MODEL 1006 DICING SAW
MAINTENANCE MANUAL

MICRO AUTOMATION
275 SANTA ANA COURT
SUNNYVALE, CA 94086

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SECTION I

SYSTEM DESCRIPTION

1-1 MECHANICAL DESCRIPTION (M-1006)

The Model 1006 Dicing Saw consists of a spindle assembly, which turns the diamond saw blade. A vacuum chuck acts as a carrier for the material to be sawed. Four motor driven assemblies control the movement between the saw blade and the chuck. These four assemblies are designated "X", "Y", "Z" and "θ". The axis definition is shown in Fig. 1-1.

1-2 OVERALL CONSTRUCTION

The M-1006 utilizes a heavy duty, rib reinforced, multi-level casting as the main support and enclosing element.

The casting has four precision-ground reference surfaces upon which the "Y" slide, the "X" slide, the "X" lead screw and the "Y" lead screw mount.

There are two rear panels which attach to the casting. Two cooling fans, all input and output utility connections, two fuse holders, and a logic reset switch are mounted on the rear panels.

The spindle power supply is mounted in the right-rear section by four socket head screws into the threaded casting.

The logic power supply is mounted in the left-rear section of the casting. The card cage assembly mounts on top of the logic power supply.

1-3 SPINDLE ASSEMBLY DESCRIPTION

The spindle used in the M-1006 is a precision, high speed, air bearing motor with a motor shaft designed to accept saw blades.

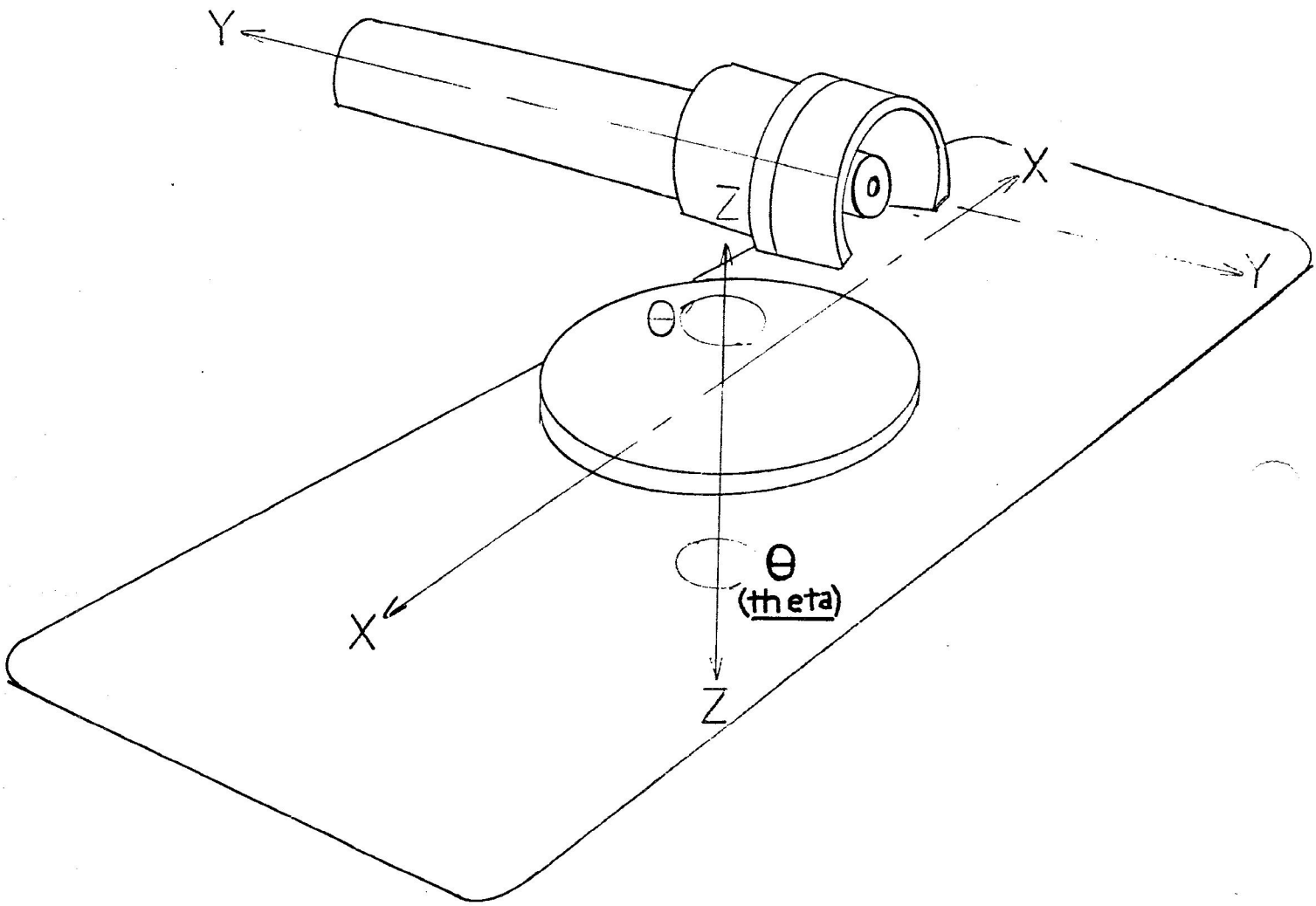


FIG. 1-1 AXIS DEFINITION

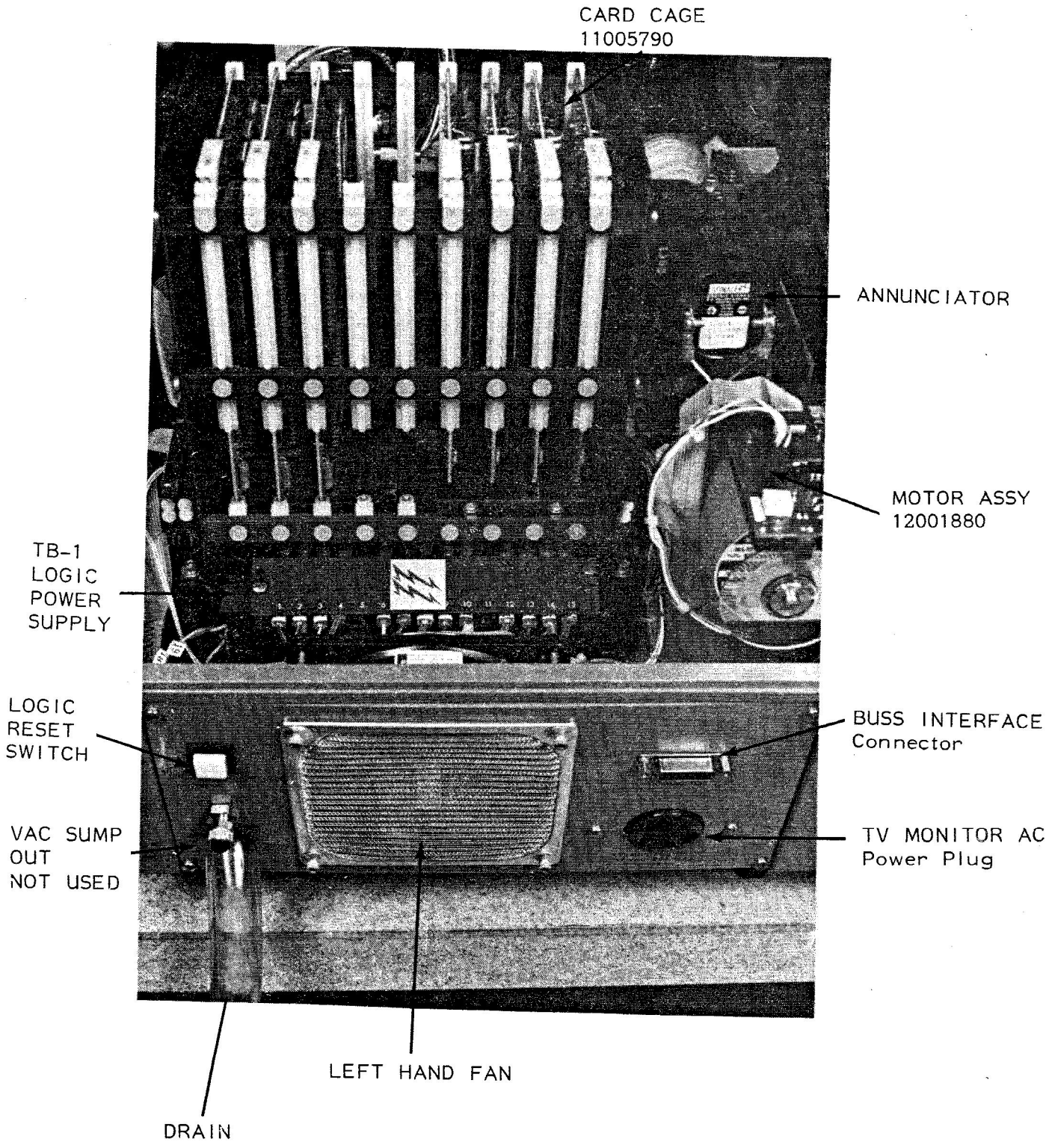


FIGURE 1-2

REAR VIEW RIGHT SIDE COVER REMOVED

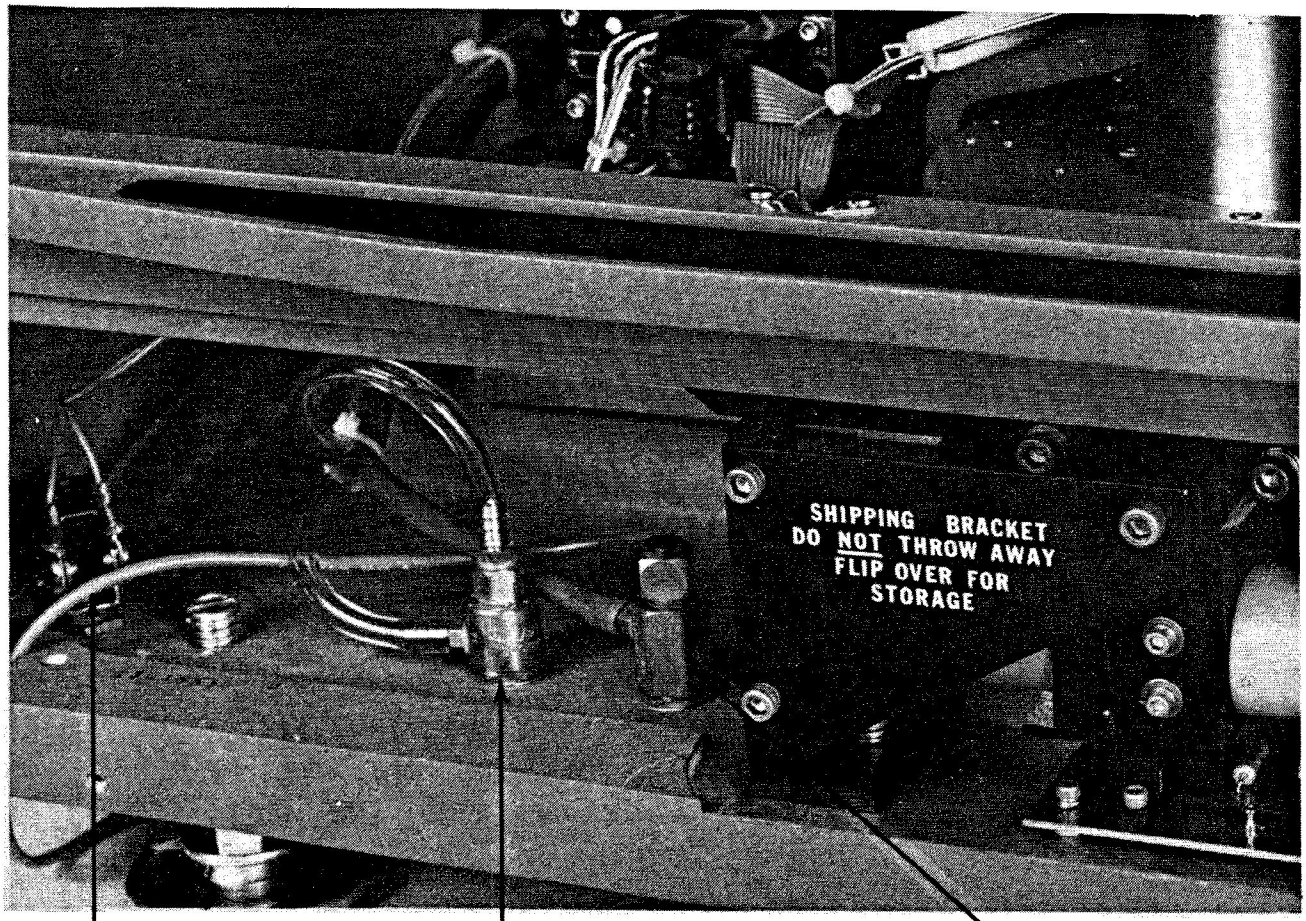


FIGURE 1-3

FRONT PANEL REMOVED TO SHOW
SHIPPING BRACKET INSTALLED FOR SHIPPING

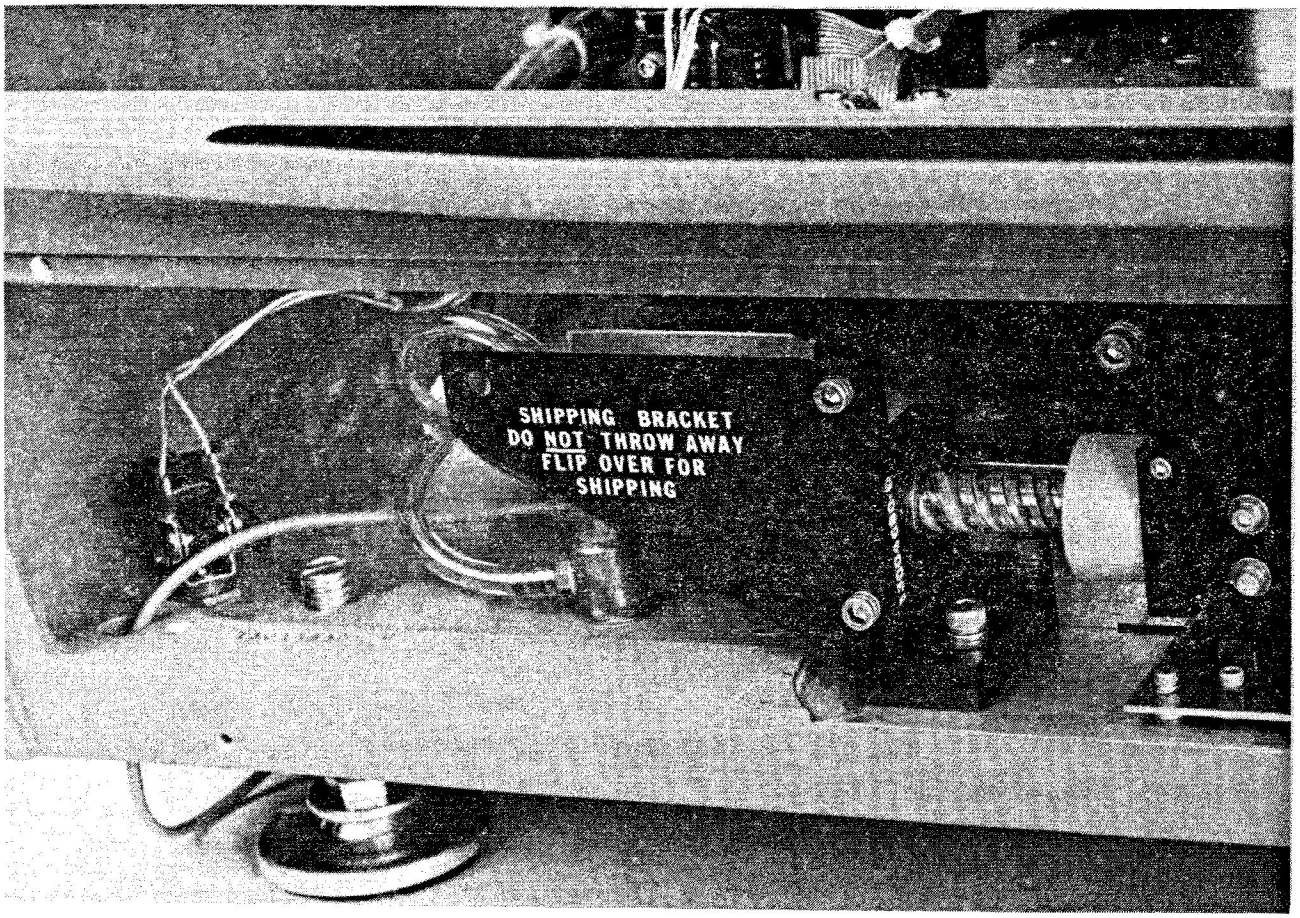


FIGURE 1-4

FRONT PANEL REMOVED TO SHOW
SHIPPING BRACKET INSTALLED FOR STORAGE

The spindle is capable of turning the blades at a controlled rate between 10,000 and 40,000 rpm. Cooling is accomplished via an externally supplied coolant which circulates through a cooling jacket. Air exits around the front of the shaft to protect the motor from water or contamination on the blade end, and through a screened port on the rear. Protective circuits turn the spindle off whenever the air pressure drops below 66 psi or the water flow drops below 1 pint per min. 2 Brushes mounted on the rear connect the spindle output shaft to the outside housing. The spindle housing is electrically isolated from the casting by a Mylar spacer.

A shroud mounted on the front of the spindle holds the blade cooling nozzles and a plexiglas blade cover.

1-4 THE "X" STAGE ASSEMBLY - DESCRIPTION

The "X" stage assembly consists of the "X" motor, "X" lead screw, "X" plate and "X" slide. The "X" plate carries the "Z" and "θ" assemblies.

Rotation of the "X" motor is converted to linear motion by the "X" lead screw. This motion is coupled to the "X" assembly to move the vacuum chuck under the cutting blade in the cutting direction.

1-5 "θ" (THETA) STAGE ASSEMBLY - DESCRIPTION

The "θ" stage assembly mounts on top of the "X" mounting plate and consists of the "θ" motor with a worm gear and the worm wheel.

Rotary motion of the motor shaft is converted to rotary motion of the worm wheel which is coupled to the chuck via the ball guide assembly. This motion is used to adjust the chuck angle in relation to the cutting motion. This axis allows automatic rotation of the vacuum chuck in preparation for the second or subsequent cuts.

1-6 "Z" STAGE ASSEMBLY - DESCRIPTION

The "Z" stage consists of the "Z" motor, "Z" lead screw, nut housing, and flanged bearing.

The "Z" nut housing mounts inside the flanged bearing and the rotary motion of the "Z" motor shaft is converted into linear motion by the "Z" lead screw. The chuck is mounted to the "Z" nut housing and the linear motion of the "Z" nut moves the chuck surface up and down in relation to the blade. This gives automatic control of cutting depth.

1-7 "Y" STAGE ASSEMBLY - DESCRIPTION

The "Y" stage consists of the "Y" slide assembly, upon which the spindle and optics are mounted, and the "Y" lead screw assembly.

Rotary motion of the "Y" stepper motor shaft is converted to linear motion by the "Y" lead screw and nut which is attached to the "Y" slide assembly and moves the cutting blade perpendicular to the cutting stroke.

Each step of the "Y" motor results in 0.000125" movement of the blade, thus giving excellent resolution of the "Y" indexing.

1-8 ELECTRICAL DESCRIPTION

1-9 INPUT AC POWER DISTRIBUTION

The Model 1006 Dicing Saw will operate on input AC power of 105 VAC to 254 VAC single phase, 50 to 60 HZ. The power supplies can be adjusted for any voltage in this range by means of multiple input taps on the input transformers. Be sure they are properly adjusted before startup.

The input power cord has three wires. The ground wire ties directly to the saw chassis.

The input neutral wire connects directly to the spindle power supply, and through a filter, to the logic power supply. The AC hot

wire connects to two fuses on the right-rear input panel, through a top cover actuated safety switch, through front panel "panic" switch. From the safety switch, it connects directly to the spindle power supply, and through a filter, to the logic power supply.

A safety switch will disconnect all power when the top cover is removed from the saw. A service position is provided and the safety switch can be bypassed by pressing the switch plunger down and twisting clockwise. The lock will be released when the top cover is reinstalled.

1-10 SPINDLE POWER SUPPLY

All input and output connectors to the spindle power supply connect to terminal boards, TB5 and TB6 which are mounted on each side of the vertical plate. The input transformer of the spindle power supply has several voltage taps which connect to the input terminal board TB6. The supply is adjusted for different input voltages by moving the AC hot input wire and connecting different jumper combinations to various terminals of TB6. The chart below shows the connections for the various input voltages.

TB6 CONNECTIONS FOR VARIOUS AC INPUT VOLTAGES

Input Voltage	TB6 Jumper #1	TB6 Jumper #2	AC Hot Connection
105V	1 & 2	3 & 4	3
117V	1 & 2	5 & 6	5
126V	1 & 2	8 & 9	8
210V	2 & 3		4
222V	2 & 3		5
234V	6 & 7		5
243V	6 & 7		9
254V	7 & 8		9

The spindle power supply provides the following output voltages:

VOLTAGE	FREQUENCY	WHERE USED	FUSE	OUTPUT	
				TB6	TB5
115V AC	50-60 HZ	Cooling Fans		1 & 2	12 & 13
5V AC	50-60 HZ	Optics Lamps		12	
4V AC	50-60 HZ	Optics Lamps		13	
3V AC	50-60 HZ	Optics Lamps		14	
60V to 164V AC	500 to 900 Hz	2 Phase Spindle Power	F4/F5 4Amp		1,2,3&4
+30V	DC	Stepper Motor Drivers	F2/8Amp		5
+ 7V	DC	Stepper Motor Drivers	F3/4Amp		6
+10V	DC	Spindle Braking			1,2,3&4
+12V DC	DC Unfiltered	Solenoids & Relays	F1/4Amp	11	

There are five fuses on the right side of the vertical mounting plate of the spindle power supply. The fuse ratings, numbers and circuit usages are listed on the chart above.

There are several internal power supplies which are used for the Spindle Drive Logic & High Voltage Supply. These supply voltages are listed below:

+220V	DC
0 to +165V	DC
+ 24V	DC
+ 15V	DC
+ 5V	DC
− 5V	DC
+0.6V	DC

1-11 LOGIC POWER SUPPLY

The logic power supply provides the +5VDC to the card cage and all sensors, the 117 VAC to the TV monitor auxiliary connector, and the 35 VAC to the TV camera.

All input and output connections to the logic power supply connect to a 15-pin terminal board, "TB1".

The input transformers in the logic power supply can be connected for either 115 VAC or 220 VAC. The input connections and jumpers are shown on the chart below.

Input Voltage	AC Hot	AC Neutral	Jumper #1
105 - 125	12 & 14	13 & 15	
200 VAC Up	12	15	13 & 14

The +5V is output on TB1-5. The +5V sense and +5V low sense connect to the card cage for voltage regulation.

Three fuses are connected to the AC output circuits. Two fuses connect to the TV camera and one connects to the TV monitor outlet.

1-12 CARD CAGE

A card cage mounts on top of the logic power supply. The card cage contains seven input-output cable connectors, nine card connectors, and an annunciator assembly. The card cage is identified as assembly A1 on all drawings. The input and output connectors are identified as A1-J1 through A1-J7. The card connectors are identified from left to right as C1 through C9. The logic board assignments are listed on the next page.

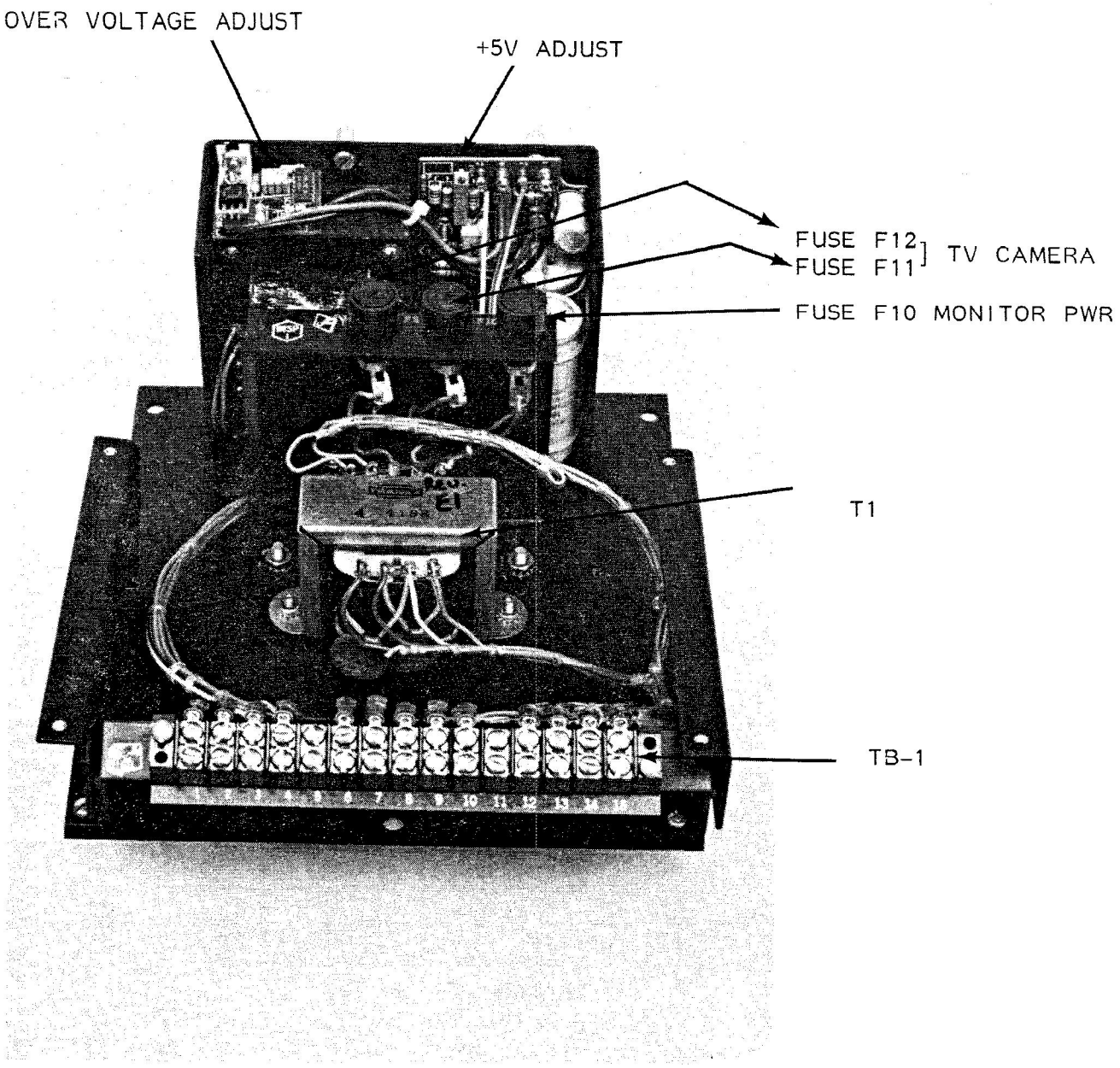


FIGURE 1-5

LOGIC POWER SUPPLY DETAIL

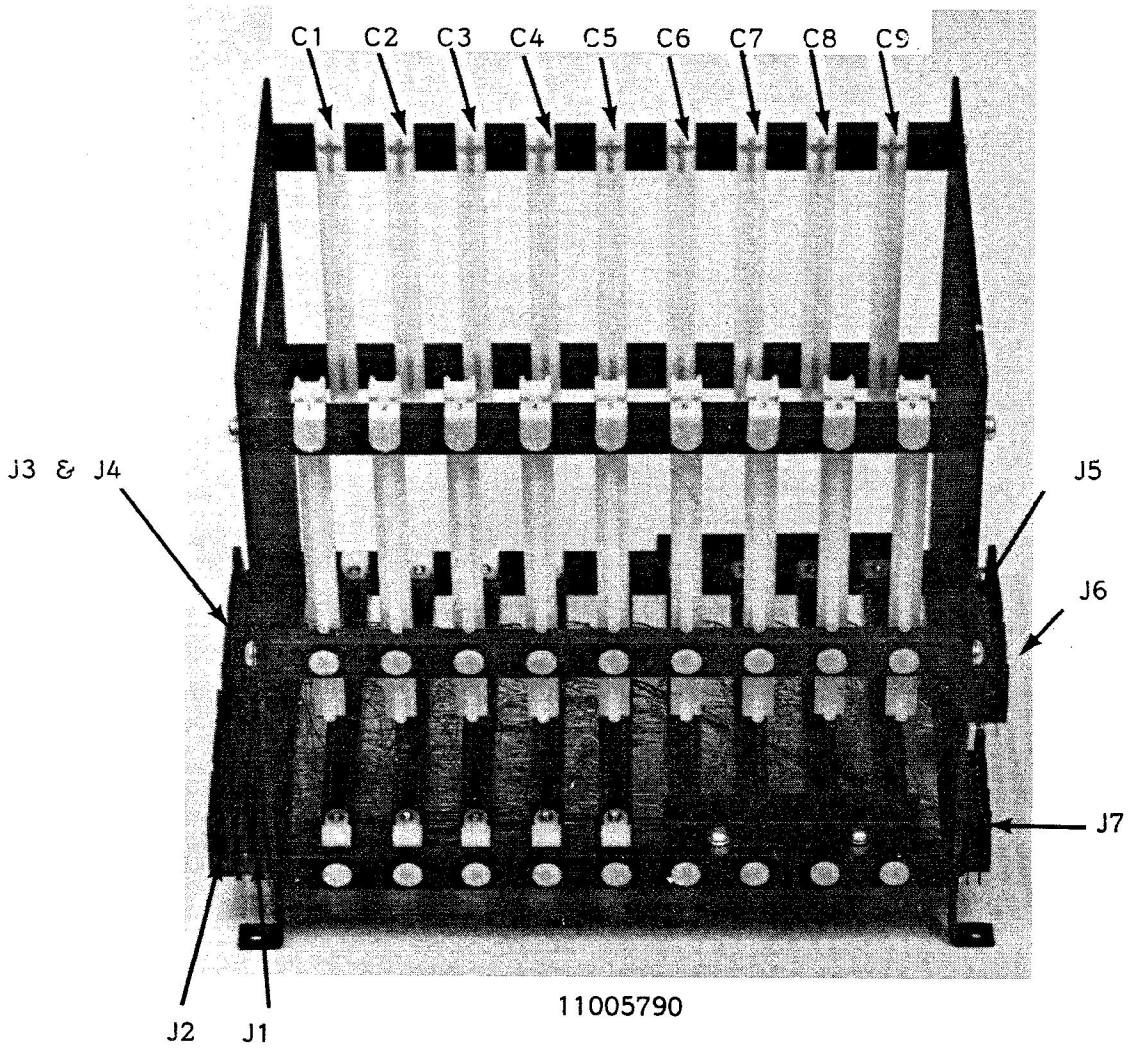
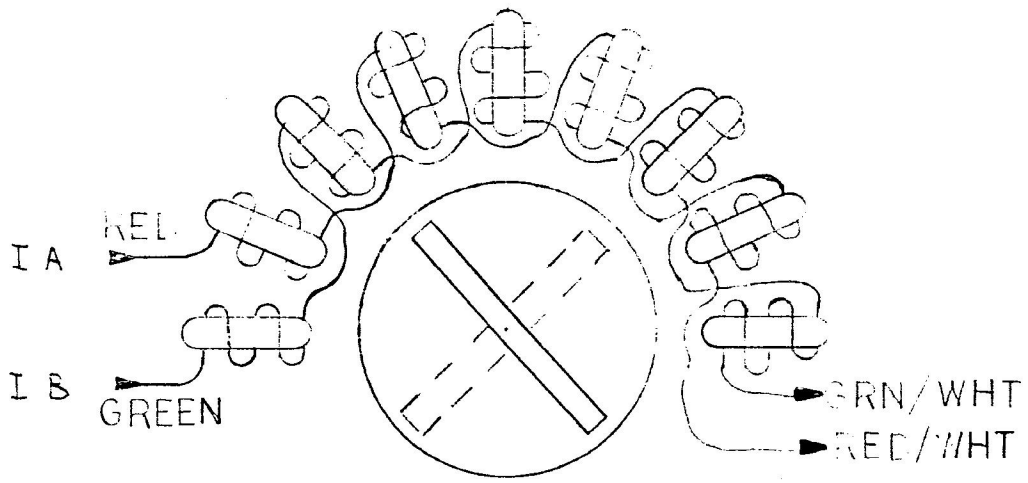


FIGURE 1-6

CARD CAGE DETAIL



I A	I B	PHASE
↑	↑	1
↑	↓	2
↓	↓	3
↓	↑	4

FIG. 1-7 STEPPER MOTOR CONFIGURATION

CONNECTOR	LOGIC PCB
C1	Housekeeper CPU
C2	Motor CPU X-θ
C3	Motor CPU Y-Z
C4	MEMORY EXPANDER OPTIONAL
C5	BUSS INTERFACE (AUTO-ALIGN ONLY)
C6	X Motor Driver
C7	Y Motor Driver
C8	θ Motor Driver
C9	Z Motor Driver

These boards are identical and interchangeable.

These four PCBs are indentical and interchangeable.

1-13 STEPPING MOTORS

There are four stepping motor assemblies in the M-1006 dicing saw. They are identified as "X", "Y", "θ", and "Z". All four motors are electrically identical. The "Z" motor is physically shorter than the others and therefore is not interchangeable with them. The "X", "Y", and "θ" motor assemblies are identical. They are all coupled to the mechanical assemblies by flexible couplings, therefore, they are easily interchangeable without requiring any realignment of the precision assemblies.

All motors are connected to the card cage via flat ribbon cables.

The stepping motors used in the M-1006 saw are permanent magnet type motors. These motors contain a stator which has a number of wound poles. Each pole may have a number of teeth as part of its flux distributing member. The rotor is cylindrical and toothed. These motors incorporate a permanent magnet in the rotor assembly. Operation of the motor is accomplished by means of the interactions between the rotor magnet biasing flux and the magnetomotive forces generated by applied current in the

stator windings. When the pattern of winding energization is fixed, there is a series of stable equilibrium points generated around the motor. The rotor will move to the nearest of these and remain there. If the windings are then excited in sequence, the rotor will follow the changing point of equilibrium. The motors used in the M-1006 have a step angle of 1.8^{o} per step, hence 200 steps are required to make a complete revolution.

The motor wiring consists of two center tapped windings. The center taps are not connected to the motor drivers.

The motor sensor PC board is mounted onto the motor plate. The PC board contains the connections for driving the motor and also the sensor for the motor encoder. An encoder wheel is attached to the rear motor shaft. This wheel turns within the slot of the photo coupler, alternately interrupting and passing the light and producing a square wave output. These encoders provide the controlling electronics with a signal to indicate motor movement.

1-14 LIMIT SENSOR CIRCUITS

Limit sensor circuits in the M-1006 saw provide feedback to the controlling circuits to indicate the travel limits of the "X", "Y", "θ" and "Z" stages. These circuits consist of photo-optical sensors which are activated by a flag which interrupts the light beam.

The "X", "θ", and "Y" axes each have two limit sensors which are mounted to a single printed circuit board. The "Z" axis has a single lower limit sensor.

The input and output wiring to all sensors is through 10 pin connectors to flat ribbon cables which connect to the card cage.

Each sensor is mounted in a plug-in socket for easy maintenance. Test pins are provided on each sensor card for failure analysis and maintenance.

The sensor boards are mounted by screws through permanent standoffs. The position and design of these standoffs is carefully controlled to provide automatic alignment when a sensor board is replaced.

1-15 FRONT PANEL DESCRIPTION

The front panel has two circuit boards mounted to the back called the control PCB (A2) and the program PCB (A3). These two PCBs are interconnected by cable A2-J1-A3-J1. All input and output signals connect to the front panel through a flat ribbon cable to the card cage. The front membrane panels connect to these PCB'S via flat ribbon cables & connectors.

1-16 AUXILIARY LOGIC

The auxiliary logic PCB mounts on standoffs to the control PCB behind the front panel.

Input and output wiring connect through one flat ribbon cable connector and one discrete wire connector.

The auxiliary logic PCB contains the following circuits:

(a) +12V DC Filter
(b) Chuck Zero Circuit
(c) Logic Reset & NVM Disable Circuit
(d) TV/Monocular Switch
(e) Metric/English Switch
(f) Limit Sensor LED Driver
(g) Various Pull Up Resistors

1-17 SWITCHES, SENSORS AND SOLENOIDS

There are various switches, sensors, and solenoids associated with control and operation of the M-1006 Dicing Saw. These are shown on the chart on the next page along with the location, function and electrical connection.

DEVICE	NAME	FUNCTION	ELECTRICAL CONNECTION	LOCATION
Push-Button Switch	SW 1	Logic Reset		Left Rear Panel
Push-Button Switch	SW 11	Turns Cutting H_2O "ON"	TB4 - 4 TB6 - 10	Under Corner Bottom Front, Right
Pressure Sensor	SW 3	Senses Low Spindle Air Pressure	TB4 - 8 & 9	Right, Rear Side
Pressure Sensor	SW 4	Senses Low Cutting Water Pressure	TB4 - 14 & 15	Right, Back Panel
Vacuum Sensor	SW 2	Senses Low Vacuum	TB4 - 12 & 13	Right, Rear Side
Flow Switch	SW 10	Senses Spindle Coolant Flow	TB4 - 6 & 7	Rear on TB4
Vacuum Toggle	NONE	Supply Vacuum to Blade Tool	NONE	Under Front Casting
Air Push Button	NONE	Remove Water From Wafer	NONE	Under Front Casting
Solenoid	Sol. 3	Control Cutting Water	TB4 - 3 & 4	Right, Back Panel
Solenoid	Sol. 4	Control Spindle Coolant	TB4 - 1 & 2	Right, Back Panel
Solenoid	Sol. 2	Control Vacuum to Chuck	TB3 - 3 & 2	Above Logic P/S Left, Center Side
Solenoid	Sol. 1	Control Air to Chuck	TB3 - 1 & 2	Above Logic P/S Left, Center Side
Solenoid	Sol. 5	H_2 Wafer Blow Off	TB-4-11-3	Rear on TB4
DIP Toggle Switch	S1 - 4	Preset TV or Monocular	Aux. Logic	Behind Front Control Panel
DIP Toggle Switch	S1 - 3	Preset English/ Metric	Aux. Logic	Behind Front Control Panel
Toggle Switch	Power On	TV Camera ON/OFF	Camera Internal	TV Camera Top
Toggle Switch	Power On	TV Monitor ON/OFF	Monitor Internal	TV Monitor Front
Toggle Switch	NONE	Monitor Load 75 ohms	Monitor Internal	TV Monitor Rear

1-18 MOTOR DRIVERS

There are four motor drivers which plug into the card cage at C6, C7, C8, and C9. The drivers provide driving signals for the "X", "Y", "θ", and "Z" motors respectively. The circuits are identical and interchangeable. In addition to the motor driving circuits, there are two solenoid drivers on each board consisting of Q6 and Q12.

The two motor coils connect through the connector at pins 15, 16 and 13, 14 for one coil, and pins 57, 58, and 59, 60 for the other coil. Transistors Q1 and Q7 act as high voltage switches which control the +30 volt starting pulses. Q2 and Q5 act as push-pull drivers in one direction and Q4 and Q3 in the other for one coil, while Q8 and Q11 with Q10 and Q9 perform the same function for the other motor coil. All these transistors are driven by optocouplers to maintain isolated grounds from the motor driver circuits to the logic circuits.

The first relay driver input is on pins 25 and 26 with the output on 65 and 66. Schmitt trigger IC14 squares up the input signal and drives optocoupler #12 which in turn drives the output driver Q12. In the C7 position, this driver controls the air solenoid. In C8, it controls the spindle relay on the spindle power supply.

The second relay driver is identical in operation to the first with inputs on pins 27 and 28, output on pins 5 and 6 and consisting of optocoupler 6 and transistor Q6.

These drivers provide the driving current for relays and solenoids according to the communication and control structure shown in Fig. 1-8.

1-19 HOUSEKEEPER MICROPROCESSOR (CPU)

The housekeeper CPU is located in the card cage at position C1. The card is powered by logic +5V. The control program is

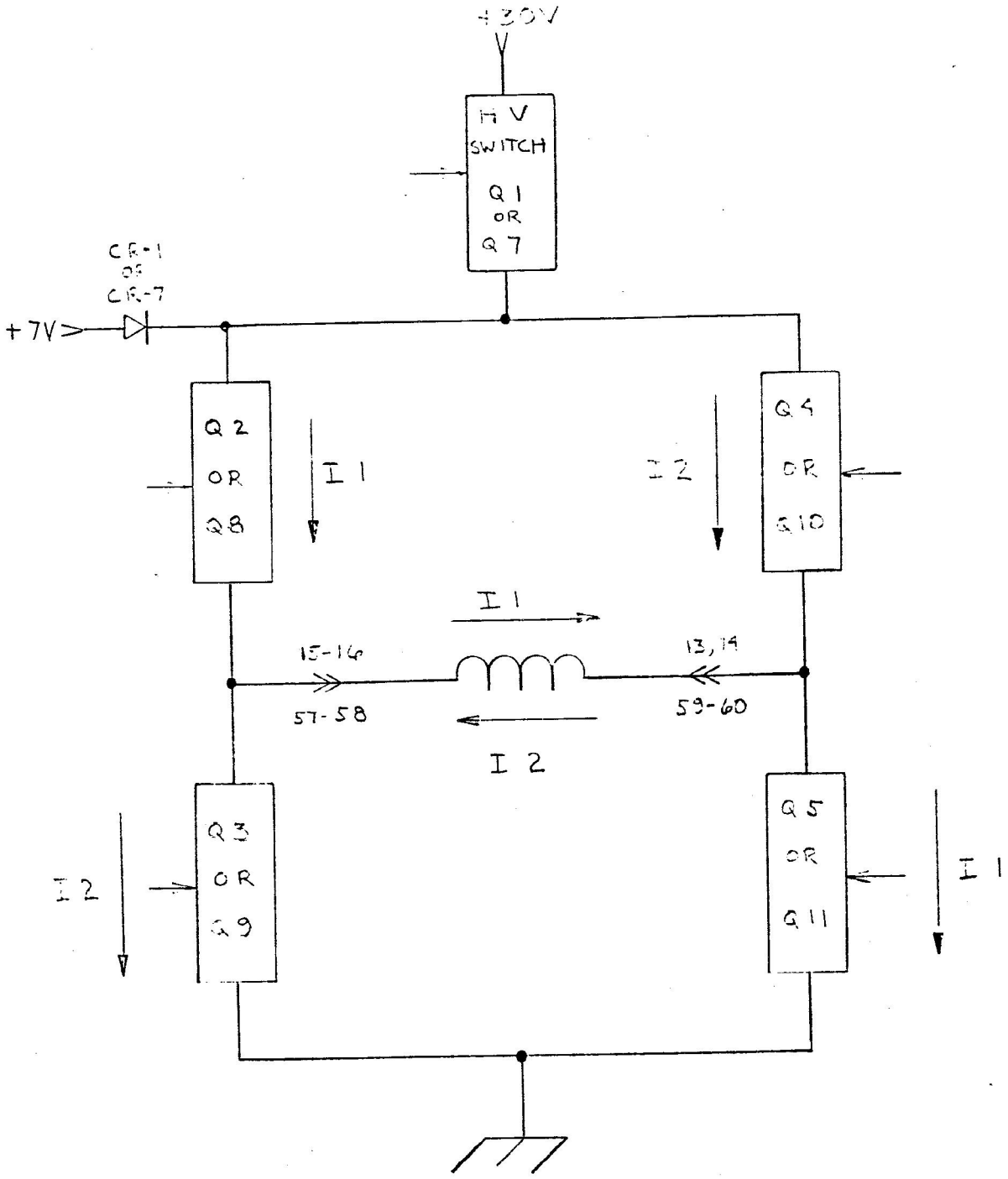


FIG. 1-8 STEPPER DRIVER CONFIGURATION (1 CCIL)

resident in the four EPROMS, R1 through R4. The housekeeper CPU performs all the arithmetic functions, samples and decodes the front panel controls and position sensors, controls the motor CPU and controls all relay and solenoid functions.

Additionally, the housekeeper CPU contains the non-volatile memory (NVM) circuit which is used for program storage.

The housekeeper CPU is the only unique PCB in the card cage and is not interchangeable with any other card in the saw. However, the artwork of the housekeeper CPU is identical to that of the motor control CPU. This enables the conversion of one type board to the other simply by changing plug-in modules, two diodes, and a battery.

1-20 MOTOR CONTROL MICROPROCESSOR (CPU)

There are two identical motor control CPU cards per saw. The CPU at location C2 controls the "X" and the "θ" motors on a time-share basis. The CPU at location C3 controls the "Y" and "Z" motors on a time-share basis. Both motor CPU receive speed, direction, and axis commands and clock signal from the housekeeper CPU.

The EPROMS contain the program which calculates acceleration and deceleration and motor drive signals.

1-21 INTERCONNECT WIRING

The wiring of the M-1006 Dicing Saw consists of a harness and seven flat ribbon cables.

The wiring harness connects the power supplies, sensors, solenoids, switches, fuses, filters, etc., to the various terminal boards and connectors. The wiring is shown in Drawing #17005800.

The ribbon cables use push-on connectors for ease of replacement or failure analysis. The connectors and sockets are color coded to aid in identification and polarity. Drawing #17005870 shows the wiring and color code of all the ribbon cables.

SECTION II

MAINTENANCE

2-1 SPINDLE ASSEMBLY MAINTENANCE (M-1006)

2-2 SPINDLE ASSEMBLY - DETAILED DESCRIPTION

The spindle assembly consists of a high-speed, water-cooled air bearing, two-phase AC spindle motor, a spindle casting and a blade shroud.

The spindle motor is mounted inside the split casting with a mylar insulator wrapping to electrically insulate the spindle motor from the casting. The two-phase power connects to the spindle motor via a four-wire cable with lug terminals connected to TB5 of the spindle power supply. The wiring color code is as follows:

Green - TB5-1
White - TB5-2
Black - TB5-3
Red - TB5-4

The spindle motor shaft is electrically connected to the outside motor housing via 2 spring-loaded brushes. These brushes are connected to and held in place by 2 slotted screws, which screw into the back of the spindle motor housing. One brush is insulated from the outside casing and also contacts the motor shaft.

The motor housing is connected to the chuck zero circuit by a lugged wire that mounts under a screw on the back of the spindle motor, and another wire that connects to the insulated brush.

The air for the air bearings comes into the spindle motor at the rear. The air exits the spindle motor through a screened outlet on the rear of the spindle motor and around the rotating shaft

at the front of the spindle motor. Extreme caution must be taken to ensure that no contaminants or foreign material enters the spindle air system. Any contamination will cause bearing failure which will require spindle replacement.

The cooling liquid enters and exits the spindle motor via two barbed tubing fittings. The spindle requires a flow of approximately one (1) pint per minute to maintain the proper temperature. When the coolant exits the spindle, it connects through a flow switch to the output fitting on the right, rear panel. The flow switch is set to close at the proper flow rate.

The blade shroud mounts to the front of the spindle motor and provides two water nozzles for cooling the cutting blade, a splash guard around the blade, a wafer-cleaning air nozzle and a plexiglas blade cover.

The position of the blade shroud is set by the two locking screws which compress the shroud assembly around the motor shaft housing.

Left blade cooling nozzle is held in place by a set screw which can be adjusted through holes in the front of the blade splash cover.

The plexiglas blade cover is held by two kuurled screws to the blade shroud.

The spindle casting mounts on top of the "Y" slide assembly. It is a split assembly designed to compress around the spindle motor and hold it in place. There are two compression screws; one at the front and one at the rear of the split. There are also two threaded holes adjacent to each compression screw. These holes are available to facilitate spreading the casting by insertion of two screws. Threaded holes are available on the top of the casting to allow mounting of the optics assembly and connectors. There is also an extension on the left side of the casting where the lead screw nut assembly attaches.

2-3 PREVENTIVE MAINTENANCE

The frequency of performing these Preventive Maintenance procedures is dependant upon equipment usage time.

2-4 INSPECTION

Every eighty hours inspect the spindle motor output shaft. Check for accumulation of "slurry" or any buildup between the blade mounting surface and the splash cover back plate.

Every eighty hours inspect the front of the spindle motor housing where it joins the casting. Look for moisture or accumulation of dirt, slurry, etc. Clean away any accumulation and dry the area thoroughly.

Every 180 hours remove the brush mounting screws from the rear of the spindle motor. Inspect the brushes for signs of wear, etc. Replace if necessary. Extend the springs to compensate for wear.

Every 180 hours inspect spindle coolant and air for signs of leaking, looseness, damage or wear. Repair or replace as required.

2-5 CLEANING

To clean around the front of the spindle output shaft, proceed as follows:

CAUTION: MAKE SURE POSITIVE AIR PRESSURE IS ON DURING ALL CLEANING OPERATIONS NEAR THE SPINDLE OUTPUT SHAFT.

(a) Remove saw blade and clean all accumulations of slurry, etc., from the spindle shaft and surrounding shroud, using water and any mild detergent. Make sure air is blowing evenly around the spindle shaft.

(b) In cases of severe accumulation which restricts air flow or causes friction between the spindle shaft and shaft housing, the splash guard may have to be removed in order to clean the assembly. After cleaning, reassemble, making sure there is uniform clearance around the output shaft. Turn spindle by hand and listen for rubbing. If required, readjust splash guard spacer to insure proper alignment.

(c) To clean the spindle housing front, where the spindle joins the casting, proceed as follows:

CAUTION: DURING THE FOLLOWING MAINTENANCE AND CLEANING OPERATIONS, TAKE CARE NOT TO DAMAGE OR WET THE MYLAR INSULATOR BETWEEN THE SPINDLE HOUSING AND THE SPINDLE CASTING. ANY CONTINUITY BETWEEN THE CASTING AND SPINDLE HOUSING WILL CAUSE FAILURE OF THE CHUCK ZERO CIRCUIT.

(1) Use a brush to clean away any accumulation of dirt, slurry, etc. from this area.

(2) Wipe away any remaining accumulation using a dry cloth or wiping tissue.

(3) Using compressed air or other inert gas, blow-dry the entire area thoroughly.

2-6 CUTTING WATER NOZZLE ADJUSTMENT

After performing the cleaning and disassembly described above, it will be necessary to check and adjust the cutting water nozzle The nozzle is held in place by an Allen set screw through the shroud. Adjust the nozzle for approximately 1/8" clearance from the upper corner of the nozzle and the edge of the cutting blade. The cutting blade should be centered in the water flow.

2-7 SPINDLE REPLACEMENT

2-8 SPINDLE REMOVAL

When it is determined that replacement of the spindle is required, proceed as follows. Note the position of the spindle in relation to the front of the casting.

(a) Disconnect the spindle cooling lines from the back of the spindle.

CAUTION: IN HANDLING COOLING LINES, BE CAREFUL NOT TO ALLOW WETTING OF THE MECHANICAL ASSEMBLIES.

(b) Remove air line from spindle motor rear fitting. Cover air line to prevent contamination.

(c) Remove two wires from screws on back of spindle.

(d) Remove all ty-wraps and cable clamps from spindle cable.

(e) Disconnect spindle wires from terminal strip on spindle power supply.

(f) Loosen the two spindle casting compression screws at the top of spindle casting.

(g) Install two 10 x 32 screws into the tapped holes next to the casting compression screws, and screw them in until they expand the casting and the spindle is free.
CAUTION: DO NOT OVER-TIGHTEN THESE SCREWS OR DAMAGE TO THE CASTING MAY RESULT.

(h) Loosen the two compression screws which hold the front housing on the spindle.

(i) Carefully move spindle to the rear while holding the front housing until the front housing is clear of the spindle and can be held aside for step (j).

(j) While holding the front housing aside, remove the spindle from the casting by pulling it forward through the front.

2-9 SPINDLE INSTALLATION

Prior to installation, clean the inside of the spindle casting.

(a) Carefully feed the spindle cable through the casting.

(b) While holding the spindle in front of the casting, wrap the mylar rectangle around the spindle, making sure the gap is offset from the spindle casting split at four (4) o'clock, and then insert the spindle into the spindle casting.

(c) Push the spindle toward the rear of the casting until you can fit the front housing over the front of the spindle, then re-position the spindle forward to the same location in the casting noted before removal of the previous spindle. With the spindle in position, loosen the spindle casting expansion screws, allowing the casting to relax and loosely hold the spindle in place.

D. Attach the spindle coolant lines onto the rear spindle barbed fittings.

E. Remove cover from the air line, turn on air pressure to blow out any foreign material.

F. Attach the air line to the rear spindle fitting. If necessary, use the fitting from the previous spindle.

G. Install cable clamps and/or ty-wraps on the spindle cable and route the cable the same as before.

H. Connect the four wires in the spindle cable to the spindle power supply terminal strip.

I. With an ohmmeter, check resistance from spindle to the spindle casting. Check at a place where there is no coating. The resistance should be infinite. If the resistance is infinite, continue assembly; if the resistance is not infinite, check mylar rectangle and casting surface. The mylar should insulate the spindle from the casting.

J. Connect the two wires under the screws at the back of the spindle. Connect the violet wire to the metal brush holder and the orange wire to the nylon brush holder.

2-10 SPINDLE ASSEMBLY ALIGNMENT

After spindle replacement, the following alignments must be made:

A. Front Housing Position Alignment (Ref. Fig. 2-1, 2-2 and 2-3)

The front housing must be positioned on the spindle so that the front of the baffle plate is 0.109 inches behind the blade mounting surface and the flat surface on the bottom of the housing is parallel to the chuck surface.

To position the front housing in relation to the blade surface:

1. Loosen the housing compression screws and rotate the housing to expose the bottom side to view.

2. Mount an old or scrap blade in a normal manner.

(3) Hold the chuck zero gauge block between the back of the blade and the baffle plate.

(4) Position the front housing so that the chuck zero gauge block is tight between the back of the blade and the baffle plate, and tighten the front housing compression screws.

(5) Put masking tape around the spindle to mark the front housing position.

(B) Front Housing Parallelism Alignment

(1) Loosen the front housing compression screws and rotate the front housing until the bottom flat is approximately parallel to the chuck surface.

(2) Place a flat bar such as a piece of machine tool steel on the chuck, parallel to the front of the machine.

(3) Manually position the chuck under the spindle and rotate the "Z" motor to raise the chuck until the flat bar approaches the bottom of the front housing.

(4) Loosen the front housing compression screws and rotate the front housing as necessary to align the bottom flat surface of the front housing parallel to the flat bar on the chuck $\pm$0.005 inch.

(5) While maintaining the parallelism and the position found in (A) above, tighten the front housing screws and remove the flat bar from the chuck.

(C) Spindle "Y" Position Alignment (Ref. Para. 2-34)

The cutting blade should be positioned over the center of the chuck when the "Y" axis is in the "Home" position. To check and adjust this, proceed as follows:

(1) With a blade mounted on the spindle, power up the saw and press the power reset switch. The "Y" axis should position itself in the approximate center of its travel.

(2) Program the saw and place in the Index mode. Position the chuck under the spindle using the wafer right/left controls.

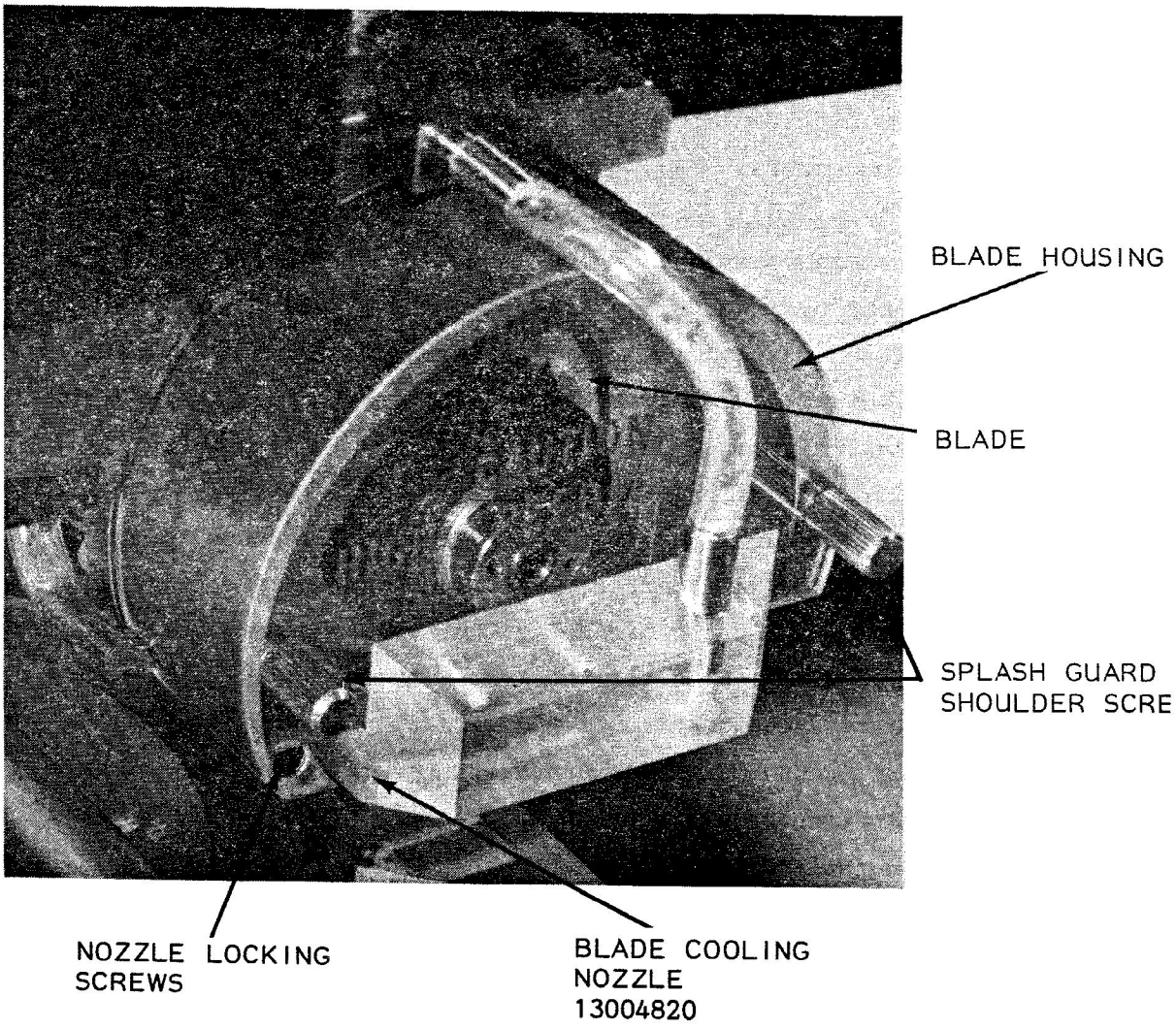


FIGURE 2-1
SPINDLE FRONT DETAIL

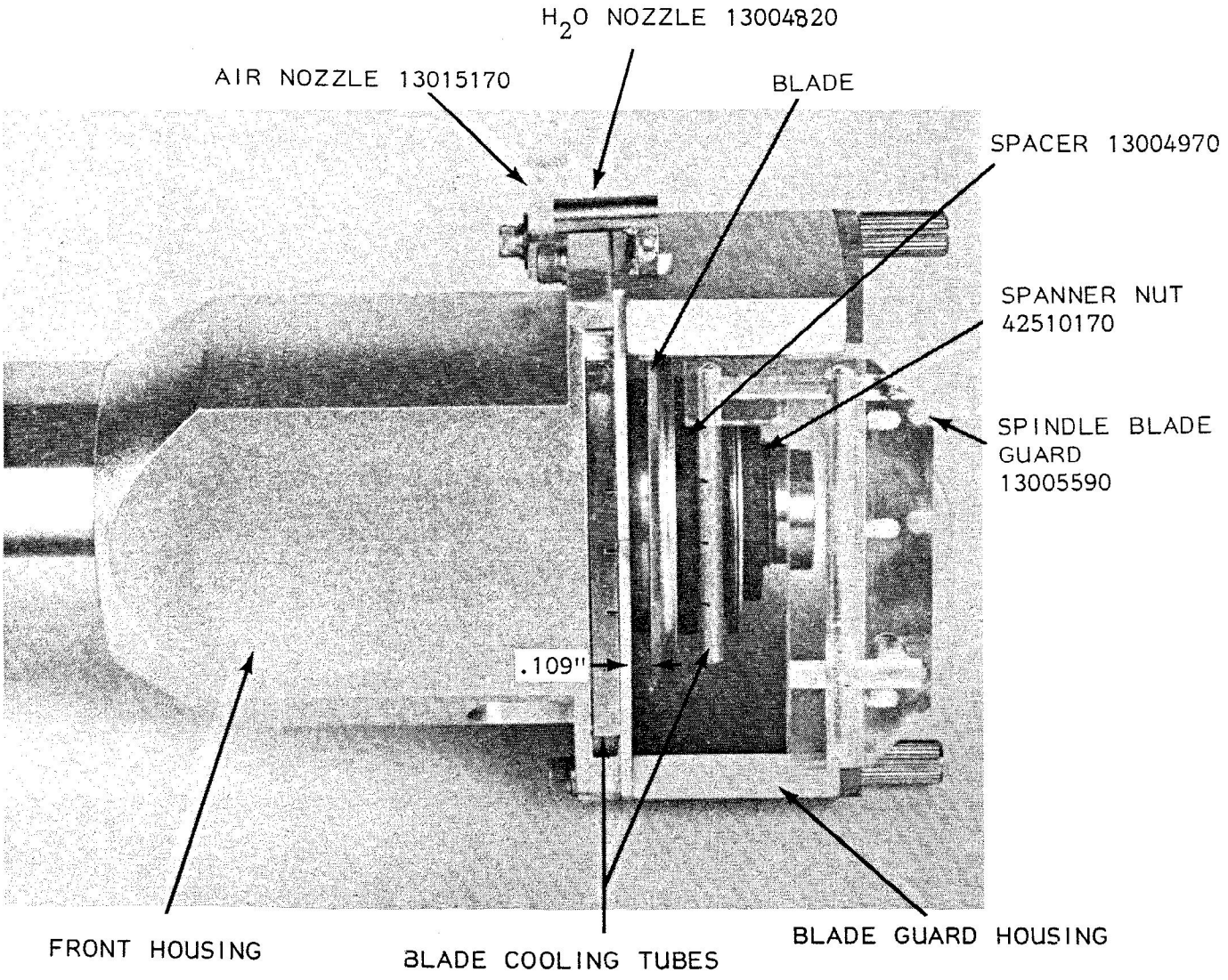


FIGURE 2-2

SPINDLE FRONT HOUSING BOTTOM VIEW

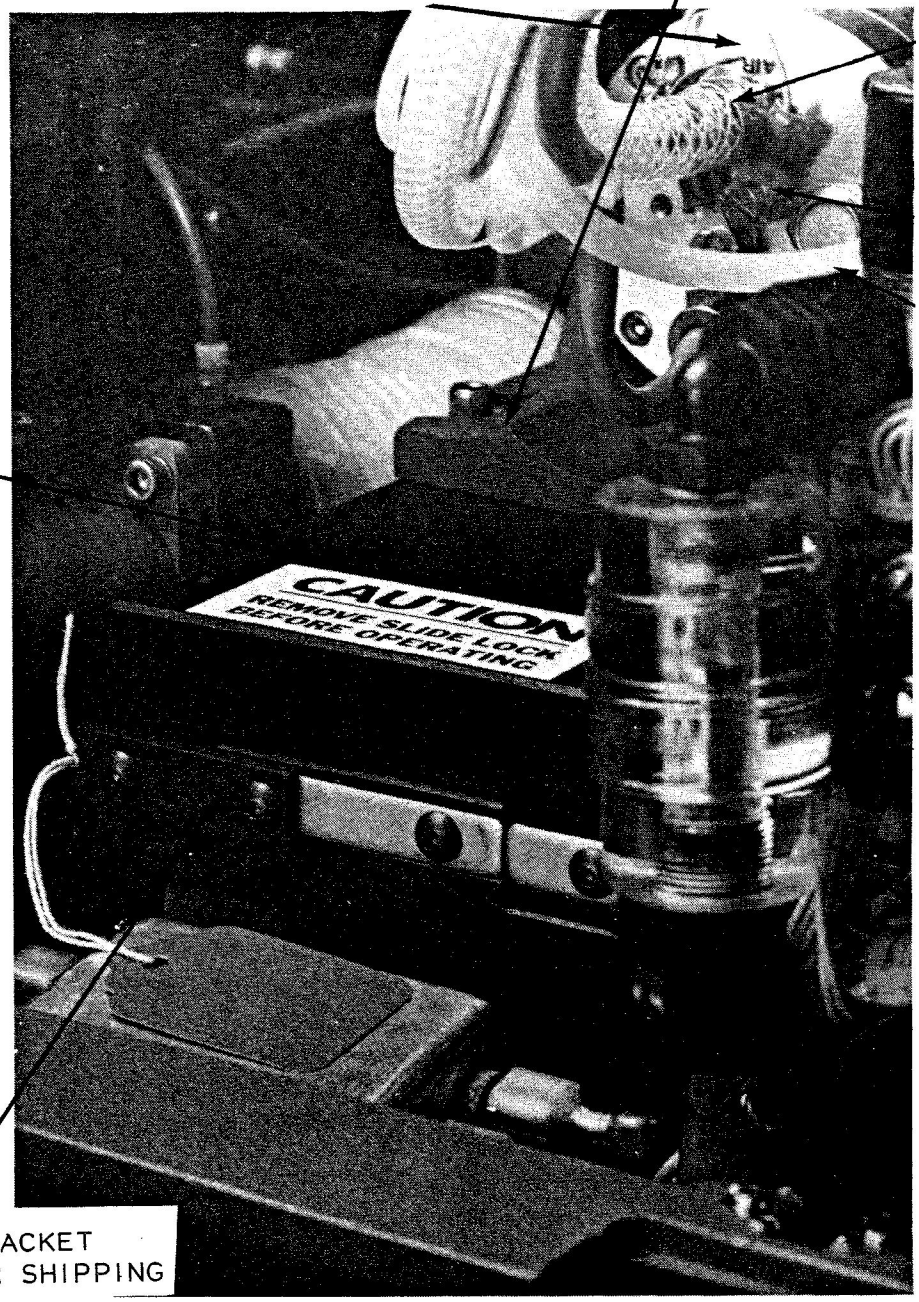


FIGURE 2-3

SPINDLE (REAR VIEW)

(3) Visually note the blade position in relation to the center hole of the chuck. If the blade is not centered, proceed as follows.

(4) Spread the casting and adjust the spindle in the casting until the blade is visually centered over the center hole of the chuck. NOTE: Make sure to maintain the spindle housing adjusted to ±0.005 inch.

(5) After alignment is finished, remove the casting expansion screws and tighten the casting contraction screws.

(D) Spindle Perpindicularity Alignment

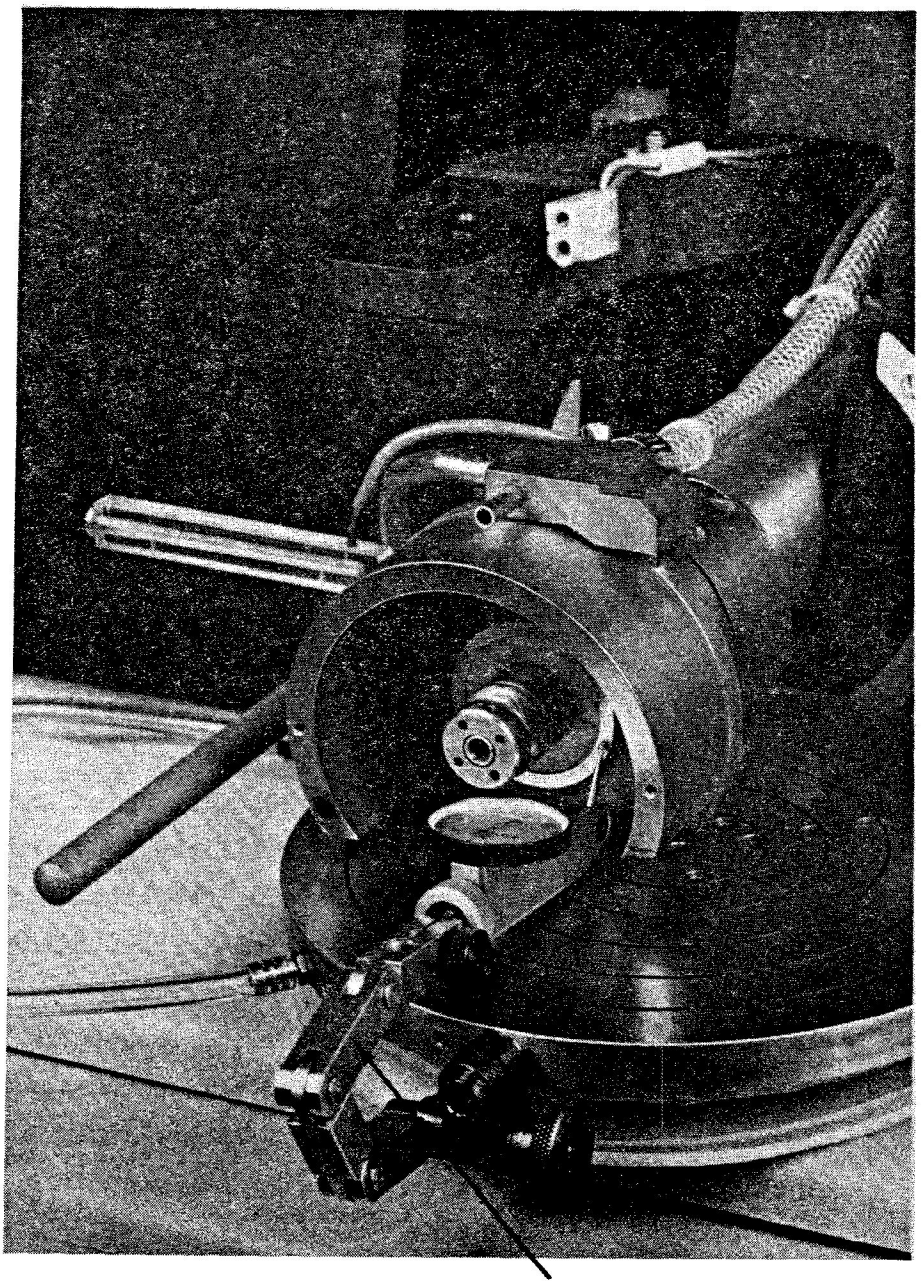
The spindle blade mounting surface must be parallel to the "X" axis travel to within 0.0001 inch. (See Fig. 2-4) To check this alignment, proceed as follows:

(1) Mount a 0.0001" indicator on top of the chuck in such a manner as to touch the blade mounting surface just below the blade mounting shaft lower surface.

(2) Adjust the indicator to read zero at this point and then carefully move "X" axis manually until the indicator engages the blade mounting surface on the other side of the blade mounting shaft. The maximum offset allowable is 0.0001 inch.

(3) If the measurement exceeds 0.0001 inch, loosen the four spindle casting mounting screws and adjust the casting position until correct alignment is accomplished.

(4) Tighten the spindle casting mounting screws. This completes the alignment of the spindle assembly.
NOTE: An alternate check of the spindle perpindicularity can be performed by making a cut in a test wafer with a blade of known thickness. An excessively wide kerf indicates misalignment.



DI 100
DIAL INDICATOR KIT

FIGURE 2-4

EQUIPMENT SET UP FOR SPINDLE
PERPINDICULARITY MEASUREMENT

FIGURE 2-5

REMOVING THE VACUUM CHUCK

2-11 SPINDLE OPERATION TESTING

After replacement, spindle operation must be tested as follows:

(a) With top cover removed and safety switch in service position, apply power to saw.

(b) Apply air pressure to saw.

(c) Press Reset switch on control panel.

(d) Mount a blade on the spindle and press Spindle switch. (Lamp should blink, and spindle should turn counterclockwise.)

(e) Spindle should reach full speed and lamp should stop blinking within one minute.

(f) Program the saw normally and perform a chuck zero operation. (If chuck zero operation is normal, the spindle is correctly installed and wired.)

2-12 "X" STAGE DETAILED DESCRIPTION (Fig. 2-6) (Fig. 2-10)

The component assemblies which make up the "X" stage are:

(1) "X" Motor Assembly

(2) "X" Lead Screw Assembly

(3) "X" Plate Assembly

(4) Roller support plate Ball Bushing X Slide Assembly

(1) Motor Assembly Description

The "X" motor assembly consists of a stepping motor, a position encoder disk, and a printed circuit assembly. The motor assembly is is identical and interchangeable with the "Y" and "θ" motor assemblies.

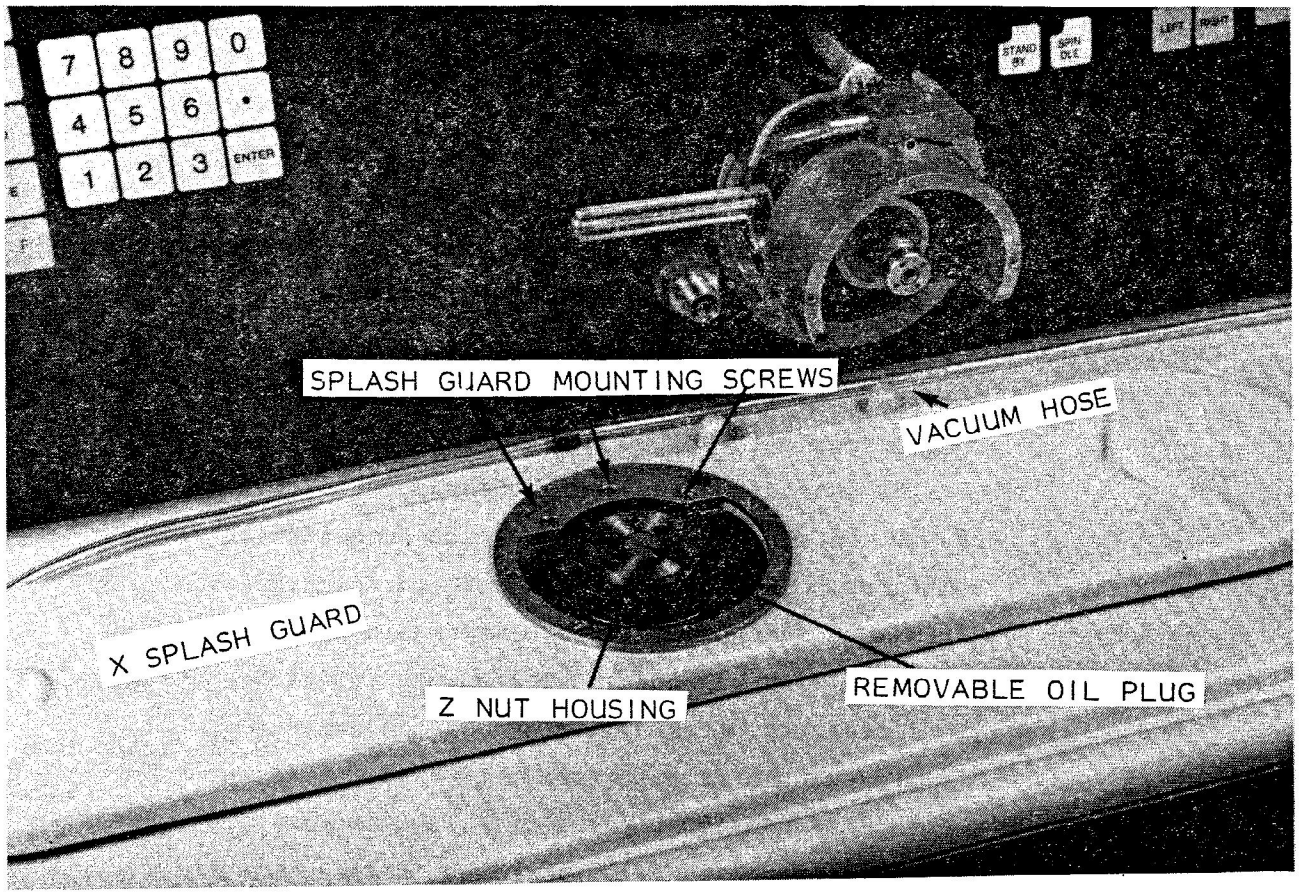


FIGURE 2-6

FRONT TRAY AREA
WITH SPRAW BAR & VACUUM CHUCK REMOVED

The motor is a permanent magnet motor which operates on phase switched d-c power. The motor shaft, which extends through both ends of the motor housing, advances 200 steps per revolution (1.8° per step) when a four-step input sequence (full-step mode) is used, and 400 steps per revolution (0.9° per step) when an eight-step input sequence (half-step mode) is used.

Since current is maintained on the motor windings when the motor is not being stepped, a high holding torque results.

The stator has two center tapped coils giving a total of six wires out of the motor which connect to a six-pin connector that plugs into the printed circuit card. The circuit is designed in such a way as to allow proper operation with the connector inserted in either position. The center tap wires (white and black) are unused.

The printed circuit assembly which mounts on a motor plate has two connectors. The six-pin wire connector described above and a 10-pin ribbon cable connector. The four motor wires connect to the ribbon connector via printed circuit traces. The other circuit on this assembly is the motor sensor circuit. This circuit contains a photo sensor (U1) which is mounted in such a way that the motor encoder wheel rotates between the photo diode and the photo transistor. The slotted encoder wheel alternately interrupts the light causing the photo transistor to turn on and off. The output of U1 (TP2) is present on the input to U2. U2 is a comparator with input hysteresis. The low trigger is +1.7V and the high is +3.4V, thus giving excellent noise immunity. The output of U2 is a zero to +5V square wave (TP3). This output is routed to the motor microprocessor.

The encoder wheel has 100 slots around the outside circumference which are spaced to align with the step angle of the motor. Since the motor has 200 steps per revolution, the output of the motor sensor will switch from zero to +5V or +5V to zero each step. Therefore, the motor microprocessor interprets a change of voltage as an indication that the motor has made a step.

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2. "X" Lead Screw Assembly Description (Fig. 2-10)

The "X" leadscrew assembly consists of the "X" leadscrew support casting (which is also the "X" motor mount), the "X" leadscrew, the "X" pillow block, the running nut and nut holder, the take-up nut and nut clamp, and a wave washer. The take-up nut and running nut are screwed toward each other until the wave washer is partially compressed. The nut clamp is tightened (not enough to bind) to maintain that spacing. The wave washer exerts pressure against both nuts to eliminate backlash. The leadscrew rotates in bearings in the "X" pillow block and the "X" leadscrew support. The leadscrew is driven by a flexible coupling which clamps to the leadscrew shaft and the "X" motor shaft. The rotary motion of the leadscrew is converted to linear motion of the double lead nut. The "X" lead nut holder has a socket into which a drive ball fits which couples the lead nut motion to the "X" stage.

3. "X" Plate Assembly Description (Fig. 2-10)

The "X" Plate Assembly is a triangular plate which mounts the ball bushings and the front roller support plate. It is coupled to the "X" leadscrew via an energy-absorbing drive pin and pin holder.

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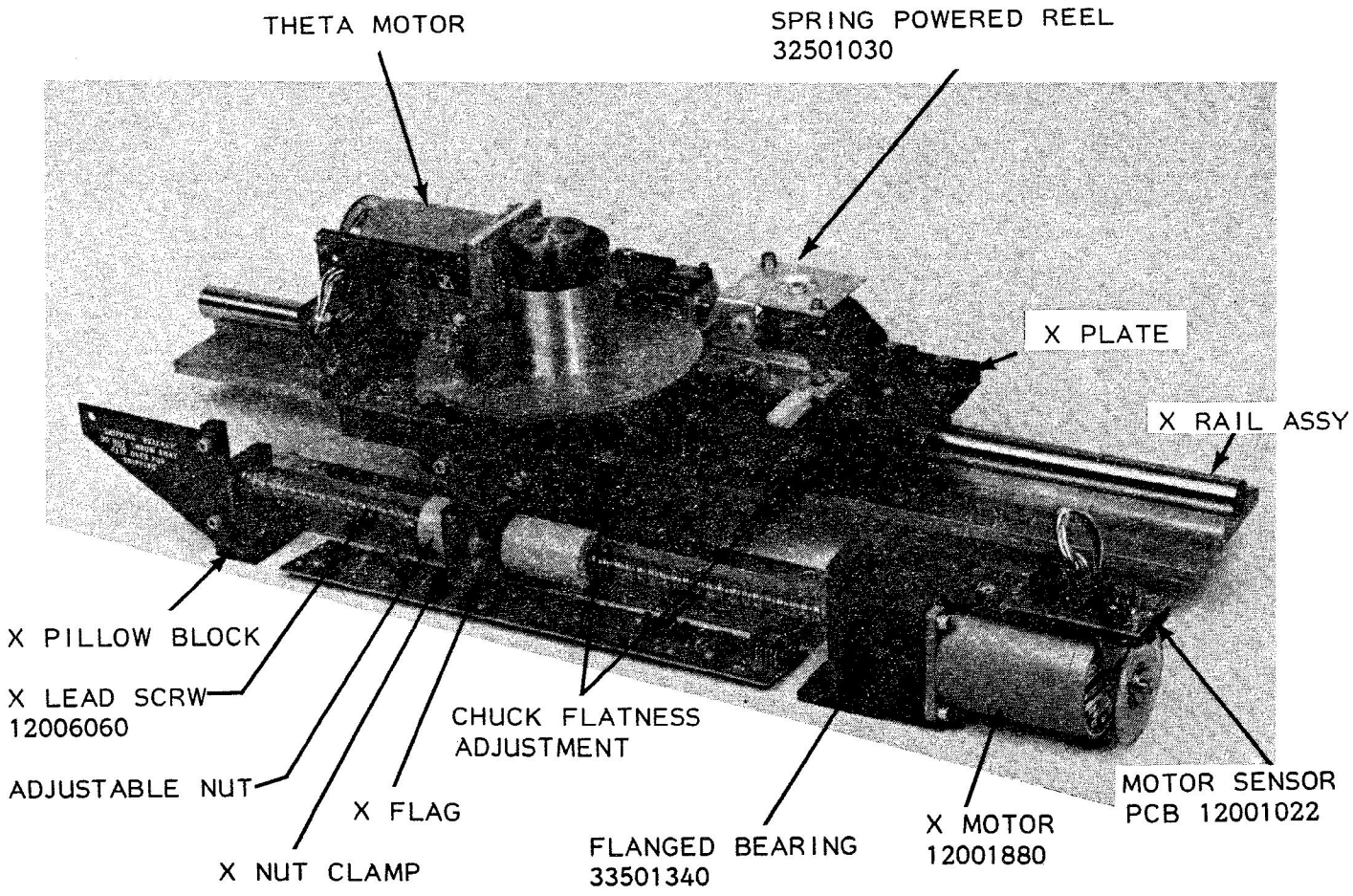

FIGURE 2-10

X STAGE WITH THETA & Z STAGES MOUNTED

(4) Roller Support Plate Description

The roller support plate is a precision ground plate which supports the front roller of the "X" plate. The right side is fastened to a precision "boss" on the casting and the left side fastens to the "X" lead screw pillow block. There is a height adjusting screw adjacent to the left-hand mounting screw which is used for fine adjustment of chuck flatness.

(5) Ball Bushing Slide Assembly Description

The Ball Bushing slide assembly consists of the "X" guide rail assembly and the Ball Bushing pillow blocks.

The "X" guide rail is a precision ground round rod attached to four precision bosses on the casting. There are no adjustments on the "X" guide rail.

There are two ball bushings and pillow blocks. These ride on the guide rail and are attached to the "X" plate by hex head screws. (See "X" plate Para. (B-3)).An adjustment screw is located in each pillow block which adjusts the pre-load on the ball bushings.

CAUTION: OVER-TIGHTENING OF THE PRE-LOAD WILL CAUSE PERMANENT DAMAGE TO THE BALL BUSHINGS. THERE ARE RUBBER BUSHING SEALS ON EITHER SIDE OF EACH BUSHING WHICH WIPE ANY DUST, ETC., FROM THE GUIDE RAIL.

(C) "X" Limit Sensor Detailed Description

The "X" limit sensors are mounted on a common printed circuit board. This board is mounted under the "X" lead screw and is held in place by three #4x40 screws into the saw casting.

There are two identical circuits on the PCB, one for the left limit and one for the right limit.

Input and output signals are routed through a 10-pin ribbon connector. Pin 1 is +5 VDC logic power to all components except the two photo diodes in U1 and U3. Pin 2 is +5 VDC switched to the two photo diodes in U1 and U3. Pins 3 and 4 are logic ground. Pin 6 is a common interrupt output. Pins 7 and 8 are the output of the left and right sensor circuits respectively. Since the circuits are identical, the left sensor circuit only will be described.

Normally, the photo diode in U1 has current through R2 to ground and infrared light is emitted. Diode CR1 protects the photo diode from accidental voltage reversal. When the photo transistor in U1 is illuminated by the light from the diode, it conducts causing TP-4 to be low-voltage. U2 is configured as an inverting comparator with a very fast rise and fall time. The input has a hysteresis of 1.7V giving excellent signal to noise. Therefore, the output of U2 is +5V and is present on TP-5. When the "X" stage reaches the left hand limit of travel, the "X" flag enters a slot in U1, blocking the light from the U1 photo diode to the U1 photo transistor. The U1 transistor will stop conduction, allowing TP-4 to rise toward +5 VDC. When Pin 2 of U2 reaches 3.4 volts, the output of U2 will switch to zero volts. The outputs of the sensors are routed directly to the housekeeper MPU.

2-13 "X" STAGE PREVENTIVE MAINTENANCE

For proper operation, the "X" stage assembly should be kept clean and lubricated. The cleaning frequency may vary depending upon conditions, such as deposit accumulation. 80 hours maximum internal is recommended.

(A) Cleaning (Every 80 Hours of Machine Operation)

Since the "X" stage is located beneath the drain tray, it is likely to become wet or get splashed with cutting water.

This water usually leaves a deposit of slurry on surfaces which must be cleaned. To clean slurry or dust from any "X" surface, use a clean damp lint-free cloth or industrial wiper. It may be necessary to use an additional commercial cleaner such as Fantastic for heavy dirt, followed always by a clean damp wiper.

All machined surfaces such as the roller support plate, ball bushing slide, and ball slide bearing rods should be cleaned with WD40 penetrating oil. The excess oil should be wiped away and not allowed to puddle.

(B) Lubrication

After cleaning, lubricate per the chart below:

Assembly	Lubricant	Period
"X" Ball Slide	WD40	180 Hrs.
"X" Ball Bushing Slide	High Grade Light Vacuum Oil	180 Hrs.
Roller Support Plate	High Grade Light Vacuum Oil	80 Hrs.
"X" Lead Screw	Lubriplate 130AA	80 Hrs.
Ball Holder	Lubriplate 130AA	180 Hrs.
Bushing Holder	Lubriplate 130AA	180 Hrs.

The lead screw, motor and front roller bearings are sealed and require no lubrication.

(C) "X" Stage P.M. Testing and Adjustment

Proper mechanical operation of the "X" stage assembly can be checked by performing the following tests:

(1) Grasp the "X" lead screw and exert force to left and then to the right. There should be no movement of the lead screw between the bearings in the pillow block and the

lead screw support casting. If there is movement between the bearings, loosen the two #10 screws which hold the lead screw support casting, push the lead screw support casting toward the "X" pillow block, and then tighten the support casting screws. This should remove any play between bearings. To adjust the double lead nut, proceed as follows:

(2) To adjust the plastic lead nut, loosen the nut clamp screw. Turn the takeup lead nut CCW until the wave washer does not touch the nut holder, then turn the takeup lead nut CW until the wave washer is barely touching both the nut holder and the takeup nut but is not compressed. Now turn the takeup nut 1/4 turn CW compressing the wave washer and tighten the nut clamp screw.

CAUTION: DO NOT OVER-TIGHTEN THE NUT CLAMP SCREW OR BINDING OF THE TAKEUP NUT WILL OCCUR.

To test this adjustment, operate the saw and observe lead screw operation. The lead screw should operate smoothly without backlash or jerkiness.

2-14 "X" STAGE PARTS REPLACEMENT

This section describes the steps necessary to replace the major stage components. Since the "θ" and "Y" assemblies mount on and are a part of the "X" stage assembly, many of these procedures

must be performed during maintenance on those assemblies also, and may be referred to in other sections of this manual.

2-15 CHUCK REMOVAL

Unscrew the three Allen cap screws from the chuck top and disconnect the vacuum line.

Carefully lift the chuck straight up and out of the saw. CAUTION: CARE MUST BE USED TO PREVENT DAMAGE TO THE "Z" SENSOR PCB AND THE "Z" FLAG.

2-16 FRONT TRAY REMOVAL

Remove the "X" splash guard by removing the three flat head screws from the mounting ring.

From the bottom, pull the two drain lines loose from the front tray drains, and disconnectthe line from the sump jar to the front tray fitting. Lift up on the front tray to disconnect the four spring retainers, and remove the front tray from the saw.

2-17 "X" LEAD SCREW ASSEMBLY REMOVAL AND PARTS REPLACEMENT

(A) "X" Motor Removal

Steps 2-15 and 2-16 must be performed first.

Disconnect the "X" motor connector. Remove the motor mounting screws and loosen the flex coupling from the "X" lead screw.

Remove motor from saw and set aside.

(B) "X" Lead Screw Removal

The lead screw can be removed with the motor attached if desired. Do not loosen or move the left-hand pillow block or realignment of chuck flatness will be required.

Remove the two screws which hold the "X" lead screw support casting base. Remove the mounting screws which mount either the ball holder plastic nut or bushing holder metal nut to

the "X" plate and remove the holder. Slide the lead screw to the left and lift the assembly from the saw and place on a work surface. To replace the lead screw bearings, press the old bearing out of the pillow block. Remove the flex coupling from the lead screw shaft.

Pull the lead screw shaft out of the support casting bearing. (Look for and retain any spacer washers on the lead screw shaft!) Press the old bearing out of the support casting. Press the replacement bearing into the support casting. Push the lead screw shaft into the support casting bearing.

(C) "X" Lead Screw Assembly Installation

The "X" lead screw assembly may be installed with the "X" motor mounted or removed. The procedure is the same in either case. If the "X" motor is mounted, use care to avoid damage to the encoder wheel.

Carefully align the left lead screw shaft with the pillow block bearing, and slide the lead screw assembly to the left, inserting the lead screw shaft into the pillow block bearing. Loosely install the two Allen cap screws into the "X" lead screw support casting, push the support casting to the left against the lead screw, then tighten the support casting mounting screws. Check that there is no play between the bearing. (See Paragraph 2-13 (C) (1))

Align the "X" plate with the lead screw nut holder, insert the drive ball into the bushing and attach the holder to the "X" plate.

(D) "X" Motor Installation

INsert "X" motor shaft into the lead screw support from the right so the flex coupling fits over the lead screw and motor shaft.

CAUTION: DO NOT DAMAGE ENCODER DISK!

Install four motor mounting screws into lead screw support casting. Tighten flex coupling. Insert "X" motor connnector.

CAUTION: CHECK POLARITY.

2-19 BALL BUSHING SLIDE "X" STAGE PARTS REPLACEMENT (Ref. Fig. 2-10)

On machines S/N 270 plus S/N 273 and up, the "X" stage has a Ball Bushing slide assembly. The replaceable assemblies on this type of stage are: two ball bushings; one front support roller bearing and wipers; one guide rail assembly; and one roller support plate. Prior to replacing any of these assemblies, you must perform Para. 2-14 chuck removal, 2-15 front tray removal. System alignment will be required following the replacement of any of these assemblies.

(A) Guide Rail Replacement

In the unlikely event that guide rail replacement is required, follow this procedure. If guide rail replacement is not required, proceed to section (B). Cut the ty-wraps that attach the cables to the "X" stage. Disconnect the cable connectors and lay the cables out of the way. Perform

2-17 (B) "X" Lead Screw Removal. Slide the "X" stage to the right and remove the two #10 x 32 Allen cap screws from the left side of the guide rail support plate. Slide the "X" stage to the left and remove the two #10 x 32 Allen cap screws from the right-hand side of the guide rail support plate.
CAUTION: USE EXTREME CAUTION DURING THE "X" STAGE REMOVAL TO ENSURE NO DAMAGE OCCURS TO THE "Z" MOTOR ENCODER.
Carefully tilt the front of the "X" plate up, (to clear the roller support plate) and lift the "X" stage free of the saw casting. Place the "X" stage on a work surface. Slide the "X" guide rail assembly to the left, out of the "X" bushing separating the "X" plate assembly and the guide rail assembly.

The bushings must be adjusted to the guide rail prior to installation. To perform this adjustment, it will be necessary to remove the bushing pillow blocks from the "X" plate. See Figure 2-10 page 40

The bushing pillow blocks are mounted to the "X" plate by four hex head screws each.

Remove these eight hex head screws and remove both bushing pillow blocks from the "X" plate. The bushing pillow blocks are a "split" assembly with an Allen adjusting screw which will compress the pillow block and "squeeze" the bushing. On some versions there is a cover plate over this adjustment screw. If there is a cover plate, remove it. Loosen the bushing adjustment screw in both pillow blocks. Carefully clean the bearings in the bushings using a solvent such as Freon TF or a penetrating oil such as WD40. After cleaning thoroughly, apply a high grade light turbine oil or vacuum oil to the bearings. Slide one bushing/pillow block assembly onto

the guide rail. The bushing should rotate freely around the rail. Insert an Allen wrench into the adjustment set screw, and while rotating the bushing and pillow block back and forth, gradually tighten the adjustment screw until the bushing begins to grip the guide rail. The tightening should be stopped as soon as an increase in the force required to rotate the bushing on the guide rail is felt. This indicates a slight pre-load fit. Repeat the pre-load adjustment for the other bushing. Reinstall the bushing pillow blocks into the "X" plate. Do not tighten the mounting screws. Slide the guide rail into both bushings. While holding the "X" plate forward as far as the clearances allow, tighten the mounting screws on both pillow blocks.

The "X" slide assembly is now ready for installation into the saw casting. Carefully clean all mating surfaces. Carefully place the "X" slide assembly into the casting, taking extreme care not to damage the "Z" motor encoder. Slide the "X" plate to the right to expose the left side mounting holes. Align the holes and loosely install the mounting screws. Slide the "X" plate to the left to expose the right-hand mounting holes. Loosely install the mounting screws. While holding the guide rail assembly as far forward and left as the mounting holes allow, tighten the right side mounting screws. Slide the "X" plate to the right and tighten the left side guide rail assembly mounting screws. Refer to Drawing #17005870 and re-connect flat ribbon cable connectors to the "Z" motor, the "θ" motor, the "θ" sensor, and the "Z" sensor. Reattach the ribbon cable hold downs.

This completes the replacement of the "X" guide rail.

(B) Ball Bushing Replacement

The "X" ball bushings can be replaced without removing the "X" stage from the casting by following this procedure.

Loosen the bushing pillow block mounting screws on both pillow blocks. This allows the "X" plate to tilt enough to clear

the pillow block to be removed. Remove the mounting screws from the bushing pillow block to be replaced. While tilting the "X" plate assembly to clear, remove the bushing pillow block by sliding it off the guide rail. Carefully lower the "X" plate using care not to damage the guide rail or "Z" motor encoder. Place the bushing pillow block on a clean work surface. Loosen the adjusting screw. Remove the bushing locating screw. Using a narrow screw driver, remove the bushing seals from both ends of the pillow block. Push the old bushing out of the pillow block. Insert the new bushing into the pillow block. Align the bushing locating hole and the locating screw hole. Screw the locating screw into the pillow block and tighten. Liberally lubricate the bearings inside the bushing with high grade light turbine or vacuum oil. Snap the bushing seals in place at each end of the pillow block. Slide the bushing onto the guide rail. The bushing should rotate freely around the rail. Insert an Allen wrench into the adjusting set screw. While rotating the bushing back and forth, gradually tighten the adjustment screw until the bushing begins to grip the guide rail. The tightening should be stopped as soon as an increase in the force required to rotate the bushing on the guide rail is felt.

Lift the "X" plate assembly up and slide the bushing pillow block into place. Loosely install the mounting screws. While holding the "X" plate forward as far as the mounting screws will allow, tighten the pillow block mounting screws.

This completes the replacement of a ball bushing. System alignment must be checked after this procedure. (See Para. 2-10)

(C) "X" Leveling Roller Replacement

To replace the leveling roller, it is necessary to remove the leveling roller holder from the "X" plate. Access to the leveling roller holder screws are from the top (Fig. 2-10).

A short 9/64 inch Allen wrench will be helpful.

There are three screws at each end of the roller holder. The large center screw is the mounting screw. Do not turn the left two set screws! Remove the two mounting screws from the leveling roller support. Remove support from saw and place on a clean work surface. Using snap-ring pliers, remove one grip ring from the bearing shaft. Press the bearing shaft out of the roller support and the bearing. Remove the bearing, making certain to retain the two spacer washers. Place one spacer washer on each side of the new bearing. With the roller support positioned so the bearing axis is vertical, carefully place the bearing and two spacers into the support slot. Using a thin round object, such as a thin screw driver blade, position the spacers and bearing in the support slot so the holes in the support align with the bearing and washer holes. Carefully insert the bearing shaft through the support, washers and bearing. Refasten the grip ring on the bearing shaft. Mount the roller support to the "X" plate using the screws removed previously. Make sure the two felt "wipers" are dressed outward from the bearing and do not interfere with roller performance. This completes the "X" leveling roller replacement. System alignment must be checked following this procedure. (Ref. Para. 2-10)

2-20 FRONT TRAY INSTALLATION

Before installing the front tray, manually position the "Y" stage fully to the rear. Lower tray over the "Z" nut and connect the vacuum line to the bottom of the tray. Press down the front and sides of the tray to snap the retainers into place. Connect the drain hoses to the tray drain tees. Mount the "X" splash guard onto the drip cover support using three flat head screws.

2-21 CHUCK INSTALLATION

Carefully clean the mating surfaces of the chuck and the "Z" nut housing. Referring to Fig. 2-14 for positioning, carefully lower the chuck down onto the "Z" nut. Care must be taken to prevent damage to the "Z" flag and "Z" limit PCB. Align the chuck mounting holes with the "Z" nut holes and install the three mounting screws. Sequentially tighten the mounting screws.

2-22 "X" FLAG ADJUSTMENT

The "X" flag is mounted to the "X" lead nut holder. Its function is to interrupt the light beam of the "X" limit sensors, thereby indicating the travel limits of the "X" stage. The position of the "X" stage during alignment and cutting are referenced to the "X" left limit sensor and, therefore, the "X" flag is adjustable to allow precise alignment of the "X" stage position.

The correct "X" flag position is indicated when the chuck is centered under the spindle output shaft during "chuck zero". To accomplish this adjustment, proceed as follows:

Remove the blade. Press Reset switch. Measure across the bottom flat area of the baffle plate, and mark the center of the baffle plate with a pencil or felt pen. (1.4 inch from either edge.) Enter a program with a Service Mode (Mode = 910). Push Chuck Lock and Chuck Zero switches. The chuck will move under the spindle and raise to the "Z" limit and stop. Error code E006 will flash. Note the position of the chuck in relation to the mark in the center of the spindle baffle. The chuck center hole should be centered under the mark. This position can be adjusted by moving the "X" flag. The flag should be moved the opposite way you want the chuck to move. If the chuck is positioned to the left of the spindle, move the "X" flag to the left the same distance as the chuck positional error. Press the Reset, Chuck Lock, and Chuck Zero switches. The "X" stage will reference to the new "X" flag

position, move under the spindle and stop with Error Code E006. Re-examine the chuck position. Continue the adjustment, reset chuck zero sequence until correct alignment is obtained. Tighten "X" flag screws. This completes the "X" flag adjustment.

"THETA" ASSEMBLY MAINTENANCE

2-23 "THETA" ASSEMBLY DETAILED DESCRIPTION

A. "Theta" Motor Assembly Description

The Theta Motor Assembly is identical and interchangeable with the "X" and "Y" motor assemblies. (See Paragraph 2-12 (A) (1) for detailed description of the motor assembly.) The motor assembly mounts to the Theta worm gear casting. The motor output shaft connects to the Theta worm gear shaft via a flexible coupling.

B. "Theta" Worm Drive Assembly Description (Fig. 2-12)

The Theta worm drive assembly consists of a Theta worm drive support casting, a Theta worm gear shaft, a Theta worm gear, a spring-loaded bearing and a flexible coupling. There is a felt-padded grease clip which provides lubrication for the worm gear. The Theta worm drive assembly is designed to pivot on a shoulder screw to provide adjustment.

C. "Theta" Worm Wheel Assembly Description

The Theta worm wheel meshes with the Theta worm gear. The worm wheel is a 5½ inch diameter brass gear which is mounted on the Theta support ring. The Theta support ring acts as a bearing around the "X" bearing housing.

The ball guide is mounted on top of the Theta worm wheel. This guide exerts rotational force on the guide ball which is mounted to the chuck, causing the chuck to rotate.

A cable retainer block is mounted to the top side edge of the worm wheel. This block retains the antibacklash cable which is attached to a spring loaded reel. The reel spring exerts a constant pull on the cable which prevents backlash between the "θ" wheel and the "θ" worm gear.

Also mounted to the top of the worm wheel is the "Z" limit sensor PCB bracket. The mounting holes for the "Z" sensor bracket, the ball guide, and the cable retaining block are repeated 180^{o} on the worm wheel. This allows rotation of the "θ" worm wheel to a previously unused area when the original position becomes worn.

Mounted to the bottom of the worm wheel are two "flags". These flags are used to sense the CW and CCW limits of travel.

A self-aligning bearing mounted in a pivot support assembly contacts the "θ" worm wheel adjacent to the worm gear and prevents the worm wheel from lifting.

(D) <u>"θ" Limit Sensors Description</u>

The CW and CCW "θ" limit sensors are mounted on a common PCB which mounts to the "X" plate under the edge of the "θ" worm wheel. The board contains two identical circuits; therefore, a description of one is sufficient. All connections are made through a 10-pin ribbon cable connector. Pin 1 is +5 VDC logic power to all components except the photo diodes in U1 and U3. Pin 2 is switched +5 VDC to the photo diodes in U1 and U3. Pins 3 and 4 are logic ground. Test point TP-1 is provided for testing. Pin 6 is common interrupt output signal. Pins 9 and 10 are the outputs on the two sensor circuits.

The photo diodes normally have +5V applied through R1 which causes the diode to emit light which shines through an aperture to the photo transistor. Diode CR1 protects the photo diode against accidental voltage reversal. The light causes the photo transistor to conduct which makes TP-2 zero. TP-2 is connected to Pins 2 and 6 of U2 pin 3 and TP-3. When the "θ" stage rotates the flag over U1, the flag interrupts the

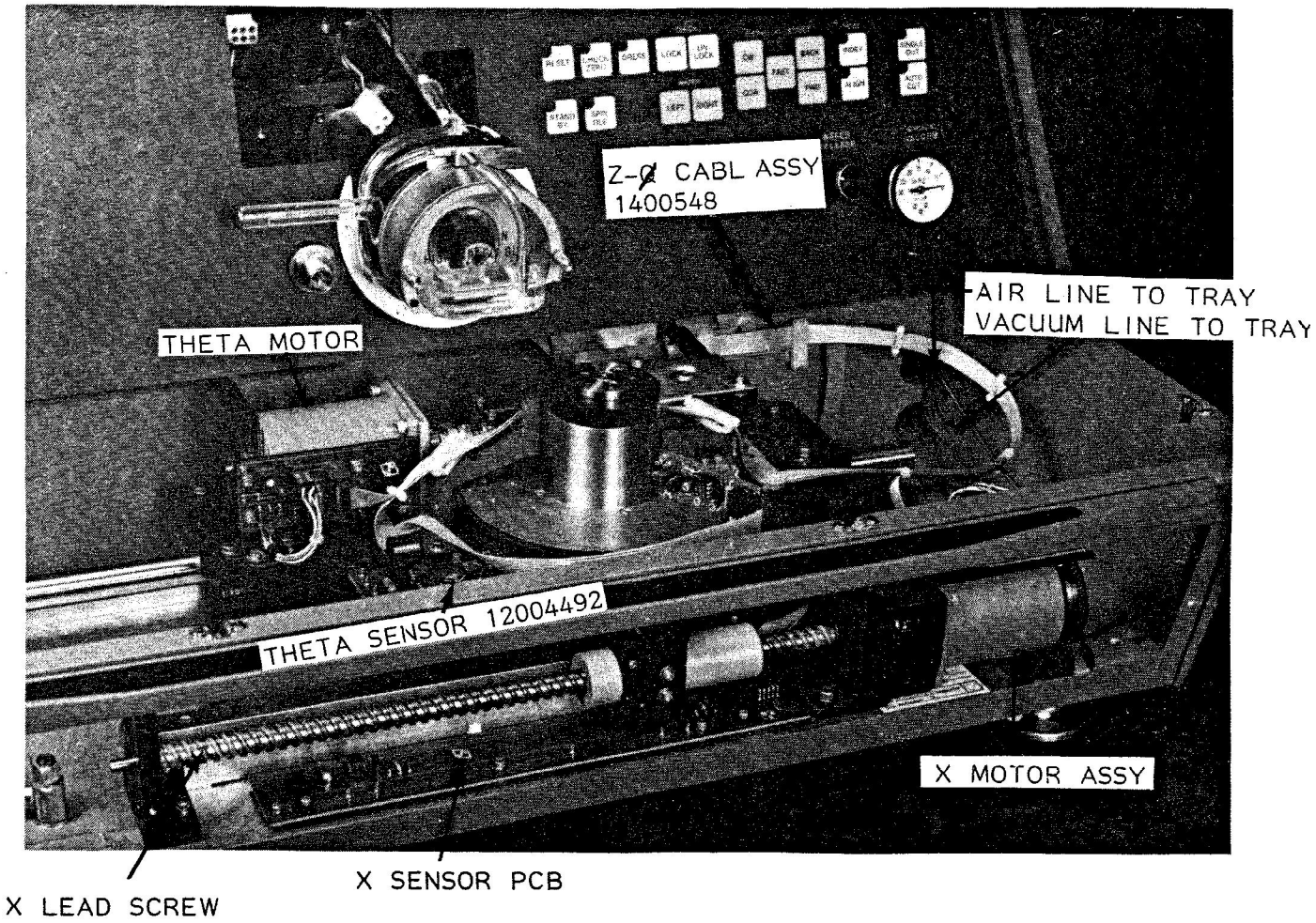

FIGURE 2-11

SAW FRONT AREA WITH VAC CHUCK & TRAY REMOVED

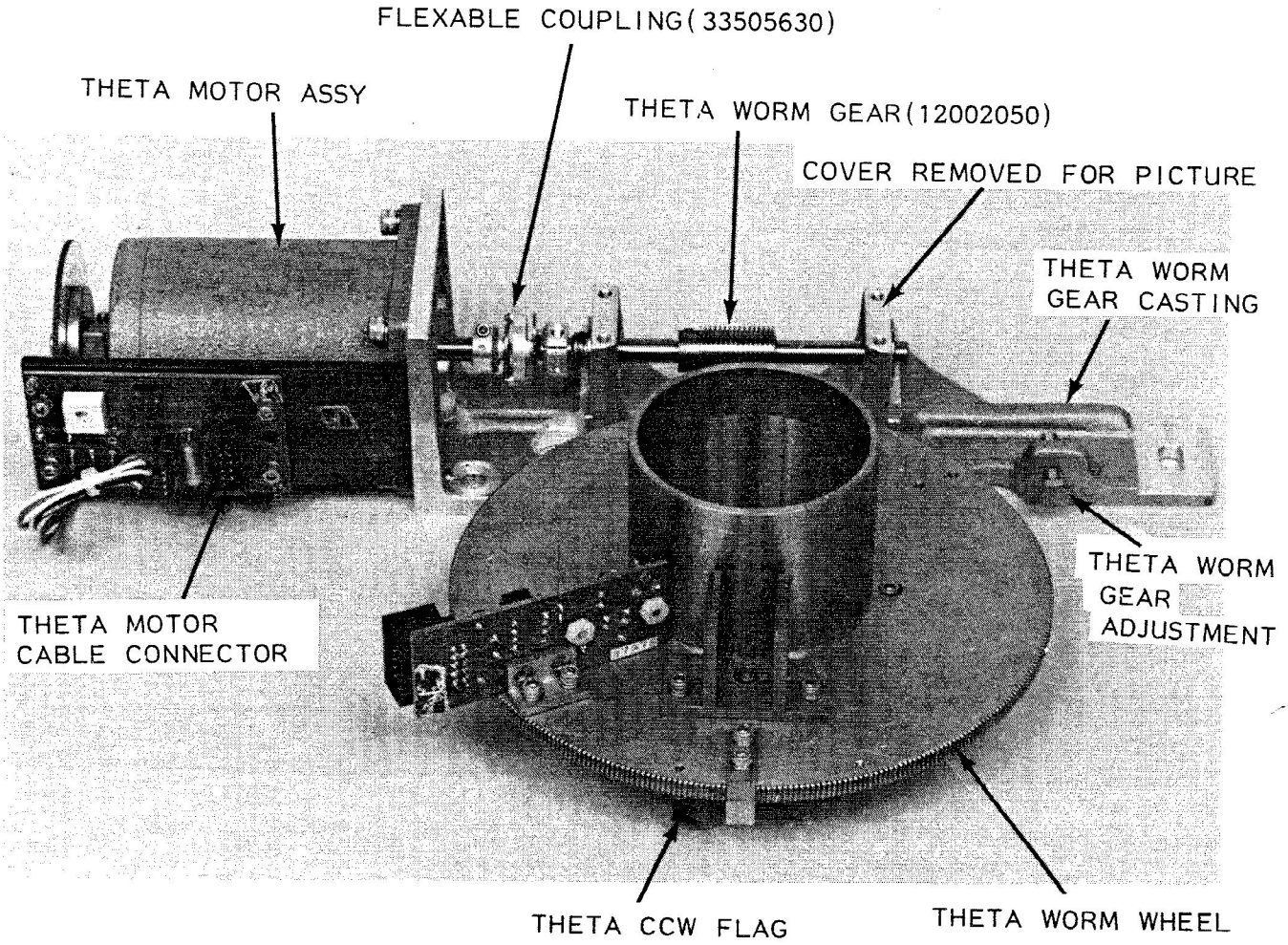

FIGURE 2-12

THETA ASSEMBLY COMPONENTS

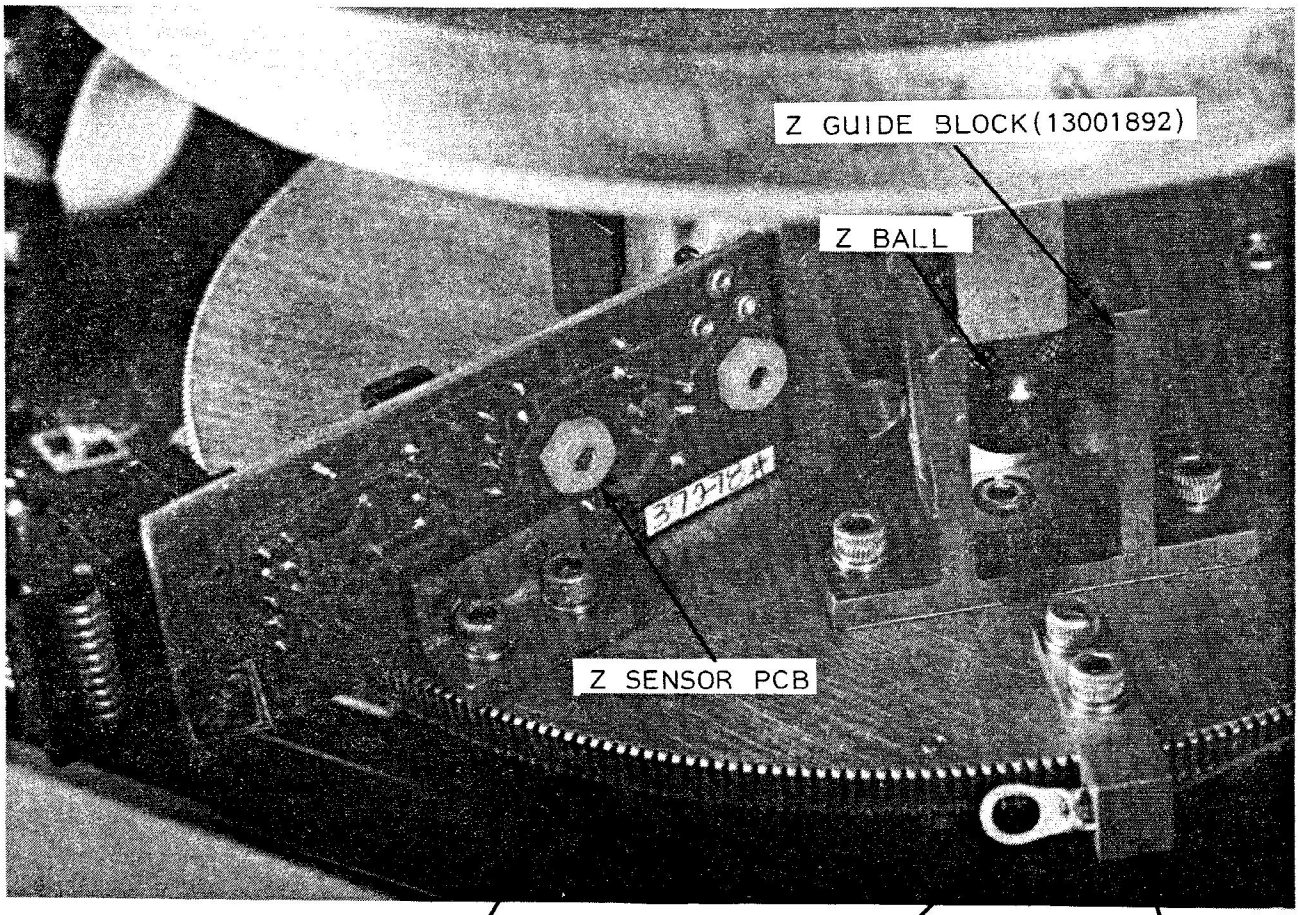

FIGURE 2-13

THETA WORM WHEEL DETAIL

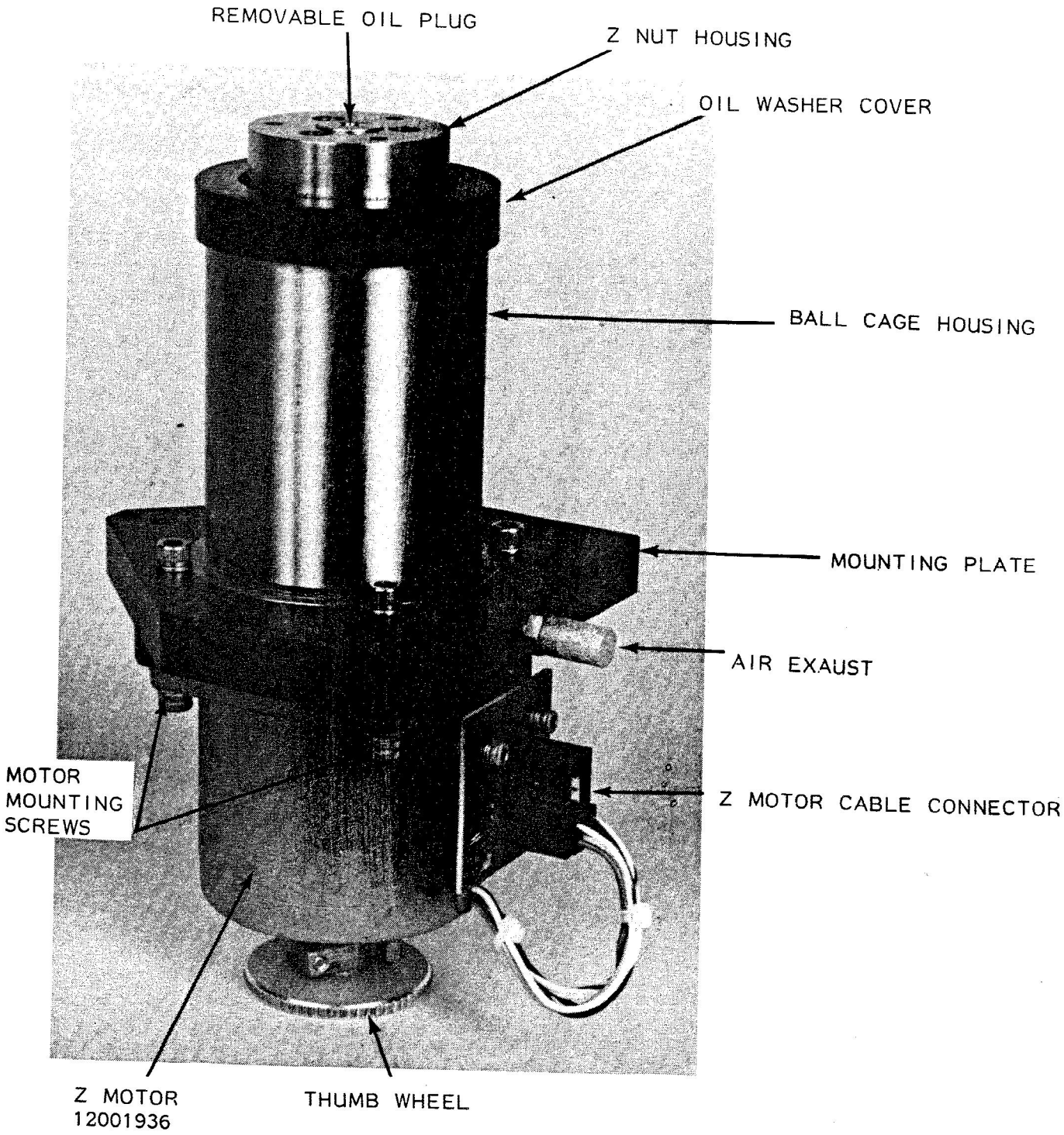

FIGURE 2-14

Z DRIVE ASSEMBLY P/N 12009410

light between U1 photo diode and U1 photo transistor. U1 photo transistor will turn off, and TP-4 will rise toward +5 VDC. When Pin 2 of U2 reaches +3.4 VDC, the output of U2 will switch from +5 VDC to zero. Zero indicates the limit has been sensed.

2-24 "THETA" ASSEMBLY PREVENTIVE MAINTENANCE

A. Cleaning (Every 80 hours of machine operation)

To gain access to the Theta assembly, the chuck and front tray must be removed, as described in Paragraphs 2-15 and 2-16. Clean the grease from the Theta worm gear and worm wheel using a solvent such as Freon.

B. Adjustment

While the worm gear and ring are "dry", check the backlash between the worm gear and worm wheel at both zero degrees and at 90 degrees. To adust backlash, loosen the two screws that hold the Theta worm support casting. Turn the "T" worm adjusting screw in one turn and, holding the worm gear against the worm wheel, retighten the holding screws finger tight. A fine adjustment can be made by screwing the "T" worm adjusting screw out until the head is touching the "X" splashguard casting. Continue turning out for 1/12th of a revolution to establish .001" play in the gear. Tighten the two mounting screws.

C. Lubrication (Every 80 hours of machine operation)

After cleaning and adjustment, apply Lubriplate 130AA to the worm gear and felt pad. Apply Lubriplate to the ball guide bracket and ball assembly. Apply #10 oil to the felt ring on top of the Theta support ring.

2-25 "THETA" ASSEMBLY REPLACEMENT

To perform replacement of the Theta assembly components, remove the chuck front tray as described in Paragraphs 2-15 and 2-16.

A. "Theta" Motor Removal

To remove the Theta motor, disconnect the motor connector. Remove the cable clamps holding the motor wires to the "X" plate. Remove the three mounting screws in the Theta support casting. Slide the assembly to the left and lift free. Remove the four screws from the motor and loosen the flexible coupling. Remove the motor.

B. "Theta" Pivot Bearing Removal

Remove the spring-loaded pressure adjusting screw from the top of the pivot arm. Remove the bearing and arm assembly.

C "Theta" Worm Gear Assembly Removal and Parts Replacement

Remove Theta support casting as in A. above. Lift the assembly to the rear to clear the worm wheel and remove from the saw.

The worm gear assembly contains two bearings which support the worm gear shaft. These bearings are press fit into the Theta worm support casting. To replace the bearings, remove the motor assembly per A. Remove the grip ring from the right side of the worm shaft. Remove the top cover. Remove the worm gear and shaft from the Theta support. Press the bearings out of the Theta support and press new bearings into the assembly.

To replace the Theta worm gear, loosen the two set screws in the worm gear. Pull the worm gear off the worm gear shaft. Push new worm gear onto shaft. Align the two set screws with the flats on the shaft. Position worm gear so that approximately 1/8-inch of the flats on the shaft extend to the left of gear and tighten the two set screws.

Install the Theta worm gear and shaft into the Theta support. Install the snap ring on the worm gear shaft. It will be necessary to press the worm shaft toward the Theta support bearing in order to get the ring in the shaft slot.

There should be no end play of the worm gear shaft between bearings. Place the worm gear support casting into the saw and readjust.

D. Worm Wheel Removal

The worm gear assembly must be moved back and pivot roller must be removed (as described in the previous paragraph) before the worm wheel can be removed. Cut the ty-wraps or unsnap the straps holding the ribbon cable on the "X" Plate. Remove the four screws holding the support bracket to the "X" plate. Unplug the Theta motor, Theta sensor, the "Z" sensor, and the "Z" motor. Lift the support bracket and cables to the right. Remove the antibacklash cable from the bracket by pulling left and down. Let the cable "wind up" until the cable end meets the cable guide. Remove the oil ring cover and oil ring from the "X" nut housing. Lift up on both sides of the worm wheel until it is free of the "X" nut housing. Note and retain any spacers under the worm wheel flange.

E. Worm Wheel Reversal

The worm wheel has a duplicate set of holes drilled 180° from those which mount parts to the wheel. These holes are provided to allow the wheel to be mounted 180° from the original position in order to increase wheel life. To reverse the worm wheel, one at a time remove a component from the original position and mount it to the identical holes 180° away. Reverse the ball guide, the Theta clockwise flag, the Theta counterclockwise flag, and position. Remove the "Z" position sensor PCB and bracket. Rotate the worm wheel 180° on the support ring. Remount the "Z" sensor PCB and bracket.

F. Worm Wheel Installation

Before installing a worm wheel, make sure the "Z" nut housing is clean and free from corrosion. Lubricate lightly with light #10 oil and lower the worm wheel over the "Z" nut housing. Make sure the wheel turns freely and smoothly.

Place a height gauge (PN 28016890) on the top surface of the worm wheel with the notches down and the "LO" notch toward the worm gear shaft. Slide the "LO" notch gauge over the worm gear shaft while the main body is touching the worm wheel. The "LO" notch should not touch the worm gear shaft. If the "LO" notch touches the worm gear shaft, the worm wheel is too low and shims must be added under the support ring. When the "LO" notch clears the worm gear shaft, turn the gauge so the "HI" notch is over the worm gear shaft. The "HI" notch should touch the gear shaft.

Add or remove shims under the Theta worm wheel support ring until the "LO notch does not touch and the "HI" notch touches the Theta worm gear shaft.

Attach the anti-backlash cable. Reinstall the "X" splash guard bracket. Plug in the Theta motor and sensor and the "Z" motor and sensor cables. Refasten the cables to the "X" plate. Install the worm gear assembly, as described previously, and adjust according to the adjustment procedure. (Ref. Paragraph 2-24)

G. "Theta" Pivot Support Roller Installation

Install the pivot roller and tighten the shoulder screw. Install the Theta gear pad bracket, making sure the felt pad is touching the Theta worm gear.

2-26 "THETA ASSEMBLY TESTING

This section describes testing methods of the Theta assembly and the mechanical adjustments. It is presumed that the motor balance and alignment adjustments are correct, and the sensor circuits are adjusted and operating properly.

Apply saw power, reset and program with any program which has an angle of 90^{o} and a diameter of 6 inches. Perform a chuck zero, remove the gauge block, lock the chuck and press Align switch. On equipment with a TV camera, focus the camera and find a reference spot on the surface. On equipment with a monocular microscope, press the Align switch again to position the microscope to the edge of the 6-inch diameter, focus the microscope on the surface and find a reference spot on the surface. Push the Theta clockwise (CW) switch and observe the reference spot movement; release the Theta clockwise (CW) switch. While observing the reference spot, push and release the Theta counterclockwise (CCW) switch to cause the Theta motor to take one step counterclockwise (CCW). The reference spot should move counterclockwise. If the reference doesn't move until Theta CCW is pressed several times, there is excessive backlash in the Theta worm gear.

Press Index switch and then the CCW switch. The Theta assembly should turn 90^{o}. Press Align switch and check backlash as in the previous paragraph, for "Pass 2" position. If there is excessive backlash, perform the alignment as outlined in Paragraph 2-27.

2-27 "THETA" ASSEMBLY MECHANICAL ADJUSTMENTS

A. Backlash Adjustment

Perform the cleaning, adjustment and lubrication outlined in Paragraph 2-24 (A, B & C). If the Theta assembly binds in one direction and not in the other, the worm gear height must be checked.

"Z" ASSEMBLY MAINTENANCE

2-28 "Z" ASSEMBLY DETAILED DESCRIPTION (See Drawing 12009410-001)

The "Z" stage consists of the "Z" motor assembly, the "Z" lead screw, "Z" nut housing, "Z" flanged bearing assembly, and "Z" mounting ring.

A. "Z" Motor Assembly Description

The "Z" motor housing is one inch shorter in length than the other motors and there is no motor encoder.

Operationally and electrically, the "Z" motor description is the same as the "X" motor. See Paragraph 2-12 (A) (1). The "Z" motor mounts vertically to the bottom of the "Z" mounting ring. The motor output shaft is coupled to the "Z" lead screw by the motor coupling.

B. "Z" Lead Screw Description

The "Z" lead screw converts rotary motion of the "Z" motor into vertical linear motion of the "Z" nut. The top of the lead screw has an "E" ring in a groove to limit the "Z" nut travel. The lead screw nut moves up and down vertically when the "Z" motor rotates the lead screw and also allows rotation around the lead screw axis.

C. "Z" Nut Housing Description

The nut housing clamps over the "Z" nut and clamps the nut into a recess. The circular clamping plate is held in the nut housing by four counter-bored screws from the top of the housing. The nut housing outside surface is a precision surface over which the ball cage of the flanged bearing assembly fits. A removable plug is provided in the top of the "Z" nut housing for oiling of the "Z" lead screw.

D. "Z" Bearing Assembly Description

The "Z" bearing assembly is made up of a ball cage and a flanged bearing housing. The bearing is designed for universal service in rotary and linear shaft motion, either separately or simultaneously. The design is based upon the principle of freely rolling balls for antifriction movement. These balls are held within a retaining cage having 230 spaced ball cavities, arranged to provide maximum contact area and balanced loading capability. There is a molded low-friction nitrile rubber wiper/seal which prevents contamination from entering the bearing surfaces. The balls are preloaded between the inside surface of the housing and the outside surface of the "Z" nut housing. This allows the "Z" nut housing to move linearly and rotationally. The vacuum chuck assembly is then mounted to the "Z" nut housing. The "Z" flanged bearing now allows the chuck to move vertically ("Z" motor) or rotate around the "Z" axis (Theta motor).

E. "Z" Mounting Ring Description

The "Z" mounting ring mounts the "Z" motor on the bottom and the flanged bearing assembly on the top. The ring is roughly triangular-shaped with a counter-bore in the top where the flange mounts. The flanged-bearing housing is held in place by four screws which mount around the flange.

There are three mounting screws at the three corners of the ring which screw into the "X" plate and are the mounting screws for the "Z" assembly. An air exhaust fitting is provided to prevent pressure buildup.

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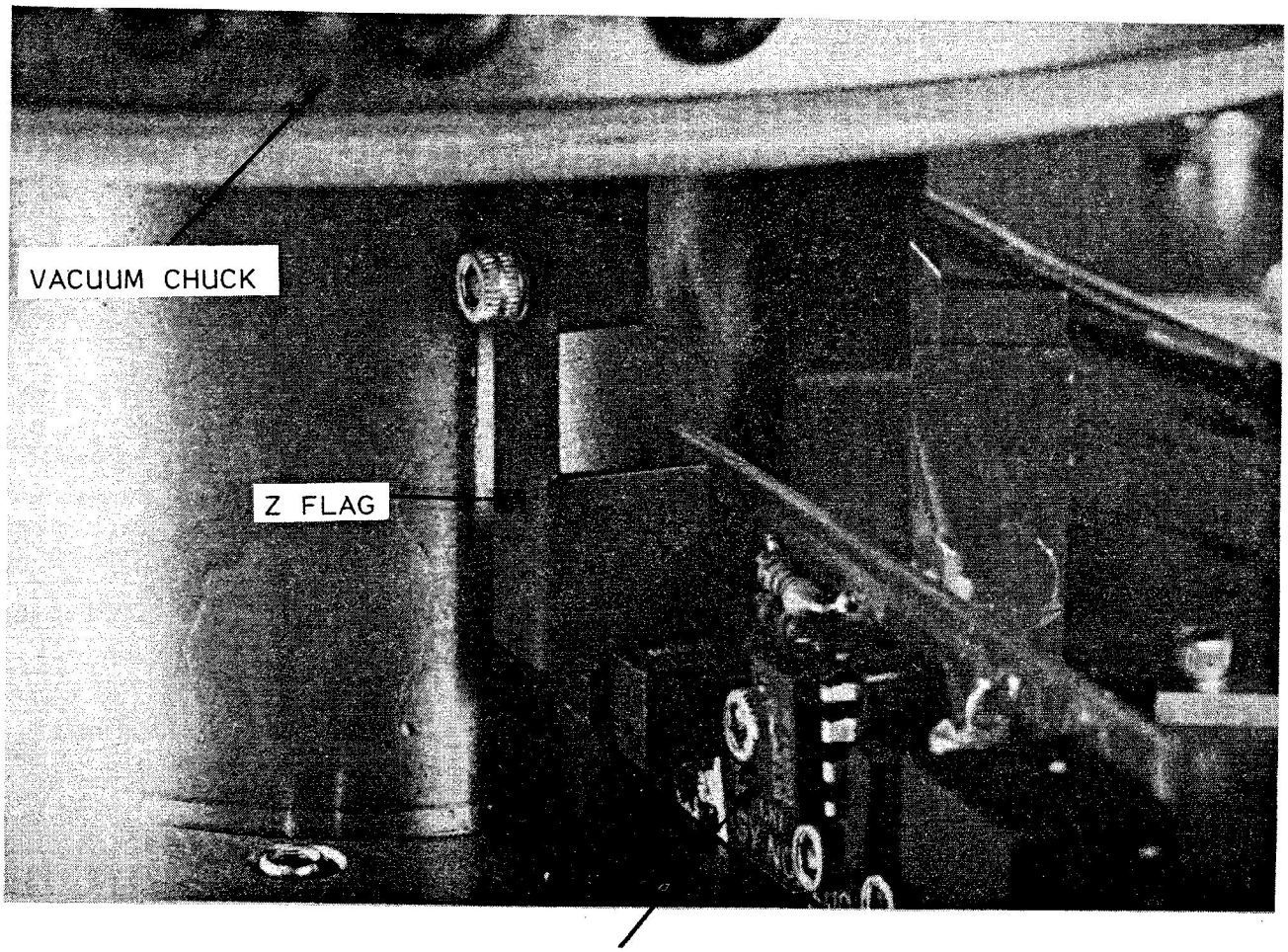


FIGURE 2-16

DETAIL OF Z SENSOR & FLAG

F. "Z" Limit Sensor Description

The "Z" limit sensor is on a PCB which mounts on top of the Theta worm wheel. There is one photo sensor which is activiated by a metal flag which mounts to the bottom of the vacuum chuck assembly. All electrical connections are routed through a 10-pin ribbon connector, except chassis ground which is carried through the mounting screws. For a detailed circuit description, refer to the "Theta" limit sensor description, Paragraph 2-23 (D).

2-29 "Z" ASSEMBLY PREVENTIVE MAINTENANCE

A. Cleaning (Every 80 hours of machine operation)

The "Z" assembly is enclosed by the flanged bearing housing and, therefore, requires little maintenance.

The "Z" nut housing is a bearing surface and should be kept clean. To clean the "Z" nut housing, remove the chuck assembly (Paragraph 2-15). With the chuck removed, unscrew the "Z" nut housing by rotating counterclockwise. This will expose the outside bearing surface of the "Z" nut housing. Clean thoroughly, using Freon. If there is corrosion that cannot be removed with Freon and the corrosion causes roughness of the housing surface, remove by polishing with #600 emery cloth. Make sure all grit and residue are cleaned off after polishing. The top surface of the "Z" nut holds the vacuum chuck assembly. Any dirt or corrosion on this surface will cause the chuck surface to be unlevel. Care must be taken to prevent marks or dents on this surface. Flatness must be maintained. Clean the top of the "Z" housing with Freon TF. If corrosion exists which the Freon will not remove, the top can be polished by wrapping some #600 emery cloth around a precision flat bar, such as a bar of machine tool steel. Hold the tool steel perfectly flat and polish the top of the "Z" nut housing using a "Figure 8" motion. Do not polish more than necessary. Carefully wipe all grit and dirt after polishing.

B. "Z" Assembly Lubrication (Every 80 hours of machine operation)

The routine lubrication required on the "Z" assembly is on the "Z" nut housing, the felt wiper/seal, and the "Z" lead screw. Saturate the felt oil ring washer using high grade light oil. Using a 4-40 screw, remove the cap in the top of the "Z" nut and introduce four drops of oil to the "Z" lead screw. Replace the cap.

2-30 "Z" ASSEMBLY PARTS REPLACEMENT

If it becomes necessary to remove, loosen, or change the "Z" mounting ring, it will then be necessary to perform a system alignment. (Ref. Paragraph 2-66)

A. "Z" Motor Replacement

It is unlikely the "Z" motor will require replacement; however, if the need arises, proceed as follows:

Remove the vacuum chuck, "X" splash guard, front tray, Theta worm gear assembly, and Theta worm wheel, according to the procedures outlined in those sections.

Remove the three mounting screws from the "Z" mounting ring.

Make sure the "Z" motor connector hs been removed and carefully lift the "X" assembly out of the "X" plate.

Place the "Z" assembly on a clean work surface.

Remove the four mounting screws from the flanged bearing housing.

Remove the bearing housing and the ball cage from the "X" nut housing.

Screw the "Z" nut housing counterclockwise while holding the motor sensor wheel until it is at the maximum height position.

Place the assembly on the work surface (on the nut housing top surface) with the motor up.

Remove the four motor mounting screws.

CAUTION: THE "Z" MOUNTING RING WILL FALL IF NOT SUPPORTED.

Lower the "Z" mounting ring until it rests on the nut housing.

Install three spacer rods between the coupling plates.

Loosen the motor shaft coupling screws and remove the motor.

Install the replacement motor shaft into the coupling, making sure the motor shaft is against the ball, and tighten the coupling screws.

Remove the three spacer rods.

B. "Z" Lead Screw Replacement

Perform the steps necessary to remove the "Z" assembly from the "X" plate, as outlined in "'Z' Motor Replacement", Paragraph A. above.

To remove the "Z" nut housing, make two cuts in a cross pattern in the rubber which blocks the three holes in the top of the "Z" nut housing. Insert a 3/32 Allen wrench through the rubber and loosen the three screws from the top of the "Z" nut housing. The nut housing will come free when all three screws are unscrewed.

With the "Z" nut housing removed, the "Z" lead screw will be visible and accessible. Loosen the shaft coupling screw and remove the "Z" lead screw. Install the three spacer rods in the coupling. Install the replacement "Z" leadscrew shaft into the coupling as far as it will go and tighten the coupling screws. Remove the spacer rods. Remove the old rubber from the nut housing mounting screw holes, and remove the three nut housing screws from the nut housing. Insert a small shaft (such as a long, small-diameter Allen wrench) through one of the mounting holes in the nut housing, then insert it into one of the holes in the nut ring. This will act to line up these two parts to enable insertion of the screws.

While holding the nut-ring in alignment with the small shaft, insert a screw into one of the other holes and screw it into the nut holder ring. Do not tighten. Insert the second screw into the nut housing and screw it into the nut holder ring. Remove the small shaft and insert the third screw into the last nut ring hole. Screw the third screw into the nut holder ring. Tighten the three nut mounting screws.

Before reassembly of the "Z" assembly, make sure the "Z" nut housing, ball cage, flanged bearing housing, and "Z" mounting ring are all clean. Liberally apply a high-quality, light vacuum oil to the ball cage. If desired, the ball cage may be "dipped" into a container of oil. Lightly coat the inside of the flanged bearing housing and seal ring and the outside of the "Z" nut housing.

To reassembly the flanged bearing ball cage and housing, screw the "Z" nut housing down to the mechanical limit. Slide the ball cage over the "Z" nut housing until the "Z" nut housing is ½-inch below the top of the ball cage. While holding the ball cage and nut housing in this position, slide the flanged bearing housing over the ball cage until balls begin engaging both the "X" nut housing and the flanged bearing housing. Once the balls are engaged, the ball cage will move in relation to the flanged bearing housing. Lower the

flanged bearing housing until the flange on the housing rests in the "Z" mounting ring. With the "Z" nut housing at lower limit, correct alignment is indicated when the ball cage bottom edge, the flanged housing bottom edge, and the top of the "Z" mounting ring all align while lowering the flanged housing into the "Z" mounting ring. Hold the "Z" assembly in a vertical position. Gently raise and lower the flanged bearing housing approximately one inch so the flange leaves and enters the "Z" mounting ring. The flange should not contact any side of the "Z" mounting ring counter-sink as the housing is lowered. If the flange contacts the "Z" mounting ring, re-position the "Z" motor assembly to prevent that condition. Position the "Z" motor assembly so the flange centers the "Z" mounting ring without contact of the outside edge. Once this position is obtained, tighten the four motor mounting screws. Install the four screws around the flanged bearing housing flange and tighten. To test the "Z" assembly for proper alignment, screw the "Z" nut housing from the bottom stop to the top stop by rotating the nut housing. The "Z" nut should turn smoothly with minimum coupling of the motor.

Re-install the "Z" assembly into the "X" plate. Install the three mounting screws into the "Z" mounting ring, and tighten. Make sure the Jacking screws do not contact the "X" plate.

Perform the chuck flatness alignment procedure, Paragraph 2-66 (C).

Re-install the Theta worm wheel, Theta worm gear assembly, and the Theta motor, according to the procedures for those assemblies.

Perform the chuck flatness procedure, Paragraph 2-66 (A) and (B). Re-assemble the front tray, "X" splash guard, and chuck assembly, according to the procedures for those assemblies. This complete the "Z" lead screw replacement. This procedure should also be followed to replace any of the other parts in this assembly.

2-21 VACUUM CHUCK ASSEMBLY PREVENTIVE MAINTENANCE

A. Cleaning

The vacuum chuck surface should always be kept clean. Examine the concentric vacuum grooves and holes for foreign material and clean as often as necessary. For difficult "plugging", it is often helpful to apply air pressure to the vacuum line fitting.

Whenever the chuck is replaced, check the bottom surface which mates with the "Z" nut housing. This surface must be clean and free from dents, scratches, or any imperfection. The cleanliness and flatness of this surface will directly effect the chuck level. If this area becomes corroded and normal cleaning fails to remove the corrosion, wrap #600 emery paper around a round, flat object (such as the pressure washer for the blade mounting) and carefully polish the area.

B. Lubrication (Every 180 hours of machine operation)

The "O" rings on the bottom of the chuck should be kept flexible by coating with a thin coat of silicon grease. The "O" guide ball and "T" spring should be lubricated with WD-40.

2-33 VACUUM CHUCK PARTS REPLACEMENT

A. The vacuum chuck bellows prevents water from entering the area under the front tray. It should be replaced whenever it becomes torn. Remove the chuck and place top-down on a clean work surface. Remove the flathead screws from the bellows retaining ring. Remove the ring and old bellows. Lay new bellows on the chuck, aligning the mounting holes. Lay the retaining ring over the new bellows and insert the mounting screws. Insure that the bellows lays flat around the chuck and tighten the screws.

B. The three "O" rings in the bottom of the vacuum chuck must be replaced any time they show evidence of leaking.

2-34 "Y" STAGE DETAILED DESCRIPTION

A. "Y" Motor Assembly Detailed Description

The "Y" motor assembly is identical and interchangeable with the "X" and "O" motor assemblies. For a detailed description, see Paragraph 2-12 (A) (1). The motor assembly mounts to a bracket which, in turn, mounts to a precision boss on the center of the saw casting near the back of the saw. The output shaft is connected through a flex coupling to the "Y" lead screw.

B. "Y" Lead Screw Assembly Description (Bellows Type) See Fig. 2-19

The "Y" lead screw assembly consists of a precision lead screw with a brass double nut, a precision tool ball and ball holder bracket, a front bearing support block assembly, a lead screw support casting and motor mount, two bellows and an air supply line assembly. The double nut assembly consists of a running nut which has spring-loaded pins for preload against the adjustable nut. The running nut also has a precision socket for the tool ball and a spring pocket for the ball spring. The adjustable nut is positioned to compress the spring pins which exert preload on both nuts. The adjustable nut is held from rotating by a wire spring pin which inserts through the adjustable nut and into a matching hole in the running nut. The leadscrew is supported on each end by precision bearings. The lead screw shaft attaches to the "Y" motor shaft by a flexible coupler. The lead screw is completely covered by two bellows which are supplied by positive air pressure to keep contamination out.

C. "Y" Slide Assembly Description

The "Y" slide is a complete assembly which provides smooth, precise, linear movement of the spindle assembly at right angles to the "X" cutting motion. Except for position, there are no field adjustments of the "Y" slide.

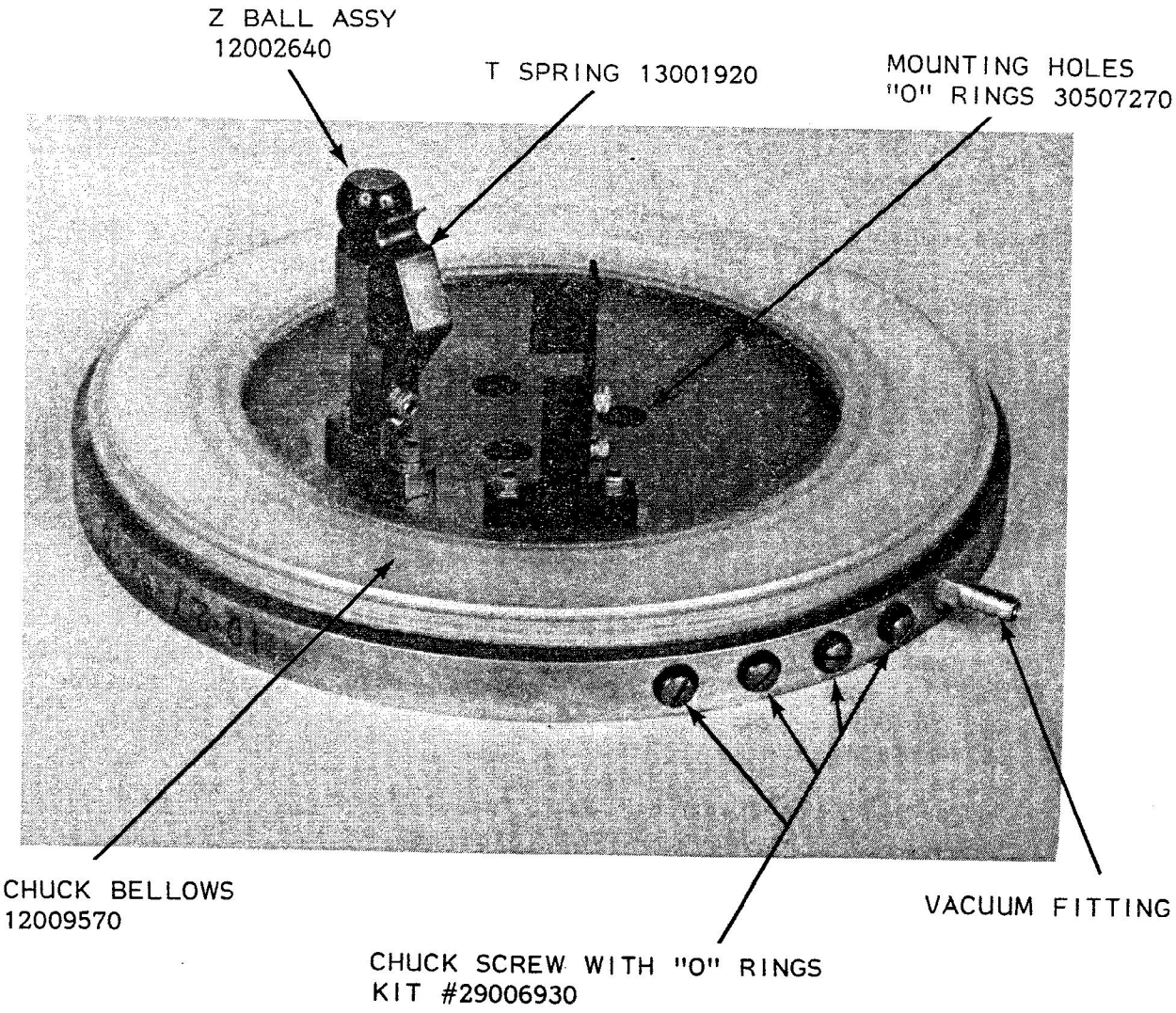


FIGURE 2-17

VACUUM CHUCK ASSEMBLY BOTTOM VIEW (PN 11005430)

D. "Y" Limit Sensor Description

The two "Y" limit sensors are mounted on a single printed circuit board. The board is mounted to the side of the "Y" slide so that a flag on the "Y" running nut will interrupt the sensors' light at either end of the"Y" travel.

For detailed circuit description, see the "X" limit sensor description, Paragraph 2-12 (C). The circuits are identical, except for the connector pins assignments.

2-35 "Y" STAGE PREVENTIVE MAINTENANCE (Every 40 hours of operation)

A. Testing and Inspection

Test the "Y" assembly by operating the saw in the index mode and looking at a grid-of-know accuracy, such as an alignment mask. Align the "Y" and "Theta" on a center line and then, in the index mode, approach the line from each direction to check repeatability. Index to the back and to the front to check for linearity.

Inspect the slide and lead screw for cleanliness and foreign material. Inspect water tubing for leaks, looseness or wear. Test lead screw for end play or looseness.

B. Cleaning and Lubrication

Clean and lubricate the "Y" slide with WD-40. Slide the bellows away from the lead screw and examine for signs of contamination. If required, spray WD-40 on the lead screw while rotating the lead screw to flush away any accumulation of contaminants. Wipe off the excess WD-40. Remove the two screws holding the ball holder to the spindle casting boss and remove the ball holder assembly. Place 20 drops of 10w oil into the ball bushing in the running nut. Loosen the ball guide spring screws and re-install the ball holder on the spindle casting boss. Tighten the ball guide spring screws.

C. "Y" Stage Adjustments

When the testing in Paragraph A. shows stepping problems, perform the following adjustments.

1. Repeatability Adjustment --- When testing shows the "Y" stage fails to repeat when approaching from opposite directions, perform the following steps: (Refer to Figure 2-19)

   a. Examine the "Y" lead screw mounting and make sure there is no end-play between the bearings. If end-play is observed, loosen the "Y" motor mounting casting and, while pushing forward, tighten the casting screws.

   b. Examine the "Y" tooling ball holder and spring. Make sure all screws are tight in this coupling. Check "Y" motor coupling for tightness.

   c. If non-repeatability is still seen, pull the bellows off the rear of the "Y" nut assembly. Remove the retaining pin from the adjustable nut. Tighten the adjustable nut one-fourth revolution toward the running nut.

   d. Re-insert the retaining pin and re-test repeatability.

2. "Y" Mis-Indexing Adjustment

   "Y" Mis-indexing is usually caused by electronic stepping problems. To test for electronics mis-indexing, program the index to 50 mils of some even multiple of 50 mils; place the saw in the INDEX mode and remove the top cover. Mark the "Y" motor encoder near the sensor for a reference mark. Index forward and back. The index mark should always stop in the position it was when you marked it. If you gain or lose steps, you must troubleshoot the electrical components and correct the problems.

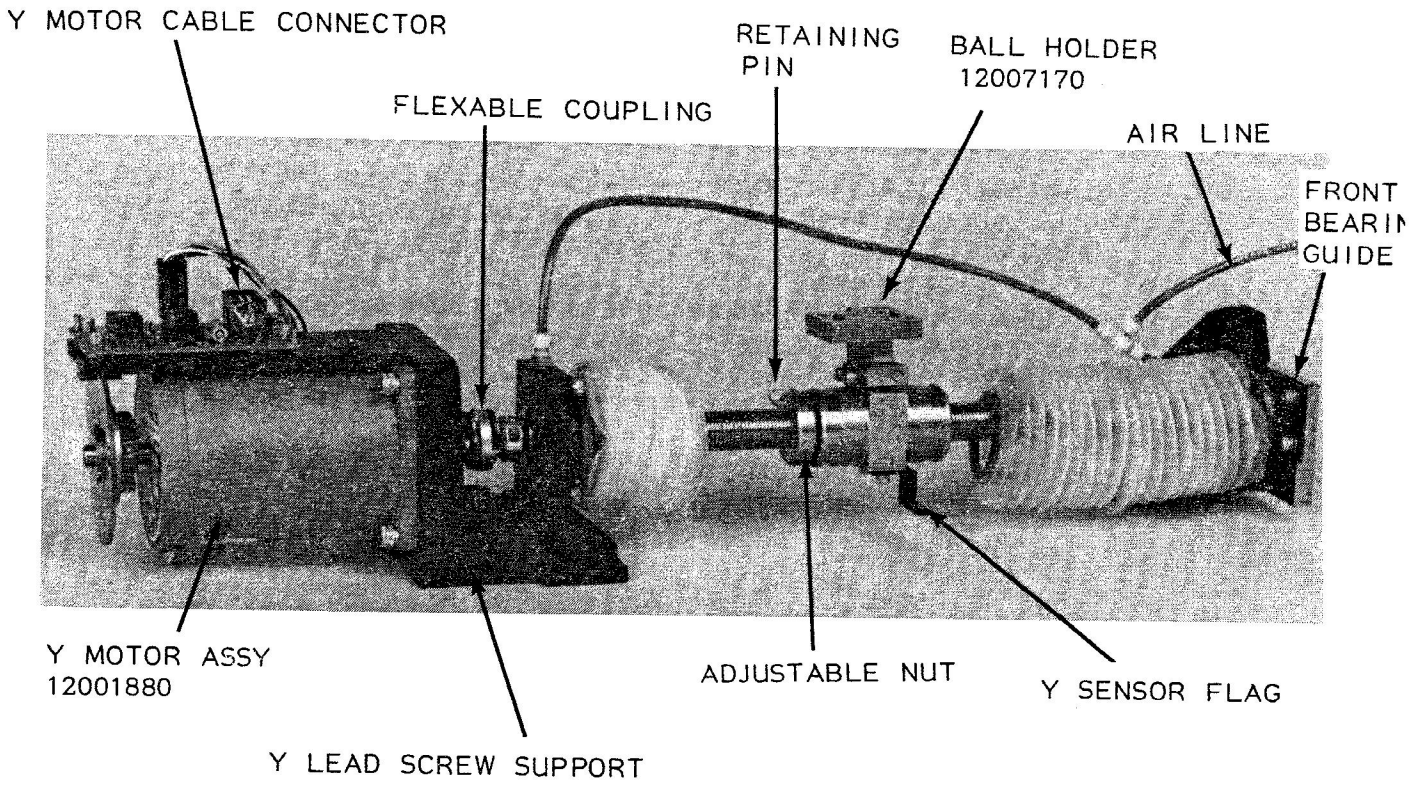


FIGURE 2-19

Y LEADSCREW ASSY WITH BELLOWS

3. "Y" Linearity or "Run Out" Adjustment

"Y" non-linearity is usually seen as a gradual misalignment which becomes greater with the distance from the alignment street or mark. This is usually caused by mechanical misalignment of the "Y" lead screw in relation to the "Y" slide. Adjust as follows:

Mount a known, accurate alignment mark or tool, such as the MAI Micro-Mask, on the chuck and perform "X" and "Theta" alignment at the rear of the "Y" travel. Index forward to the front of the mask and observe the error on the optics. Loosen the four screws which hold the front bearing of the "Y" lead screw and, while watching the optics, move the front of the lead screw left or right to correct the position. Tighten one screw in the front bearing plate and index to the rear. Repeat these steps until you achieve accurate stepping over the entire Mask.

NOTE: You may have to reposition the "Y" motor to achieve the correct alignment.

2-36 "Y" STAGE PARTS REPLACEMENT (Ref. Fig. 2-19, Page 81)

2-37 "Y" MOTOR ASSEMBLY REPLACEMENT

A. "Y" Motor Removal

Remove the four #8-32 screws which mount the "Y" motor to the "Y" support bracket. Loosen the flexible coupling screw from the motor shaft. Disconnect the ribbon cable from the motor encoder connector and remove the motor.

B. "Y" Motor Installation

Place the motor shaft into the lead screw flex-coupling and install the four #8-32 screws into the "Y" mount. Stretch the flex-coupling approximately 1/8-inch and tighten onto the motor shaft. Install the ribbon connector into the motor sensor connector.

2-38 "Y" LEAD SCREW ASSEMBLY REMOVAL

A. "Y" Lead Screw Assembly Removal

Remove the two screws from the ball holder and lift it out. Remove the two #10x32 screws which mount the "Y" lead screw support to the casting. Carefully slide the lead screw assembly toward the back until the lead screw shaft is clear of the front bearing and then carefully lift the assembly to the rear and remove from the saw.

B. "Y" Lead Screw Assembly Installation

Lift the assembly into position so the lead screw shaft is inserted into the front bearing. Make sure the wave washer and spacer washer are on the front lead screw shaft. Install the ball holder into the running nut bushing and tighten the screws. While pushing forward lightly, move the motor end of the assembly left or right until the running nut flat is parallel to the ball bracket surface. Install the two #10x32 mounting screws through the slotted holes in the "Y" support bracket. While pushing forward to compress the front wave washer, tighten the two mounting screws. Adjust, per Paragraph 2-35 C.

2-39 "Y" SLIDE REPLACEMENT

A. "Y" Slide Removal

To remove the "Y" slide assembly, remove saw blade, then remove the four screws which mount the spindle casting to the "Y" slide. Retain any washers from under the spindle casting. Disconnect the "Y" sensor cable. Remove the four slide retaining screws and, while holding the spindle casting up, slide the "Y" slide to the rear and remove from the saw.

B. "Y" Slide Installation

With the "Y" sensor PCB mounted and the mating surfaces cleaned, lift the spindle casting up and slide the "Y" slide assembly into place. Install the slide mounting screws finger-tight. Install the spindle casting mounting screws, using the washers from A. above and, while holding pressure to the front and the right, tighten the casting to the slide. Holding pressure as above, tighten the slide mounting screws. Install the "Y" sensor cable.

2-40 "Y" LIMIT SENSOR TESTING AND REPLACEMENT

A. Limit Sensor Testing

To test the "Y" limit sensor circuits, connect a voltmeter negative lead to TP-1 (logic ground). Connect the + voltage lead to TP-3 to test the rear sensor or TP-5 to test the front sensor. The voltage should be +5V with the sensors unblocked. Block the light in the sensor with a flat-bladed screwdriver or equivalent. The voltage should switch to zero. If either of these conditions are incorrect, replace the IC in the failed sensor circuit. For the front sensor, replace U2; for the rear sensor, replace U4. If replacing U2 or U4 does not correct the failure, it will be necessary to replace the "Y" limit sensor PCB assembly.

B. "Y" Limit Sensor Removal

To remove the "Y" limit sensor, unplug the connector from the front of the sensor PCB. Remove the three Allen screws which mount the board to the "Y" slide. Bring the PCB back and up until the front clears the casting and can be rotated toward the rear. When the PCB is vertical, lift from the saw.

C. "Y" Limit Sensor Installation

Lower the "Y" sensor PCB connector first between the "Y" lead screw and the casting, and then tilt the PCB into position. Insert the three mounting screws and tighten. Connect the ribbon cable to the PCB connector. Manually move the "Y" stage back and forward, checking that the flag enters the sensors without interference.

2-41 MONOCULAR MICROSCOPE ASSEMBLY PREVENTIVE MAINTENANCE (Every 80 hours of Operation)

A. Monocular Microscope Cleaning

Clean lenses and housing using a soft cloth and water soluable detergent or lens cleaning agent. Rinse with clear water. Wipe slide and slide gear races with a dry cloth and oil lightly.

B. Monocular Microscope Maintenance Adjustment

The only maintenance adjustment on the monocular microscope is the crosshair. The adjustment is made by loosening the Allen set screw in the side of the eyepiece and rotating the eyepiece to align with the cut.

2-42 MONOCULAR MICROSCOPE REPLACEMENT

A. Monocular Microscope Removal

To remove the monocular microscope, first remove the illuminating lamp and slide locking screw. Rotate the knurled position adjustment knob forward until you are able to remove the microscope from the slide. Remove the two slide mounting screws and remove the slide from the casting.

B. Monocular Microscope Installation

To install the monocular microscope, first mount the slide on the casting. Screw the slide locking screw into the slide and make sure the brass slide protector shim or plug is in place. Slide the microscope assembly onto the slide, engage the gear and rack and adjust to the center of the rack. Install the illuminating lamp and plug in the connector.

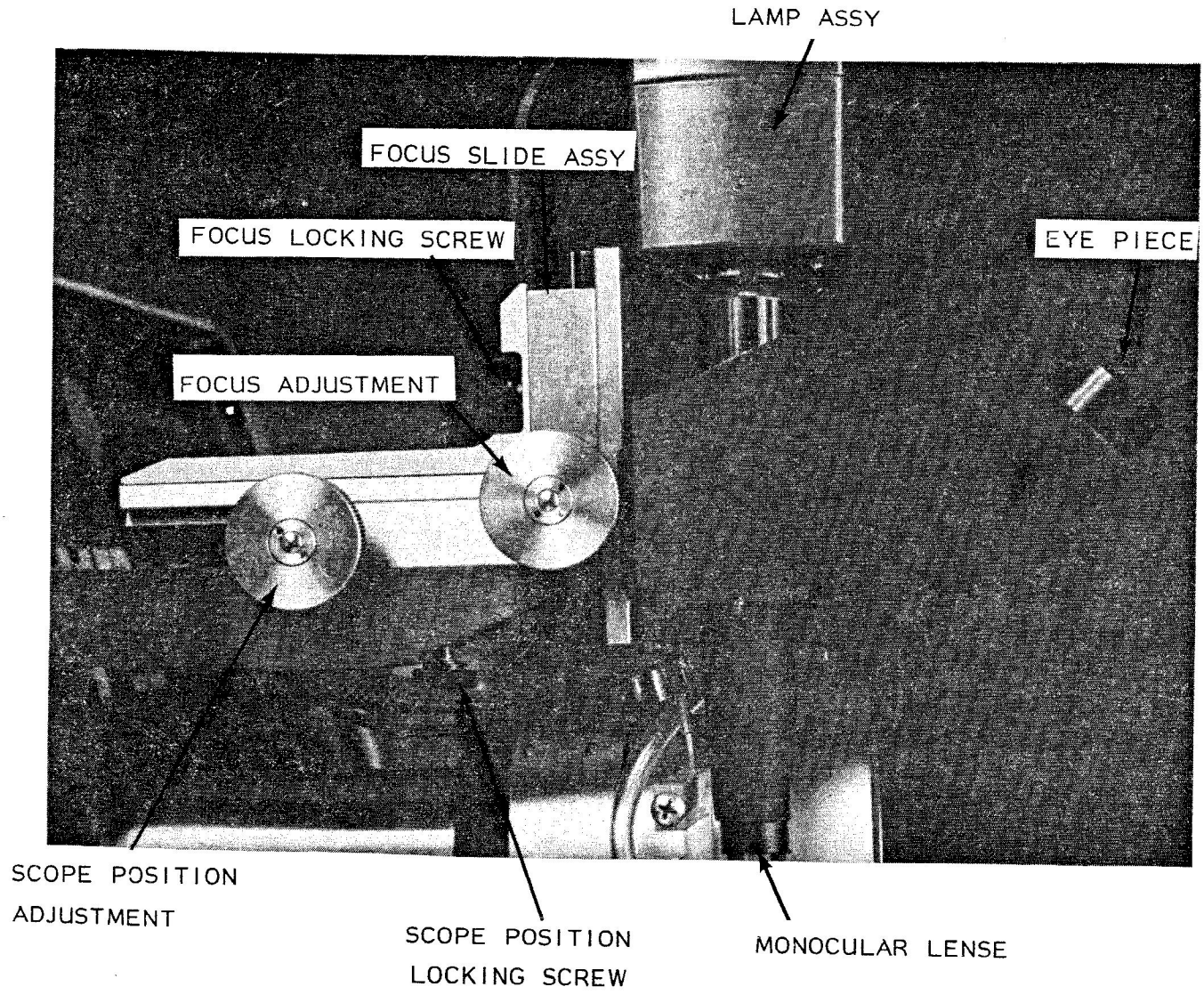


FIGURE 2-20

MONOCULAR OPTICS

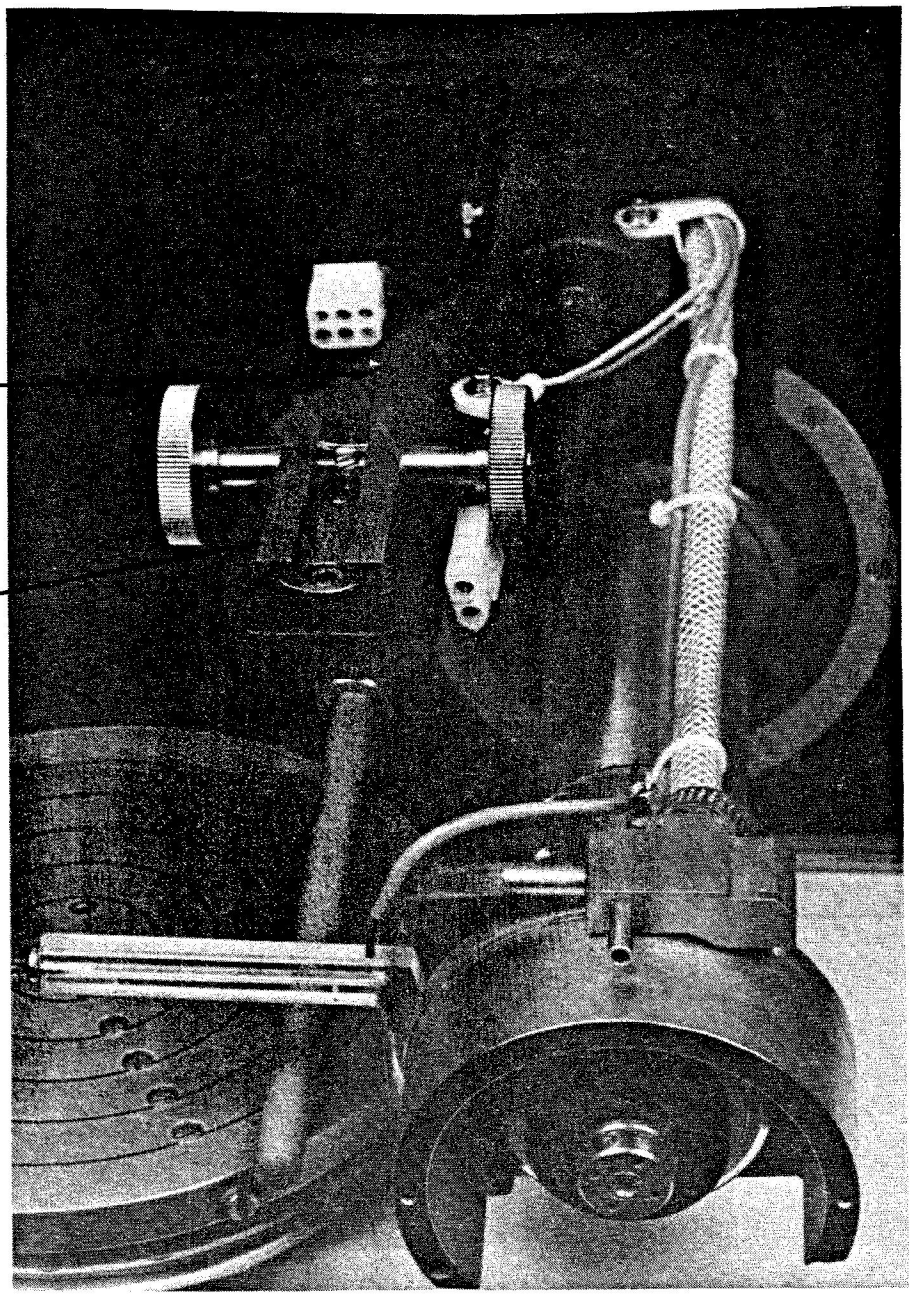


FIGURE 2-21

MONOCULAR SCOPE SLIDE

C. Monocular Microscope Alignment

Alignment of the monocular microscope assembly must be made after installation and should be checked whenever a cutting blade has been installed. Program the saw to make a cut in a scrap or blank wafer. Place the saw in the INDEX or ALIGN mode and make a single cut. Using the left and right controls, position the cut under the microscope. Loosen the focus lock screw and focus onto the wafer surface. Loosen the position lock screw and adjust the microscope position until the crosshair is aligned with the cut; tighten the lock screw.

NOTE: The position may change slightly while locking, so allowance for that change must be made.

2-43 SPLIT IMAGE TV MICROSCOPE ASSEMBLY PREVENTIVE MAINTENANCE (Every 80 hours of machine operation)

A. TV Microscope Cleaning

Clean lenses and housing with a soft wiper and water and detergent or alcohol.

CAUTION: DO NOT GET LIQUID INSIDE THE CAMERA !!!

Rinse with clear water and dry with a soft, dry cloth or wiper.

B. TV Microscope Assembly Adjustments

1. TV Microscope Assembly Focus Adjustments.

To adjust the focus, perform the steps as follows:

a. Program the saw with a height and thickness which correspond to the wafer to be used as a reference.

b. Perform a CHUCK ZERO operation.

c. Mount the reference wafer and enter ALIGN mode. The wafer will be positioned under the TV optics.

d. Adjust the TV monitor controls for the clearest picture.

e. Adjust the TV camera focus kob for the clearest picture on both sides of the monitor. When one side of the picture is in focus at a different height from the other side, it will be necessary to adjust the optical lens as follows:

i. Adjust the focus as above for the clearest picture on the right side of the TV monitor.

ii. Remove the body cover from the TV optics body.

iii. Add or remove the spacer shims between the lefthand lens and the optics casting until you achieve a focus comparable to the righthand side.

iv. Replace the body cover.

2. TV Microscope Assembly Position Adjustment (non-adjustable mount).

Whenever the TV microscope is changed or moved, the position may require adjustment. To determine if the TV assembly requires adjustment, test as follows:

a. Program the saw normally using a height and thickness which correspond to a blank polished wafer (at least two inches in diameter).

b. Perform a CHUCK ZERO operation.

c. Mount the blank polished wafer and lock the vacuum chuck.

d. Put saw in ALIGN mode and make a single cut.

e. Blow water from the wafer and observe the picture on the monitor.

The TV microscope position is correct when the cut appears as a continuous black line across the entire screen and the cut is superimposed over the reticle at the center of the monitor.

NOTE: If the reticle has been moved up or down via the control buttons, the center can be found by momentarily turning the camera power OFF and then ON. The reticle will always turn on "black" and in the center.

If the cut line does not appear as a continuous line across the TV monitor face and/or is not superimposed under the reticle, the TV microscope position must be adjusted as follows for the non-adjustable mount:

i. Loosen the two TV microscope mounting screws in the mounting arm.

ii. While watching the TV monitor, adjust the TV microscope position until the cut appears as a continuous line across the TV monitor, superimposed under the reticle.

iii. Tighten the mounting screws.

NOTE: The assembly may move while tightening, so you must compensate for this movement until proper alignment is accomplished with the screws tight.

3. TV Microscope Assembly Adjustment (adjustable mount) Fig. 2-22 A.

a. Test the camera adjustment by performing Steps in 2.a., b., c., d., and e. above.

b. If the cut does not appear to be a continuous line across the TV monitor, adjust the camera Theta adjustment lever on the right side of the camera mount to achieve a continuous-appearing cut across the TV monitor.

c. If the cut is not centered under the reticle, adjust the camera "Y" adjustment knob on the back lefthand side of the camera mount to center it.

d. When there is looseness in the camera "Y" position adjustment screw, tighten the "Y" adjust tension screws to remove looseness.

e. Adjust the mounting ball tension screw to remove any play in the mounting ball position.

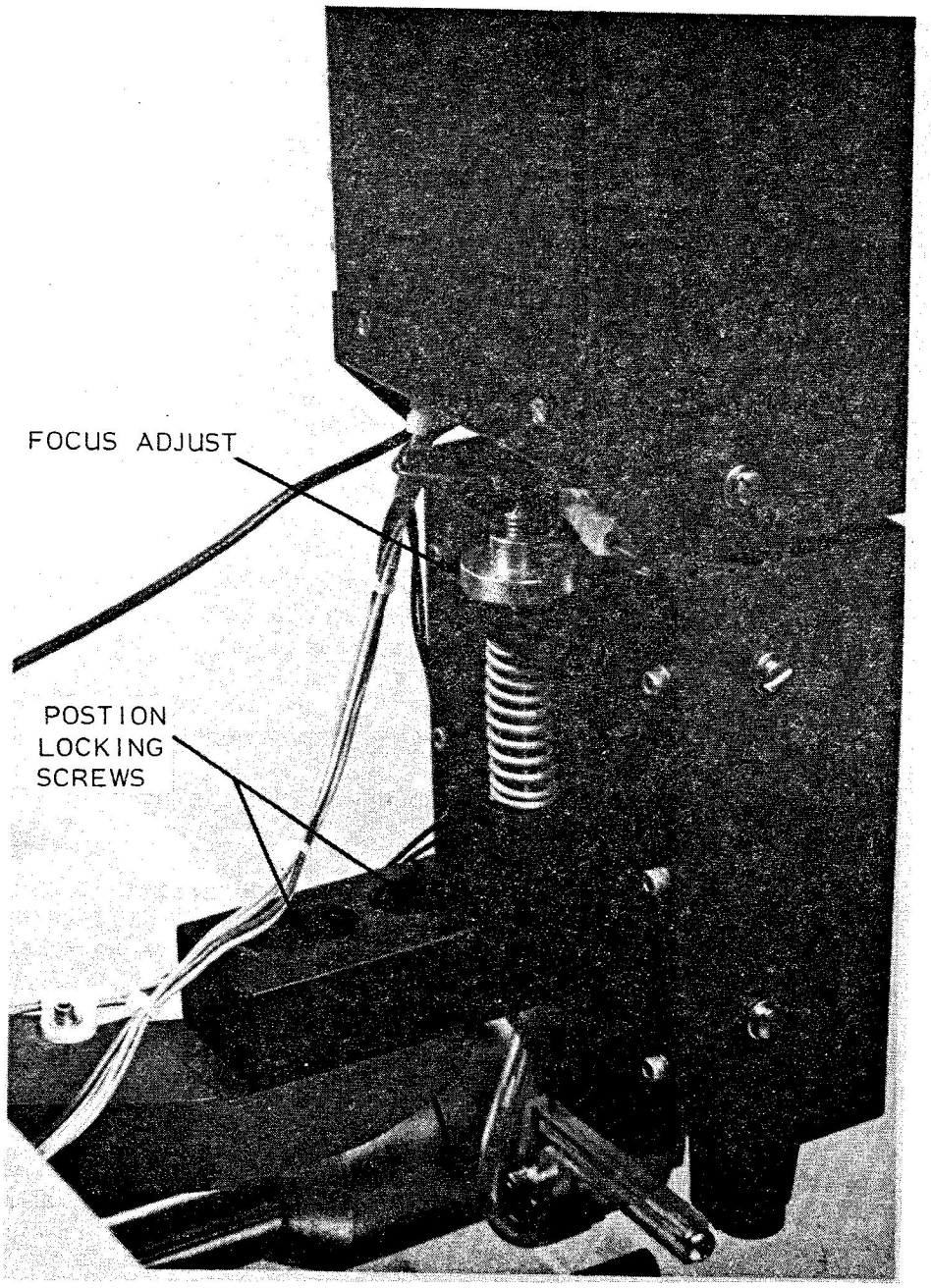


FIGURE 2-22

TV OPTICS MOUNTING AND ADJUSTING

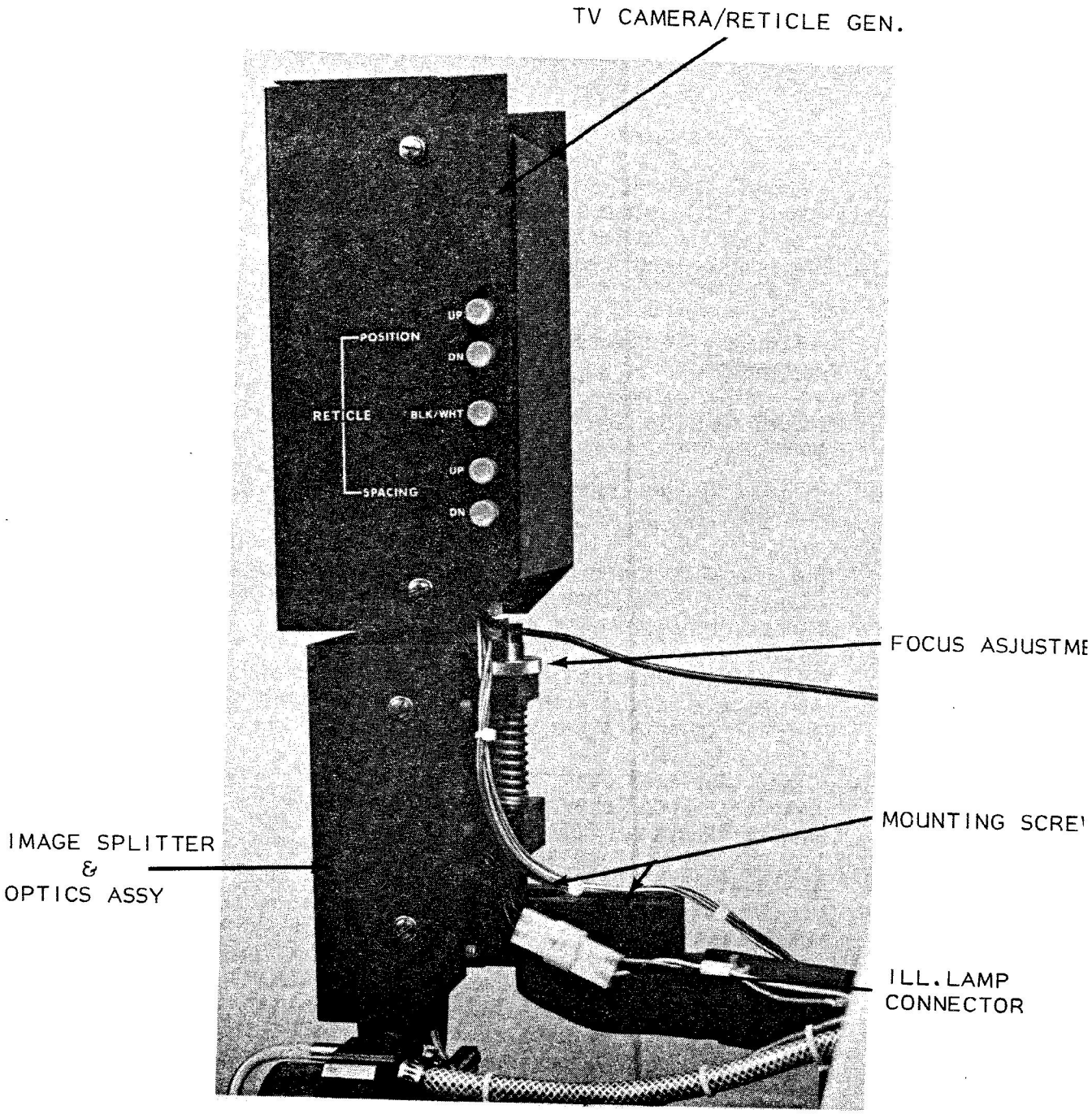


FIGURE 23

TV SPLIT IMAGE OPTICS ASSY (SIDE VIEW)

4. TV Camera Adjustments

The TV camera has several internal adjustments. These adjustments should not change under normal conditions. However, it may be desired to optimize these adjustments; therefore, the adjustments are described herein.

a. Perform the TV microscope focus adjustment as described in Paragraph 2-43 B. 1.

b. Remove the six cover mounting screws and remove the TV camera cover.

CAUTION: THERE ARE DANGEROUS VOLTAGES PRESENT INSIDE THE TV CAMERA.

c. Turn the BEAM control clockwise until the picture suddenly "blooms". Then, turn the BEAM counterclockwise just past the position where the picture "un-blooms".

d. Adjust the electrical focus for the clearest picture. Alternately adjust with the microscope focus adjustment in order to obtain the best picture.

e. Adjust the level control for minimum after-image and correct contrast. Keep level control as low as comfortable for longest TV-tube life.

f. To adjust the SET-UP control, turn the "V HOLD" control on the monitor until the line between frames is visible and stable on the monitor. This line should be comprised of a black band at the top and a gray area at the bottom of the line. If the line is solid black, turn the SET-UP control counterclockwise until the bottom of the line is gray. If this condition cannot be adjusted with the SET-UP control, it may be necessary to decrease the level.

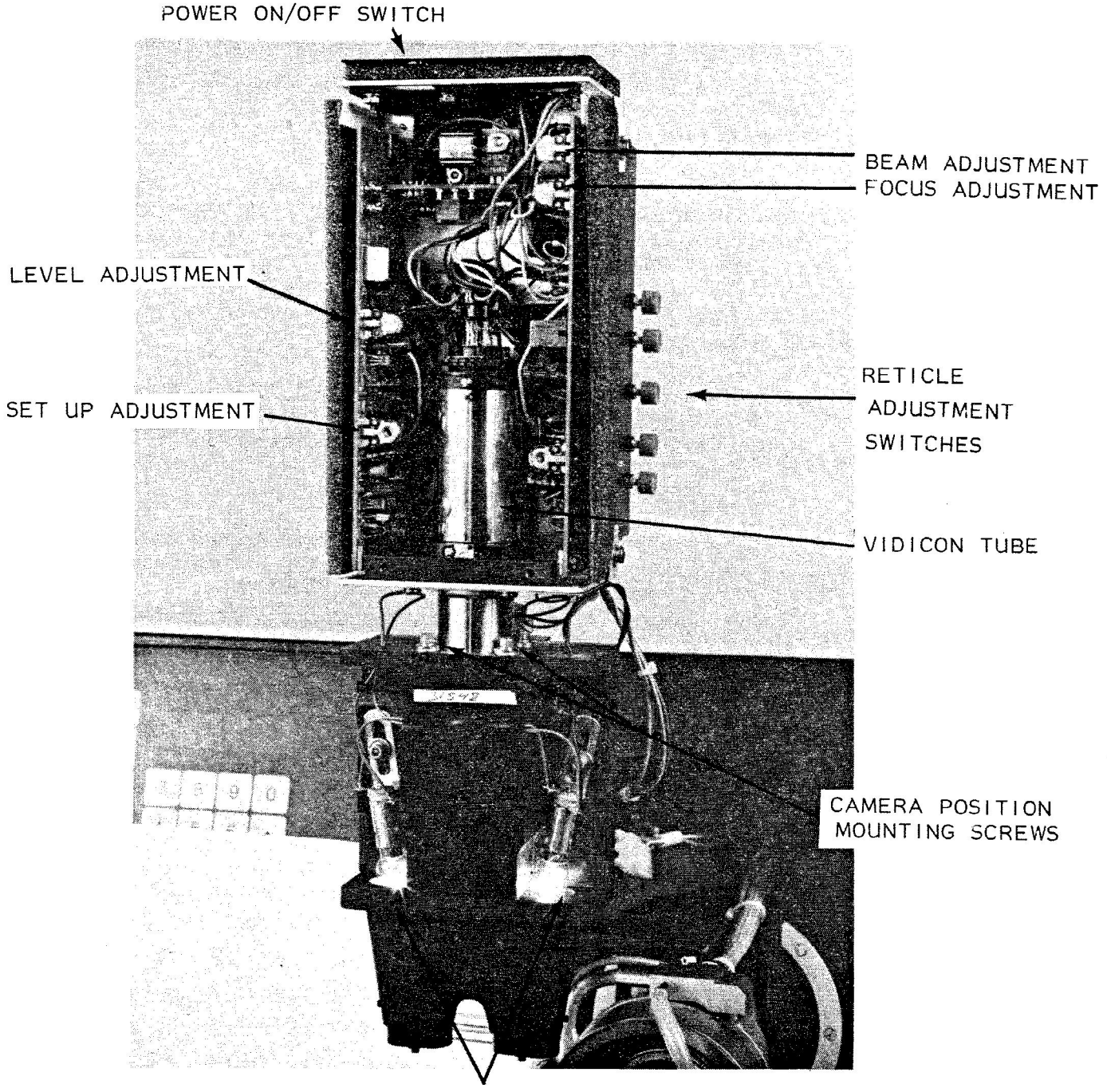


FIGURE 2-24

TV SPLIT IMAGE OPTICAL ASSY
WITH COVERS REMOVED

5. TV Camera Position Adjustment

The TV camera is held in position by four #6 x 32 Allen cap screws which hold the camera adaptor in the optics housing. To determine whether the camera position requires adjustment, proceed as follows:

a. Perform the TV microscope focus and position adjustments in Paragraph 2-43 B. 1., 2., and 3.

b. If the camera position is correct, the reticle will be parallel to the cut line. When the reticle is not parallel to the cut line, adjust the camera position as follows:

   i. Remove the lower housing cover.

   ii. Use a short 7/64 Allen wrench and loosen the four camera mounting screws around the camera adapter ring.

   iii. Rotate the camera and adaptor until the reticle is parallel to the cut line and tighten the four camera mounting screws. Allowance must be made for any movement caused by the tightening of the mounting screws.

6. TV Reticle Adjustment

The TV reticle generator has an individual adjustment for the intensity of the black and the white reticle. If the reticle line is either difficult to see, or if it seems excessively wide, it may be due to the reticle intensity adjustment. When it has been determined that adjustment is required, this procedure should be followed:

a. Remove the six camera cover screws (two in front and two on each side) and remove the camera cover.

   CAUTION: HIGH VOLTAGE PRESENT!

b. Hinge the back cover toward the rear of the saw to allow access to the reticle generator PC board.

c. Mount a wafer and operate the saw to produce a normal picture on the TV monitor.

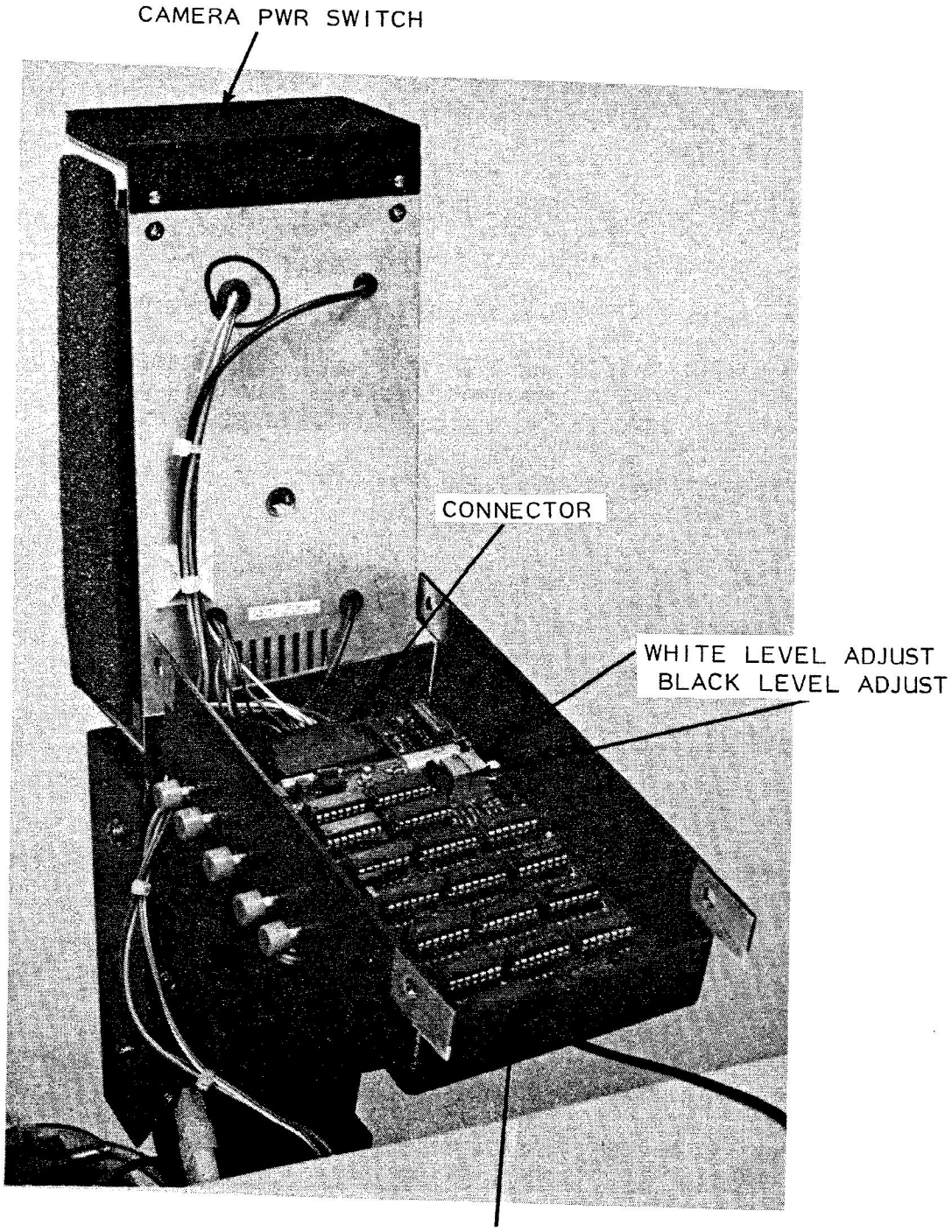


FIGURE 2-25

TV CAMERA WITH COVERS REMOVED

&

RETICLE GENERATOR IN THE SERVICE POSITION

d. Set the reticle for a single white line in the middle of the picture.

e. Adjust R15 for the proper white level intensity.

f. Press the center push button making the reticle black.

g. Adjust R16 for the proper black level intensity.

NOTE: The R15 and R16 adjustments are located on the left of the component side of the reticle generator PCB. R15 is nearest the PC board outside edge.

h. Re-assemble camera and check focus and alignment.

2-44 TV MICROSCOPE PARTS REPLACEMENT

A. TV Lamp Replacement and Adjustment

The two lamps in the TV microscope can be replace as follows: (Only G.E. 872 bulbs are recommended)

1. Remove the TV microscope lower housing cover. (Two screws each side.)

2. Push upward and twist counterclockwise one-half revolution and the lamp will come out of the socket. (If necessary, loosen the socket holding screw to allow lamp removal.)

3. Insert replacement lamp into the socket, push up and twist clockwise one-half revolution to lock.

4. Program the saw, mount a wafer, position the optics to present a normal picture on the TV monitor.

5. Adjust the lamp position for best picture and tighten lamp position screw.

6. Lamp intensity may be adjusted by selecting different voltage taps on TB6 on the spindle power supply. The saw is normally set with the wire on TB6 Terminal 13, which is the center voltage tap for the lamps.

7. To increase the lamp intensity, move the wire from Terminal 13 to Terminal 12.

8. To decrease the lamp intensity, move the wire from Terminal 13 to Terminal 14.

B. TV Camera Replacement

To remove the TV camera, perform the following steps:

1. Disconnect the power and lamp connectors.

2. Disconnect the co-axial cable from the TV monitor.

3. Remove the TV microscope lower housing cover.

4. Using a short 7/64 Allen wrench, remove the four camera mounting screws from around the camera adaptor.

5. Lift straight up to remove the camera and adaptor from the lower housing. (Take care to prevent contamination from entering the lower housing or damage to the image splitter.)

6. Place the camera and adaptor into the recess on top of the TV microscope lower housing.

7. While supporting the camera, install the four camera mounting screws and washers.

8. Perform the TV camera position adjustment in Paragraph 2-43 B 4.

9. Install the TV microscope lower housing cover.

C. Reticle Generator Replacement

To replace the reticle generator PCB, perform the following steps:

1. Remove power from the saw.

2. Remove the six camera screws. (Two in front and two on each side.) Remove the TV camera cover.

3. Remove the four flathead screws from the TV camera back cover. Remove the back cover.

4. Unplug the reticle generator PCB from the connector and remove.

5. Plug the replacement reticle generator PCB into the connector.

6. Install the four flathead screws through the TV camera back cover into the PCB.

7. Check reticle intensity adjustment per Paragraph 2-43 B. 5.

8. Install the TV camera cover. (Six screws -- two front and two on each side.)

2-45 STEPPER MOTOR MAINTENANCE

The stepper motors used in the Model 1006 Dicing Saw are permanently lubricated. Care should be taken to avoid spraying any liquids into the motor bearings which might contaminate or dissolve the bearing grease. Never dis-assemble the motors as permanent damage will result.

The stepper motors should be kept clean and free of dust or other foreign materials. Compressed air can be used to blow off the motors or they can be wiped clean with a clean wiper. The encoder wheels must be clean to prevent light blockage.

Motor balance is defined as the position of the encoder wheel on the motor shaft when the motors are at rest in the FULL STOP mode. The adjustment is correct if the encoder wheel is positioned to fully block the light or to allow maximum light. The photo amplifier output is measured at TP2 of the encoder printed circuit card. The voltage at TP2 is proportional to the light. Normally, the balance is adjusted where the voltage at TP2 is minimum to enable use of the most sensitive range on the voltmeter. (Only on analog meter.)

Two methods of testing and adjusting the motor balance will be discussed; the "manual" mode and the "automatic" mode. The motor balance must be tested whenever the motor driver is changed, a component on the motor encoder PCB is changed, or stepping problems occur. Balance only the "X", "Y" and "Theta" motors. The "Z" encoder is not used and will not affect machine operation.

Motor alignment is an electronic adjustment, which will provide a symmetrically timed output from the encoder wheel when the motor is rotated at a uniform rate. Motor alignment must be tested whenever a component is replaced on the motor encoder PCB. Alignment must be adjusted if timing symmetry is not within ± 5 percent.

2-46 STEPPER MOTOR MANUAL BALANCE AND ALIGNMENT

A. Manual Motor Balance Testing and Adjustment

1. Attach a voltmeter plus lead to TB2 of the motor encoder PCB to be tested.

2. Connect the negative lead to signal ground (TB1).

3. Push "RESET" switch. All motors will "HOME". If the voltage at TP2 is less than +2VDC, continue to Step 4. If voltage is higher than +2VDC, press "RESET" switch again. If voltage is still higher than +2VDC, loosen the locking screw on the encoder wheel locking collar and rotate the encoder to a low voltage position and tighten the locking collar screw.

4. Set the voltmeter to the most sensitive range; turn the encoder slightly in one direction and turn it slightly in the other direction. The voltage at TP2 should increase while turning the encoder wheel in either direction and return to minimum when released.

5. If the voltage at TP2 is not at the minimum level, loosen the locking collar screw and adjust the encoder wheel for minimum voltage.

B. Manual Motor Alignment Testing and Adjustment

1. Install the motor to be tested into the "X" position.

2. Program the saw as follows:

Mode	=	930
1st Index	=	.25
2nd Index	=	.25
Height	=	5
Thickness	=	6
Angle	=	90
Diameter	=	5500
Speed	=	1000
*	=	5500

3. Perform a "FALSE" chuck zero by pressing CHUCK ZERO switch and, when chuck begins to raise toward the spindle, short the spindle shroud to the chuck with a screwdriver or other conductor.

4. Connect an oscilloscope to the motor encoder PCB output at TP3.

5. Place saw in AUTO CUT MODE and observe a zeo to +5V square wave. During the cutting stroke (as the chuck moves left to right) measure the time from zero to +5V and compare to the time from +5V to zero. Adjust R3 until symmetry is accomplished within +5%.

2-47 STEPPER MOTOR AUTOMATIC BALANCE AND ALIGNMENT

Saws having software level 084 and higher can test the motor balance and alignment with the aid of automatic testing routines. To utilize these testing routines, a set of "800" codes has been developed which are entered into the mode program position. The chart on the next page shows the code assignment.

MODE	FUNCTION
801	"X" Motor Balance Test
802	"X" Motor Alignment Test
803	"Y" Motor Balance Test
804	"Y" Motor Alignment Test
805	Theta Motor Balance Test
806	Theta Motor Alignment Test

A. Automatic Motor Balance Testing

1. Enter the odd mode number into the mode program position for the motor to be tested according to the chart above.

2. Press the "RESET" switch. The saw will perform the balance test and display a number on the front panel display.

3. If the number displayed is between 90 and 110, the motor balance is correct.

4. If the number displayed is not between 90 and 110, fine adjustment can be made by loosening the PCB screws and moving the PCB slightly and retightening the screws.

5. If the motor still does not perform properly, perform manual balance, per Paragraph 2-46.

B. Automatic Motor Alignment Testing and Adjusting

1. Enter the even mode number into the mode program position according to the chart for the motor to be tested.

2. Press the "RESET" switch. The saw will perform an alignment test and display a number on the front panel display.

3. If the number displayed is between 90 and 110, the alignment is correct.

4. If the number displayed is not between 90 and 110, adjust R3 and then press "RESET" switch again. Turn R3 clockwise to increase the number; counterclockwise to decrease the number.

2-48 UTILITY SYSTEMS MAINTENANCE

2-49 AIR SYSTEM DETAILED DESCRIPTION

High pressure (85 psi) air enters the saw through the righthand access panel and through a 3-microm filter.

High pressure air then goes to a pressure switch (SW 3), and to the air input fitting of the spindle motor. A pressure regulator is mounted under the pressure switch. The output of the pressure regulator goes to the wafer blow-off pushbutton and solenoid, to the vacuum chuck air solenoid located above the spindle power supply and behind the control panel, to the "Y" lead screw bellows, and to the camera optics blow-off. The output of the air solenoid (chuck unlock) goes to a front panel pressure and then to the vacuum chuck. This air releases the vacuum on the chuck.

2-50 AIR SYSTEM PREVENTIVE MAINTENANCE

A. Examine all air connections for leaks, damage or wear.

B. The air pressure sensor is factory-adjusted to open at 66 psi. To test the setting of the air pressure sensor, proceed as follows:

Turn the saw power off and connect an ohmmeter across the air pressure sensor contacts (N.O. and unmarked terminal). Turn the air pressure on and adjust to 85 psi. There should be continuity across the sensor contacts. Lower the air pressure slowly until the sensor contacts open. Read the pressure on the gauge at the service unit. It should read "66 ±2 psi". Should the sensor require adjustment, loosen the Allen screw that holds the air sensor switch in the holder, raise the holder approximately ¼-inch and tighten the screw. Remove the tape from the body separation and rotate the top of the sensor in the direction indicated by the arrow to either set the switch point higher (H) or lower (L). Retest, as described above. When the switch point is at 66 psi, place tape over the body separation, loosen the set screw, lower the sensor into the holder and retighten the set screw.

CAUTION: SETTING THIS SENSOR TO TRIP AT A LOWER PRESSURE THAN 66 PSI WILL VOID THE SPINDLE WARRANTY!

C. The air solenoid may require cleaning. To clean the air solenoid, first unscrew the nut on top of the solenoid coil. Lift the coil off the shaft. Using a wide standard screwdriver, unscrew the shaft from the valve body.

CAUTION: THE SHAFT CONTAINS A PLUNGER AND SPRING. DO NOT DROP!

Remove the shaft plunger and spring. Clean the valve orifices and the plunger. Re-assemble in the reverse order from disassembly.

2-51 AIR SYSTEM PARTS REPLACEMENT

A. Inside Filter Replacement

The 3-micro filter should be replaced any time the pressure drop across the filter exceeds 7 psi. To replace the 3-micro filter proceed as follows:

1. Turn air pressure off.

2. Remove the filter by loosening the two fitting nuts. Take precautions to prevent contamination of the input line.

3. Install the new filter and tighten the two fitting nuts.

4. Turn on air and test for leaks.

B. Air Pressure Sensor Replacement

1. Remove air pressure.

2. Loosen the Allen screw which holds the sensor in the plexiglas holder.

3. Remove the two wires from the sensor terminals.

4. The sensor can now be lifted high enough to attach a wrench and unscrew the sensor.

5. Turn on low air pressure to blow out contamination.

6. Wrap teflon thread tape on the replacement sensor threads.

7. Screw the replacement sensor into the "T" fitting until the threads are tight and leakproof.

8. Attach the two wires to the sensor terminals.

9. Adjust the sensor switch point. (Ref. Paragraph 2-50 B.)

C Pressure Regulator Replacement

1. Turn air pressure off.

2. Loosen the Allen screw holding the air pressure sensor in the plexiglas holder.

3. Remove the slotted screw from the adjustable "T" fitting in the side of the pressure regulator.

4. Unscrew the regulator from the "T" fitting.

5. Turn on low air pressure to blow out any contamination.

6. Wrap teflon thread tape around the threads of the replacement regulator.

7. Screw the replacement regulator into the "T" fitting, making sure the output part is positioned correctly when tight.

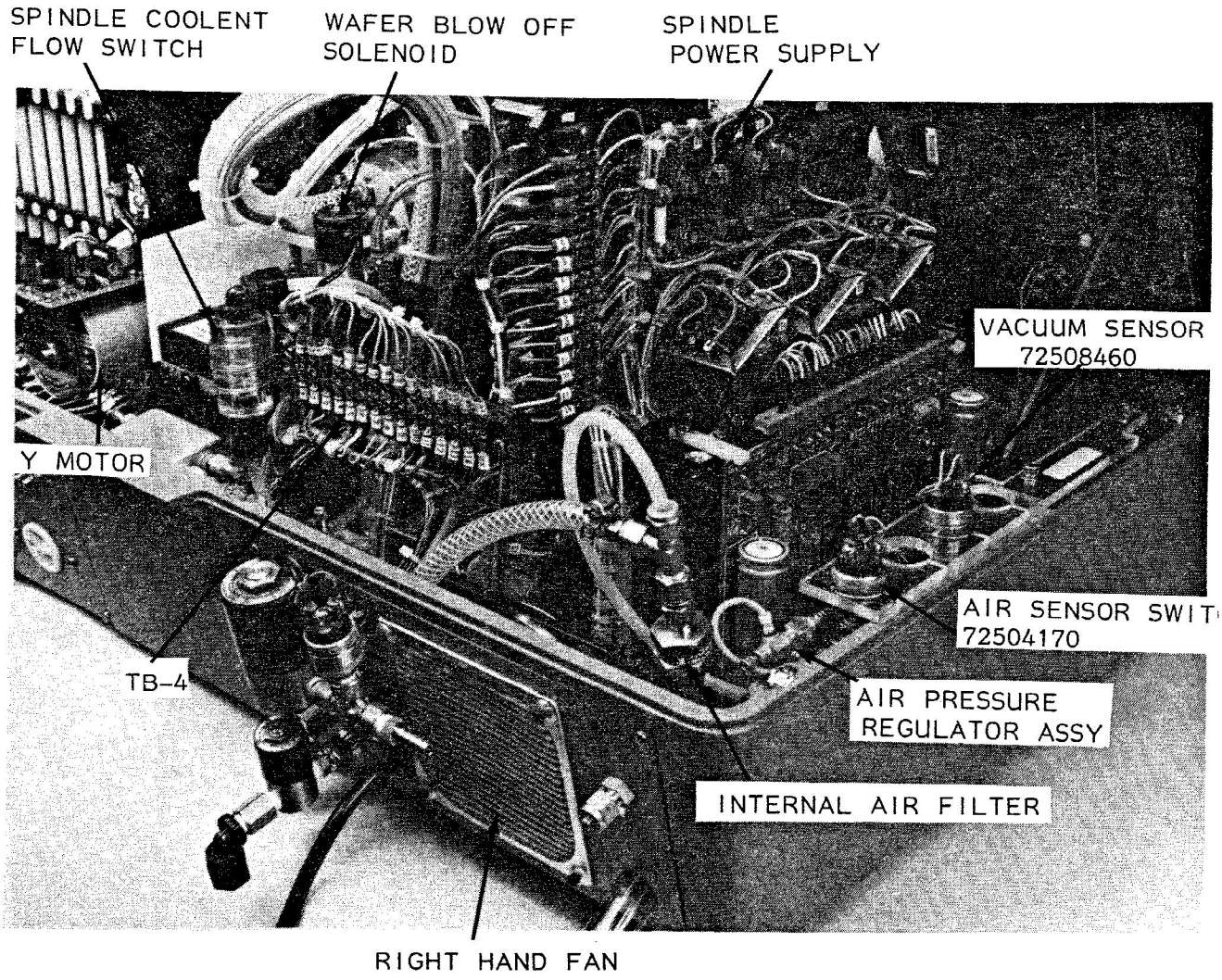


FIGURE 2-26

RIGHT REAR PANEL DETAIL

(8) Install the adjustable "T" fitting to the side of the regulator.

(9) Adjust the regulator adjustment knob until no threads are visible outside the regulator body. (This is the rough adjustment.)

(10) The final adjustment of the regulator knob is made to give optimum blow-off and chuck unlock operation.

(D) Air Solenoid Replacement

The air solenoid is located on a bracket behind the control panel and above the logic power supply. To replace the solenoid perform these steps:

(1) Turn off the air pressure and main power.

(2) Disconnect the input and output air lines from the solenoid.

(3) Remove the lug from TB3 Terminal #1 and cut the wire from the air solenoid to TB3 #2.

(4) Remove the two 10 x 32 Allen cap screws which mount the solenoid assembly bracket to the front panel brace.

(5) Turn the solenoid assembly upside down and remove the screws from the bottom of the air solenoid.

(6) Remove the solenoid.

(7) Remove all input and output fittings from the air solenoid and install them onto the replacement air solenoid. (Use teflon thread tape where appropriate.)

(8) Install the new solenoid to the bracket with the two bottom screws removed in Step (5).

(9) Install the solenoid assembly onto the front panel bracket with the two 10 x 32 Allen cap screws.

(10) Attach the input and output air lines to the air solenoid fittings.

(11) Install one wire from the solenoid to TB3 Terminal #1 and the other to TB3 Terminal #2.

(12) Adjust per Para. 2-52 (B).

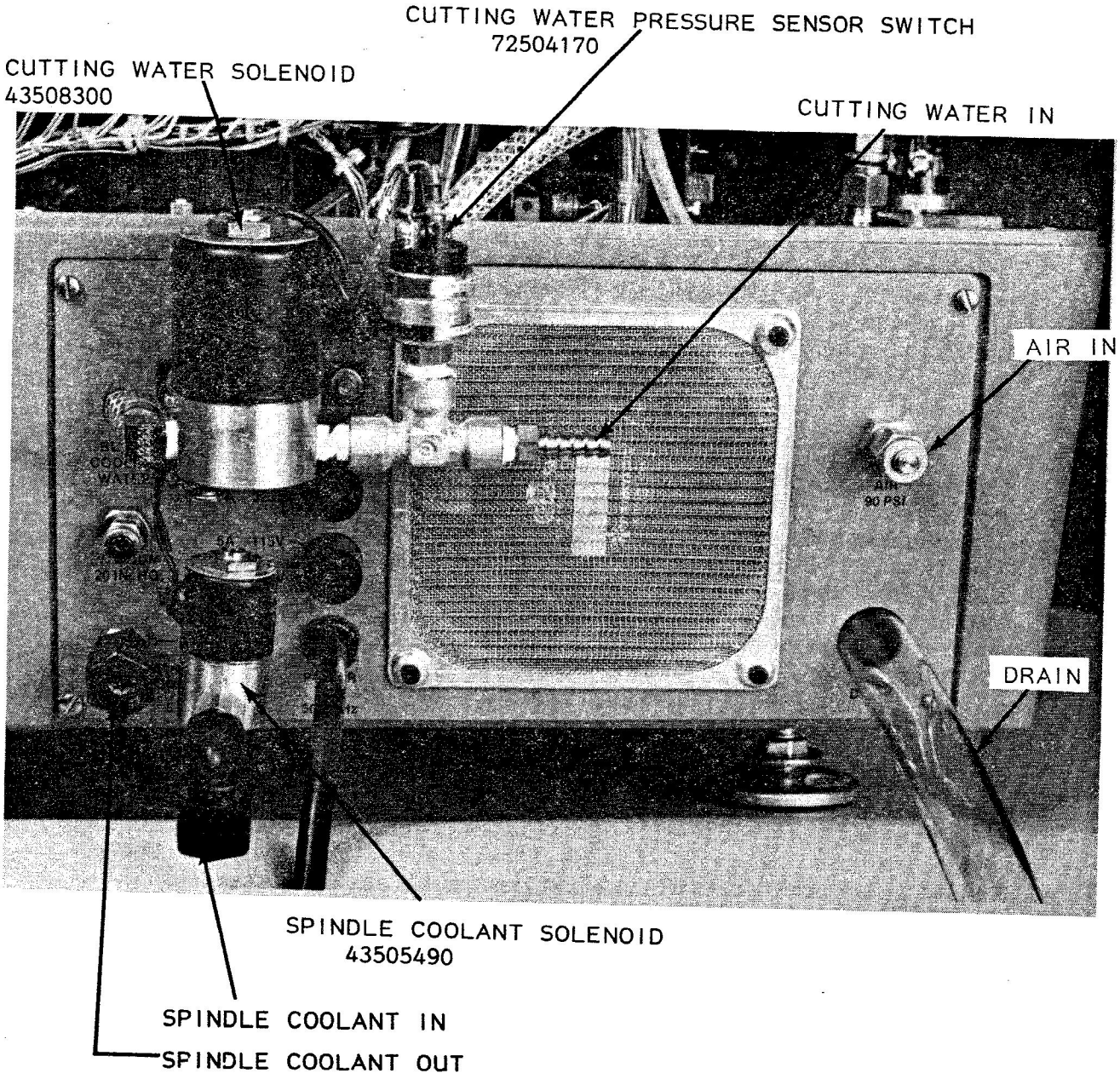


FIGURE 2-27

RIGHT REAR PANEL DETAIL

2-52 AIR SYSTEM ADJUSTMENTS

A. Low-Pressure Regulator Adjustment

The Low-Pressure Regulator adjusts the pressure to the water blow-off and the chuck unlock. The adjustment is not critical. Normally, the adjustment screw is turned until no threads are visible. To increase the output air pressure, turn the adjustment screw into the regulator body; to reduce the pressure, screw it out of the body.

B. Wafer Blow-Off Volume Adjustment

The volume of air going to the blow-off nozzle is adjustable. Normally, the adjustment needle valve is turned fully open. However, if adjustment is required, remove the front access panel and locate the blow-off pushbutton under the saw casting on the operator's left side. The blow-off volume adjustment is mountd on top of the push-button valve inside the saw to the left of the "X" lead screw. Turn clockwise to reduce blow-off air volume and counterclockwise to increase volume.

C. Vacuum Chuck Unlock Air Pressure Adjustment

The air pressure to unlock the vacuum chuck is controlled by a front panel control. The operator normally adjusts this control for enough air to release the chuck vacuum without damage to the wafer. When cutting on film this is normally adjusted to maximum pressure.

2-53 VACUUM SYSTEM DETAILED DESCRIPTION

The vacuum system in the Model 1006 Dicing Saw performs two functions. The primary function is to lock material on the vacuum chuck during sawing. The secondary function is to provide holding force to the blade removal tool.

The vacuum enters the system through the righthand panel. The tubing goes to a "T" fitting, the output going to the vacuum solenoid, the vacuum sensor and the toggle valve.

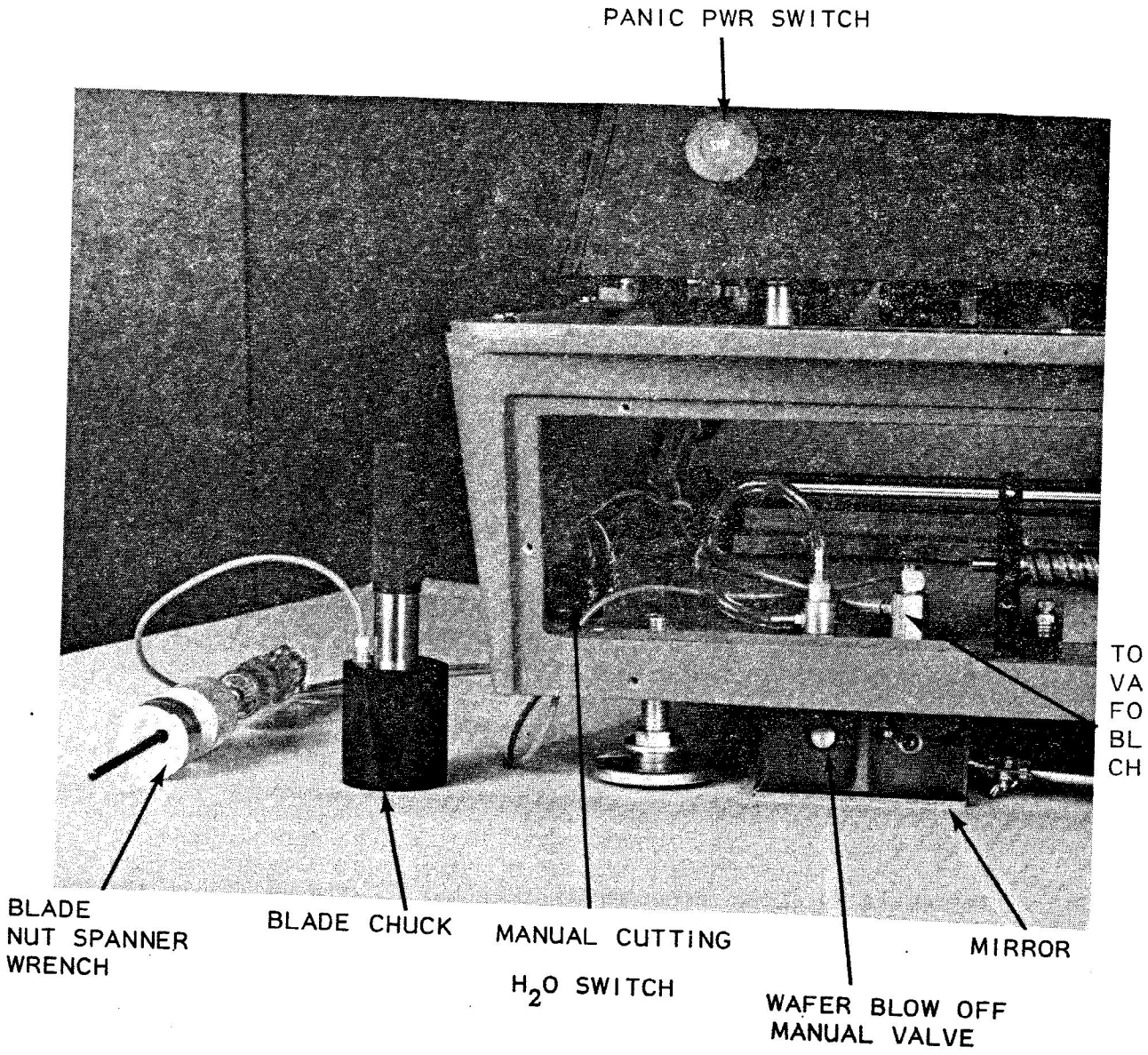


FIGURE 2-28

FRONT LEFT SIDE WITH A MIRROR POSITIONED
TO SHOW THE LOCATION OF OPERATOR CONTROLS

From the vacuum solenoid the vacuum goes through a fitting in the front tray and then to the vacuum chuck assembly. The vacuum sensor will signal the logic if the vacuum goes below a preset level. (Normally five inches Hg.)

The vacuum toggle valve, located under the base casting at the front center of the saw, controls the vacuum to the blade removal chuck. When the toggle is pointing left, the vacuum to the blade removal chuck is on. During sawing this toggle valve should be OFF (pointing right).

2-54 VACUUM SYSTEM PREVENTIVE MAINTENANCE

A. Cleaning and Inspection

The vacuum system must be cleaned periodically (every 500 hours of operation suggested) to ensure proper operation. Inspect vacuum tubing for signs of wear or deterioration and replace, as required.

B. Vacuum Sensor Testing and Adjustment

Adjustment of the vacuum sensor will require a vacuum gauge. Attach the vacuum gauge to the vacuum input line at the rear of the saw. Turn saw main power off and attach an ohmmeter across the vacuum sensor contacts (N.O. and unmarked terminal). With no vacuum applied the sensor contacts will be shorted. Apply normal vacuum. The contacts should open. Slowly reduce vacuum until the sensor contacts close. Read the vacuum gauge. To adjust the sensor "trip point", loosen the Allen screw holding the sensor in the plexiglas bracket, lift the sensor up ¼-inch and retighten the screw. Remove the tape from the body separation and the top of the sensor in the direction of the arrow to either lower the trip point (L), or raise the trip point (H). When the adjustment is set for five inches Hg, apply tape to the body separation, loosen the mounting screw, lower the sensor into the normal position and tighten the mounting screw.

(C) Vacuum Solenoid Cleaning and Testing

When the vacuum to the chuck does not shut off completely, it will be necessary to clean the solenoid. To determine if the coil to the solenoid is de-energized, bring a tool or piece of ferrous metal into contact with the top of the solenoid. If the coil is energized, the metal will be attracted down to the solenoid. If the solenoid is not energized, and there is still vacuum at the output, clean the solenoid as follows: (Be sure solenoid is de-energized.)

(1) Remove the hex nut from the top of the solenoid.

(2) Lift the coil off the valve body.

(3) Using a large standard screw driver, unscrew and remove the valve plunger housing.

CAUTION: DO NOT DROP THE PLUNGER AND SPRING.

(4) Clean the seat and the plunger of all contaminants.

(5) Reassemble plunger and screw the housing back into the valve body.

(6) Test for vacuum at the output. If there is no leak, install the coil over the plunger housing and replace the retaining nut.

(D) Blade Removal Chuck Maintenance

The blade removal tool must be kept clean and the face must be free of scratches and dents. If the face becomes scratched, place the tool face down on #600 grade abrasive paper on a flat surface and carefully polish until all dents and scratches are removed.

2-55 VACUUM SYSTEM PARTS REPLACEMENT

(A) Vacuum Solenoid Replacement

The vacuum solenoid is located on a bracket behind the control panel and above the logic power supply. To replace the solenoid, perform these steps:

(1) Turn off the vacuum and main power.

(2) Disconnect the input and output lines from the vacuum solenoid.

(3) Remove the lug from TB3 Terminal #3 and cut the wire to Terminal #2.

(4) Remove the two 10 x 32 Allen cap screws which mount the solenoid assembly bracket to the front panel brace.

(5) Turn the solenoid assembly upside down and remove the two screws from the bottom of the vacuum solenoid.

(6) Remove the solenoid.

(7) Remove all input and output fittings from the old solenoid and install them on the replacement solenoid. (Use teflon thread tape wherever appropriate.)

(8) Install the new solenoid to the bracket with the two screws removed in (5).

(9) Install the solenoid assembly to the front panel brace with the two 10 x 32 Allen cap screws.

(10) Attach all vacuum input and output lines to the new solenoid.

(11) Install one wire to TB3 Terminal #2 and the other to TB3 Terminal #3.

(B) (Deleted.)

(C) Vacuum Sensor Replacement

To replace the vacuum sensor, follow these steps:

(1) Turn off vacuum and main power.

(2) Remove the two wires from the sensor terminals.

(3) Loosen the Allen screw holding the sensor in the plexiglas holder.

(4) Lift the sensor up until the tubing fitting clears the holder.

(5) Disconnect the tubing from the sensor fitting.

(6) Remove the fitting from the old sensor and install into the replacement sensor using teflon tape to seal the threads.

(7) Bring the vacuum tube up through the mounting hole and connect to the fitting.

(8) Mount the sensor into the plexiglas holder and tighten the mounting screw.

(9) Attach the two wires to the sensor terminals (N.O. and unmarked terminal).

(10) Test and adjust if necessary per Para. 2-54 (B).

2-56 DRAIN SYSTEM PREVENTIVE MAINTENANCE

The drain system must be kept clean and free of obstructions. It is recommended that a daily inspection and cleaning be performed.

(1) A flexable wire can be used to push out obstracting material, or air pressure is sometimes effective.

(2) If the blockage cannot be cleared from the tray, it will be necessary to disassemble the drain system until all blockages are removed and drains run free.

2-57 SPINDLE COOLING SYSTEM DETAILED DESCRIPTION

The spindle cooling system provides control and flow sensing of the liquid coolant which flows through the spindle water jacket. The coolant flow is turned on and off by a solenoid valve to conserve coolant when the spindle is turned off. A flow switch in the coolant line disables the spindle motor when the flow drops below a preset one pint per minute.

2-58 SPINDLE COOLING SYSTEM PREVENTIVE MAINTENANCE

Inspection and Testing

Inspect all tubing for wear and leaks. To test the spindle cooling system, perform the following steps:

(1) Remove top cover and override the safety switch.

(2) Apply main power to the saw.

(3) Press "Reset" switch on the control panel.

(4) Press the spindle switch while watching the flow switch. (Attached to TB4.) The metal plunger should raise quickly to the top of the plexiglas housing and the spindle should start.

(5) Examine all coolant lines for leaks.

(6) Press spindle switch. The water should shut off and the metal plunger in the flow switch should drop to the bottom of the switch housing.

2-59 SPINDLE COOLING SYSTEM PARTS REPLACEMENT

(A) Spindle Coolant Solenoid Replacement

To replace the spindle solenoid, perform the following steps:

(1) Turn spindle coolant and main power off.

(2) Disconnect the solenoid wires from TB4-1 and 2.

(3) Cut the ty-wraps to free the wires and pull the wires out through the back panel grommet.

(4) Disconnect the input tubing from the solenoid fitting.

(5) Disconnect the solenoid swagelock fitting from the back panel bulkhead fitting, and remove the solenoid.

(6) Transfer the input and output fittings from the old solenoid to the replacement solenoid.

(7) Route the solenoid wire into the grommet and attach one to TB4-1 and the other to TB4-2. Install ty-wraps as required.

(8) Attach the coolant tubing to the solenoid input fitting.

(9) Turn coolant pressure on and check for leaks.

(10) Test the solenoid operation per Para. 2-58 (A) (4) & (6).

(B) Spindle Coolant Flow Switch Replacement

(1) Turn spindle coolant pressure and main power off.

(2) Disconnect the two yellow wires from the coolant flow switch at TB4-6 and 7.

(3) Cut ty-wraps to release the wires from the harness.

(4) Disconnect the bottom tubing connector from the flow switch fitting.

(5) Disconnect the top tubing connector from the flow switch fitting.

(6) Slide the flow switch up and out of the mounting clamps. (Loosen clamps if required.)

(7) Transfer all fittings from old flow switch to the replacement switch using thread seal as required.

(8) Install replacement switch into the mounting clamps.

(9) Connect the tubing to the top and bottom fittings.

(10) Attach the two wires to TB4-6 and 7 and ty-wrap as required.

(11) Test per Para. 2-58 (A) (4) & (6).

2-60 CUTTING WATER SYSTEM DETAILED DESCRIPTION

The cutting water system provides water to cool the cutting blade and to the spray tube which floods the vacuum chuck surface. Low cutting water pressure is sensed by a sensor at the input at the rear right-hand access panel. This sensor is factory set to stop the cutting when water pressure drops below 10 psi. The water solenoid controls cutting water under program control. Additionally, there is a switch (SW II), located under the base casting on the operator's left side, which energizes the solenoid any time it is pressed and power is applied to the saw. This switch allows easy manual testing of cutting water flow, nozzles,

flood bar adjustment and drains. The cutting water out of the solenoid connects to a "T" fitting with one output going to the spray tube and the other to the spindle guard housing which contains the blade cooling nozzles. The angular position of the flood bar and blade cooling nozzle is adjustable.

2-61 CUTTING WATER SYSTEM PREVENTIVE MAINTENANCE

A. Nozzle Position Testing and Adjustment

The nozzle position should be such that cooling water surrounds the blade when entering and leaving the material being cut. Perform the following steps to determine proper positioning whenever a new type of blade is installed or every 40 hours of operation.

1. Turn main power ON and push "RESET".
2. Remove the plexiglas spindle guard.
3. Examine the position of the blade in relation to the left nozzle position. Proper position is when the blade surface is centered in the output orifice. Adjust the cutting head, if necessary, to achieve this position. Replace the blade cover.
4. Turn the spindle "ON".
5. Perform "CHUCK ZERO".
6. Program a thickness of 25 mils.
7. Press "INDEX".
8. Manually move the chuck to a position under the blade.
9. Press the manual cutting water switch (SW 4) and adjust the water flow into the saw between 40 and 60 gph.
10. Observe the water in the blade area.
11. The nozzle should be adjusted to wet the blade on both sides of the blade at the chuck surface.
12. Loosen the set screw in the guard housing to adjust the nozzle position. Do not over-tighten or damage to the nozzle will occur!

B. Spray Tube Testing and Adjustment

1. Press the manual cutting water switch (SW 11) and observe the water pattern from the spray tube.

2. If any orifices are plugged, unscrew the spray tube connector from the panel fitting and remove the spray tube. Clean the plugged holes by inserting a fine wire.

3. Re-install the tube but do not fully tighten the connector nut. Press SW 11 again and rotate the spray tube until the wtaer is spraying toward the blade at an angle that just clears the bottom of the guard housing.

4. Hold the tube in position and tighten the connector nut. (Normally, finger-tight is sufficient.)

C. Cutting Water Pressure Sensor Testing and Adjustment

1. Remove top cover.

2. Turn power ON.

3. Connect a voltmeter from TB4-14 (negative) to TB4-15 (positive).

4. Turn cutting water pressure on.

5. The meter should read zero.

6. Reduce the cutting water pressure. The pressure to the sensor can be relieved by pressing the manual cutting water switch (SW II) under the base casting near the left front leveling mount, while adjusting an input pressure regulator.

7. When the voltmeter reads +5V, read the water pressure. The sensor is factory-adjusted for 10 psi. If the meter switched to +5V at 10 psi $\pm$ 2 psi, the adjustment is correct.

8. To adjust the sensor switching pressure, remove the tape from the body separation and rotate the top of the water sensor. Rotate in the direction of the markings on the body (L) for lower pressure and (H) for a higher pressure. When adjustment is correct, apply tape to the body separation.

D. Cutting Water Solenoid Testing and Cleaning

To test the water solenoid operation, press and release the manual cutting water switch (SW 11) several times. Observe that the water at the blade nozzles and spray tube turns on and off quickly and completely. To clean the cutting water solenoid, proceed as follows:

(1) Turn off the cutting water supply.

(2) Press SW II to relieve any system pressure.

(3) Remove the large hex nut from the top of the solenoid.

(4) Remove the coil from the plunger housing and let it hang from the coil wires.

(5) Insert the points of a needle-nose pliers or tru arc pliers into the two indents on either side of the plunger housing from the solenoid body.

(6) Carefully remove the plunger housing, plunger and spring from the solenoid.

(7) Clean all foreign material from inside the solenoid body, especially the valve seat.

(8) Clean the plunger, spring and plunger housing, checking for free smooth clearance when the plunger is manually pressed into the housing.

(9) Re-assemble the solenoid in the reverse of the steps above (3 through 6).

(10) Turn the cutting water pressure on and check for leaks. Correct if required.

(11) Re-check the solenoid operation as described above.

2-62 CUTTING WATER SYSTEM PARTS REPLACEMENT

(A) Blade Nozzle Replacement

(1) Loosen the Allen set screw in the guard housing holding the nozzle to be replaced.

(2) Slide the nozzle from the guard housing.

(3) Remove the tubing from the nozzle.

(4) Install the tubing onto the replacement nozzle.

(5) Insert the nozzle into the guard housing.

(6) Adjust the nozzle position per Para. 2-61 (A).

(B) Cutting Water Sensor Replacement

(1) Turn off cutting water and relieve pressure by pressing SW IL

(2) Remove the two sensor wires from the sensor terminals.

(3) Unscrew the sensor from the "T" fitting.

(4) Using teflon tape on the threads, screw the replacement sensor into the "T" fitting.

(5) Connect the sensor wires to the sensor terminals (N.O. and unmarked terminal).

(6) Turn cutting water on and check for leaks.

(7) Test and adjust the sensor per Para. 2-61 (C).

(C) Cutting Water Solenoid Replacement

(1) Turn cutting water off.

(2) Disconnect input tubing clamp and disconnet tubing.

(3) Remove the two Solenoid wires from TB4 Terminals 3 & 4.

(4) Cut all ty-wraps necessary to free the solenoid wires from the wiring harness.

(5) Pull the solenoid out through the grommet.

(6) Unscrew the two mounting screws from the bottom of the solenoid and remove the solenoid.

(7) Exchange the input and output fittings from the old solenoid to the replacement solenoid. (Use teflon thread tape as required.)

(8) Mount the replacement solenoid onto the mounting bracket with the two screws removed from the original solenoid.

(9) Connect the tubing to the solenoid "out" fitting.

(10) Thread the wires through the panel grommet and connect them to TB4, Terminals 3 and 4.

(11) Attach the water input tubing to the "input" fitting using the tubing clamp.

(12) Test solenoid operation per Para. 2-61 (D).

2-63 SERVICE UNIT DETAILED DESCRIPTION

(A) Pressure Tank Description

The pressure tank assembly of the Service Unit is an air reserve. In the event air pressure is lost, the tank holds enough reserve air to lubricate the air bearings of two

spindles during spindle shut down. The air enters the tank through a filter/regulator and a shuttle valve. The tank output connects to a pressure relief valve set at 100 psi and then to a dual 1 micro filter assembly. The output of the filter has a pressure gauge and two output fittings. When the service unit is connected to only one saw, the unused output fitting must be sealed.

B. Water Flowmeter Description

Two identical flowmeters are mounted on top of the pressure tank. These flowmeters provide accurate control of the cutting blade coolant flow to the saw.

The input and output connections are on the back of the flowmeter. The coolant supply is connected to the bottom and the saw to the top. As the coolant flows from the bottom fitting to the top, it causes a steel ball to rise in the vertical column, which is graduated in gallons per hour. The flow rate is adjusted by a black knurled knob at the bottom front. Fittings are provided on the bottom of the flowmeter to allow easy connection to the spindle coolant solenoid.

2-64 PRESSURE TANK PREVENTIVE MAINTENANCE

A. Inspection, Adjustment and Testing

Approximately every 80 hours of machine operation inspect the air and water lines for looseness, wear or leaking. When air pressure drop from input to output is excessive (more than 5 psi), it may be necessary to clean or replace the filter elements. Push the water release valve at the tank bottom and hold until the air flow is dry; then release.

B. The Input Filter-Regulator Cleaning and Adjustment

To unlock the adjustment, push knob down. Turn knob clockwise to increase the regulated pressure and counterclockwise to lower the pressure.

To lock the adjustment, pull knob to the upward position. If tamper-proof adjustment is desired, remove knob completely.

A visible coating of dirt or condensate on the filter element or excessive pressure drop indicates that cleaning is necessary. To clean, depressurize and disassemble the filter-regulator. Clean parts with denatured alcohol and blow out body with compressed air. When reassembling, make sure the disc stem fits into the center hole of the diaphram assembly. Tighten the bonnet slightly more than hand tight (to 45in/lbs torque).

Wash porous bronze filter elements with denatured alcohol.

CLEAN PLASTIC BOWL ONLY WITH HOUSEHOLD SOAP!

C. The Dual Filter Maintenance

The upper cartridge will turn red when it is used up and should be replaced whenever one-half of the cartridge has turned red.

Change the lower cartridge whenever the pressure drop is excessive.

CAUTION: POLYCARBONATE SUMPS OR BOWLS MUST NEVER BE EXPOSED TO SYNTHETIC LUBRICANTS, ESPECIALLY PHOSPHATE-ESTER BASED OILS, OR AROMATIC OR CHLORINATED HYDROCARBON LIQUIDS OR VAPORS. WHEN CLEANING THE SUMP AND BOWL, USE SOAP AND WATER ONLY! DO NOT USE STRONG DETERGENTS OR SOLVENT-BASE CLEANING SOLUTIONS!!

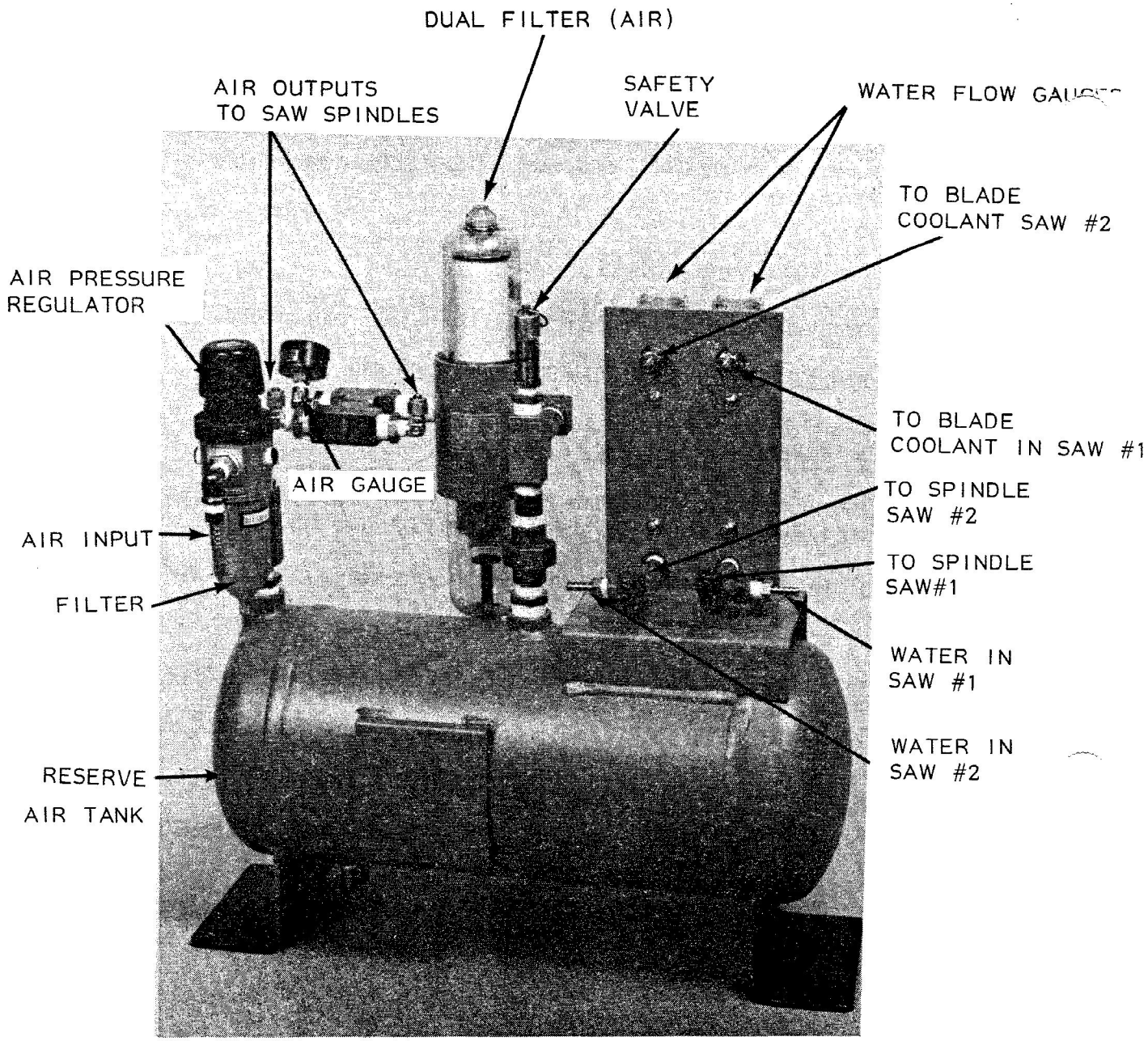


FIGURE 2-29

SERVICE UNIT DETAIL (SU106)

2-65 SYSTEM PREVENTIVE MAINTENANCE SCHEDULE

FREQUENCY	DESCRIPTION	REFERENCE
DAILY	Clean Vacuum Chuck	2-32 A
	Clean Drains	
	Clean Spindle	
40 HOURS OF SAW OPERATION	"Y" Stage	2-35 A-B
	Cutting Water Nozzle	2-61 A-B
	Vacuum Cooling Fan Filters	
80 HOURS OF SAW OPERATION	Spindle	2- 4
	"X" Stage	2-13 A-B
	Theta Stage	2-24 A-B-C
	"Z" Assembly	2-29 A-B
	Monocular Microscope	2-41
	TV Microscope	2-43
180 HOURS OF SAW OPERATION	"X" Stage Lube	2-13 B
	Vacuum Chuck	2-32 B
	Cutting Water Sensor	2-61 C-D
	Vacuum System	2-54 A-B-C

2-66 SYSTEM ALIGNMENT

A. Chuck Flatness Testing (See Fig. 2-30, page 128)

There are two methods of testing for chuck flatness. The simplest is to examine a wafer after cutting or cutting into film. When examining a cut wafer to determine chuck flatness, measure from the bottom of the wafer to the bottom of the cut, not from the top of the wafer to the bottom of the cut. When examination of a wafer indicates a possible chuck flatness problem, it will be necessary to test the flatness using an indicator gauge, as follows:

1. Remove the blade cover and blade.

2. Install an indicator mount to the blade splash cover, using the hole for the blade cover screw.

4. Program the Saw, as follows:

   1st Index ... 1000

   2nd Index ... 1000

   Height 100

   Thickness ... 102

   Angle ..... 90°

   Speed 1000

   Diameter ... 6000

   Mode 910

5. Push CHUCK LOCK and CHUCK ZERO.

   CAUTION: THE SAW SHOULD "CHUCK ZERO" ON THE GAUGE. BE PREPARED TO RESET IF THE GAUGE TIP SHOULD BE POSITIONED OVER A HOLE OR VACUUM GROOVE. IF THE GAUGE IS POSITIONED OVER A HOLE OR VACUUM GROOVE, PUSH RESET SWITCH, REPOSITION THE GAUGE AND CHUCK ZERO AGAIN.

6. After CHUCK ZERO, press CHUCK UNLOCK, CHUCK LOCK, INDEX and WAFER LEFT. Hold WAFER LEFT switch until the right side of the chuck is under the indicator gauge.

7. Note the gauge reading, then push WAFER LEFT switch until the left side of the chuck is under the gauge and note the gauge reading again. The difference between the righthand reading and the lefthand reading should be 0.0004 inch or less.

8. Push WAFER RIGHT switch until the chuck is centered under the gauge.

9. Push FAST and then STREET BACK. Hold STREET BACK until the spindle has indexed to the back of the chuck.

10. Note the gauge reading at the back of the chuck. Press FAST, and then press and hold STREET FWD switch until the gauge is at the front of the chuck. Note gauge reading. The difference between the back and the front readings should be 0.0004 inch or less.

11. Push "Theta" CW switch. Machine will cycle to PASS 2 position.

12. Perform Steps 6 through 10 while in PASS 2. If the readings in PASS 2 are different than those in PASS 1, the "Z" perpendicularity is off, check the three (3) components, as described in Paragraph B-3.

B. Chuck Flatness Adjustment (Saw S/N 929 and higher)
(NOTE: For adjustment of SN 928 or lower, see FCN 062.)

(Ball bushing slide "X" stage only.) No adjustment should be made for chuck flatness until you are certain of proper assembly of the chuck components and that the chuck mounting surface is clean and free of irregularities. When the assembly has been checked, perform chuck flatness adjustment as follows:

1. Using the Dial Indicator mounted on the spindle housing, check the chuck flatness from left to right in the center of the chuck.

2. Record the difference between the readings of left and right.

3. Rotate the chuck 90^{o} and again check flatness from left to right in the center of the chuck. If the difference from the left to right reading is within .0004" of the difference in Step 2, proceed to the next step. If the flatness difference at 0^{o} and 90^{o} is larger than .0004', remove the chuck and clean the "Z"-housing and chuck mating surfaces, remount the chuck and retest. If the flatness difference is still larger than .0004", the "Z"-mounting plate and "Z"-housing may require replacement. Do not proceed further until the left/right flatness at 0^{o} is the same as at 90^{o}.

   NOTE: The height may differ but the flatness should not.

4. Index the "Y"-stage back until the dial indicator is reading 2" back from the centerline of the chuck.

5. Take a reading on the left side of the chuck and then, using left/right controls, take a reading on the right side of the chuck.

6. Loosen the socket headscrew in the pillow block adjustment jack and rotate the hex head nut until the righthand reading is the same as the lefthand reading.

7. Index the "Y" stage forward until the indicator is reading 2" forward of the centerline.

8. Note the reading on the left side of the chuck; then, using left/right controls, take a reading on the right side of the chuck.

9. Adjust the jack screw in the left side of the "X"-support plate until the reading on the right is the same as the left.

10. Repeat Steps 8 and 9 until the chuck is flat left to right at the front.

    NOTE: The height of the readings in Steps 6 and 9 may be different; they will be made the same later.

11. Repeat Steps 4 through 9 until the left to right readings are flat in both front and back locations.

12. Front-to-back flatness -- Index "Y" back and move "X" until the indicator is near the back of the chuck near the centerline. Take a reading.

13. Index forward until the indicator is near the front of the chuck.

14. Adjust the roller support jacking screws until the chuck is flat back to front. (Make sure the roller bearing is flat on the support plate.)

15. Check the chuck flatness across both centerlines and in all quadrants. Rotate 90° and repeat the test. It should be possible to obtain chuck flatness within a T.I.R. of .0004". If necessary, split the difference between PASS 1 and PASS 2.

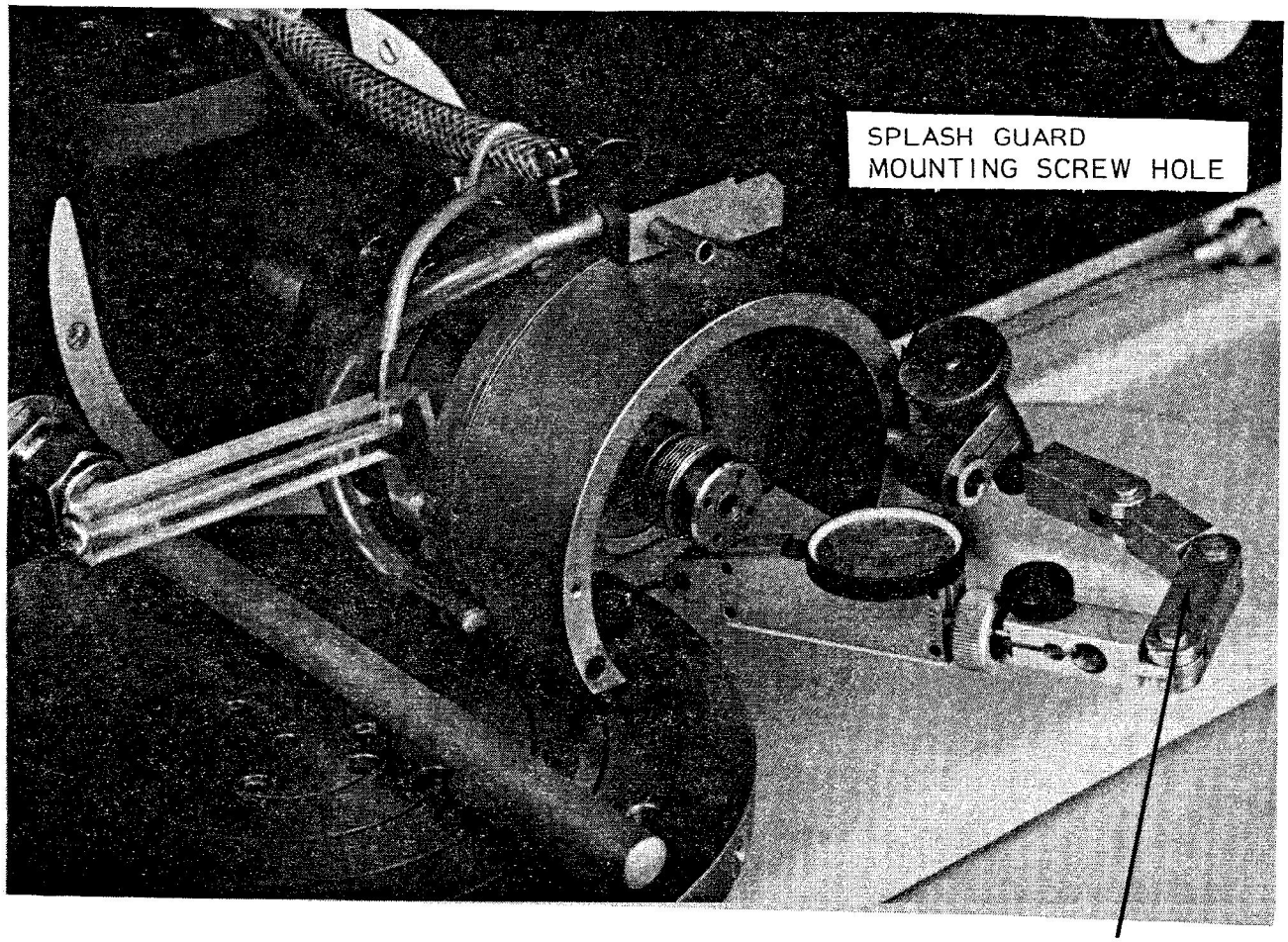


FIGURE 2-30

EQUIPMENT SET UP FOR CHUCK
FLATNESS MEASUREMENT

D. "Y" Flag Adjustment

The "Y" Flag is mounted to the "Y" lead nut housing. The function of the "Y" flag is to interrupt the "Y" limit sensors, indicating the travel limits of the "Y" stage. The position of the "Y" stage during alignment and cutting are referenced to the "Y" rear limit sensor and, therefore, the "Y" flag is adjustable to allow precise alignment of the "Y" stage position.

E. "Y" Flag Alignment Procedure

1. Mount a used or "scrap" blade on the spindle in the normal manner.

2. Program the saw normally in any test mode and, without a guage block, press CHUCK LOCK and CHUCK ZERO.

   The chuck will move to the center position and start raising toward the blade. STOP the chuck before it contacts the blade by pressing the LOGIC RESET switch at the rear of the saw. After the chuck is stopped under the blade, note the position of the blade over the chuck. The cutting edge should be centered over the chuck center hole $\pm$ 0.005 inch.

3. If the blade cutting edge is in front of the center hole, adjust the "Y" flag toward the front by the same distance.

4. If the blade cutting edge is behind the chuck center hole, adjust the "Y" flag toward the back by the same distance.

5. After adjustment (per Step 3 or 4) press RESET and then perform Step 2 again. Continue Steps 2 and 3 or 4 until the proper position is accomplished.

2-67 SPINDLE POWER SUPPLY MAINTENANCE

A. Spindle Power Supply Detailed Description

All AC power inputs connect to the spindle power supply at TB6, according to the Chart on Page 5. The fans connect to the 117 VAC taps on the primary of the main transformer T1.

1. The secondary at TB6 12, 13 and 14 provide 5 VAC, 4 VAC and 3 VAC for the optics lamps with the common controlled by K1, the "AC Relay".

2. The +30 VDC supply consists of the full wave bridge rectifier BR1, filter capacitor C3 and fuse F2. The unfiltered voltage is controlled by Relay K1, the AC Relay.

3. The +7 VDC supply consists of the full wave rectifier BR2, filter capacitor C4, fuse F3 and bleeder resistor R2. The unfiltered voltage is controlled by Relay K1, the AC Relay.

4. The +10 VDC supply consists of the full wave bridge rectifier BR3 with a series resistor R6. When K3 (spindle) is de-energized the +10 VDC is connected to both spindle motor windings to provide braking.

5. The +12 VDC supply consists of BR4, a full wave bridge rectifier and is connected unfiltered through fuse F1 to TB6 Terminal 11. The filter for +12 VCD is located on the Auxiliary Logic PCB.

6. The two-phase AC spindle motor power supply consists of the power supply logic PCB, the power output circuits on the heat sink assembly, the D.C. filter (consisting of R1, R2, C1, L2 and C2), the driver transfers (T4, T5 and T6), the Scott "T" filter (T3) and fuses (F4 and F5). The spindle voltage is switched by K3. K2 and K3 are the SPINDLE ON relays. The power supply logic board contains a ramp generator with an up-to-speed circuit. The ramp controls the frequency of a VCO which has a three-phase output to transformers T4, T5 and T6. The secondarys of T4, T5 and T6 connect to the inputs of the six power output transistors on the heat sink. The ramp also controls the turn-on pulses to the SCR's in the bridge rectifier for the output high voltage. Therefore, the power supply logic PCB controls the voltage and frequency simultaneously to provide a two-phase AC voltage to the spindle motor.

B. Spindle Power Supply Testing and Adjusting

Testing of the D.C. power supplies can be done using a multimeter and normal methods of testing unregulated power supplies. The spindle two-phase AC supply, however, requires special procedures and this section will describe these procedures. This procedure should be performed whenever a component has been replaced or a spindle malfunction has occurred.

CAUTION: HIGH VOLTAGES ARE PRESENT!

1. Preparation ---

   a. Turn off the main power to the Dicing Saw.

   b. Remove the edge connector from the spindle P/S Logic PCB Assembly #12015362 or #12015360 only. (See Fig. 2031 in the Maintenance Manual.)

   c. Remove the P/S Logic PCB from the power supply and reconnect J2 with the board extended horizontally.

   d. Insulate the underside of the PCB to insure that no accidental contact is made.

   e. Preset the trim pots on the P/S Logic PCB as follows:

POT	PRESET POSITION	FUNCTION
R3	Fully CW	Freq. Start.
R24	Fully CW	Spindle Speed
R4	Fully CCW	Freq. Max.
R5	Fully CCW	V Run
R6	Fully CCW	V Start

   f. Connect a jumper from Tp-06 to Tp-11. (This disables the high Volt.)

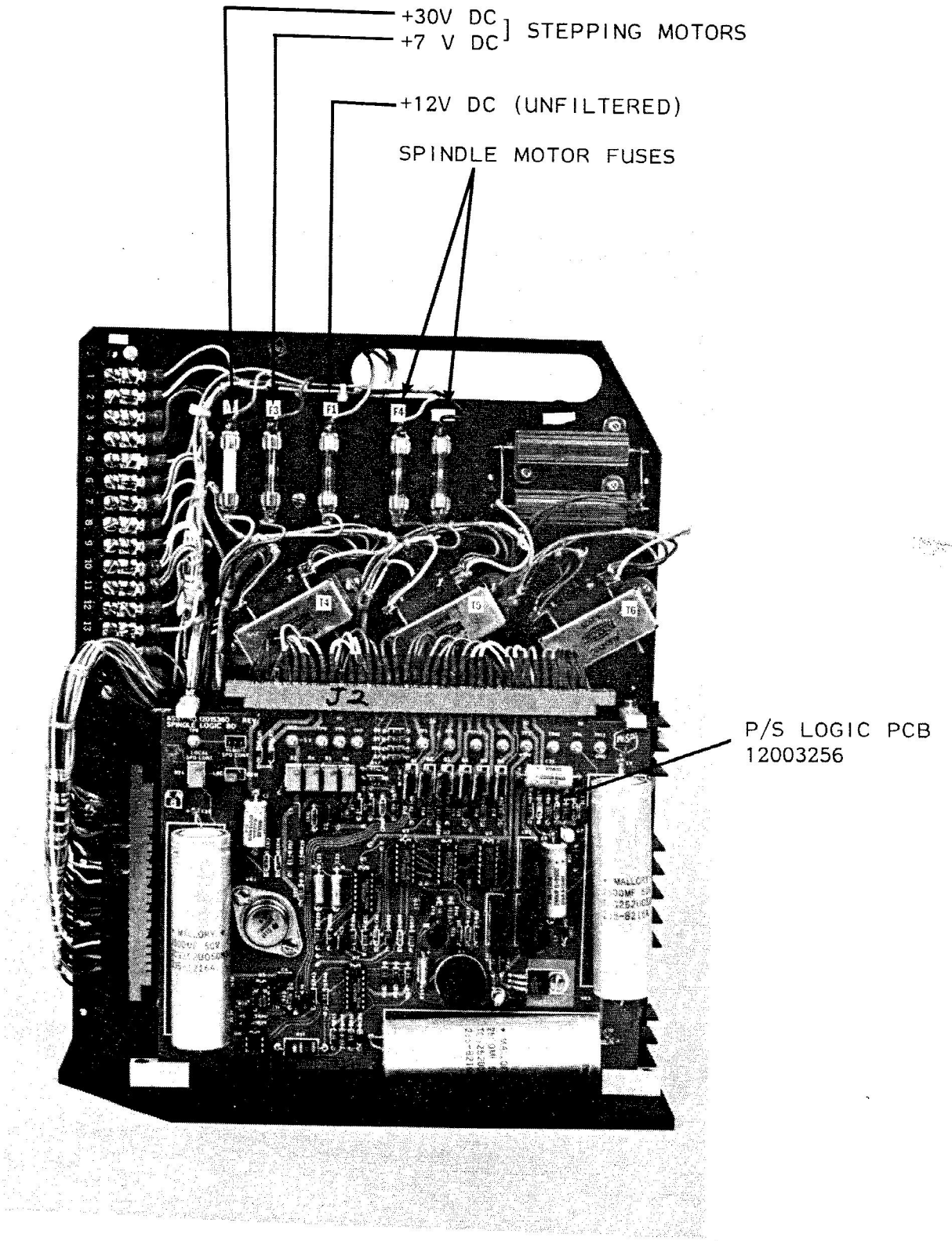


FIGURE 2-31

SPINDLE POWER SUPPLY (RIGHT SIDE)

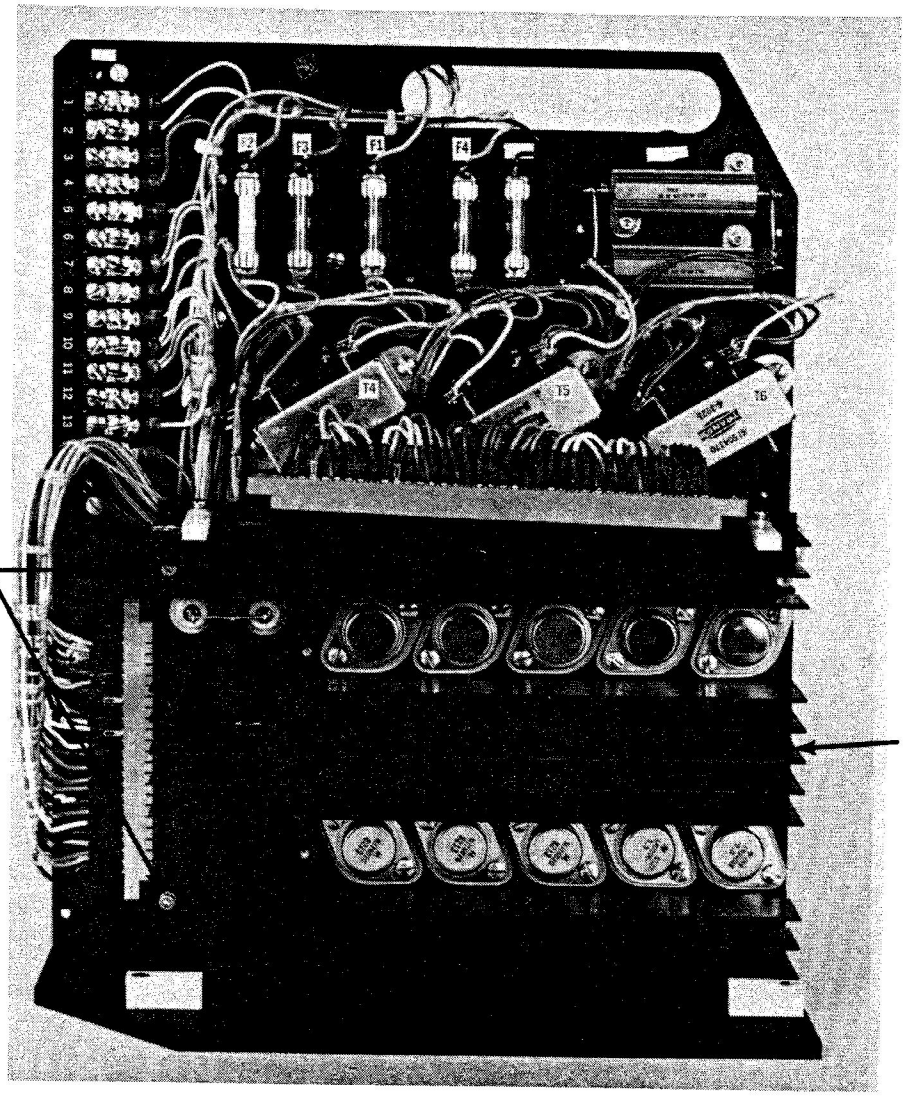


FIGURE 2-32

SPINDLE POWER SUPPLY
(RIGHT SIDE LOGIC BD REMOVED)

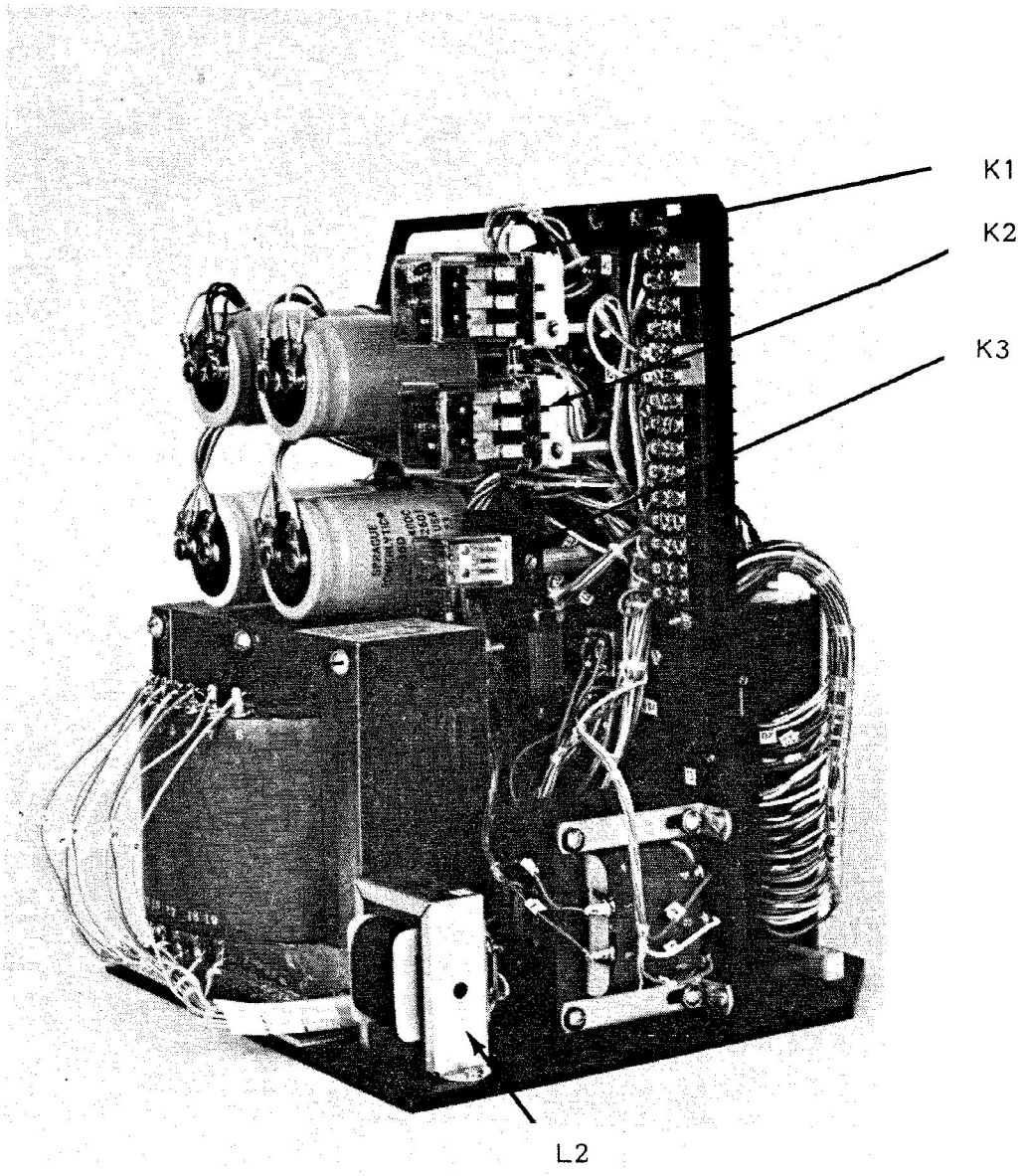


FIGURE 2-33

SPINDLE POWER SUPPLY (LEFT SIDE)

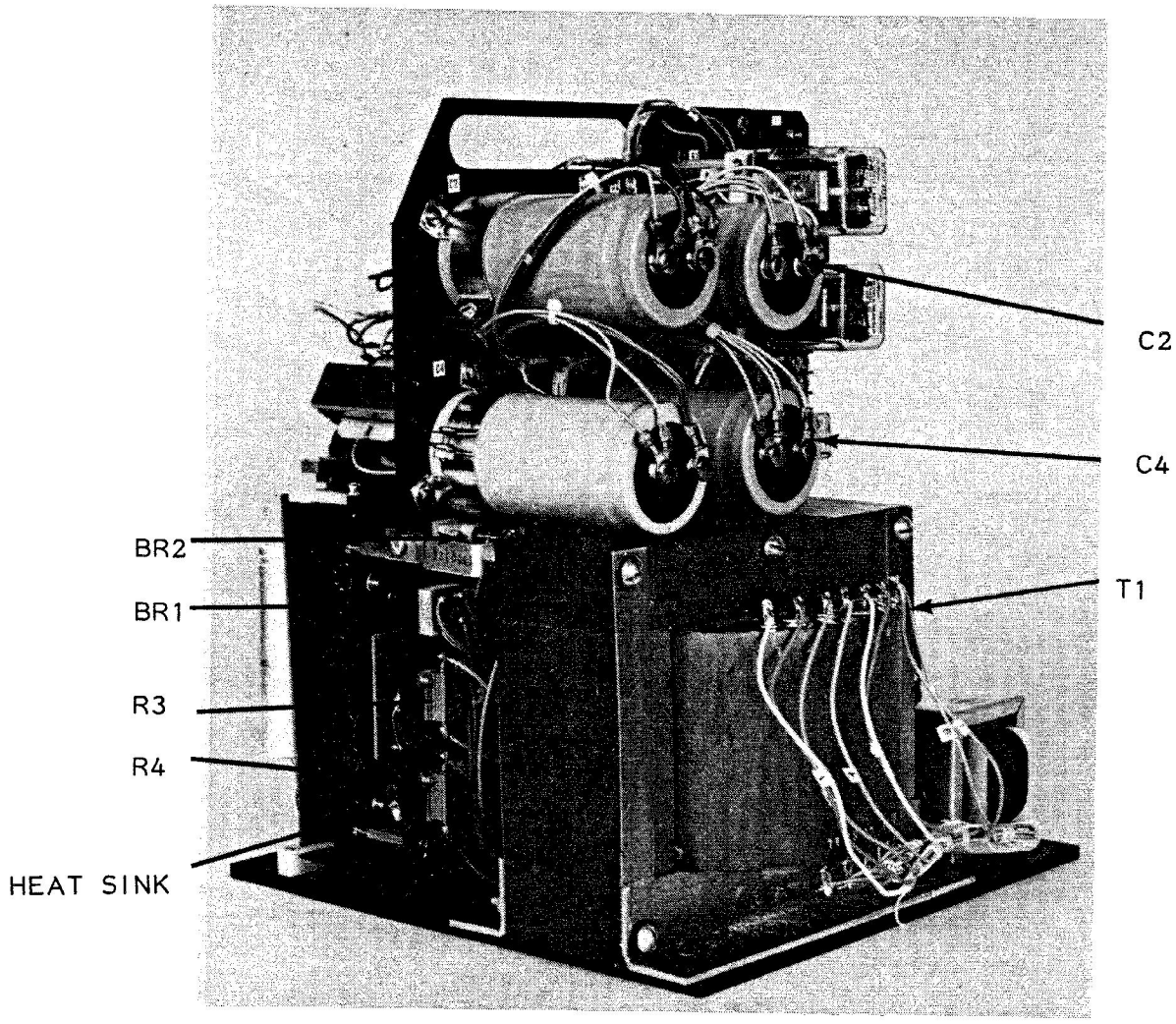


FIGURE 2-34

SPINDLE POWER SUPPLY (FRONT VIEW)

2. Initial Tests and Frequency Adjustment ---

a. Turn on the AC power to the saw and push "RESET" switch.

b. Ground the meter or o'scope on the TP-11 and verify the following measurements:

i. TP-2 = +15 VDC
ii. TP-3 = - 5 VDC
iii. TP-6 = 0 VDC
iv. TP-8 = 0 VDC
v. TP-9 = - 5 VDC

c. Connect oscilloscope to TP-7. Observe a 0V to +15V square wave (not symetrical).

d. Adjust trimmer R3 for a period of 3.8 milliseconds per cycle at TP-7. (This is the starting frequency adjustment.)

e. Verify a +15V to -15V square wave on the collector of transistors Q1 through Q6. (Collector is the metal mounting tab.) This signal should have a straight rise and fall with no distortion at the +15V or -15V levels. The negative level may be less than -15V.

3. Integrator and Up-To-Speed Tests

a. Connect o'scope to TP-8 and turn spindle on. The integrator should start ramping to approximately 11.5VDC. When ramp is maximum, the annunciator should sound.

b. Connect the o'scope to TP-9. It should be approximately +13VDC (up to speed signal). (TP-12 will go to logic ground)

4. High Frequency Adjustment

a. Connect o'scope to TP-7 and adjust trimmer R4 for a period of 240 microseconds per cycle. (Maximum speed Adj.)

b. Adjust spindle speed Adj. Pot R24 for a period of 320 microseconds per cycle at TP-7. (Normal speed adj.)

c. Turn spindle off. Verify that the square wave at TP-7 is approximately four milliseconds per cycle. (Starting frequency)

5. High Voltage Adjustment

a. Connect DVM to TP-5. (Ground DVM on TP-11.)

b. Remove LOC/REM jumper.

c. Remove the jumper wire from TP-11 to TP-6 (installed in Step 1.f.)

d. Turn spindle on.

e. The voltage on TP-5 should be approximately 7 volts.

f. Adjust trimmer R6 for -14 PVDC (starting voltage).

g. Turn spindle off.

h. Re-install the LOC/REM jumper in the local position.

i. Remove Fuses F4 and F5.

j. Turn spindle on and wait until annunciator sounds for spindle up-to-speed indication. (Spindle will not run.)

k. Adjust trimmer R5 for -137 VDC at TP-5 (running voltage).

l. Turn spindle off. This completes the adustment procedure.

m. Turn main power off and re-install the spindle P/S Logic PCB and Fuses F4 and F5.

n. To verify operation, turn power on, reset, and turn spindle on.

o. Observe spindle as it comes up to speed in the normal manner.

C. Parts Replacement

1. Logic PCB Replacement -- To replace the logic PCB, perform the following steps:

   a. Disconnect the AC power from the saw.

   b. Disconnect the edge connect (J-2) from the top of the logic PCB.

   c. Unsnap the top snaps and tilt the logic PCB away from the heat sink.

   d. Lift the logic PCB up and out of the saw.

   e. Lower the replacement logic PCB into place, making sure the bottom corners of the PCB are in the mounts.

   f. Tilt the logic PCB toward the heat sink and snap the mounting snaps.

   g. Connect the edge connector (J-2) to the top of the logic PCB.

2. Heat Sink Replacement:

   a. Remove the logic PCB per Steps 1, a, b, c, and d above.

   b. Remove the rear bottom mounting screw from the heat sink.

   c. Disconnect the heat sink edge connector (J-1) from the heat sink.

   d. Remove the top rear mounting screw from the heat sink.

   e. Slide the heat sink toward the back and lift the entire heat sink out of the power supply.

   f. Lower the replacement heat sink into place. Line up the heat sink slots with the front mounting screws. Slide the heat sink forward onto the front mounting screws.

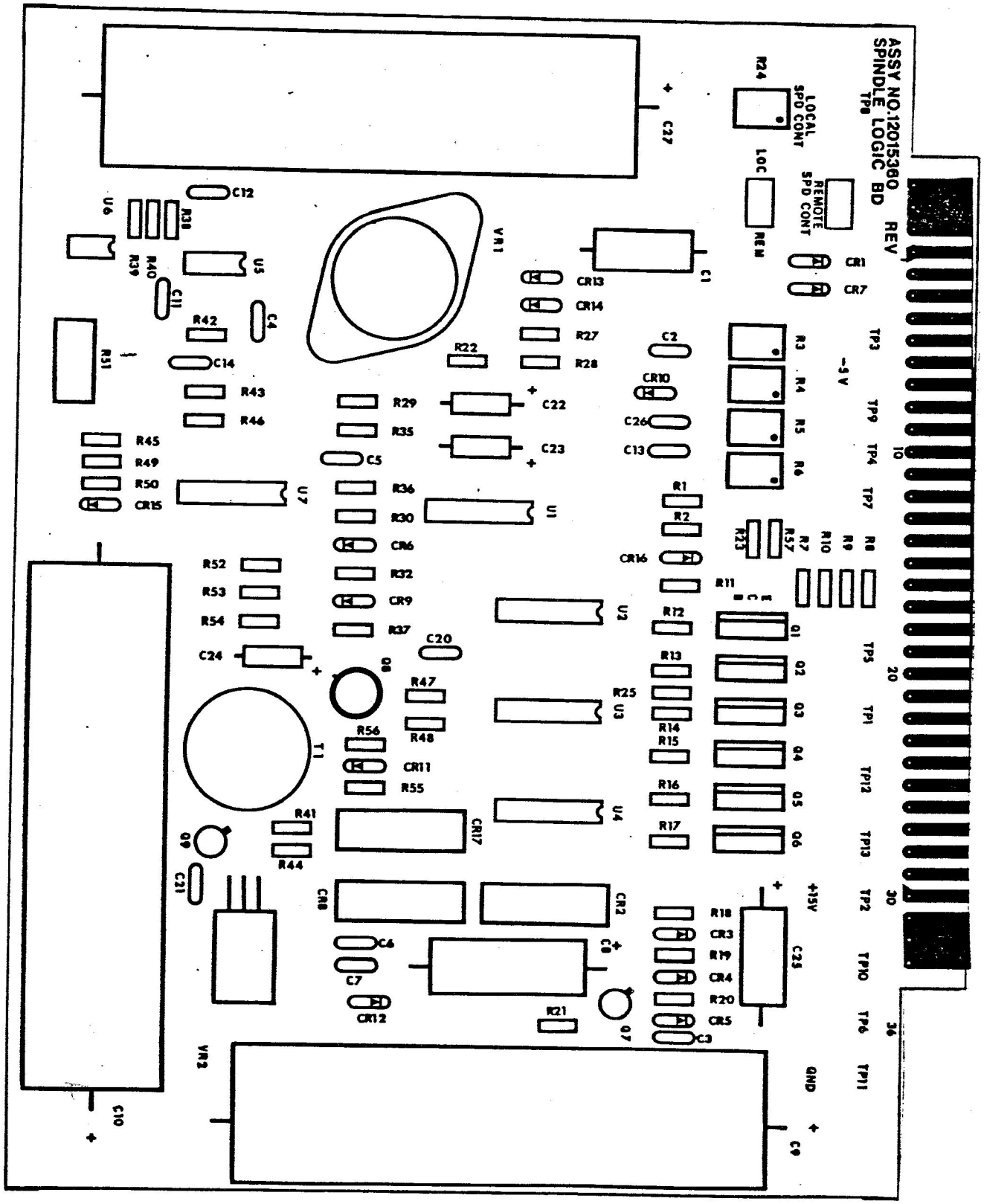
   g. Insert the upper rear mounting screw.

   h. Insert the lower rear mounting screw.

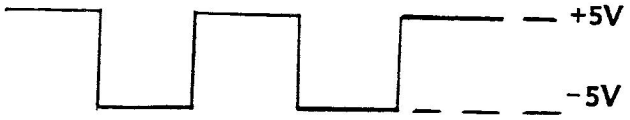
   i. Connect the edge connector (J-1).

SPINDLE P/S LOGIC PCB

FIG. 2-35

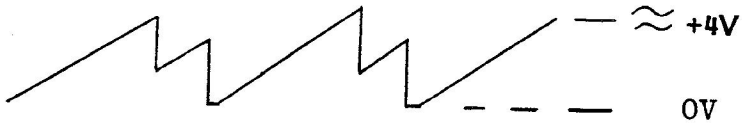


(A)



T4, T5, & T6 signals on.
Terminals 4 & 7 with spindle off.

(B)



Signal on TP 6

(C)

Signal at TP 13

(D)

Oscillator output at TP 7

LOGIC WAVEFORMS

FIG. 2-36

3. Spindle Power Supply Replacement

   a. Disconnect and mark all wires from TB-5 and TB-6.

   b. Remove the four ¼ x 20 Allen cap screws from the bottom of the spindle power supply.

   c. Lift the supply clear of the casting and remove from the saw.

   d. Carefully lower the replacement power supply into place.

   e. Insert the four ¼ x 20 Allen cap screws.

   f. Connect all wires to TB-5 and TB-6.

2-68 FRONT PANEL MAINTENANCE

A. Fault Analysis
(See Control & Program Panel Schematics, Pages 218 & 219)

All control switches on the front panel are normally open switches. The only problems that can occur with the switches are shorted, open or intermittant contacts.

If a switch is open, testing the appropriate ribbon cable plug contacts with a continuity test will locate the problem. The same method will work for intermittant contacts. When any switch is shorted, the logic will ignore all other switches. The first indication that a switch is shorted is when the saw will not respond to any front panel switches. The annunicator (beeper) will not sound to any switches when one is shorted.

On the control panel U1, U3 and U4 are mounted in PCB sockets and can easily be exchanged. Exchange U1 when there are switch malfunctions; exchange U3 and U4 when there are lamp or display malfunctions.

When a short is found on either laminated panel, the entire front panel must be replaced.

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SECTION III

SYSTEM SEQUENCING

3-1 SYSTEM OPERATIONAL SEQUENCING

Normal sequence of operation is shown by use of direction-arrow diagrams. These arrows indicate chuck and spindle motion. Refer to these diagrams while reading the following descriptions.

3-2 RESET HOMING SEQUENCE (Fig. 3-1)

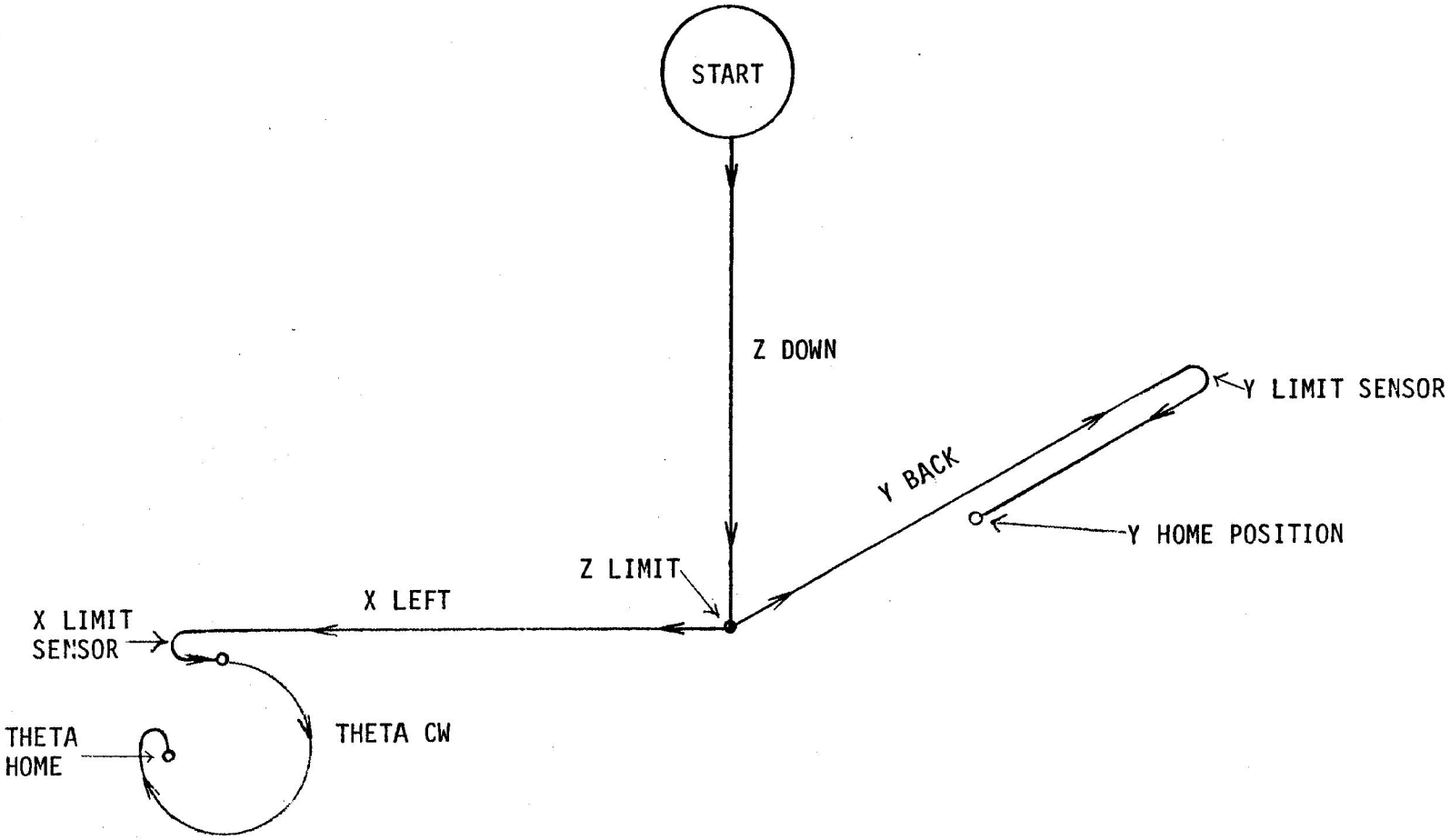
Reset homing occurs whenever the reset switch is pressed. The reset switch is always enabled.

Upon actuation of the reset switch, the "Z" axis lowers to the limit sensor. Nothing else can occur until the "X" limit is sensed. When "Z" limit is sensed, "Z" motor stops, and "X" and "Y" axes start to their limit sensors simultaneously. When the limits are sensed, the "X" and "Y" motors reverse and start slowly in the other direction. When the flag leaves limit sensor, the motor accelerates to high speed and continues to the home position. When the "X" axis stops at home, the "Theta" axis starts clockwise fast until the clockwise limit is sensed. It then reverses and steps slowly counterclockwise until the clockwise sensor turns off and then accelerates to the home position.

3-3 STANDBY SEQUENCING (Fig. 3-1)

The standby switch is always enabled and may be used as a panic stop button. The sequence of the standby mode is identical to the reset homing sequence with the following exceptions:

Upon pressing the standby control, the spindle will turn off. At the completion of the homing sequence, all motor voltages and the microscope lamp are turned off.



RESET HOMING SEQUENCE
FIG. 3-1

3-4 CHUCK ZERO SEQUENCING (Fig. 3-2)

The CHUCK ZERO control is enabled only in the HOME/POWER ON mode.

When the CHUCK ZERO control is pressed, the "Z" axis moves down to the limit sensor. When the "Z" limit sensor is detected, the "X" axis moves to position the chuck directly under the spindle. The computer now checks the output of the CHUCK ZERO circuit (aux. logic) for the correct level with the spindle grounded through Relay K1 on the auxiliary logic PCB; then, K1 is de-energized and the circuit is again checked. If the circuit operation is correct, the "Z" axis starts to raise the chuck toward the cutting blade. When the blade contacts the gauge block, the "Z" axis reverses and goes down 0.005". "X" then returns home and "Z" raises 0.109". The "Z" then goes down the amount in "THICKNESS". The chuck vacuum is turned off to facilitate removal of the gauge block.

3-5 AUTOCUTTING SEQUENCE (Dice, Single Alignment)

A. Pass 1 (Fig. 3-3)

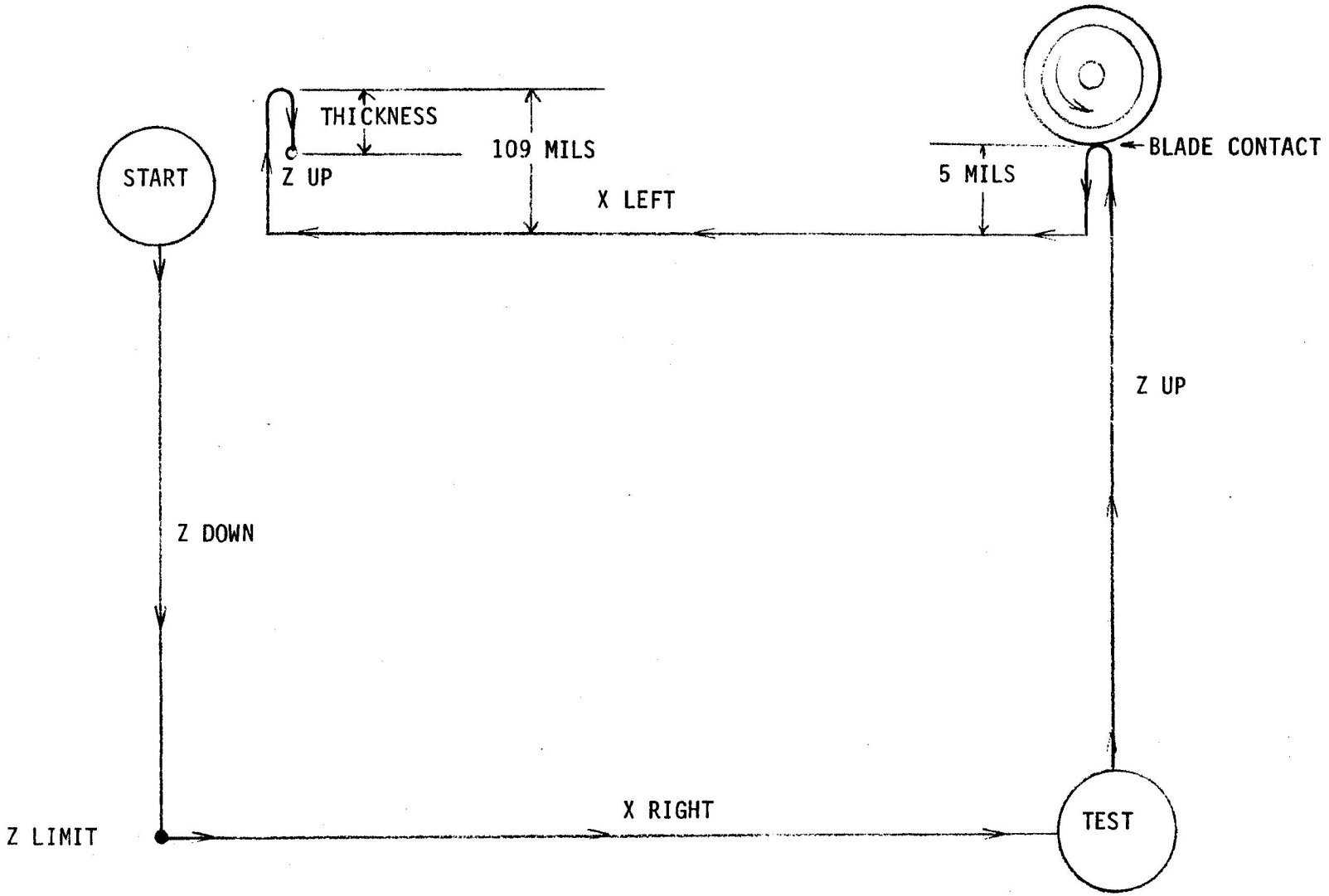
Autocutting is initiated by pressing the AUTOCUT while in ALIGN or INDEX modes.

When autocutting is started from ALIGN, the "X" motor moves left and "Y" moves forward to position the chuck for a cut at the front of the wafer. Then "Z" raises the chuck to the programmed height and "X" moves right at the programmed cutting speed, performing the cutting stroke. At the end of the cutting stroke, "X" stops and "Z" goes down to thickness +0.005". Then, "X" moves left and "Y" moves back simultaneously to the starting position of the next cut. This sequence is repeated until the programmed diameter +20% has been cut. The saw then cycles to autocut Pass 2.

B. Pass 2 (Fig. 3-4)

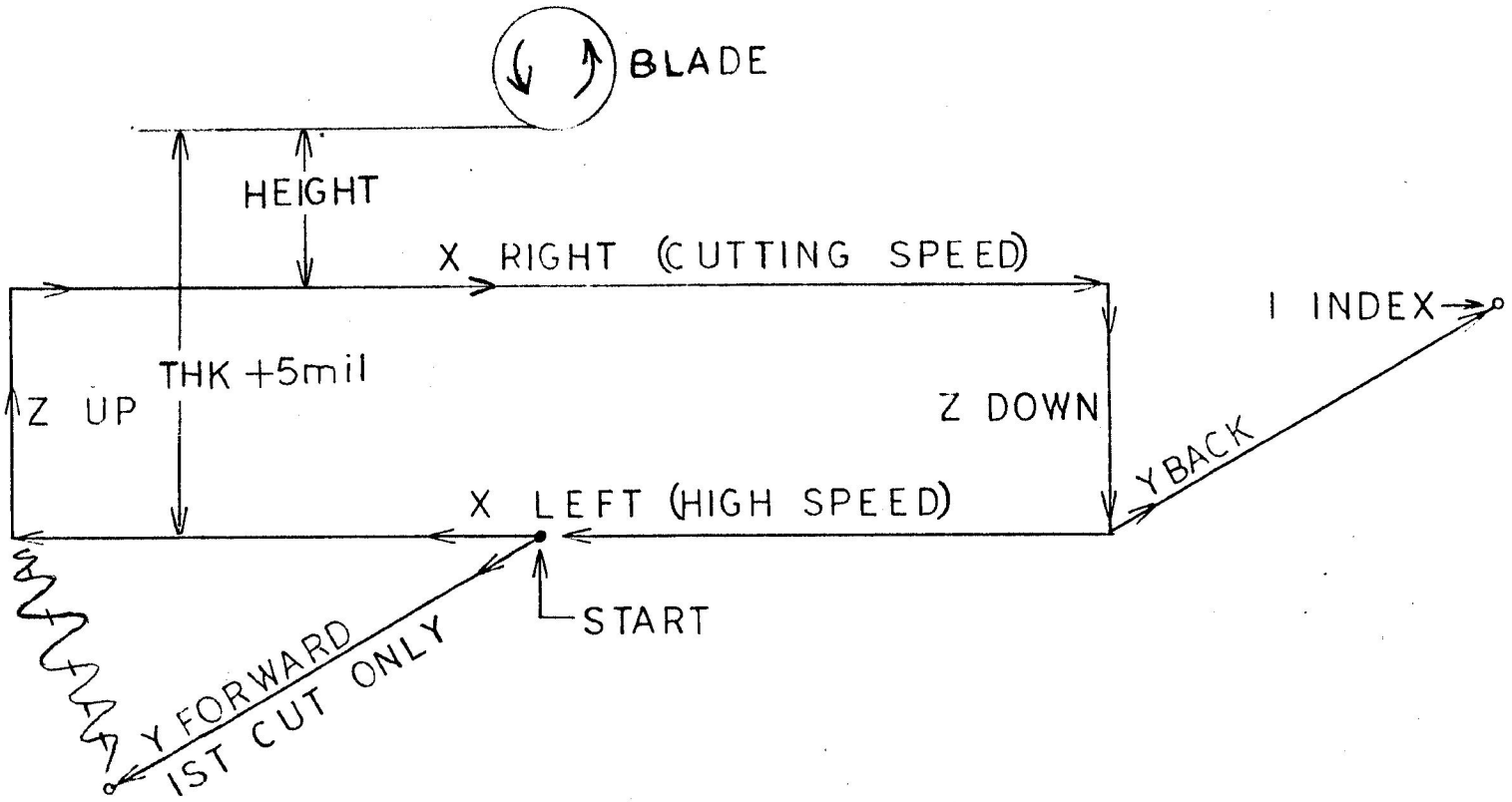
The sequence to Pass 2 is as follows:

At the completion of the final cut in Pass 1, Theta rotates counter-clockwise to the programmed angle and "Y" moves to the home position. "X" then moves to center the chuck under the optics and the saw goes into the ALIGN mode.



CHUCK ZERO SEQUENCING

FIG. 3-2



DICE AUTO CUTTING
SEQUENCE —PASS 1
FIG. 3-3

Pressing the AUTOCUT will now start the Pass 2 autocutting sequence, which is identical to Pass 1 except for Pass 2 index. At the completion of Pass 2, the "X", "Y" and "Theta" axes all home and the saw returns to the POWER ON/PROGRAMMED state.

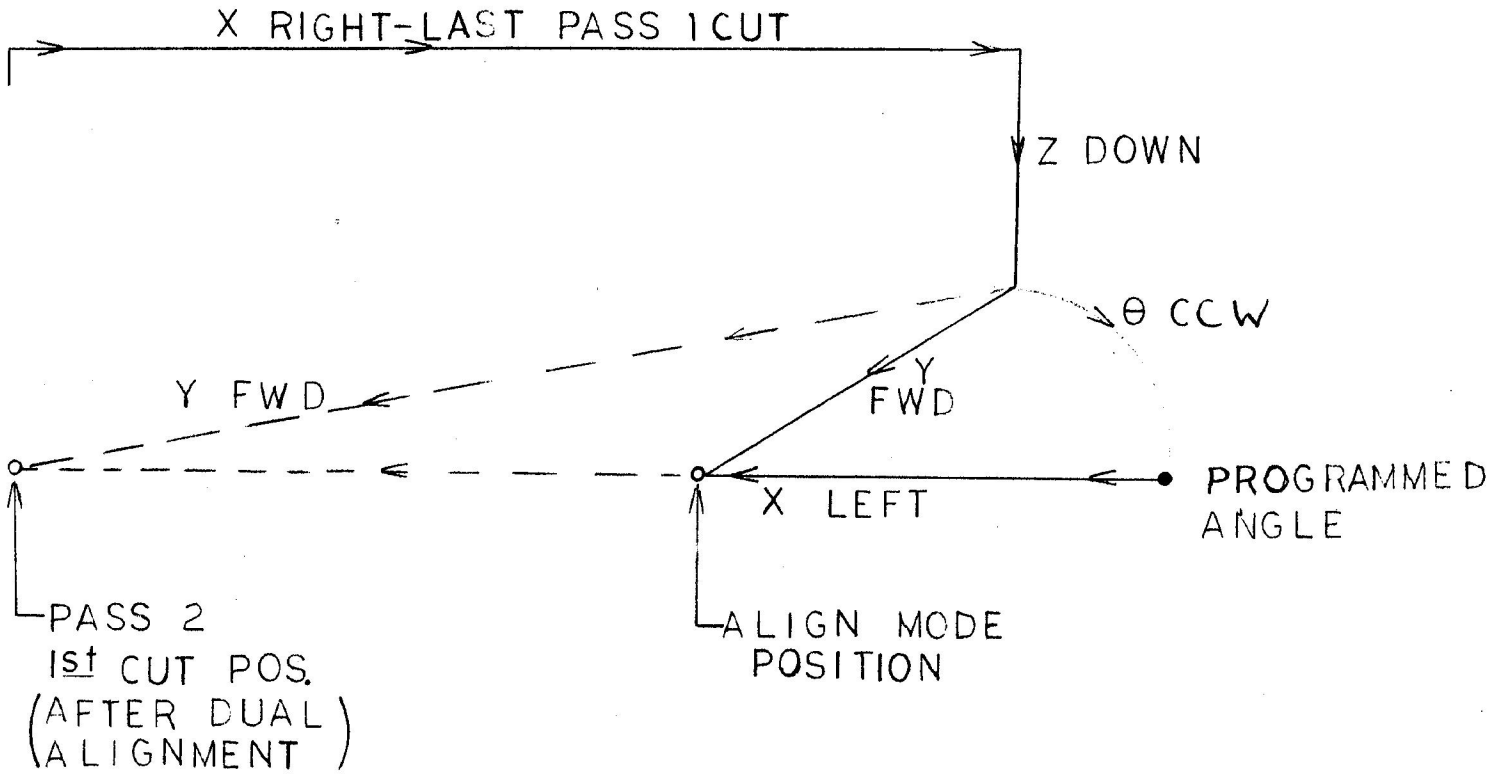
3-6 AUTOCUTTING SEQUENCE (Dice, Dual Alignment)

The Model 1006 Dicing Saw can be aligned for both Pass 1 and Pass 2 prior to cutting either pass. This is called "dual alignment". Dual alignment saves time since both alignments are performed prior to cutting, eliminating problems caused by water, and also eliminates any waiting time between passes. The saw software does not require a particular alignment sequence. It detects if an alignment has been performed in both axes prior to initiation of the autocut switch. Therefore, Pass 1 can be aligned before or after Pass 2, and the saw will still cut both passes without further alignment.

The sequence of operation after dual alignment is the same as that described in "single alignment" except that after rotating to the second cutting axis, the saw automatically starts AUTOCUT instead of entering the ALIGN mode.

3-7 SCRIBE MODE SEQUENCE

The sequence in the SCRIBE mode is altered so that cutting occurs when "X" moves left and right. When scribing, if the height is more than 5 mils, the "Z" will not move up and down between cuts.



DICE SEQUENCE
PASS 1 TO PASS 2
FIG 3-4

SECTION IV

FAULT ANALYSIS DESCRIPTION

This section provides two methods of Fault Analysis. The first section provides step-by-step instructions for analyzing a machine malfunction when a Fault Code is displayed. The second section contains diagnostic flow charts for analysis of malfunctions which are not detected by a Fault Code.

4-1 FAULT CODE ANALYSIS

The following fault analysis steps are designed to examine the most likely cause of each failure. Each step assumes that no problems were found on a previous step, and that all previous steps have been performed. Other analysis steps may suggest themselves upon examination of the circuit schematics.

4-2 SENSOR FAILURE ANALYSIS

A. F201 - "Chuck Zero Circuit Open"

This fault code indicates that the output of the chuck zero circuit (on TP-5 of the Auxiliary Logic board) failed to switch to +5V when the CPU sent a test command to energize Relay K1 on the Auxiliary Logic Board.

(Refer to Schematic 17020620-001, page 223)

1. Remove top cover and disconnect the orange wire from the insulated brush holder on the rear of the spindle. Turn the spindle on and check the resistance from one brush to the other. (Must be 1 kohm or less.) If the brush resistance is more than 1 kohm, clean the brushes and the spindle surface where the brush contacts and extend the brush springs.

2. Make certain the orange and violet wires are secure and are attached to the brushes. (Violet to the non-insulated brush.)

3. Check that Relay K1 is inserted in the socket of the Auxiliary Logic PCB properly.

4. Turn power off.

5. Test continuity from spindle to U2 Pin 2 (Auxiliary Logic PCB).

6. Test continuity from Relay K1, Pin 8 to chassis ground.

7. Replace Relay K1 (Auxiliary Logic PCB) and re-test.

8. Replace IC U1 (Auxiliary Logic PCB) and re-test.

9. Replace Auxiliary Logic PCB.

B. F202 - "Chuck Zero Circuit Shorted"

This fault code indicates that the output of the Chuck Zero Circuit (on TP-5 of the Auxiliary Logic PCB) failed to switch to Zero Volts when the CPU sent a test command to de-energize Relay K1 on the Auxiliary Logic PCB.

Fault Analysis Steps:

1. Turn power off and disconnect Cable J1 of the Auxiliary Logic PCB.

2. Check the resistance from the spindle to the vacuum chuck.

3. If the resistance in Step 2 is less than infinite, disconnect the spindle motor wires from the Spindle Power Supply TB5 terminals 1, 2, 3 and 4 and go to Step 4. If the resistance in Step 2 is infinite, go to Step 8.

4. Check the resistance from the spindle to the vacuum chuck.

5. If the resistance is now infinite, the spindle is internally shorted and should be replaced.

6. If resistance is still less than infinite, disconnect the orange and violet wires from the screw at the rear of the spindle and re-test.

7. If resistance is still less than infinite, look for water between the spindle and the spindle casting or damage to the Mylar insulator. (Ref. Paragraph 2-7, 8, 9 and 10)

8. If the resistance at Step 2 is infinite, re-connect J1 of the Auxiliary Logic PCB, replace Relay K1, apply power and re-test. If still bad, go to Step 9.

9. Replace IC U1 on Auxiliary Logic PCB.

10. Replace Auxiliary Logic PCB.

C. F211 - "Theta Motor Sensor Failure"

This fault code indicates that the CPU did not detect a change of voltage from the Theta motor sensor circuit when a move command was sent to the Theta motor.

Fault analysis steps:

1. Place saw into the STANDBY mode.

2. Connect a volt meter to the Theta motor sensor PCB. Connect the "minus" lead to TP1 and the "positive" lead to TP2.

3. Manually rotate the motor. The voltage at TP2 should alternately switch from approximately +0.2V to approximately +4 VDC. If this signal is correct, go to Step 5.

4. If the signal at TP2 does not switch correctly, unplug U2 and test again. If TP2 now switches correctly, replace IC U2 and go back to Step 3. If the TP2 voltage still does not switch correctly, replace the Theta motor sensor PCB.

5. When the voltage at TP2 switches correctly (as described in Step 3), move the "positive" meter lead to TP3 and manually rotate the Theta motor. The voltage at TP3 should alternately switch from approximately 0 V to +5 VDC. If the TP3 voltage switches correctly, go to Step 8.

6. If the TP3 voltage does not switch correctly, replace IC U2 and re-test.

7. If the TP3 voltage does not switch correctly after Step 6., turnn power off, remove Card C2 from the card cage, turn power on and re-test the Theta motor sensor (per Step 5). If the TP3 voltage switches correctly with Card C2 removed from the card cage, replace C2.

8. If TP3 switches normally and Fault Code F211 is still occurring, replace Theta motor driver C8 in the card cage and re-test.

9. Replace "Z", Theta cable.

D. F212 - "Y Motor Sensor Failure"

This fault code indicates that the CPU did not detect a change of voltage from the "Y" motor sensor circuit when a MOVE command was sent to the "Y" motor.

Fault analysis steps:

1. Place saw into the STANDBY mode.

2. Connect a volt meter to the "Y" motor sensor PCB. Connect the "minus" lead to TP1 and the "positive" lead to TP2.

3. Manually rotate the motor. The voltage at TP2 should alternately switch from approximately +0.2V to approximately +4 VDC. If this signal is correct, go to Step 5. If the TP2 voltage still does not switch correctly, replace the Theta motor sensor PCB.

4. If the signal at TP2 does not switch correctly, unplug U2 and test again. If TP2 now switches correctly, replace IC U2 and go back to Step 3. If the TP2 voltage still does not switch correctly, replace the "Y" motor sensor PCB.

5. When the voltage at TP2 switches correctly (as described in Step 3), move the "positive" meter lead to TP3 and manually rotate the "Y" motor. The voltage at TP3 should alternately switch from approximately 0 V to +5 VDC. If the TP3 voltage switches correctly, go to Step 8.

6. If the TP3 voltage does not switch correctly, replace IC U2 and re-test.

7. If the TP3 voltage does not switch correctly after Step 6., turnn power off, remove Card C3 from the card cage, turn power on, and re-test the "Y" motor sensor (per Step 5.). If the TP3 voltage switches correctly with Card C3 removed from the card cage, replace C3.

8. If TP3 switches normally and Fault Code F212 is still occurring, replace "Y" motor driver C7 in the card cage and re-test.

9. Replace X-Y cable assembly.

E. F213 - "X Motor Sensor Failure"

This fault code indicates that the CPU did not detect a change of voltage from the "X" motor sensor circuit when a MOVE command was sent to the "X" motor.

Fault analysis steps:

1. Place saw into the STANDBY mode.

2. Connect a volt meter to the "X" motor sensor circuit. Connect the "minus" lead to TP1 and the "positive" lead to TP2.

3. Manually rotate the motor. The voltage at TP2 should alternately switch from approximately +0.2V to approximately +4 VDC. If this signal is correct, go to Step 5.

4. If the signal at TP2 does not switch correctly, unplug U2 and test again. IF TP2 now switches correctly, replace IC U2 and go back to Step 3. If the TP2 voltage still does not switch correctly, replace the "X" motor sensor PCB.

5. When the voltage at TP2 switches correctly (as described in Step 3), move the "positive" meter lead to TP3 and manually rotate the "X" motor. The voltage at TP3 should alternately switch from approximately 0 V to +5 VDC. If the TP3 voltage switches correctly, go to Step 8.

6. If the TP3 voltage does not switch correctly, replace IC U2 and re-test.

7. If the TP3 voltage does not switch correctly after Step 6, turn power off, remove Card C2 from the card cage, turn power on and re-test the "Y" motor sensor (per Step 5.). If the TP3 voltage switches correctly with Card C2 removed from the card cage, replace C2.

8. If TP3 switches normally and Fault Code F213 is still occurring, replace "X" motor driver C6 in the card cage and re-test.

9. Replace the X-Y cable assembly.

F. F214 - "Vacuum Service Malfunction"

This fault code indicates that the CPU has received a "0V" signal from the vacuum sensor switch.

Fault analysis steps:

1. Check the vacuum fittings and tubing to the rear panel for leaks or looseness.

2. Check for vacuum to the blade mounting chuck by switching ON the vacuum toggle valve (under the front of the main casting).

3. Connect a volt meter from logic ground (TB1-1) to both wires on the vacuum sensor switch. One contact should read +5V, the other 0V.

4. If both contacts are 0 volts, test and adjust the vacuum sensor (per Paragraph 2-54).

G. F215 - "Cutting Water Pressure Malfunction"

This fault code indicates the CPU has received a +5V signal from the cutting water sensor switch. This switch will "open" when cutting water pressure is less than 10 psi.

Fault analysis steps:

1. Check the cutting water pressure. If there is no pressure gauge, you can check the cutting water flow rate on the flow gauge of the service unit. If the flow is adequate, the pressure is probably correct. Check for line restrictions, etc.

2. Perform the cutting water sensor testing and adjustment, per Paragraph 2-61 C.

H. F220 - "Machine Has Detected the 'X' Left Limit"

This fault code indicates that the CPU has detected a 0 Volt signal from the "X" left limit sensor (TP5) at a time when the "X" stage should not be at the limit.

Fault analysis steps:

1. Examine the "X" stage position. If the "X" stage is at the lefthand limit and the "X" flag is in the "X" left photo-sensor slot, the sensor is okay, but the "X" stage is in the wrong position. Test the "X" motor balance and alignment, per Paragraph 2-46 or 2-47.

2 Mechanical problems such as looseness or binding can cause the "X" motor to "walk" one way or the other during cutting. This is especially true when cutting in the DICE mode, as the movement from left to right is done at a different speed than the movement from right to left. If the "X" stage "walks" causing the stage to reach the limit, perform the "X" stage P.M. testing and adjusting, per Paragraph 2-13 C.

3. If the "X" stage is not at the limit position when F220 occurs, the problem is probably electrical. Connect a volt meter to the "X" limit sensor PCB with the "minus" lead on TP1 and the "positive" lead on TP4. The voltage should be near zero volts.

4. If the voltage at TP4 is +1 VDC or higher, replace the "X" sensor PCB or the "X" left photo sensor U1.

5. If the TP4 voltage is 0 VDC to .7V, U1 is okay -- move the "positive lead to TP5. If the voltage on TP5 is not +5 VDC $\pm$0.5V, replace U2.

6. If the TP5 voltage is still less than +4.5 VDC, replace the "X" limit sensor PCB.

7. Replace the motor CPU in Card Cage slot C2.

8. Replace the "X-Y" cable assembly.

I. F221 - "Machine Has Detected the 'X' Right Limit

This fault code indicates that the CPU has detected a 0 volt signal from the "X" right limit sensor (TP3) at a time when the "X" stage should not be at the limit.

Fault analysis steps:

1. Examine the "X" stage position. If the "X" stage is at the righthand limit and the "X" flag is in the "X" left photo-sensor slot, the sensor is okay, but the "X" stage is in the wrong position. Test the "X" motor balance and alignment, per Paragraph 2-46 or 2-47.

2. Mechanical problems such as looseness or binding can cause the "X" motor to "walk" one way or the other during cutting. This is especially true when cutting in the DICE mode as the movement from left to right is done at a different speed than the movement from right to left. If the "X" stage "walks" causing the stage to reach the limit, perform the "X" stage P.M. testing and adjustment, per Paragraph 2-13 C.

3. If the "X" stage is not at the limit position when F221 occurs, the problem is probably electrical. Connect a volt meter to the "X" limit sensor PCB with the "minus" lead on TP1 and the "positive" lead on TP2. The voltage should be near zero volts.

4. If the voltage at TP2 is +1 VDC or higher, replace the "X" sensor PCB or the right photo sensor U3.

5. If the voltage at TP2 0V to +0.7 VDC, U3 is okay -- move the "positive" lead to TP3. If the TP3 voltage is not +5 VDC $\pm$0.5V, replace U4.

6. If the TP3 voltage is still not +5 VDC after performing Step 5, replace the "X" sensor PCB.

7. Replace the motor CPU in card cage location C2.

8. Replace the "X-Y" cable assembly.

J. F222 - "The Machine Has Detected the 'Y' Rear Limit

This fault code indicates that the CPU has detected a 0 signal from the "Y" limit PCB (TP3) at a time when the "Y" stage should not be at the limit.

Fault analysis steps:

1. Examine the "Y" stage position. If the "Y" stage is in the rear position and the "Y" flag is in the "Y" rear limit sensor slot, the limit sensor is okay, but the "Y" stage is at the wrong position. Check the "Y" motor balance and alignment, per Paragraph 2-46 or 2-47.

2. Perform the "Y" stage maintenance, per Paragraph 2-35 A, B, and C, as required.

3. Check all "Y" stage couplings and screws for proper tightness.

4. If the "Y" flag is not in the "Y" rear limit sensor slot, the "Y" limit sensor has probably failed. Connect a voltmeter to the "Y" limit sensor PCB with the "negative" lead on TP1 and the "positive" lead on TP2. If the voltage is more positive than 0.7 VDC, replace the "Y" sensor PCB or the "Y" rear photo sensor U3.

5. If the voltage at TP2 is 0 to 0.7 VDC, move the positive meter lead to TP3. If the voltage at TP3 is less than +4.5 VDC, replace U4.

6. If the TP3 voltage is still less than +4.5 VDC, replace the "Y" limit sensor PCB.

7. Replace the motor CPU in card cage slot C3.

8. Replace the "X-Y" cable assembly.

K. F223 - "The Machine Has Detected the 'Y' Forward Limit

This fault code indicates that the CPU has detected a 0 volt signal from the "Y" limit sensor PCB (TB5) at a time when the "Y" stage should not be at the limit.

Fault analysis steps:

1. Examine the "Y" stage position. If the "Y" stage is in the forward position and the "Y" flag is in the "Y" rear limit sensor slot, the limit sensor is okay, but the "Y" stage is at the wrong position. Check the "Y" motor balance and alignment, per Paragraph 2-46 or 2-47.

2. Perform the "Y" stage maintenance, per Paragraph 2-35 A, B, and C, as required.

3. Check all "Y" stage couplings and screws for proper tightness.

4. If the "Y" flag is not in the "Y" forward limit sensor slot, the "Y" limit sensor has probably failed. Connect a voltmeter to the "Y" limit sensor PCB with the "negative" lead on TP1 and the "positive" lead on TP4. If the voltage is more positive than 0.7 VDC, replace the "Y" sensor PCB or the "Y" rear photo sensor U1.

5. If the voltage at TP4 is θV to 0.7 VDC, move the "positive" meter lead to TP5. If the voltage at TP5 is less than +4.5 VDC, replace U2.

6. If the voltage at TP2 is θ to 0.7 VDC, move the "positive" meter lead to TP5. If the voltage at TP5 is less than +4.5 VDC, replace U4.

7. Replace the motor CPU in card cage slot C3.

8. Replace the "X-Y" cable assembly.

L. F224 - "Machine Has Detected the Theta CCW Limit"

This fault code indicates that the CPU has detectd a θ volt signal from the limit sensor PCB (TP5) when the Theta stage should not be at the limit.

Fault analysis steps:

1. Remove the front cover and examine the Theta stage position. If the Theta flag (on the bottom of the Theta worm wheel) is in the sensor slot, the limit sensor is probably okay; the Theta stage, however, is in the wrong position. Check the Theta motor balance and alignment, per Paragraph 2-46 or 2-47.

2. Perform the Theta stage maintenance, per Paragraphs 2-24, 2-26 and 2-27.

3. If the Theta flag is not in the sensor, then the sensor may have failed. Test the Theta limit sensor PCB by connecting a voltmeter to the board with the "minus" lead on TP1 and the "positive" lead on TP4. If the TP4 voltage is greater than +.7 VDC, replace the θ sensor U3 or the Theta limit sensor PCB.

4. If the TP4 voltage is +7 VDC or lower, move the positive meter lead to TP5. If the voltage at TP5 is not +5 VDC $\pm$.5 V, replace U4.

5. If TP5 is still not +5 VDC $\pm$.5 V after Step 4, replace the CPU in card cage location C2.

6. Replace the Theta sensor PCB.

7. Replace the "Z" θ cable.

M. F225 - "Machine Has Detected the Theta CW Limit"

This fault code indicates that the C2 CPU circuit has detected a θ volt signal from the Theta limit sensor PCB (TP3) when the Theta stage should not be at that limit.

Fault analysis steps:

1. Check that the ribbon cable connector is fully plugged in.

2. Remove the front cover and examine the Theta stage position. If the Theta flag (on the bottom of the Theta worm wheel) is in the sensor slot, the limit sensor is probably okay; the Theta stage, however, is in the wrong position. Check the Theta motor balance and alignment, per Paragraph 2-46 or 2-47.

3. Perform the Theta stage maintenance, per Paragraph 2-24, 2-26 or 2-27.

4. If the Theta flag is not in the sensor, then the sensor may have failed. Test the Theta limit sensor PCB by connecting a voltmeter to the board with the "minus" lead on TP1 and the "positive" lead on TP2. If the TP2 voltage is greater than +.7 VDC, replace the θ sensor U1 or the Theta limit sensor PCB.

5. If the TP2 voltage is +.7 VDC or lower, move the "positive" meter lead to TP3. If the voltage at TP3 is not +5 VDC $\pm$.5V, replace U4.

6. If TP3 is still not +5 VDC $\pm$.5V after Step 4, replace the CPU in card cage location C2.

7. Replace the Theta sensor PCB.

8. Replace the "Z" θ cable.

N. F226 - "Machine Has Detected the "Z" Lower Limit"

This fault code indicates that the C3 CPU circuit has detected a θ volt signal from the "Z" limit sensor PCB (TP3) when the vacuum chuck should not be at the lower limit position.

Fault analysis steps:

1. Remove the front cover and examine the position of the "Z" flag (ref. Fig. 2-16). If the "Z" flag is in the sensor slot, then the "Z" limit sensor is probably okay; the "Z" stage, however, is in the wrong position. Proceed to Step 2. If "Z" flag is not in the sensor slot, see Step 8.

2. Test the "Z" stage operation looking for mechanical binding, etc.

3. Program the saw with a test program to exercise the "Z" stage and operate the saw to test the "Z" stage operation.

4. If the operation of the "Z" stage is erratic, replace motor driver C9.

5. Exchange C2 and C3 CPU cards and re-test.

6. Replace the "Z" θ cable assembly and re-test.

7. Replace the "Z" drive assembly.

8. When F226 occurs and the flag is not in the sensor slot, the circuitry has improperly detected the "Z" limit. Attach a voltmeter to the "Z" limit PCB with the "negative" lead on TP1 and the "positive" lead on TP3. Wiggle the cable. If the voltage changes, replace the "Z" θ cable.

9. Attach a voltmeter to the "Z" limit sensor PCB with the "negative" lead on TP1 and the "positive" lead on TP2.

10. If the voltage at TP2 is greater than +.7 VDC, replace "Z" limit sensor U1 or the "Z" limit sensor PCB.

11. If the voltage at TP2 is +.7 VDC or less, move the "positive" meter lead to TP3. (Use caution to prevent accidental grounding.) If the TP3 voltage is not +5 VDC $\pm$.5V, replace U2.

12. If the voltage at TP3 is still not +5 VDC $\pm$.5V, replace CPU C3.

13. Replace "Z" sensor PCB.

14. Replace "Z" θ cable assembly.

O. F230 - "Machine Has Run Maximum Distance without Detection of the 'X' Left Sensor"

This failure code is displayed anytime the "X" stage is "homing" and the "X" motor CPU (C2) has detected a given number of pulses from the "X" motor sensor without detecting the "X left sensor. Since the motor is operating "closed loop", the most likely cause of this failure is a loose coupling between the "X" motor and the "X" leadscrew.

Fault analysis steps:

1. Check the motor coupling for tightness.
2. Check the "X" motor sensor for oscillation.
3. Replace C2 ("X" motor CPU).

P. F232 - "Machine Has Run Maximum Distance without Detection of 'Y' Rear Sensor"

This failure code is displayed anytime the "Y" stage is "homing" and the "Y" motor CPU (C3) detects a given number of pulses from the "Y" motor sensor without detecting the "Y" rear limit sensor. Since the "Y" motor is operating "closed loop", the most likely cause of this failure is a loose coupling between the "Y" motor and the "Y" leadscrew.

Fault analysis steps:

1. Check the "Y" motor coupling for tightness.
2. Check the "Y" motor sensor.
3. Replace C3 ("Y" motor CPU).

Q. F234 - "Machine Has Run Maximum Distance without Detection of the 'Theta' CCW Limit Sensor

This failure code is displayed anytime the θ stage is "homing" and the θ motor CPU (C2) detects a given number of pulses from the θ motor sensor without detecting the "Theta" CCW (counterclockwise) limit sensor. Since the "Theta" motor is operating in the "closed loop" mode, the most likely cause of this failure is a loose coupling between the "Theta" motor and the "Theta" worm gear.

Fault analysis steps:

1. Check the mechanical coupling between the "Theta" motor and the "Theta" worm wheel.
2. Check the "Theta" motor encoder circuit.
3. Replace the θ motor CPU (C2).

R. F236 - "Machine Has Run the Maximum Distance without Detection of the "Z" Limit Sensor"

This failure code is displayed any time the "Z" stage is "homing" and the motor CPU (C3) has sent a pre-determined number of step commands to the "Z" motor driver without detecting the "Z" limit sensor.

Since the "Z" motor operates "open loop", the cause of this failure can be mechanical or electrical.

Fault analysis steps:

1. Remove the front cover and examine the "Z" flag position. If the "Z" flag is in the "Z" limit sensor slot, the "Z" limit is probably defective; proceed to Step 2. If the "Z" flag is not in the limit sensor slot, proceed to Step 7.

2. Connect a voltmeter to the "Z" limit sensor PCB with the "negative" lead on TP1 and the "positive" lead on TP2. With the flag in the sensor, the TP2 voltage should be +4 VDC ±1V.

3. If the TP2 voltage is +4 VDC ±1V with the flag in the sensor, move the positive meter lead to TP3. The voltage should be ~~0~~VDC+.7V.

4. If either Step 2 or 3 are incorrect, replace U2 and re-test. If they are correct, go to Step 5.

5. While monitoring TP3, wiggle the ribbon cable. If the voltage changes while moving the cable, replace the "Z" ~~θ~~ cable.

6. Replace motor CPU (C3).

7. If the flag is not in the sensor slot, check the motor ribbon cable connector for proper seating.

8. Replace "Z" motor drive C9 and re-test.

9. Replace motor CPU (C3) and re-test.

10. Check the tightness of the coupling between the "Z" motor and the "Z" nut housing by holding one while manually turning the other. If the coupling is loose, correct the problem by referring to Paragraphs 2-28, 2-29 and 2-30.

S. F240 - "Machine Has Run Maximum Distance without Leaving the "X" Left Sensor"

This failure code will occur during a "homing" sequence when the motor CPU (C2) has sent a pre-determined number of step commands to the "X" motor driver C6 without detecting that the "X" left limit sensor output at TP5 has switched to +5VDC ±.5V.

Fault analysis steps:

1. Check that the "X" limit sensor cable connector is seated properly.

2. Check that the "X" motor cable connection is seated properly.

3. If the "X" flag is in the "X" left limit sensor slot, manually turn the "X" motor until the flag is not in the "X" left limit sensor slot. Check the motor coupling for tightness.

4. If the "X" flag is not in the "X" left limit sensor slot, test the "X" left limit sensor circuit, as follows--

   a. Attach a voltmeter to the "X" left limit sensor PCB with the "negative" lead on TP1 and the "positive" lead on TP4. The voltage on TP4 should be +.7VDC or less with the slot open. If the voltage is incorrect, see Step 5.

   b. Move the "positive" lead to TP5. The voltage on TP5 should be +5VDC ±1V with the slot open.

5. If either Step 4a. or 4b. voltages are incorrect, replace U4 and re-test. If either voltage is still incorrect, replace the limit sensor.

6. If Step 4a. or 4b. voltages are correct, block the "X" left limit sensor slot. TP4 should now be +4VDC ±1V and TP5 should be +.7VDC or less. If the voltages are correct, the limit sensor is okay.

7. Replace "X" CPU (C2).

8. Replace "X" motor driver C6.

T. F242 - "Machine Has Run Maximum Distance without Leaving the "Y" Left Sensor"

This failure code will occur during a "homing" sequence when the motor CPU (C3) has sent a pre-determined number of step commands to the "Y" motor driver (C7) without detecting that the "Y" rear limit sensor output at TP3 has switched to +5VDC ±.5V.

Fault analysis steps:

1. Check that the "Y" sensor cable connector is seated properly.

2. Check that the "Y" motor cable connection is seated properly.

3. Check if the "Y" flag is in the rear limit sensor slot and check the "Y" motor coupling for tightness.

4. If the "Y" flag is not in the "Y" rear limit sensor slot, test the "Y" limit sensor, as follows--

   a. Attach a voltmeter to the "Y" limit sensor PCB with the "negative" lead on TP1 and the "positive" lead on TP2. With the "Y" flag out of the sensor slot, the TP2 voltage should be +.7VDC or less. If the voltage is incorrect, see Step 5.

   b. Move the "positive" meter lead to TP3. The voltage on TP3 should be +5 VDC ±1V.

5. If the voltages in either Step 4a. or 4b. are incorrect, replace U2 and re-test. If either voltage is still incorrect, replace the limit sensor.

6. If the voltages at 4a. or 4b. are correct, block the "Y" rear limit sensor slot. The TP2 voltage should now be +4 VDC ±1V and TP3 should be +.7 VDC or less. If these voltages are correct, the limit sensor is okay.

7. Replace "Y" CPU (C3).

8. Replace "Y" motor driver (C7).

U. F244 - "Machine Has Run Maximum Distance without Leaving the "Theta" CCW Limit Sensor"

This failure code will occur during a "homing" sequence when the motor CPU (C2) has sent a pre-determined number of step commands to the "Theta" motor driver (C7) without detecting that the "Theta" CCW left limit sensor output at TP5 has switched to +5VDC ±.5V.

Fault analysis steps:

1. Check that the "Theta" sensor cable connector is seated properly.

2. Check that the "Theta" motor cable connection is seated properly.

3. If the "Theta" flag is in the "Theta" CCW limit sensor slot, manually turn the "Theta" motor until the flag is not in the "Theta" CCW limit sensor slot. Check the motor coupling for tightness.

4. If the "Theta" flag is not in the "Theta" CCW limit sensor slot, test the "Theta CCW limit sensor, as follows--

   a. Attach a voltmeter to the "Theta" CCW limit sensor PCB with the "negative" lead on TP1 and the "positive" lead on TP4. The voltage on TP4 should be +.7VDC or less with the slot open. If the voltage is incorrect, see Step 5.

   b. Move the "positive" lead to TP5. The voltage on TP5 should be +5 VDC ±1V with the slot open.

5. If the voltages in either Step 4a. or 4b. are incorrect, replace U4 and re-test. If either voltage is still incorrect, replace the limit sensor.

6. If the voltages at 4a. or 4b. are correct, block the "Theta" CCW limit sensor slot. The TP4 voltage should now be +4 VDC ±1V and TP5 should be +.7 VDC or less. If these voltages are correct, the limit sensor is okay.

7. Replace "Theta" CPU (C2).

8. Replace "Theta" motor driver (C7).

V. F246 - "Machine Has Run Maximum Distance without Leaving the "Z" Limit Sensor"

Fault analysis steps:

1. Check that the "Z" sensor cable connector is seated properly.

2. Check that the "Z" motor cable connection is seated properly.

3. Check if the "Z" flag is in the down limit sensor slot, and check the "Z" motor coupling for tightness.

4. If the "Z" flag is not in the "Z" down limit sensor slot, test the "Z" limit sensor, as follows--

   a. Attach a voltmeter to the "Z" limit sensor PCB with the "negative" lead on TP1 and the "positive" lead on TP2. With the "Z" flag out of the sensor slot, the TP2 voltage should be +.7VDC or less. If the voltage is incorrect, see Step 5.

   b. Move the "positive" meter lead to TP3. The voltage on TP3 should be +5 VDC $\pm$1V with the slot open.

5. If the voltages in either Step 4a. or 4b. are incorrect, replace U2 and re-test. If either voltage is still incorrect, replace the limit sensor.

6. If the voltages at 4a. or 4b. are correct, block the "Z" down limit sensor slot. The TP2 voltage should now be +4 VDC $\pm$1V and TP3 should be +.7 VDC or less. If these voltages are correct, the limit sensor is okay.

7. Replace "Z" CPU (C3).

8. Replace "Z" motor driver (C9).

4-3 ELECTRICAL HARDWARE FAILURE CODES

The failure codes beginning with F3 are provided to locate faults in the card cage printed circuit cards. Whenever possible, the diagnostics will locate the failed device.

A. F310 - "EProm Failure"

This failure code indicates that a comparison of the information read from the EProms does not match the information which was written at the time of manufacturing.

1. Press "ENTER" switch on the program panel. Another code will be displayed which indicates which CPU board has the failure.

2. Refer to the Fault Analysis for the displayed code.

B. F311 - "Ram Failure"

This failure code indicates a failure of a random access memory on one of the CPU boards during initialization testing.

1. Press "ENTER" switch on the program panel. Another code will be displayed which indicates which CPU board has the failure.

2. Refer to the Fault Analysis for the displayed code.

C. F330 - "Program Storage Failure"

This failure code indicates that the information read from this program storage location is not the same as the information written. This code will occur only when storing or reading information from the program storage.

Fault analysis steps:

1. Re-enter a program into the failed storage location.

2. Re-read the program stored in Step 1. If fault code F330 does not re-occur, the memory is okay, but the memory protection circuit may be faulty. If F330 does re-occur, go to Step 5.

3. Remove the main power from the saw, wait five minutes; turn main power to the saw and repeat Step 2. If fault code F330 re-occurs after Step 3, press "ENTER" switch on the program panel. Another code will be displayed which indicates which board has the failure.

4. Refer to the Fault Analysis for the displayed code.

D. F331 - "Spindle Speed Failure"

This failure code indicates that the voltage on TP5-14 of the spindle power supply (TB5-14) is +5 VDC when it should be ~~0~~VCD. This +5 VDC indicates that the spindle power supply is not detecting a full speed condition.

Fault analysis steps:

1. Remove top cover, defeat the safety interlock, press "RESET". While observing the Relay K2 on the spindle power supply, press the spindle switch. If K2 energizes, go to Step 7. If K2 does not energize, go to Step 2.

2. Check air pressure to the saw. It should be 85 psi.

3. Check the spindle cooling water supply pressure. It should be 10 psi minimum.

4. Check the air pressure switch, per Paragraph 2-50.

5. Check the spindle cooling water flow switch, per Paragraph 2-58.

6. Replace the motor driver C6.

7. If the Relay K2 energizes and the spindle does not come up to speed, the spindle power supply is faulty. Perform testing, per Paragraph 2-67 B.

E. F301 - "The Problem is on Card C-1"

This code may occur when the "ENTER" switch is pressed after either Fault Code F310, F311 or F330. This code indicates that the malfunction is on the Housekeeper CPU Card located in card cage location C-1.

Fault analysis steps:

1. When F301 occurs after F310 (EPROM problem), press the "ENTER" switch again.

2. Code d001, d002, d003, or d004 will be displayed indicating the device number which has failed. Turn main power off and remove failed PCB.

3. Replace the indicated device, as follows --

   d001 -- replace IC - U1 and re-test
   d002 -- replace IC - U2 and re-test
   d003 -- replace IC - U3 and re-test
   d004 -- replace IC - U4 and re-test

4. When F301 occurs after F311 (RAM problem), press the "ENTER" switch again.

5. Code d005 will be displayed, indicating that the Random Access Memory IC U5 has failed the initialization test. Turn power off and remove failed PCB.

6. Replace IC - U5 and re-test.

7. When F301 occurs after F330 (Program Storage problem), press "ENTER" switch again.

8. Code d006 or d007 will be displayed, indicating the device number in which the problem was detected.

9. Remove PCB C1 from the card cage and place it on a non-conductive work surface with the components up.

10. With a DVM, measure the voltage across Battery B1. If the voltage is +2.4 VDC or less, replace B1.

11. If the voltage across B1 is +2.4 VDC or greater, measure the voltage from Pin 18 (gnd) and Pin 22 of U6 and U7. If the voltage on Pin 22 is less than +2 VDC, replace CR1 and re-test.

12. If the voltage on Pin 22 of U6 and U7 is +2 VDC or greater, replace the IC, as follows:

    d006 was displayed in Step 8; replace IC U6 and re-test
    d007 was displayed in Step 8; replace IC U7 and re-test

F. F302 - "The Problem is on Card C-2"

This problem may occur when the "ENTER" switch is pressed after Fault Code F310. This code indicates that the malfunction is on the Motor CPU Card located in the card cage location C-2.

Fault analysis steps:

1. When F302 occurs after F310 (EPROM problem), press the "ENTER" switch again.

2. Code d001, d002, d003, or d004 will be displayed indicating the device number which has failed. Turn main power off and remove failed PCB.

3. Replace the indicated device, as follows --

    d001 -- replace IC - U1 and re-test
    d002 -- replace IC - U2 and re-test
    d003 -- replace IC - U3 and re-test
    d004 -- replace IC - U4 and re-test

G. F303 - "The Problem is on Card C3"

This problem may occur when the "ENTER" switch is pressed after Fault Code F310. This code indicates that the malfunction is on the Motor CPU Card located in the card cage location C-3.

Fault analysis steps:

1. When F303 occurs after F310 (EPROM problem), press the "ENTER" switch again.

2. Code d001, d002, d003, or d004 will be displayed indicating the device number which has failed. Turn main power off and remove failed PCB.

3. Replace the indicated device, as follows --

    d001 -- replace IC - U1 and re-test
    d002 -- replace IC - U2 and re-test
    d003 -- replace IC - U3 and re-test
    d004 -- replace IC - U4 and re-test

H. F304 - "The Problem is on Card C-4"

This problem may occur when the "ENTER" switch is pressed after Fault Code F310, F311 or F330. This code indicates that the malfunction is on the Memory Expander PCB located in the card cage location C-4.

Fault analysis steps:

1. When F304 occurs after F310 (EPROM problem), press the "ENTER" switch again.

2. A Code d015 will be displayed indicating the failed device is U15.

3. Turn main power off, remove PCB C4 from the machine, replace IC U15 and re-test.

4. When F304 occurs after F330 (Program Storage problem), press the "ENTER" switch again.

5. Code d001 through d012 will be displayed, indicating the failed device number.

6. Remove PCB C-4 from the card cage and place it on a non-conductive work surface with the components up.

7. With a DVM, measure the voltage across the three batteries B1, B2 and B3. If the voltage across any of the batteries is less than +2.4 VDC, replace the battery and re-test the card.

8. If the voltages are +2.4 VDC or greater, measure the voltage across the indicated device from Pin 9 gnd to VCC Pin 18. The voltage should be +2 VDC or higher.

9. If the voltage on Pin 18 of the indicated device is less than +2 VDC, replace the series diode, as follows--

   a. Low voltage on U1 thru U4, replace CR1.
   b. Low voltage on U5 thru U8, replace CR2.
   c. Low voltage on U9 thru U12, replace CR3.

10. If the voltages on U1 thru U12 Pin 18 are +2 VDC or higher, replace the indicated device, as follows--

    d001 - replace IC - U1 and re-test
    d002 - replace IC - U2 and re-test
    d003 - replace IC - U3 and re-test
    d004 - replace IC - U4 and re-test
    d005 - replace IC - U5 and re-test
    d006 - replace IC - U6 and re-test
    d007 - replace IC - U7 and re-test
    d008 - replace IC - U8 and re-test
    d009 - replace IC - U9 and re-test
    d0010 - replace IC - U10 and re-test
    d0011 - replace IC - U11 and re-test
    d0012 - replace IC - U12 and re-test

I. F305 - "The Problem is on Card C-5"

This code may occur after the "ENTER" switch is pressed following either Fault Code F310 or F311. This code indicates that the malfunction is on the bus interface card in the card cage location C-5.

Fault analysis steps:

1. When F305 occurs after F310 (EPROM problem), press the "ENTER" switch again.

2. Code d001 will be displayed, indicating the failure has occurred in device U1.

3. Turn main power off, remove card C5 and replace IC U1 and re-test.

4. When F305 occurs after F110 (RAM problem), press the "ENTER" switch again.

5. Code d002 will be displayed, indicating that the failed device is IC U2.

6. Turn power off, remove card C5 and replace IC U2 and re-test.

4-4 MOTOR FAILURE CODES

The Motor Failure Codes begin with F4. When the "READ" or "PROGRAM" switches are pressed, these codes will indiate when one of the motors have not completed moving in the last sequence.

A. F412 - "The 'Y' or 'Z' Motor Has Not Finished Stepping"

This code will occur anytime a "READY" code is not seen by the Housekeeper CPU (C1) from the "Y-Z" Motor PCU (C3) when "READ" or "PROGRAM" switches were pushed.

1. Check "Y" motor connector, "Y" limit sensor, and "Y" flag.
2. Test the "Y" motor balance and alignment, per Paragraph 2-46 or 2-47.
3. Check "Y" leadscrew, slide, motor, etc, per Paragraph 2-35.
4. Replace "Y" motor driver C7.
5. Replace "Y" motor.
6. Replace "X-Y" cable assembly.
7. Replace motor CPU C3.

B. F413 - "The 'X' or 'Theta' Motor Has Not Finished Stepping"

This code will be seen anytime a "READY" code is not seen by the Housekeeper CPU (C1) from the "X-Theta" motor CPU (C2) when the "READ" or "PROGRAM" switch is pressed.

Fault analysis steps:

1. Check "X" and "Theta" motor connectors, limit sensors and flags.
2. Test and adjust "X" and "Theta" motor balance and alignment, per Paragraph 2-46 or 2-47.
3. Test the "X" stage, per Paragraph 2-13.
4. Test the "Theta" assembly, per Paragraph 2-26.
5. Replace "X" motor driver C6.

6. Replace "Theta" motor driver C8.

7. Replace "X" motor CPU C2.

8. Replace "X" motor.

9. Replace "Theta" motor.

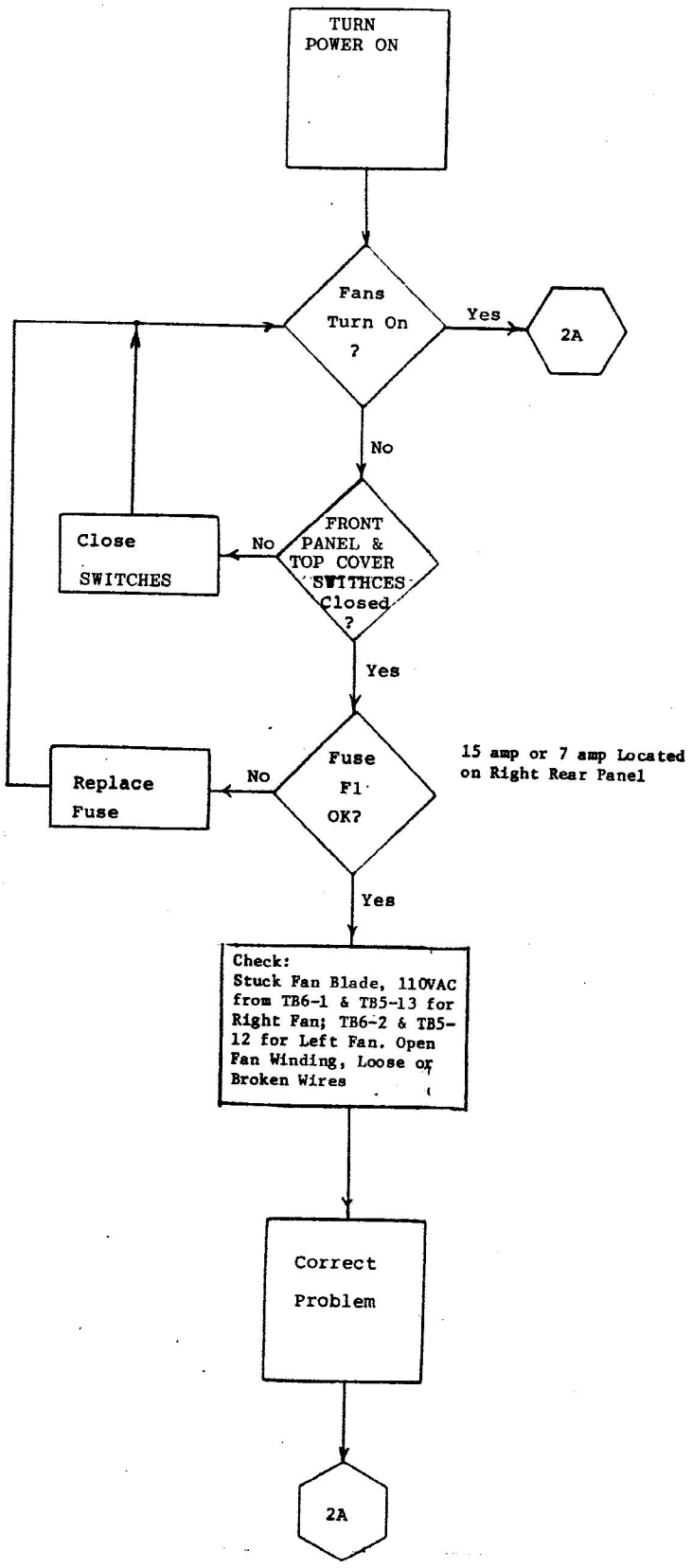
10. Replace "X-Y" cable.

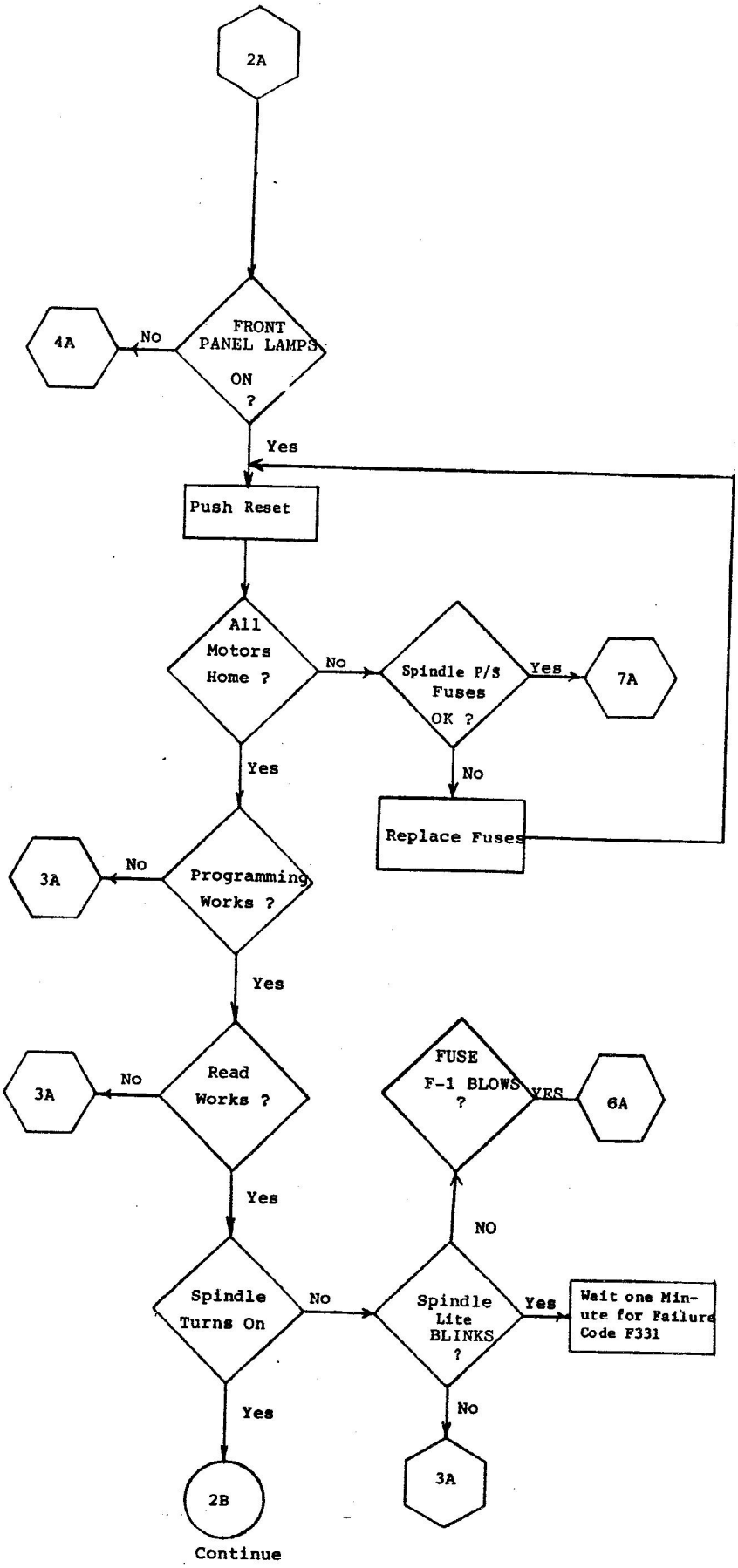
11. Replace "Theta-Z" cable.

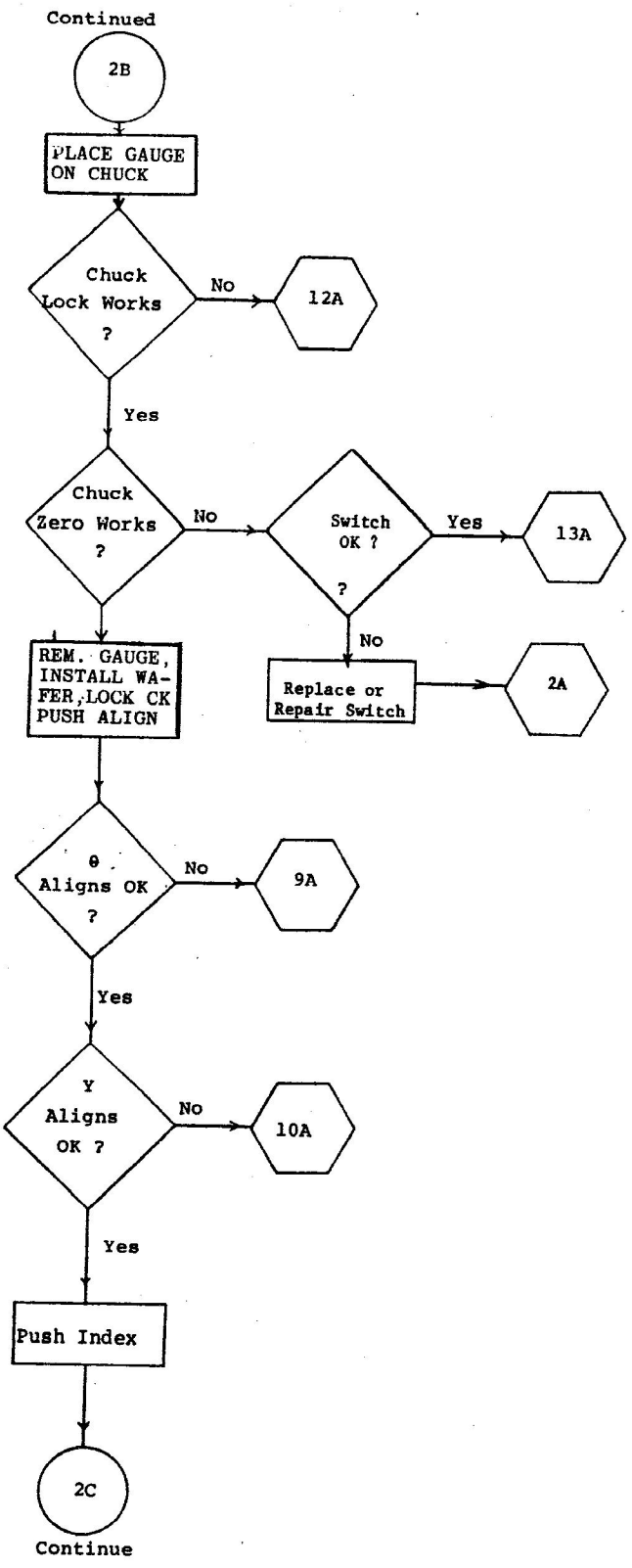
4-5 DIAGNOSTIC FLOW CHART ANALYSIS

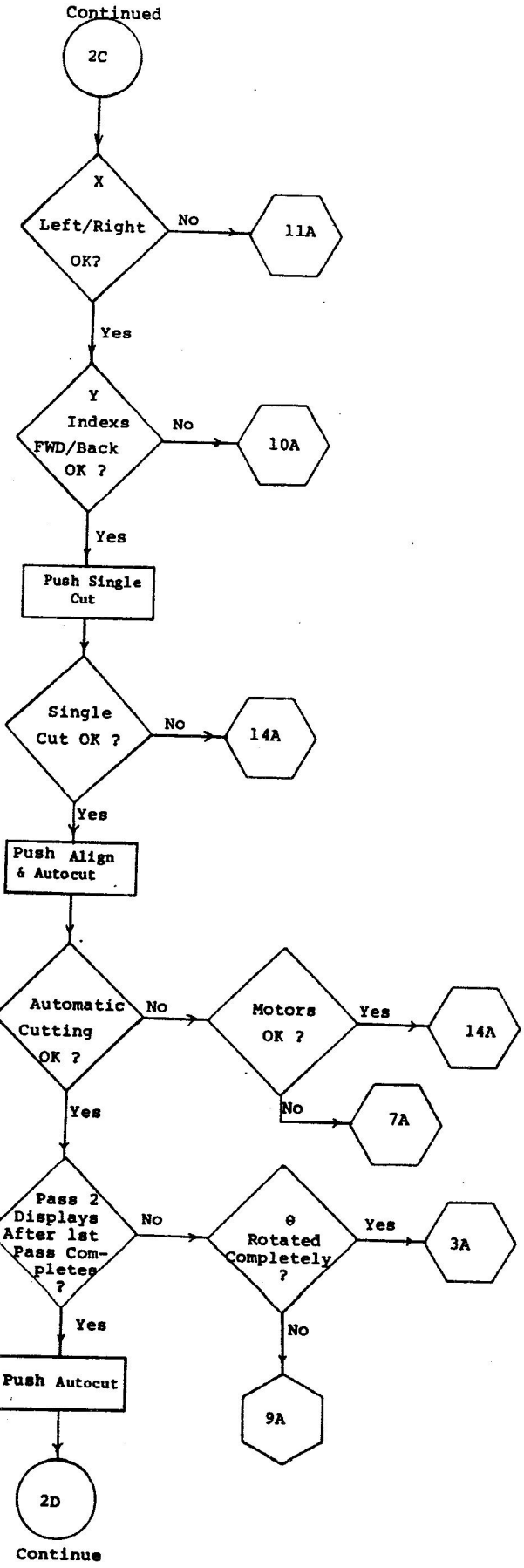
The following flow charts are provided to aid in fault analysis in those cases where a fault code is not displayed. Start on Chart 1A at the top of the page and follow the chart arrows until the fault is located, or until the line of investigation comes to an end. These charts can be used to test the saw by starting at Chart 1A and performing all the operations to 2D, where you are directed to return the machine to service.

The rectangular blocks direct an action; the diamond-shaped blocks indicate inquiry steps; and the hexagon blocks refer you to another chart.

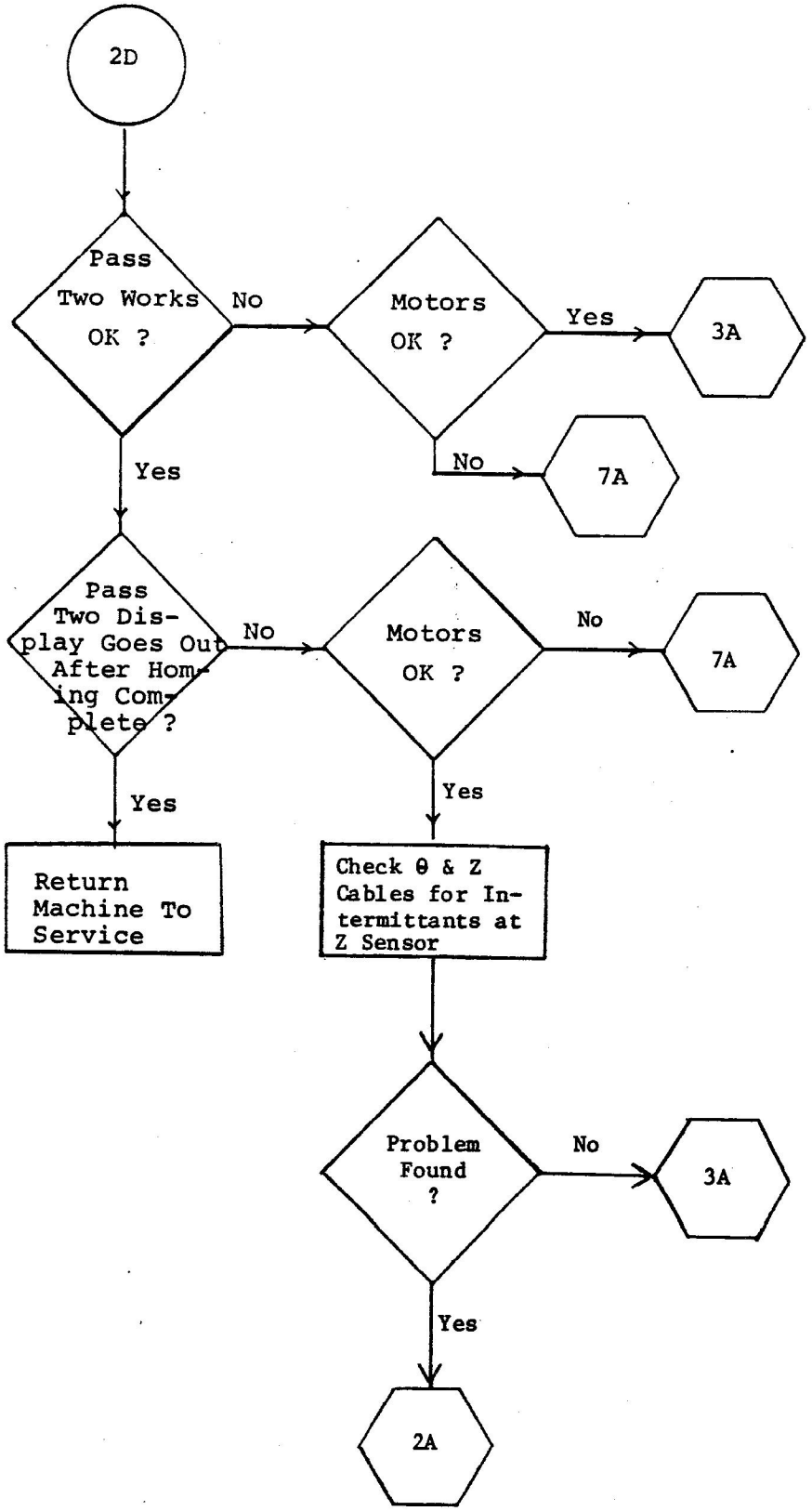

TURN POWER ON
Fans Turn On ?
Yes
2A
No
FRONT PANEL & TOP COVER SWITCHES Closed ?
No
Close SWITCHES
Yes
Fuse F1 OK?
No
Replace Fuse
15 amp or 7 amp Located on Right Rear Panel
Yes
Check: Stuck Fan Blade, 110VAC from TB6-1 & TB5-13 for Right Fan; TB6-2 & TB5-12 for Left Fan. Open Fan Winding, Loose or Broken Wires
Correct Problem
2A

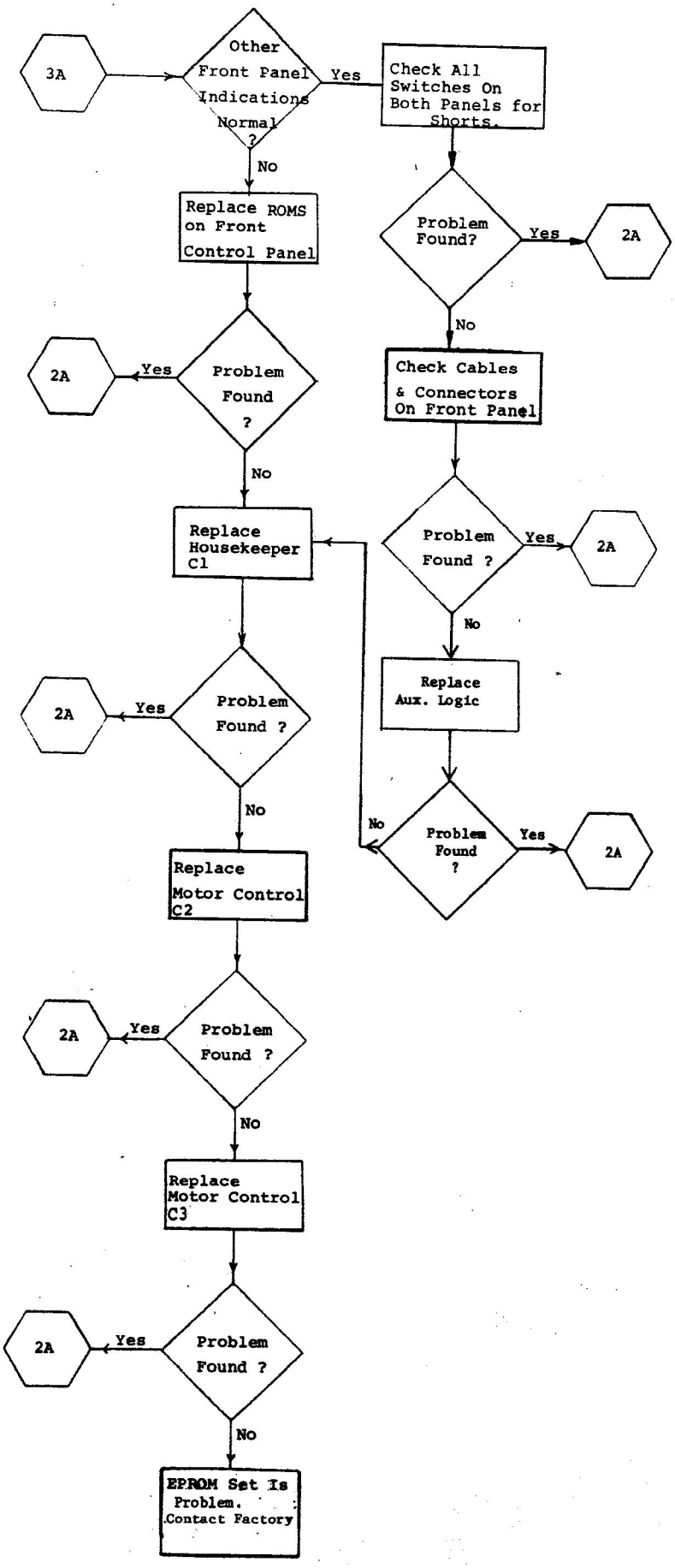

2A
FRONT PANEL LAMPS ON ?
No
4A
Yes
Push Reset
All Motors Home ?
No
Spindle P/S Fuses OK ?
Yes
7A
No
Replace Fuses
Yes
Programming Works ?
No
3A
Yes
Read Works ?
No
3A
Yes
FUSE F-1 BLOWS ?
YES
6A
NO
Spindle Turns On
No
Spindle Lite BLINKS ?
Yes
Wait one Minute for Failure Code F331
No
3A
Yes
2B
Continue

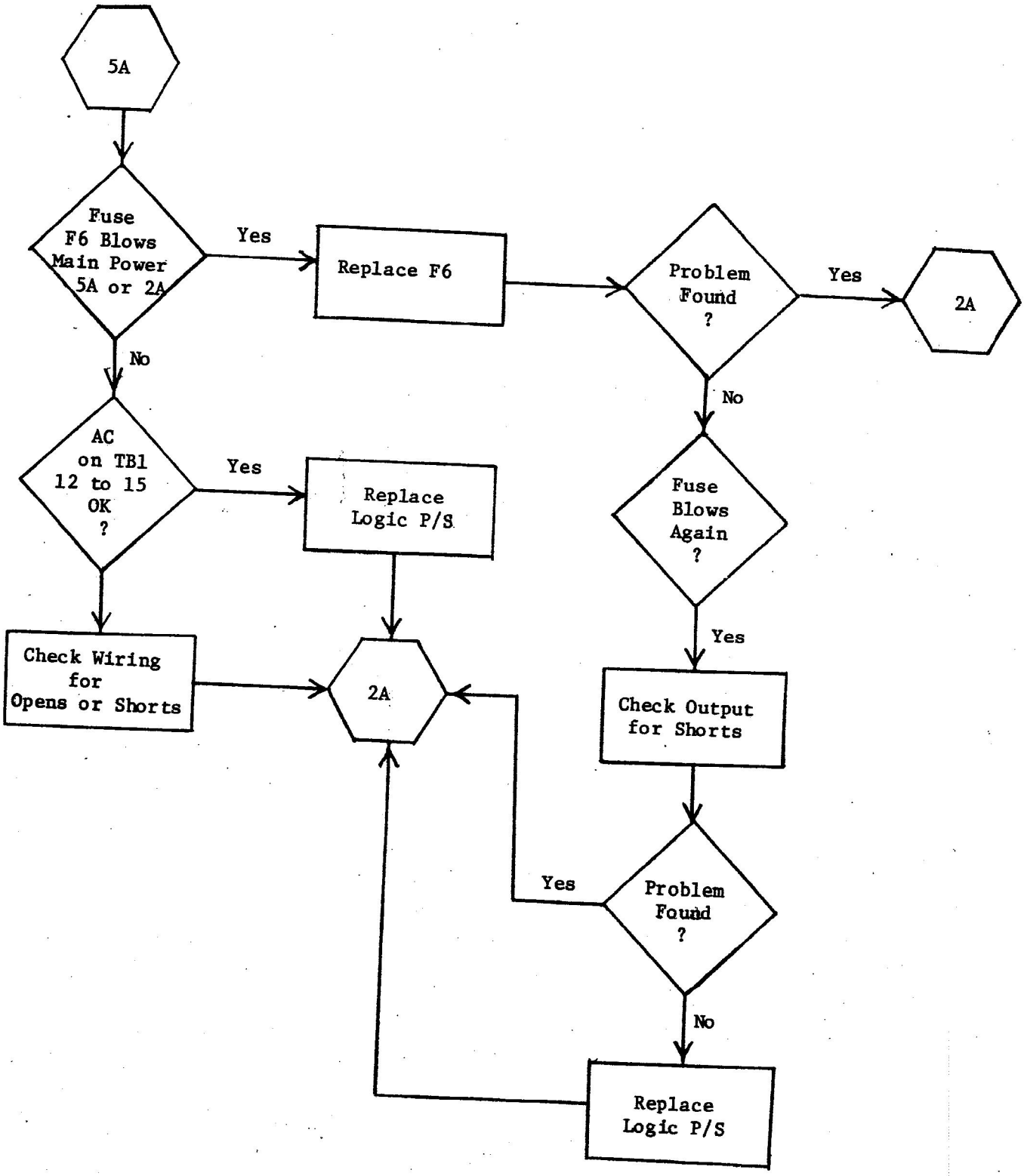

Continued
2B
PLACE GAUGE ON CHUCK
Chuck Lock Works ?
No
12A
Yes
Chuck Zero Works ?
No
Switch OK ? ?
Yes
13A
No
Replace or Repair Switch
2A
REM. GAUGE, INSTALL WAFER, LOCK CK PUSH ALIGN
θ Aligns OK ?
No
9A
Yes
Y Aligns OK ?
No
10A
Yes
Push Index
2C
Continue


Continued
2C
X
Left/Right
OK?
No
11A
Yes
Y
Indexs
FWD/Back
OK ?
No
10A
Yes
Push Single
Cut
Single
Cut OK ?
No
14A
Yes
Push Align
& Autocut
Automatic
Cutting
OK ?
No
Motors
OK ?
Yes
14A
No
7A
Yes
Pass 2
Displays
After 1st
Pass Com-
pletes
?
No
θ
Rotated
Completely
?
Yes
3A
No
9A
Yes
Push Autocut
2D
Continue

Continued

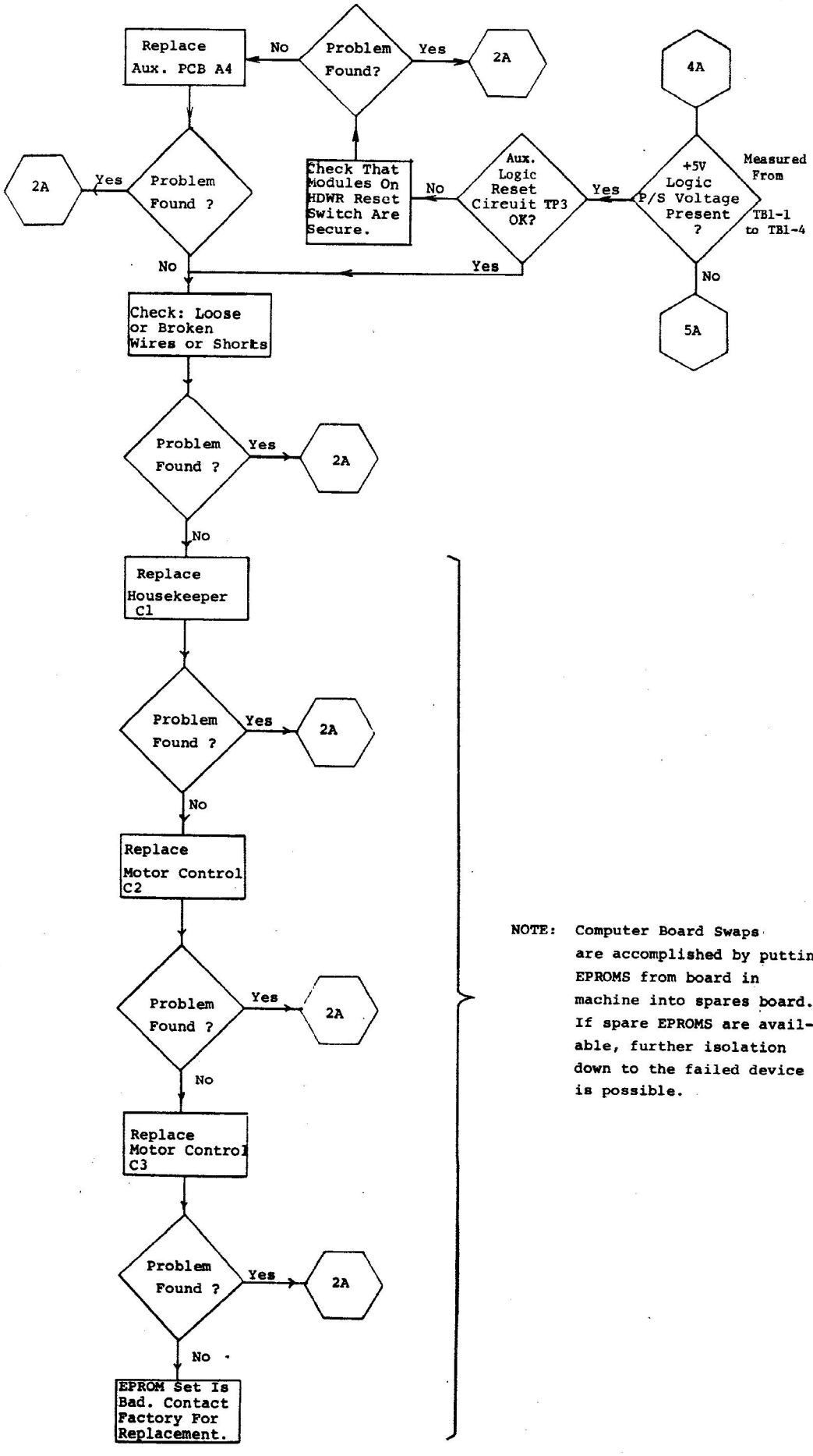

2D
Pass Two Works OK ?
No
Motors OK ?
Yes
3A
No
7A
Yes
Pass Two Display Goes Out After Homing Complete ?
No
Motors OK ?
No
7A
Yes
Yes
Return Machine To Service
Check θ & Z Cables for Intermittants at Z Sensor
Problem Found ?
No
3A
Yes
2A


3A
Other Front Panel Indications Normal ?
Yes
Check All Switches On Both Panels for Shorts.
No
Replace ROMS on Front Control Panel
Problem Found?
Yes
2A
No
Check Cables & Connectors On Front Panel
2A
Yes
Problem Found ?
No
Problem Found ?
Yes
2A
Replace Housekeeper C1
No
Replace Aux. Logic
2A
Yes
Problem Found ?
No
Problem Found ?
Yes
2A
No
Replace Motor Control C2
2A
Yes
Problem Found ?
No
Replace Motor Control C3
2A
Yes
Problem Found ?
No
EPROM Set Is Problem. Contact Factory

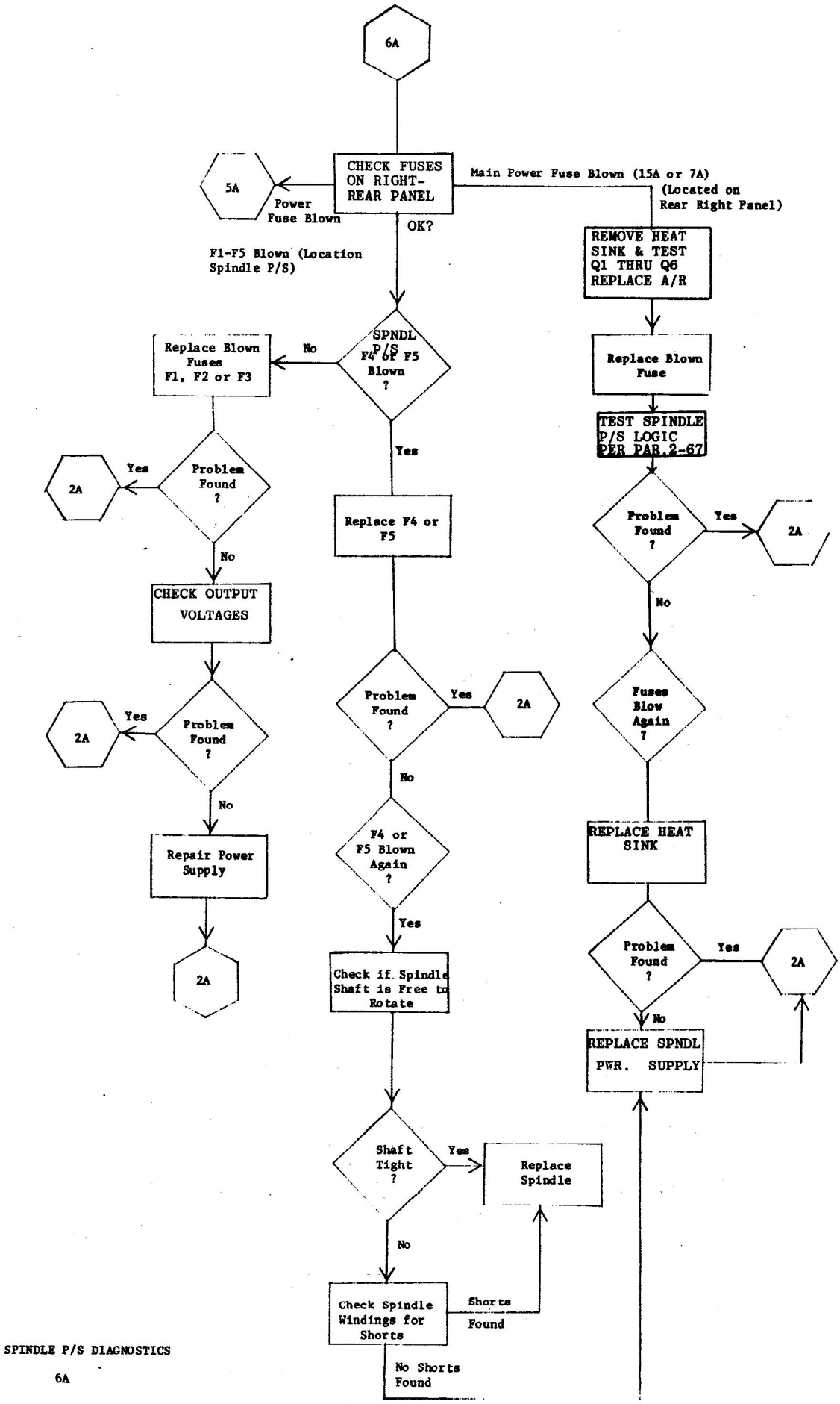


+5V LOGIC SUPPLY DIAGNOSTICS

5A

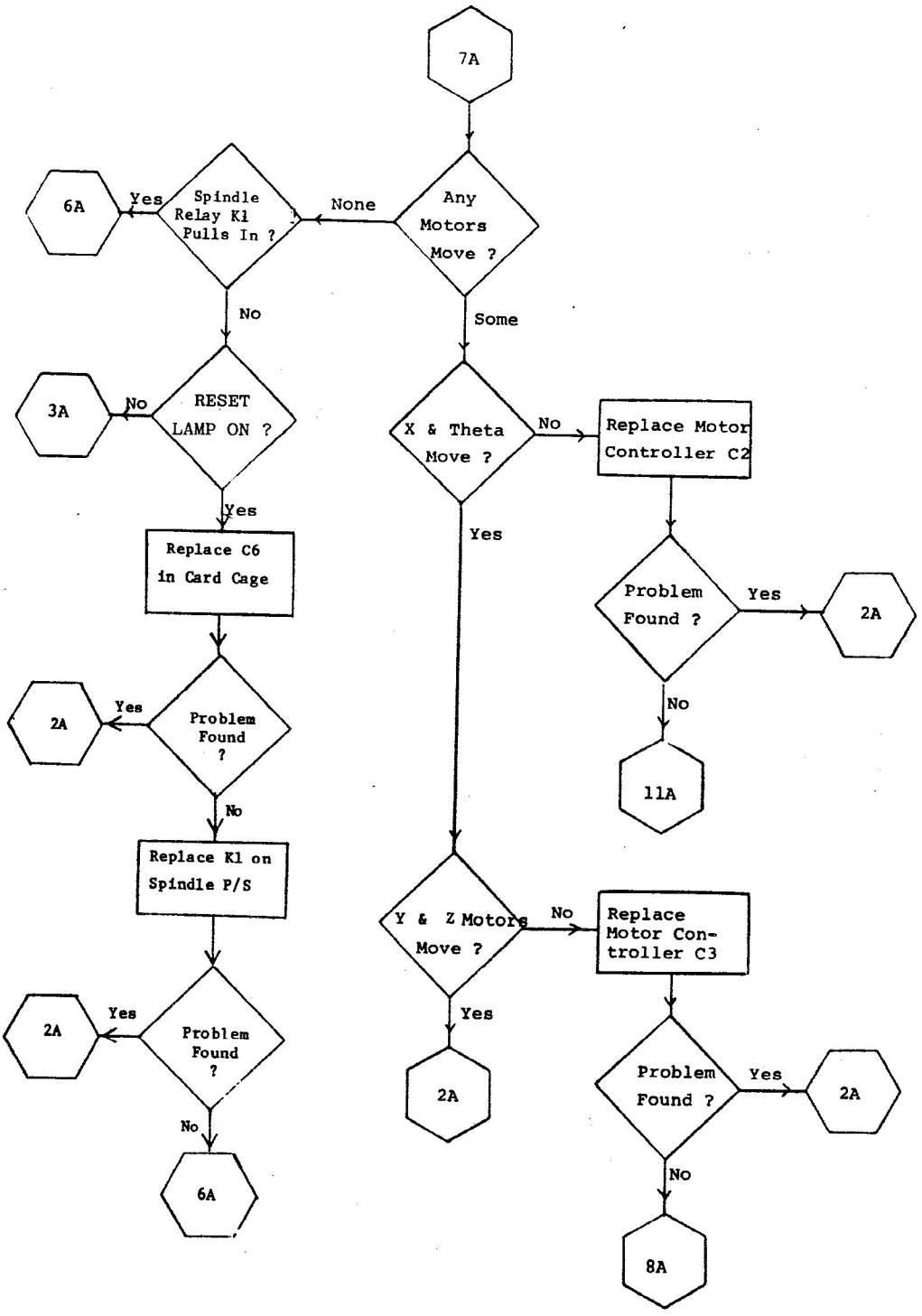


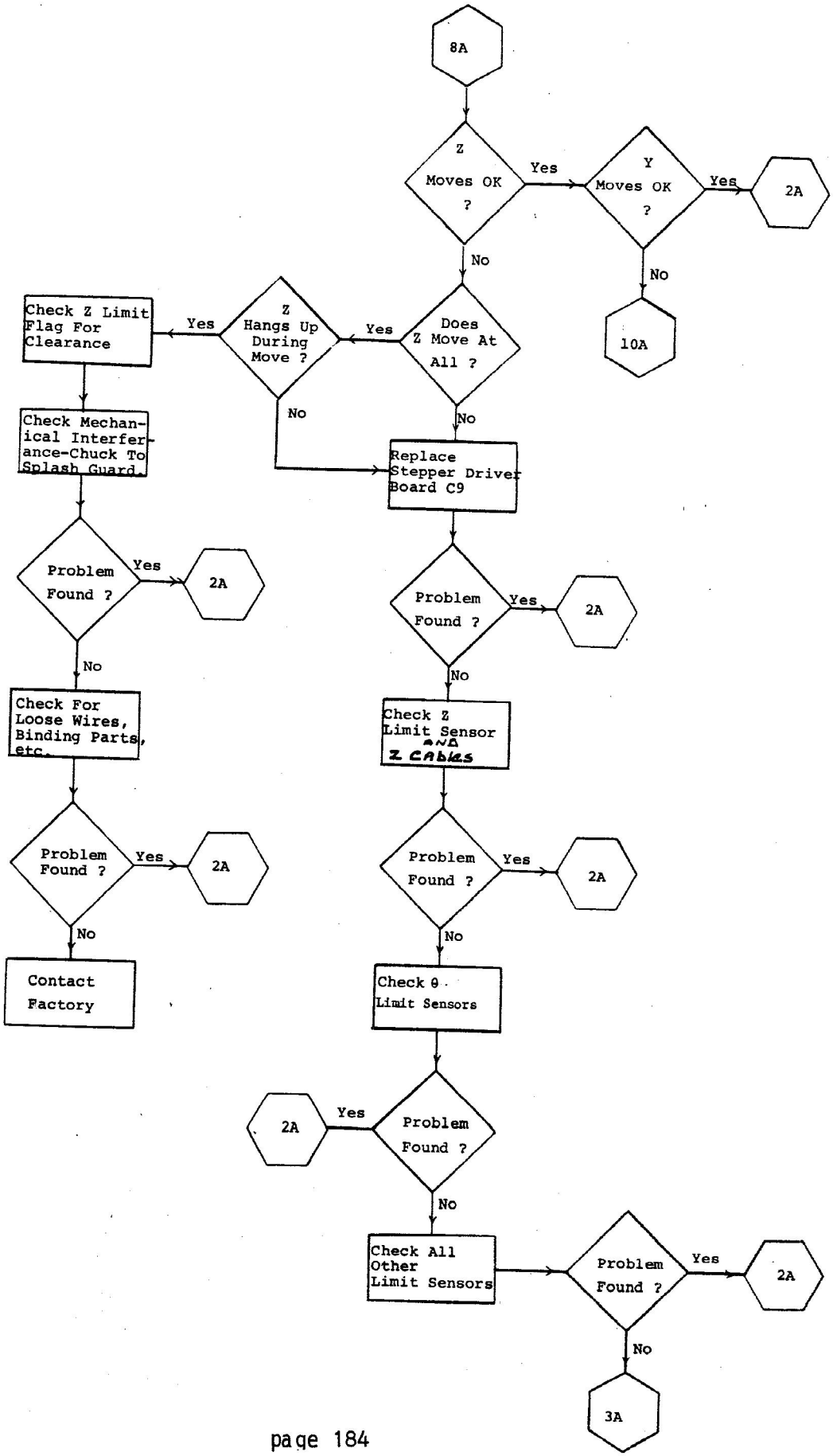
NOTE: Computer Board Swaps are accomplished by putting EPROMS from board in machine into spares board. If spare EPROMS are available, further isolation down to the failed device is possible.

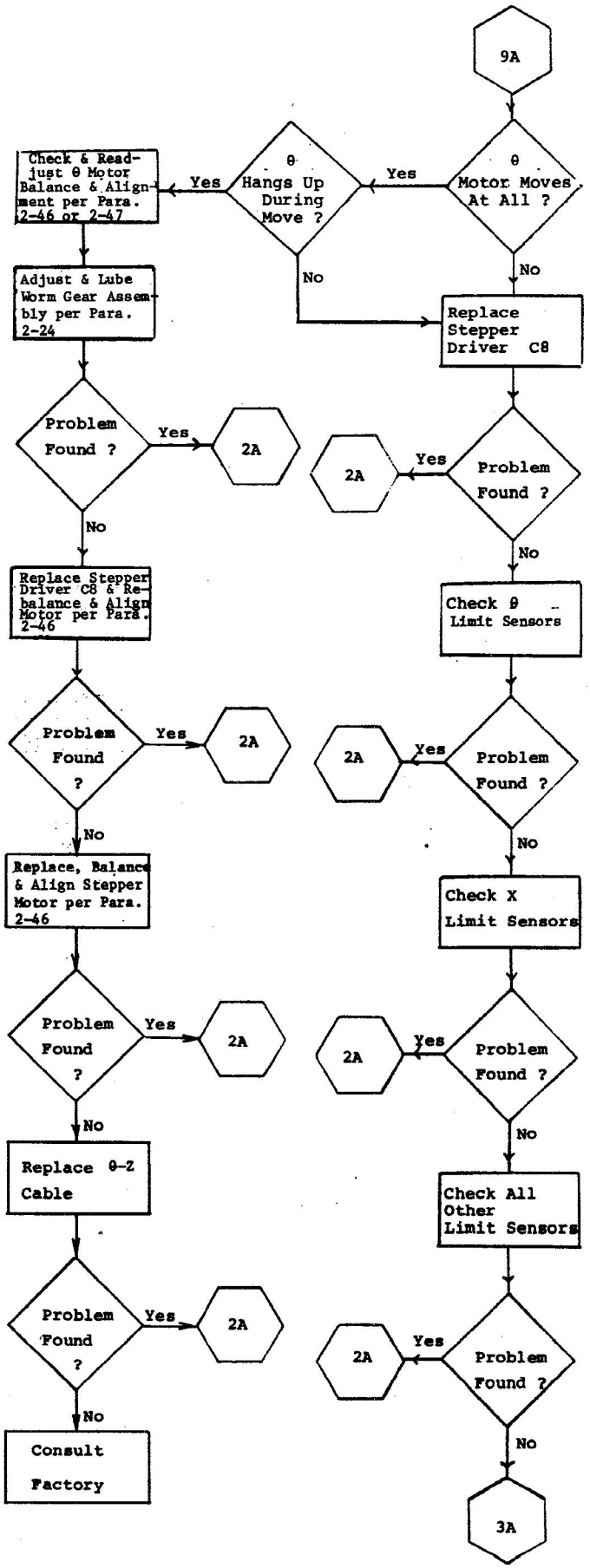


SPINDLE P/S DIAGNOSTICS

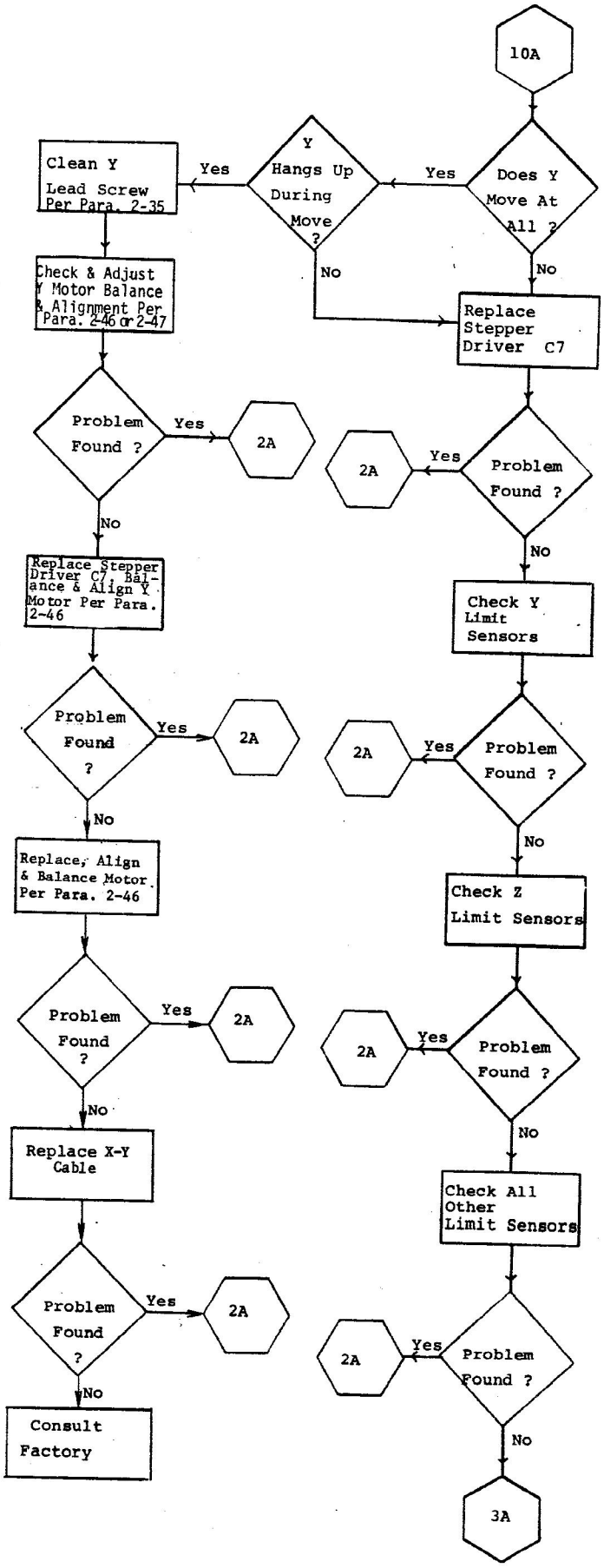
6A


7A
Any Motors Move ?
None
Some
Spindle Relay K1 Pulls In ?
Yes
6A
No
RESET LAMP ON ?
No
3A
Yes
Replace C6 in Card Cage
Problem Found ?
Yes
2A
No
Replace K1 on Spindle P/S
Problem Found ?
Yes
2A
No
6A
X & Theta Move ?
No
Replace Motor Controller C2
Problem Found ?
Yes
2A
No
11A
Yes
Y & Z Motors Move ?
No
Replace Motor Controller C3
Yes
2A
Problem Found ?
Yes
2A
No
8A


8A
Z Moves OK ?
Yes
Y Moves OK ?
Yes
2A
No
No
10A
Does Z Move At All ?
Yes
Z Hangs Up During Move ?
Yes
Check Z Limit Flag For Clearance
No
No
Check Mechanical Interferance-Chuck To Splash Guard.
Replace Stepper Driver Board C9
Problem Found ?
Yes
2A
Problem Found ?
Yes
2A
No
No
Check For Loose Wires, Binding Parts, etc.
Check Z Limit Sensor AND Z Cables
Problem Found ?
Yes
2A
Problem Found ?
Yes
2A
No
No
Contact Factory
Check θ Limit Sensors
2A
Yes
Problem Found ?
No
Check All Other Limit Sensors
Problem Found ?
Yes
2A
No
3A

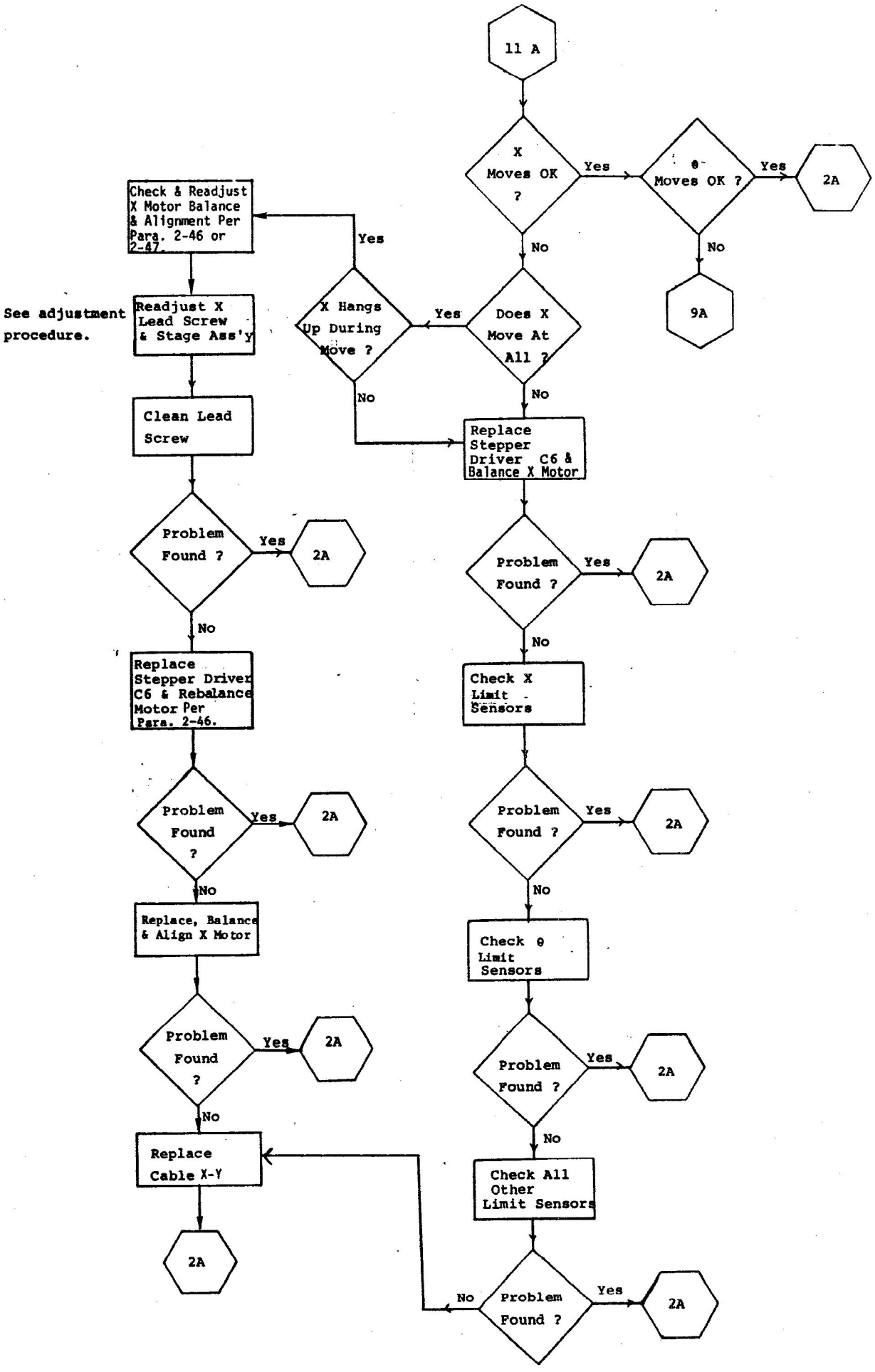


θ MOTOR DIAGNOSTICS



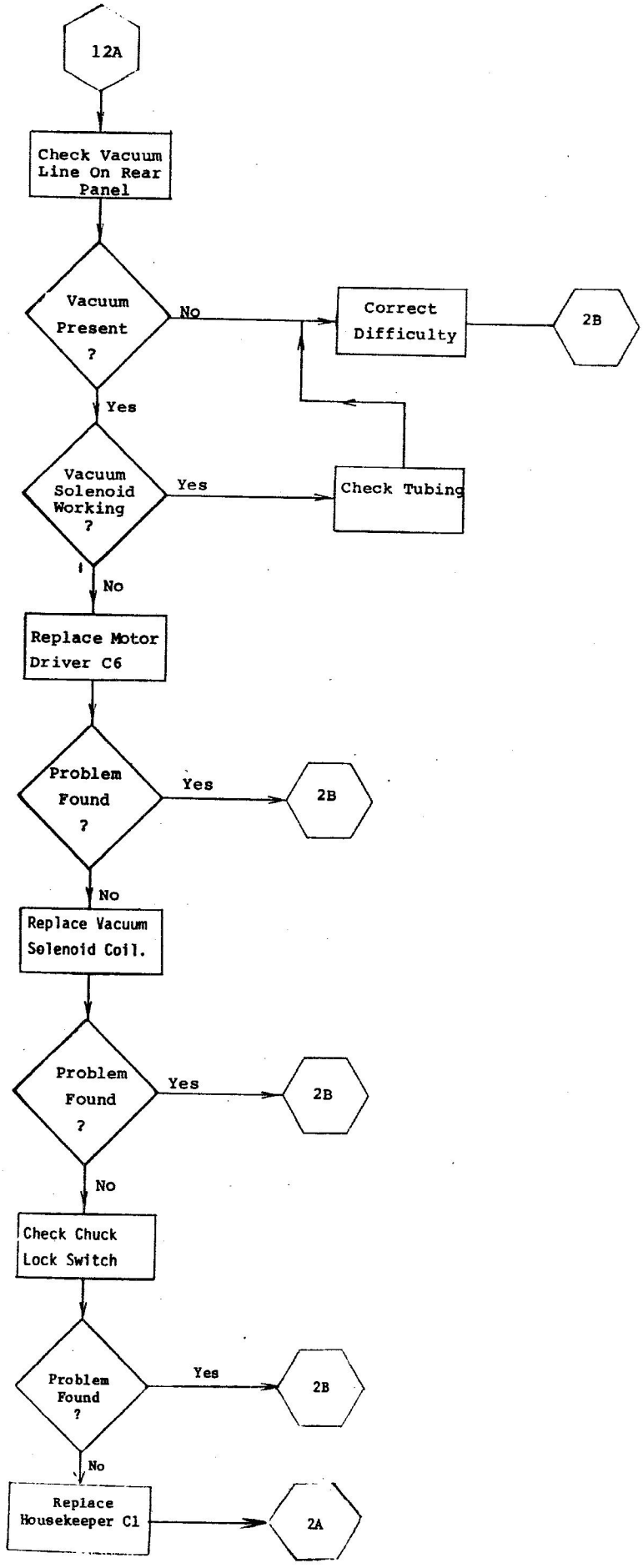
Y MOTOR DIAGNOSTICS

10A

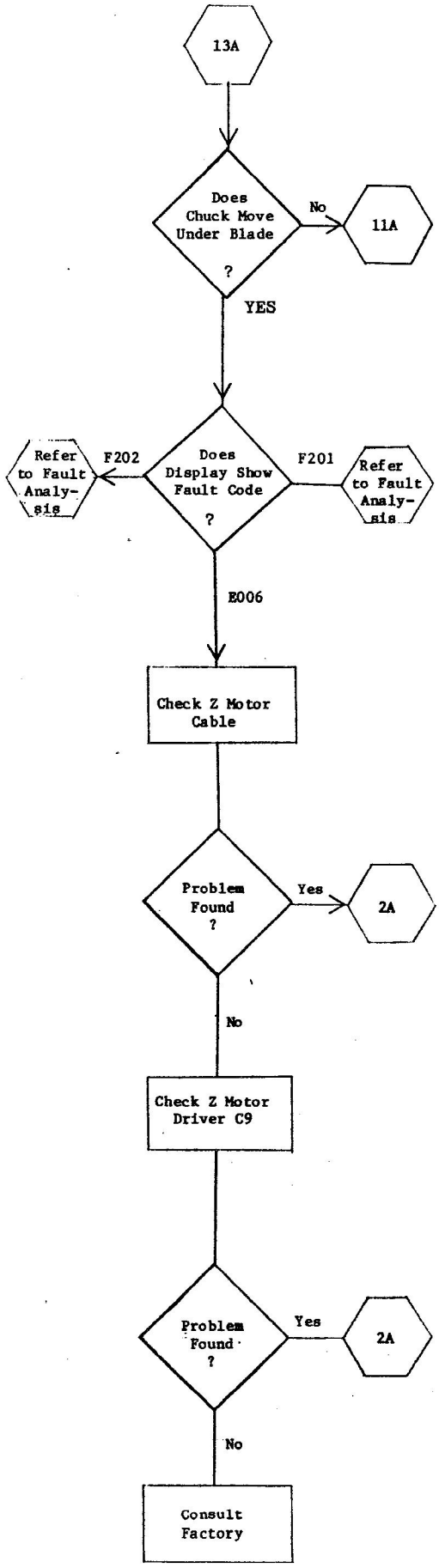


X MOTOR DIAGNOSTICS

11A

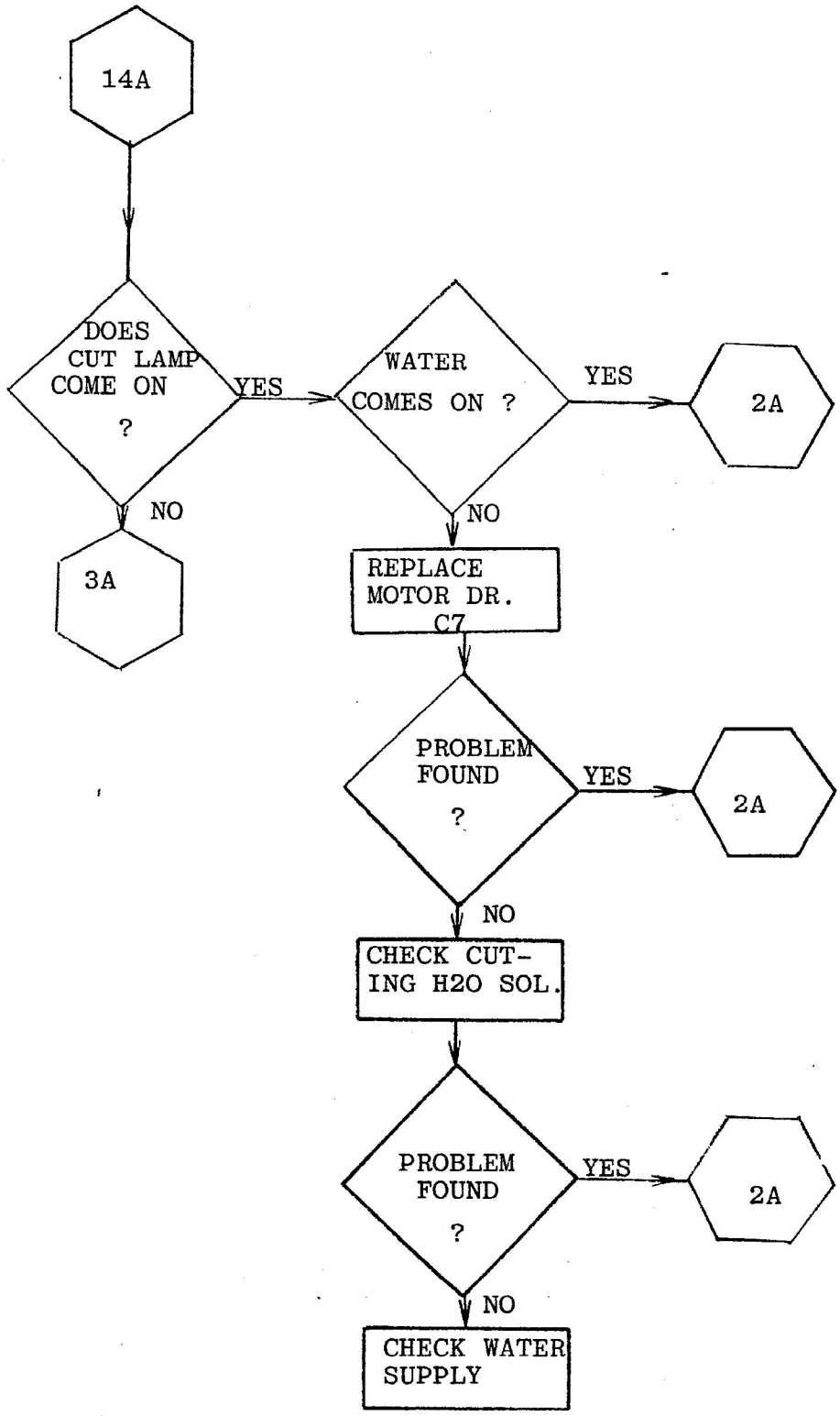


VACUUM SYSTEM DIAGNOSTICS



CHUCK ZERO DIAGNOSTICS

13A



CUTTING DIANOSTICS