O	O	O	X
T15	O	O	O	O	X
T16	X	X	X	X	O
T17	O	X	X	X	O
T18	X	O	X	X	O
T19	O	O	X	X	O
T20	X	X	O	X	O
T21	O	X	O	X	O
T22	X	O	O	X	O
T23	O	O	O	X	O
T24	X	X	X	O	O

O and X represent ON and OFF, respectively.

4-3-3 Hydraulic motor (ORB mark motor)

1) Component Parts Drawing and Designation of Parts



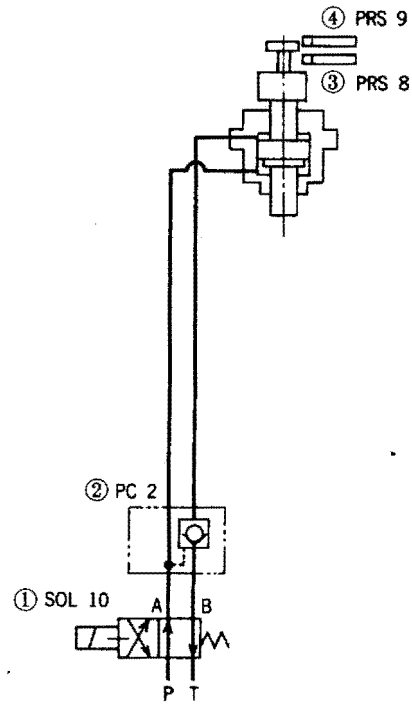
Parts List

Code	Designation	Code	Designation
1	Body	18	O-ring (S44)
2	Valve plate	19	O-ring (S38)
3	End cover	21	O-ring (S6)
4	Two-hole flange	22	Steel ball (3/16")
5	M type outer rotor	23	Spring
7	Inner rotor	24	Plug
8	Shaft	25	Shaft key
10	Spline joint shaft	26	Hexagonal socket head bolt
11	Rotary valve	27	Spring washer
12	Fixed plate	28	Hexagonal socket head bolt
13	Pin	29	Pressure-resistant seal
14	Space (A)	30	Dust seal
15	Space (B)	35	Thrust needle bearing
16	Collar	36	Thrust track ring
17	Needle bearing	37	Snap ring

2) Trouble and Repair of Hydraulic Motor (ORB mark motor)

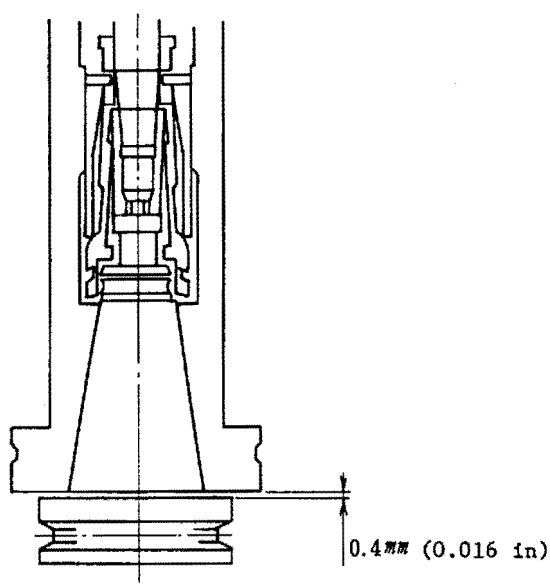
Problem	Cause	Repair Method
Motor operates too slowly.	a) Feed pump capcity reduced. b) Motor capacity reduced. c) Extremely hot oil has caused pump and motor to slip. d) Pump is cavitating. e) Filter is clogged. f) Relief valve is set to too low a pressure.	a) Repair or replace pump. b) Replace worn-out parts or motor. c) Maintain appropriate temperature. d) Eliminate cause. e) Replace or clean filter element. f) Set relief valve to an appropriate pressure.
Motor does not run.	a) Foreign matter, such as chips, etc. has collected. b) Shaft is broken.	a) Clean new equipment well and check filter. b) Repair or replace.
Motor turning in the wrong direction	a) Hose is connected in reverse.	a) Re-connect piping.
Oil leaking from shaft.	a) Shaft seal worn out or damaged.	a) Replace shaft seal. Polish shaft with #600 sand paper.
Oil leaking between flange and body.	a) Flange bolts loose. b) O-ring broken.	a) Tighten (to a torque of 180 kg-cm). b) Replace O-ring. (Note possible damage to the body surface).
Oil leaking between body and valve plate or between valve seat and G rotor.	a) End cover bolts loose. b) O-ring broken.	a) Tighten end cover bolts (to a torque of 300 kg-cm). b) Replace O-ring.
Oil leaking from piping connections.	a) Joints defective. b) O-ring broken.	a) Replace joints. b) Replace body.

4-4 Unclamping and Clamping Tools

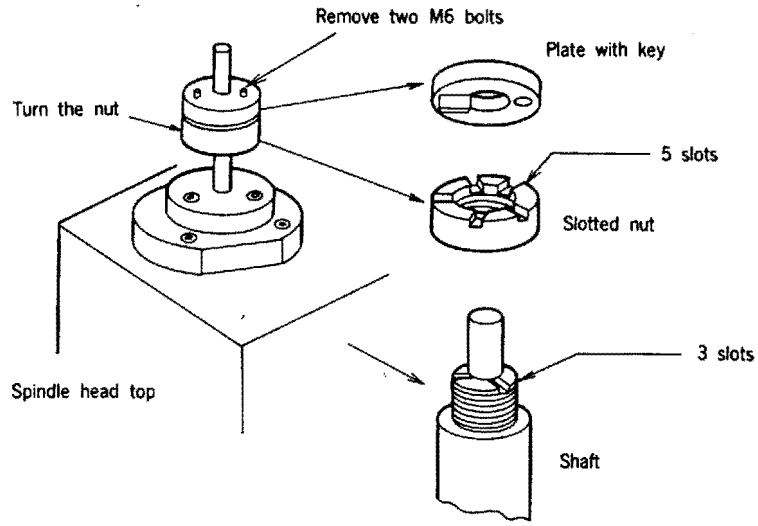


No.	Designation	Model No.	Q'ty	Manufacturers	Application
①	Solenoid valve	SA-G01-A3X-C1-11	1	FUJIKOSHI	To unclamp tools
②	Check valve	OC-G01-P1-10	1	"	To hold tools unclamped
③	Proximity/ switch	FL1-2D6-E3	1	YAMATAKE	To unclamp tools
④	Proximity/ switch	FL1-2D6-E3	1	YAMATAKE	To clamp tools

When a tool is unclamped, the draw bar should push the pull stud approximately 0.4 mm. (0.016 in)



Adjust the push gap as follows:

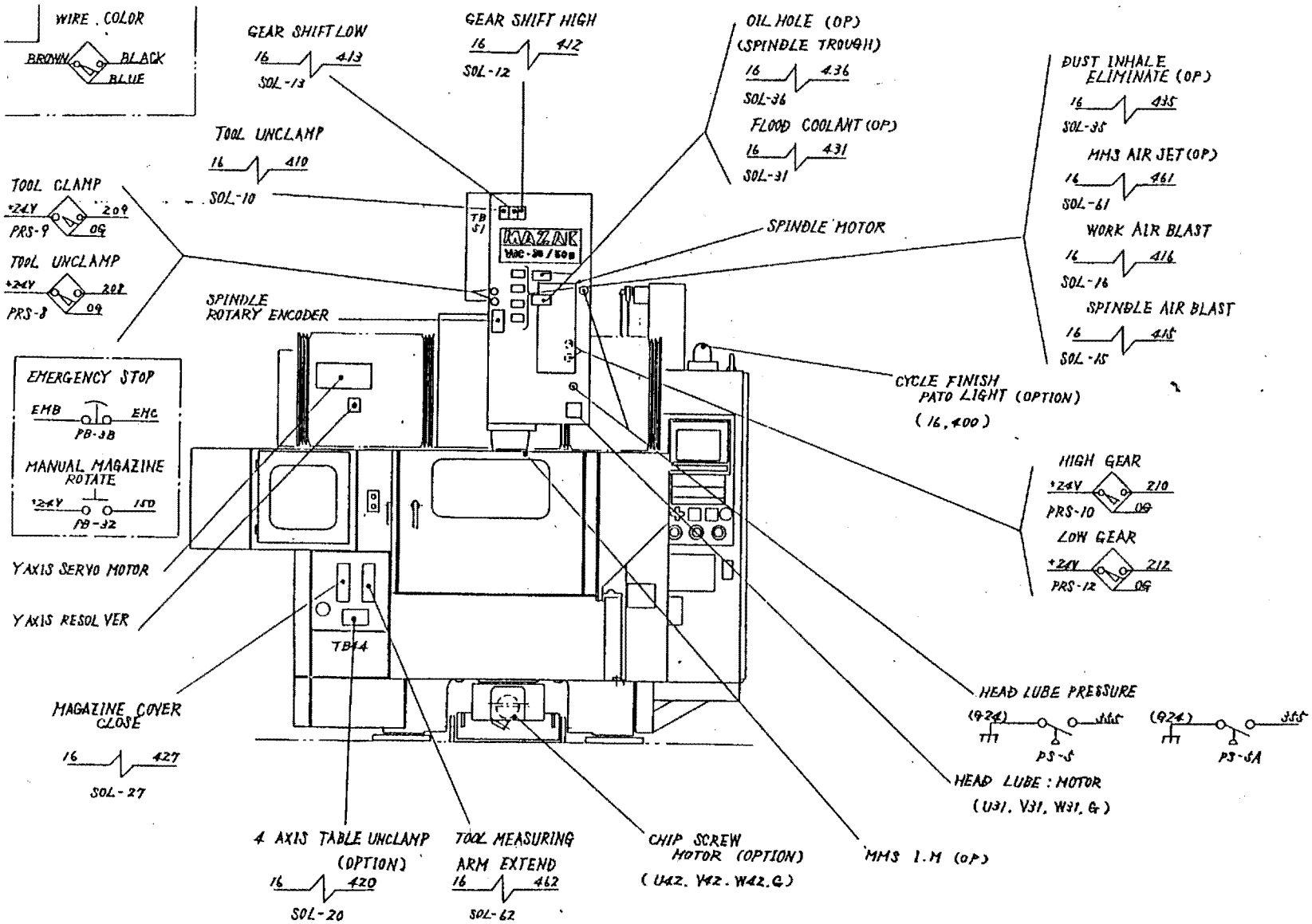


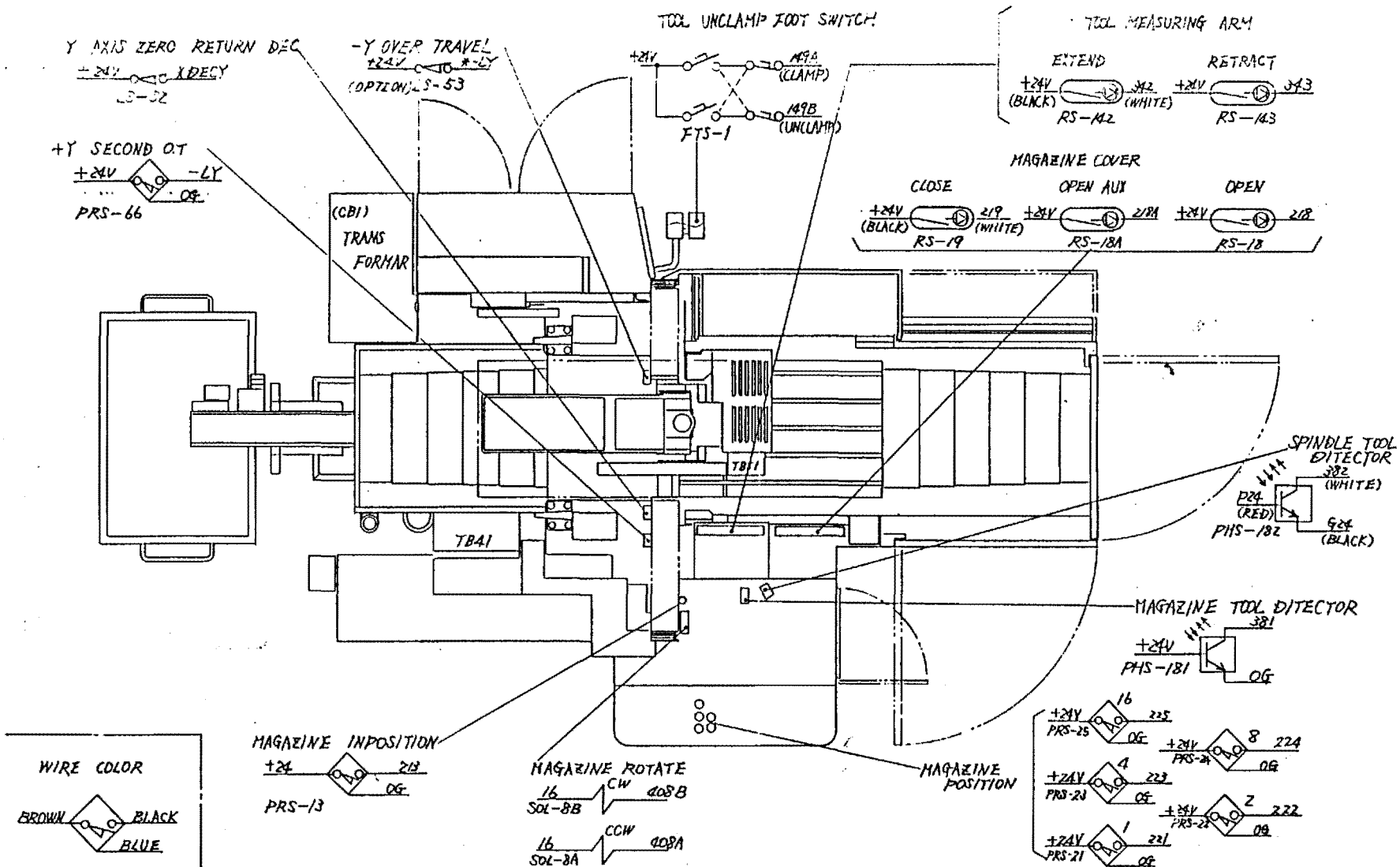
As illustrated, use the cylinder in the upper part of the spindle to perform the adjustment.

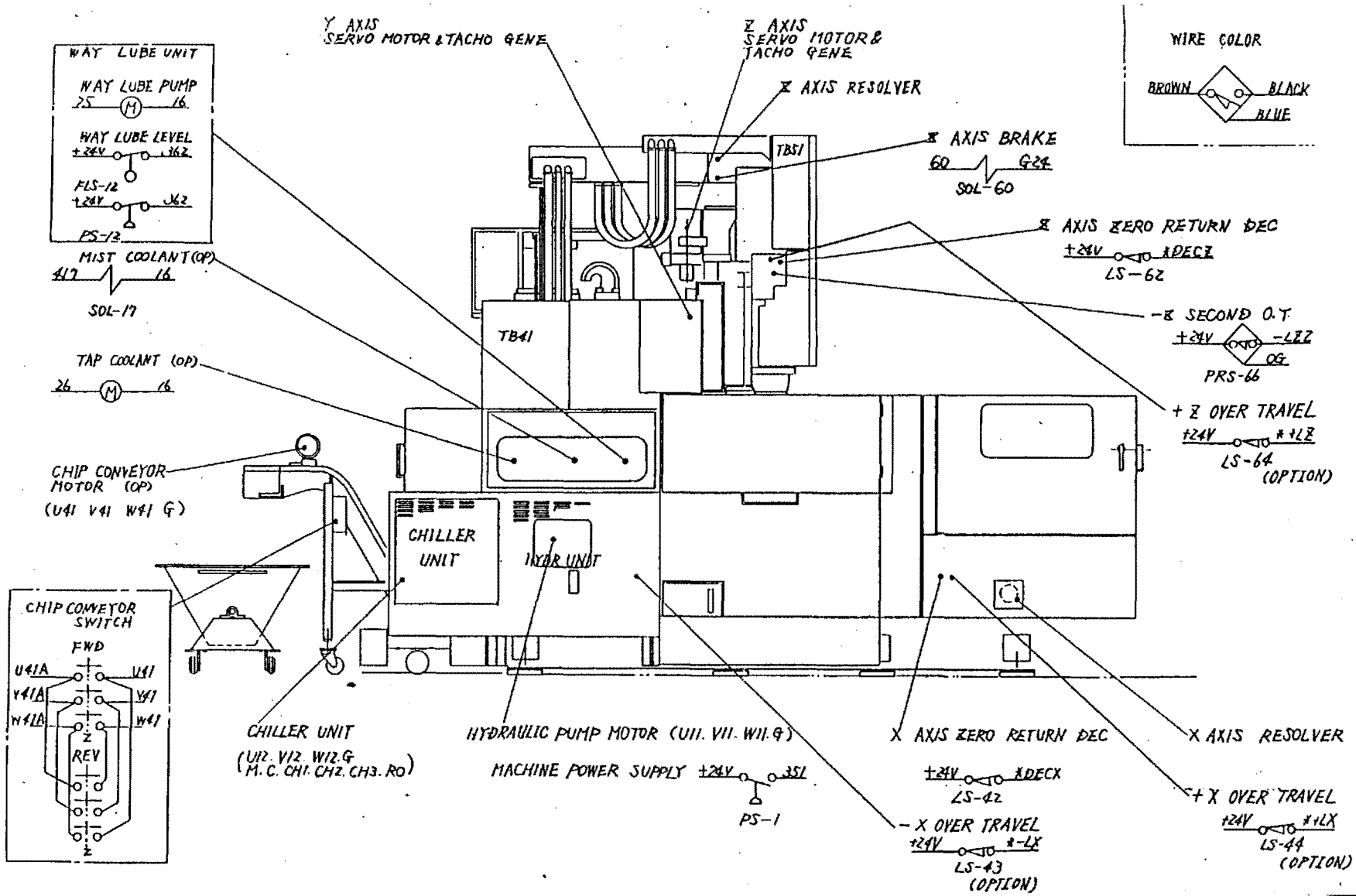
(1) Pull out M6 bolts and remove the plate with a key.
(2) Next, turn the nut.
To enlarge the gap, turn the nut counterclockwise. To decrease the gap, turn it clockwise.
(3) One turn of the nut will move it 1.5 mm (0.06 in).
The nut and the shaft have five and three key ways, respectively.
One nut key way should fit one shaft key way. Giving a 1/15 turn to the nut will make one of its keyways fit to one of the shaft's key ways. Giving a 1/15 turn, that is, turning the nut by 24°, will allow an adjustment of the push gap by 0.1 mm (0.004 in).
(4) Insert the plate key to the key ways fitted and tighten the bolts as they were before.

5. Switches on the Machine Body

5-1 Switch Arrangement

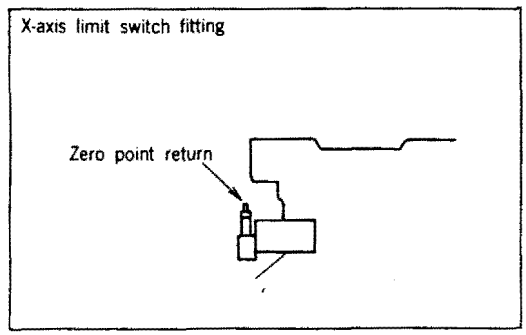


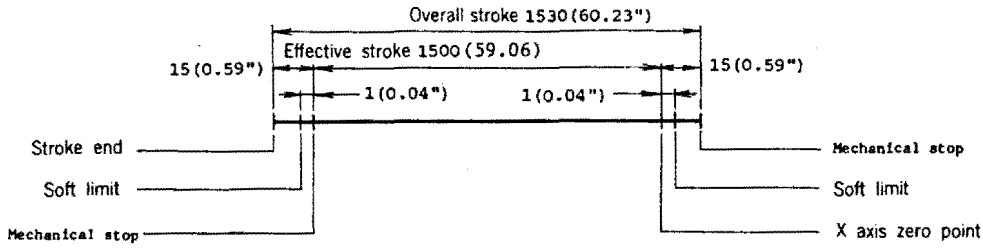

Y AXIS ZERO RETURN DEC
+24V
XDECY
-Y OVER TRAVEL
+24V
*-LY
(OPTION) S-53
TOOL UNCLAMP FOOT SWITCH
+24V
149A
(CLAMP)
149B
(UNCLAMP)
FTS-1
TOOL MEASURING ARM
EXTEND
RETRACT
+24V
(BLACK)
342
(WHITE)
343
RS-142
RS-143
+Y SECOND OT
+24V
-LY
0G
PRS-66
MAGAZINE COVER
CLOSE
OPEN AUX
OPEN
+24V
(BLACK)
219
(WHITE)
218
RS-19
RS-18A
RS-18
(CBI)
TRANS
FORMAR
TB41
TB41
SPINDLE TOOL
DITECTOR
382
(WHITE)
+24
(RED)
0G
(BLACK)
PHS-182
MAGAZINE TOOL DITECTOR
381
+24V
PHS-181
0G
WIRE COLOR
BROWN
BLACK
BLUE
MAGAZINE INPOSITION
+24
219
0G
PRS-13
MAGAZINE ROTATE
16
SOL-8B
CW
408B
16
SOL-8A
CCW
408A
MAGAZINE
POSITION
16
225
+24V
PRS-25
0G
8
224
+24V
PRS-24
0G
4
223
+24V
PRS-23
0G
2
222
+24V
PRS-22
0G
1
221
+24V
PRS-21
0G


WAY LUBE UNIT
WAY LUBE PUMP
25 M 16
WAY LUBE LEVEL
+24V J62
FLS-12
+24V J62
PS-12
MIST COOLANT (OP)
417 16
SOL-17
TAP COOLANT (OP)
26 M 16
CHIP CONVEYOR MOTOR (OP)
(U41 V41 W41 G)
CHIP CONVEYOR SWITCH
FWD
U41A U41
V41A V41
W41A W41
REV
Y AXIS SERVO MOTOR & TACHO GENE
Z AXIS SERVO MOTOR & TACHO GENE
Z AXIS RESOLVER
TB51
TB41
Z AXIS BRAKE
60 G24
SOL-60
Z AXIS ZERO RETURN DEC
+24V XDECZ
LS-62
-Z SECOND O.T
+24V -LZZ
OG
PRS-66
+Z OVER TRAVEL
+24V *+LZ
LS-64
(OPTION)
CHILLER UNIT
HYDR UNIT
CHILLER UNIT
(U12. V12. W12. G
M.C. CH1. CH2. CH3. R0)
HYDRAULIC PUMP MOTOR (U11. V11. W11. G)
MACHINE POWER SUPPLY +24V 3S1
PS-1
X AXIS ZERO RETURN DEC
+24V XDECX
LS-42
X AXIS RESOLVER
-X OVER TRAVEL
+24V *-LX
LS-43
(OPTION)
+X OVER TRAVEL
+24V *+LX
LS-44
(OPTION)
WIRE COLOR
BROWN
BLACK
BLUE

5-2 Switch Details

5-2-1 X-axis zero point return switch

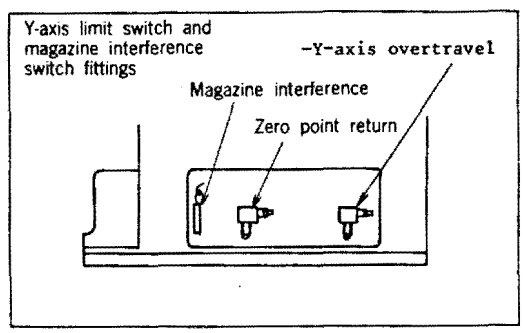


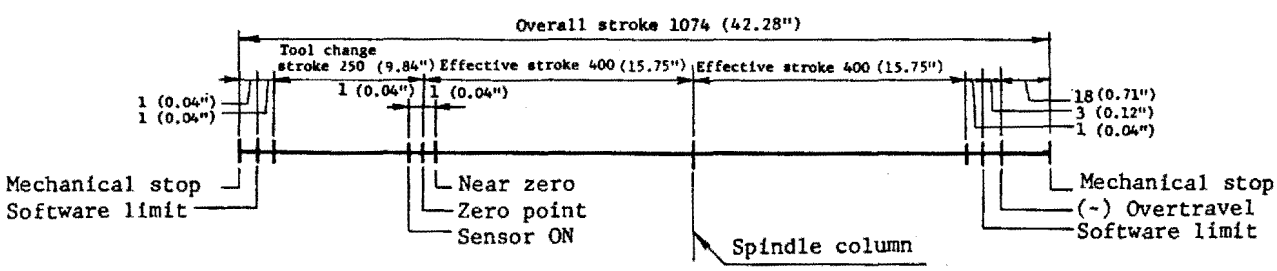


The X-axis limit switch is located on t e magazine side of the base.

The X-axis dog is located on the magazine side at the lower end of the table.

5-2-2 Y-axis zero point return and magazine interference switches



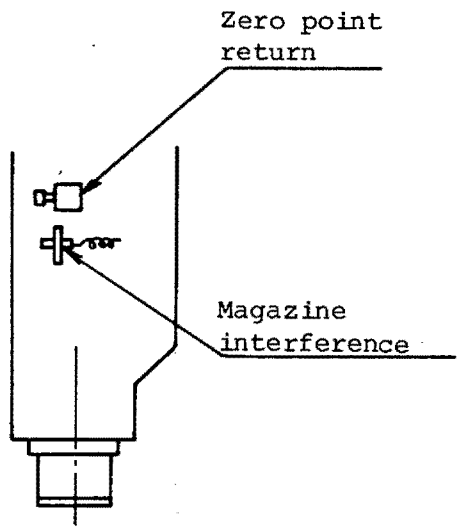


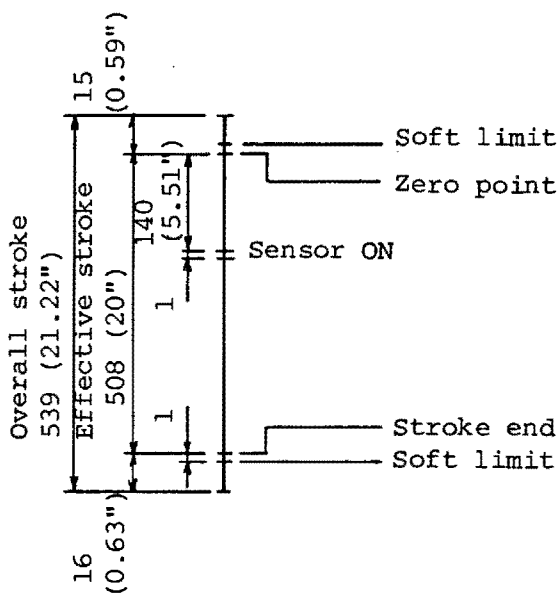
Unit: mm(inch)

The Y-axis limit switch and the magazine interference switch are located on the upper surface of the column.

The Y-axis dog is attached to the saddle.

5-2-3 Z-axis zero point return and magazine interference switches





The Z-axis zero point return switch and the magazine interference switch are located on the **magazine** side of the head.

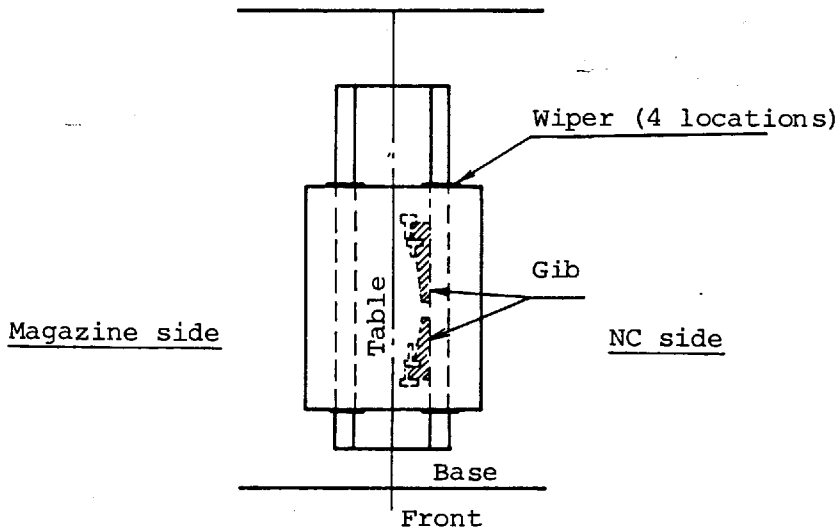
The Z-axis dog is attached to the saddle.

6. Inspecting and Adjusting Every Part of Machine

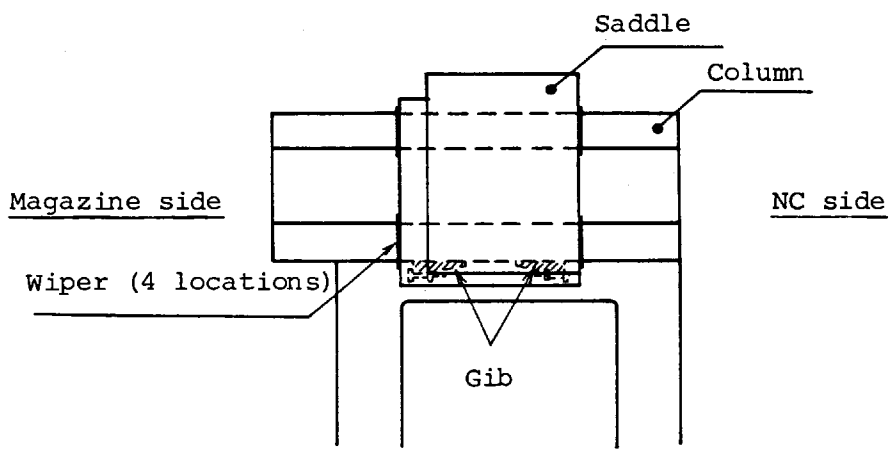
6-1 Gib and Wiper Arrangement

6-1-1 Gib and wiper arrangement

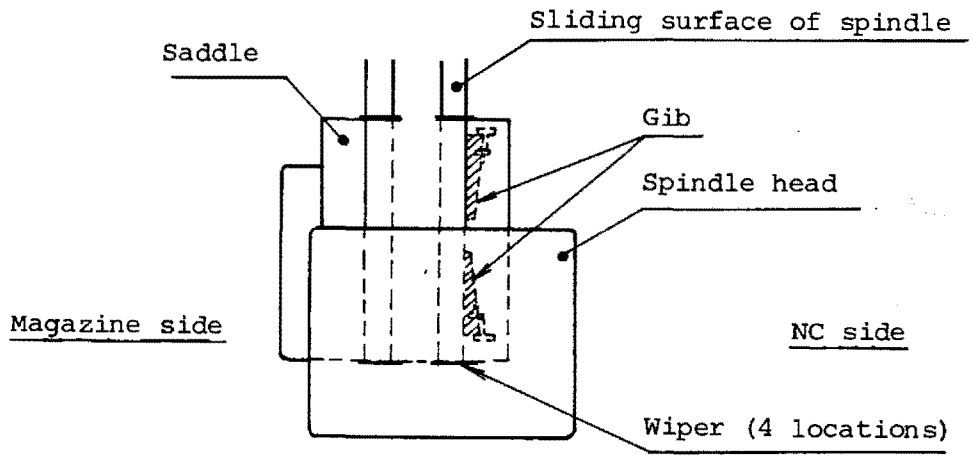
(1) Arrangement of gib and wiper between base and table (X-axis)

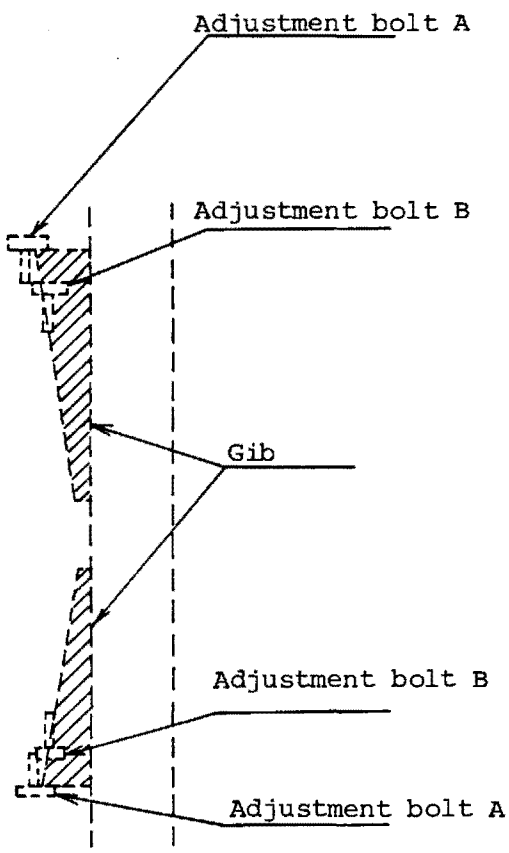


(2) Arrangement of gib and wiper between column and saddle (Y-axis)



(3) Arrangement of gib and wiper between saddle and head (Z-axis)





Expanded View of Gib

All gibs are arranged in sets of two (for X-, Y- or Z-axis). Adjustment bolt A tightens the gib while adjustment bolt B pulls (loosens) the gib.

6-1-2 Adjusting the gib

The clearance of each sliding surface is adjusted by gibs.
Pulse response, positioning accuracy and cutting property depend upon whether the gib adjustment is correct or not.

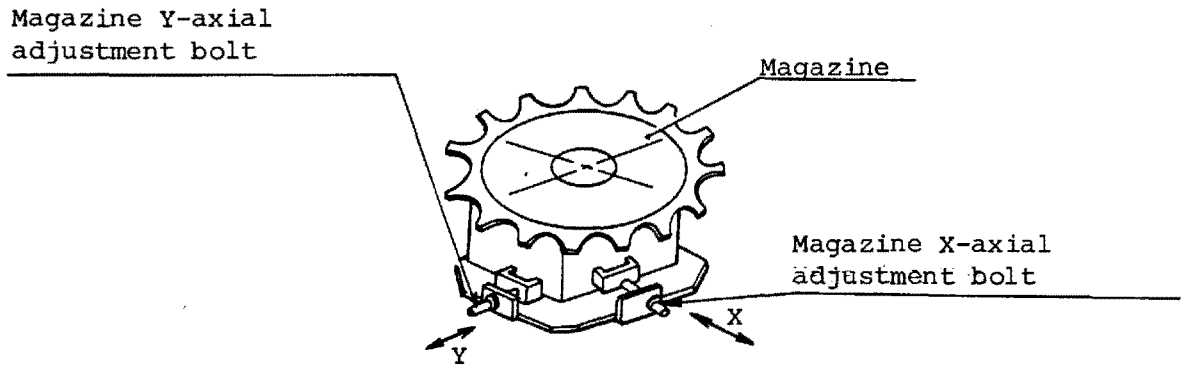
Gib adjustment procedure:

1) Remove the cover, if any.
2) Remove the wiper plate and the wiper from the sliding surface on which a gib has been mounted.
3) Loosen adjustment bolts A and B to free the gib completely.
4) After fully tightening adjustment bolt A (gib thick side), return it by about half a turn. Next, pull the gib by adjustment bolt B.
5) Install the wiper plate and the wiper.
6) Mount the cover, if any.

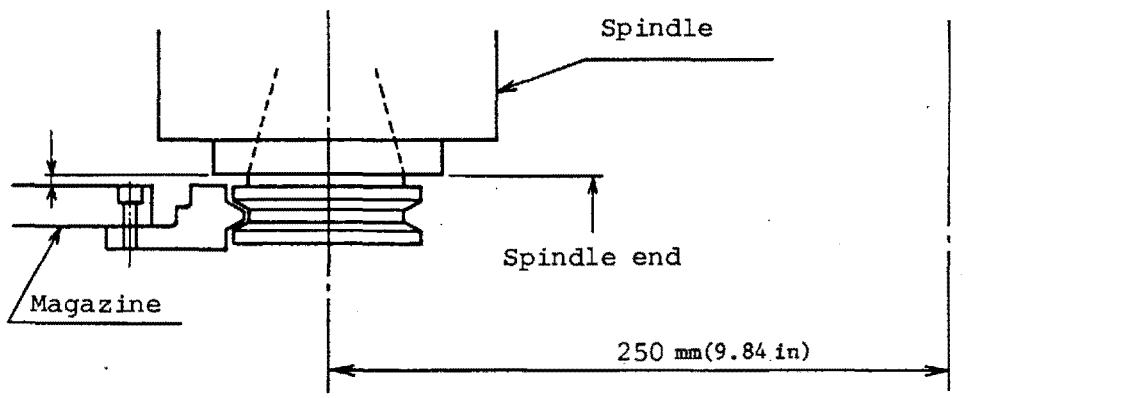
NOTE: The method of tightening adjustment bolt A referred to in Step (4) above varies with a tightening torque, gib interference condition, etc. After completion of the adjustment by the above-mentioned method, put the machine into operation and make certain that the gib has been adjusted properly.

6-2 Centering the Magazine

The magazine has been optimally centered before shipment from factory. Do not adjust the magazine unnecessarily.

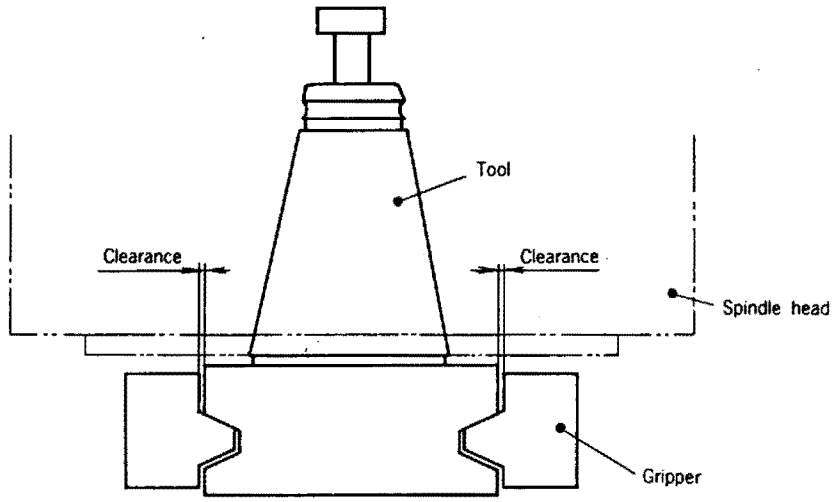


(1) Z-axial adjustment method:



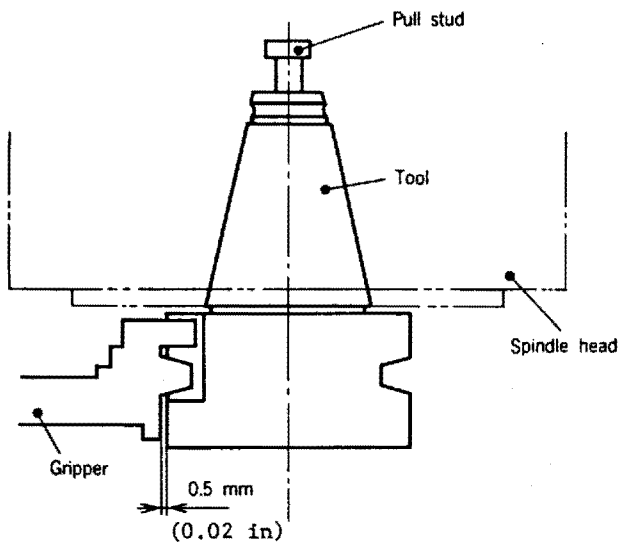
Attach a tool to the spindle and feed it slowly in the Y-axis direction from No. 1 zero point to No. 2 zero point.
Then, adjust the Z-axial position so that the tool will be fit into the gripper. Input parameter [RP3] . About -140.000 (5.51 in) is appropriate.
The spindle is in position when there is a clearance of 1 mm (0.04 in) between the end of the spindle and the magazine.

(2) X-axial adjustment method



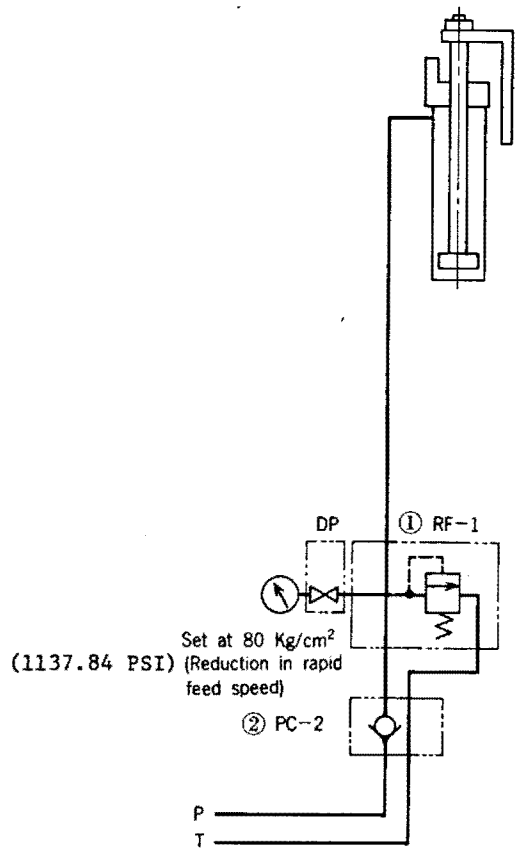
Move the spindle head to No. 2 zero point (ATC location) and clamp a tool held with the gripper located at ATC. Then, adjust the X-axial adjustment bolt so that the gripper and the tool will have an equal clearance (see figure) on both sides.

(3) Y-axial adjustment method



Move the spindle head to No. 2 zero point (ATC Location) and clamp a tool held beforehand with the gripper located at ATC. Then, after fully tightening the Y-axis adjustment bolt, loosen it by a quarter turn and the gripper will have a Y-axial clearance of 0.5 mm (0.02 in) against the tool. (Giving a quarter turn to the Y-axis adjustment bolt makes a pitch of 2 mm (0.08 in). and will cause it to move 0.5 mm (0.02 in).)

6-3 Counterbalance



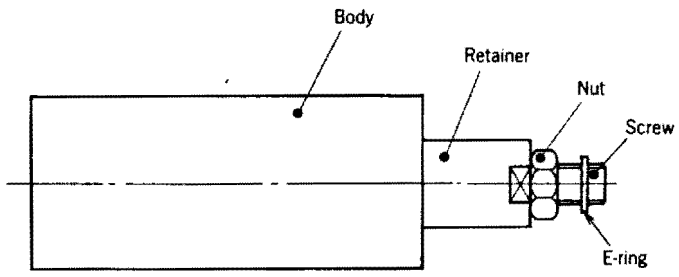
No.	Designation	Model No.	Q'ty	Manufacturers	Application
1	Relief valve	OR-G01-P2-5539B	1	FUJIKOSHI	Pressure setting
2	Check valve	OC-G01-P1-10	1	FUJIKOSHI	Head slip prevention

6-3-1 Adjusting counterbalance pressure

The counterbalance has been adjusted to an optimum pressure before shipment from the factory.

To adjust the counterbalance, regulate the pressure control valve in the relief valve.

Counterbalance pressure adjustment procedure:



Relief Valve

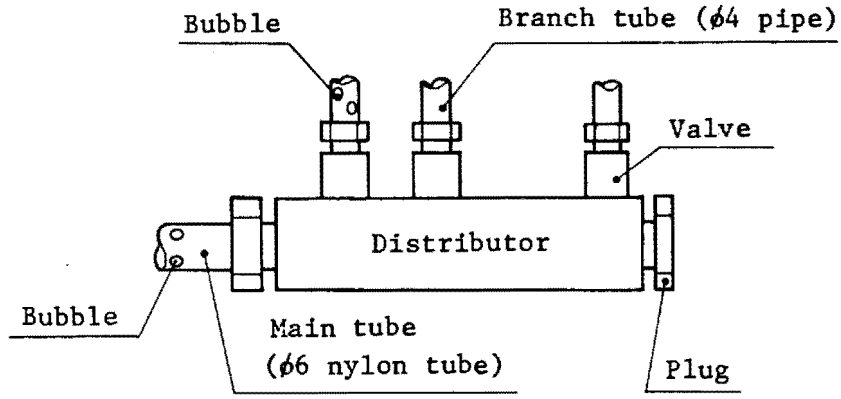
OR-G01-P2-5539B

(1) Loosen the nut.
(2) While reading the pressure gage, lower the Z-axis and adjust the screw to set the pressure to 80 kg/cm^2(1137.84 PSI)
(3) Move the Z-axis up and down several times and check that the pressure stabilizes at 80 Kg/cm^2(1137.84 PSI),with the Z-axis down.
(4) Finally, tighten the nut and lock it.

6-4 Deaerating

If air is trapped in the nylon tubes after the central lubrication system plumbing was completed, turn the power switch on and press the lubrication push button to supply oil to the tubes, then deaerate the tubes as follows:

1) To deaerate the main tube, loosen the terminal distributor plug, then press the lubrication push button until all bubbles in the tube disappear.



2) To deaerate the branch tubes, plug the main tube after eliminating all of the bubbles from it, then press the lubrication push button switch on the front of the pump. Since it takes about 60 seconds until the valve can discharge oil again after discharging once, press the push button again about 60 seconds after the lubrication indicator goes out. Repeat the above operation until no bubble remains in the tubes.

MAINTENANCE MANUAL
FOR
VQC 2 PALLET CHANGER

Mazak YAMAZAKI MAZAK CORPORATION

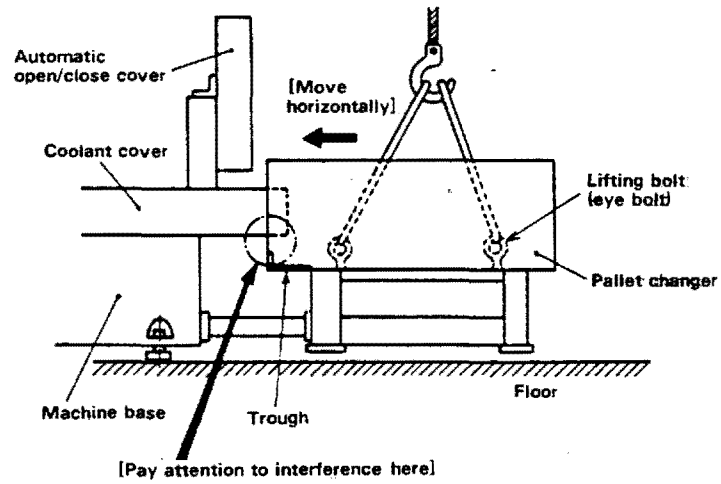
CONTENTS

1. CAUTIONS ON INSTALLATION

1-1. When installing the pallet changer, install it so that it will not interfere with the coolant cover on the machine.

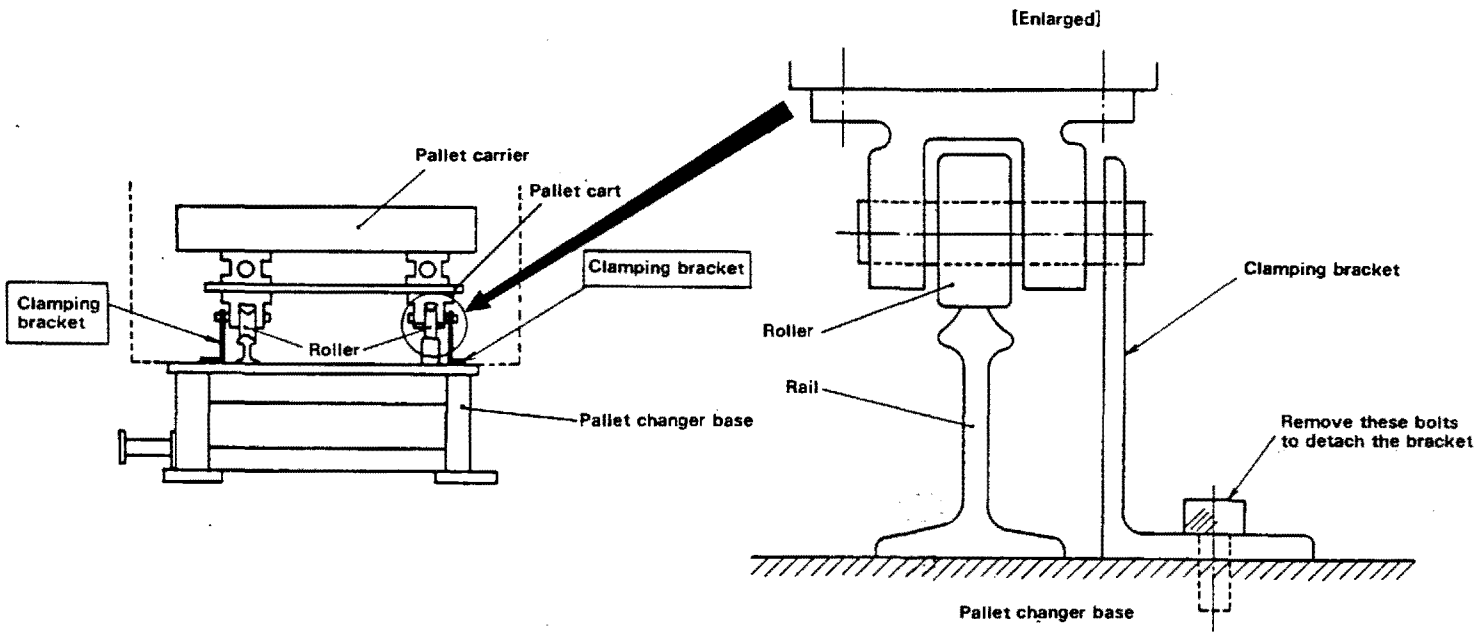
The trough provided on the pallet changer base is located under the coolant cover on the machine when the pallet changer is installed. To do this, move the pallet changer horizontally toward the machine while lifting it as shown in the figure below. To lift the pallet changer, use four M24 eye bolts on the base.

After use of the eyebolts, remove them and cap the resultant holes with the hexagon socket head



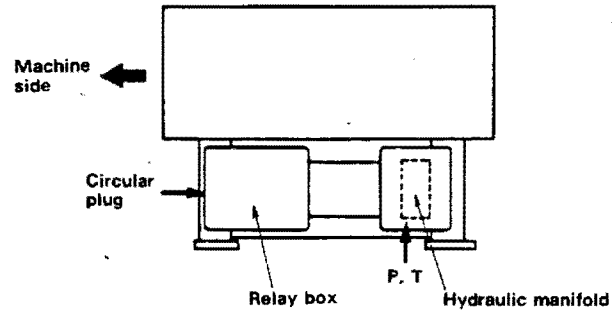
1-2. While transportation, four roller clamping brackets are installed on the rollers of the pallet cart to assure safe transportation. Remove these brackets.

Note that one bracket is used to clamp one roller.



1-3. Connection of Power Cables and Hydraulic Hoses

Connection ports are provided on the right hand side of the pallet changer.



There are three receptacles of circular connectors on the relay box. Connect the circular connectors correctly as identified on the circular connectors.

Connect hydraulic hoses to the manifold at the side of the relay box. Two hoses, P and T, should be connected from the hydraulic power unit of the machine correctly as identified on the respective hoses.

2. ALIGNMENT

For operation procedures of the pallet changer, refer to the Operation Manual for the pallet changer.

2-1. Procedure

1) Loosen four bracket clamping bolts (M12 x 30) securing the pallet changer to the machine.

2) Place the pallet either to station 1 or station 2.

3) Adjustment of the pallet changer in crosswise direction to the machine is made by moving the whole pallet changer in that direction.

4) To adjust the pallet changer in vertical direction, first place the clamp unit of the machine to the "unclamp" state. After that adjust the pallet changer height with six leveling blocks so that no vibration or shocks result when the pallet is transferred between the pallet changer and the machine.

5) After completing the adjustment in crosswise and vertical direction, secure the four bracket clamping bolts (M12 x 30) loosend in step 1) to fix the pallet changer to the machine.

6) Adjustment of the pallet loading position and unloading position can be made with the adjusting nuts provided on either end of the carrier guide shaft.

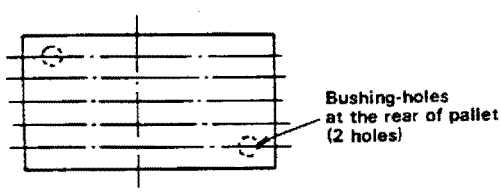
   a) To adjust the pallet loading position, bring the clamp unit to the 'unclamp' state and load the pallet.

   Adjust the loading position by turning the nut at the front side of the shaft (loading side) so that the two bushing-holes at the rear side of the pallet are neatly aligned with the pins on the machine.

   With repeating clamp and unclamp several times, adjust the carrier position so that no shocks or vibration results in clamp/unclamp operation.

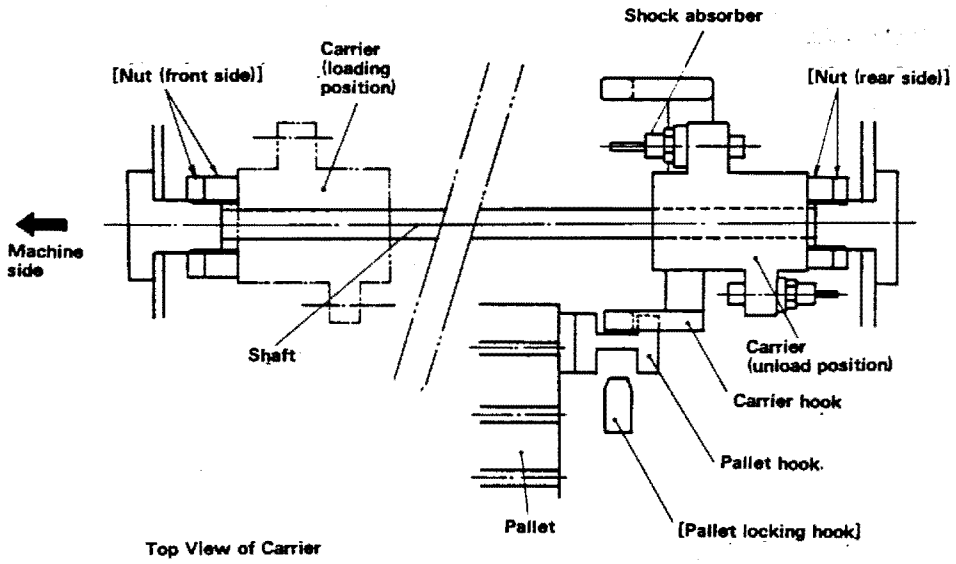
   See the figure below for bushing-hole location.

   Note: There are two bushing-holes on the rear of the pallet.



b) To adjust the unload position, turn the nut at the rear of the shaft (unloading side) so that the pallet locking hook mounted to the pallet cart can be correctly engaged with the pallet hook with the pallet unloaded.

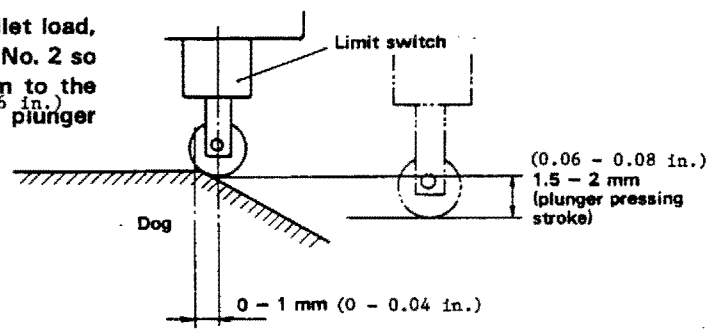
After the adjustment, lock the nut firmly without fail.



Top View of Carrier

3. ADJUSTMENT OF POSITION CONFIRMATION SWITCHES

3-1. Adjust the position of limit switches detecting pallet load, pallet unload, pallet select No. 1, and pallet select No. 2 so that they are actuated at the position 3 to 4 mm (0.12 - 0.16 in.) to the stroke end. Actuating stroke of the limit switch plunger should be 1.5 to 2 mm. (0.06 - 0.08 in.)

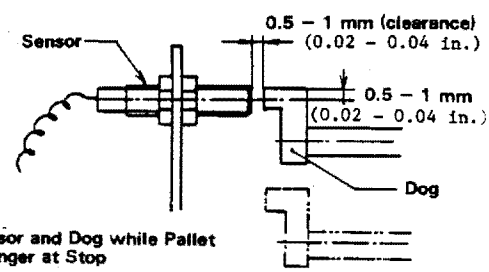


Relation between Limit Switch and Dog while Pallet Changer at Stop

3-2. For sensors (proximity switches), adjust the clearance between the dog and the sensor detecting surface to 0.5 mm. (0.02 in.)

Adjust the dog position for pallet clamp and unclamp so that the respective sensors turn ON at the position 2 to 3 mm to the stroke end. (0.08 - 0.12 in.)

(Pallet clamp/unclamp sensor is provided in the table on the machine side).

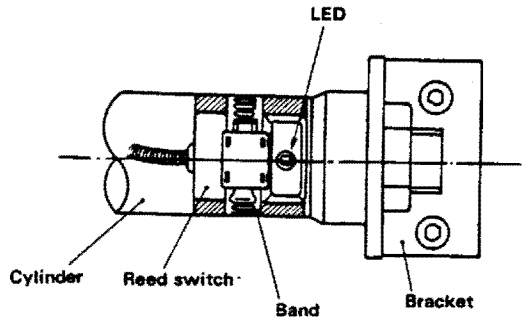


Sensor and Dog while Pallet Changer at Stop

3-3. Reed switch position is adjustable by moving it after loosening the band clamping the cylinder in position.

Adjust so that the reed switch turns ON at the position 5 to 10 mm (0.20 - 0.39 in.) to the stroke end.

After the adjustment, be sure to confirm that the reed switch remains ON at the stroke end.



4. ADJUSTMENT OF SHOCK ABSORBER

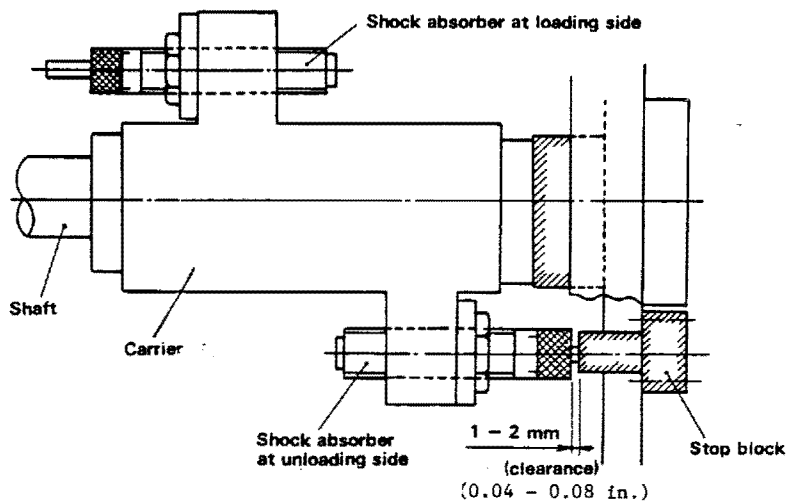
Shock absorbers are mounted on the carrier of the pallet carrier (at load side and unload side).

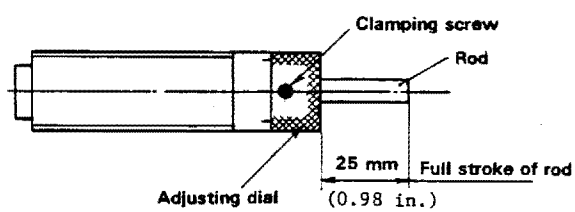
To adjust them, follow the steps below:

1) Loosen the clamping screw.

2) Rotate the adjusting dial. Shock absorbing energy becomes larger as the setting is away from the '0' position.

   Adjust it by repeating loading and unloading operation several times so that the pallet smoothly stops at the loading and unloading end.



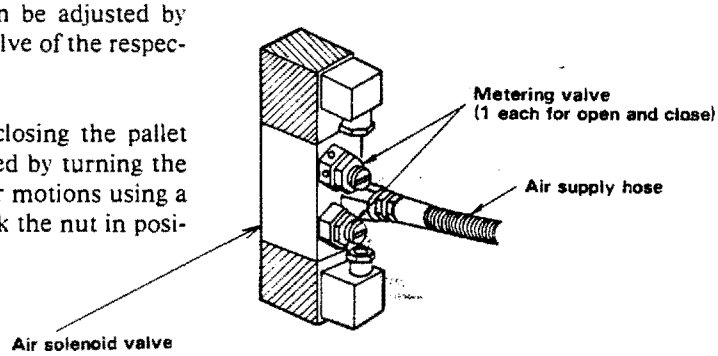


3) Rod projection amount at the pallet stop condition (either at load or unload end) should be 1 to 2 mm. (Adjust so that rod stroke will be 23 to 24 mm.) (0.04 - 0.08 in.) (0.91 - 0.94 in.)

5. SPEED ADJUSTMENT (2 PALLET CHANGER)

For the hydraulic actuators such as load/unload, pallet selection and pallet clamp/unclamp, their operation speeds can be adjusted by turning the adjusting screws on the flow control valve of the respective solenoid valves.

For pneumatic actuators used for opening and closing the pallet doors, door open and close speeds can be adjusted by turning the metering valve adjusting screw for respective door motions using a screw driver. After the adjustment, be sure to lock the nut in position.

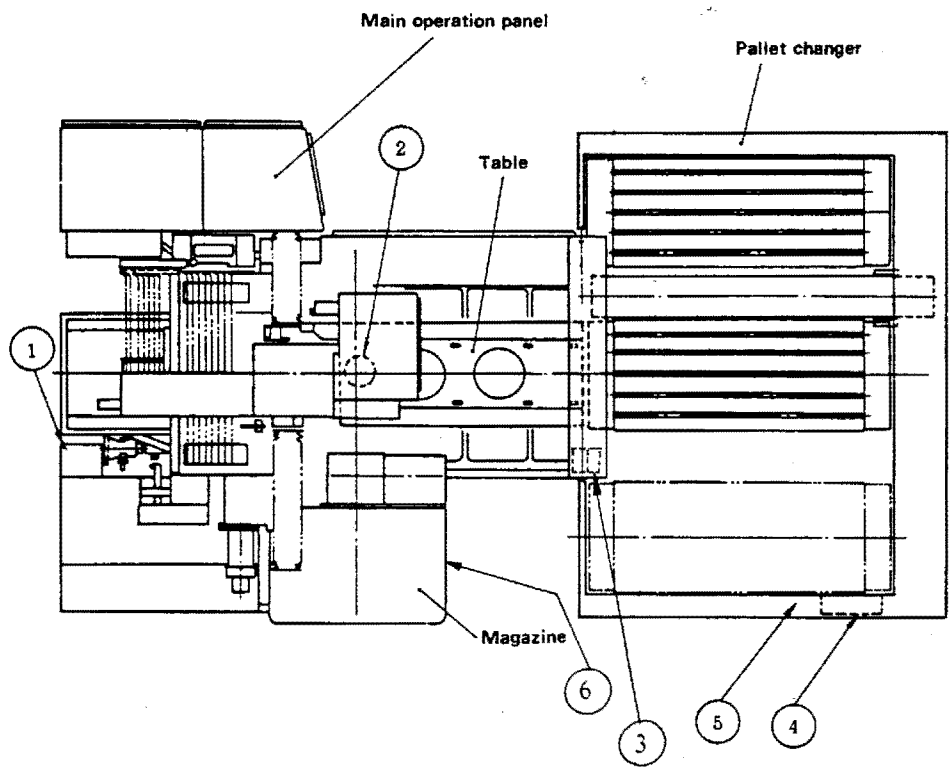


Adjust the speed as follows:

Load/unload time	
Loading	7.5
Unloading	7.5
Pallet selection	6.5
Pallet door open/close	
Open	2.5
Close	2.5
Pallet clamp/unclamp	
Clamp	1.5-2.0
Unclamp	1.0-1.5

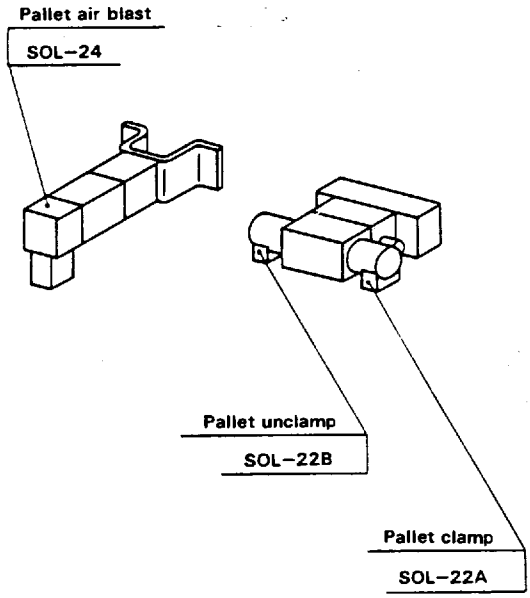
6. ARRANGEMENT OF SWITCHES AND VALVES

Switches and valves are located at the position indicated below:

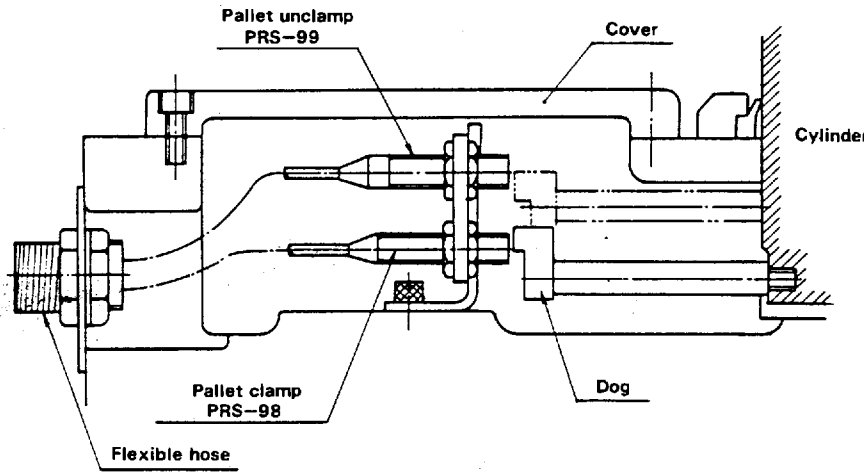


(1) Pallet clamp/unclamp solenoid valve and pallet air blast solenoid valve
(2) Pallet clamp/unclamp proximity switch
(3) Pallet door open/close solenoid valve and its reed switch
(4) Pallet load/unload solenoid valve and pallet select solenoid valve
(5) Pallet select, pallet on stocker and paller load/unload limit switches
(6) Pallet door poen/close solenoid valve

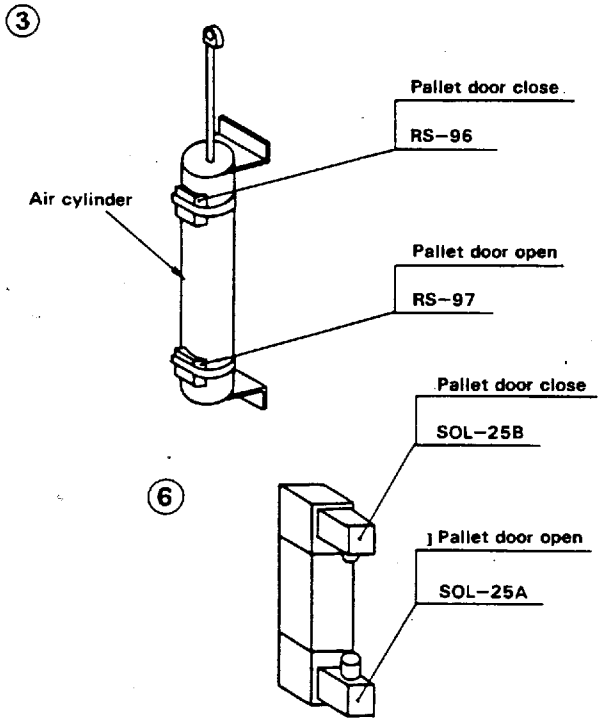
①



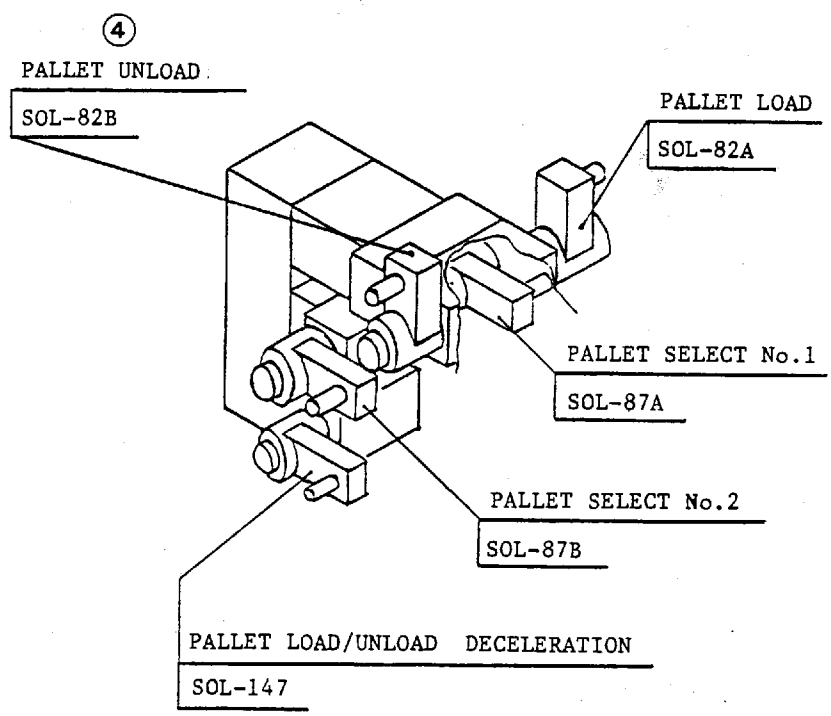
②



③

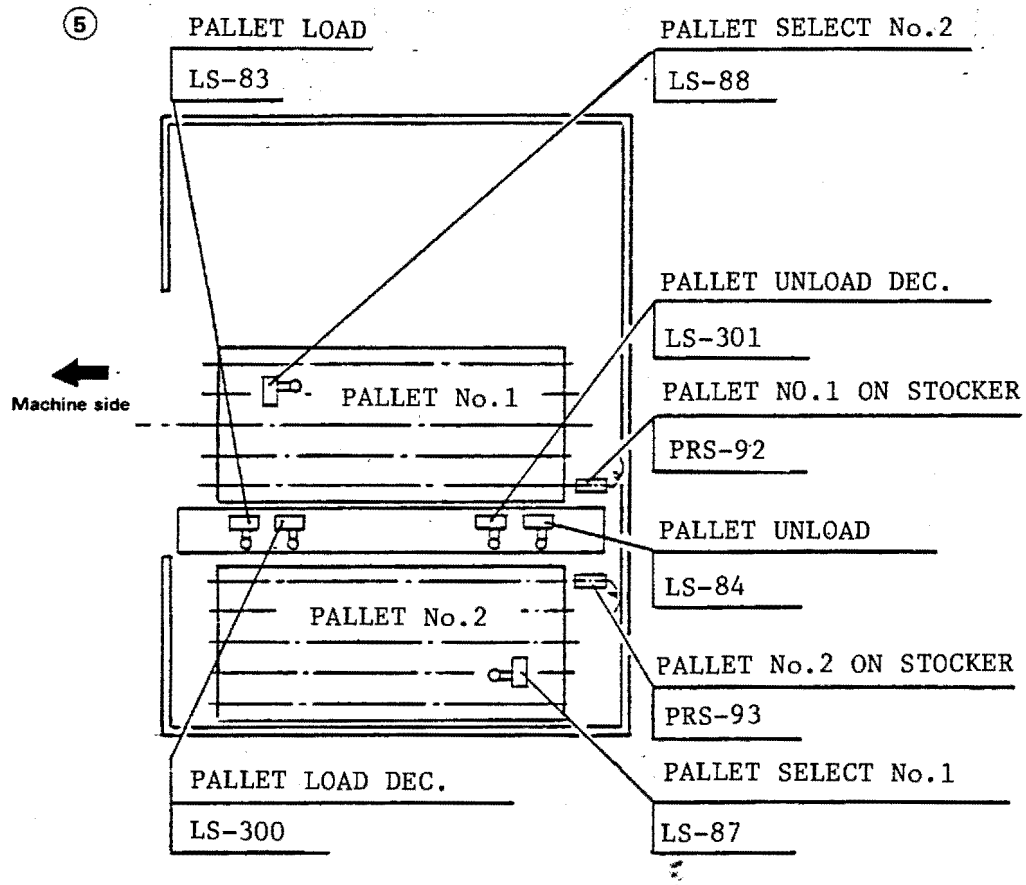


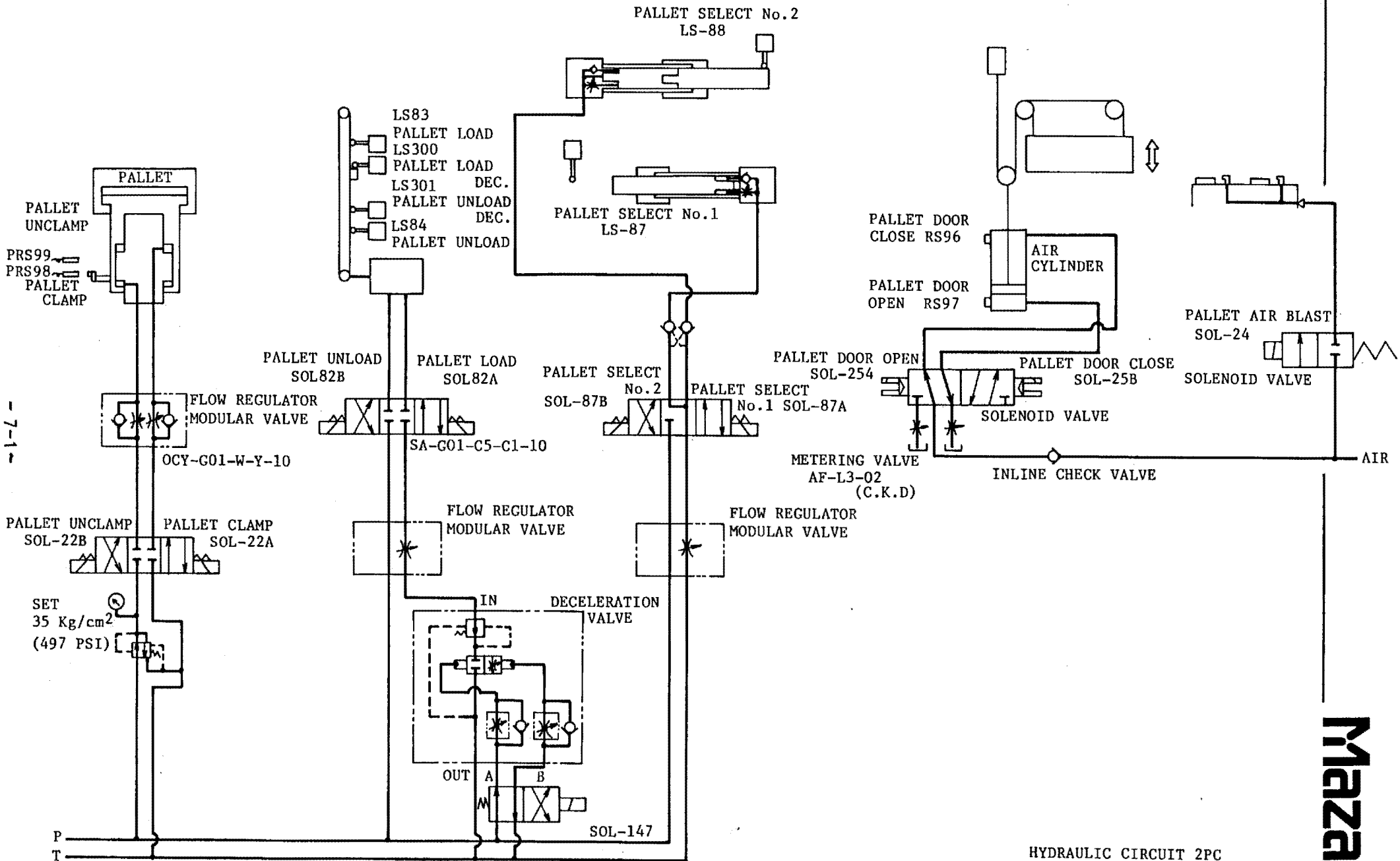
④



⑥

⑤


PALLET LOAD
LS-83
PALLET SELECT No.2
LS-88
PALLET UNLOAD DEC.
LS-301
PALLET NO.1 ON STOCKER
PRS-92
PALLET UNLOAD
LS-84
PALLET No.2 ON STOCKER
PRS-93
PALLET SELECT No.1
LS-87
PALLET LOAD DEC.
LS-300
PALLET No.1
PALLET No.2
Machine side



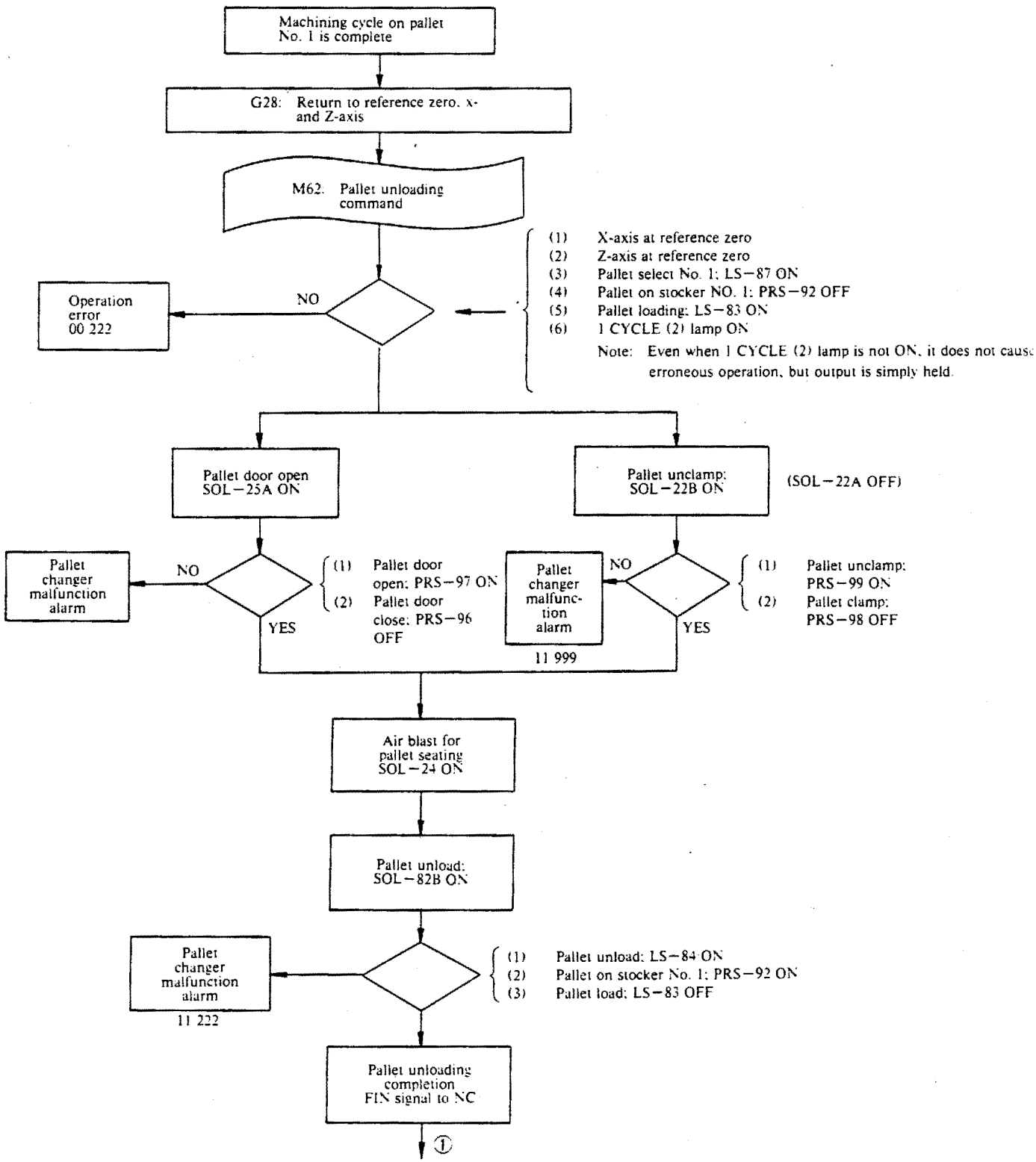
HYDRAULIC CIRCUIT 2PC

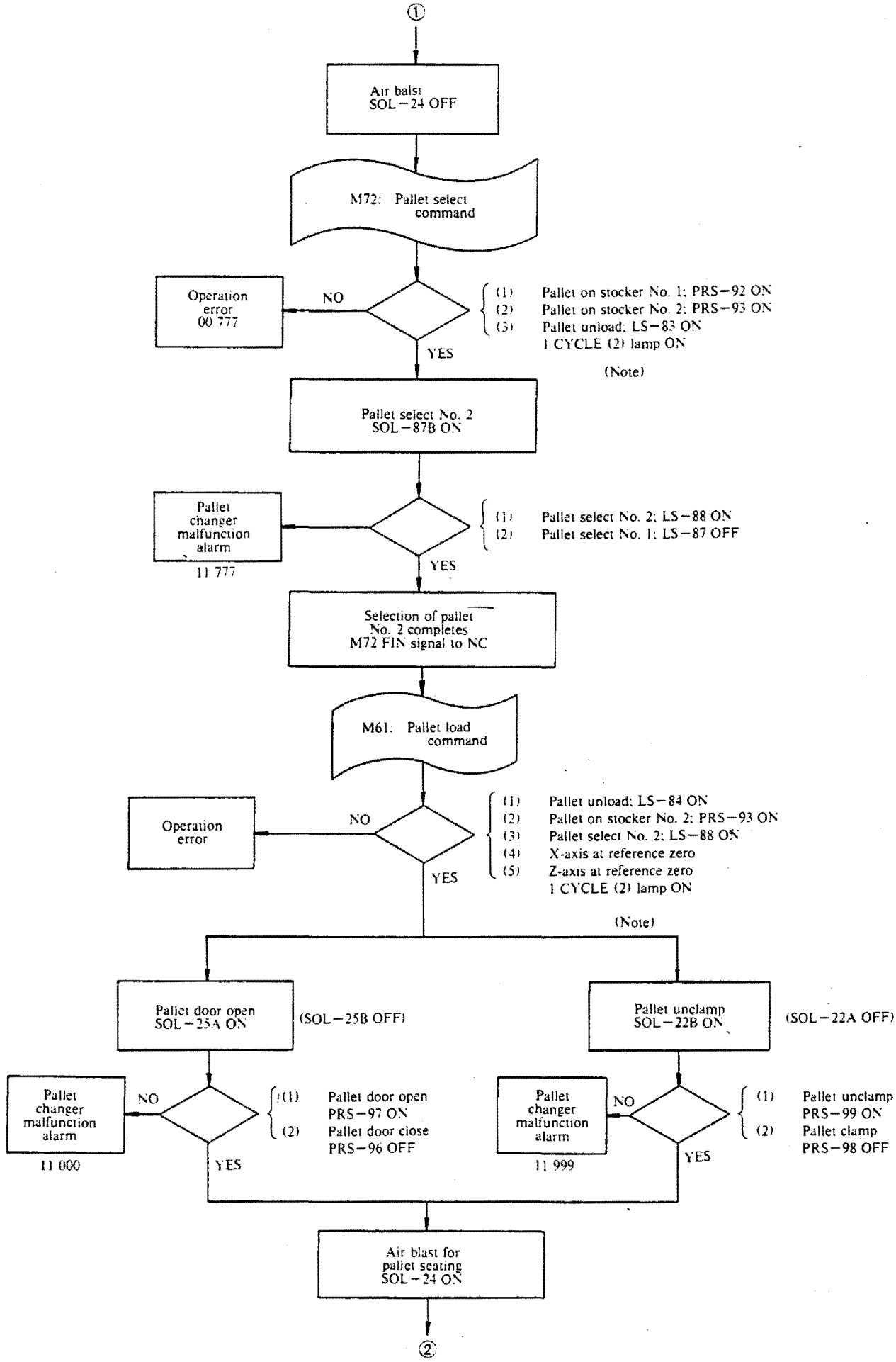
Mazak

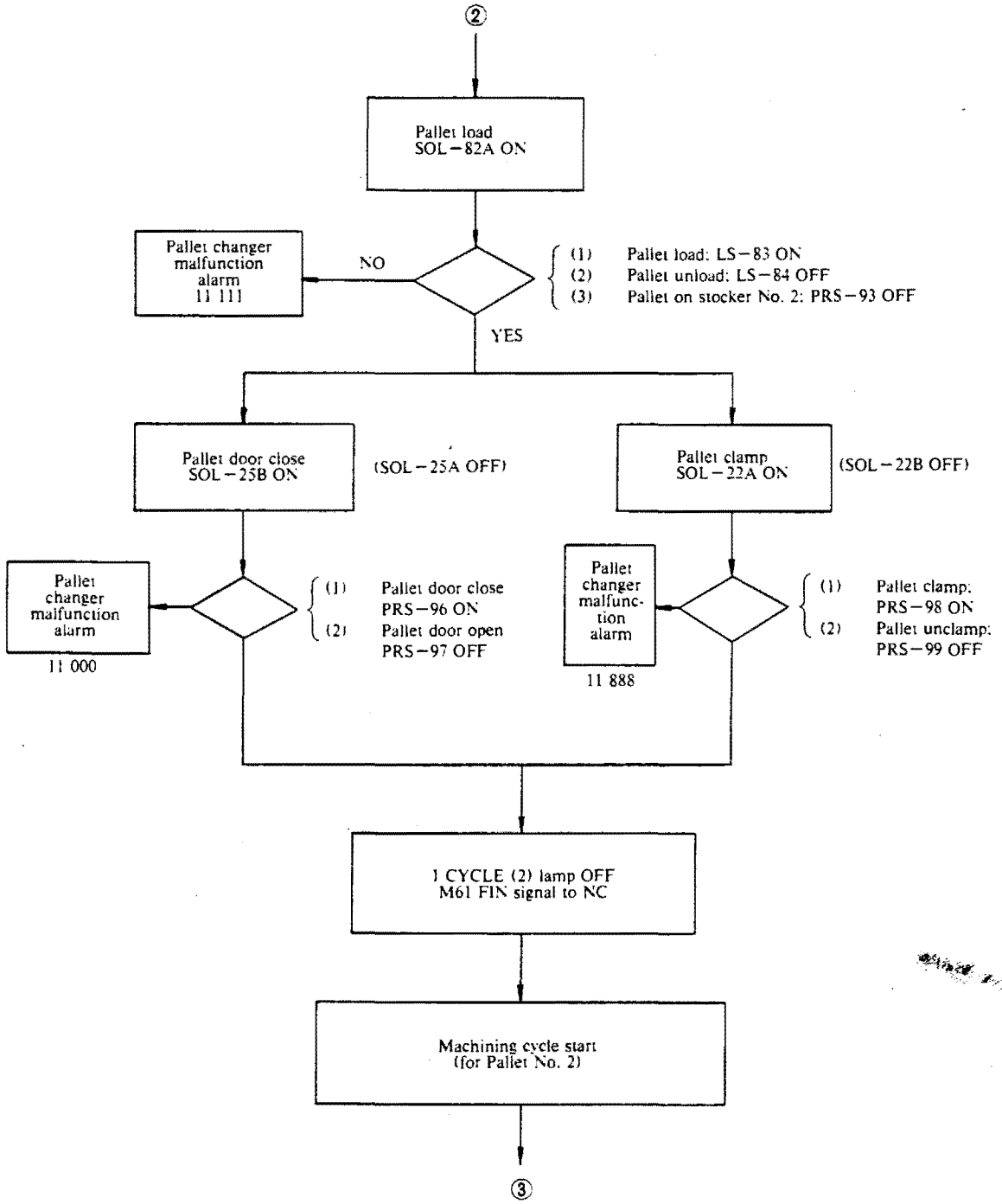
7. FLOW CHART

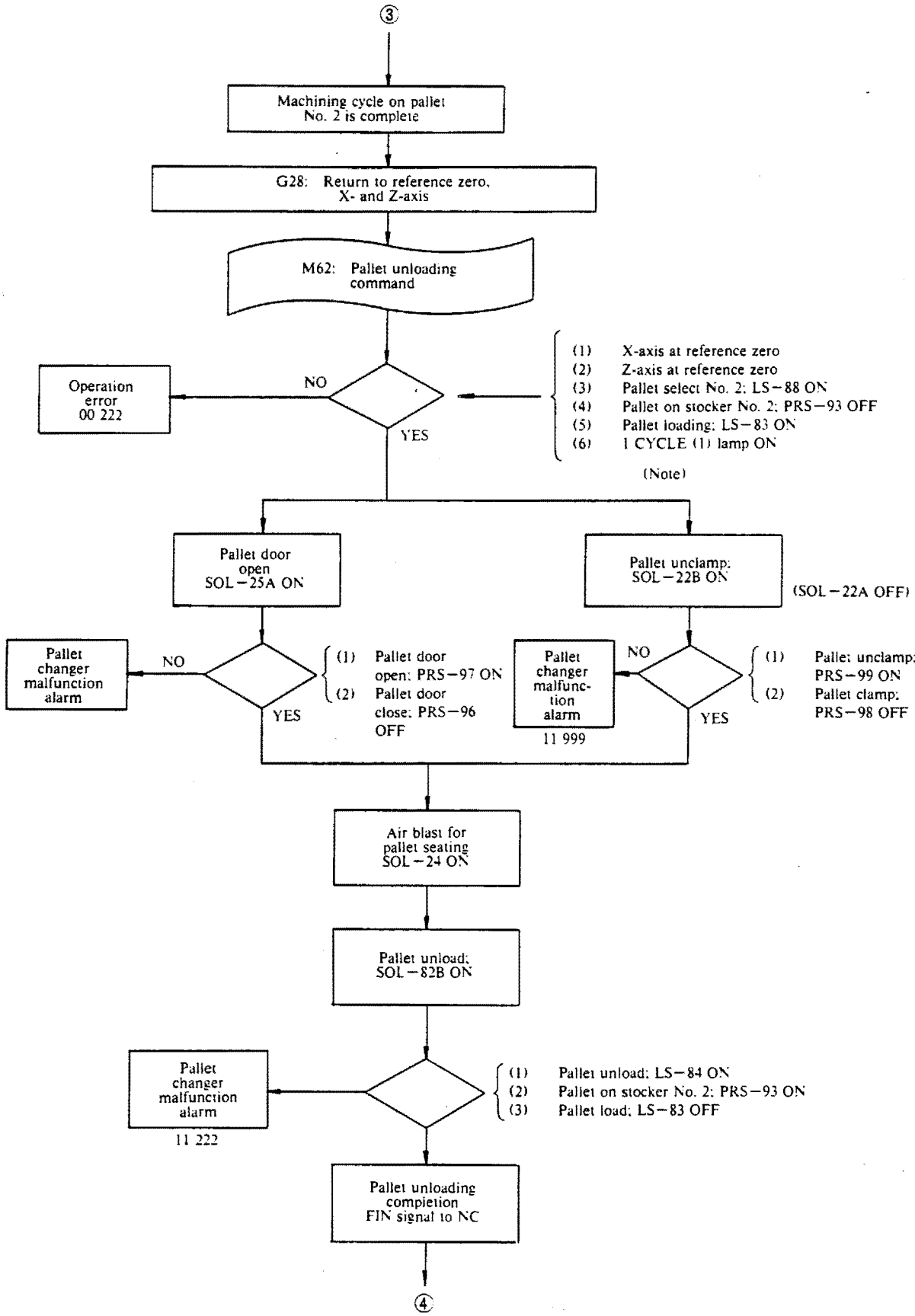
This flow chart shows the operation sequence of the pallet changer as:

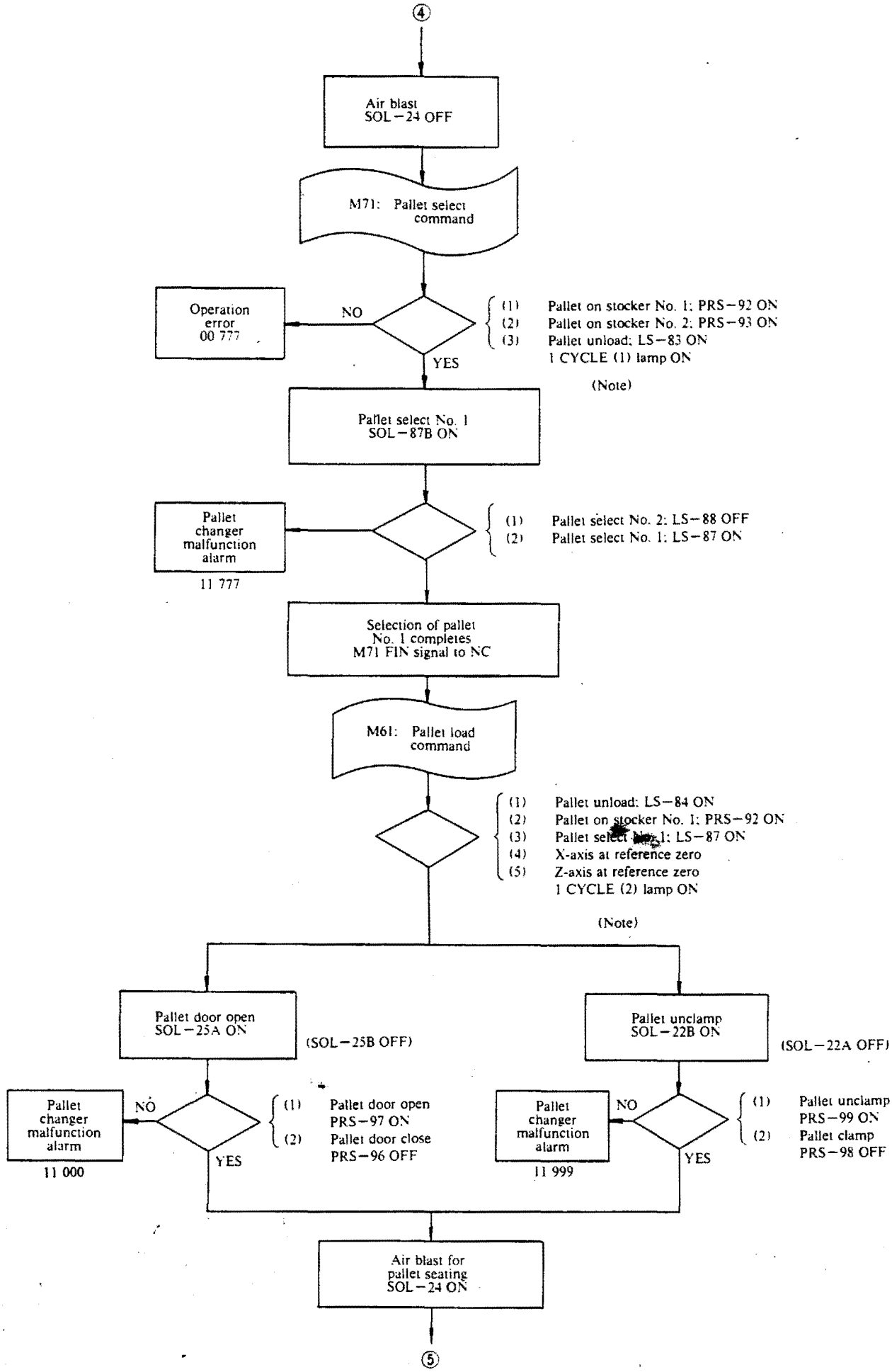
- ○ Machining cycle for the workpiece on pallet No. 1 complete
- ○ Pallet No. 1 unloading
- ○ Pallet No. 2 loading
- ○ Machining cycle for the workpiece on pallet No. 2
- ○ Pallet No. 2 unloading
- ○ Pallet No. 1 loading

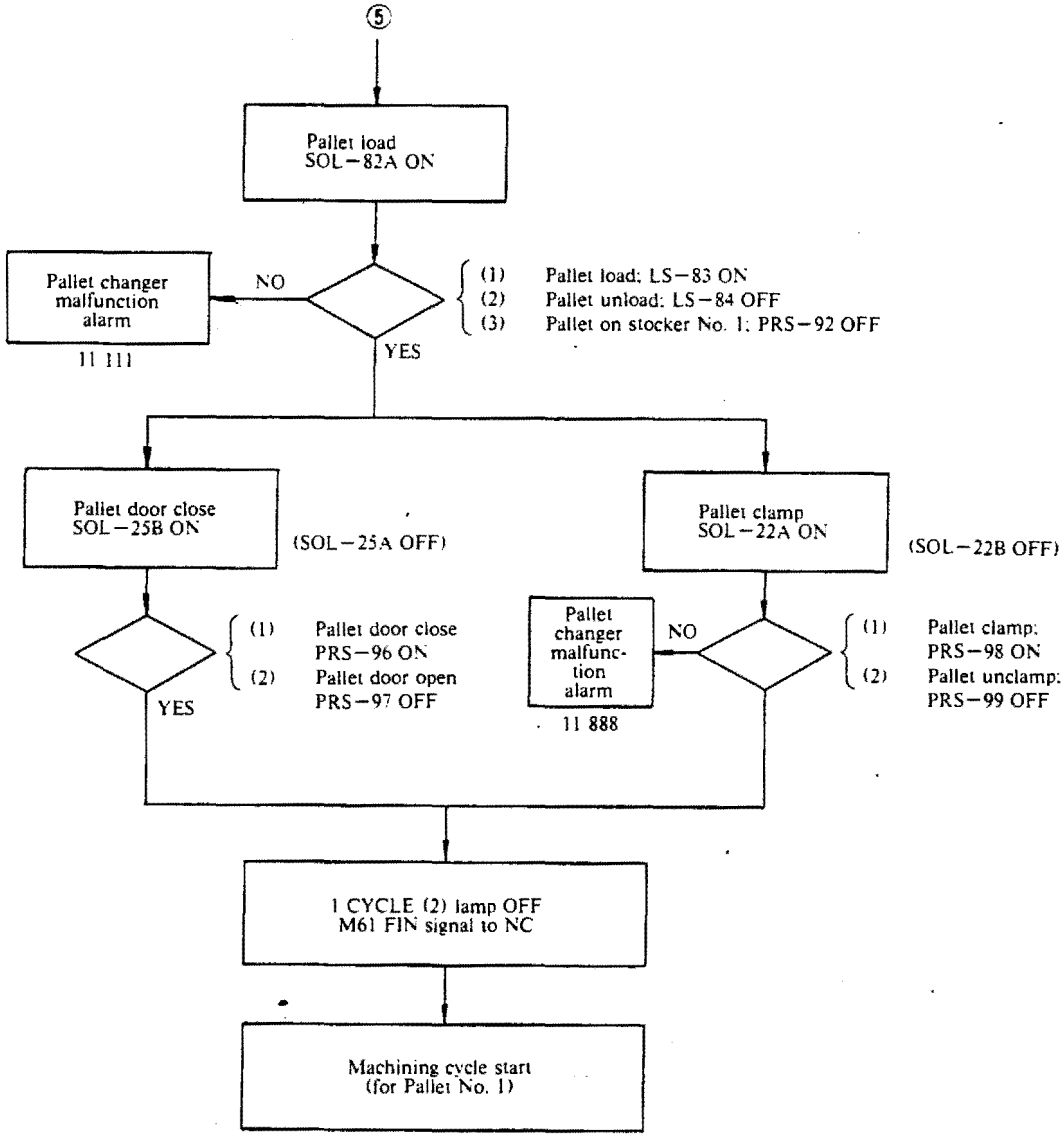



①
Air balst
SOL−24 OFF
M72: Pallet select command
Operation error
00 777
NO
YES
(1) Pallet on stocker No. 1; PRS−92 ON
(2) Pallet on stocker No. 2; PRS−93 ON
(3) Pallet unload; LS−83 ON
1 CYCLE (2) lamp ON
(Note)
Pallet select No. 2
SOL−87B ON
Pallet changer malfunction alarm
11 777
(1) Pallet select No. 2; LS−88 ON
(2) Pallet select No. 1; LS−87 OFF
Selection of pallet No. 2 completes
M72 FIN signal to NC
M61: Pallet load command
Operation error
(1) Pallet unload; LS−84 ON
(2) Pallet on stocker No. 2; PRS−93 ON
(3) Pallet select No. 2; LS−88 ON
(4) X-axis at reference zero
(5) Z-axis at reference zero
1 CYCLE (2) lamp ON
(Note)
Pallet door open
SOL−25A ON
(SOL−25B OFF)
Pallet unclamp
SOL−22B ON
(SOL−22A OFF)
Pallet changer malfunction alarm
11 000
(1) Pallet door open PRS−97 ON
(2) Pallet door close PRS−96 OFF
Pallet changer malfunction alarm
11 999
(1) Pallet unclamp PRS−99 ON
(2) Pallet clamp PRS−98 OFF
Air blast for pallet seating
SOL−24 ON
②


②
Pallet load
SOL−82A ON
Pallet changer malfunction alarm
11 111
NO
(1) Pallet load: LS−83 ON
(2) Pallet unload: LS−84 OFF
(3) Pallet on stocker No. 2: PRS−93 OFF
YES
Pallet door close
SOL−25B ON
(SOL−25A OFF)
Pallet clamp
SOL−22A ON
(SOL−22B OFF)
Pallet changer malfunction alarm
11 000
(1) Pallet door close PRS−96 ON
(2) Pallet door open PRS−97 OFF
Pallet changer malfunc-tion alarm
11 888
(1) Pallet clamp: PRS−98 ON
(2) Pallet unclamp: PRS−99 OFF
1 CYCLE (2) lamp OFF
M61 FIN signal to NC
Machining cycle start
(for Pallet No. 2)
③

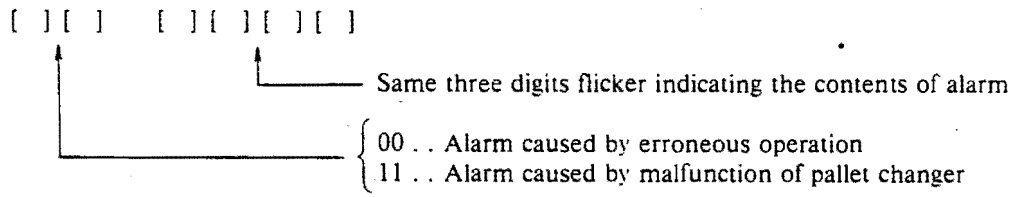

③
Machining cycle on pallet No. 2 is complete
G28: Return to reference zero, X- and Z-axis
M62: Pallet unloading command
Operation error 00 222
NO
YES
(1) X-axis at reference zero
(2) Z-axis at reference zero
(3) Pallet select No. 2: LS−88 ON
(4) Pallet on stocker No. 2: PRS−93 OFF
(5) Pallet loading: LS−83 ON
(6) 1 CYCLE (1) lamp ON
(Note)
Pallet door open SOL−25A ON
Pallet unclamp: SOL−22B ON
(SOL−22A OFF)
Pallet changer malfunction alarm
NO
YES
(1) Pallet door open: PRS−97 ON
(2) Pallet door close: PRS−96 OFF
Pallet changer malfunc-tion alarm
11 999
NO
YES
(1) Pallet unclamp: PRS−99 ON
(2) Pallet clamp: PRS−98 OFF
Air blast for pallet seating SOL−24 ON
Pallet unload: SOL−82B ON
Pallet changer malfunction alarm
11 222
(1) Pallet unload: LS−84 ON
(2) Pallet on stocker No. 2: PRS−93 ON
(3) Pallet load: LS−83 OFF
Pallet unloading completion FIN signal to NC
④


④
Air blast
SOL−24 OFF
M71: Pallet select command
Operation error
00 777
NO
YES
(1) Pallet on stocker No. 1; PRS−92 ON
(2) Pallet on stocker No. 2; PRS−93 ON
(3) Pallet unload; LS−83 ON
1 CYCLE (1) lamp ON
(Note)
Pallet select No. 1
SOL−87B ON
Pallet changer malfunction alarm
11 777
(1) Pallet select No. 2; LS−88 OFF
(2) Pallet select No. 1; LS−87 ON
Selection of pallet No. 1 completes
M71 FIN signal to NC
M61: Pallet load command
(1) Pallet unload; LS−84 ON
(2) Pallet on stocker No. 1; PRS−92 ON
(3) Pallet select No. 1; LS−87 ON
(4) X-axis at reference zero
(5) Z-axis at reference zero
1 CYCLE (2) lamp ON
(Note)
Pallet door open
SOL−25A ON
(SOL−25B OFF)
Pallet unclamp
SOL−22B ON
(SOL−22A OFF)
Pallet changer malfunction alarm
11 000
NO
YES
(1) Pallet door open PRS−97 ON
(2) Pallet door close PRS−96 OFF
Pallet changer malfunction alarm
11 999
NO
YES
(1) Pallet unclamp PRS−99 ON
(2) Pallet clamp PRS−98 OFF
Air blast for pallet seating
SOL−24 ON
⑤


⑤
Pallet load
SOL−82A ON
Pallet changer malfunction alarm
11 111
NO
(1) Pallet load: LS−83 ON
(2) Pallet unload: LS−84 OFF
(3) Pallet on stocker No. 1: PRS−92 OFF
YES
Pallet door close
SOL−25B ON
(SOL−25A OFF)
Pallet clamp
SOL−22A ON
(SOL−22B OFF)
(1) Pallet door close PRS−96 ON
(2) Pallet door open PRS−97 OFF
YES
Pallet changer malfunction alarm
11 888
NO
(1) Pallet clamp: PRS−98 ON
(2) Pallet unclamp: PRS−99 OFF
1 CYCLE (2) lamp OFF
M61 FIN signal to NC
Machining cycle start
(for Pallet No. 1)

8. ALARM TABLE

Alarm state of the pallet changer involving both erroneous operation and pallet changer malfunction are indicated on the display unit (PALLET ALARM) on the pallet changer operation panel.



8-1. Erroneous Operation

Display and Alarm Name	Contents of Alarm
00 000 Pallet Door Close Alarm	Pallet is not at load or unload end.
00 111 M61 Pallet Load Alarm	1) Pallet is not at the unloading position. 2) X- and Z-axis are not at their reference zero. 3) No pallet is present at the selected side.
00 222 M62 Pallet Unload Alarm	1) Pallet is not at the loading position. 2) X- and Z-axis are not at their reference zero. 3) Pallet is present at the selected side.
00 333 Manual Load/ Unload Alarm	1) X- and Z-axis are not at their reference zero. 2) Door is not open. 3) Pallet is not unclamped. 4) Pallet is at the stocker side when unload comand is provided while the pallet is at the loading end.
00 444 Manual Pallet Select Alarm	1) There are no pallets No. 1 and No. 2 on stocker. 2) Pallet is not at the unloading end.
00 555	Not used.
00 666 M71 Pallet No. 1 Select Alarm	1) There are no pallets No. 1 and No. 2 on stocker. 2) Pallet is not at the unloading end.
00 777 M72 Pallet No. 2 Select Alarm	1) There are no pallets No. 1 and No. 2 on stocker. 2) Pallet is not at the unloading end.
00 888 Pallet Clamp Alarm	Pallet is not at the loading end.
00 999 Pallet Unclamp Alarm	X- and Z-axis are not at their reference zero. (Note: In manual pallet changer operation mode, this requirement is neglected when power is shut off during loading or unloading cycle.)

8-2. Pallet Operation Alarm

Display and Alarm Name	Contents of Alarm
11 000 Pallet Door Alarm	1) Even when the door open command is provided, the corresponding switches do not function normally: RS−97 (door open) does not turn on. RS−96 (door close) does not turn off. 2) Even when the door close command is provided, the corresponding switches do not function normally: RS−96 (door close) does not turn on. RS−97 (door open) does not turn off.
11 111 Pallet Load Alarm	Even when the pallet load command is provided, the corresponding switches do not function normally: LS−83 (pallet load) does not turn on. LS−84 (pallet unload) does not turn off.
11 222 Pallet Unload Alarm	Even when the pallet unload command is provided, the corresponding switches do not function normally: LS−84 (pallet unload) does not turn on. LS−83 (pallet load) does not turn off.
11 333 Pallet Load Deceleration Sensor Defect Alarm	The LS-300 load deceleration sensor was not "ON" with the pallet load command, but the LS-83 was "ON" at a continued high speed instead.
11 444 Pallet Unload Deceleration Sensor Defect Alarm	The LS-301 unload deceleration sensor was not "ON" with the pallet unload command, but the LS-84 was "ON" at a continued high speed instead.
11 555	Not used
11 666 Pallet No. 1 Select Alarm	Even when pallet No. 1 select command is provided, corresponding switches do not function normally: LS−87 (pallet No. 1 select) does not turn on. LS−88 (pallet No. 2 select) does not turn off.
11 777 Pallet No. 2 Select Alarm	Even when pallet No. 2 select command is provided, corresponding switches do not function normally: LS−88 (pallet No. 2 select) does not turn on. LS−87 (pallet No. 1 select) does not turn off.
11 888 Pallet Clamp Alarm	Even when the pallet clamp command is provided, corresponding switches do not function normally: PRS−98 (pallet clamp) does not turn on. PRS−99 (pallet unclamp) does not turn off.
11 999 Pallet Unclamp Alarm	Even when the pallet unclamp command is provided, corresponding switches do not function normally: PRS−99 (pallet unclamp) does not turn on. PRS−98 (pallet clamp) does not turn off.

Respective alarm is detected in the period indicated below after the command is provided.
11 000 − 11 222: 10 sec.
11 666 − 11 777: 40 sec.
11 888 − 11 999: 10 sec.

8-3. How to Reset Alarm and Restore Operation

(1) Alarm Caused by Erroneous Operation

a) When operating the pallet changer to fulfill the requirements for pallet changer operation resumption:

1) Press RESET.

2) Clear the NC memory.
This extinguishes alarm display.

3) In manual or MDI mode, operate the machine and pallet changer to fulfill the requirements for pallet changer operation.

4) Rewind the program to the block right before the alarm took place (Restart).

5) Press CYCLE START.

This resumes pallet changer operation.

b) When continuing the pallet changer operation since necessary requirements are all fulfilled:

1) Press FEED HOLD.

2) Reset alarm.
This extinguishes alarm display.

With this, pallet changer operation is resumed.

(2) Alarm Caused by Malfunction of Pallet Changer

a) When operating the pallet changer to remove the cause of the alarm:

1) Press RESET.

2) Clear the NC memory.
This extinguishes alarm display.

3) Restore the pallet changer to the state before alarm occurrence.

4) Turn off main power disconnect.

5) Remove the cause of alarm.

6) Turn on main power disconnect.

7) Rewind the program to the block right before the alarm took place (Restart).

8) Press CYCLE START.

This resumes pallet changer operation.

b) To continue pallet changer operation after removing cause of alarm:

1) Press FEED HOLD.

2) Remove the cause of alarm.
This extinguishes alarm display.

With this, pallet changer operation is resumed.

8-4. Interlock of X- and Z-axis

Axis interlock (X- and Z-axis) is reset only when the pallet is unclamped while the pallet is either at the pallet unloading position or at the pallet loading end.

9. OPERATION RESUMPTION AFTER PALLET CHANGE CYCLE HALT

To resume the pallet change cycle after interruption, follow the steps below.

When it is necessary to command an M code to resume the operation, be sure to confirm that 1 CYCLE lamp is illuminating, referring to the M code table.

9-1. Halt during Pallet Shift (M66, M67)

A) In case power is turned OFF due to power failure:

1) Turn on main power disconnect.

2) Return X-axis to the reference zero and Z-axis to either the reference or the 2nd reference zero.

3) After selecting manual mode, complete the remaining operation using the PALLET SELECT switch on the pallet changer operation panel.

4) Set the pallet changer for continuing the succeeding sequence and then press CYCLE START to resume the operation.

B) In case EMERGENCY STOP switch is pressed:

1) Restore the pallet changer to the state before the activation of the EMERGENCY STOP using the PALLET SELECT switch on the pallet changer operation panel.

2) After turning off power, remove the cause of cycle halt.

3) Return X-axis to the reference zero and Z-axis to either the reference or the 2nd reference zero.

4) In automatic mode of operation, set the pallet changer and the machine to the state right before the activation of the EMERGENCY STOP, then resume the operation.

C) In case the control is reset:

1) Follow the same steps indicated in item B) above.
In this case, however, steps 2) and 3) may be omitted if it is not necessary to turn off power.

9-2. Halt during Pallet Loading/Unloading

Halt during pallet clamp/unclamp and door open/close is included.

A) In case main power is turned OFF:

1) Turn on main power disconnect.

2) Complete the remaining operation of the pallet changer using the PALLET LOAD/UNLOAD selector on the pallet changer operation panel after selecting manual mode of operation.

3) Return X-axis to the reference zero and Z-axis to either the reference or the 2nd reference zero.

4) Set the pallet changer for continuing the succeeding sequence and then press CYCLE START to resume the operation.

B) In case EMERGENCY STOP switch is pressed:

1) Restore the pallet changer to the state before the activation of the EMERGENCY STOP using the PALLET LOAD/UNLOAD switch on the pallet changer operation panel.

2) After turning off power, remove the cause of cycle halt.

3) Return X-axis to the reference zero and Z-axis to either the reference or the 2nd reference zero.

4) In automatic mode of operation, set the pallet changer and the machine to the state right before the activation of the EMERGENCY STOP, then resume the operation.

C) In case the control is reset:

1) Follow the same steps indicated in item B) above.
In this case, however, steps 2) and 3) may be omitted if it is not necessary to turn off power.

D) Halt during pallet clamp/unclamp:

Pallet clamp and unclamp operation continue until the hydraulic pressure drops below the certain level. In this case, the remaining operation is continued when the hydraulic pressure is built-up after the main power is turned on.

E) Pallet door open/close operation:

Pallet door open/close operation continues until the pneumatic pressure drops below the certain level.

AC SPINDLE DRIVE UNITS
FREQROL-SE
MAINTENANCE MANUAL

NO. 1

MITSUBISHI ELECTRIC CORPORATION

NAGOYA WORKS

CONTENTS

CHAPTER 1 GENERAL

1.1 OBJECTIVES OF MANUAL

The FR-SE series of AC spindle drive units are energy-conserving DDC inverters which have been developed to drive machine tool spindles. They operate stably over a wide speed range with a high response and yet with low vibration and noise levels and their braking energy is regenerated in the AC power supply. This manual describes the maintenance procedures for such units and it centers on regular inspections and troubleshooting.

1.2 SAFETY MEASURES AND MAINTENANCE PERSONNEL

Listed below are the checkpoints which should be strictly adhered to during maintenance and adjustments in order to assure safety.

- Control units should be started up, maintained and inspected by qualified electricians. It is dangerous for non-qualified personnel to touch these units.
- When handling a "live" control unit, remove all rings, watches, tie-pins and other metallic objects from your person.
- Electric shocks sustained from the units can result in death.

  Regardless of whether or not the power supply is grounded, high voltages are supplied to various locations in the unit and so particular care should be taken in the selection and use of the test equipment.

  When attaching the test equipment to the item under test, the test personnel should take care not to touch any units which are grounded. Generally speaking, the chassis of the

test instruments must not be grounded for testing. Consequently, high voltages may pass between ground and the chassis of a test instrument during testing and so particular care should be taken when operating the units while adjusting or repairing them.

- o Do not wear loose apparel which may be caught up by rotating objects when approaching a drive unit which is operating.
- o Do not remove or replace any of the circuit boards while power is being supplied to the drive units or while they are operating. Failure to heed this caution may result in damage.
- o Do not touch the controller immediately after the power has been switched off. Proceed to maintain and inspect after checking that power lamp LED19 (SE-CPU1, 2 cards) has gone off. (Wait at least 3 minutes.)

1.3 STORAGE

When equipment is not to be installed or used immediately, store it away in a clean and dry environment at a suitable temperature and take care not to allow steam or vapor to enter inside the control units. Any steam, vapor or dust finding its way inside the equipment invites deterioration in the insulation. When suspending operation of the equipment for a long or short period of time, take care to maintain the same environment as that effective during operation. Depending on the conditions, a heater may prove useful.

CHAPTER 2 SPECIFICATIONS

2.1 AC SPINDLE MOTORS

(1) Standard specifications

Output power	Continuous rating (KW)	3.7	5.5	7.5	11	15	18.5
	30-minute rating (KW)	5.5	7.5	11	15	18.5	22
	50% ED rating (KW)	5.5	7.5	11	15	18.5	22
Speed	Base speed (RPM)	1500		1500			
	Maximum speed (RPM)	8000 (Note 1)		6000			4500
Frame number		A112	B112	B132		C132	A160
Continuous rated torque (Kg m)		2.4	3.57	4.87	7.15	9.74	12.0
GD² (Kg m²)		0.08	0.10	0.17	0.21	0.27	0.55
Weight (Kg)		60	70	100	110	130	175
Allowable radial load (Kg)		150	200	300			
Cooling fan (W)		35					100
Vibration		V5					V10
Noise (db)(A)		75					80
Mounting direction		Output shaft mounted horizontally or perpendicularly.					
Overload resistance		1 minute at 120% of 30-minute rated output.					
Ambient temperature (℃)		0—40					
Insulation		F type					
Color of paint		Munsell 5.2TG 2.46/0.21					
Accessories		Pulse generator, overheating detector					
Controller type FR-SE-2-		5.5K	7.5K	11K	15K	18.5K	22K
Power capacity (KVA)		9	12	17	23	28	33
Power supply and power line frequency		200/200～230V±10%, 50/60Hz±3% Note 2					

Note 1: A reduced output is obtained for speeds of 4500 rpm and above; this is calculated by:

$$\text{Rated output} \times \frac{4500}{\text{rotational speed}}$$

Note 2: A power transformer should be provided for use at all voltages not listed here.

(2) Semi-standard specifications

Use the 1150 rpm base given below if it is not possible to provide a high reduction gear ratio in the gear system.

Output power	Continuous rating [KW]	2.2	3.7	5.5	7.5	11	15	18.5
	30-minute rating [KW]	3.7	5.5	7.5	11	15	18.5	22
	50% ED rating [KW]	3.7	5.5	7.5	11	15	18.5	22
Speed	Base speed [RPM]			1150				
	Maximum speed [RPM]	8000		6000			4600	
Frame number		A112	B112	B132		C132	A160	B160
Continuous rated torque [Kgm]		1.86	3.13	4.66	6.35	9.32	12.7	157
GD² [Kgm²]		0.08	0.10	0.17	0.21	0.27	0.55	0.69
Weight [Kg]		60	70	100	110	130	175	200
Allowable radial load [Kg]		150	200	300				
Cooling fan [W]		35					100	
Vibration		V5					V10	
Noise [db] (A)		75					80	
Mounting direction		Output shaft mounted horizontally or perpendicularly.						
Overload resistance		1 minute at 120% of 30-minute rated output.						
Ambient temperature [℃]		0 ~ 40						
Insulation		F type:						
Color of paint		Munsell 5.2 7G 2.4 6 / 0.2 1						
Accessories		Pulse generator, overheating detector						
Controller type FR-SE-2-		3.7K	5.5K	7.5K	11K	15K	13.5K	22K
Power capacity [KVA]		6	9	12	17	23	28	33
Power supply and power line frequency		200/200 ~ 230V ± 10%, 50/60Hz ± 3%						

2.2 AC SPINDLE CONTROLLERS

(1) Specifications

Type FR-SE-2-		5.5K	7.5K	11K	15K	18.5K	22K
50% ED output	Output power [KW]	5.5	7.5	11	15	18.5	22
	Power capacity [KVA]	9	12	17	23	28	28
Weight [Kg]		25			37	48	
Main circuitry system		Transistorized sinusoidal wave PWM inverter					
Control system		Vector control, digital closed loop control, speed feedback with pulse generator					
Braking system		Power regenerative braking					
Speed control range		35～8000RPM					
Speed fluctuation rate		Max. 0.2% of maximum speed (at 10-100% load fluctuation)					
Speed commands		Digital commands: binary 12-bit or BCD 2-digits (Note 1) Analog commands: +10V max. (approx. 10 kilohms inputimpedance)					
Ambient temperature/humidity		-5～55℃/45～85%					
Atmosphere		No noxious gases or dust (environmental resistance performance conforms to JEM1103 grade C)					
Vibration		Max. 0.5G					
Standards conformed to		IEC					
Cooling		Air cooling with fan					

Note 1: Selection between the binary 12-bit and BCD 2-digit formats is enabled by the internal DIP switches and that between the digital and analog commands is enabled by external inputs.

(2) Protection functions

Name	Function	Description
OVER HEAT (MOTOR)	Overload protection	When an overload occurs or when the blower motor stops and the motor itself overheats, the base is cut off and the main circuitry contactor is set OFF.
EXCESSIVE SPEED ERROR	Excessive speed error	When the error between the command speed and current speed becomes excessive, the base is cut off and the main circuitry contactor is set OFF.
BREAKER TRIP	Short-circuit/ grounding protection	When a high current flows to the main circuitry, the base is cut off and the main circuitry contactor is set OFF.
PHASE LOSS	Phase loss protection	The main circuitry contactor is set OFF.
EXTERNAL EMERGENCY	External emergency stop	After the emergency stop signal has been received from the external source and the motor has stopped by regenerative braking, the base is cut off and the main circuitry contactor is set OFF.
OVER SPEED	Over speed protection	When the speed exceeds 115% of the maximum speed, the base is cut off and main circuitry contactor is set OFF.
IOC TRIP (CONVERTER)	Instantaneous over current protection	When an over current flows to the converter, the base is cut off and the main circuitry contactor is set OFF.
OVER HEAT (CONTROLLER)	Main circuitry overload protection Air cut-off protection	When an overload occurs or when the air-cooling fan stops and the main circuitry elements over heat, the base is cut off and the main circuitry contactor is set OFF.
UNDER VOLTAGE	Main power supply drop protection	When the supply voltage drops, the base is cut off and the main circuitry contactor is set OFF.
OVER VOLTAGE (REGENERATION)	Main circuitry over voltage protection	When an over voltage occurs with regeneration of the main circuitry's capacitor voltage, the base is cut off and the main circuitry contactor is set OFF.
IOC TRIP (INVERTER)	Instantaneous over current protection	When an over current flows to the inverter, the base is cut off and the main circuitry contactor is set OFF.

Note:
When any of these protection functions except the external emergency stop signal is activated, the base (the inverter and regenerative converter) is cut off, the main circuitry contactor is set OFF and the motor stops by free-running.

(3) Auxiliary functions

Function	Application	Details	Output
Load meter signal	Load meter connections	Connect a single-deflection DC 1mA meter; full-scale and 3V or 10V/120% load outputs under a 120% load (100-120% adjustable) are obtained.	
Speed meter signal	Speed meter connections	Connect a single-deflection DC 1mA meter; full-scale and 10V/maximum speed outputs at maximum speed are obtained.	
Zero speed signal	Machine interlock	An ON-setting contact signal is obtained at a motor speed of 50 rpm or less than 25 rpm.	Contact/open emitter
Speed arrival signal	Answer back to NC	Obtained is a signal which actuates the output transistors at within +/-15% of the set speed.	Open emitter
Load detection signal	Cutter intrusion prevention	Obtained is a signal which actuates the output transistors above a current value (110% output) near the current limit value (120% output).	Open emitter
Override	Override with automatic operation	Variable range: 50-120% Released by controller terminal DEF off	
Orient (optional function)	Orient	Single point positioning for magnetic sensor system and multiple point positioning for encoder system possible. Started by orient start signal (ORCM1, ORCM2); orient finish signal is output upon completion.	Contact/open emitter
Torque limitation	Gear shift, etc.	With gear shifting, etc., the torque limitation is temporarily reduced and the spindle motor is operated. During torque limitation.	Open emitter
Speed detection signal		Obtained is a signal which actuates the output transistors at less than a detection level with a motor speed absolute value. Speed detection value is set in 8 steps from 2% to 58% in 8% steps.	Open emitter
Acceleration/ deceleration time constant		Acceleration/deceleration of speed command is restricted. 0.3 - 10 S	

2.3 CONTROLLER CONFIGURATIONS

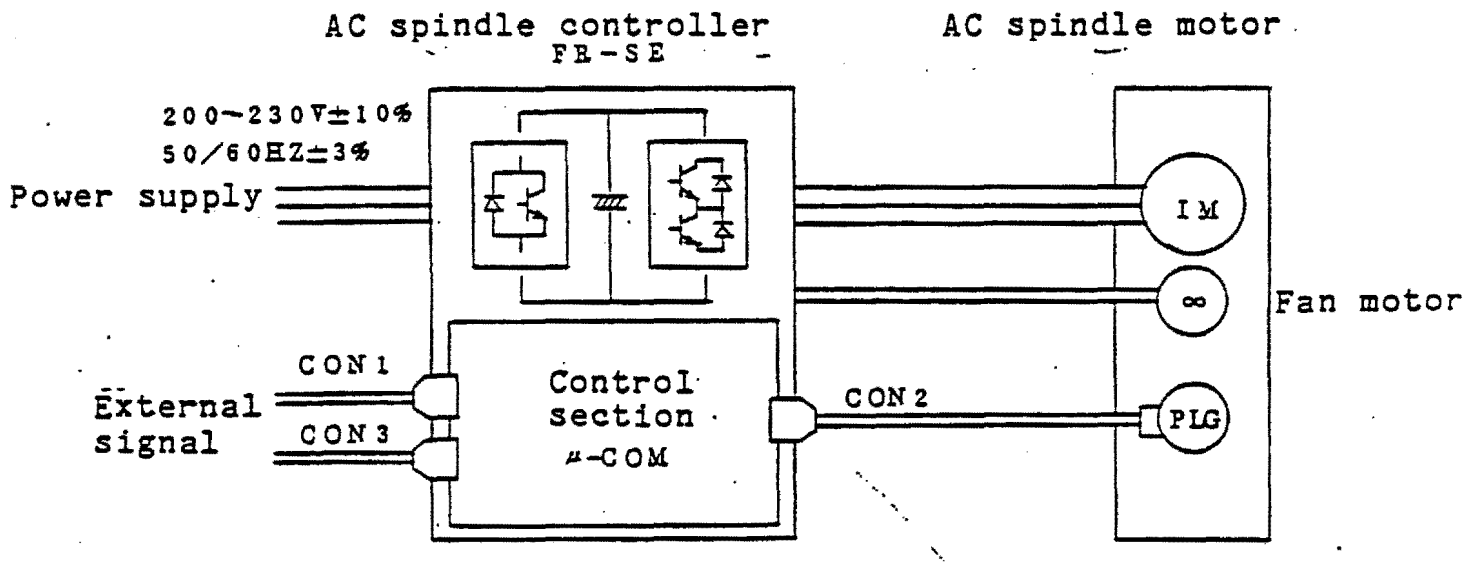
The basic configuration of the type FR-SE AC spindle unit is shown below.

(1) Basic configuration

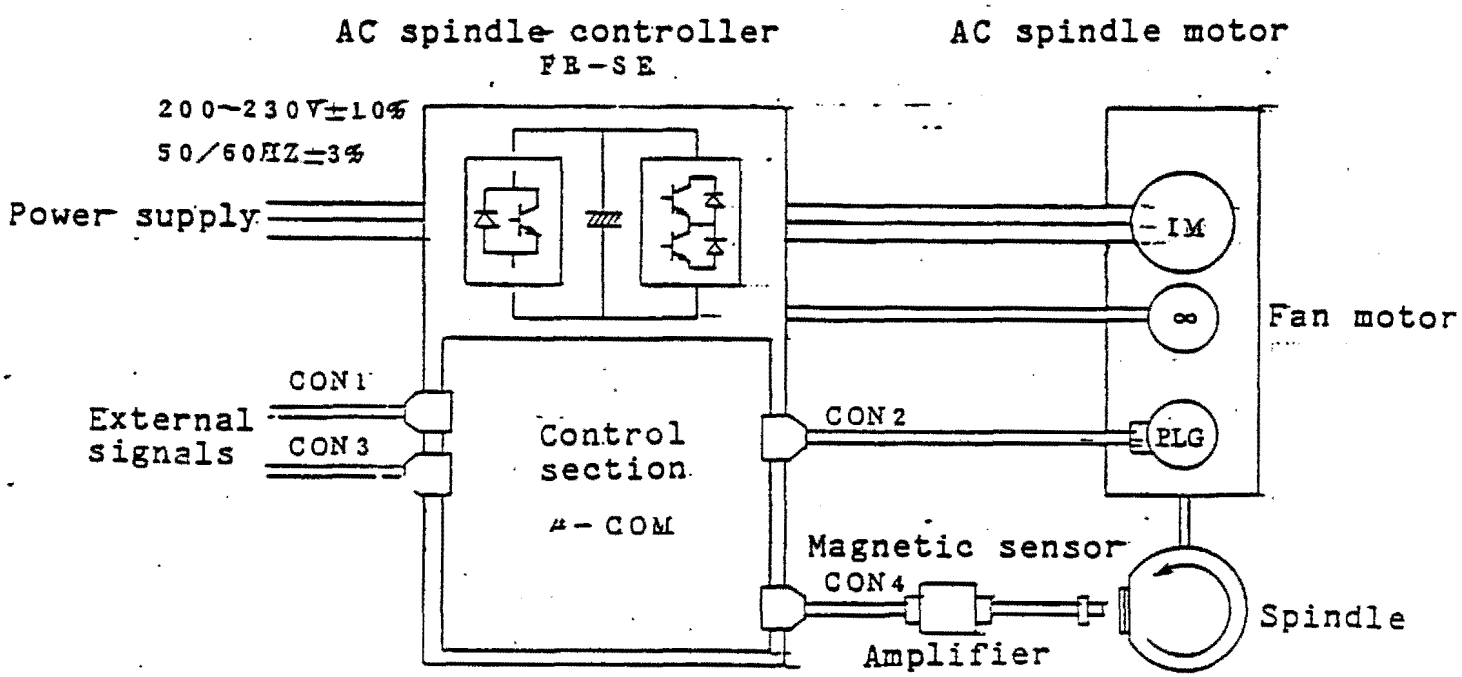
(a) Type SJ AC spindle motor (with speed detector)

(b) Type FR-SE AC spindle controller

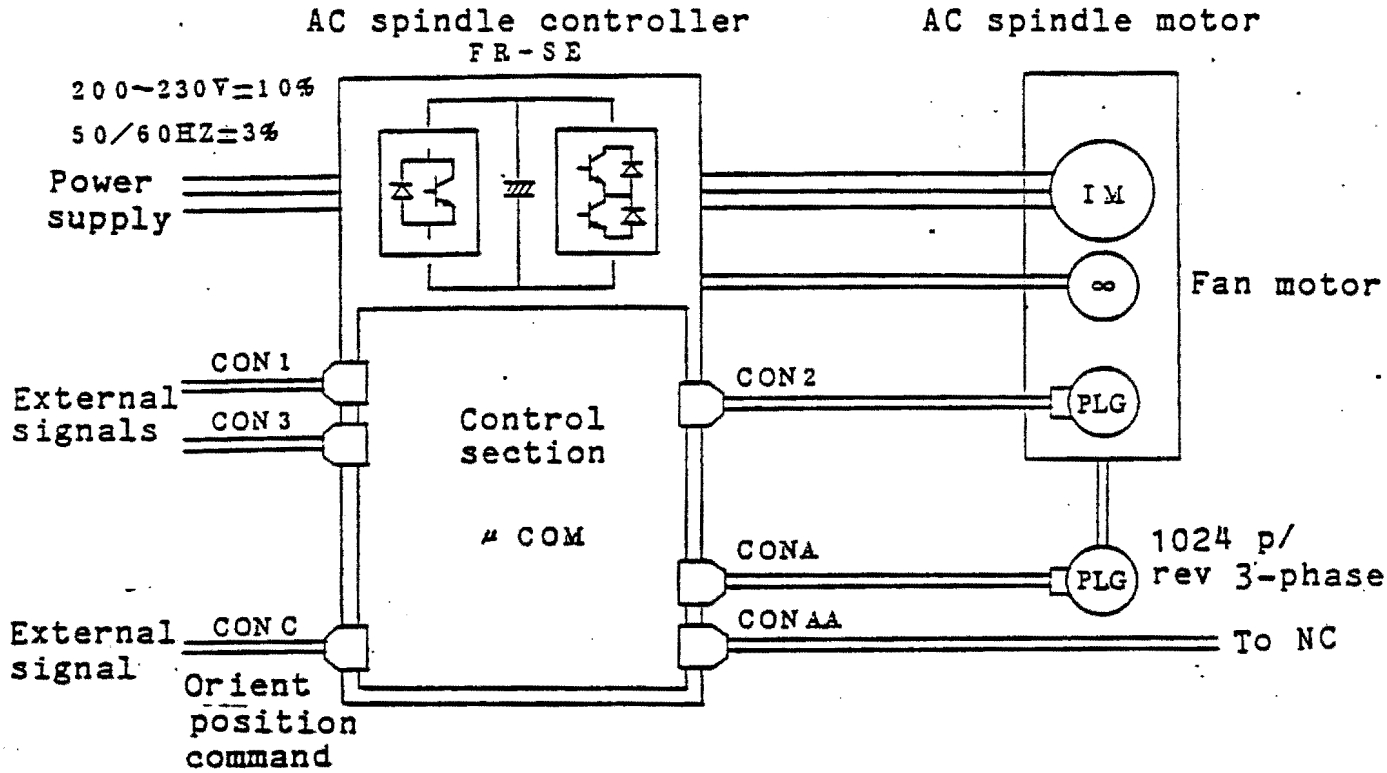
(c) Spare fuse 100%



(2) Magnetic sensor system with single point orient unit



(3) Encoder system with multiple point orient unit

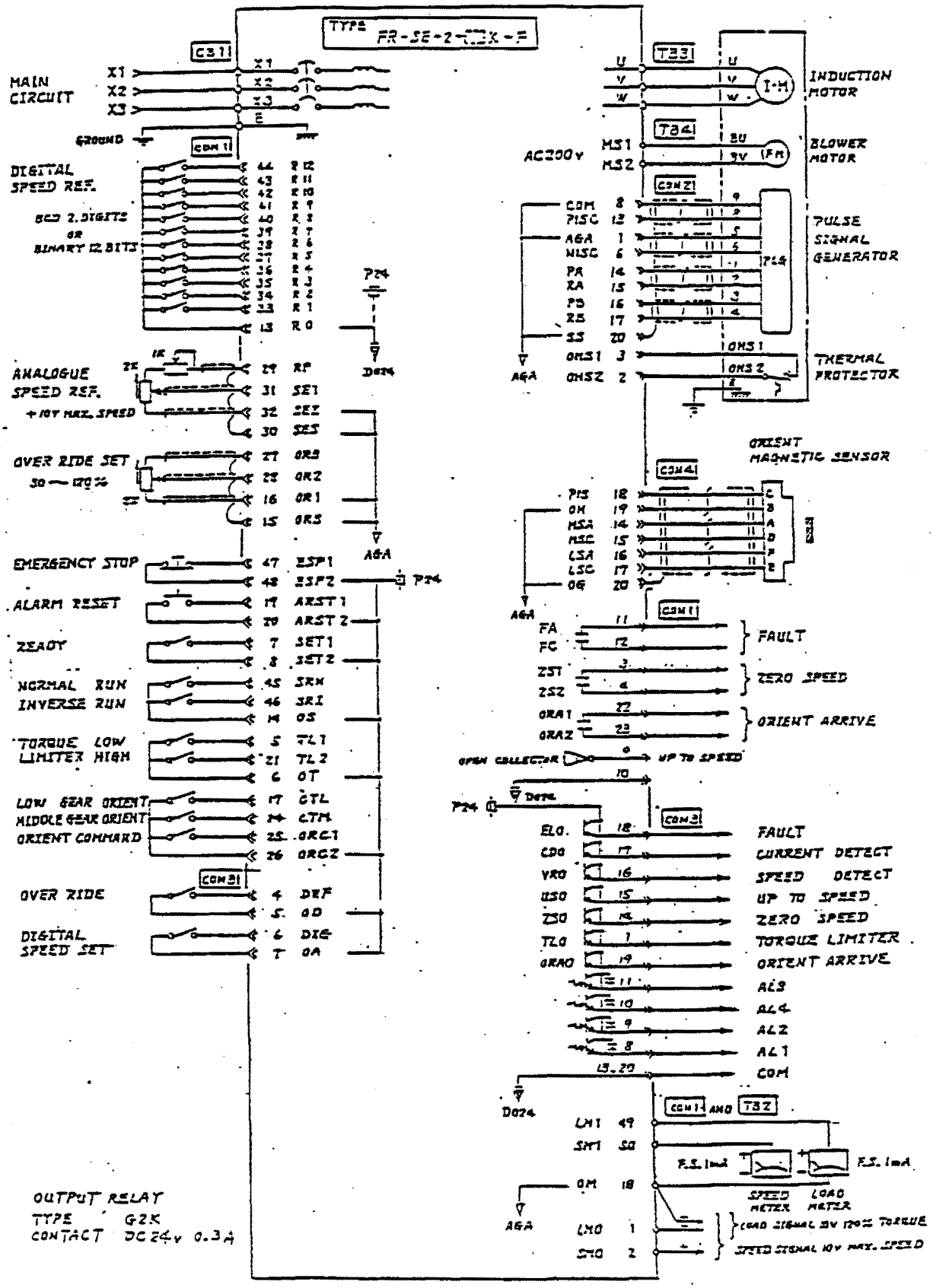


(4) Internal configuration of controller

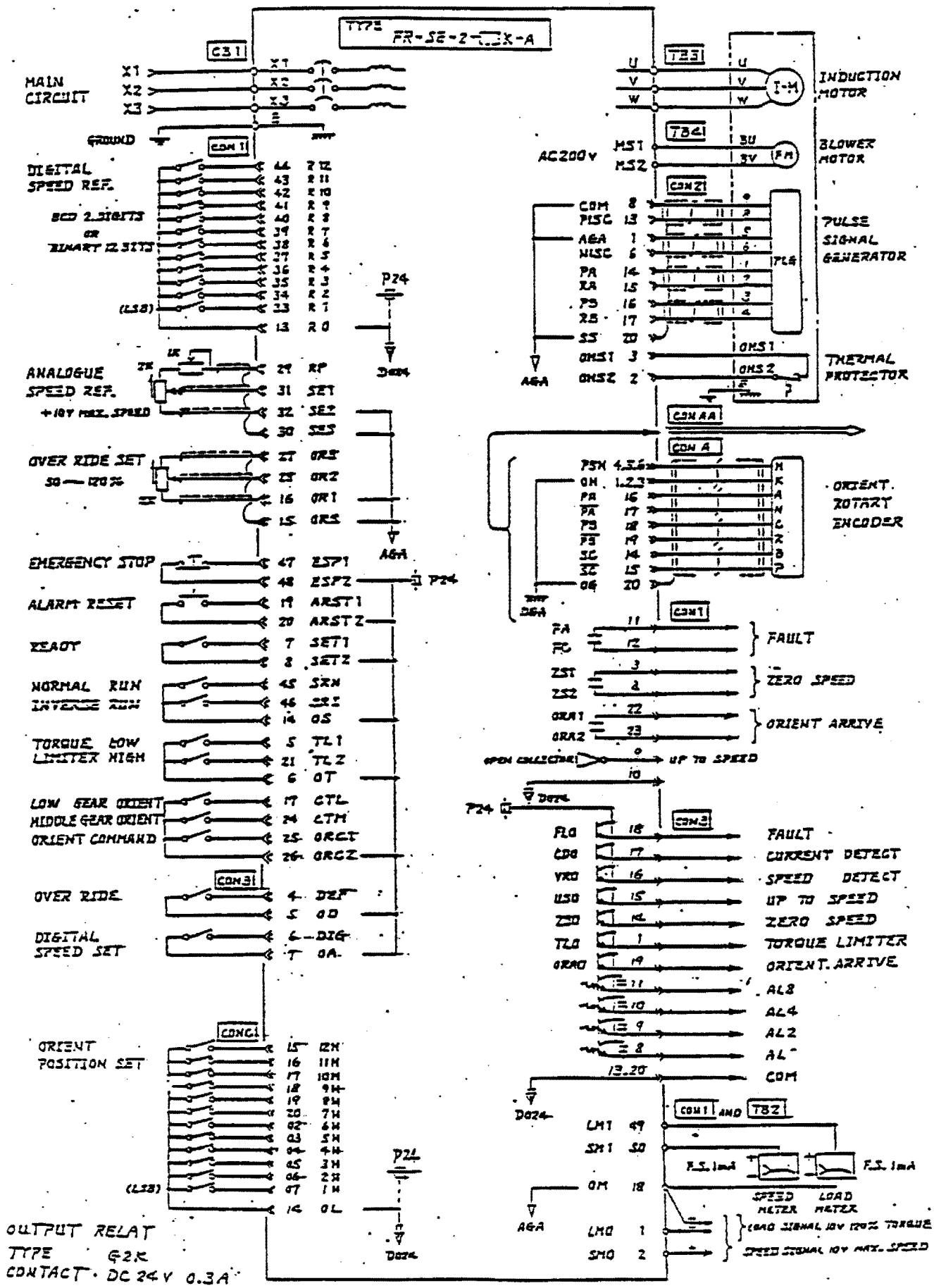
Configuration	Circuit board configuration
(a) Basic configuration	SE-PW, SE-IO1, SE-CPU1 or CPU2
(b) Magnetic sensor system With single point orient unit	SE-PW, SE-IO1, SE-CPU1
(c) Encoder system With multiple point orient unit	SE-PW, SE-IO1, SE-CPU2

2.4 EQUIPMENT CONNECTION DIAGRAMS

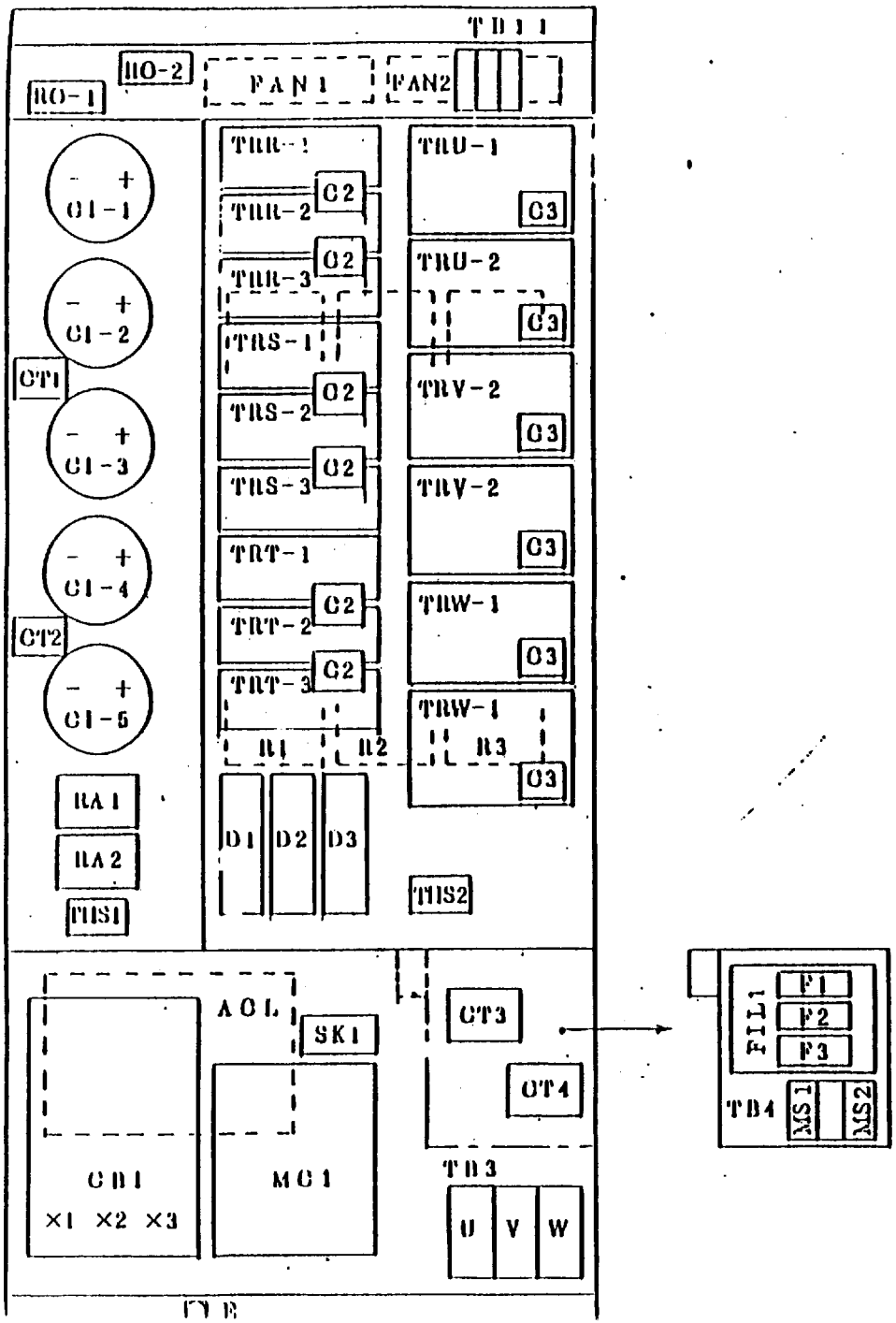
(1) Magnetic sensor type with single point orient unit



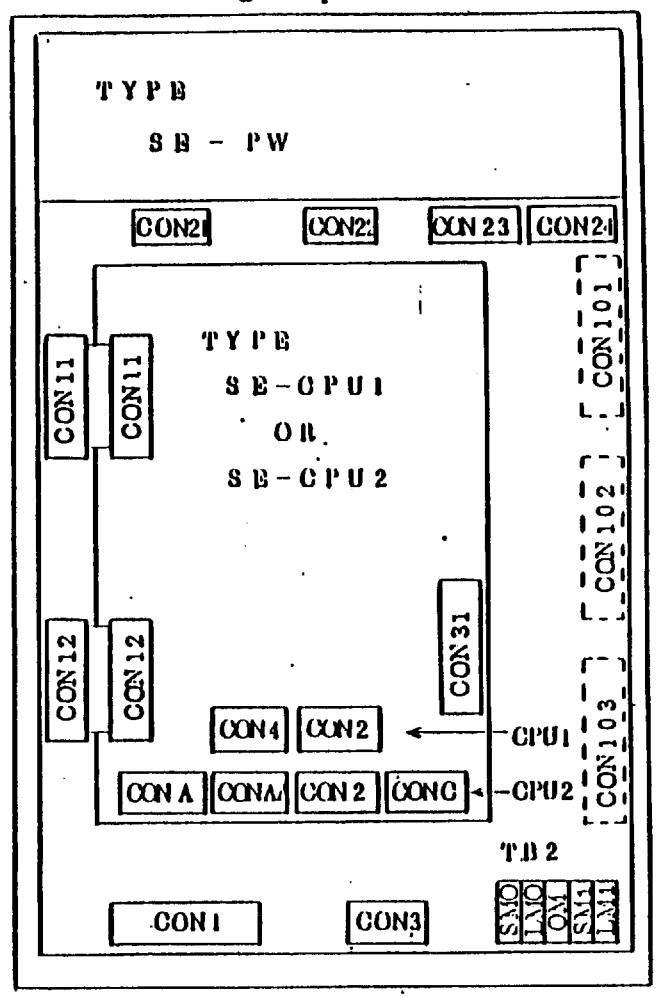
(2) Encoder type with multiple point orient unit



Main panel



Hinged panel



CHAPTER 3 OPERATIONAL ADJUSTMENTS

3.1 OPERATION PREPARATIONS

Check the following points when switching on the power to the controller for the first time:

(1) Has all the equipment been properly wired and connected as shown in the drawings?

(2) Have the motor and control panel been grounded properly?

(3) Have the shield wire terminations been connected properly?

- o Make the proper connections to the shield terminals.
- o Make the connections so that the shield areas do not form a loop.

(4) Check that the equipment is secured properly to avoid looseness and damage.

(5) Check that metal chips, pieces of wire and other foreign matter have not entered inside the equipment.

(6) Check that there is nothing abnormal with the exteriors of the printed circuit boards.

(7) Check that the ROM numbers and DIP switch settings are as per the order list.

3.2 RECEIVING POWER

If all items under section 3.1 are satisfactory, power up the equipment as follows:

(1) Switch on the incoming power.

(2) Check that light-emitting diodes LED13, 14, 15 and 16, which are designed to indicate trouble and which are located on the front of the controller, have not lighted.

(3) Check that light-emitting diodes LED2 (READY) and LED10 (ZERO SPEED), which are designed to indicate the status and which are located on the front of the controller, have lighted.

These procedures enable operation.

No problems are posed with the controller and re-connection is not necessary even if the phase sequence of the incoming power is reversed. It is possible to check whether the phase sequence is positive or reversed by observing LED1 (PHASE SEQUENCE). A positive phase sequence is indicated when LED1 lights.

3.3 ADJUSTMENT LOCATIONS

(1) Speed meter; VR14; load meter: VR15

When driving the speed meter with the spindle inverter:

Adjust VR14 so that the speed meter indicates the maximum speed by setting DIP switch SW6-6 to OFF.

Adjust VR15 so that the load meter indicates 120%.

Upon completion of the adjustments, set SW6-6 to ON and set the reset (ST1) switch to on once. Under no circumstances should the VRs be touched unless absolutely necessary.

(2) Setting DIP switches, setting pins

Re-check that the DIP switches and pins are set as in the order list in accordance with the machine. If they have not been set, change their settings. Set the reset (ST1) switch to ON the settings have been changed.

Adjust the orientation when changing the stop position in accordance with the machine. See Section 3.5 for details.

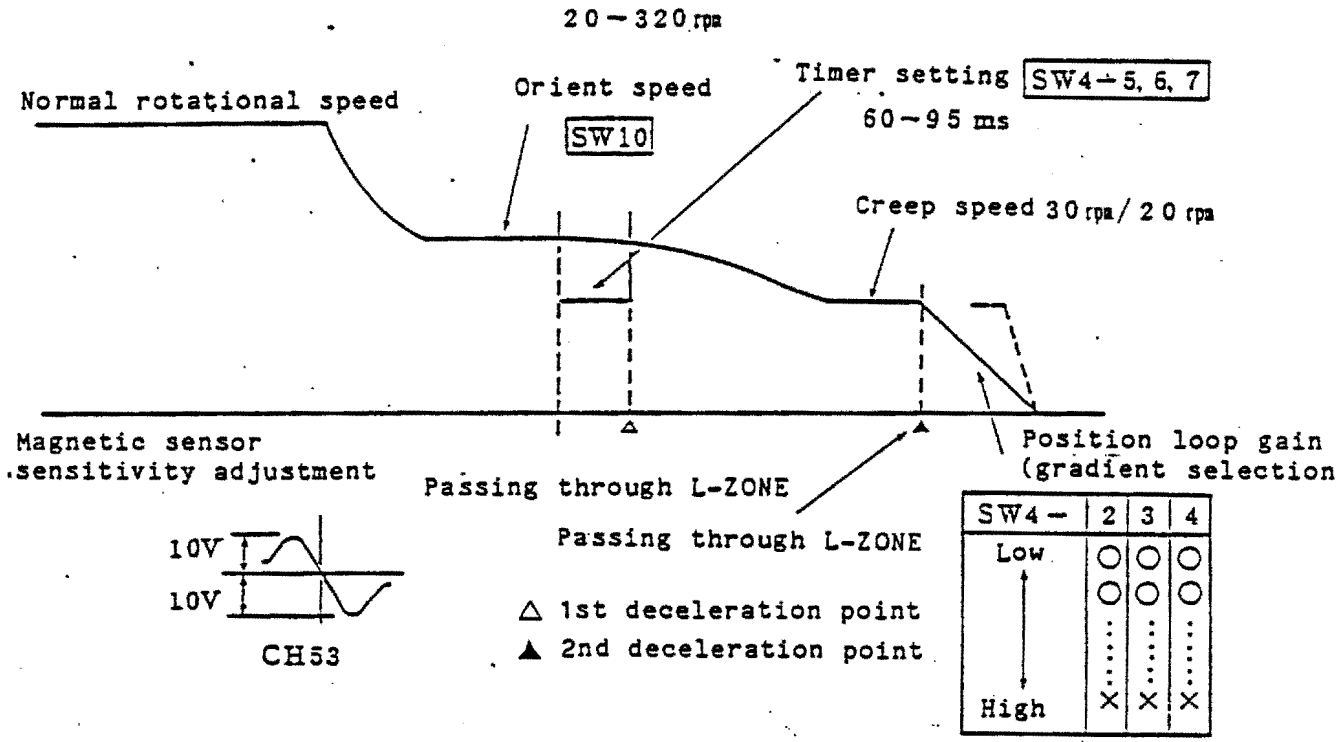
3.4 RUNNING-IN OPERATION

Couple the motor and machine and then check the machine running-in and control state. Next, operate the motor under actual load conditions and check that there is no:

- o Abnormal noise
- o Abnormal smells
- o Abnormal bearing temperature

3.5 ORIENT ADJUSTMENT PROCEDURES

(1) Magnetic sensor system



Operate at the orient speed with SW6-10FF and ST2, adjust VR2 to the limit at which the magnetic sensor sensitivity LED11 lights and set CH53 to the peak voltage +/-10V.

The speed pattern for orient is now as shown in the figure above.

Therefore,

Proceed as follows when over shoot with stop:

- o Reduce the timer setting (SW4-5,6,7) time.
- o Reduce the position loop gain (SW4-2,3,4) gradient.
- o Reduce the orient speed. (SW10 F → E → .... → 0)
- o Reduce the creep speed. (SW4 OFF → ON)

Reduce the orient time.

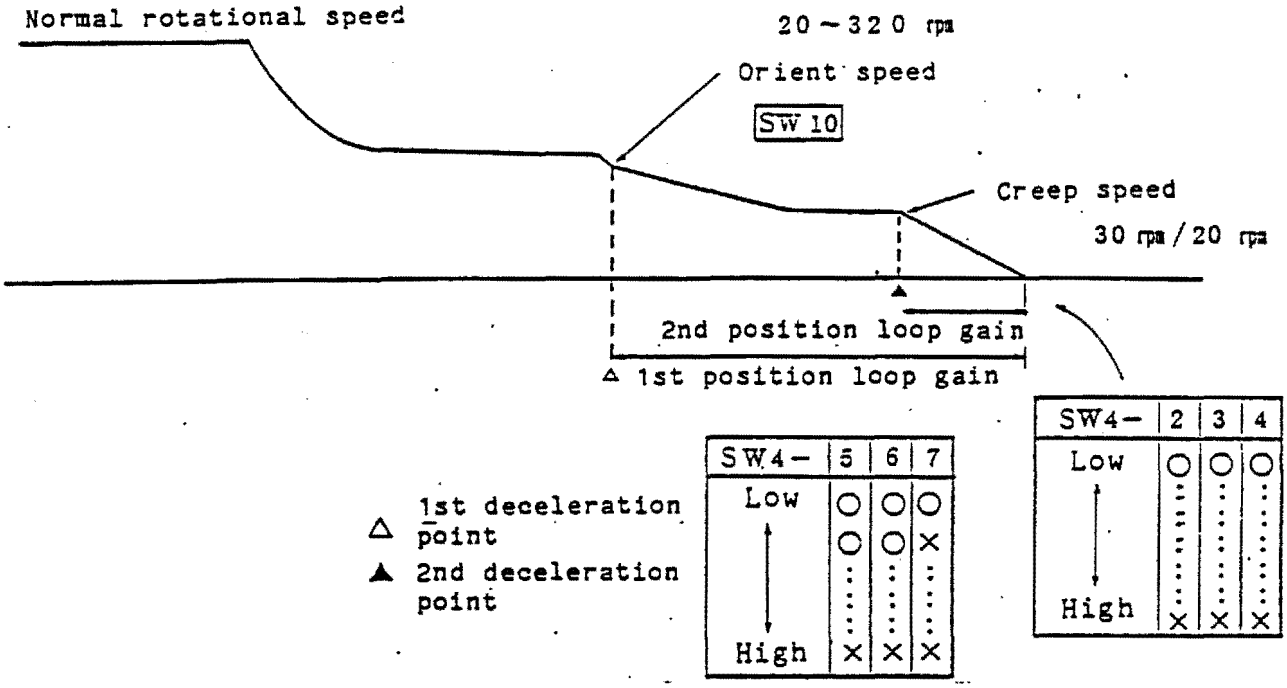
- o Increase the timer setting (SW4-5,6,7) time.
- o Increase the position loop gain (SW4-2,3,4) gradient.
- o Increase the orient speed. (SW10 0 → 1 → .... ..F)

Hunting when drive unit stops

- o Reduce the position loop gain (SW4-2,3,4) gradient.
- o Reduce the magnetic sensor sensitivity. (VR2)
- o Reduce the creep speed. (SW4 OFF → ON)

Furthermore, adjust the stop position with position shift VR1.

(2) Encoder system



The speed pattern for orient is the same as that shown above.

Therefore,

Proceed as follows when over shoot with stop:

- o Reduce the 1st position loop gain.
- o Reduce the orient speed. (SW10 F → E → .... → 0)
- o Reduce the 2nd position loop gain.
- o Reduce the creep speed. (SW4 OFF → ON)

Reduce the orient time.

- o Increase the 1st position loop gain.
- o Increase the orient speed. (SW10 0 → 1 → .... F)
- o Increase the 2nd position loop gain.

Hunting when drive unit stops

- o Reduce the 2nd position loop gain.
- o Reduce the creep speed. (SW4 OFF → ON)

Furthermore, adjust the stop position with position shift switches 13, 14 and 15.

CHAPTER 4 REGULAR INSPECTIONS

Regular inspection and maintenance are indispensable if the equipment is to do full justice to its performance, if breakdowns are to be prevented and if reliable operation is to be assured over a long period of time.

WARNING
Electric shocks can lead to death. Make sure that all power to the equipment is off before proceeding with the inspections.

4.1 CONTROLLER INSPECTIONS

Inspection item	Inspection period	Checkpoints	Remedy
1. Cooling fan	Monthly	1. Try rotating by hand. Does it rotate smoothly? 2. Try supplying power. Does it rotate effectively? 3. Any abnormal noise from bearing sections?	Replace fan.
2. Dirt, looseness	When appropriate	Clean parts regularly; tighten up input/output terminals and connections regularly.	
3. Small relay	Every 3 months.	1. Are contacts worn? 2. Is main circuitry contactor operating properly with operation of this relay?	Replace relay.
4. Wiring	When appropriate	Conductors must not touch case by wires being caught in hinge section.	

4.2 MOTOR INSPECTIONS

Inspection item	Inspection period	Checkpoints	Remedy
1 Noise	Monthly	Any noise or abnormal vibration not previously perceived? If present, check out the following: 1 Check foundation, installation. 2 Check centering accuracy of coupling. 3 Vibration from coupled equipment? 4 Bearing damage or abnormal noise? 5 Reduction gear or belt drive noise? 6 Trouble with controller? 7 Trouble with cooling fan? 8. Belt tension.	
2 Temperature rise	Monthly	Abnormal bearing temperature? (Normally, ambient temperature of +10 to 40 deg.C) Motor frame temperature different from usual? If so, check points below: 1 Is cooling fan rotating normally? 2 Any foreign matter in cooling path (between frame and cover) which is blocking path? 3 Abnormally increased load? 4 Trouble with controller?	Clean. Refer to trouble-shooting

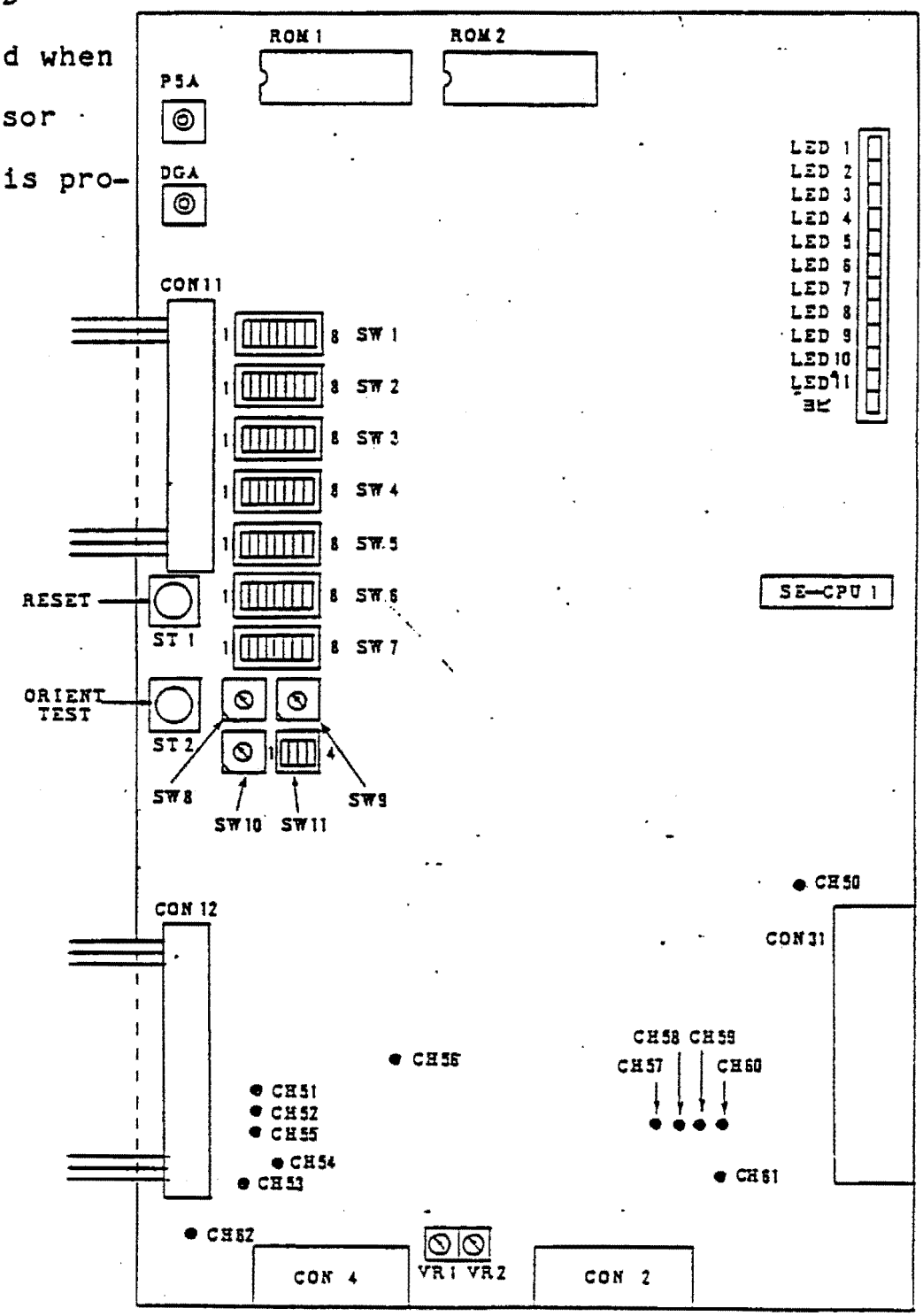
3 Insulation resistance	Every 6 months	Abnormally low insulation resistance? Isolate connections to control panel and use megger to measure across circuitry and ground. (No problem if 1 megaohm or more when measured with 500V megger.) If less than 1 Megaohm, inside of motor must be cleaned and dried. Disassemble motor and dry in an oven at a temperature not exceeding 90 deg.C.
4 Cooling fan	Every week Every month	Is fan rotating and cooling properly? Any abnormal noise or vibration present?

CHAPTER 5 CARD CHECKS

All the adjustments on the control cards have been made prior to shipment to the machine builders. Avoid, therefore, rotating the controls (VRs).

5.1 SE-CPU1 CARD

This card is used when the magnetic sensor orient function is provided.



(1) List of LEDs

LED	Name	Application	Description
LED1	PHASE SEQUENCE	Power supply phase identification	Lights when power supply phase rotation is positive. OFF when power supply phase rotation is negative.
LED2	READY	Ready.	Lights when controller is ready to operate; OFF when SET1-SET2 inputs are OFF or when alarm occurs.
LED3	CW DRIVE	Motor forward (CW) rotation command	Lights when forward rotation command is input; also lights with orient stop.
LED4	CCW DRIVE	Motor reverse (CCW) rotation command	Lights when reverse rotation command is input.
LED5	SPEED DETECTION	Speed detection	Lights when motor speed falls below DIP switch setting.
LED6	CURRENT DETECTION	Current detection	Lights when a current equivalent to 110% of rated current flows to motor.
LED7	UP TO SPEED	Speed arrival	Lights when actual motor speed is +/-15% of command speed.
LED8	APPROACH	Approach	Lights during period from 1st to 2nd deceleration point.
LED9	IN-POSITION	In-position	Lights with orient stop within range of pulse number set by rotary switch.

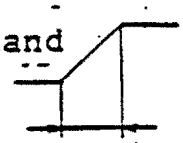
LED	Name	Application	Description
LED10	ZERO SPEED	Zero	Lights when speed is below zero speed set by DIP switch.
LED11	SENS	Magnetic sensor sensitivity	Lights when magnetic sensor output during orient is 8.5V or more.
LED12	——	——	Not used.

List of DIP switches

Note 1: "O" denotes DIP switch ON setting.

"X" denotes DIP switch OFF setting

Switch	Name	Description
SW1	Gear ratio (H range)	Used to set gear ratio. $\text{Gear ratio} = \frac{\text{Maximum spindle speed}}{\text{Maximum motor speed}} \times 80^{H}$ Setting example: When max. spindle speed is 5000 rpm with a maximum H gear motor speed of 6000 rpm Hexa-decimal Gear ratio = 5000/6000 x 128 ≒ 106D = $6A^{H}$ SW1 all switches ON .. Gear ratio = 80^{H} SW2 all switches ON .. Gear ratio = 40^{H} SW3 all switches ON .. Gear ratio = 20^{H} 
SW2	Gear ratio (M range)	
SW3	Gear ratio (L range)	
SW4-1	Creep speed	Used to set creep speed with orientation. 1 — Creep speed 0 ····· 20 rpm X ····· 30 rpm
SW4-2 ~4	Position loop gain	Used to set position of 2nd deceleration point. 2 3 4 0 0 0 ···· 25 deg. 0 0 X ···· 23.75 deg. 0 X 0 ···· 22.5 deg. 0 X X ···· 21.25 deg. X 0 0 ···· 20 deg. X 0 X ···· 18.75 deg. X X 0 ···· 17.5 deg. X X X ···· 16.25 deg.
SW4-5 ~7	Magnetic sensor orient speed timer	Used to set timer time up to 1st deceleration point after L-ZONE passing subsequent to orient speed arrival.

		5 6 7 0 0 0 ··· 60 ms (212 deg.) 0 0 X ··· 65 ms (203 deg.) 0 X 0 ··· 70 ms (194 deg.) 0 X X ··· 75 ms (185 deg.) X 0 0 ··· 80 ms (176 deg.) X 0 X ··· 85 ms (167 deg.) X X 0 ··· 90 ms (158 deg.) X X X ··· 95 ms (149 deg.)
SW4-8	Magnetic sensor mounting direction	8 0 -- Forward X -- Reverse Set to reverse position if high degree of hunting occurs with orient stop.
SW5-1 ·2	Torque limit	Used when limiting motor torque. External input TL1--ON TL2--OFF 1 2 — Torque limit 0 0 ·· 10% 0 X ··· 15% X 0 ·· 20% X X ·· 25% TL1--OFF TL2--ON 0 0 ··· 20% 0 X ··· 30% X 0 ··· 40% X X ··· 50% Note: 30-minute rated torque is 100%.
SW5-3 ~5	Cushion time constant	Used to set time constant of maximum speed command from 0. 3 4 5 — Cushion time constant 0 0 0 ··· 0.3 s —— Standard setting 0 0 X ··· 1.5 s 0 X 0 ··· 3 s 0 X X ··· 4 s X 0 0 ··· 5 s X 0 X ··· 6 s X X 0 ··· 8 s X X X -10 s  Speed command Cushion time constant

<table>
<tr><td>SW5-6
~8</td><td>Speed detection range</td><td>Output transistors are activated when speed falls below set motor speed.

<table>
<tr><th>6</th><th>7</th><th>8</th><th>Speed detection range</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>…2%</td></tr>
<tr><td>0</td><td>0</td><td>X</td><td>…10%</td></tr>
<tr><td>0</td><td>X</td><td>0</td><td>…18%</td></tr>
<tr><td>0</td><td>X</td><td>X</td><td>…26%</td></tr>
<tr><td>X</td><td>0</td><td>0</td><td>…34%</td></tr>
<tr><td>X</td><td>0</td><td>X</td><td>…42%</td></tr>
<tr><td>X</td><td>X</td><td>0</td><td>…50%</td></tr>
<tr><td>X</td><td>X</td><td>X</td><td>…58%</td></tr>
</table>
Note: Maximum speed is 100%.</td></tr>
<tr><td>SW6-1</td><td>Normal/test</td><td>1
0 …Normal mode
X …Test mode

Normal mode is used for normal operation.

Test position is used for orient tests.</td></tr>
<tr><td>-2</td><td>Closed/open</td><td>2
0 …Closed loop
X …Open loop

Used for switching between open/closed speed loop.

Used with closed loop for normal operation.

Speed detector go/no go is identified by comparison of open and closed operation states.</td></tr>
<tr><td>SW6-3</td><td>Binary/BCD</td><td>3
0 …Speed command binary
X …Speed command BCD

Used to select digital speed command format.

Speed command is read as binary 12-bit input for binary and as BCD 2-digit input for BCD.</td></tr>
<tr><td>-4</td><td>Speed input emitter/ collector</td><td>4
0 …Speed input open emitter
X …Speed input open collector

First refer to the I01 card pin 2 and 3 settings on page 49 and then set.</td></tr>
<tr><td>-5</td><td>Position input emit-</td><td>5
0 …Position input open emitter
X …Position input open collector</td></tr>
</table>

	ter/collector	First refer to IO1 card pin 12 and 13 settings on page 46 and then set.
-6	Meter calibration	6 O ··· Meter OFF X ··· Meter ON Used to calibrate speed meter and load meter full scale. In ON mode, the meter full scale voltage is output and so adjust speed meter (VR14-SE-IO1 card) and load meter (VR-15-SE-IO1 card) VRs.
SW6-7	Maximum speed	7 O — Maximum speed LOW X — Maximum speed HIGH Used to select 3450/4600, 4500/6000, 6000/10000 rpm speed. Set to HIGH for 8000 rpm specifications.
-8	Zero speed	8 O — Zero speed LOW (25 rpm) X — Zero speed HIGH (50 rpm) Zero speed is output at zero speed setting or below.
SW7-1	Magnetic sensor orient in-position range	1 O — Magnetic sensor in-position range LOW (1 deg.) X — Magnetic sensor in-position range HIGH (5 deg.)
-2	External emergency stop	2 O — LED ON with emergency stop X — LED OFF with emergency stop Used to select mode with alarm display or mode without alarm display in external emergency stop.

SW7-3	Load meter output	3 O — Load meter output HIGH (10V) X — Load meter output LOW (3V) Used to select output voltage with 120% output.
-4	Base speed	4 O — 1150 rpm base speed X — 1500 rpm base speed Used to select base speed of applicable motor
SW7-5 ~8	Motor type	

1150 rpm base speed

5	6	7	8	— Capacity	Top speed
O	O	O	O	··· Spare	Spare
O	O	O	×	··· 2.2/3.7kW	3450/4600 rpm
O	O	×	O	··· 3.7/5.5	〃
O	O	×	×	··· 5.5/7.5	〃
O	×	O	O	··· 7.5/11	〃
O	×	O	×	··· 11/15	〃
O	×	×	O	··· 15/18.5	〃
O	×	×	×	··· 18.5/22	〃
×	O	O	O	··· Spare	Spare
×	O	O	×	··· Spare	Spare
×	O	×	O	··· 2.2/3.7	8000
×	O	×	×	··· 3.7/5.5	〃
×	×	O	O	··· 5.5/7.5	6000
×	×	O	×	··· 7.5/11	〃
×	×	×	O	··· 11/15	〃
×	×	×	×	··· Spare	Spare

1500 rpm base speed

5	6	7	8		
O	O	O	O	··· Spare	Spare
O	O	O	×	··· 2.2/3.7kW	4500/5000
O	O	×	O	··· 3.7/5.5	〃
O	O	×	×	··· 5.5/7.5	〃
O	×	O	O	··· 7.5/11	〃
O	×	O	×	··· 11/15	〃
O	×	×	O	··· 15/18.5	〃
O	×	×	×	··· 18.5/22	〃
×	O	O	O	··· Spare	Spare
×	O	O	×	··· Spare	Spare
×	O	×	O	··· 3.7/5.5	8000
×	O	×	×	··· 5.5/7.5	〃
×	×	O	O	··· 7.5/9	〃
×	×	O	×	··· 2.2/3.7	6000/10000
×	×	×	O	··· 2.2/3.7/5.5	〃
×	×	×	×	··· 5.5/7.5	〃

Used to select applicable motor in combination with maximum speed selection (SW6-7) and base speed selection (SW7-4).

<table>
<tr><td>SW11-
1,2</td><td>Orient rotation direction</td><td>
<table>
<tr><th>1</th><th>2</th><th></th></tr>
<tr><td>0</td><td>0</td><td>··· Pre mode Orient from previous motor rotation direction</td></tr>
<tr><td>0</td><td>X</td><td>··· Reverse mode Motor reverse rotation direction orient</td></tr>
<tr><td>X</td><td>0</td><td>··· Forward mode Motor forward rotation direction orient</td></tr>
<tr><td>X</td><td>X</td><td>··· Forward mode Motor forward rotation direction orient</td></tr>
</table>
</td></tr>
<tr><td>-3,4</td><td>Control with orient stop</td><td>
<table>
<tr><th>3</th><th>4</th><th></th></tr>
<tr><td>0</td><td>0</td><td>··· PI control</td></tr>
<tr><td>0</td><td>X</td><td>··· Delay/advance control W_T = 1.17 rad/sec</td></tr>
<tr><td>X</td><td>0</td><td>" = 0.78 rad/sec</td></tr>
<tr><td>X</td><td>X</td><td>" = 0.39 rad/sec</td></tr>
</table>
Enables delay/advance control when servo rigidity is to be increased with orient stop.
</td></tr>
</table>

List of rotary switches

SW8 — Speed control loop Proportional gain ... Kp

Notch	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮
Magnification	8/32	11/32	14/32	17/32	20/32	23/32	26/32	29/32	1	1.2	1.4	1.6	1.8	2	2.2	2.4
ω_c	25	34	44	53	63	72	81	91	100	120	140	160	180	200	220	240

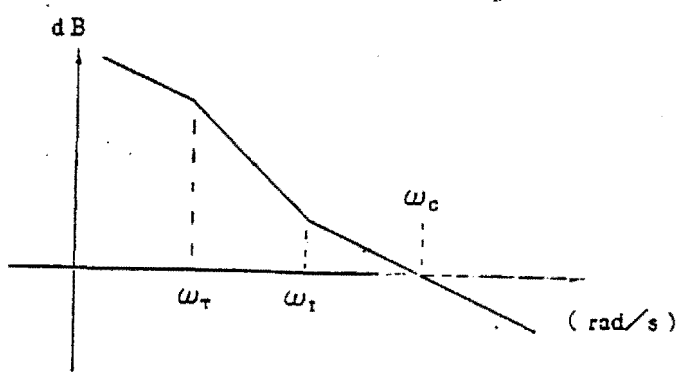
(rad/s)

SW9 — Speed control loop Integral gain ... Ki

Notch	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮
Magnification	8/32	11/32	14/32	17/32	20/32	23/32	26/32	29/32	1	1.2	1.4	1.6	1.8	2	2.2	2.4
ω_I	1.5	2.1	2.6	3.2	3.8	4.3	4.9	5.4	6.0	7.2	8.4	9.6	10.8	12.0	13.2	14.4

(rad/s)

Used to determine loop transfer function of speed control loop in combination with SW11-3,4 mode selection.



Note: The following condition must be met: $\omega_\tau > \omega_I > \omega_c$

Standard settings: notch 8 for both SW8 and SW9.

SW10	Orient speed setting	Notch	
		0	20
		1	40
		2	60
		3	80
		4	100
		5	120
		6	140
		7	160
		8	180
		9	200
		A	220
		B	240
		C	260
		D	280
		E	300
		F	320

Used to set orient speed with encoder orient.
Speeds on left are spindle speeds.
Motor speed depends on gear ratio.
Orient speed should be reduced with switch when load GD^2 is high and there is tendency to over shoot during orient.

List of snap switches

No.	Name	Description
ST1	Reset	Used for initialization of inverter operations. Must not be used while motor is operating. The ST1 switch must be pressed with DIP switch resetting. When reset during motor operation, motor free-runs and then stops.
ST2	Orient test	Motor operates at motor orient speed while this switch is ON. When OFF, orient is performed once and then motor stops.

List of variable resistors

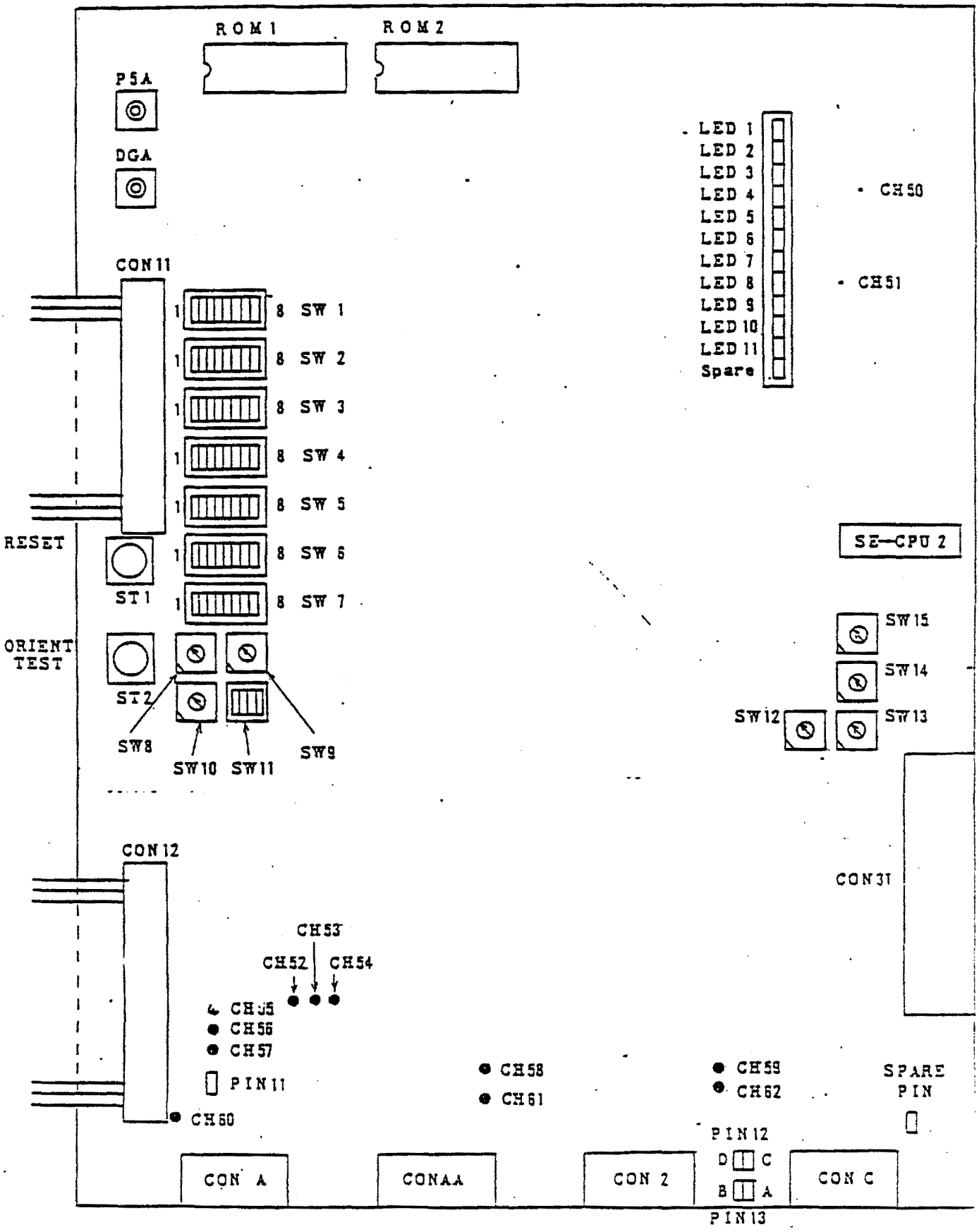
VR	Name	Description
VR1	Position shift	Enables fine adjustment of stop point.
VR2	Magnetic sensor sensitivity	Adjusted so that magnetic sensor sensitivity LED 11 lights.

List of check pins

No.	Description
P5A	+5
DGA	+0V (digital ground)
CH50	Speed feedback, phase A, square wave
CH51	-15V
CH52	+15V
CH53	Magnetic sensor output
CH54	+0V (analog ground)
CH55	+15V
CH56	A/D converter input
CH57	Speed feedback, phase B, sinusoidal wave
CH58	Speed feedback, phase $\overline{B}$, sinusoidal wave
CH59	Speed feedback, phase $\overline{A}$, sinusoidal wave
CH60	Speed feedback, phase A, sinusoidal wave
CH61	Speed feedback, phase B, square wave
CH62	+24V

5.2 SE-CPU2 CARD

This card is used when the 1024 p x 4/rev encoder type of multi point orient function is provided.



(1) List of LEDs

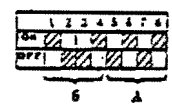
LED	Name	Application	Description
LED1	PHASE SEQUENCE	Power supply phase identification	Lights when power supply phase rotation is positive. OFF when power supply phase rotation is negative.
LED2	READY	Ready	Lights when controller is ready to operate; OFF when SET1-SET2 inputs are OFF or when alarm occurs.
LED3	CW DRIVE	Motor forward (CW) rotation command	Lights when forward rotation command is input; also lights with orient stop.
LED4	CCW DRIVE	Motor reverse (CCW) rotation command	Lights when reverse rotation command is input.
LED5	SPEED DETECTION	Speed detection	Lights when motor speed falls below DIP switch setting.
LED6	CURRENT DETECTION	Current detection	Lights when a current equivalent to 110% of rated current flows to motor.
LED7	UP TO SPEED	Speed arrival	Lights when actual motor speed is +/-15% of command speed.
LED8	APPROACH	Approach	Lights during period from 1st to 2nd deceleration point.
LED9	IN-POSITION	In-position	Lights with orient stop within range of pulse number set by rotary switch.

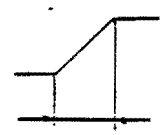
LED10	ZERO SPEED	Zero speed	Lights when speed is below zero speed set by DIP switch.
LED11	———	———	Not used
LED12	———	———	Not used.

List of DIP switches

Note 1: "O" denotes DIP switch ON setting.

"X" denotes DIP switch OFF setting

Switch	Name	Description
SW1	Gear ratio (H range)	Used to set gear ratio. $\text{Gear ratio} = \frac{\text{Maximum spindle speed}}{\text{Maximum motor speed}} \times 80^{H}$ Setting example: When max. spindle speed is 5000 rpm with a maximum H gear motor speed of 6000 rpm Hexa-decimal Gear ratio = 5000/6000 x 128 ≒ 106D = $6A^{H}$ SW1 all switches ON .. Gear ratio = 80^{H} SW2 all switches ON .. Gear ratio = 40^{H} SW3 all switches ON .. Gear ratio = 20^{H} 
SW2	Gear ratio (M range)	
SW3	Gear ratio (L range)	
SW4-1	Creep speed	Used to set creep speed with orientation. 1 — Creep speed 0 ···· 20 rpm X ···· 30 rpm
SW4-2 ~4	2nd position loop gain	Used to set position of 2nd deceleration point. 2 3 4 0 0 0 ---25 deg. 0 0 X ---24 deg. 0 X 0 ---23 deg. 0 X X ---21 deg. X 0 0 ---20 deg. X 0 X ---18 deg. X X 0 ---17 deg. X X X ---15 deg.
SW4-5 ~7	1st position loop gain	Used to set position of 1st deceleration point.

		5 6 7 — 0 0 0 ··· 225 deg. 0 0 X ··· 214 deg. 0 X 0 ··· 203 deg. 0 X X ··· 191 deg. X 0 0 ··· 180 deg. X 0 X ··· 169 deg. X X 0 ··· 158 deg. X X X ··· 146 deg.
SW4-8	Magnetic sensor mounting direction	8 0 ··Forward X ··Reverse Set to reverse position if high degree of hunting occurs with orient stop.
SW5-1,2	Torque limit	Used when limiting motor torque. 1 2 — Torque limit External input TL1--ON TL2--OFF: 0 0 ··· 10% 0 X ··· 15% X 0 ··· 20% X X ··· 25% TL1--OFF TL2--ON: 0 0 ··· 20% 0 X ··· 30% X 0 ··· 40% X X ··· 50% Note: 30-minute rated torque is 100%.
SW5-3 ~5	Cushion time constant	Used to set time constant of maximum speed command from 0. 3 4 5 — Cushion time constant 0 0 0 ··· 0.3 s —— Standard setting 0 0 X ··· 1.5 s 0 X 0 ··· 3 s 0 X X ··· 4 s X 0 0 ··· 5 s X 0 X ··· 6 s X X 0 ··· 8 s X X X ··· 10 s Speed command  Cushion time constant

<table>
<tr><td>SW5-6
~8</td><td>Speed detection range</td><td>Output transistors are activated when speed falls below set motor speed.
<table><tr><td>6</td><td>7</td><td>8</td><td>··· Speed detection range</td></tr><tr><td>0</td><td>0</td><td>0</td><td>··· 2%</td></tr><tr><td>0</td><td>0</td><td>X</td><td>··· 10%</td></tr><tr><td>0</td><td>X</td><td>0</td><td>··· 18%</td></tr><tr><td>0</td><td>X</td><td>X</td><td>··· 26%</td></tr><tr><td>X</td><td>0</td><td>0</td><td>··· 34%</td></tr><tr><td>X</td><td>0</td><td>X</td><td>··· 42%</td></tr><tr><td>X</td><td>X</td><td>0</td><td>··· 50%</td></tr><tr><td>X</td><td>X</td><td>X</td><td>··· 58%</td></tr></table>Note: Maximum speed is 100%.</td></tr>
<tr><td>SW6-1</td><td>Normal/test</td><td>1
0 ··· Normal mode
X ··· Test mode
Normal mode is used for normal operation.
Test position is used for orient tests.</td></tr>
<tr><td>-2</td><td>Closed/open</td><td>2
0 ··· Closed loop
X ··· Open loop
Used for switching between open/closed speed loop.
Used with closed loop for normal operation.
Speed detector go/no go is identified by comparison of open and closed operation states.</td></tr>
<tr><td>SW6-3</td><td>Binary/BCD</td><td>3
0 ··· Speed command binary
X ··· Speed command BCD
Used to select digital speed command format.
Speed command is read as binary 12-bit input for binary and as BCD 2-digit input for BCD.</td></tr>
<tr><td>-4</td><td>Speed input emitter/ collector</td><td>4
0 ··· Speed input open emitter
X ··· Speed input open collector
First refer to the IO1 card pin 2 and 3 settings on page 49 and then set.</td></tr>
<tr><td>-5</td><td>Position input emit-</td><td>5
0 ··· Position input open emitter
X ··· Position input open collector</td></tr>
</table>

	ter/collector	First refer to IO1 card pin 12 and 13 settings on page 46 and then set.
-6	Meter calibration	6 O ··· Meter OFF X ··· Meter ON Used to calibrate speed meter and load meter full scale. In ON mode, the meter full scale voltage is output and so adjust speed meter (VR14-SE-IO1 card) and load meter (VR-15-SE-IO1 card) VRs.
SW6-7	Maximum speed	7 O ··· Maximum speed LOW X ··· Maximum speed HIGH Used to select 3450/4600, 4500/6000, 6000/10000 rpm speed. Set to HIGH for 8000 rpm specifications.
-8	Zero speed	8 O ··· Zero speed LOW (25 rpm) X ··· Zero speed HIGH (50 rpm) Zero speed is output at zero speed setting or below.
SW7-1	Magnetic sensor orient in-position range	1 O ··· Magnetic sensor in-position range LOW (1 deg.) X ··· Magnetic sensor in-position range HIGH (5 deg.)
-2	External emergency stop	2 O ··· LED ON with emergency stop X ··· LED OFF with emergency stop Used to select mode with alarm display or mode without alarm display in external emergency stop.

SW7-3	Load meter output	3 0 ··· Load meter output HIGH (10V) X ··· Load meter output LOW (3V) Used to select output voltage with 12% output.
-4	Base speed	4 0 ··· 1150 rpm base speed X ··· 1500 rpm base speed Used to select base speed of applicable motor
SW7-5 ~8	Motor type	

1150 rpm base speed

5	6	7	8	Capacity	Top speed
○	○	○	○	Spare	Spare
○	○	○	×	2.2/3.7kW	3450/4600 rpm
○	○	×	○	3.7/5.5	〃
○	○	×	×	5.5/7.5	〃
○	×	○	○	7.5/11	〃
○	×	○	×	11/15	〃
○	×	×	○	15/18.5	〃
○	×	×	×	18.5/22	〃
×	○	○	○	Spare	Spare
×	○	○	×	Spare	Spare
×	○	×	○	2.2/3.7	8000
×	○	×	×	3.7/5.5	〃
×	×	○	○	5.5/7.5	6000
×	×	○	×	7.5/11	〃
×	×	×	○	11/15	〃
×	×	×	×	Spare	Spare

1500 rpm base speed

5	6	7	8		
○	○	○	○	Spare	Spare
○	○	○	×	2.2/3.7kW	4500/6000 rpm
○	○	×	○	3.7/5.5	〃
○	○	×	×	5.5/7.5	〃
○	×	○	○	7.5/11	〃
○	×	○	×	11/15	〃
○	×	×	○	15/18.5	〃
○	×	×	×	18.5/22	〃
×	○	○	○	Spare	Spare
×	○	○	×	Spare	Spare
×	○	×	○	3.7/5.5	8000
×	○	×	×	5.5/7.5	〃
×	×	○	○	7.5/9	〃
×	×	○	×	2.2/3.7	6000/10000
×	×	×	○	2.2/3.7/5.5	〃
×	×	×	×	5.5/7.5	〃

Used to select applicable motor in combination with maximum speed selection (SW6-7) and base speed selection (SW7-4).

SW11-1,2	Orient rotation direction	1 / 2	
		0 / 0	···Pre mode Orient from previous motor rotation direction
		0 / X	···Reverse mode Motor reverse rotation direction orient
		X / 0	···Forward mode Motor forward rotation direction orient
		X / X	···Forward mode Motor forward rotation direction orient
-3,4	Control with orient stop	3 / 4	
		0 / 0	···PI control
		0 / X	···Delay/advance control W_T = 1.17 rad/sec
		X / 0	" = 0.78 rad/sec
		X / X	" = 0.39 rad/sec
		Enables delay/advance control when servo rigidity is to be increased with orient stop.	

List of rotary switches

SW8 — Speed control loop Proportional gain ... Kp

Notch	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	Ⓕ
Magnification	8/32	11/32	14/32	17/32	20/32	23/32	26/32	29/32	1	1.2	1.4	1.6	1.8	2	2.2	2.4
ω_c	25	34	44	53	63	72	81	91	100	120	140	160	180	200	220	240

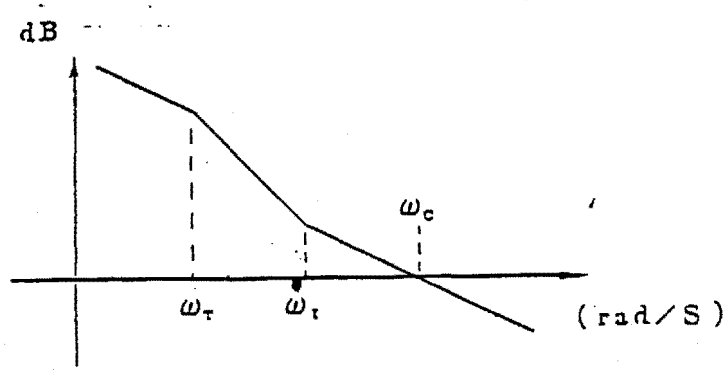
(rad/S)

SW9 — Speed control loop Integral gain ... Ki

Notch	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	Ⓕ
Magnification	8/32	11/32	14/32	17/32	20/32	23/32	26/32	29/32	1	1.2	1.4	1.6	1.8	2	2.2	2.4
ω_1	1.5	2.1	2.6	3.2	3.8	4.3	4.9	5.4	6.0	7.2	8.4	9.6	10.8	12.0	13.2	14.4

(rad/S)

Used to determine loop transfer function of speed control loop in combination with SW11-3,4 mode selection.



Note: The following condition must be met: $\omega_\tau > \omega_\iota > \omega_c$

Standard settings: notch 8 for both SW8 and SW9.

SW10 — Orient speed setting

Notch	
0	20
1	40
2	60
3	80
4	100
5	120
6	140
7	160
8	180
9	200
A	220
B	240
C	260
D	280
E	300
F	320

Used to set orient speed with encoder orient.

Speeds on left are spindle speeds. Motor speed depends on gear ratio.

Orient speed should be reduced with switch when load GD^2 is high and there is tendency to over shoot during orient.

SW12 — Encoder orient in-position range

Notch	
0	0
1	0.09 deg.
2	0.18 deg.
3	0.26 deg.
4	0.35 deg.
5	0.44 deg.
6	0.53 deg.
7	0.62 deg.
8	0.70 deg.
9	0.79 deg.
A	0.88 deg.
B	0.97 deg.
C	1.06 deg.
D	1.14 deg.
E	1.23 deg.
F	1.32 deg.

Used to set position error range in which orient finish signal is output. Since a single spindle rotation is divided into 4096 parts:

Error range =

$$360 \text{ deg.} \times \frac{\text{set value}}{4096}$$

Standard notch A setting

SW13 / SW14 / SW15 — Orient position shift

SW13 0 - F x 256

SW14 0 - F x 16, 12-bit binary

SW15 0 - F x 1

$$\text{Position shift} = 360 \text{ deg.} \times \frac{\text{set value}}{4096}$$

$$\text{Least increment} = 360 \text{ deg.} \times \frac{1}{4096} = 0.09$$

Set for stopping at regular orient position with encoder mounting.

Position will not shift even when selected during orient stop and so re-orient.

List of snap switches

No.	Name	Description
ST1	Reset	Used for initialization of inverter operations. Must not be used while motor is operating. The ST1 switch must be pressed with DIP switch re-setting. When reset during motor operation, motor free-runs and then stops.
ST2	Orient test	Motor operates at motor orient speed while this switch is ON. When OFF, orient is performed once and then motor stops.

Setting pins

Note: ▨ denotes that pin is inserted.

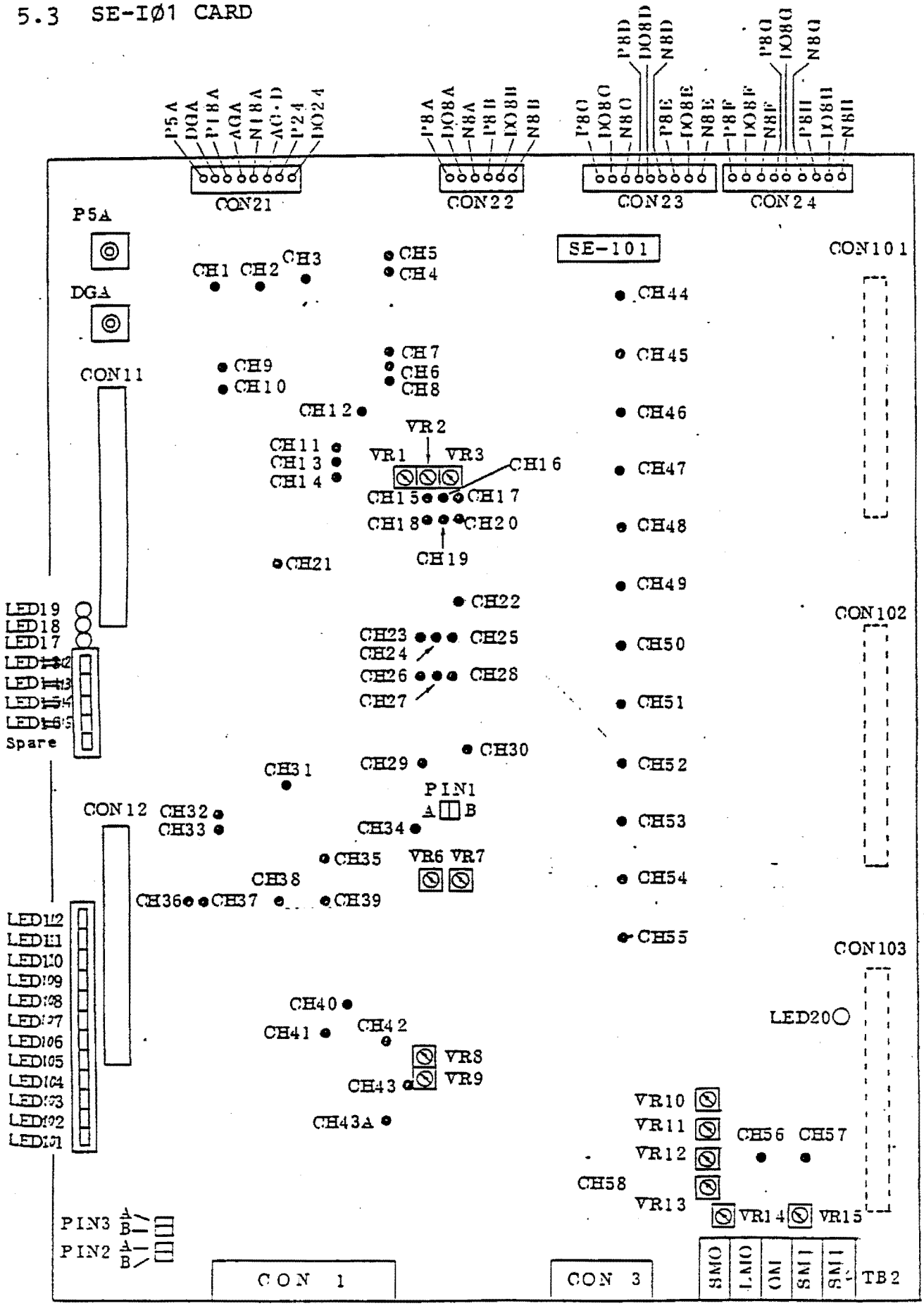
▯ denotes that pin is removed.

<table>
<tr><th>No.</th><th>Name</th><th>Description</th></tr>
<tr><td>PIN 11</td><td>Orient encoder power supply</td><td>
<table>
<tr><td>C1</td><td>Supply from NC Yes</td><td>PIN11 ▯</td><td>SPARE PIN ▨</td></tr>
<tr><td>C2</td><td>Supply from NC No</td><td>PIN11 ▨</td><td>SPARE PIN ▯</td></tr>
</table>
</td></tr>
<tr><td>PIN 12
13</td><td>Orient position command interface setting</td><td>
<table>
<tr><td>B1</td><td>Source drive (open emitter)</td><td>PIN12 D ▯ C</td><td>PIN13 B ▨ A</td></tr>
<tr><td>B2</td><td>Sync drive (open collector)</td><td>PIN12 D ▨ C</td><td>PIN13 B ▯ A</td></tr>
</table>
Refer to pages 27 and 39 and set at the same time as SW-6-5.
</td></tr>
</table>

List of check pins

No.	Description
P5A	+5V
DGA	+0V (digital ground)
CH50	Speed feedback, phase B, square wave
CH51	Speed feedback, phase A, square wave
CH52	Orient position feedback, phase B
CH53	Orient position feedback, phase A
CH54	Orient position feedback, mark pulse
CH54A	A/D input signal
CH55	+15V
CH56	+0V (analog ground)
CH57	-15V
CH58	Speed feedback, phase $\overline{B}$, sinusoidal wave
CH59	Speed feedback, phase A, sinusoidal wave
CH60	+24V
CH61	Speed feedback, phase $\overline{A}$, sinusoidal wave
CH62	Speed feedback, phase B, sinusoidal wave

5.3 SE-IØ1 CARD



List of LEDs

No.	Symbol	Description
LED 13 LED 14 LED 15 LED 16	AL 8 4 2 1	Refer to separate sheet for details on fault code displays.
LED 17		Indicates undervoltage. Lights with voltage drop of less than 170V, more than 15mS.
LED 18		Lights with converter regeneration.
LED 19		Lights with base cut-off of inverter, converter transistors.
LED 20		Lights with converter voltage charging.
LED112 ⋮ LED101		Speed command display X 1 X 2 X 4 ⋮ X 2048 } 12 bits

List of setting pins

No.	Name	Description
PIN 1	Speed setting	Max. speed setting: HH 10000 / 8000 (RPM) — PIN1 A / B — SPARE PIN H 6000 / 4600 (RPM) — PIN1 A / B — SPARE PIN L 4500 / 3450 (RPM) — PIN1 A / B — SPARE PIN
PIN 2 3	Digital speed command interface setting	A1 Source drive (open emitter) — PIN3 A / B — PIN2 C / D A2 Sync drive (open collector) — PIN3 A / B — PIN2 C / D Refer to pages 27 and 39, and set these pins at the same time as SW6-4.

Alarm signals

0: LED OFF, output = High (transistors cut off)

1: LED ON, output = Low (transistors activated)

No.	Output AL8 (LED12)	AL4 (LED13)	AL2 (LED14)	AL1 (LED15)	Alarm-signal significance	Details	Reset method
1	0	0	0	1	Motor overheating	This is detected when the temperature inside the motor has exceeded the prescribed level.	Alarm reset or reset PB after motor has cooled off
2	0	0	1	0	Excessive speed error	This is detected when the motor speed differs greatly from the command value.	After the motor has stopped, eliminate the cause and use alarm reset or reset PB
3	0	0	1	1	(Spare)		
4	0	1	0	0	Breaker trip	This signal is output when an abnormal current flows to the input and the breaker trips.	
5	0	1	0	1	Phase loss	This detects phase loss in the input with resetting and power switch-on.	
6	0	1	1	0	Emergency stop	This indicates that the emergency stop pushbutton on the external control panel is ON.	External emergency stop PB to OFF
7	0	1	1	1	Over speed	This occurs when the motor speed exceeds 115% of its rated speed.	
8	1	0	0	0	Converter overcurrent	This detects an overcurrent in the converter.	
9	1	0	0	1	Controller overheating	Overheating is detected when the temperature of the heat sinks of the semiconductors, etc. is abnormally high.	
10	1	0	1	0	Undervoltage detection	This detects that the input voltage is more than 15ms and less than 170V.	
11	1	0	1	1	Overvoltage detection	This detects that the converter's DC voltage is abnormally high.	
12	1	1	0	0	Inverter overcurrent	This detects an overcurrent in the inverter.	
13	1	1	0	1	CPU fault 1	Microcomputer fault	
14	1	1	1	0	CPU fault 2	〃	
15	1	1	1	1	CPU fault 3	〃	

List of check pins

No.	OV	Description
P5A	DGA	+5V
DGA	DGA	0V (digital ground)
CH1	AGA	+15V
CH2	AGA	0V (analog ground)
CH3	AGA	-15V
CH4	AGA	Phase V, reference sinusoidal wave
CH5	AGA	Phase U, reference sinusoidal wave
CH6	AGA	Phase V, voltage command
CH7	AGA	Phase U, voltage command
CH8	AGA	Phase W, voltage command
CH9	AGA	Current amplitude signal
CH10	AGA	Triangular wave carrier
CH11	DGA	Phase U, PWM waveform
CH13	DGA	Phase V, PWM waveform
CH14	DGA	Phase W, PWM waveform
CH15	DGA	Phase U, base amplifier drive signal
CH16	DGA	Phase V, base amplifier drive signal
CH17	DGA	Phase W, base amplifier drive signal
CH18	DGA	Phase $\overline{U}$, base amplifier drive signal
CH19	DGA	Phase $\overline{V}$, base amplifier drive signal
CH20	DGA	Phase $\overline{W}$, base amplifier drive signal
CH21	DGA	Phase sequence detection, positive sequence: High
CH22	DGA	Base cut-off during regeneration
CH23	DGA	Phase R, base amplifier drive signal
CH24	DGA	Phase T, base amplifier drive signal
CH25	DGA	Phase $\overline{S}$, base amplifier drive signal

CH26	DGA	Phase S, base amplifier drive signal
CH27	DGA	Phase $\overline{R}$, base amplifier drive signal
CH28	DGA	Phase $\overline{T}$, base amplifier drive signal
CH29	AGA	Overcurrent setting level
CH30	AGA	Inverter side, phases U, V, W, full-wave rectification waveforms
CH31	AGA	Override command
CH32	AGA	-10V, reference voltage
CH33	AGA	+10V, reference voltage
CH34	AGA	Speed meter output
CH35	DGA	Regenerative converter, overcurrent level: Low
CH36	DGA	Speed arrival signal
CH37	DGA	Zero speed signal
CH37A	DGA	Orient finish
CH38	DGA	Regenerative side current limiting: high while limiting
CH39	DGA	Regenerative side current limiting
CH40		
CH41	AGA	Analog-speed command input, max. speed at +10V
CH42	AGA	Converter voltage, 10V at 400V
CH43	AGA	Supply voltage, peak rectification
CH43A	AGA	Regenerative side converter current
CH44	Non insulated D08F	Inverter side base amplifier output, phase U
CH45	Non insulated D08G	Inverter side base amplifier output, phase V
CH46	Non insulated D08H	Inverter side base amplifier output, phase W
CH47	Non insulated D08A	Inverter side base amplifier output, phase $\overline{U}$
CH48	Non insulated D08A	Inverter side base amplifier output, phase $\overline{V}$

CH49	Non insulated D08A	Inverter side base amplifier output, phase $\overline{W}$
CH50	Non insulated D08C	Converter side base amplifier output, phase R
CH51	Non insulated D08D	Converter side base amplifier output, phase S
CH52	Non insulated D08E	Converter side base amplifier output, phase T
CH53	Non insulated D08B	Converter side base amplifier output, phase $\overline{R}$
CH54	Non insulated D08B	Converter side base amplifier output, phase $\overline{S}$
CH55	Non insulated D08B	Converter side base amplifier output, phase $\overline{T}$
CH56	AGA	Phase U, inverter side current detection
CH57	AGA	Phase V, inverter side current detection
CH58	AGA	Converter side DC current detection

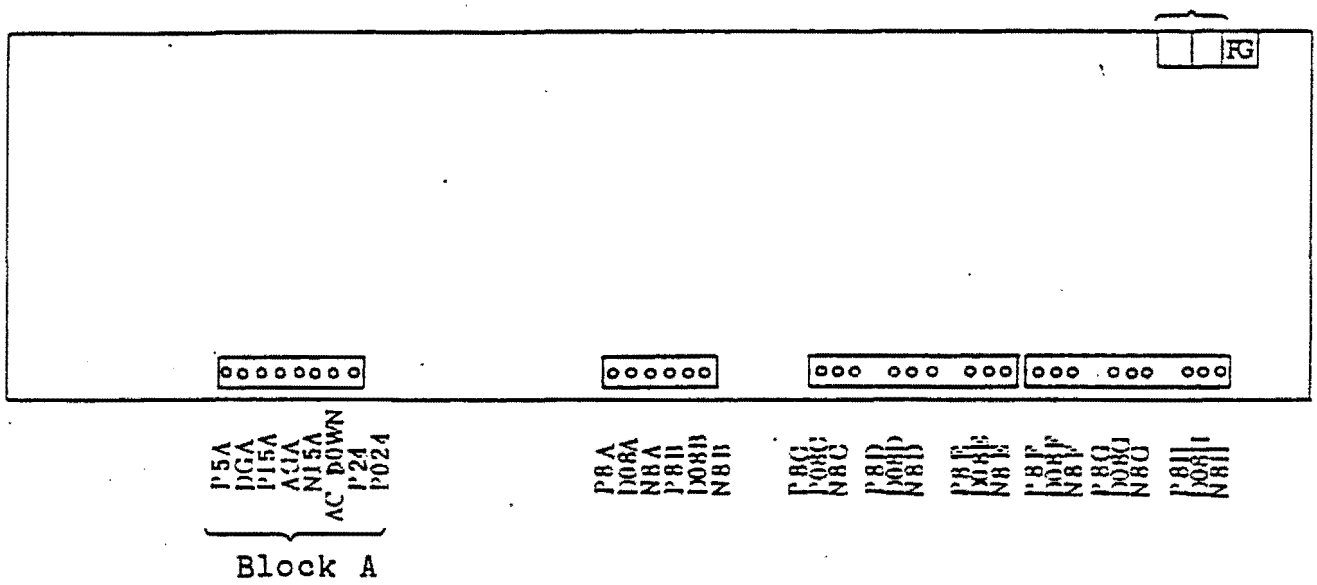
List of VRs

No.	Description
VR1	Phase W, current command zero adjustment
VR2	Phase V, current command zero adjustment
VR3	Phase U, current command zero adjustment
VR5	+/-10V, reference power supply
VR6	High speed setting, over-speed level adjustment, PIN1-A
VR7	Low speed setting, over-speed level adjustment, PIN1-B
VR8	Converter voltage feedback gain adjustment
VR9	Supply voltage peak value gain adjustment
VR10	Regenerative converter current zero adjustment, CH43A
VR11	Converter DC current zero adjustment, CH58
VR12	Inverter side, phase V, current feedback zero adjustment, CH57
VR13	Inverter side, phase U, current feedback zero adjustment, CH56
VR14	Speed meter adjustment
VR15	Load meter adjustment

5.4 SE-PW CARD

This is the power supply card which supplies all the FR-SE DC power.

AC 170-253V input



Notes:

(1) Note that except for block A no insulation is provided with the main circuitry.

(2) Line 0 in block A is connected.

Block	Name	Ground		DC output voltage
A	P5A	DGA	Com-	+5V +/-3%
	P24A	D024	mon	+24V +/-10%
	P18A	AGA	ground	+18V +/-10%
	N18A			-18V +/-10%
B	P8F	D08F		+8V, +15%/-5%
	N8F			-8V, +15%/-5%
C	P8G	D08G		+8V, +15%/-5%
	N8G			-8V, +15%/-5%
D	P8H	D08H		+8V, +15%/-5%
	N8H			-8V, +15%/-5%
E	P8A	D08A		+8V, +15%/-5%
	N8A			-8V, +15%/-5%
F	P8C	D08C		+8V, +15%/-5%
	N8C			-8V, +15%/-5%
G	P8D	D08D		+8V, +15%/-5%
	N8D			-8V, +15%/-5%
H	P8E	D08E		+8V, +15%/-5%
	N8E			-8V, +15%/-5%
I	P8B	D08B		+8V, +15%/-5%
	N8B			-8V, +15%/-5%
J	AC DOWN signal			

CHAPTER 6 ORIENT POSITION DETECTOR MOUNTING PROCEDURE

6.1 MAGNETIC SENSOR TYPE OF SINGLE POINT ORIENT

(SE-CPU1 card is used)

1.1 MAGNET AND SENSOR OPERATION

Depending on the position relationship with the magnet, the sensor generates two kinds of voltages (see Fig. 6.1).

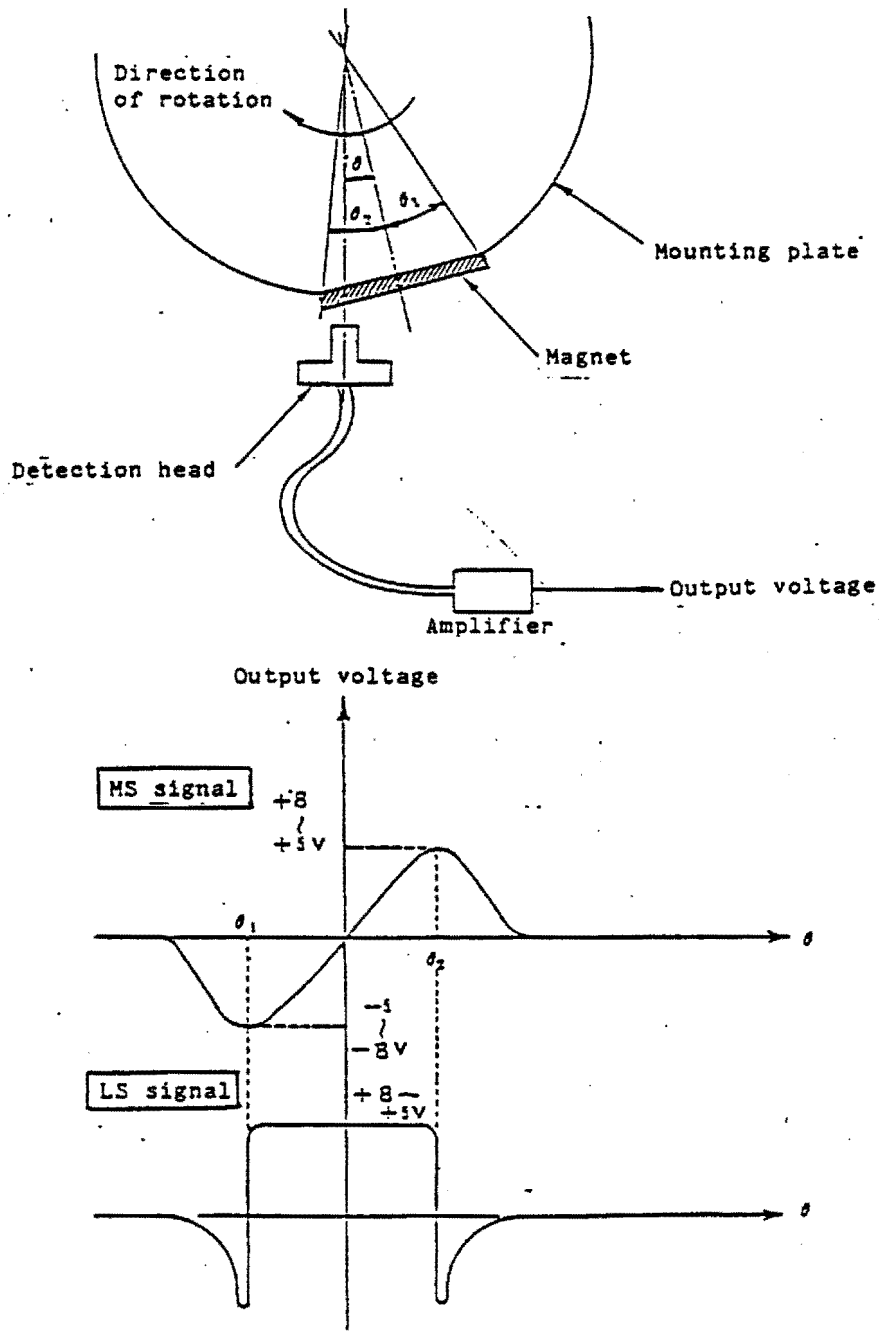


Fig. 6.1 Sensor output voltages

MS signal

This is characterized by the fact that its output voltage is 0V at the center position of the magnet and that it reaches a peak at both ends of the magnet. It is controlled so that the 0V voltage position is always the home position.

LS signal

This is characterized by the fact that it is a constant voltage within the area of the magnet. It is employed for checking that stopping has without fail occurred within the magnet area.

1.2 TIME CHART

Fig. 6.2 is a time chart of the various signals.

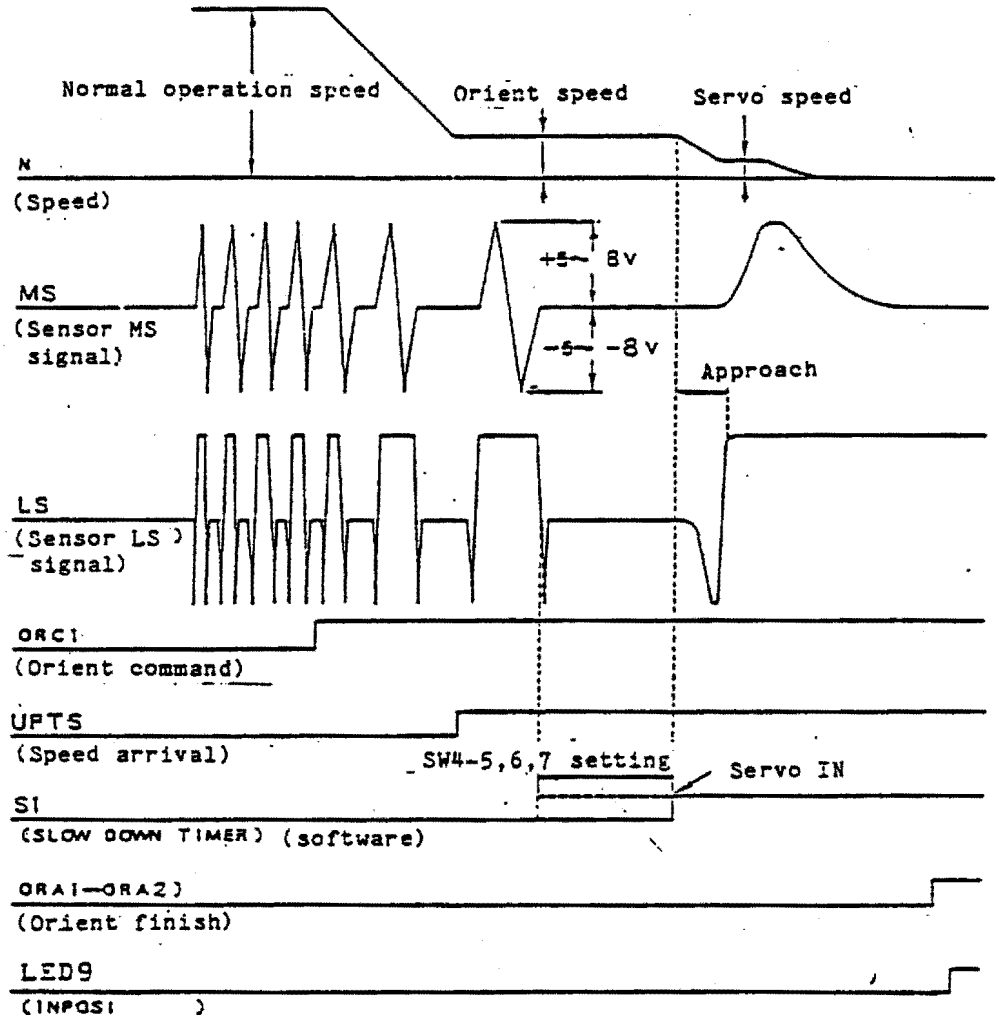


Fig. 6.2 Time chart

(1) When the ORCI (orient signal) is set ON, the motor speed is switched over from the normal operation speed to the orient speed.

(2) When the motor speed arrives at the orient speed, the speed arrival signal rises.

(3) After the speed arrival signal has risen, the software slowdown timer starts operating at the timing (at the very time the magnet passes in front of the sensor) during which the sensor LS signal falls.

(4) The slowdown timer is set by SW4-5,6,7. When the timer counts up, the orient speed loop is switched to the position servo loop (servo IN).

(5) The sensor MS signal stops at the 0V position due to the position loop control.

(6) The orient finish signal rises at the target position and ORA1-ORA2 (orient finish contact signal outputs) are set to closed.

1.3 MAGNET AND DETECTION HEAD MOUNTING DIRECTIONS

The mounting directions for the magnet and detection head are specified as shown in Figs. 6.3, 4 and 5.

(1) Mount so that the index hole in the center of the magnet an the key slot on the detection head are positioned on the same side.

(2) Mount the index hole on the right side (on the opposite sid to that of the tool) when the spindle tool is on the left side.

Case 1 Mounting the magnet onto the circumference of a rotating body

As shown in Fig. 6.3, mount so that the key slot and index hole point to the non-load side of the spindle.

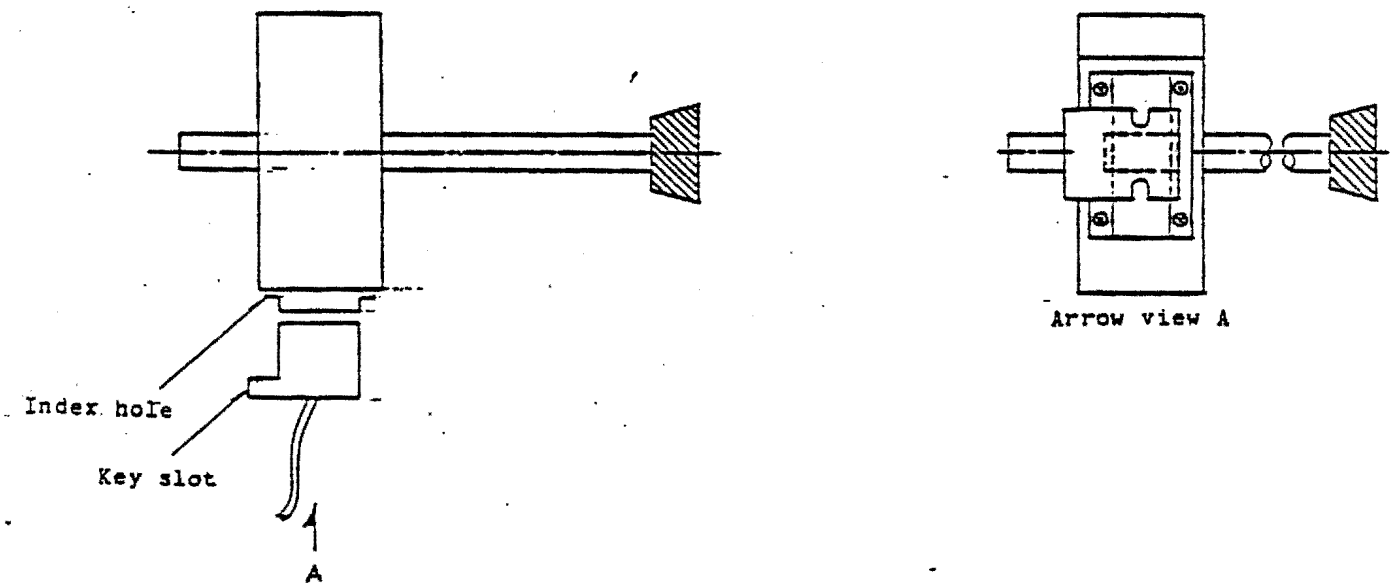


Fig. 6.3 Mounting onto the circumference of a rotating body

Case 2 Mounting the magnet onto the flat surface of a rotating body

(1) When the mounting surface is on the non-load side of the spindle, mount so that the index hole and key groove are pointing toward the center side, as shown in Fig. 6.4.

(2) When the mounting surface is on the spindle load side, mount so that the index hole and key groove are on the circumference side, as ahown in Fig. 6.5.

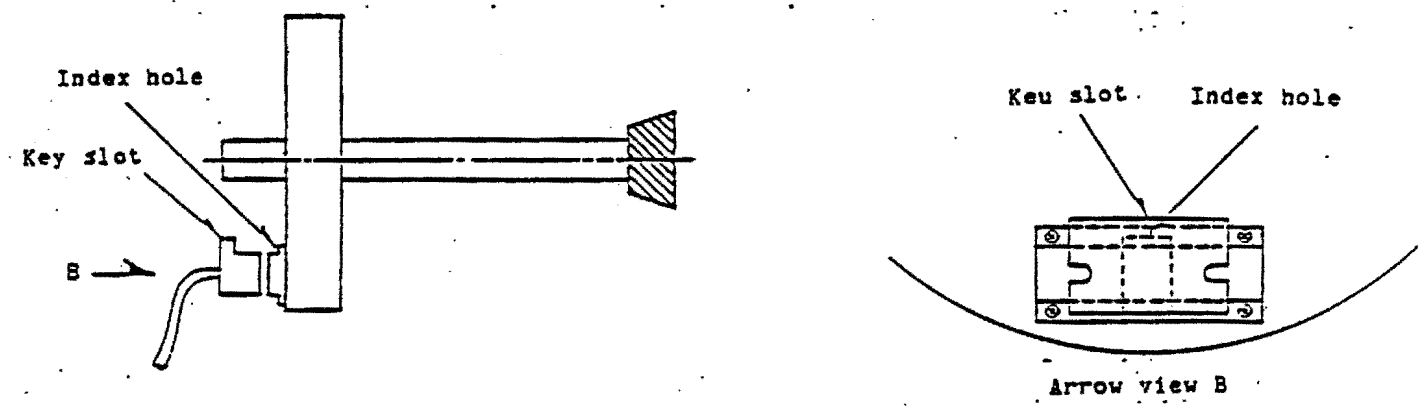


Fig. 6.4 Mounting onto a flat surface on the non-load side of the rotating body

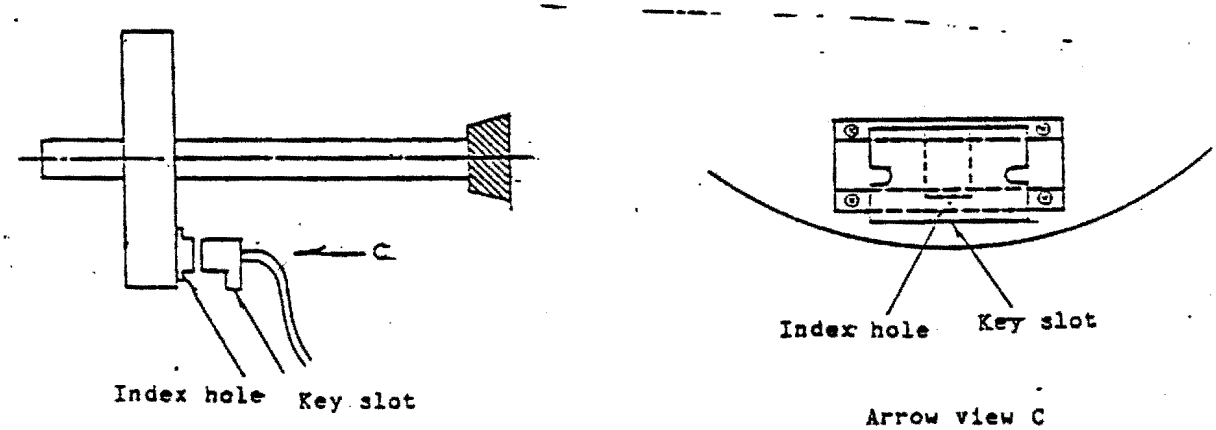


Fig. 6.5 Mounting onto a flat surface on the load side of the rotating body

Notes

(1) Orientation will remain normal even if the magnet and detector are mounted, as shown in Fig. 6.6, in the opposite way to that shown in Figs. 6.3, 4 and 5.

(2) Unless the directions in which the magnet and detector point tally, as shown in Fig. 6.7, a high level of vibration results at both ends of the magnet and orientation is disabled.

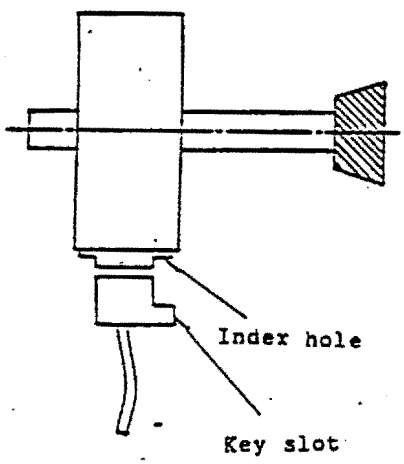


Fig. 6.6

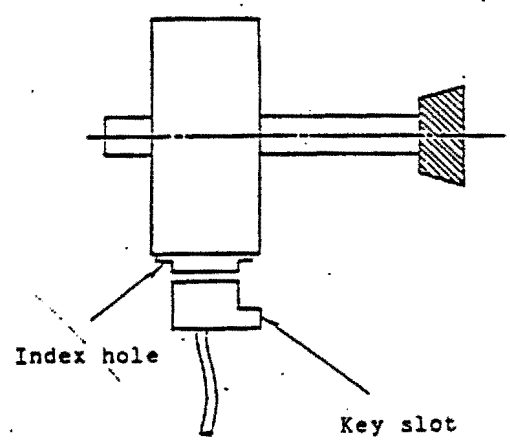


Fig. 6.7

1.4 CHECKPOINTS WHEN MOUNTING MAGNET

Bear in mind the following points when mounting the magnet onto the spindle.

(1) Do not bring strong magnetic objects near the magnet.

(2) Take care not to subject the magnet to shocks.

(3) Use M4 screws to secure the magnet rigidly to the spindle.

(4) Provide the rotational balance of the whole spindle with the magnet mounted.

(5) Bring the index hole in the center of the magnet to the center of the mounting disc and align its direction with that shown in Figs. 6.3, 4 and 5.

(6) Make sure that the surroundings are clean so that metal chips and dust do not adhere to the magnet and thereby cause errors.

(7) Paint over the mounting screws to lock them in position so as to avoid any looseness.

(8) When the magnet is to be mounted onto a polished disc, the disc may have become magnetized. Steps should therefore be taken to demagnetize it.

(9) The diameter of the disc onto which the magnet is mounted should be not less than 80 mm and not more than 120 mm. It may be larger if the spindle speed is low.

(10) When the spindle onto which the magnet is mounted rotates a a speed higher than 6,000 rpm, the magnet must be replaced with a high-speed version (which can be used up to 10,000 rpm).

1.5 CHECKPOINTS WHEN MOUNTING SENSOR

Bear in mind the following points when mounting the sensor.

(1) Ensure that the key slot on the detection head and the index hole in the magnet are pointing in the same direction.

(2) Mount the sensor so that the center line on the end of the head and the center of the magnet are aligned (see Figs. 6-3, 4 and 5).

(3) Refer to Table 1 for the size of the gap between the magnet and detector when the mounting method in Fig. 6.3 is adopted. Refer to Table 2 when the methods in Fig. 6.4 or 6.5 is employed.

* It is recommended that jigs be made for mass production.

(4) Although the pre-amplifier connector is oil-proof, it should be mounted where the chances for oil to come into contact with it are minimal.

(5) Lay the cable to the controller from the pre-amplifier at a distance from the power supply circuitry wires so that it is isolated from them.

(6) First check the connector connections and ensure that the connectors have been inserted properly into the receptacles, and then tighten up their lock screws.

Table 1

	Sony product		Makome product	
Radius (mm)	Max. gap (mm)	Min. gap (mm)	Max. gap (mm)	Min. gap (mm)
40	11.5 +/-0.5	2.7 +/-0.5		
50	9.5 +/-0.5	2.8 +/-0.5	8 +/-0.5	1.31 +/-0.5
60	8.5 +/-0.5	3.0 +/-0.5	7 +/-0.5	1.5 +/-0.5
70			7 +/-0.5	2.38 +/-0.5

Table 2

	Sony product	Makome product
Radius (mm)	Gap (mm)	Gap (mm)
40	6 +/-0.5	5 +/-0.5
50	"	"
60	"	"

Fig. 6.8 Mounting the detector

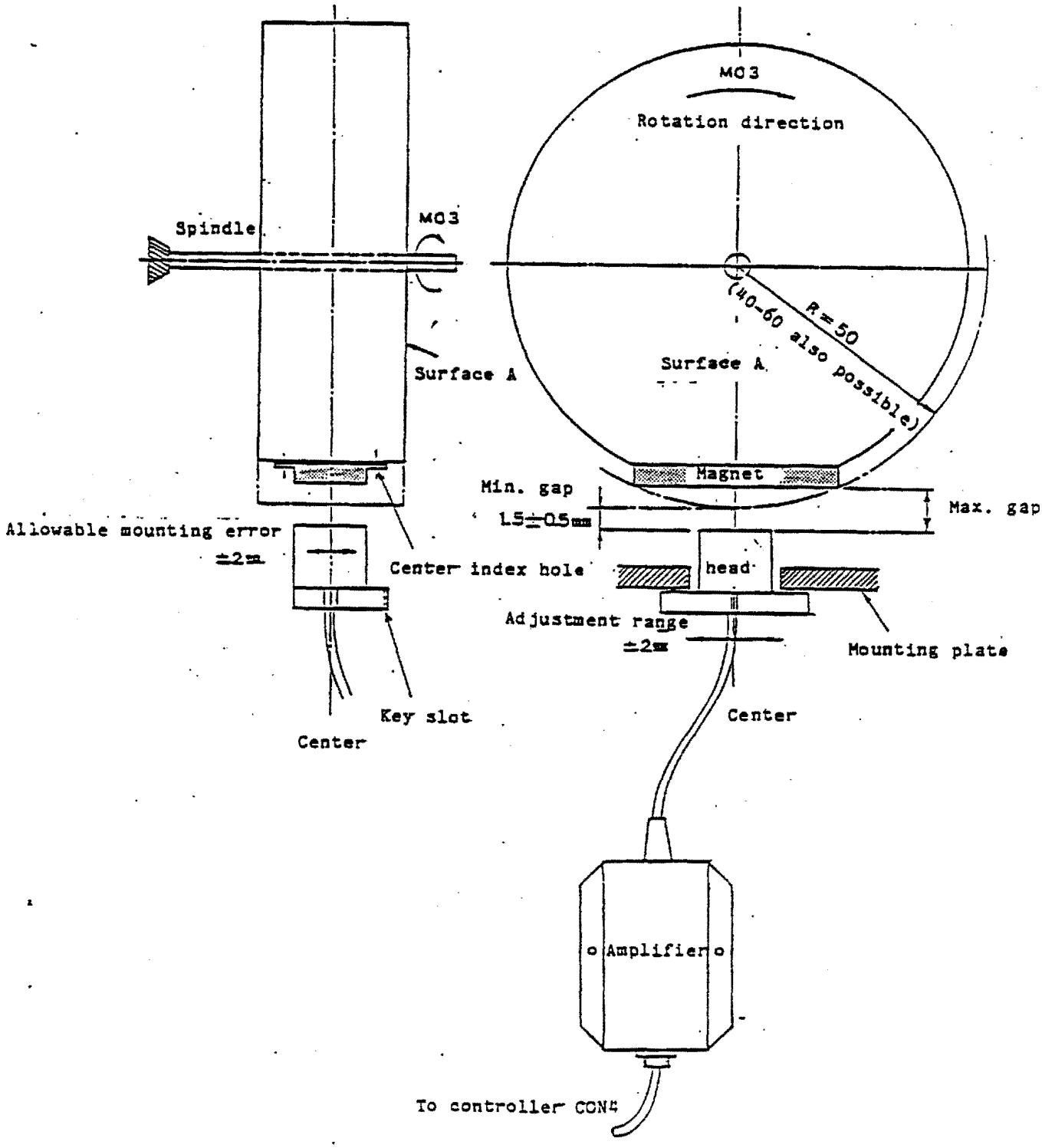
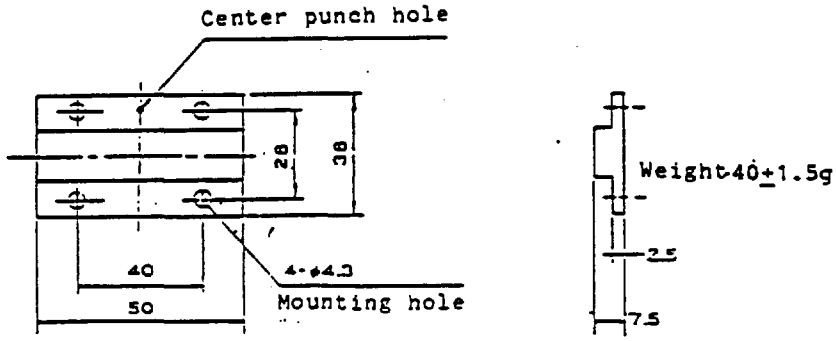


Fig. 6.8 Mounting the detector

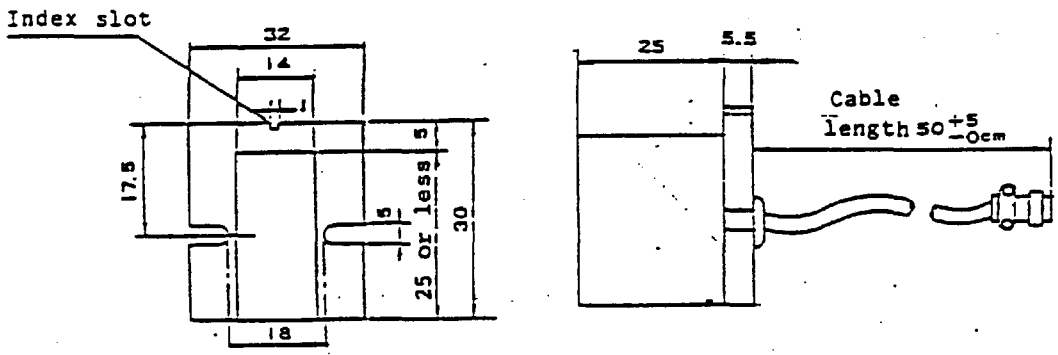
1.6 EXTERNAL VIEWS

3.1 Magnetic sensor

(1) Magnet



(2) Detection head



(3) Amplifier

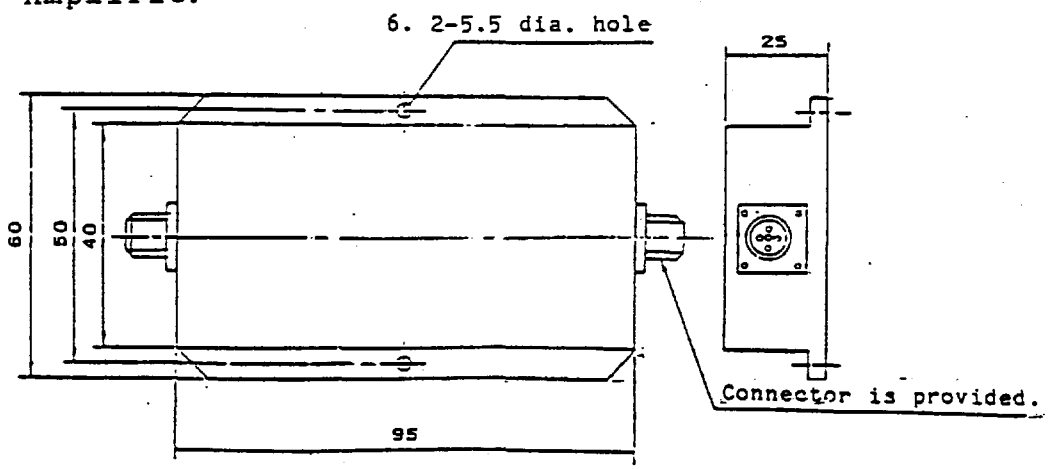


Fig. 6.9

6.2 ENCODER TYPE OF MULTIPLE POINT ORIENT

2.1 DESCRIPTION OF OPERATION

Operation is shown below in the form of a time chart.

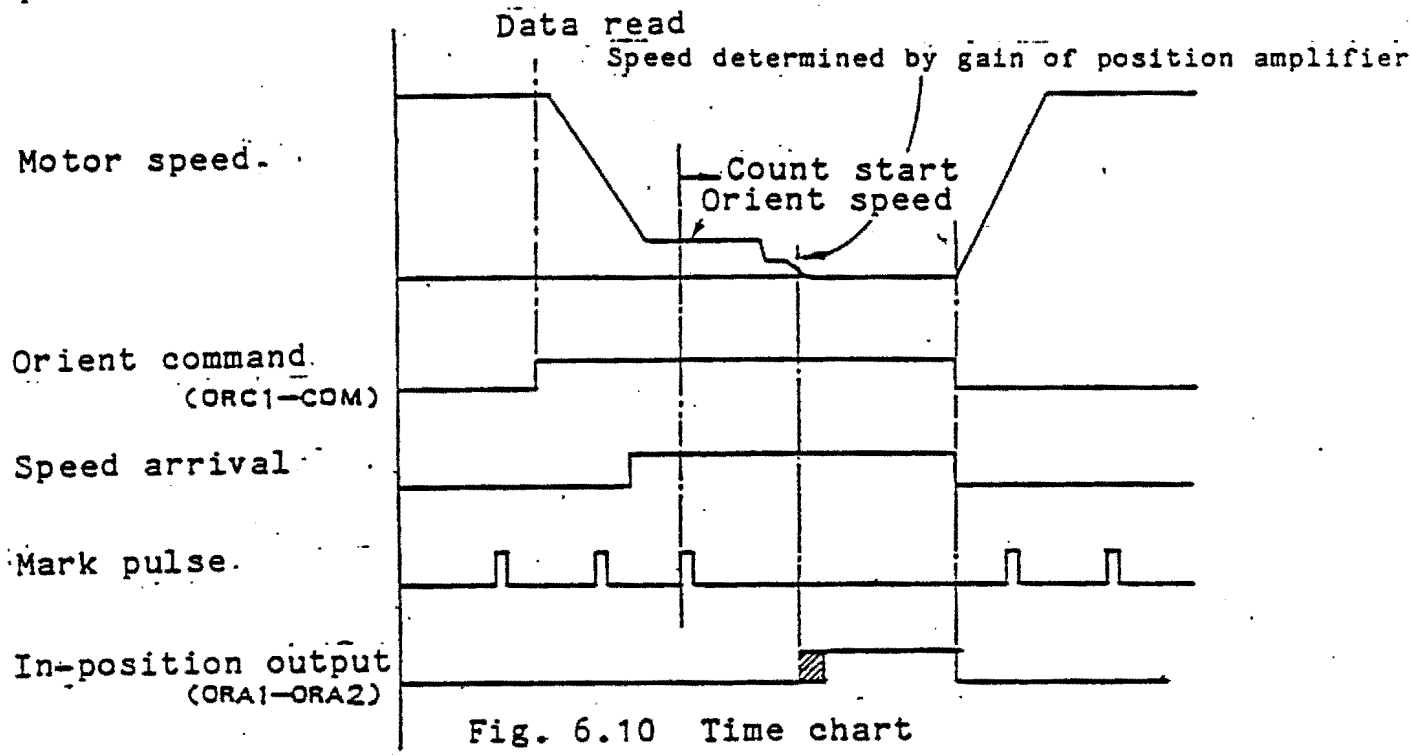


Fig. 6.10 Time chart

(1) The orient position is read in with the orient command and the motor speed is switched to the orient speed.

(2) When the motor speed arrives at the orient speed, the speed arrival signal, which is detected by the comparator, rises.

(3) After the speed arrival signal has risen, the orient position count given in 12-bit binary code from the external source starts when the mark pulse is input. The motor speed remains at the orient speed at this time.

(4) The control loop is switched from the speed loop to the position loop when the value set with SW4 5, 6 and 7 is reached from the target point. The motor speed is further switched from the orient speed to a speed determined by the gain of the position amplifier.

(5) The linear zone of the position loop is entered at the value set by SW4 2, 3 and 4 from the target point, and the motor starts decelerating and it stops at the target point.

(6) The IN-POSITION signal rises before the target point by an amount equivalent to the SW12 setting value and then the IN-POSITION signal output contact closes.

(7) When the orient command is released, the motor is reset to the speed of the S command given at that time.

(8) When re-orienting from the orient mode, the spindle rotates once and orientation is performed.

Depending on the settings of SW13, SW14 and SW15 for position adjustment and on the orient position given externally, the spindle will rotate more than once.

2.2 CONFIGURATION

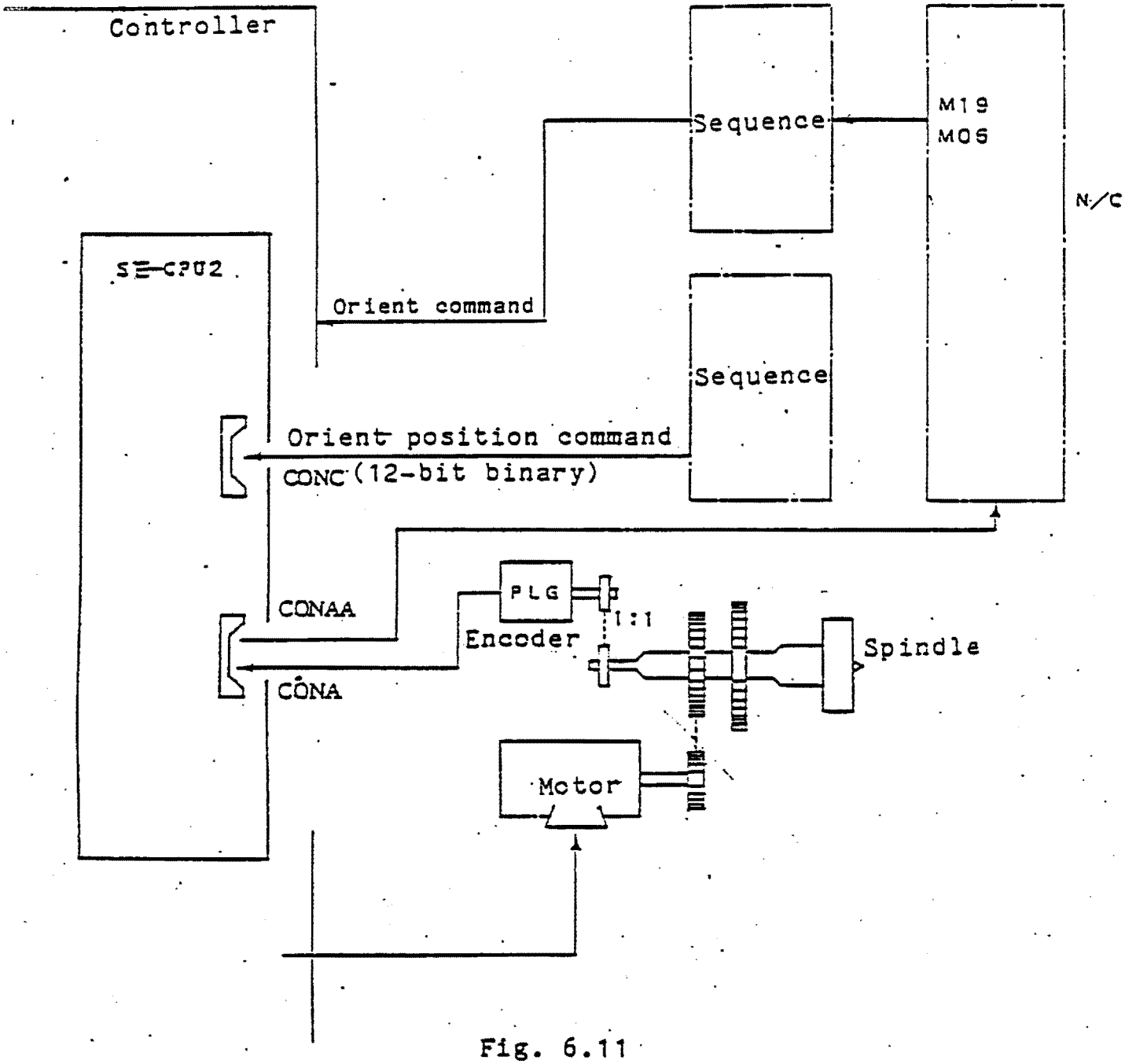
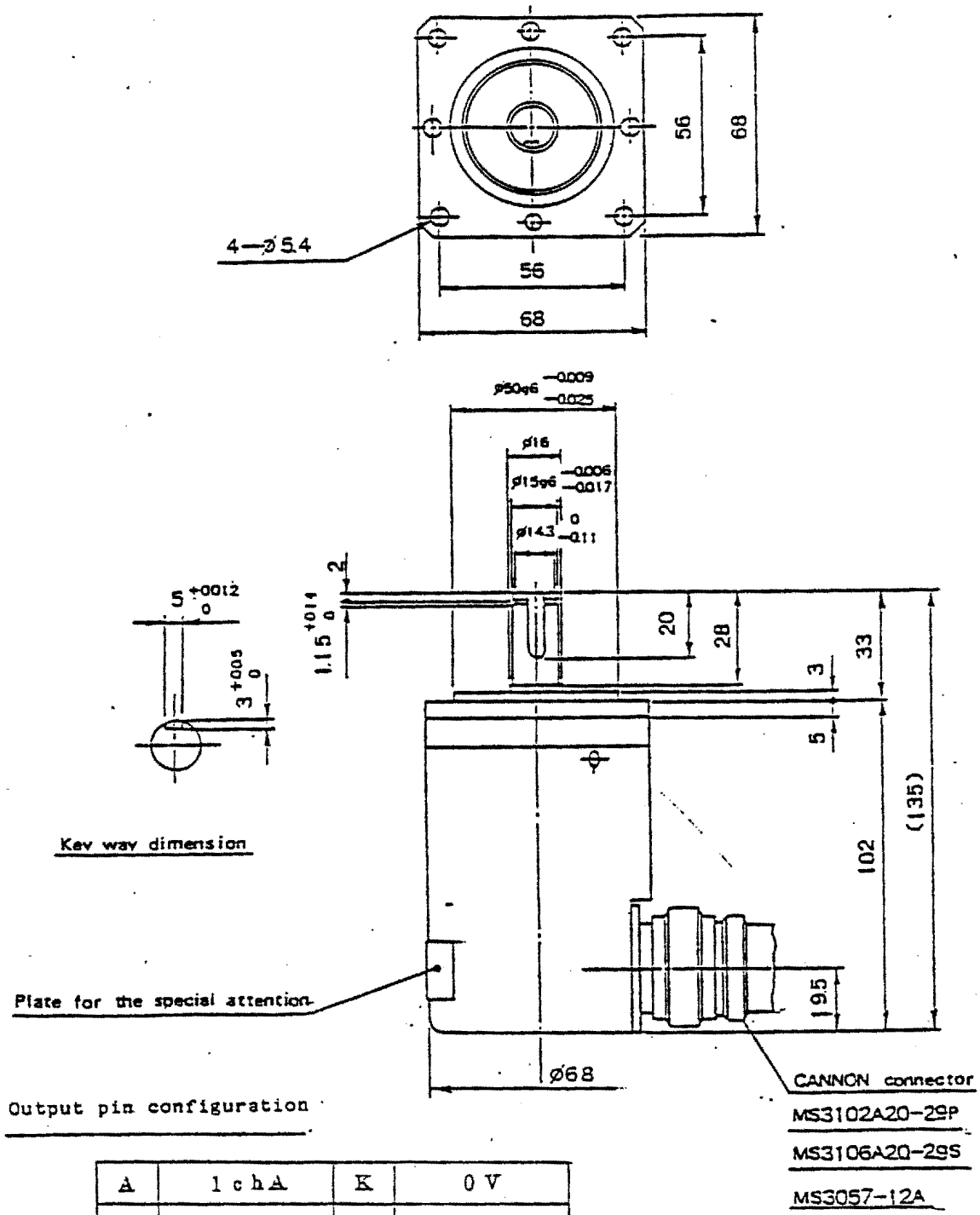


Fig. 6.11

Note: When the motor rotation direction and encoder rotation direction differ, make the adjustment using DIP switch SW4-8 on SE-CPU2.

2.3 ENCODER DIMENSIONS



Output pin configuration

A	1 ch A	K	0 V
B	2 ch A	L	
C	1 ch B	M	
D		N	* 1 ch A
E	Chassis ground	P	* 2 ch A
F		R	* 1 ch B
G		S	
H	+ 5 V	T	
J			

(Cable connector is not supplied.)

* Reverse rotation signal

Fig. 6.12

CHAPTER 7 TROUBLESHOOTING

7.1 INTRODUCTION

When trouble occurs in the controller, check out the following points as far as possible. Then proceed with inspection and repair work as outlined in the sections below.

The following points are extremely useful when making contact with servicing personnel and explaining what has happened.

Checkpoints when trouble occurs

(1) Have trouble lamps on controller's cosmetic panel lighted? Which lamps have lighted?

(2) If a fuse has blown, is it the R, S or T phase? (Control circuit input fuses)

(3) Does the trouble or failure recur?

(4) Are the ambient temperature and temperature inside the panel at the regular levels?

(5) Does the trouble occur during acceleration, deceleration or during constant speed operation? What is the speed at the time of the trouble?

(6) Is there any difference with forward and reverse rotation?

(7) Was there a momentary power failure?

(8) Does the trouble ocur with a specific operation or command?

(9) What is the frequency with which the trouble occurs?

(10) Does the trouble occur with a load added or reduced?

(11) Have parts been replaced or any other stopgap measures taken?

(12) How many years have passed since the equipment was first operated?

(13) Is the supply voltage normal? Does it vary greatly depending on the time zone.

7.2 STEP 1

Check the following points as the first step in troubleshooting.

(1) Supply voltage:

200V +/-10%, 50/60Hz, 210/220/230V +/-10%, 60Hz

The power supply should not be allowed to fall below 200V -10% even for short periods of time.

Examples: Voltage drops at certain times every day.

Voltage drops when certain machines are started.

(2) Is anything wrong with the control functions around the controller?

Examples: Anything wrong with NC, sequence circuitry?

Visually inspect parts, connections for trouble.

(3) Is the temperature around the controller (temperature inside panel) less than 55 deg.C.

(4) Anything wrong with exterior of controller?

Examples: Card parts, pattern burnouts, trouble, etc.

Loose connections, damage, foreign matter.

(5) Do all the SE-PW DC power outputs correspond with the prescribed voltages?

Once the above checks have been carried out, it should be possible to determine which parts are the cause of the trouble and to identify what the trouble is. Trouble in the FR-SE series can be broadly divided as follows:

Trouble group A

- Power is supplied to the controller for the first time but it does not operate properly (I)

- The controller has been operating properly to date but has suddenly ceased to do so (II)
- The controller does not operate properly from time to time and position shift trouble occurs (III)

Trouble group B

- Trouble in the controller
    - Trouble in main circuitry semiconductors
    - Trouble in control circuitry
- Trouble in the detector
    - Trouble in encoder for speed detection
    - Trouble in encoder for multiple point orient
    - Trouble in magnetic sensor for single point orient
- Trouble in power supplies
- Trouble in motor
- Other trouble (inadequate input signal conditions, cable disconnection, etc.)

7.3 STEP 2

Trouble group I	Checkpoints	Remedy
Power is supplied to controller for first time but it does not operate properly.	Stringent tests were conducted when unit was shipped but if unit does not operate properly when power is turned on for first time, cause may be: 1 Controller sustained a heavy blow during operation or installation and was damaged.	1 Visually inspect exterior of unit for signs of trouble.
	2 External wiring or sequence error, disconnection. Has unit been grounded? Note 1: Power supply phase sequence is unrelated.	2 Check that power LEDs 1-4 inside SE-PW light. Check that nothing is wrong with external wiring and sequence. (Note 1).
	3 Check again that ROM numbers and DIP switch settings are identical to those on order form list.	3 If they differ, replace ROM or reset.
	*4 Motor speed does not increase.	4 Change over any 2 of U, V, W phases of motor

		armature wiring.
	5 OK if only motor operates.	5 Re-check that load corresponds to design value.
	6 Irregular operation with orient stop only. (over shoot, etc.)	6 Re-adjustment required.
	7 Controller fault LEDs light: AL8, AL4, AL2, AL1 (LED13)(LED14)(LED15)(LED16).	Refer to Section 7.4.

Note 2: The start signal CW and CCW inputs must be set ON after the READY signal and speed command have been supplied.

Trouble group II	Checkpoints	Remedy
Controller has been operating properly to date but has suddenly ceased to do so.	1 Check for blown fuses, main circuitry no-fuse breaker tripping.	1 Replace any blown fuses; if fuse blows even after replacement, check under step 3.
	2 Check input power. AC200V +/-10%, 50/60Hz AC200-230V +/-10%, 60Hz	2 Reset to normal value if incorrect. Make available power supply so that voltage on left is maintained even in transient state.
	3 Controller fault LEDs light: AL8, AL4, AL2, AL1 (LED13)(LED14)(LED 15)(LED16).	Refer to Section 7.4.
	4 Input signal from NC or sequencer OK? LED2 (READY) lights in ready state; LED3 (CW) lights with forward rotation; LED4 (CCW) lights with reverse rotation.	4 Restore external input to normal.
	5 Check whether open operation is possible	5 If operation possible, trouble lies

	with SW6-2 OFF open, SW5-3,4,5 OFF cushion 10S, reset PB ON.	in speed feedback encoder. Try replacing encoder. If operation is still disabled, trouble lies in main circuitry: fault LED will light.

Trouble group III	Checkpoints	Remedy
Controller does not operate properly from time to time. Orient stop position shifts. Fault LED lights. Switching on power or resetting after power has been switched off results in resetting and normal operation.	In this case, whole situation must be clearly grasped. (Load situation, operation mode) Cause may be (3) below.	
	1 Input power is sudden-cut off or reduced, undervoltage LED or LED17 lights.	1 Check fluctuations in input power and other details.
	2 Control circuitry malfunctions with abnormally high noise level. Controller is guaranteed to withstand 1600V/1us power line noise in both common and normal modes.	2 Locate source of noise, and mount surge killer at source. Ground (particularly, detector) connection method. Re-check that chassis has been grounded properly.
	3 Is load overloaded momentarily under effect of vibration, etc? Check thoroughly with orient errors, etc.	3 Check out machine system. Check backlash with spindle encoder and spindle.

7.4 SYMPTOMS AND REMEDIES

1. When the fault lamps light

The trouble code related to which fault LED has been activated the fastest is indicated.

(1) MOTOR OVER HEAT

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
0	0	0	1

OHS1 and OHS2 are not activated.

Trouble	Checkpoints	Remedy
Overloading	1 Motor load 2 Start/stop frequency	1 Reduce load. 2 Reduce frequency.
Fan failure	Is fan motor working properly?	Repair or replace fan.
Blocked motor air intake	Sufficient air passing through?	Clean.
Thermal protector device failure	Reset after motor fan is operated for several minutes in motor stop state?	1 Shortcircuit OHS1-OHS2 as stopgap measure and continue operating. 2 Replace motor.

(2) EXCESSIVE SPEED ERROR

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
0	0	1	0

When an error (500 rpm) greater than prescribed between command speed and present speed occurs for 12 seconds.

Trouble	Checkpoints	Remedy
Overloading	1 Motor load	1 Reduce load.
Speed detec-	1 Open operation pos-	1 Replace encoder.

tion encoder trouble	sible	
Card trouble	1 SE-CPU1 or SE-IO1 card trouble	1 Replacement sequence: CPU1, 2 → IO1

(3) BREAKER TRIP

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
0	1	0	0

Lights when main input NFB is tripped.

IOC (converter/inverter) LED may light first.

Trouble	Checkpoints	Remedy
Supply voltage of 180V or less	Check that supply voltage during deceleration (regeneration) does not fall below prescribed value.	When voltage is near 180V in normal mode, it may fall below this value in transient mode and so it should be increased. Or increase power supply capacity.
Refer to IOC trip.	Refer to IOC trip.	Refer to IOC trip.

(4) PHASE LOSS

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
0	1	0	0

This is checked and lights up only when power is ON.

Trouble	Checkpoints	Remedy
Phase loss	Check voltage of input phases.	Return 3-phase power supply to normal.
Blown fuse F1, 2, 3	Check cause, inspect for shortcircuiting.	Replace unless something is wrong.

(5) EXTERNAL EMERGENCY

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
0	1	1	0

When SW7-2 is ON

This lights when the external emergency stop input (normally ON) is cut off. Inspect thoroughly for causes and then set input to ON. Return to normal operation.

When SW7-2 is OFF

External emergency stop lamp does not light.

(6) OVER SPEED

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
0	1	1	1

This lights when the motor speed reaches 115% of the maximum speed and the over-speed detector circuit is activated.

Trouble	Checkpoints	Remedy
Incorrect max. speed setting	SE-IO1 PIN1 setting Check if SE-CPU SW7-4~8/ SW6~7 are set properly.	Reset if incorrect.
Speed detector trouble	Check encoder output frequency: CH59/CH62 on CPU2 card CH60/CH57 on CPU1 card	Replace detector. $\frac{256 \times 1500}{60}$ at 1500 rpm = 6.4 kHz
Speed detector command circuit trouble	Defective card.	Replacement sequence: CPU1, 2 → IO1

(7) IOC TRIP (INVERTER, CONVERTER)

Converter IOC

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
1	0	0	0

Inverter IOC

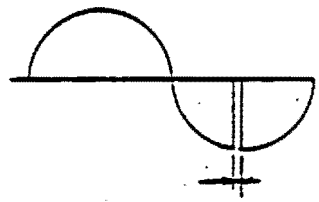
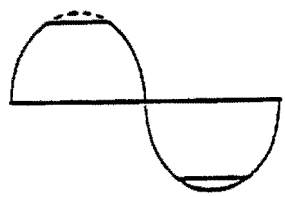
AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
1	1	0	0

IOC tripping can occur at the inverter or converter side.

Overcurrent is denoted when either lamp lights.

The main circuitry semiconductors may be damaged when the IOC fault recurs even if the reset signal is suppressed.

Trouble	Checkpoints	Remedy
Damage to power transistors	Disconnect connection between controller and motor and operate controller alone. Does IOC trip light? o If it lights, power transistors are damaged. o If it does not light, advance to following checks.	Replace power transistors.
High motor load	Check motor load.	Reduce load.
Faulty motor connections	Check wires around motor. Inspect for looseness in terminal screws.	Correct wiring. Tighten up screws.
Shorting of motor winding or grounding	Measure with megger; motor is defective if less than 1 Mohm.	Replace motor.
Incorrect power sup-	Must be 180V or more even under load conditions during acceleration/decel-	Increase power capacity.

ply capa-ity	eration.	
Abnormal supply voltage waveforms	Observe supply voltage waveforms with synchroscope and check that they are normal during acceleration and deceleration. 1 When there is a partial drop  Must be less than 100μs  Must be less than 2-3%	Eliminate waveform distortion 1 Increase capacity or increase power cable size. 2 Improve other semiconductor unit in which waveform distortion occurs.
Abnormal power frequency	Must not change more than +/-3% of prescribed frequency.	Improve frequency fluctuations.
Defective current detector circuit	Inverter CH30-AGA Trouble at 10V peak Converter CH43A-AGA Trouble at 10V peak.	Replace SE-IO1 card.

(8) CONTROLLER OVER HEAT

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
1	0	0	1

Controller's thermal protector (mounted on cooling fan) is activated.

Trouble	Checkpoints	Remedy
Overloading	1 Motor load 2 Start/stop frequency	1 Reduce load. 2 Reduce frequency.
High ambient temperature	Measure controller's ambient temperature.	Consider cooling if it exceeds 55 deg.C.
Failure of fin cooling fan	Is fan working properly?	Replace fan.

(9) UNDERVOLTAGE

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
1	0	1	0

LED lights when input power is 25ms, 170V-164V or less.

Trouble	Checkpoints	Remedy
Usually, operation normal; normal operation with resetting	Lights with speed change or under heavy load conditions.	Increase power capacity.
Lights usually	If input power is normal: SE-PW card trouble SE-PW pins ACDOWN-D05A High when control circuitry is normal (+5V)	Replace SE-PW card.

(10) OVERVOLTAGE (CONVERTER)

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
1	0	1	1

This LED lights when voltage of internal smoothing capacitors has risen above the value permitted for the protection of the unit.

Trouble	Checkpoints	Remedy
High power impedance		Increase power capacity.
Momentary drop or momentary power failure during deceleration	Check if LED17 has come on.	Reset and then observe state.
Detector circuit trouble	When above cases do not apply, fault may lie in detector circuit.	Replace SE-IO1 card.

(11) Trouble in CPU

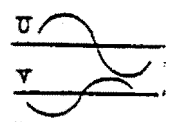
AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
1	1	0	1
1	1	1	0
1	1	1	1

This consists of errors in the logic or in the operations (such as division errors) inside the CPU cards. Observe the state after resetting. It may be necessary to replace the cards (or the CPU chips).

Trouble lies in the CPU when the CPU fault lamps (LED13-16) on the CPU1 or 2 card do not light during resetting. The CPU1 or 2 card must be replaced.

2. When the fault lamps do not light

(1) The motor does not operate at all even though there is no fault display.

Trouble	Checkpoints	Remedy
Incorrect connections or disconnection	Check wiring and inspect for disconnections.	Wire properly.
Incorrect in-input voltage	200V, 50Hz/200-230V, 60Hz for all 3 phases?	Return power supply to normal.
Incorrect DC power	Check all output voltages of cards and SE-PW with multimeter.	Replace if defective.
Defective card	Set SW6-2 to OFF (normally ON), establish open mode and increase command speed. Are reference sine waves produced? SE-IO1 card CH 5 AGB CH 4 AGB 	If trouble is found: replace cards starting with SE-IO1 card finishing with SE-CPU card.
External emergency stop or reset signal input	Check if LED19 has lighted.	Check connections.

(2) Motor operates only slowly even though there is no fault display.

Trouble	Checkpoints	Remedy
Faulty motor	Is motor connected in proper	Re-connect pro-

connection	sequence to output terminals U, V and W on controller?	perly.
Incorrect input power	Is input power normal for all 3 phases?	Return power to normal.
Incorrect external speed command	When speed command from external source is increased, does motor speed increase in proportion?	Reset external speed command circuit.
Speed detection encoder trouble	Is open operation possible with SW6-2 OFF?	Replace encoder.

(3) Motor operates at specific speed only and not as commanded.

Trouble	Checkpoints	Remedy
Incorrect external speed command	Does speed command from external source change linearly from 0V to 10V? (CH41-AGA)	Reset external speed command circuit.

(4) Insufficient torque

Inspect as indicated in (5), (6) and (7).

(5) Motor takes longer to start.

Trouble	Checkpoints	Remedy
Increased load	Check load.	Reduce load.

(6) No speed arrival signal (CP-TO SPEED)

Trouble	Checkpoints	Remedy
SE-IO1 card output circuit failure	Does LED7 on SE-CPU light upon completion of acceleration/deceleration?	Replace SE-IO1 card.
Speed arrival detector cir-	LED7 (UP TO SPEED) on SE-CPU card does not light.	SE-CPU card failure if otherwise normal

	operation; replace card.

(7) No NC feed operation

This is caused by the failure of the UP-TO SPEED signal to operate. Inspect in the same way as for the relay sequence and (10).

(8) No speed detection signal

Trouble	Checkpoints	Remedy
SE-IO1 card failure	Does SE-CPU1 LED5 light above set speed? If it lights, failure lies in output circuitry.	Replace SE-IO1 card.
Speed detector circuit failure	SE-CPU2 LED5 does not light.	SE-CPU card failure if otherwise normal operation; replace card.

(9) No zero speed detection signal

Trouble	Checkpoints	Remedy
RA-1 relay failed on SE-IO1 card	Does SE-CPU LED10 light at motor speed of under 25 rpm or 50 rpm? Relay has failed if signal is not output even when LED10 lights.	Replace RA1 relay or replace SE-IO1 card.
Zero speed detector circuit failure	Failure in detector circuit if LED10 does not light.	Replace SE-CPU1 or 2 card.

(10) No speed range selection

This is caused by the speed detection or zero speed signal

not functioning. Inspect as for (12) and (13).

(11) Speed does not increases beyond a certain value.

Review settings to see whether maximum speed has been set properly. Check whether override input is not being supplied.

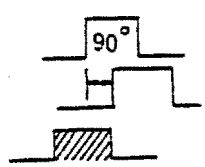
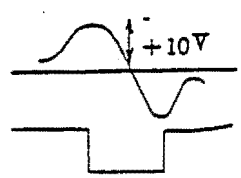
Is the load meter value too high? Check the load.

(12) High vibration, noise levels

Trouble	Checkpoints	Remedy
Poor dynamic balance		Review dynamic balance.
Drop in insulation resistance	Disconnect R, S, T phases from power supply and measure with 500V megger (disconnect wires connected to ground terminals). a Across main circuitry and ground: 20Mohms or more (terminals X1, X2, X3, U, V, W, MS1 and MS2) b Across control circuit COM and ground; 20Mohms or more (IO1 card, terminal block TB1 OM) c Across main circuity and control circuit COM: 20 Mohms or more	When this has dropped, inspect for places where insulation may have deteriorated, and restore.
Defective motor bearing	Try rotating motor alone by hand. Does it rotate smooth-	Replace bearings.

	ly?	
Motor screws not tight enough	Are any of the motor screws loose?	Re-tighten screws.
Motor shaft movement	Does motor shaft show any trace of having been bumped into something?	Repair or replace motor.
Unbalanced reference sine waves	Are SE-IO1 card CH5, CH6-AGA waveforms balanced?	Replace SE-IO1 card.

(13) Speed control operates normally but trouble with orient operation.

Trouble	Checkpoints	Remedy
Orient speed established but motor does not stop	Is position feedback encoder or magnetic sensor operating normally? Operate motor under speed control only and check if position feedback is normal. SE-CPU2 card, forward rotation CH52 - DGA CH53 - DGA CH54 - DGA Mark pulse  SE-CPU1 card, forward rotation CH53 - AGA IC 21A-7 - AGA 	Replace detector. Defective SE-CPU card interfacce; replace card.

Stop positions differ for forward and reverse rotation orient with multiple-point orient	Check backlash at encoder mounting area.	
Hunting during stop	Reduce position gain and observe. Reduce orient speed.	SE-CPU2 SW4-2~4 SW4-5~7 (Position loop gain) SW10 Orient speed SE-CPU2 SW4-2~4 SW10 5~7 Orient speed
Stop state differs according to gear	Check that gear ratio setting is normal. DIP switch setting	Change if different. If normal, re-set position loop gain and orient speed.
Poor servo rigidity	Check that gear ratio setting is normal. DIP switch setting	Increase speed loop gain. SW8
Speed overshooting		Reduce speed loop gain. SW9

CHAPTER 8 PARTS REPLACEMENT METHODS

8.1 CARD REPLACEMENT

(1) SE-PW card

Replace this card if something is wrong with the DC voltages.

The SE-IØ1 card must be removed in order to replace the card.

(2) SE-CPU1 card

First check the ROM number, DIP switch settings and setting pin positions again before proceeding with replacement.

Magnetic sensor sensitivity (VR2) } Re-adjust these
Orient shift (VR1) } controls.

(3) SE-CPU2 card

First check the ROM number, DIP switch settings and setting pin positions again before proceeding with replacement.

(4) SE-IØ1 card

First check the setting pinpositions again before proceeding with replacement. When replacing the card, bear in mind that the connectors hooking up the main circuitry are located on the rear side of panel B.

- CH56-AGA (U phase reference sinusoidal wave) ... VR13
  CH43A-AGA regenerative converter DC current ... VR10
  CH57-AGA (V phase reference sinusoidal wave) ... VR12
  CH58-AGA converter DC current ... VR11
  Re-set the zero adjustments.
- Set the maximum speed using pin 1 on the IO1 card and SW6-7 on the CPU card.
- Set the meter calibration SW6-6 to OFF and re-adjust VR6 and

7 so that the CH34 voltage is made 10V.

o After the above calibrations re-adjust the speed meter (VR14) and load meter (VR15).

8.2 DIODE AND TRANSISTOR MODULES

(1) Removal of defective module

Detach the wires connecting the module and remove the module from the heat-dissipating fin.

In this case, bearing in mind that emitter pin E and base pin B of the transistor module can be detached and re-inserted, remove these pins.

(2) Application of silicon grease

Apply an even layer of silicon grease to the rear side of the module.

(3) Tightening up

Restore the wires to their original state using the specified tightening torque. Cover the base and emitter pins of the transistor module with silicon tubes as before.

Note:	Only the diodes and transistors listed in the specifications may be used. Replacements or spares must, therefore, be purchased from Mitsubishi or its authorized representative.

	Model	Screw size	Max. tightening torque (kg-cm)	Recommended tightening torque (kg-cm)
Diodes	RM 30TA RM 60DZ-H RM100DZ-H	M5 x 0.8	20	17 +/-2
Transistors	QM 75DY-H QM100DY-H QM150DY-H			

Table 6.1 Tightening torques

8.3 TYPE SJ AC SPINDLE MOTOR DISASSEMBLY AND RE-ASSEMBLY

[1] Cables and PCB

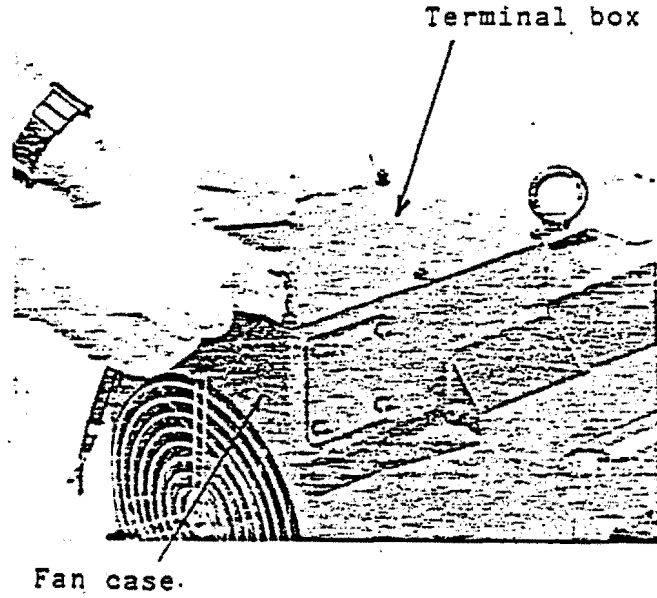
1. Remove the lid of the terminal box on top of the fan case.
2. Disconnect the cables from the power board to the motor.

a) 3 motor main leads (U, V, W)

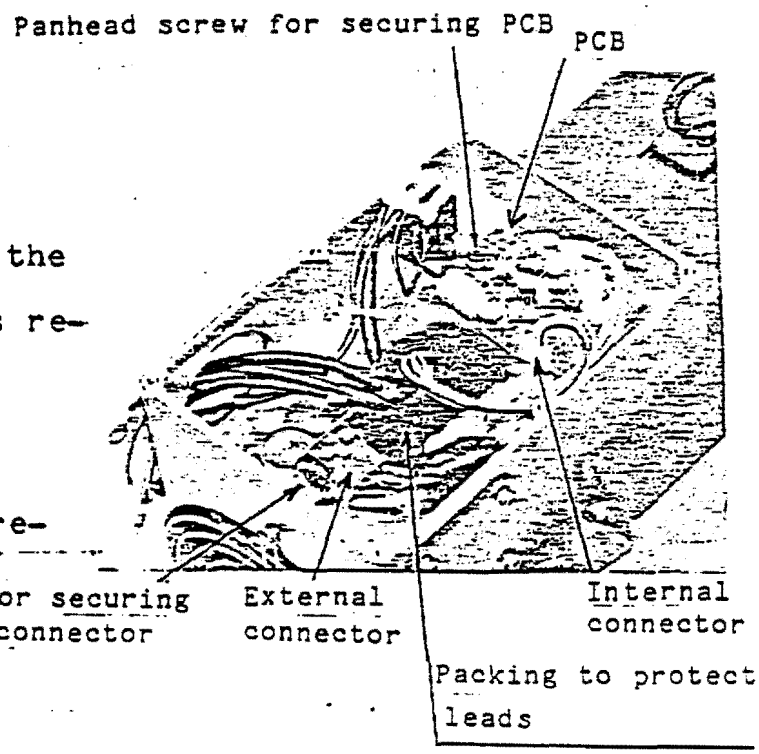
b) 2 cooling fan leads (BU, BV)

c) 2 thermal protector leads (OHS1, OHS2)

d) Companion plug for PCB's external connector

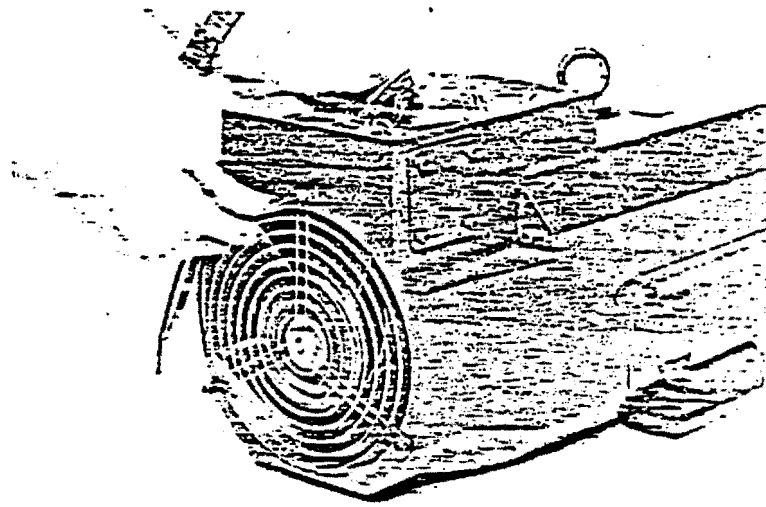


3. Remove the external connector from the fitting which secures it and remove the internal connector from the socket.
4. The PCB can be removed once the panhead screw securing it is removed.
5. For re-assembly, follow the above steps (1)-(4) in the reverse order.

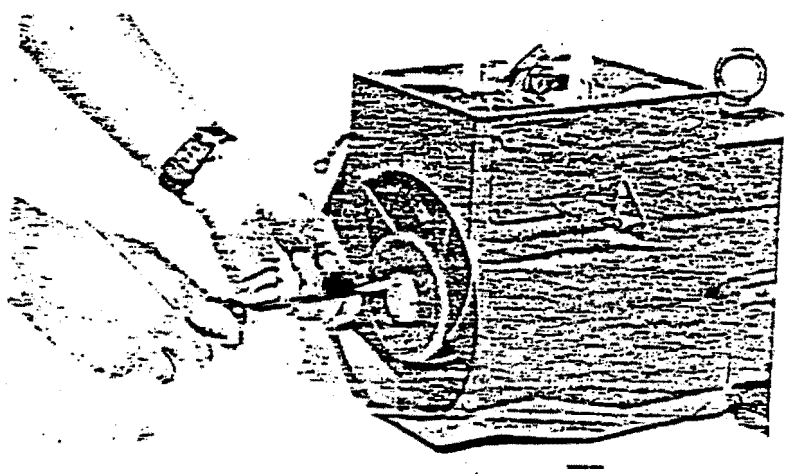


[2] Cooling fan

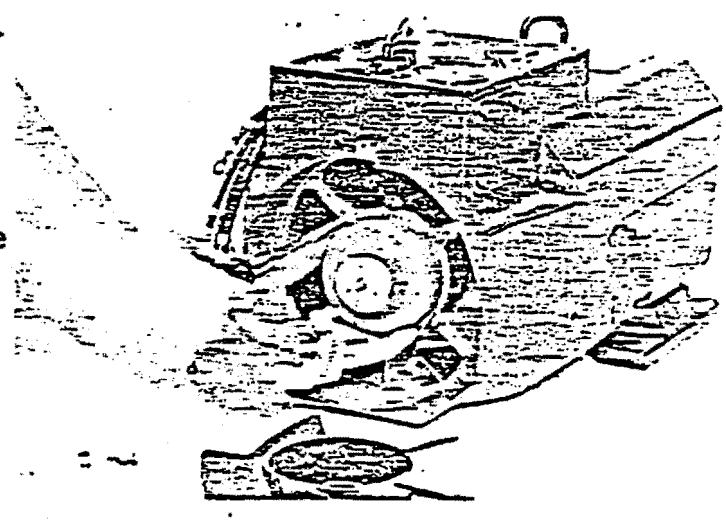
1. Remove the hexagon socket head bolts which secure the finger guard.



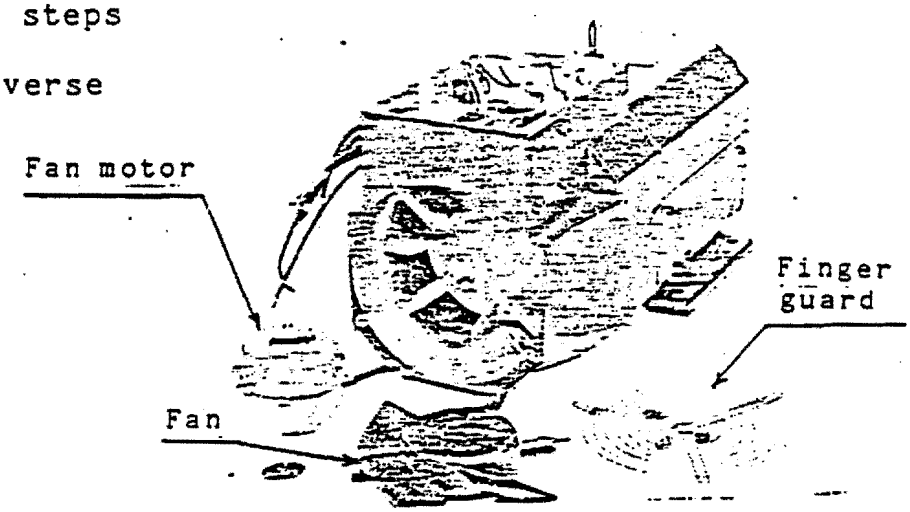
2. The fan alone can be removed once the flat-head screws at the center of the cooling fan are removed.



3. Cut the 4 cooling fan leads connected inside the terminal box. The fan motor itself can be removed from the fan case once the panhead screws which attach it are removed.

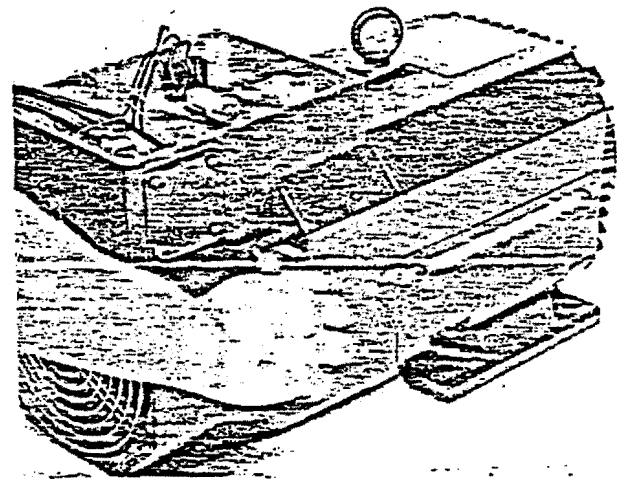


4. For re-assembly, follow steps (1)-(3) above in the reverse order.

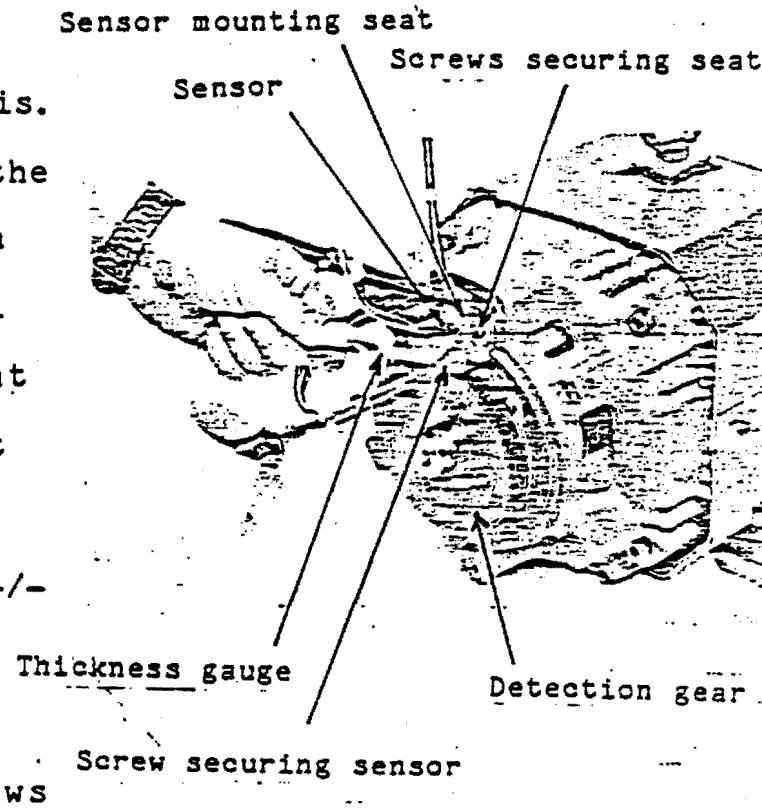


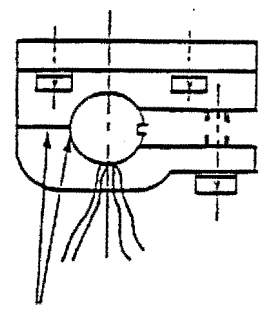
[3] Sensor and detection gear

1. Detach the internal connector of the sensor from the PCB inside the terminal box.
2. Remove the 3 hexagon socket head bolts attaching the fan case, and the fan case with the cooling fan attached can be removed once the fan case is pulled out toward the rear.

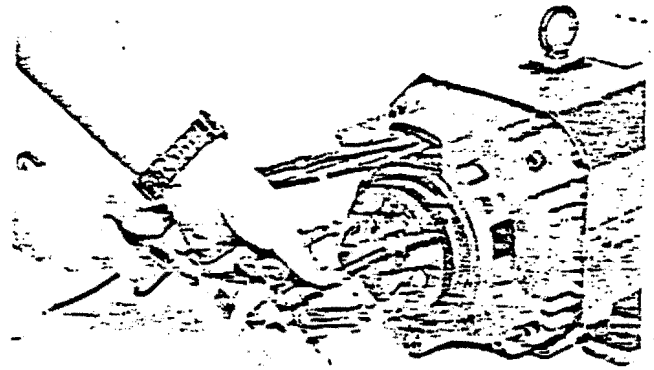


3. Once the 2 panhead screws securing the sensor mounting seat are removed, the seat with sensor attached can be removed. Take care not to bring the sensor into contact with the detection gear while doing this.
4. To adjust the sensor, loosen the screw securing the sensor with the sensor mounting seat still secured and make the adjustment with a thickness gauge so that the gap between the detection gear and sensor is made 0.15 +/- 0.01. Check that the marks (index lines) on the sensor tally, and tighten up the screws securing the sensor to secure the sensor.
(See figure on right)
5. Paint over the screws securing both the sensor and its mounting seat to prevent looseness.
6. When re-assembling the fan case, draw it sufficiently into the terminal box so that the sensor leads are not sandwiched inside.




Align the marks (index lines)

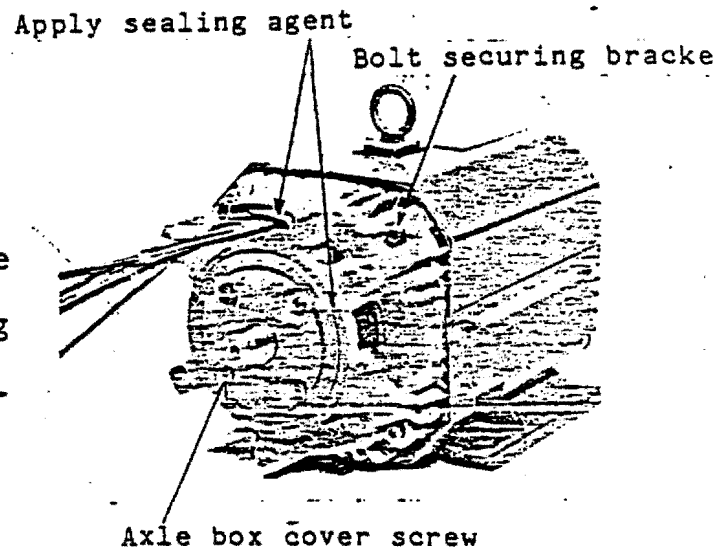
7. The detection gear is removed by screwing the eyebolt into the screw (M8) hole, drawing it out with a removal tool and then rotating the bolt using a wrench or similar tool.



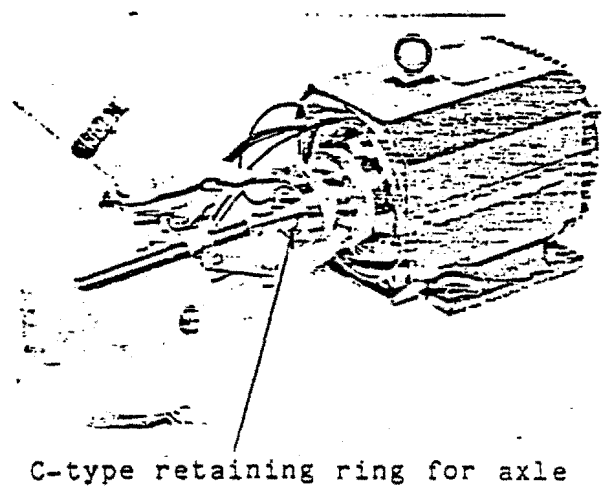
8. When re-assembling the detection gear, insert it into the axle at a shrink-fit temperature within 100-150 deg.C, taking care not to wrench it into place.
   An excessively high shrink-fit temperature will cause distortion in the detection gear.

[4] Bearings

1. The non-load side bracket can be removed once the screws securing the axle box cover and the hexagon socket-head bolts securing the bracket are all removed.



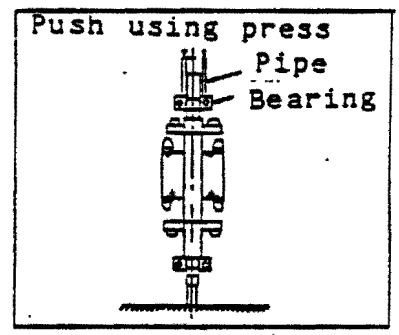
2. When re-assembling the non-load side bracket, apply a sealing agent to the interlocking surface.
3. The non-load side bearing is removed by first removing the C-type retaining ring for the axle, using a bearing removal tool to



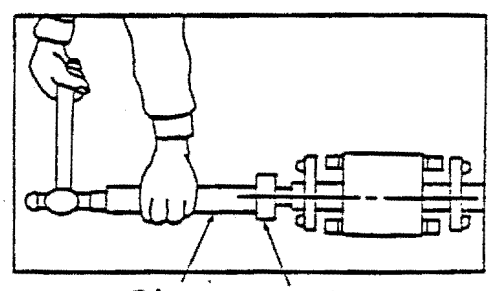
remove the bearing along with the axle box cover and by rotating the bolts with a wrench.

4. Remove the load-side bearing by applying the pawl of the removal tool to its inner ring and rotating the handle.

5. When fitting the bearing into the axle, wipe clean the part of the bearing which interlocks to remove marks and projections.
6. Apply oil to the inner diameter of the bearing and interlocking surface of the axle, interlock the bearing at right angles, place a suitable appropriate pipe on the inner ring and insert gently under pressure using a press.
7. If a press is unavailable, tap gently into place. Take care not to force the bearing into position or to bring the pipe into contact with the outer ring area.



Mounting the bearing using a press



Mounting the bearing using a hammer

CHAPTER 9 PARTS LIST

AC SPINDLE CONTROLLER & MOTOR(TYPE FR-SE-2)

NOTE: Option spare parts A-----Maintenance spare parts for every two years.
Option spare parts B-----Maintenance spare parts for every five years.
Option spare parts C-----Maintenance spare parts for machine maker's stock.

ITEM	DESCRIPTION	TYPE KW	TYPE		MAKER	SYMBOL	QTY	SPARE PARTS STAND.	SPARE PARTS OPTION A	SPARE PARTS OPTION B	SPARE PARTS OPTION C	NOTE
1	CIRCUIT BREAKER	5.5	NF 50CB 3P	40A05	MITSUBISHI ELECTRIC	CB1	1	0	0	0	1	
		7.5										
		11		50A05								
		15	NF100CB 3P	75A05								
		18.5		100A05								
		22										
2	TRANSISTOR	5.5	QM75DY-H		MITSUBISHI ELECTRIC	TRR TRS TRT	3	0	0	0	3	FOR CONVERTER
		7.5										
		11	QM100DY-H									
		15	QM150DY-H									
		18.5										
		22	QM75DY-H				9	0	0	0	9	
3	TRANSISTOR	5.5	QM75DY-H		MITSUBISHI ELECTRIC	TRU TRV TRW	3	0	0	0	3	FOR INVERTER
		7.5	QM100DY-H									
		11	QM150DY-H									
		15										
		18.5	QM100DY-H				6	0	0	0	6	
		22	QM150DY-H									
4	DIODE STACK	5.5	RM30TA-H		MITSUBISHI ELECTRIC	D1	1	0	0	0	1	FOR CONVERTER
		7.5										
		11	PT758		NIHON INTER							
		15	RM60DZ-H		MITSUBISHI ELECTRIC	D1-1 D1-2 D1-3	3	0	0	0	3	
		18.5										
		22	RM100DZ-H									

ITEM	DESCRIPTION	KW	TYPE	MAKER	SYMBOL	QTY	SPARE PARTS STAND.	SPARE PARTS OPTION A	SPARE PARTS OPTION B	SPARE PARTS OPTION C	NOTE
5	CAPACTOR	5.5	3200UFX 350V BKO-NC 1043-H05	NITSUKO	C1-1 C1-2 C1-3 C1-4 C1-5	2	0	0	2	2	
		7.5				3	0	0	3	3	
		11				4	0	0	4	4	
		15									
		18.5				5	0	0	5	5	
		22									
6	CONTACTOR	5.5	SK50 AC200V	MITSUBISHI ELECTRIC	MC1	1	0	0	0	1	
		7.5									
		11									
		15									
		18.5	SK65- AC200V								
		22									
7	FAN	5.5	N3951ML	TOOBISHI	FAN1 FAN2	2	0	2	0	2	
		7.5									
		11									
		15									
		18.5	HS4556ML								
		22									
8	AC REACTOR	5.5	BKO-NC6 NC6132- H02	CHUO DENKI	ACL	1	0	0	0	1	
		7.5	H03								
		11	H04								
		15	H05								
		18.5	H06								
		22	H07								
9	CAPACTOR	5.5	MEUZ105 600A BKO- NA1061-05	SIZUKI DENKI	C2 C3	6	0	0	6	6	FOR CONVERTER INVERTER
		7.5									
		11			C2	3	0	0	3	3	
10	SURGE KILLER	11	BKO-C1916 H02	SIZUKI DENKI	C3	3	0	0	0	3	FOR INVERTER
		15									
		18.5				6	0	0	0	6	
		22									
11	SURGE KILLER	15	BKO-C1916 H01	SIZUKI DENKI	C2	3	0	0	0	3	FOR CONVERTER
		18.5									
		22				6	0	0	0	6	

ITEM	DESCRIPTION	TYPE KW	TYPE		MAKER	SYMBOL	QTY	SPARE PARTS STAND.	SPARE PARTS OPTION A	SPARE PARTS OPTION B	SPARE PARTS OPTION C	NOTE
12	RESISTOR	5.5	BKO-NC1072-	H02	MICRON	R1 R2 R3	3	0	0	0	3	
		7.5		H03								
		11		H04								
		15		H05								
		8.5		H06								
		22		H07								
13	RESISTOR	5.5	MFS30A 802K		MICRON	R0	1	0	0	0	1	
		7.5										
		11				R0-1 R0-2	2	0	0	0	2	
		15										
		18.5										
		22										
14	RELAY	—	G4J3342J DC24V		OMRON	RA1 RA2	2	0	0	0	2	
15	THERMAL DETECTOR	—	OHD- 60B		TOOKIN	THS1	1	0	0	0	1	
16	THERMAL DETECTOR	—	OHD-100B		TOOKIN	THS2	1	0	0	0	1	
17	CT	5.5	BKO-NC6131-	H02		CT1 CT2 CT3 CT4	4	0	0	0	4	
		7.5		H03								
		11		H04								
		15		H05								
		18.5		H06								
		22		H07								
18	TERMINAL	5.5	TE-K14-3		MITSUBISHI ELECTRIC	TB3	1	0	0	0	1	
		7.5										
		11	TE-K22B-3									
		15										
		18.5	TE-K60B-3									
		22										
19	TERMINAL	—	TE-K2-3		MITSUBISHI ELECTRIC	TB4 TB11	2	0	0	0	2	
20	FILTER	—	BKO-NC6143 H01		SIZUKI DENKI	FIL1	1	0	0	1	1	

ITEM	DESCRIPTION	KW	TYPE	MAKER	SYMBOL	QTY	SPARE PARTS STAND	SPARE PARTS OPTION A	SPARE PARTS OPTION B	SPARE PARTS OPTION C	NOTE
21	FUSE	—	~~HP~~ 50NB-5A-S	TOYO	SE-FW	3	3	0	0	3	
22	PRINTED CIRCUIT BOARD	—	EKO-NC6135	YAMABISHI	SE-IO1	1	0	0	0	1	
23	PRINTED CIRCUIT BOARD	—	SE-IO1	MITSUBISHI ELECTRIC		1	0	0	0	1	
24	PULSE SIGNAL GENERATOR	—	TS1860N2	TAMAGAWA DENKI		1	0	0	1	1	FOR MOTOR
25	FAN	5.5 7.5 11 15 18.5	IA-15101	UNION SEIKO		1	0	0	1	0	FOR MOTOR
		22	-	AKAMATSU ELECTRIC							
26	BEARING (LOAD SIDE)	5.5 7.5	6307~~M~~ZZCS19	TOYO BEARING		1	0	0	0	1	FOR MOTOR
		11 15 18.5	6310~~M~~ZZCS22								
		22	6312~~M~~ZZCS16								
27	BEARING (OPPOSITE SIDE)	5.5 7.5	6306~~M~~ZZCS16	TOYO BEARING		1	0	0	1	1	FOR MOTOR
		11 15 18.5 22	6308~~M~~ZZCS19								
28	MAGNETIC SENSOR ORIENT P.C.B		SE-CPU1	MITSUBISHI ELECTRIC		1	0	0	0	1	
29	ENCODER ORIENT P.C.B		SE-CPU2	MITSUBISHI ELECTRIC		1	0	0	0	1	

AC SPINDLE DRIVE UNITS
FREQROL-SE
INSTRUCTIONS FOR OPERATION AND ADJUSTMENTS

NO. 2

MITSUBISHI ELECTRIC CORPORATION

NAGYA WORKS

[1] PREPARING TO OPERATE

Check the following points when switching on the power to the controller for the first time:

(1) Has all the equipment been properly wired and connected as shown in the drawings?

(2) Have the motor and control panel been grounded properly?

(3) Have the shield wire terminations been connected properly?

- o Make the proper connections to the shield terminals.
- o Make the connections so that the shield areas do not form a loop.

(4) Check that the equipment is secured properly to avoid looseness and damage.

(5) Check that metal chips, pieces of wire and other foreign matter have not entered inside the equipment.

(6) Check that there is nothing abnormal with the exteriors of the printed circuit boards.

(7) Check that the ROM numbers and DIP switch settings are as per the order List.

[2] RECEIVING POWER

If all items under section [1] are satisfactory, power up the equipment as follows:

(1) Switch on the incoming power.

(2) Check that light-emitting diodes LED13, 14, 15 and 16, which are designed to indicate trouble and which are located on the front of the controller, have not lighted.

(3) Check that light-emitting diodes LED2 (READY) and LED10 (ZERO SPEED), which are designed to indicate the status and

which are located on the front of the controller, have lighted.

These procedures enable operation.

No problems are posed with the controller and re-connection is not necessary even if the phase sequence of the incoming power is reversed. It is possible to check whether the phase sequence is positive or reversed by observing LED1 (PHASE SEQUENCE). A positive phase sequence is indicated when LED1 lights.

[3] ADJUSTMENT LOCATIONS

(1) Speed meter adjustment (effective only with connections to ammeter terminals SM1 and LM1)

Item	Method		Adjustment VR
Speed meter	SW6-6 on SE-CPU1(2)	Set to maximum speed meter indication.	VR14, SE-101 card
Load meter	card to OFF.	Set to 120% load meter indication.	VR15, SE-101 card

(2) Setting DIP switches, setting pins

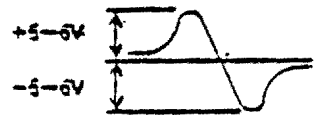
Check again that the settings in the order list corresponding to the machine have been made. Change the settings if they have not been made. To change the settings, set the set switch (ST1) to ON.

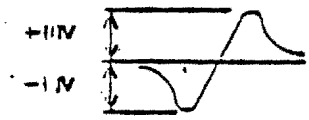
Refer to pages 10 to 14 for details on the settings.

(3) Orient operation adjustment (only when optional functions are provided)

Magnetic sensor orient (SE-CPU1 card)

(A) Magnetic sensor sensitivity adjustment

Check location	Between CON4(14)-(15)
	
Gap adjustment is required if the status is not as that in the figure above. Refer to the INSTRUCTIONS FOR OPERATION AND ADJUSTMENT.	

Check location	Between CH53-54
	
VR2 for adjustment	

(B) Use VR1 to adjust the orient stop position.

(C) Use switches SW4-8 to identify the mounting direction of the magnetic sensors.

* Set SW4-8 in reverse of their present settings to identify the mounting direction of the sensors with a high degree of hunting at orient stop.

Encoder orient (SE-CPU2 card)

(A) Orient stop position adjustment

Change angle		Change switch
Per notch	0.088 deg. (1 pulse)	SW15
	1.4 deg. (16 pulses)	SW14
	22.5 deg. (256 pulses)	SW13

Position shift = 360 deg. x $\frac{\text{set value}}{4096}$

(B) Use SW4-8 to identify the encoder mounting direction.

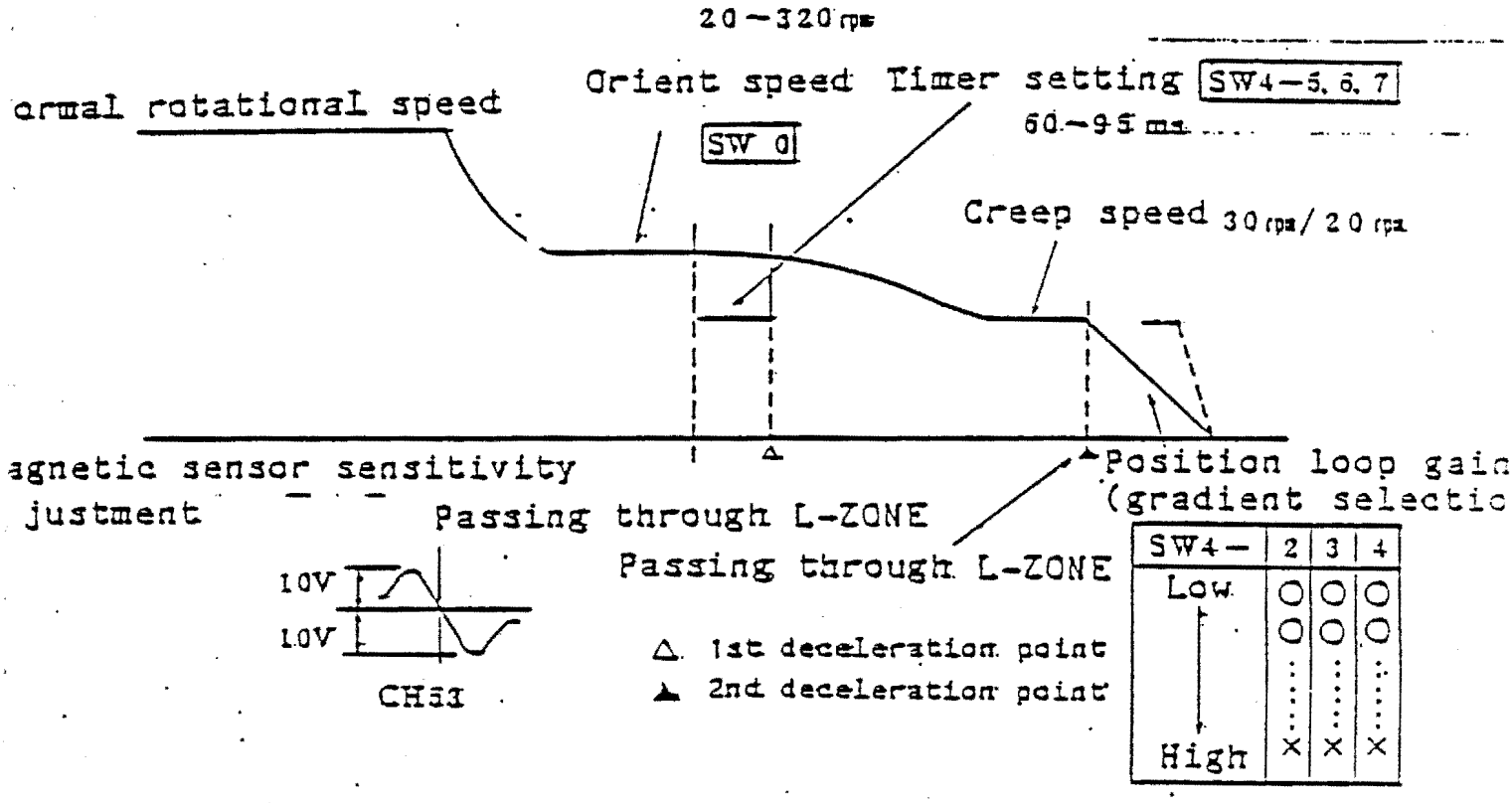
* Set SW-8 in reverse of their present positions to identify the mounting direction of the encoder with a high degree of hunting at orient stop.

These procedures complete the adjustments made when combining the machines.

Refer to pages 7 to 9 for the adjustments applying to the first machine.

[4] ORIENT ADJUSTMENTS

(1) Magnetic sensor system



SW4—	2	3	4
Low	○	○	○
	○	○	○
	⋮	⋮	⋮
High	×	×	×

Operate at the orient speed with SW6-10FF and ST2, adjust VR2 to the limit at which the magnetic sensor sensitivity LED11 lights and set CH53 to the peak voltage +/-10V.

The speed pattern for orient is now as shown in the figure above.

Therefore,

Proceed as follows when over shoot with stop:

- Reduce the timer setting (SW4-5,6,7) time.
- Reduce the position loop gain (SW4-2,3,4) gradient.
- Reduce the orient speed. (SW10 F → E → .... → 0)
- Reduce the creep speed. (SW4 OFF → ON)

Reduce the orient time.

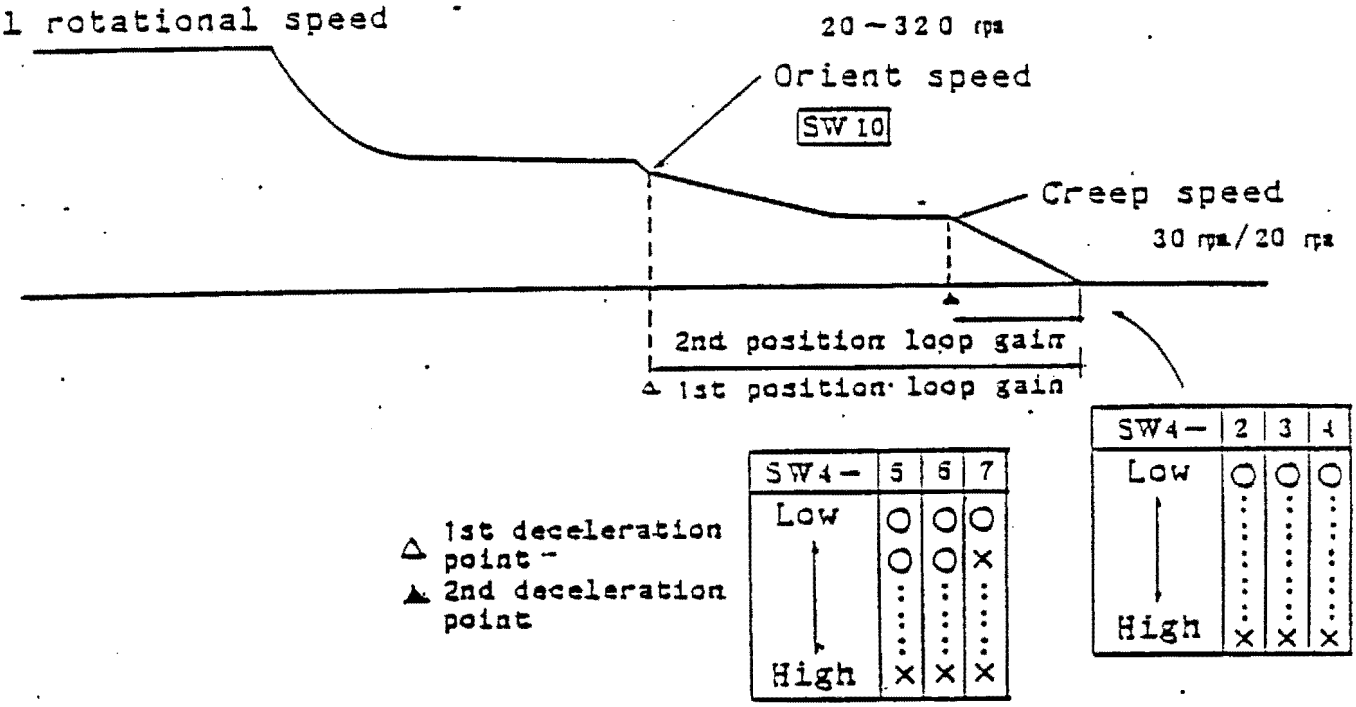
- Increase the timer setting (SW4-5,6,7) time.
- Increase the position loop gain (SW4-2,3,4) gradient.
- Increase the orient speed. (SW10 0 → 1 → .... F)

Hunting when drive unit stops

- Reduce the position loop gain (SW4-2,3,4) gradient.
- Reduce the magnetic sensor sensitivity. (VR2)
- Reduce the creep speed. (SW4 OFF → ON)

Furthermore, adjust the stop position with position shift VR1.

(2) Encoder system



The speed pattern for orient is the same as that shown above.

Therefore,

Proceed as follows when over shoot with stop:

- o Reduce the 1st position loop gain.
- o Reduce the orient speed. (SW10 F → E → .... → 0)
- o Reduce the 2nd position loop gain.
- o Reduce the creep speed. (SW4 OFF → ON)

Reduce the orient time.

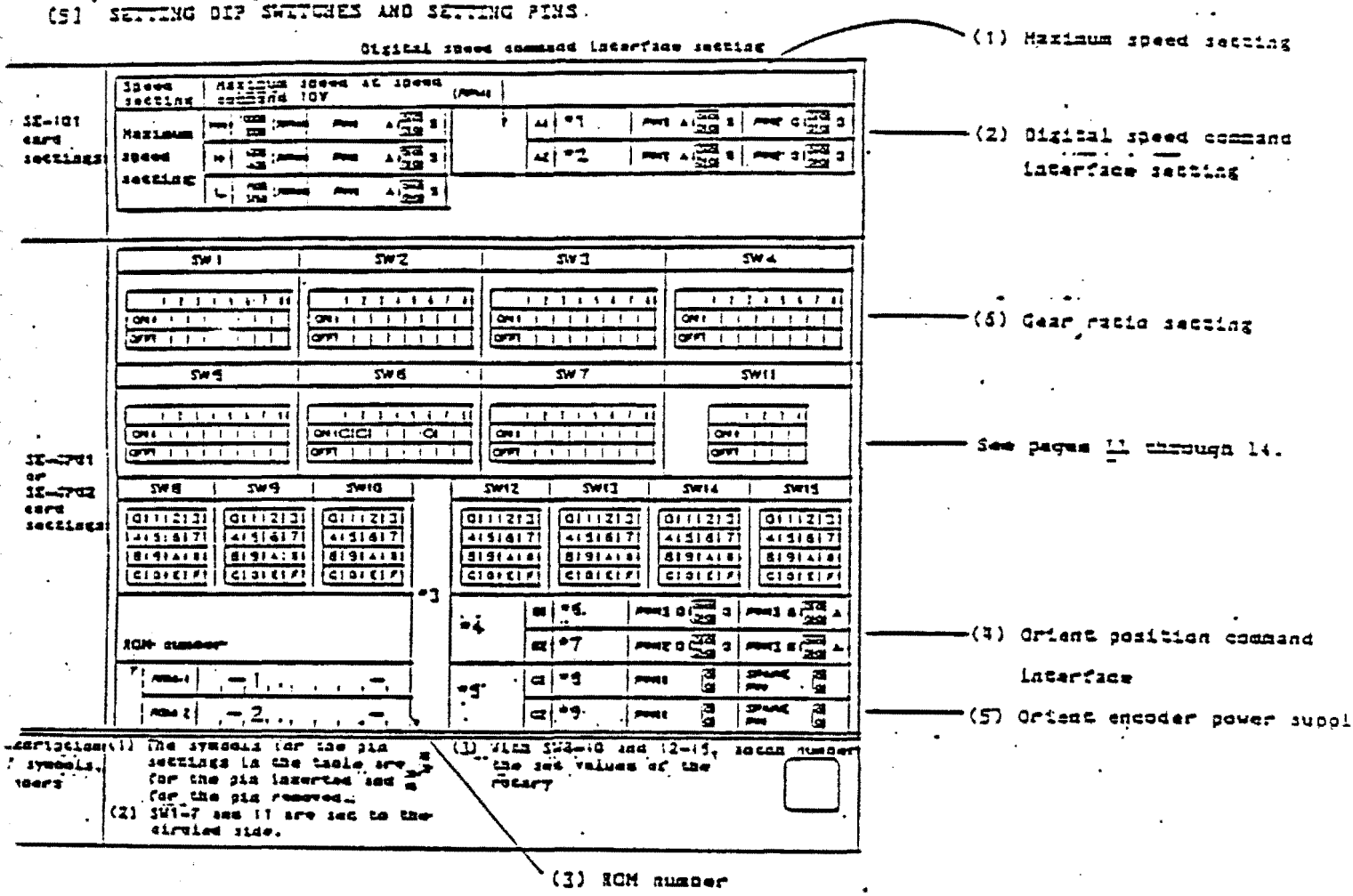
- o Increase the 1st position loop gain.
- o Increase the orient speed. (SW10 0 → 1 → .... F)
- o Increase the 2nd position loop gain.

Hunting when drive unit stops

- o Reduce the 2nd position loop gain.
- o Reduce the creep speed. (SW4 OFF → ON)

Furthermore, adjust the stop position with position shift switches 13, 14 and 15.

(5) SETTING DIP SWITCHES AND SETTING PINS



SW1 Gear ratio H

SW2 Gear ratio MH · ML

SW3 Gear ratio L

$$\text{Set value (hexadecimal)} = \left(\frac{\text{Last axis (magnetic sensor/encoder axis)}}{\text{Maximum motor speed}} \times 128^{D} \right)^{H}$$

Decimal

Hexadecimal 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F.

(Example)

3. Machine specifications		
Direction of encoder rotation with forward motor rotation	Forward rotation (CW)	*13
	Reverse rotation (CCW)	
Drive system	Gear	*20
	Belt	
	Direct	
Final magnetic sensor/encoder axis speed with respect to maximum speed of motor shaft	*10	1/10
	*11	1/10
	*12	1/10
	*13	*22
	*14	1/1
Motor shaft-converted load GD²	*15	*22
	*16	
	*17	
	*18	

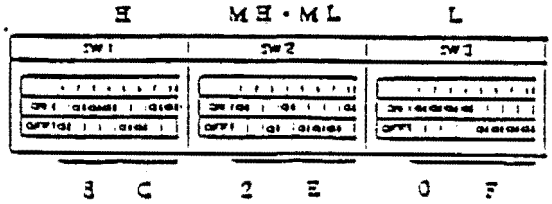
$$H = \frac{4950}{4500} \times 128 = 140.8^{D} = 8C^{H}$$

$$MH = \frac{1650}{4500} \times 128 = 46.93^{D} = 2E^{H}$$

$$ML$$

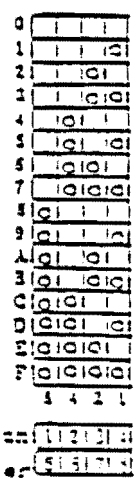
$$L = \frac{535}{4500} \times 128 = 15.22^{D} = F^{H}$$

Note: Circle when there is no gear.



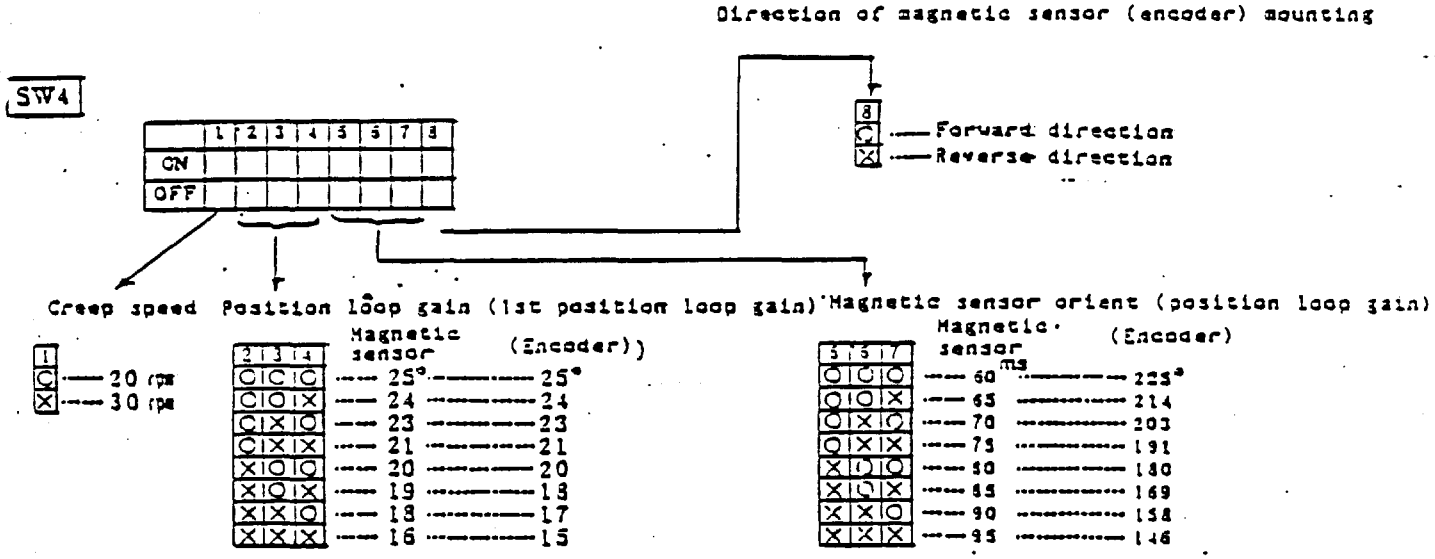
8 C 2 E 0 F

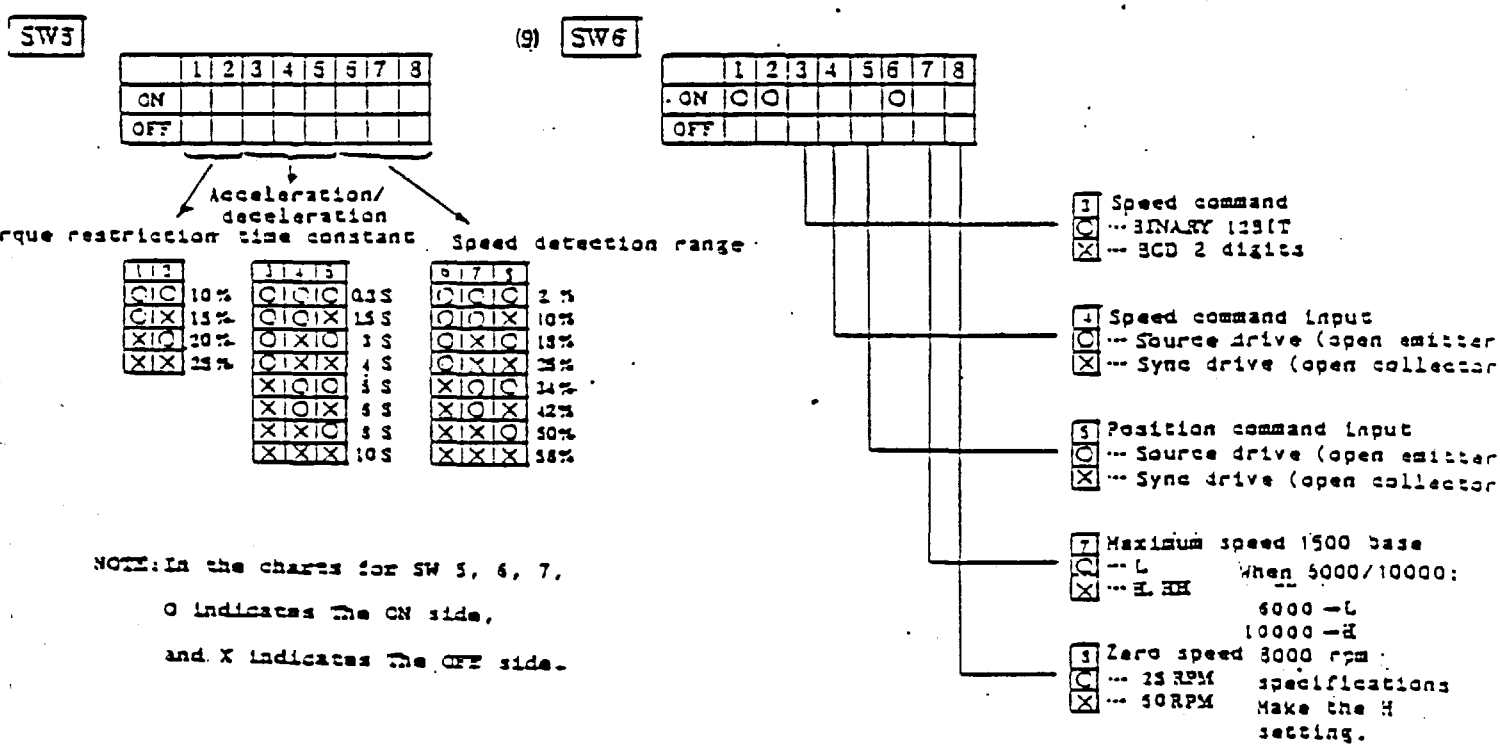
Switch OFF position



*1 *6 Source drive (open emitter)
*2 *7 Sink drive (open collector)
*3 SE-202 card only
*4 Orient position command interface setting
*5 Orient encoder power supply
*8 Supplied from NC
*9 Not supplied from NC
*10 Maximum value
*15 H: High speed
*16 MH: Medium-high speed
*17 ML: Medium-low speed
*18 L: Low speed
*20 Circle either.
*22 Enter required value.

(7) Orientation setting



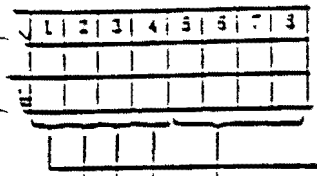


NOTE: In the charts for SW 5, 6, 7,

O indicates the ON side,

and X indicates the OFF side.

1) SW7



1		
O	Magnetic sensor in-position range	LOW (1°)
X	"	HIGH (5°)
2		
O	With emergency stop	LED ON
X	"	LED OFF
3		
	Load meter output.	HIGH (10V)
X	"	LOW (3V)
4		
O	Base speed	1150 rpm
X	"	1500 rpm

Base = 1150 rpm

5	6	7	8	Capacity	Top speed
O	O	O	O	Spare	Spare
O	O	O	X	2.2/3.7kW	3450/4600rpm
O	O	X	O	3.7/5.5	"
O	O	X	X	5.5/7.5	"
O	X	O	O	7.5/11	"
O	X	O	X	11/15	"
O	X	X	O	15/18.5	"
O	X	X	X	18.5/22	"
X	O	O	O	Spare	Spare
X	O	O	X	Spare	Spare
X	O	X	O	2.2/3.7	8000
X	O	X	X	3.7/5.5	"
X	X	O	O	5.5/7.5	6000
X	X	O	X	7.5/11	"
X	X	X	O	11/15	"
X	X	X	X	Spare	Spare

Base = 1500 rpm

5	6	7	8		
O	O	O	O	Spare	Spare
O	O	O	X	2.2/3.7kW	4500/6000rpm
O	O	X	O	3.7/5.5	"
O	O	X	X	5.5/7.5	"
O	X	O	O	7.5/11	"
O	X	O	X	11/15	"
O	X	X	O	15/18.5	"
O	X	X	X	18.5/22	"
X	O	O	O	Spare	Spare
X	O	O	X	Spare	Spare
X	O	X	O	3.7/5.5	8000
X	O	X	X	5.5/7.5	8000
X	X	O	O	7.5/9	8000
X	X	O	X	2.2/3.7	6000/10000
X	X	X	O	2.2/3.7/5.5	"
X	X	X	X	5.5/7.5	"

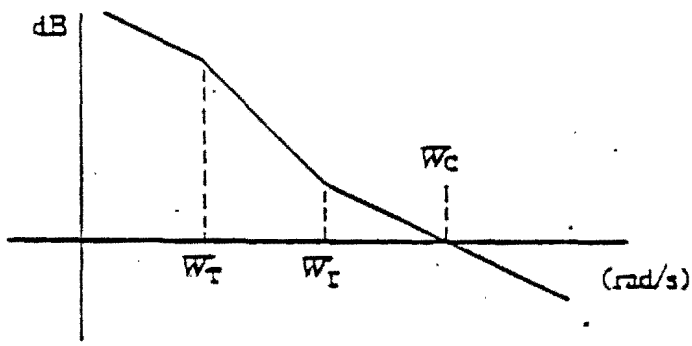
( ) SW8 Speed control loop proportional gain

Notch	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	Ⓕ	
Magnification	8/32	11/32	14/32	17/32	20/32	23/32	26/32	29/32	1	1.2	1.4	1.6	1.8	2	2.2	2.4	
W_C	25	34	44	57	63	72	81	91	100	120	140	160	180	200	220	240	(rad/s)

SW9 Speed control loop integral gain

Notch	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	Ⓕ	
Magnification	8/32	11/32	14/32	17/32	20/32	23/32	26/32	29/32	1	1.2	1.4	1.6	1.8	2	2.2	2.4	
W_I	1.5	2.1	2.6	3.2	3.8	4.3	4.9	5.4	6.0	7.2	8.4	9.6	10.8	12.0	13.2	14.4	(rad/s)

Determine the loop transfer function of the speed control loop in combination with the SW11-3.4 mode selection.



Note: The condition of WT>WI>WC must be met.

The standard settings are notch 8 for both SW8 and for SW9.

2) SW10 Orient speed setting

Notch	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮
rpm	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320

(13) SW11

	1	2	3	4
ON				
OFF				

Orient rotation direction

1	2	
O	O	—— Pre-mode
O	X	—— Reverse rotation mode
X	O	—— Forward rotation mode
X	X	—— 〃

Control with orient stop

3	4	
O	O	—— PI control
O	X	—— Lag/advance control
X	O	
X	X	

WT = 1.17 rad/sec
0.78
0.39

(14) SW12 In-position range

In-position range				
	0	±0	8	±0.704
	1	±0.088	9	±0.792
	2	±0.176	A	±0.88
	3	±0.264	B	±0.968
	4	±0.352	C	±1.056
	5	±0.44	D	±1.144
	6	±0.528	E	±1.232
	7	±0.616	F	±1.320

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