MODEL 1006 DICING SAW
OPERATIONS MANUAL

MICRO AUTOMATION
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SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION

This manual provides the information you will need to program and operate the Micro Automation, Inc. (MAI) Model 1006 and 1006A Wafer Dicing Saws. This section of the manual describes the equipment and operation in a general way. Section II tells you how to select a cutting wheel (blade) for different cutting jobs. Section III describes mounting the blade on the saw. Section IV outlines programming rules and limits, then gives specific instructions for programming and operating the saw for production cutting and blade dressing.

1-2. EQUIPMENT DESCRIPTION, GENERAL

The Micro Automation, Inc. Model 1006 and 1006A are precision machines for cutting semiconductor wafers into individual integrated circuits, or dies.

NOTE

The Model 1006 and 1006A are identical except for the optical alignment system. These differences will be explained later in this manual.

Figure 1-1 is a picture of a Model 1006A Wafer Dicing Saw with the parts significant to the operator identified. Following is a descripiton of each part.

1-3. Split-image TV Camera and TV Monitor

These are used to align the wafer with the saw blade before cutting. You will be told how to operate the camera and monitor in Section IV. The Model 1006 uses a monocular alignment system. It, too, will be explained in Section IV.

1-4. Spindle and Cutting Wheel

The spindle is a high speed motor with air bearings which allow the motor to turn with almost no friction. The cutting wheel (blade) mounts on the spindle.

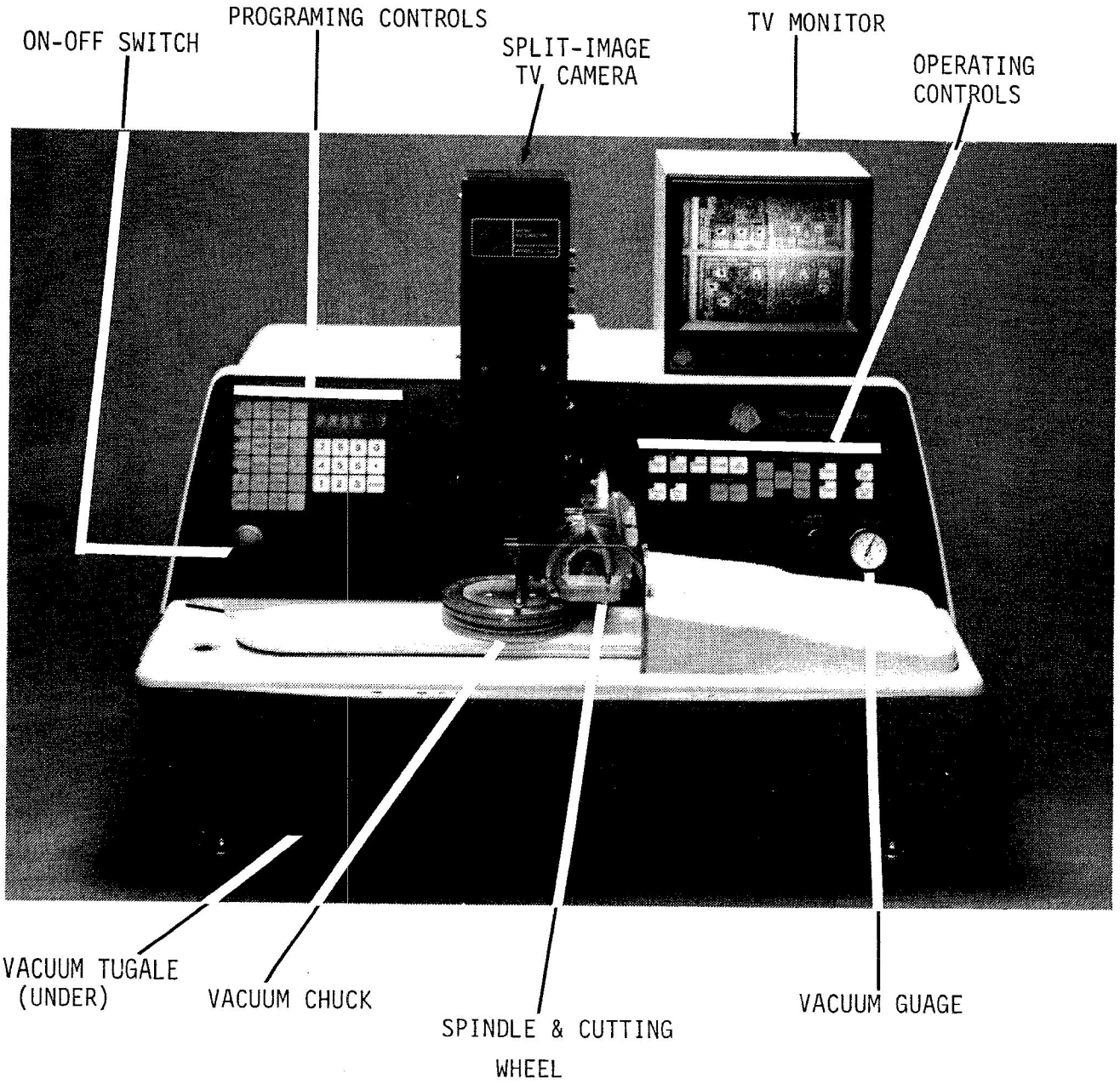


Figure 1-1. Model 1006A Dicing Saw

1-5. Vacuum Chuck

The vacuum chuck holds the wafer securely by vacuum while cutting. The chuck moves right and left to move the wafer under the saw blade. The chuck can also rotate and move up and down under operator or program control. The vacuum chuck has concentric grooves cut into its face (Figure 1-2). When small wafers are being cut, vacuum is shut off to the outer rings so that excess water is not sucked into the vacuum system. Vacuum is shut off by inserting screws into the holes near the rings. In Figure 1-2, the two outer rings are shut off, and vacuum is applied to the inner three rings. There are five tapped holes in the edge of the chuck for storing screws not in use.

1-6. ON-OFF Switch

This is a red pushbutton switch used to turn the main power on and off. To turn the saw on, turn the button to the right (clockwise). To turn it off, push the button in.

CAUTION

Do not turn off main power
when the spindle is running.

1-7. Operating Controls

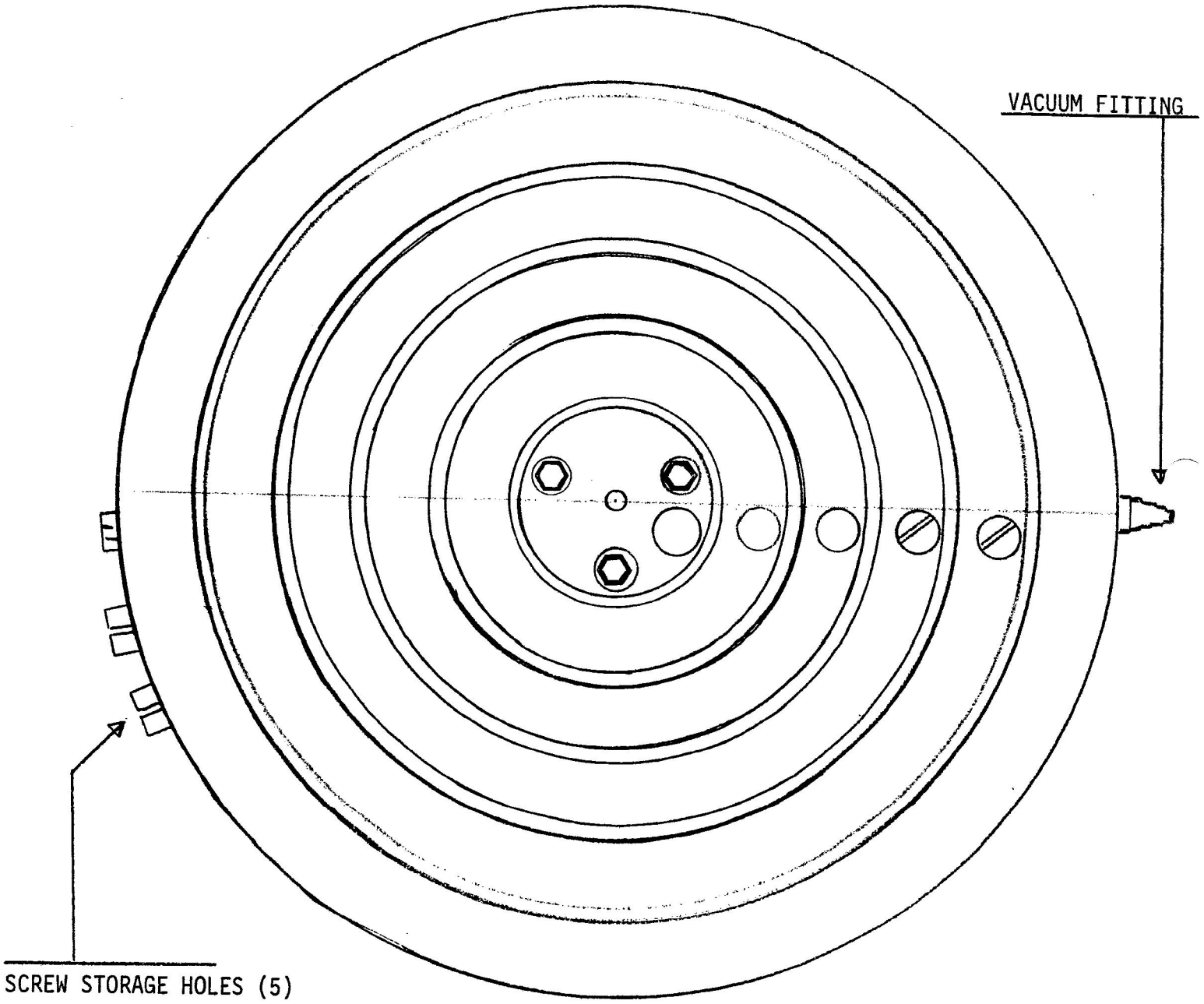
The operating controls are grouped to the right of the spindle. They are used to operate the saw manually. The switches are pressure sensitive and are operated by pressing on the area with your finger.

CAUTION

You can damage these switches
if you push them with metal tools,
tweezers, pencils, etc. Use only
the tip of your finger.

1-8. Programming Controls

These controls are grouped to the left of the spindle. They are used to enter values for programmed (automatic) operation. They are pressure sensitive switches like the operating switches. Use of these controls and the operating



VACUUM CHUCK

FIGURE 1 - 2

controls will be explained in Section IV.

1-9. Model 1006

The Model 1006 is identical to the Model 1006A except for the optical alignment system. The Model 1006 uses a monocular microscope instead of a TV camera.

1-10. Axis Definitions

There are four motor-driven assemblies in the saw that control relative motion between the chuck (and the wafer on it) and the saw blade. These are called the X, Y, Z, and Theta axes. You can control all four axes from the control panel, or you can program the motion of these axes for automatic operation. The relationship between the axes is shown in Figure 1-3 and explained below.

a. X-axis. This assembly moves the chuck in the left-right directions. Speed and amount of travel is controlled by the operator.

b. Y-axis. This assembly moves the spindle and blade in the front-back directions, and controls the distance between each cut.

c. Z-axis. This assembly moves the chuck up and down, and determines how deep the saw blade will cut into the wafer.

d. Theta-axis. This assembly rotates the chuck. After cuts are made in one direction, the theta axis is turned and cuts are made in the other direction.

1-11. GENERAL OPERATION

The saw is simple to operate. The basic steps for any sawing operation are as follows:

a. Program the saw. This simply means telling the saw, in advance, how you want it to cut.

b. Put a wafer on the chuck.

c. Turn on vacuum to hold the wafer on the chuck.

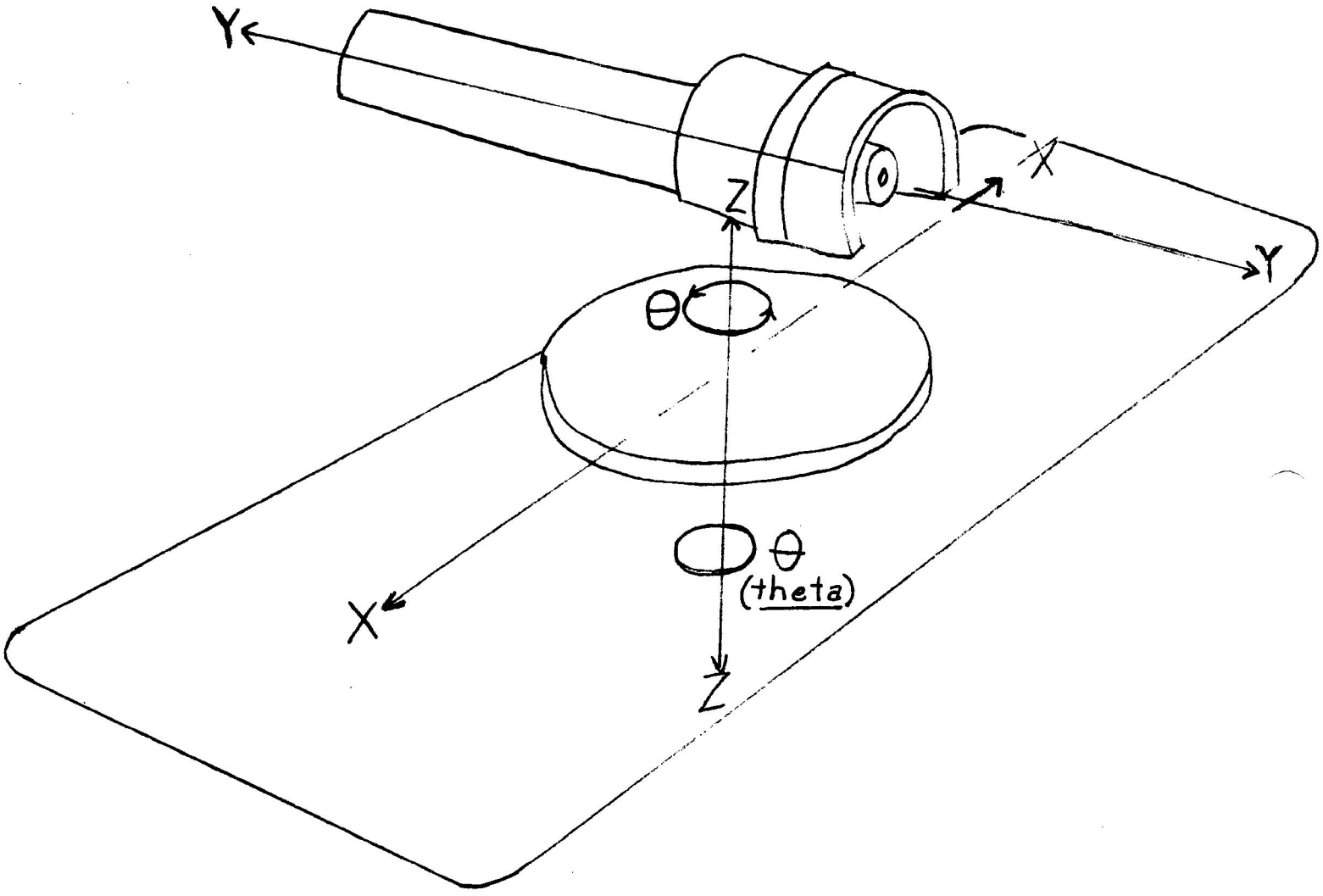


Figure 1-3. Axis Definition

d. Move the chuck so that the wafer is under the TV camera (Model 1006A) or the microscope (Model 1006).

e. Align the wafer to the saw blade so that the saw will cut where you want it to.

f. Push AUTOCUT. The saw will automatically cut the wafer.

1-12. DICING AND SCRIBING

There are two basic methods of cutting wafers. The next two paragraphs describe them.

1-13. Dicing

Figure 1-4 shows the relative movement between the cutting wheel and the wafer while dicing. The sequence is as follows:

a. The wafer is raised to the programmed height.

b. The chuck moves from left to right, making the first cut.

c. The chuck is lowered, and moved back to the left.

d. At the same time, the Y axis is moved toward the rear of the saw. It moves a programmed distance so that it is in position to make a cut in the next street.

e. This action continues until all cuts are made in one direction.

f. The chuck rotates through a programmed angle and cuts are made in the other direction.

Note that when a circular wafer is cut, the chuck moves only as far as necessary to make the cuts at the top and bottom. This built-in feature saves about 25% of cutting time.

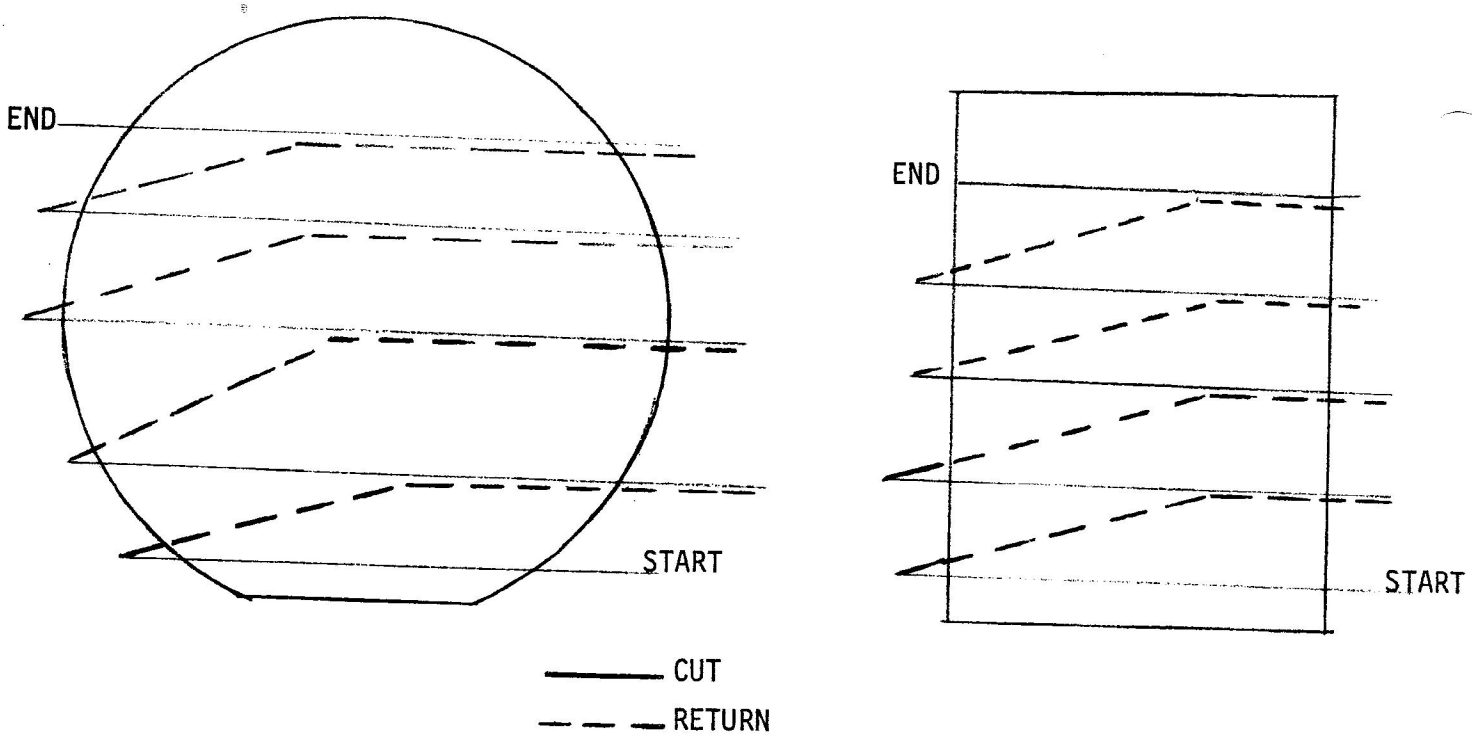


FIGURE 1 - 23 CUTTING PATH, DICING

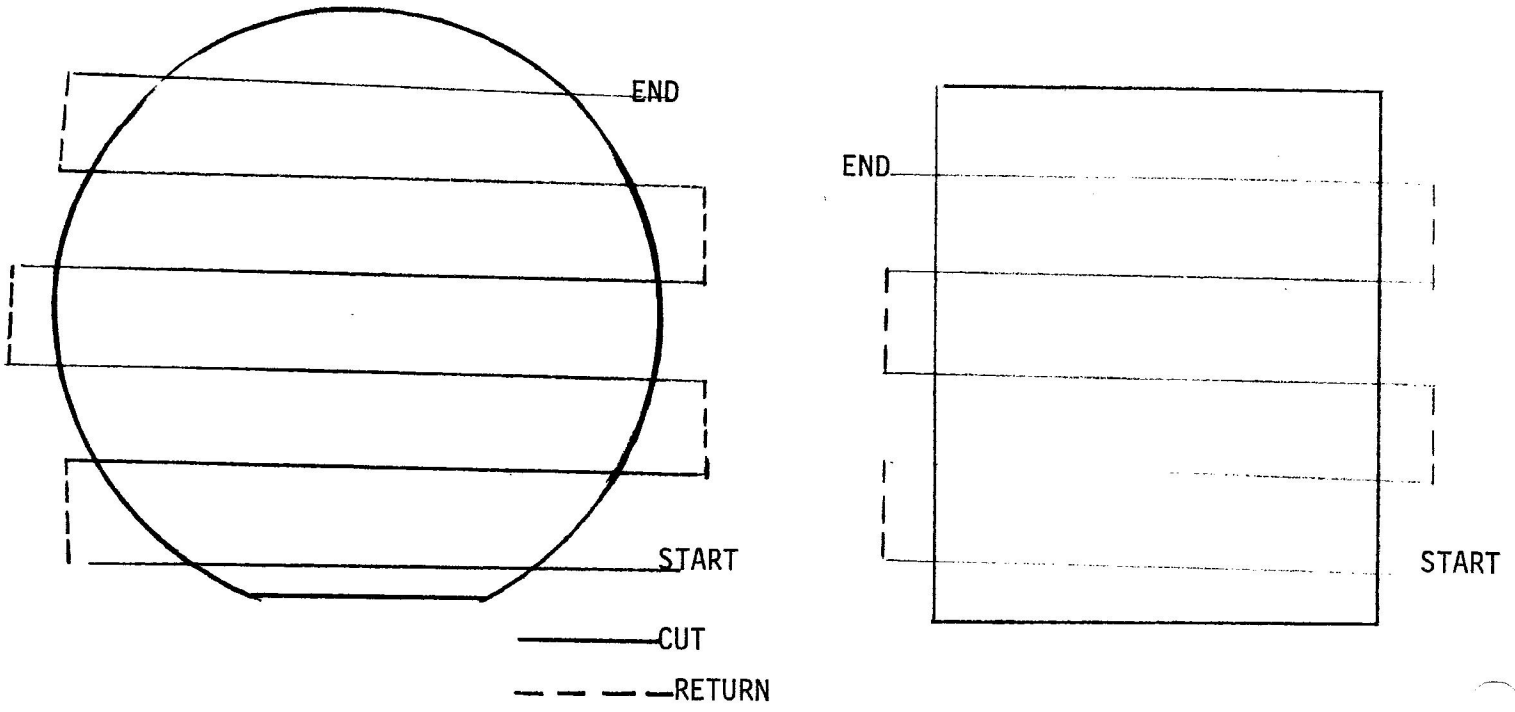


FIGURE 1 - 34 CUTTING PATH, SCRIBING

1-14. Scribing

Scribing is similar to dicing, except that the saw cuts in both directions. Figure 1-5 shows the chuck movement during scribing. Scribing is faster than dicing but other considerations, such as chipping and cooling must be taken into consideration. These factors are discussed in subsequent sections of this manual.

SECTION II

BLADE SELECTION

2-1. INTRODUCTION

This section provides information on how to select the right blade for a sawing operation. Unfortunately, there are no hard and fast rules for this; it requires experience and some trial and error. However, by using the guidelines in this section you will be able to select a blade which will give the best quality of cut together with long blade life and high production rates.

NOTE

Blades are also called 'wheels' and 'cutting wheels'. The terms are interchangeable.

2-2. DEFINITIONS

There are a few terms used in this section, and in wafer dicing generally, that you should know. These are listed below.

a. Aggregate (Grit) Size. The average size of the abrasive (usually diamond) chips in the cutting wheel. It is measured in microns. One micron = 10^{-6} meters. There are approximately 25 microns in a mil (0.001 inches).

b. Blade Thickness. Thickness of the blade part of a cutting wheel. Dimension A on Figure 2-1. Measured in mils.

c. Blade Width. Another term for blade thickness, above.

d. Chipping. Chipping occurs when small pieces of the material being cut break off the edge of the cut. There is always some chipping.

e. Cut Count. The total number of cuts a blade has made. The MAI Model 1006 and 1006A saws automatically keep track of the cut count.

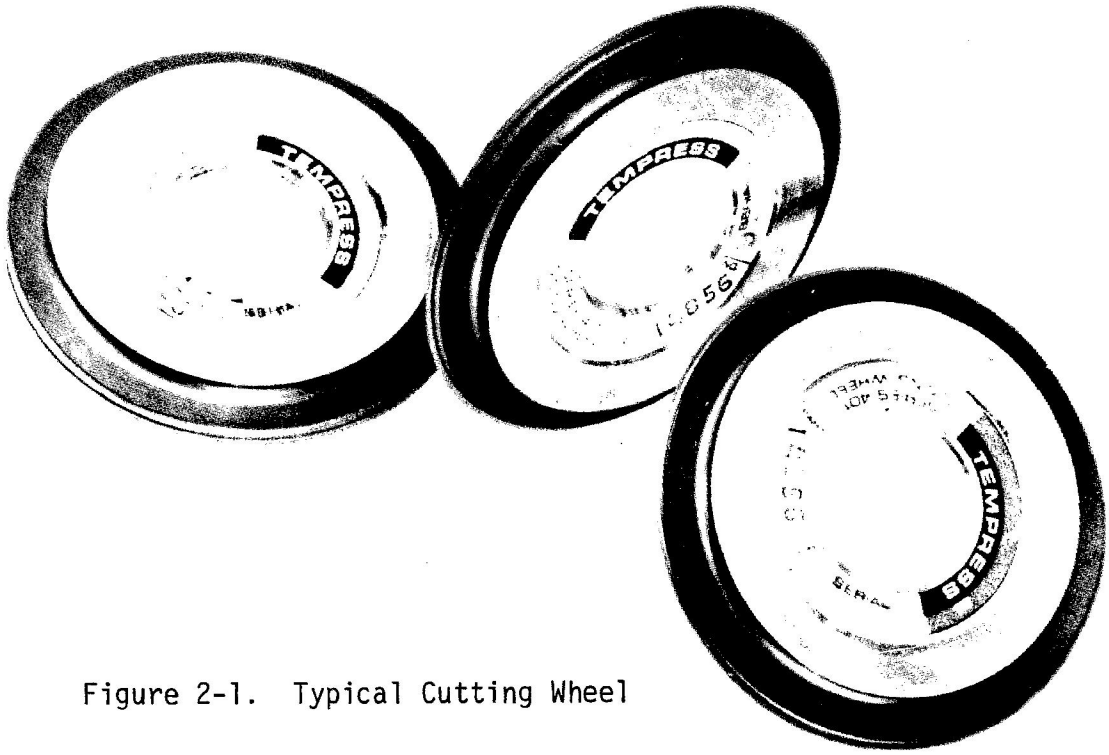


Figure 2-1. Typical Cutting Wheel

f. Dressing. A new blade must be 'dressed' to prepare it for production sawing. Dressing is done by making cuts at progressively higher rates until the blade is conditioned for the mterial to be cut. The MAI saws have a program for doing this automatically. It can also be done under full operator control.

g. Exposure. The distance that the blade protrudes from the hub. Also called 'blade length'. Dimension B on Figure 2-1. Measured in mils.

h. Kerf. The width of the saw cut. Kerf is always larger than the blade width.

i. Kerf Loss. The difference between the kerf and the blade width.

j. Loading. Loading occurs when material gathers in the spaces between the abrasive cutting edges in the blade. This reduces cutting action.

k. Lubricant. Solutions or chemicals other than water used to improve cutting.

l. Penetration. The depth that a blade cuts into the material. Measured in mils.

m. Slurry. Material suspended in the coolant. It consists of the material being cut plus small amounts of blade wear products.

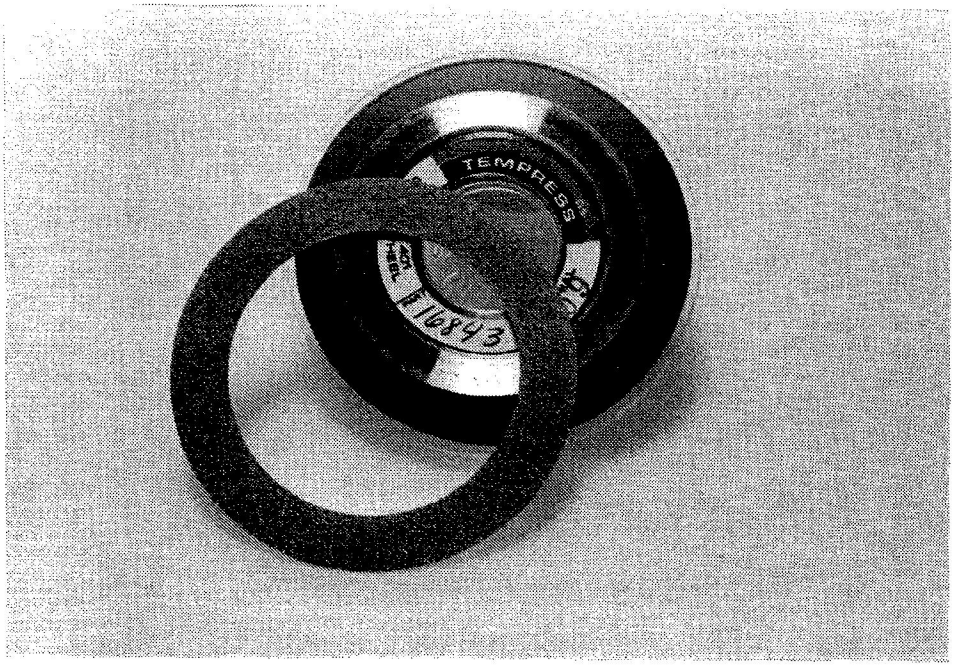


Figure 2-2. Blade Types. Mounted, and Unmounted

2-3. BLADE TYPES

The two basic types of blades are mounted blades and unmounted blades. The difference between them is shown in Figure 2-2. The following paragraphs describe these blades and give some of the characteristics of each type.

2-4. Mounted Blades

Mounted blades are made by directly plating a nickel alloy mixed with diamong chips on a hub. Figure 2-1 shows details of a mounted blade. The small edge (dimension B) is the actual cutting part of the blade. Some characteristics of this type of blade are:

a. Rugged. Less chance of damage in handling.

b. Good cooling by heat transfer from cutting edge to hub, which means less chipping and kerf loss.

c. Less kerf loss due to reduced virbation.

d. More consistent performance from one manufacturer's lot to another.

2-5. Unmounted (Hubless) Blades

Unmounted blades are made by compressing (usually under heat) abrasive material with some bonding material to form a flat cutting disc. Most unmounted blades are of two types:

a. Resinoid. These are sometimes called 'wear blades'. These are usually used for cutting very hard material.

b. Sintered. Sintered blades are made by compressing a paste-like mixture of abrasives under heat. Sintered blades are usually used for cutting silicon.

The characteristics of unmounted blades are:

a. Very delicate. There is a high risk of damage during handling.

b. Blades require mounting hubs or adapters to hold them on the spindle.

c. The heat transfer between the blade and the hub is less efficient.

d. By using progressively smaller mounting adapters, blade life can be extended.

2-6. GUIDELINES FOR BLADE SELECTION

The folloiwng paragraphs will help you select the right blade for a specific cutting application.

2-7. Blade Thickness (Width

The thinner the blade is, the narrower the kerf will be; but the wider the blade is, the longer it will last. Choose the widest blade possible that will still give an acceptable kerf width. As a rule of thumb, kerf width will be about 1.3 times the blade thickness.

2-8. Blade Exposure (Length)

Blade exposure determines the deepest cut you can make. Ideally, about 80% of the blade should be in the cut. At this depth, the walls of the cut help support the blade and keep it straight, and there is not too much loading on the

blade. To find the ideal exposure, multiply the depth of the cut by 1.25.

2-9. Aggregate (Grit) Size

The best grit size to use depends on the material being cut, the allowable kerf loss and chipping, and the speed and depth of cut. Table 2-1 gives recommended grit sizes for materials commonly cut. Larger grit tends to cut faster, and reduce loading of the blade. It is usually best to select the largest grit that you can use without excessive chipping.

Table 2-1. Recommended Diamond Grit Size

Particle Size (Microns)	Recommended for Cutting
5	Silicon
15	Silicon, Gallium Arsenate, Lithium Niobate
30	Lithium Niobate, Barium Titanate, Ferrite, Glass
45	Quartz, Glass, Sapphire, Garnet, Ruby, Ferrite
70	Quartz, Glass, Ceramic, Sapphire, Ruby, Carbides

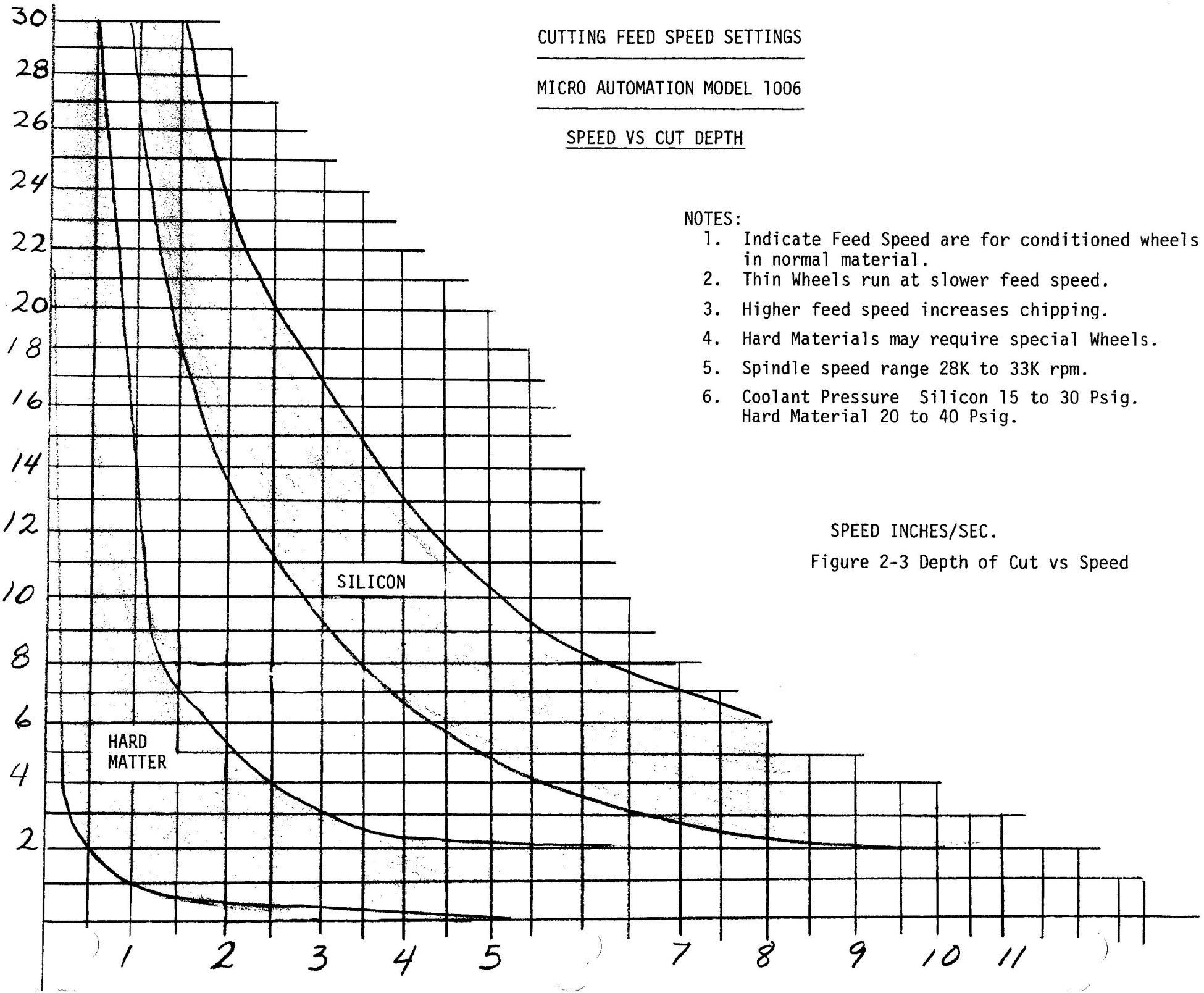
2-10. Cutting Speed

Production rate should be considered when selecting a wheel, and high cutting speed means high production. Figure 2-3 is a graph showing cutting speed versus depth of cut for a typical 1 mil thick blade. Thicker blades can cut faster than the graph indicates, and thinner blades must cut at slower speeds, but figure 2-3 is a practical guide.

CUTTING FEED SPEED SETTINGS

MICRO AUTOMATION MODEL 1006

SPEED VS CUT DEPTH



NOTES:

1. Indicate Feed Speed are for conditioned wheels in normal material.
2. Thin Wheels run at slower feed speed.
3. Higher feed speed increases chipping.
4. Hard Materials may require special Wheels.
5. Spindle speed range 28K to 33K rpm.
6. Coolant Pressure Silicon 15 to 30 Psig. Hard Material 20 to 40 Psig.

Figure 2-3 Depth of Cut vs Speed

SECTION III

BLADE MOUNTING

3-1. INTRODUCTION

This section tells you how to mount hubless blades in adapters and how to install both hubless and mounted blades on the saw spindle.

CAUTION

Never touch the cutting edge of a blade. Even the slightest touch can bend the blade. If the blade is bent it will cause excessive kerf and shorten blade life.

3-2. MOUNTING HUBLESS BLADES IN ADAPTERS

Before a hubless (unmounted) blade can be used for dicing wafers it must be mounted in an adapter. The following paragraphs explain how to put 1-inch ID (inside diameter) and 40 mm ID blades into MAI adapters.

3-3. Mounting 1-inch ID Hubless Blades

Figure 3-1 shows a disassembled MAI blade holder, a 1-inch ID unmounted blade, and the disassembly tool for the adapter. Blade exposure is one-half the difference between the blade OD (outside diameter) and the OD of the adapter. You determine blade exposure by choosing an adapter to give the exposure you want. Table 3-1 lists MAI's adapters and the OD of each. The adapters are identified by the number of punch marks on the parts.

Table 3-1. Adapters for 1-inch ID Blades

Model Number	MAI Part Number	Punch Marks	OD Adapter	Exposure with Standard 2" Blade
BA101	11007410	None	1.950 In.	.025 In.
BA102	11007420	2	1.960 "	.020 "
BA103	11007430	3	1.920 "	.040 "
BA104	11007440	4	1.880 "	.060 "

The disassembly tool for 1-inch blade adapters is a Model RT25, MAI part number 11007480.

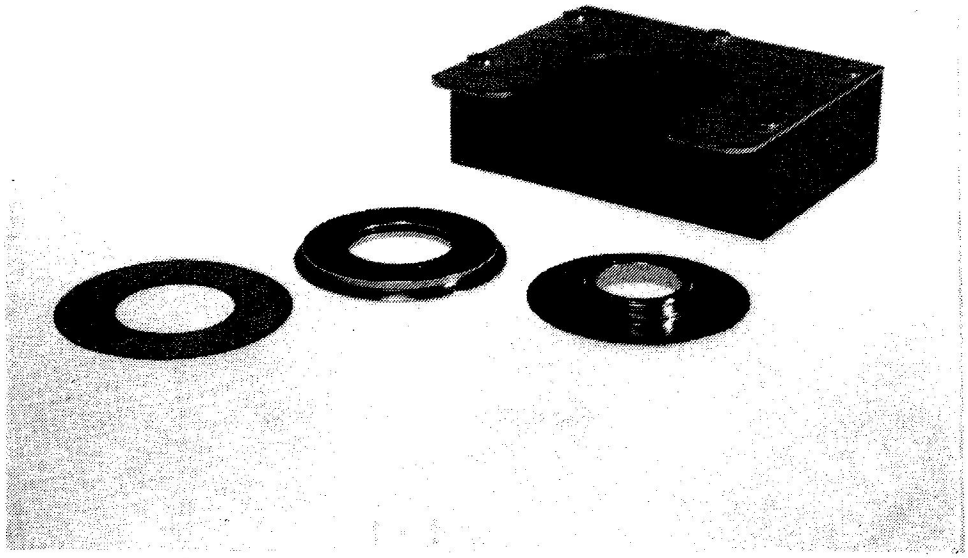


Figure 3-1. One-inch ID Blade with Adapter and Disassembly Tool

To mount the blade in the adapter, perform the following steps:

a. Wipe the hub and the retainer clean with a cloth or tissue.

b. Place the hub on a clean surface with the flat side down. (The same way as it is shown in figure 3-1.)

c. Place the blade on the hub. Center it on the raised shoulder on the hub.

d. Place the retainer over the hub. The large diameter should be down. (The same way it is in figure 3-1.)

e. Push down evenly on the retainer until it snaps into place.

To remove the blade from the adapter perform the following steps.

a. Place the blade and adapter in the disassembly tool as shown in figure 3-2.

b. Push firmly and evenly on the inside hub. The retainer and blade will snap out of the hub and drop to the bottom of the tool.

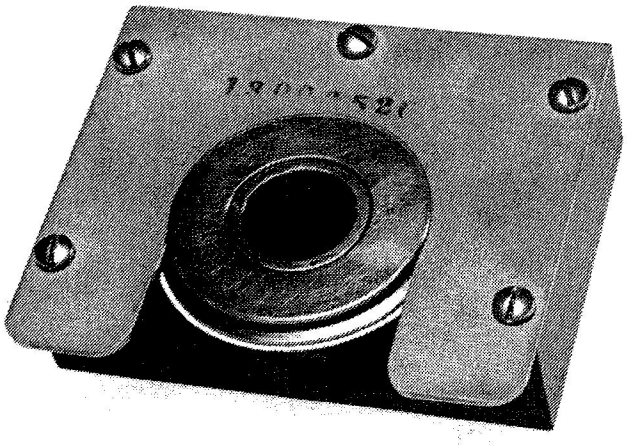


Figure 3-2. Blade and Adapter in Disassembly Tool

3-4. Mounting 40 Millimeter ID Hubless Blades

Mounting 40 mm blades is similar to mounting one-inch blades. Disassembly of these blades and adapters requires a different tool.

Figure 3-3 shows a disassembled adapter, a blade, and the disassembly tool. See table 3-2 to determine the proper hub for the blade exposure you want. The adapters are identified by engraved marks.

Table 3-2. Adapters for 40 mm ID Blades

Model Number	MAI Part Number	Engraved Marks	OD Adapter
BA100	11006880	None	1.950 In.
BA105	37511900	1	2.157 "
BA106	37511910	2	2.127 "

The disassembly tool for 40 mm ID adapters is a Model RT40, MAI part number 11007480.

To mount the blade in the adapter perform the following steps.

a. Wipe hub and retainer clean with a cloth or tissue.

b. Place the hub on a clean, flat surface with the flat side down. (The same way it is shown in figure 3-3.)

c. Place the blade on the hub. Center it on the raised shoulder on the hub.

d. Place the retainer over the hub with the largest diameter down (as it is shown in figure 3-3).

e. Push down evenly on the retainer until it snaps into place.

To remove the blade from the adapter perform the following steps. Refer to figure 3-4.

a. The three pins on the disassembly tool fit into the three holes in the assembled adapter. Place the assembled adapter on top of the

tool with the three pins of the tool in the three holes of the adapter.

b. With the base of the tool resting on a firm flat surface, push the inside of the hub down. It will snap out of the retainer.

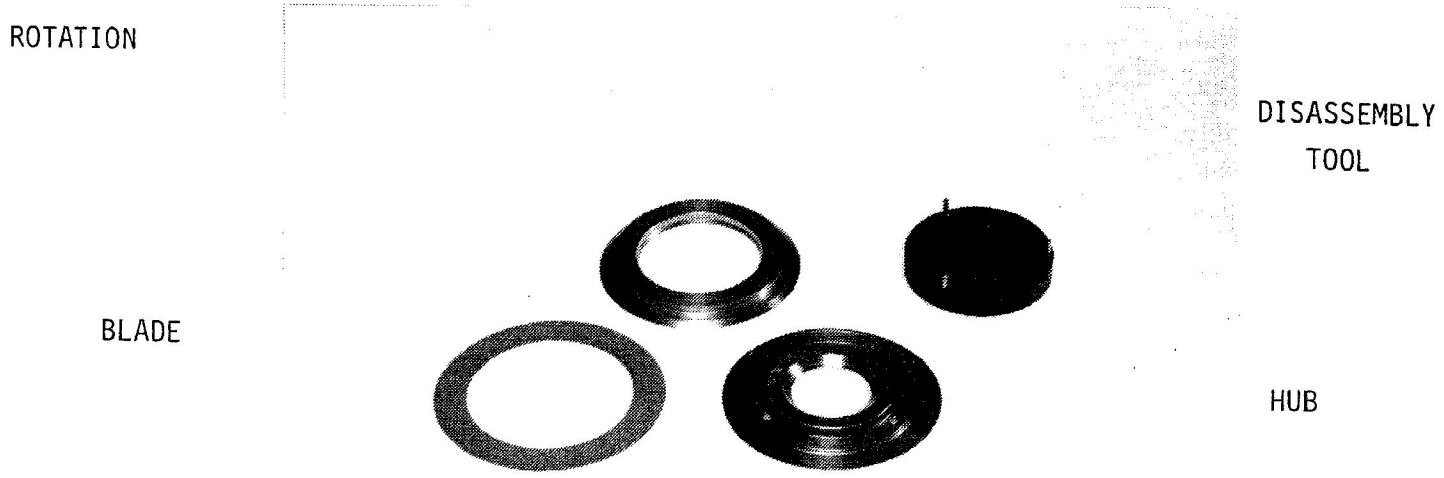


Figure 3-3. 40 mm ID Hubless Blade, with Adapter and Disassembly Tool

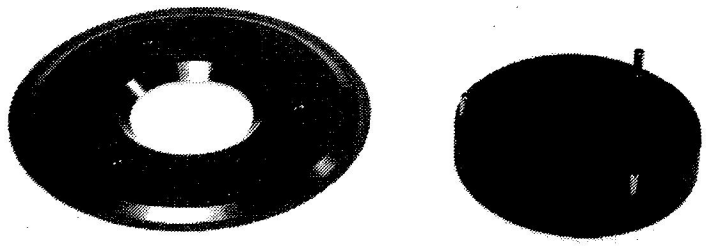


Figure 3-4. Blade in Adapter with Disassembly Tool

3-5. MOUNTING BLADES ON THE SAW

Two tools are provided with the saw to help mount the blade on the spindle: the wheel-mounting chuck and the wheel-installation/removal tool.

The wheel-mounting chuck is an accessory which aids in wheel mounting and unmounting. It is attached to the saw via a vacuum tube at the front left side of the saw. The vacuum for the tool is turned on by a toggle valve located under the front left side of the saw casting (see figure 1-1).

The wheel installation/removal tool consists of a knurled spanner wrench and an Allen wrench. The Allen wrench fits into an Allen screw in the end of the spindle to allow the spanner wrench to tighten the spindle nut.

Figure 3-5 shows the blade mounting chuck with a blade already picked up out of its plastic container. To use the tool to install a mounted blade on the saw follow the steps below.

NOTE

The vacuum blade holder is free to move up and down on the blade centering shaft.

3-6. Mounting the Blades

CAUTION

Do not remove the plastic blade guard while the spindle is running.

a. Remove the front blade guard from the spindle by removing the two knurled screws (figure 1-1). Lay the plastic piece, still attached to the tubing, to the side.

b. Wipe off the spindle and spindle face with a clean cloth or tissue.

c. Place the mounted blade in its plastic container on a flat surface.

d. Pull the blade holder toward the knurled handle of the tool, exposing the centering shaft.

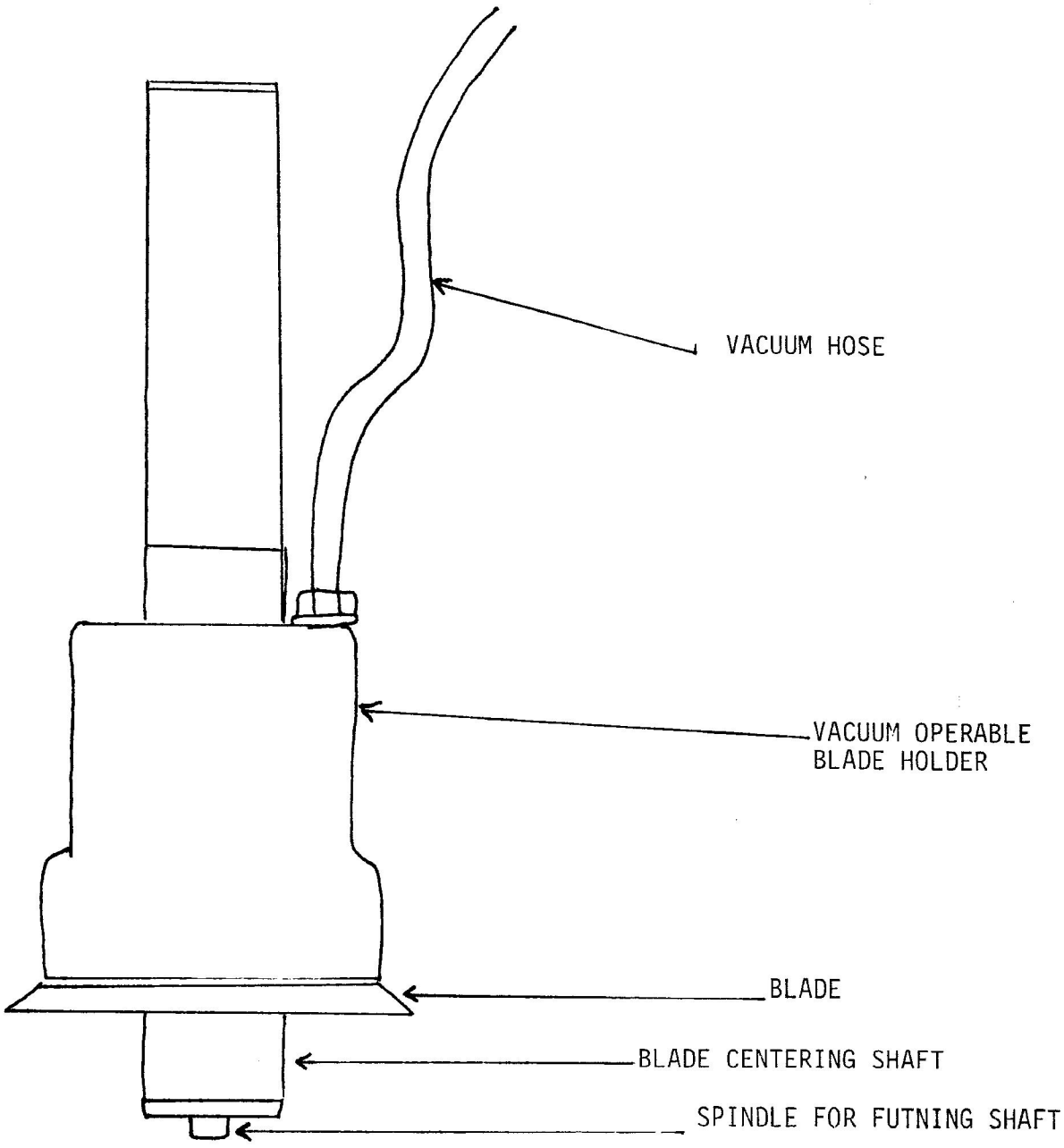


Figure 3-5. Wheel-mounting Chuck

e. Insert the centering shaft in the blade's hub while holding the vacuum holder back.

f. Turn on the vacuum by moving the vacuum toggle under the saw to the left. See Figure 1-1 for the location of the vacuum toggle.

g. Gently lower the vacuum holder until it contacts the wheel. The vacuum will hold the wheel on the holder.

h. Pull the vacuum holder back. This will lift the blade.

i. With the vacuum holder and blade still retracted, insert the spindle centering shaft into the Allen screw hole in the front of the spindle.

j. Push the vacuum holder and blade all the way onto the spindle shaft until the blade is against the spindle face.

k. Turn off the vacuum by moving the toggle to the right.

l. Carefully pull the vacuum holder back, leaving the blade in place.

m. Remove the mounting tool from the spindle.

NOTE

The order of assembly of the blade, pressure washer, and nut are shown in figure 3-6.

n. Place the pressure washer and the nut on the spindle.

NOTE

The pressure washer must be placed so that the raised face contacts the blade. See figure 3-7.

o. Use the installation/removal tool to tighten the nut (figure 3-8). Hold the Allen wrench handle to keep the spindle from turning while tightening the nut with the spanner.

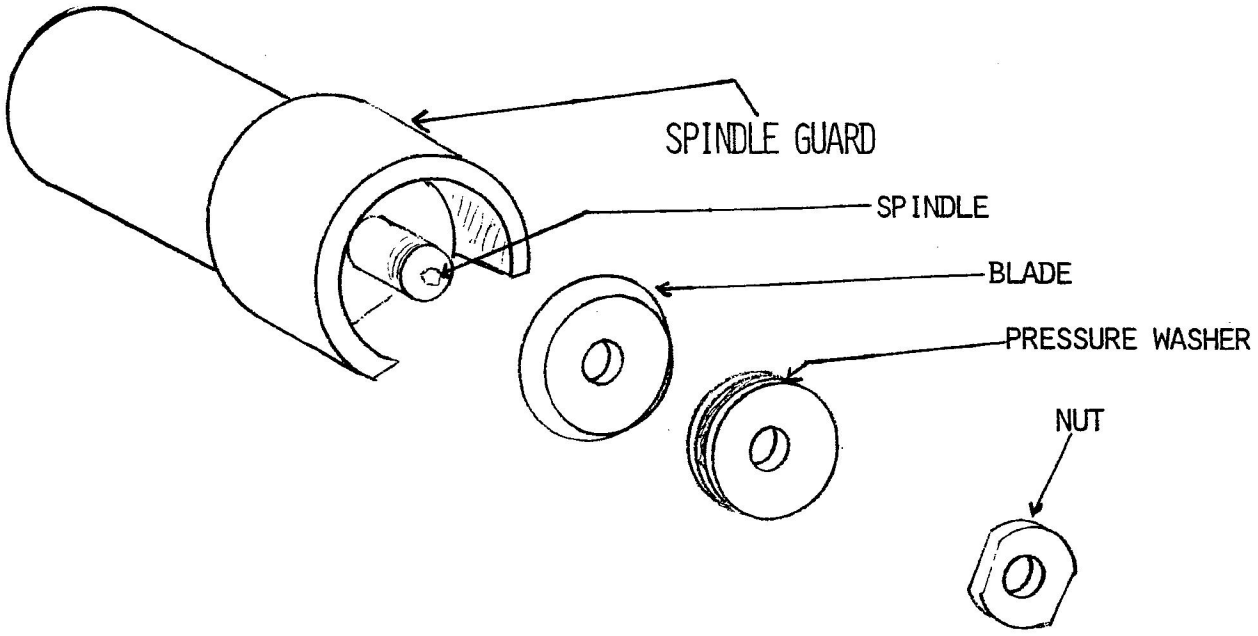
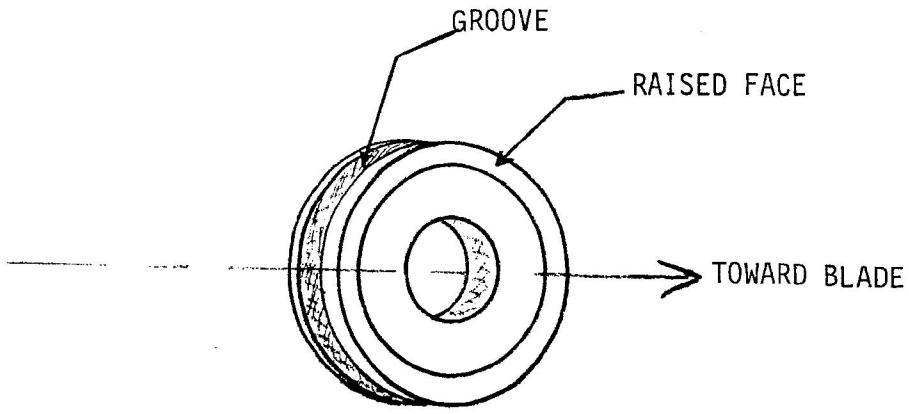


Figure 3-6 Assembly of Blade, Pressure Washer, and Nut.
(Front blade cover is not shown)



RAISED FACE CONTACTS BLADE

Figure 3-7 Pressure Washer

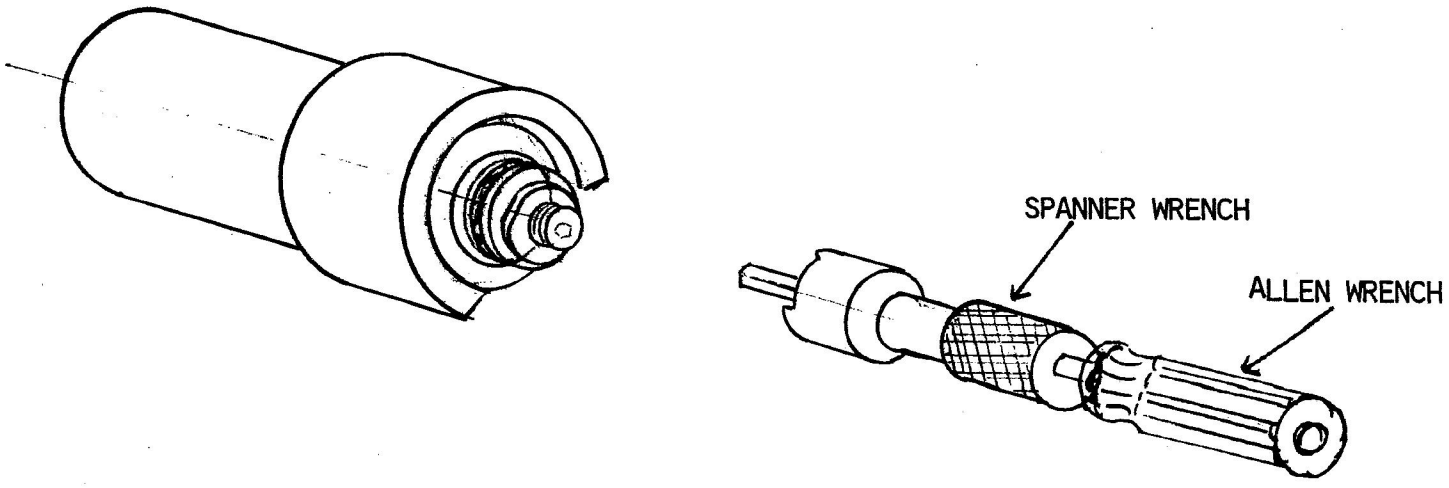


Figure 3-8. Use of Installation/Removal Tool

p. Reinstall the plastic blade guard.

CAUTION

The spindle must never be turned on without the guard in place.

q. The blade is removed by reversing the above procedure.

NOTE

Sometimes the blade cannot be removed with the vacuum tool. When this happens, heat the blade slightly with a heat gun. This loosens the blade so that it can be removed easily.

3-7. Hubless Blades in Adapter

The procedure for mounting hubless blades in adapters is the same as described above, except there is no plastic blade guard. The adapters must go on the spindle with the hub part of the adapter contacting the spindle face.

SECTION IV

PROGRAMMING AND OPERATING

4-1. INTRODUCTION

'Programming' simply means putting a set of instructions and numbers into the saw memory. Once the instructions are in the working memory, the saw will perform all the 'programmed' steps automatically. This section gives the general rules for programming, explains the functions of each control, introduces error and fault codes, and explains the flow chart format used in this manual.

4-2. GENERAL RULES

The following statements apply to all programming situations.

a. Once you have started to program the saw you must finish. That is, a value must be set into the saw working memory for each cutting parameter.

b. A number other than zero must be entered for each parameter except CUT COUNT.

c. Numbers are entered into working memory when the ENTER button is pressed.

d. If you have selected a wrong number by mistake you can press CLEAR, change the number, then press ENTER.

e. You can program the saw in either STANDBY or RESET condition.

f. When the light on the PROG button is lit, the saw is in program mode. The saw cannot be operated unless the PROG lamp is out.

g. The numbers entered and displayed are in mils (.001 in.) or mm depending on the Eng/Met switch.

h. If the saw is started up from the standby condition, the program used in the last operation is in the working memory.

4-3. PROGRAMMING CONTROLS

The programming panel is to the left of the spindle (see Figure 1-1). There are three parts to this panel: the programming switches, the numerical keyboard, and the alpha-numeric display. The main on-off pushbutton switch is located below the programming switches.

Table 4-1 lists each programming pushbutton and briefly explains its function. It also lists the largest and smallest number that the saw will accept for this parameter.

Table 4-1. Programming Controls and Functions

Name	Function/Explanation
PROG	This switch puts the saw into, and takes it out of, the programming mode. This switch is a toggle; that is, pressing the switch lights the PROG light and puts the saw in the programming mode. Pushing the switch again takes it out of programming mode. The saw cannot be operated while the PROG lamp is lit.
READ	When READ is pressed you can read the parameters already set in the saw. It also allows you to read labels of programs stored in the saw permanent memory. The saw cannot be operated if the READ lamp is on. READ and PROG toggle between each other.
SCR/DICE	This switch selects scribing or dicing operation. (See Section I for a description of dicing and scribing motions.) This switch toggles, and lamps associated with the button tell which operation is selected.
ENG/MET	You can program the saw in either English or Metric units. In ENG, numbers are set in in mils (1 mil = 0.001 inches). In MET operation, units are millimeters. This switch is also a toggle.
* (Asterisk)	This button is used for program storage and in cutting rectangular wafers. In rectangular wafer cutting (*) is used to insert the dimension for wafer length.
LOCAL	When the LOCAL light is lit, the saw is controlled from the front panel. When the saw is used as part of a wafer dicing system the switch is pressed, the lamp goes out, and the saw is under external control. LOCAL is also a toggle.
# (Number)	This switch is used for storing programs and for using stored programs. Its use will be explained later in this manual.

Table 4-1. Programming Controls and Functions (Continued)

Name	Function/Explanation
1st INDEX	When this switch is pressed you can program the distance between cuts (Y axis movements) with the numerical keyboard. This is the street-to-street dimension for the first cut (pass 1). The maximum number you can program is 4 inches (4000 mils). The smallest index you can program is 0.125 mils (101.6 mm to 0.0032 mm).
HEIGHT	When this button is pressed you can program the depth of the cut the saw will make. Height is the distance from the top of the chuck to the bottom of the cut. Depth of cut equals thickness of wafer minus height. The largest height you can program is 511 mils; the smallest is 0.25 mils (13 mm to 0.0064 mm).
ANGLE	When this switch is pressed you can program the angle the chuck will turn (Theta axis) between passes. You can set any angle between 1° and 121°, except when in 'Hex' cutting mode. In 'Hex' the largest angle you can program is 60.1°.
DIA	DIA = wafer diameter. Diameter is programmable from 6 inches to 0.25 mils (152 mm to 0.0064 mm). In rectangular wafer cutting DIA is used to insert the dimension for wafer width.
CUT COUNT	Pressing CUT COUNT allows you to set the cut count at any number between zero and 99,999. When a new blade is installed CUT COUNT is set to zero. If used blades are being remounted, the count can be preset to pick up the previous count on the blade.
MODE	This button selects the mode of cutting, which is determined by the type of wafer to be diced/scribed. Modes are set in by pressing MODE, then setting a number on the numeric keyboard, then pressing ENTER. Cutting modes are listed below.

Mode No.	Description
10	Round wafers. Alignment required for each pass.
11	Round wafers. No alignment required for second pass. (Blank wafers)
20	Round wafers, hexagonal die. Alignment required for each pass.(Triple alignment option)
21	Round wafers, hexagonal die. No alignment required for last two passes.(Blank wafers
22	Round wafers, hexagonal die. No alignment required for pass two. Pass three alignment is made to an intersection of cuts one and two. (Blank wafers)

Table 4-1. Programming Controls and Functions (Continued)

Name	Function/Explanation

MODE (Cont)

Mode No.	Description (Cont)
30	Rectangular wafers. Alignment required for each pass.
31	Rectangular wafers. No alignment required for second pass. (Blank wafers)
60	Same as 10 except for progressive depth cuts.
61	Same as 11 except for progressive depth cuts. (Blank wafers)
70	Same as 30 except for progressive depth cuts.
71	Same as 31 except for progressive depth cuts. (Blank wafers)

2nd INDEX — This sets the street-to-street dimension for the second cut. 2nd INDEX is programmable from 4 inches to 0.125 mils (101.6 mm to 0.0032 mm).

THICKNESS — When this button is pressed, the saw is programmed for the thickness of the wafer. Thickness is programmable from 511 mils to 0.25 mils (13 mm to 0.0064 mm).

NOTE

If you are cutting wafers mounted on film frames or host wafers, thickness is the wafer thickness plus the host or film thickness.

SPEED — This determines the speed of X-axis travel, which is the wafer cutting speed. Speed is programmable from 19.999 inches per second down to 50 mils/second (508 mm/sec to 1.27 mm/sec).

NOTE

A special lead screw may be installed, allowing speeds from 12.5 mils/sec to 4.999 mils/sec. This version of the saw is called a Model 1006L.

CLEAR — Pressing CLEAR clears numbers from the alpha-numeric display during programming, clears error and fault codes when they come on, and clears the saw to the wafer load position during automatic sawing, indexing or alignment.

Table 4-1. Programming Controls and Functions (continued)

Name	Function/Explanation
STOP COUNT	Setting STOP COUNT stops the saw after a preset number of cuts have been made. It is programmable from 1 to 999 cuts. When the saw is turned on, STOP COUNT is automatically set to 999. STOP COUNT automatically goes back to 999 after each pass.
A through F	These switches are reserved for future or special applications.
1 through 9	Number buttons for setting numbers into memory.
0 (zero)	0 (zero) is used as a number button in putting numbers into memory; it is also used to select the size of progressive depth steps. This use of the zero button will be explained later in this manual.
(.) decimal point	Used in setting fractional numbers into the memory.

4.4 OPERATING CONTROLS

The operating controls are located to the right of the spindle. Table 4-2 lists each operating control and briefly describes its function.

Table 4-2. Operating Controls and Functions

Name	Function/Description
STANDBY	The STANDBY switch is always enabled while the saw is on. If STANDBY is pressed while the saw is operating, the saw immediately returns to the home position and the spindle turns off. A lamp on the button indicates standby status.
RESET	Pressing RESET immediately sends the saw to the home position. The spindle, if turned on, stays on. A lamp indicates reset status.
SPINDLE ON/OFF (Toggle)	Push for SPINDLE ON. Push again for SPINDLE OFF.
(Chuck) ZERO	This switch, when pressed, starts the automatic chuck zero sequence. A lamp indicates that the chuck zero sequence is completed. This sequence sets the blade size into the saw.
(Chuck) LOCK	Applies vacuum to chuck to hold the wafer in place.
(Chuck) UNLOCK	Removes the vacuum from the chuck. Allows the wafer to be removed. While the button is pressed, air blows in the vacuum line to help release the wafer.

Table 4-2. Operating Controls and Functions (Continued)

Name	Function/Description
ALIGN	Pressing ALIGN moves the chuck into position under the optical alignment system and enables the Street and Theta switches (see below). If ALIGN is pressed while the saw is cutting, it finishes the cut it is making, stops cutting, and returns to the align position. The ALIGN switch toggles with INDEX.
INDEX	Pressing INDEX also moves the chuck into position under the optics. If INDEX is pressed while the saw is cutting, it will finish the cut, then position the last cut under the optics.
(Wafer) RIGHT	Moves the X axis to the right (saw must be in INDEX or ALIGN mode).
(Wafer) LEFT	Moves the X axis to left (saw must be in INDEX or ALIGN).
(Theta) CW	Turns chuck clockwise. In ALIGN mode the chuck turns as long as the switch is pressed. In INDEX mode, the chuck turns through the angle programmed.
(Theta) CCW	Same as above, except chuck turns counterclockwise.
(Street) FWD	Moves the spindle forward (toward the operator). In ALIGN mode, the spindle moves as long as FWD is pressed. In INDEX the spindle moves, in steps, the distance programmed as 1st or 2nd index.
(Street) BACK	Same as above, except the spindle moves back (away from the operator).
FAST	This switch modifies the action of the Street and Theta controls the next time one of these controls is pressed. After a Theta or Street control is released, FAST is no longer operative. (If you want the next action to be fast, you must press FAST again.) The action of the FAST switch on the Street and Theta controls depends on whether the saw is in ALIGN or INDEX condition. When in ALIGN, FAST causes the Y or Theta axes to move faster as long as the switches are depressed. When in INDEX, FAST causes the Y axis to step the programmed 1st or 2nd index distances as long as FWD or BACK is pressed, or until the edge of the wafer is reached. When in INDEX, FAST causes the chuck to rotate the programmed angle whenever CW or CCW is pressed.

Table 4-2. Operating Controls and Functions (Continued)

Name	Function/Description
SINGLE CUT	Enabled only in Align or Index mode. When this switch is pressed, the saw will make one cut and return the cut under the optics.
AUTO CUT	This switch starts the automatic cutting sequence as programmed. If AUTO CUT is pressed while in the INDEX mode, the saw will start to cut one street back from its last position. If AUTO CUT is pressed while the saw is in ALIGN mode, the saw will start to cut at the front of the wafer.

4-5. FAULT AND ERROR CODES

Fault codes and error codes are displayed in the alpha-numeric panel whenever the self checking circuits of the saw detect a malfunction, or a mistake in programming. Fault and error codes are tabulated in Appendix A of this manual. Error codes that may come up during programming are explained in each instruction.

4-6. Fault Codes

Fault codes are displayed as an 'F' followed by three digits. They indicate a mechanical or electrical malfunction. When a fault code is displayed a maintenance technician should be called.

4-7. Error Codes

Error codes are usually an indication that an incorrect operation was performed, such as trying to insert a parameter out of range, or forgetting some required operation. Error codes are displayed as an 'E' followed by three digits. They may also be displayed as a warning. For example, E110 is displayed to warn the operator that he is about to alter the contents of a memory. Error codes are usually correctible by the operator. They are cleared by pressing CLEAR, then correcting the error in programming or operation.

4-8. Error Codes E002 and E101

These two error codes can occur at any time during programming. To list these codes after each direction block would take up space and present redundant information; therefore, these two codes are explained here. The explanations apply to all flow charts.

a. E002 means that an attempt was made to operate the saw in an improper manner (that is, the switch just pressed doesn't make sense to the saw logic). The usual cause of this error code is an attempt to operate the saw while in PROG or READ modes. If PROG or READ lamps are lit, push the appropriate switch to put the lamp out. Another common cause of E002 is when a switch is pressed twice and is often caused by contact 'bounce'. Simply pressing the next switch normally clears this.

b. E101 means that two or more front panel buttons have been pushed at the same time. If you have not pressed more than one switch, and the error cannot be cleared, call maintenance to check for a sticking switch.

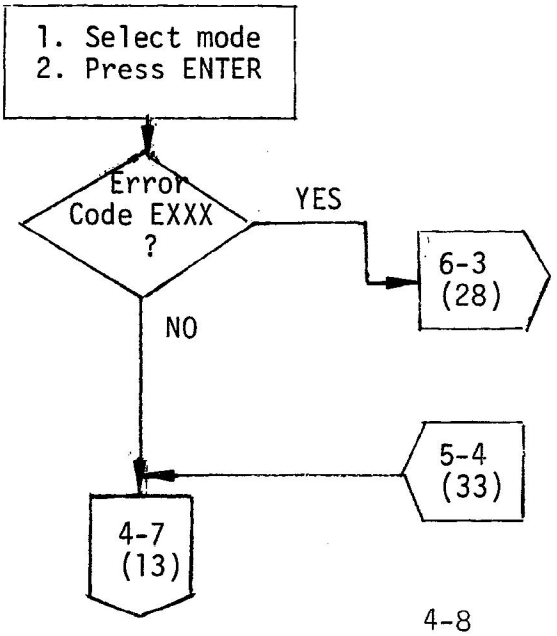
4-9. SPECIFIC OPERATING INSTRUCTIONS

The rest of the paragraphs in this section give instructions for performing specific dicing or scribing operations. Most of the instructions are given in flow chart form. Flow chart is abbreviated 'FC'.

4-10. Flow Charts

To use a flow chart, start at the top of the first page and follow the arrows to the end.

The shape of the blocks used in the charts indicate the actions to be taken. A rectangle gives directions for actions to be performed. A diamond shape box contains questions, and the answers to these questions direct you to the proper path. A trapezoidal arrowhead directs you to or from another part of the chart, or to another flow chart. See the examples below.



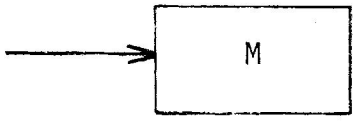
Directions

Questions

This is called a 'connector'. It means go to incoming connector 6-3 on page 4-28.

Incoming connector. Enter here from connector 5-4, page 4-33.

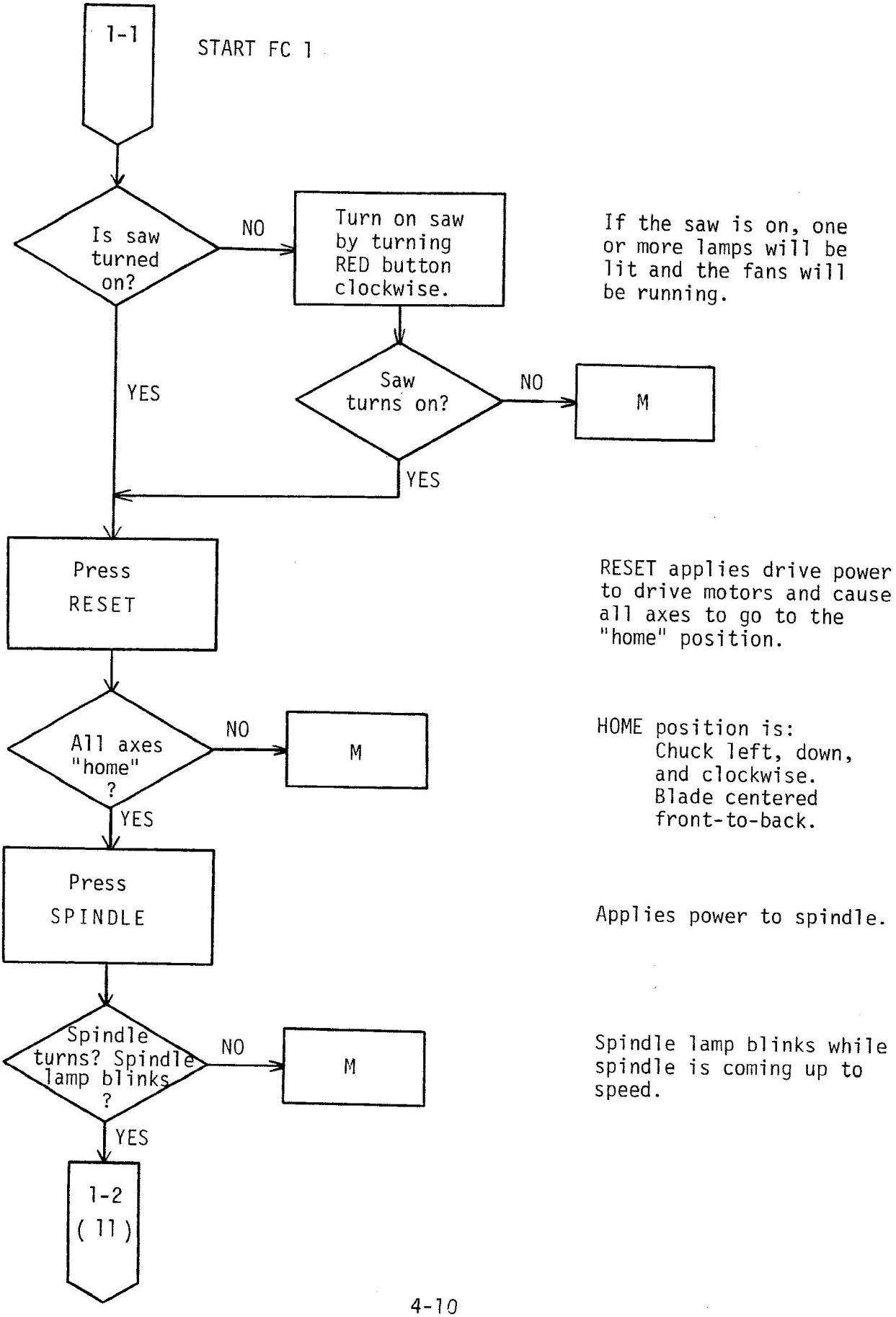
Go to FC4, connector 7, page 4-13.

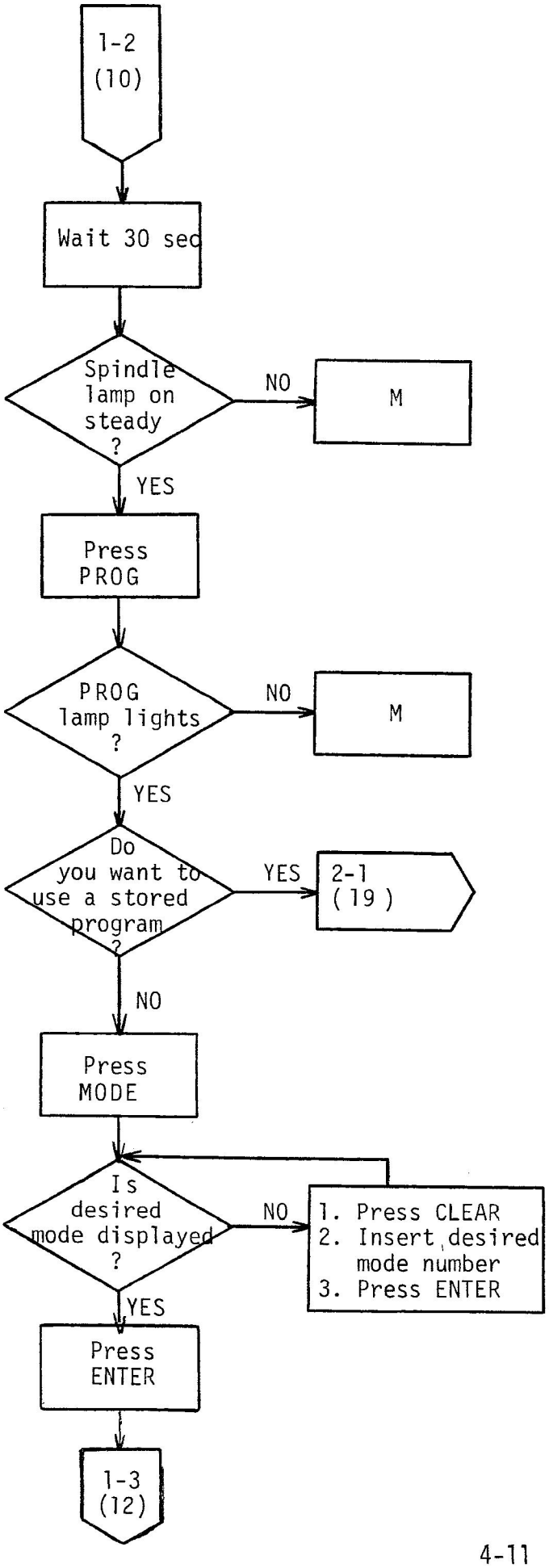


A rectangle with a capital 'M' means that a maintenance technician should be called.

4-11. Flow Chart 1. Turn-on and Basic Programming

This flow chart shows how to turn on the saw, put a program into the saw's working memory, and perform a chuck zero operation. When all the steps in this chart are completed, the saw is ready for blade dressing, optic system alignment or production cutting. In this chart, you will be referred to other charts or instructions for specific tasks.


1-1
START FC 1
Is saw turned on?
NO
Turn on saw by turning RED button clockwise.
If the saw is on, one or more lamps will be lit and the fans will be running.
YES
Saw turns on?
NO
M
YES
Press RESET
RESET applies drive power to drive motors and cause all axes to go to the "home" position.
All axes "home" ?
NO
M
HOME position is:
Chuck left, down, and clockwise.
Blade centered front-to-back.
YES
Press SPINDLE
Applies power to spindle.
Spindle turns? Spindle lamp blinks ?
NO
M
Spindle lamp blinks while spindle is coming up to speed.
YES
1-2
(11)

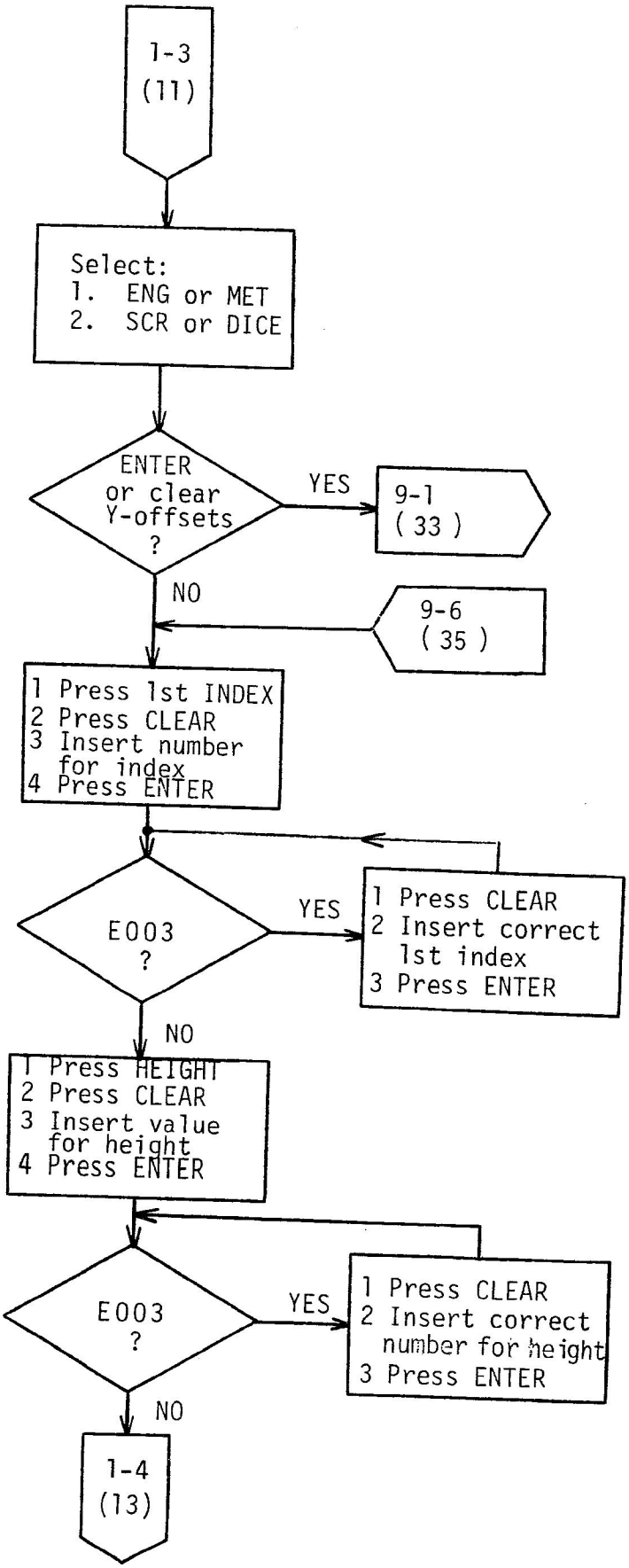


Lamp glowing steadily means spindle is up to speed.

This step starts the programming procedure.

Frequently used cutting programs may be stored in memory for future use. If the cutting program you want to use has already been stored, FC2 will tell you how to put the program into the working file.

If the saw was started from an OFF condition, the display will show 10. If the saw was started from the STANDBY condition, the mode last used will be displayed.



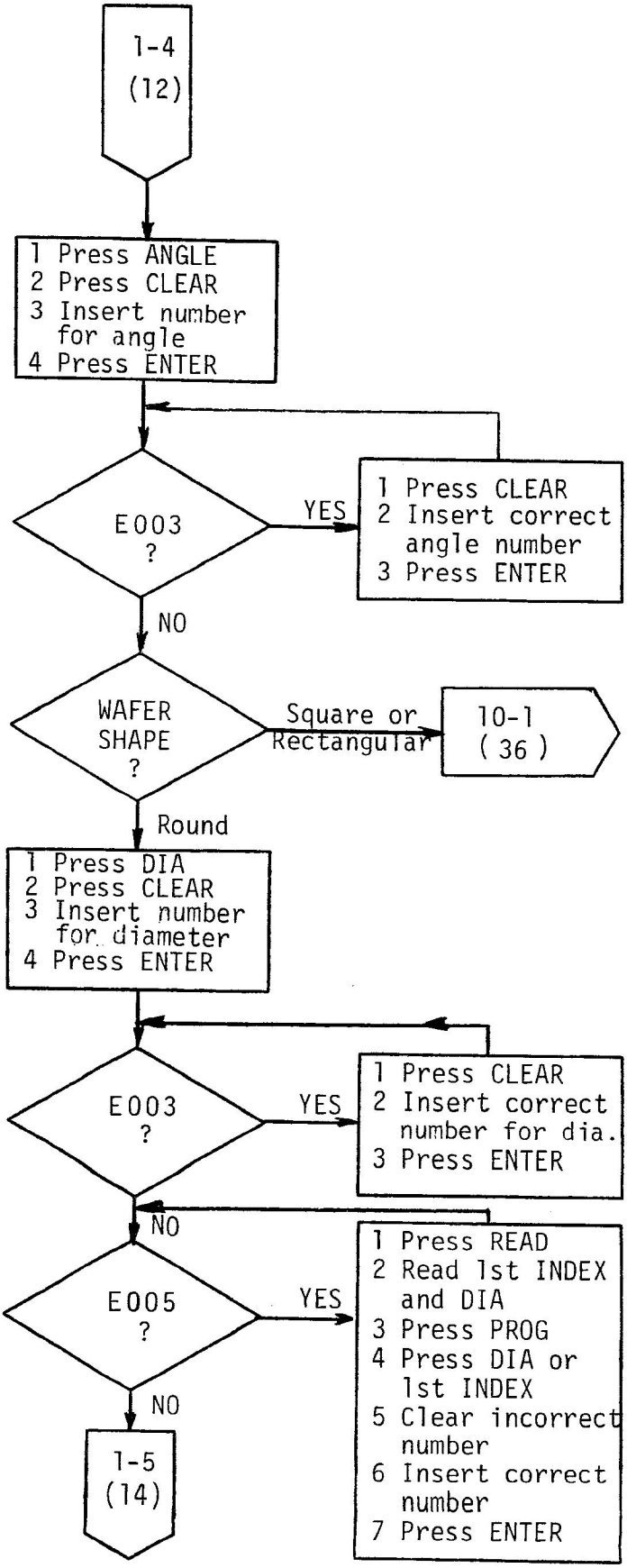
The saw normally moves to the center of the chuck for alignment. If you want the saw to go to a position other than the center for alignment, you can insert an offset into the program. FC9 shows you have to insert and clear Y-offsets.

First index is the distance between streets for the first pass. Display is in mils.

E003 means that the number entered was outside the limits for that parameter. Index must be between 0.125 and 4000 mils. (0.003 and 101.6 mm)

Height = Thickness - depth of cut.
(Amount of material that will be left after cutting)

E003 Number of range. Height must be between 0.25 and 511 mils (0.006 and 13 mm)



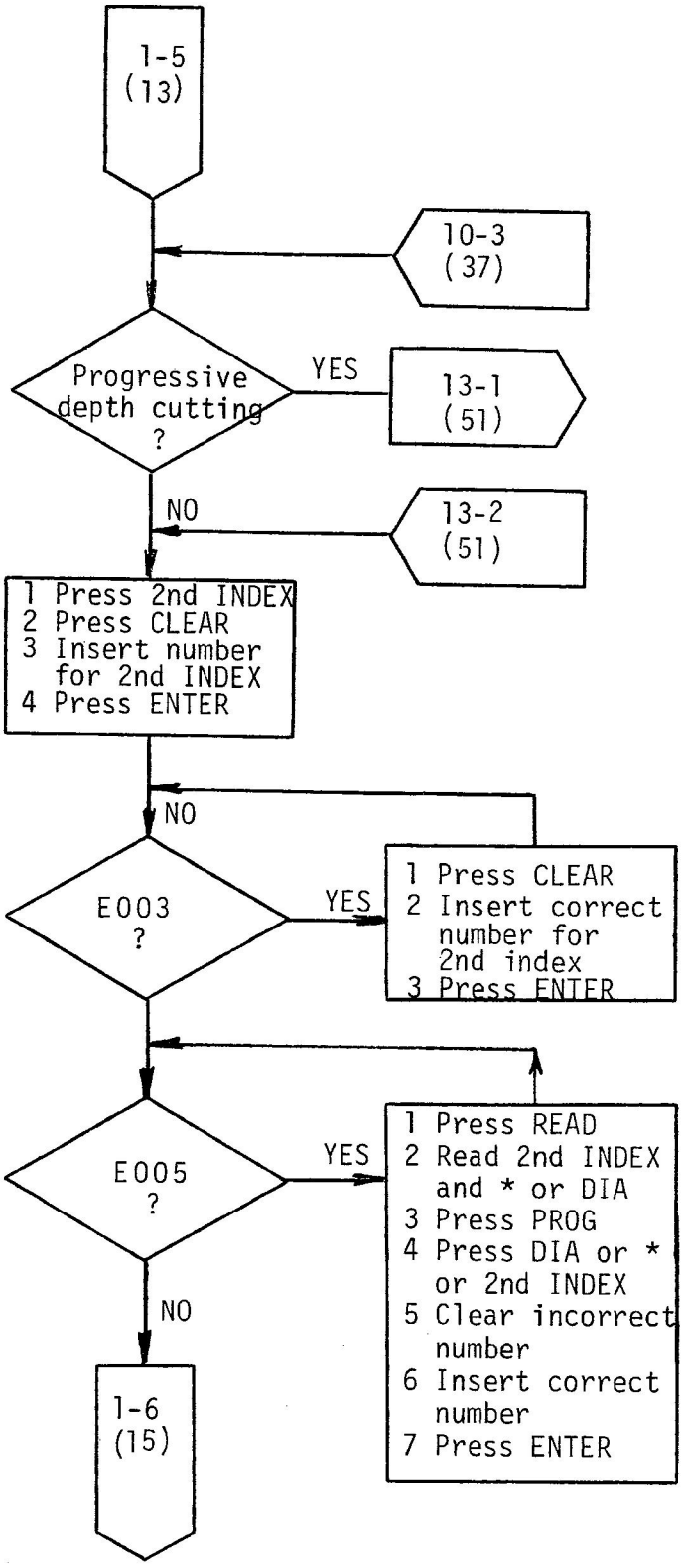
E003 Number out of range. Angle must be between 1° and 121° for other modes. Angle must be between 1° and 60.5° if you have selected a hex die cutting mode.

DIA is the diameter of round wafers.

E003 Number out of range. Wafer diameter must be between 0.25 and 6000 mils. (0.006 and 152 mm)

E005 means that the number inserted for 1st index, above, is too large for the wafer diameter just entered.

This procedure corrects DIA or 1st INDEX number.



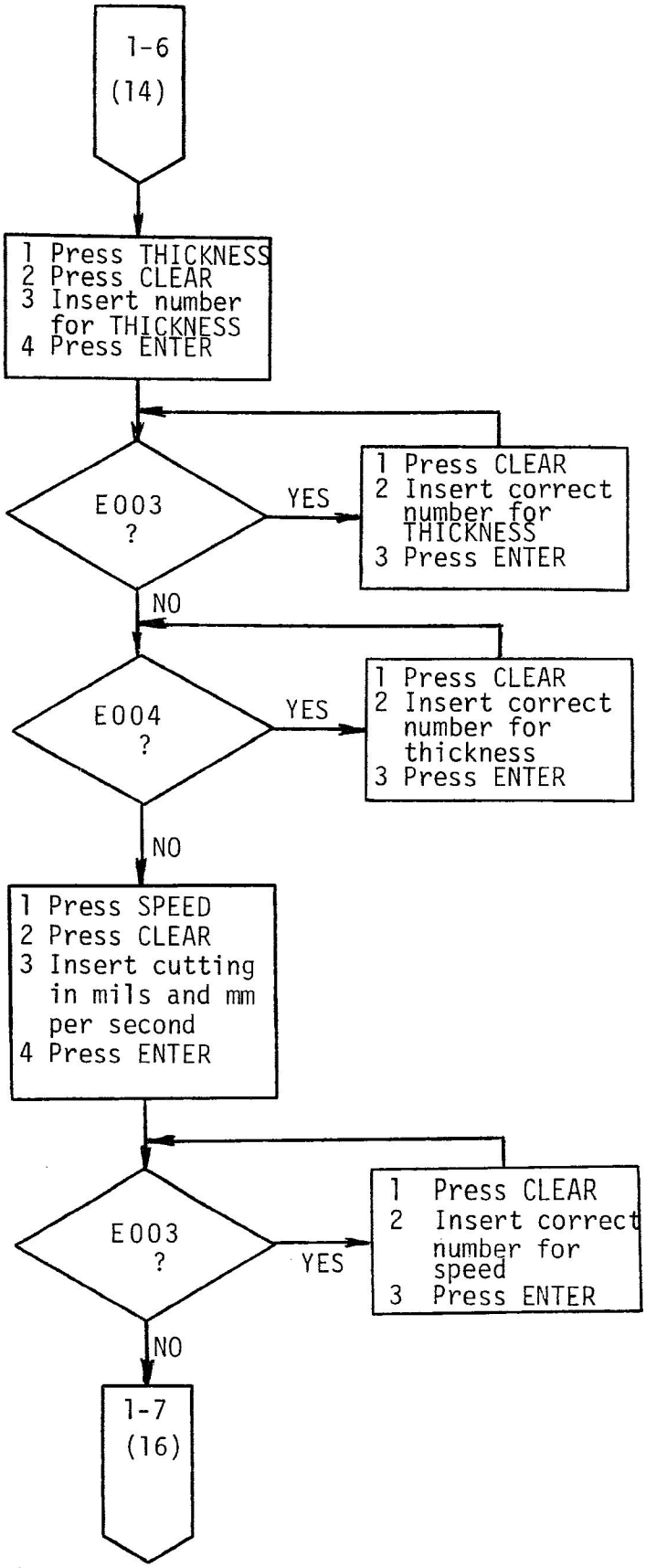
Reenter this flow chart here after programming for rectangular wafers.

Reenter this flow chart here after programming for progressive depth cutting.

E003 Number out of range. 2nd Index must be between 0.125 and 4000 mils (0.003 and 102 mm.)

E005 means that the number inserted for 2nd Index is too large for the wafer diameter or the length of the rectangular wafer if you re-entered this flow chart from FC10. This procedure corrects the wafer diameter, the 2nd index, or the wafer length number.

FC 1 - Continued



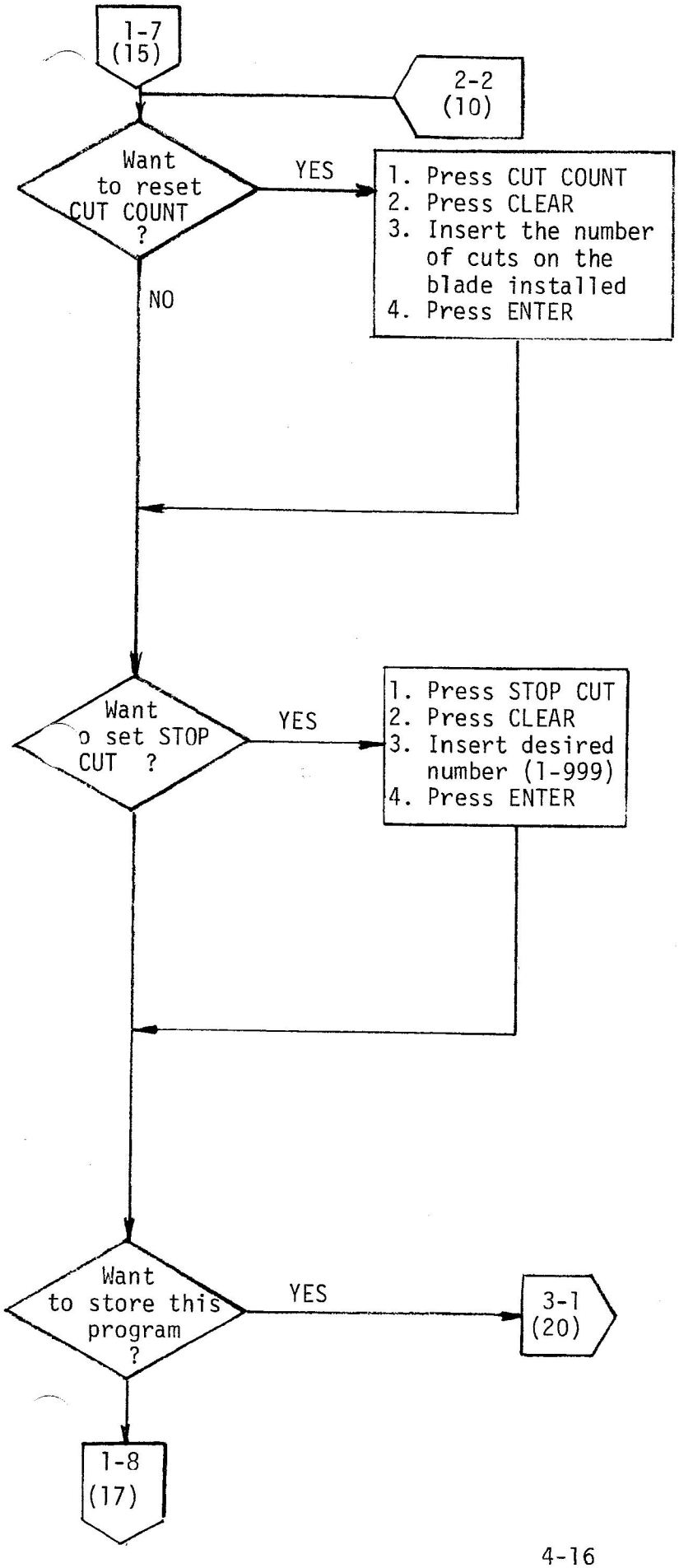
Thickness number must include thickness of film or host wafer plus wafer thickness

E003 Number out of range. Thickness number must be between 0.25 and 511 mils (0.006 and 13 mm.)

E004 means that the number inserted for thickness is less than the number inserted for height.

E003 Number out of range. Speed must be between 50 and 19,999 mils per second (1.27 and 508 mm per second)

NOTE: There is a low speed option available. With this option cutting speeds are 12.5 to 5000 mils per second. This option makes the saw a Model 1006L.



This is the point where you reenter this flow chart if you have used a program stored in memory.

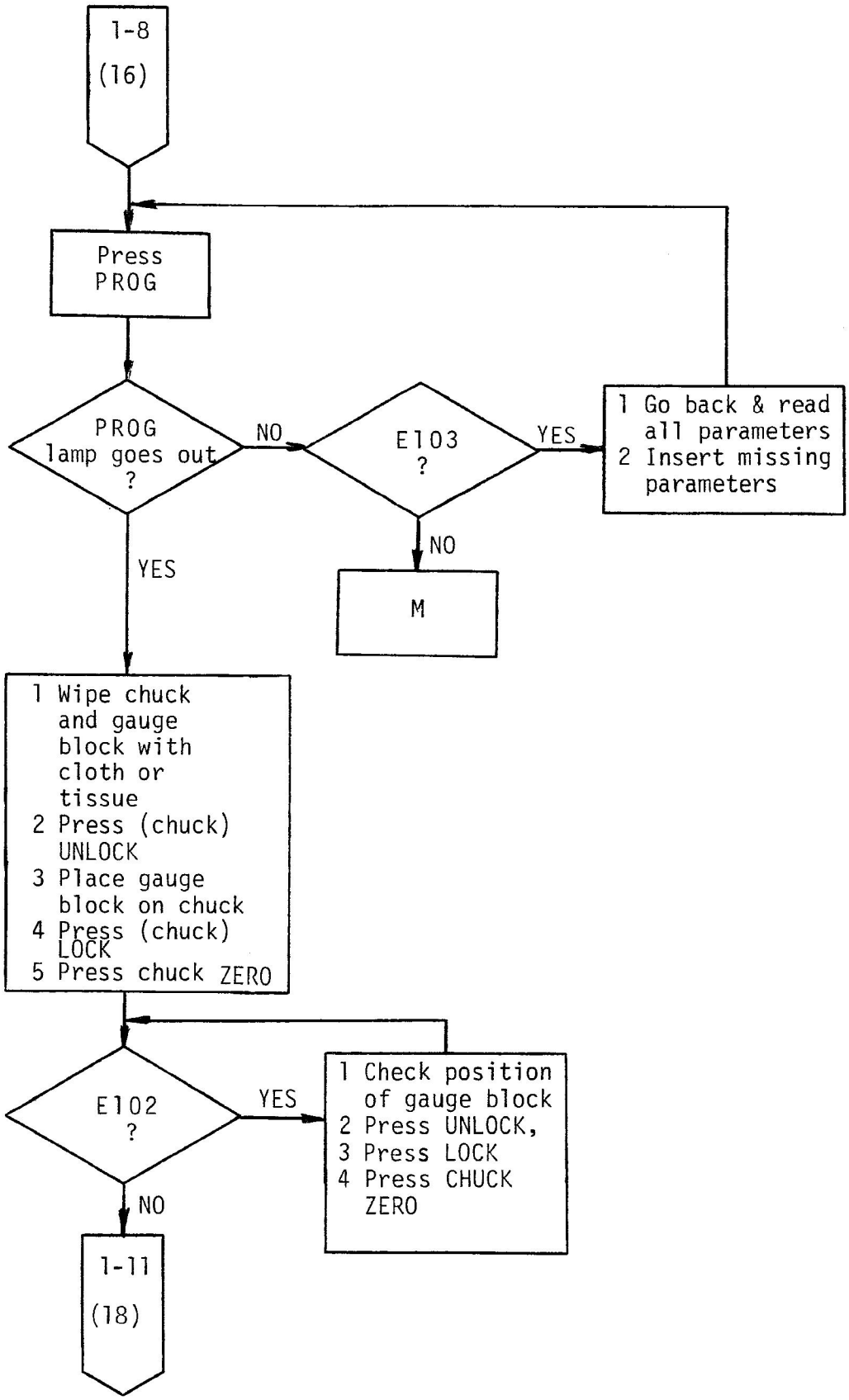
Cut count is usually set at zero when a new blade is installed. When a used blade is installed, cut count can be set to pick up the previous count. Cut count can be set from zero to 99,999.

STOP CUT can be set to stop the saw after the programmed number of cuts have been made. STOP CUT is automatically reset each time AUTO CUT is pressed. If the saw is turned off, CUT COUNT goes to 999.

Performing the steps of FC 3 will store the parameters you have just put in the saw. This cutting program can be recalled for future use.

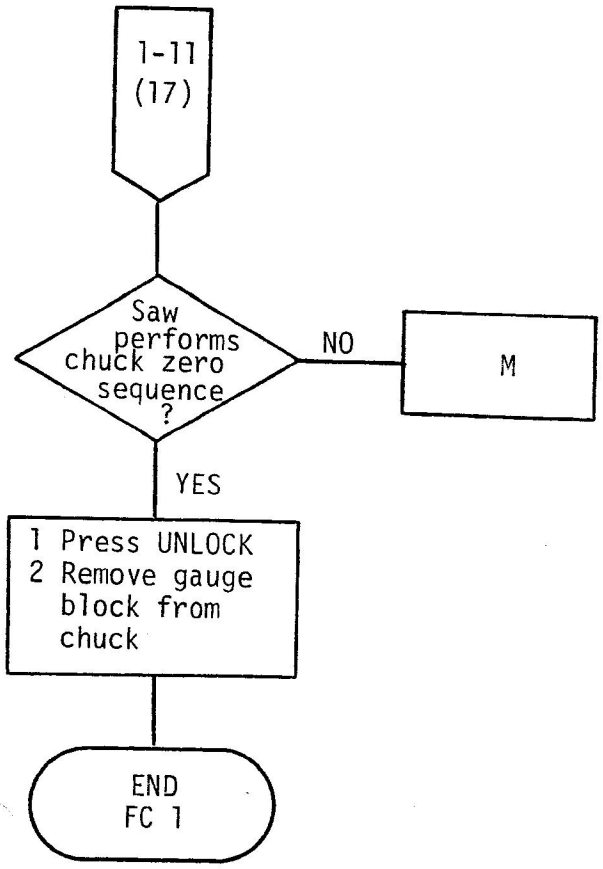
At this point a complete cutting program has been put into the saw working file.

FC 1 - Continued



E103 means that an attempt was made to operate the saw with one or more cutting parameters missing. If cutting rectangular wafers, be sure to check the asterisk (*).

E102 means that the vacuum chuck was not locked. If this condition persists, call maintenance.



Chuck zero sequence:
1. Chuck lowers
2. Chuck moves to position under blade
3. Chuck rises until the gauge block touches the blade
4. Chuck lowers
5. Chuck moves to left
6. Chuck raises
7. Chuck ZERO lamp comes on

After the steps in this Flow Chart are completed, the saw is ready to use.

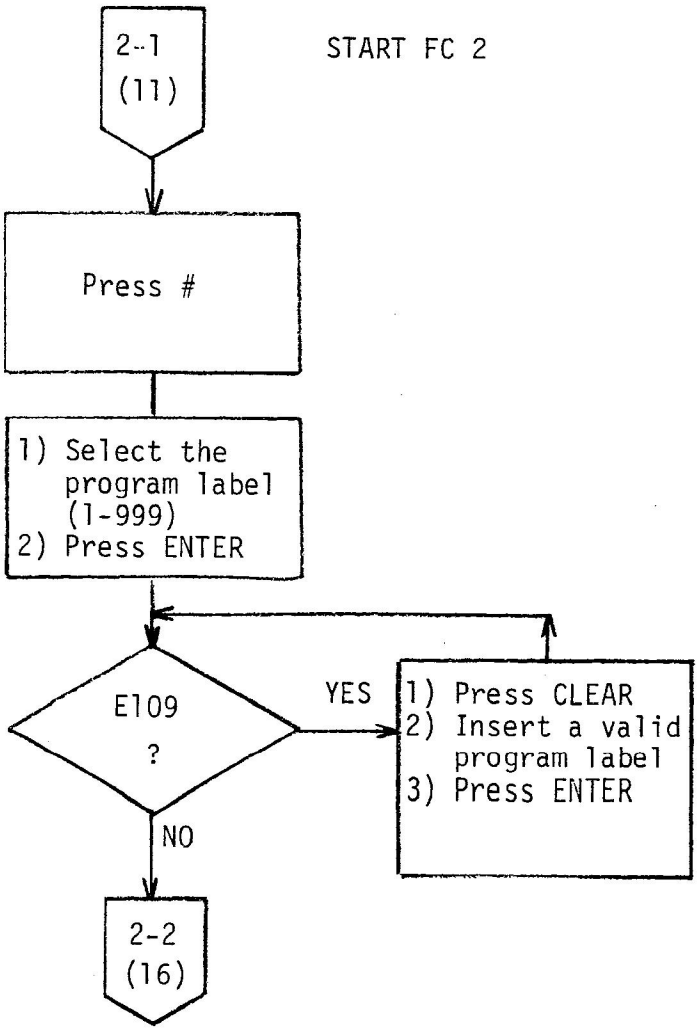
NOTE: Before production cutting starts, it may be necessary to dress the blade or to align the optics. See the paragraphs listed below for these procedures.

Blade dressing: FC 6 (page 4-24) for automatic dressing, or paragraph 4-27 (page 4-56) for manual dressing.

Optics alignment: Model 1006, FC 7 (page 4-27). Model 1006A, FC 8 (page 4-30).

4-12. Flow Chart 2. Loading a Stored Program into the Working File

If there are programs stored in the saw's program memory, one of these programs can be transferred to the working file by following FC 2, below. Using stored programs is faster and more accurate than step-by-step programming.



Enter this flow chart from FC 1.

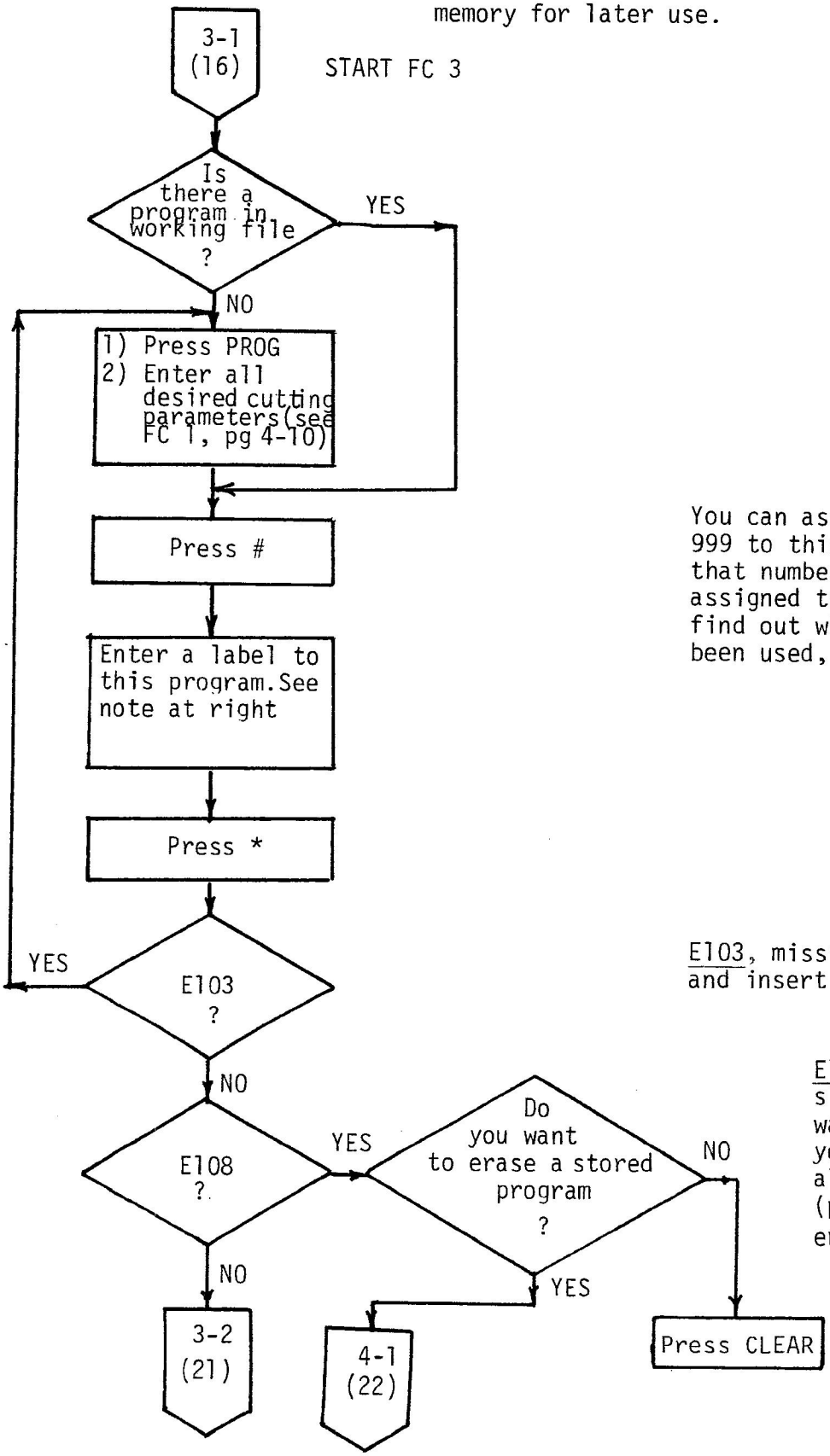
Programs are stored under labels numbered from 1 to 999.

E109 means that there is no program stored under the number you used.

Program has been transferred from storage to the working file. Reenter FC 1.

4-13. Flow Chart 3. Loading a Program into Memory

Following this flow chart loads a program from the working file into memory for later use.



This FC may be entered from FC 1, or may be used on its own.

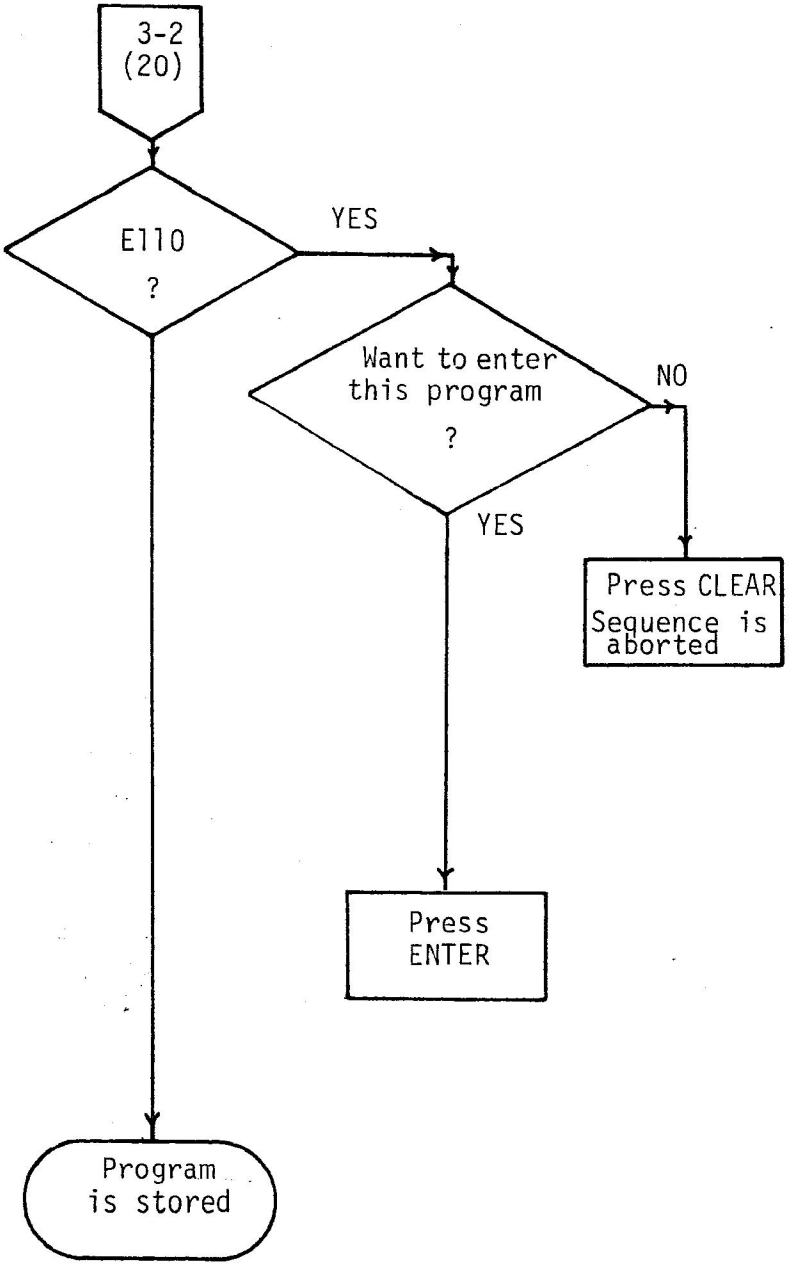
You can assign any label from 1 to 999 to this program, as long as that number has not been already assigned to another program. To find out which labels have already been used, go to FC 5 (page 4-23).

E103, missing parameters. Go back and insert missing parameters.

E108 means that all memory slots are filled. If you want to enter this program you must erase a program already stored. Go to FC 4 (page 4-22) if you want to erase a stored program.

Pressing CLEAR aborts this sequence without changing the working file or memory.

FC 3 - Continued

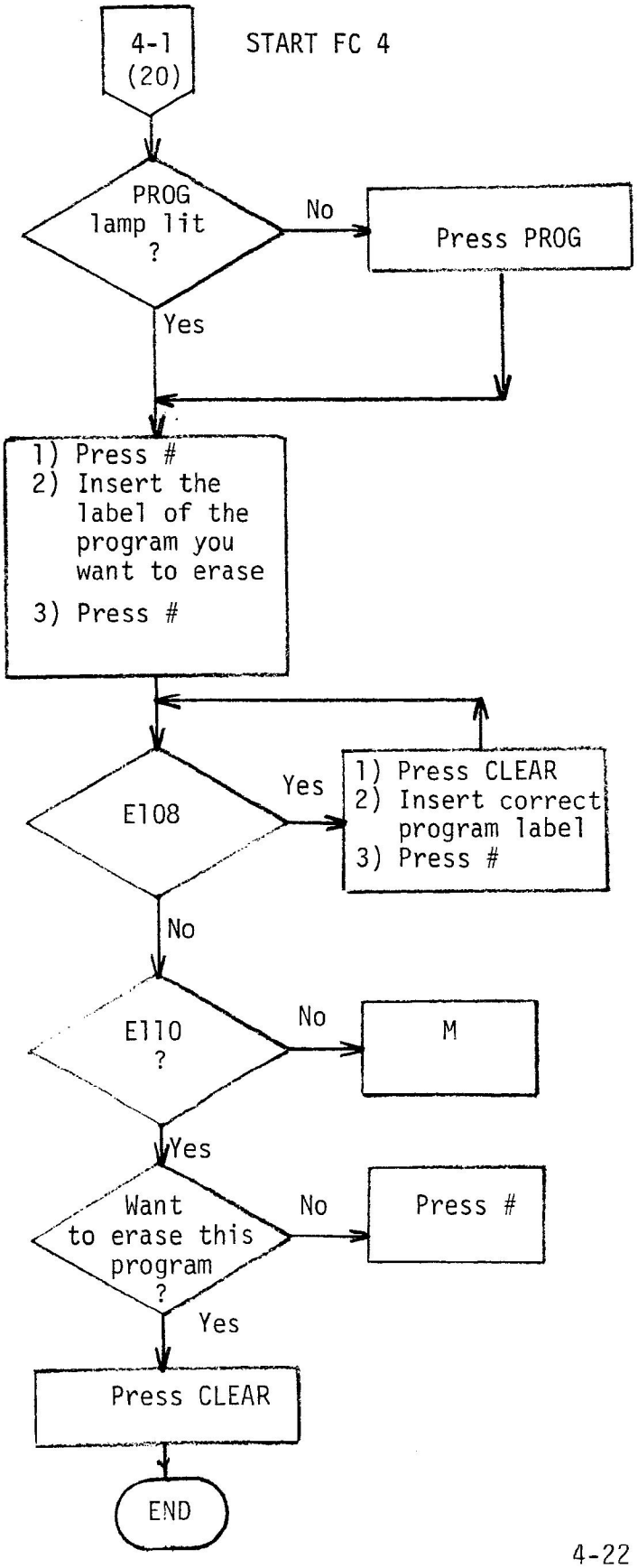


E110 is a warning that you are about to change the contents of memory.

Pressing ENTER enters the program, writing over whatever was stored there previously. Pressing CLEAR aborts the sequence.

Program is now stored under the label you selected.

4-14. Flow Chart 4. Erasing a Program from Memory



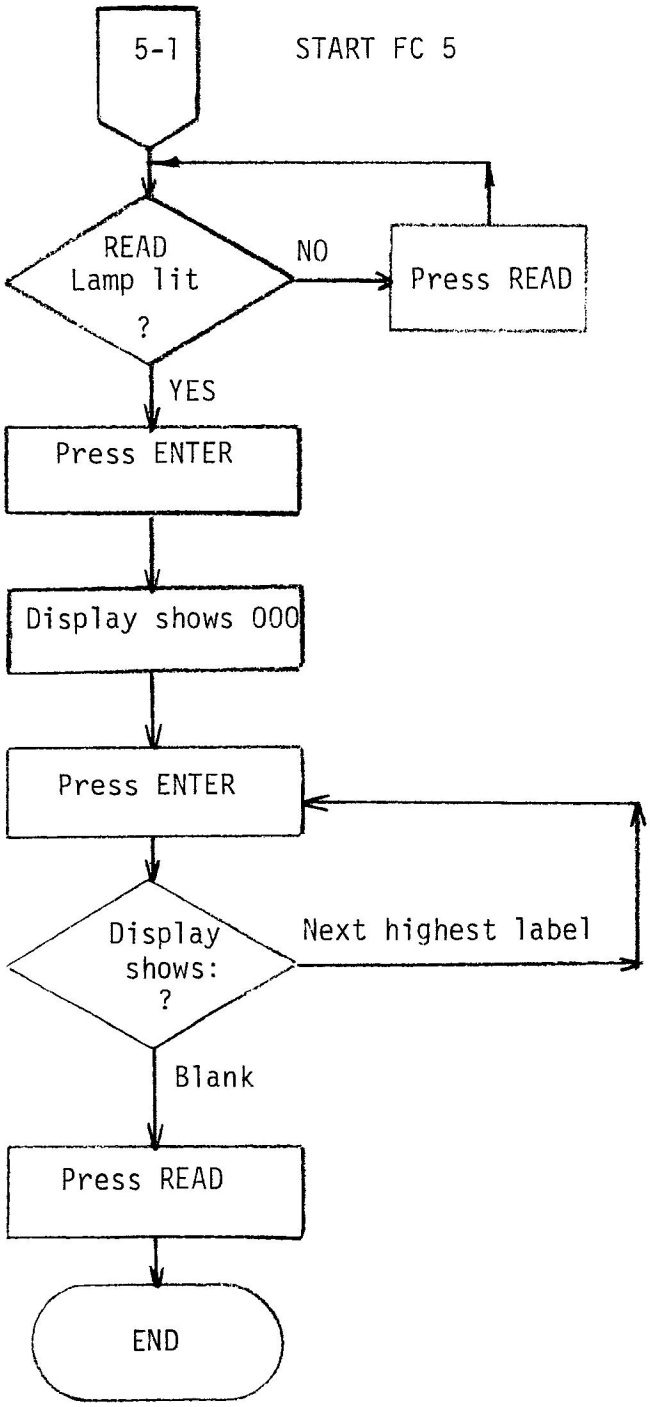
E108 means that there is no program stored under the label you inserted.

E110 is a warning that you are about to alter memory.

Pressing # aborts this sequence.

Pressing CLEAR erases the program stored under the number you selected.

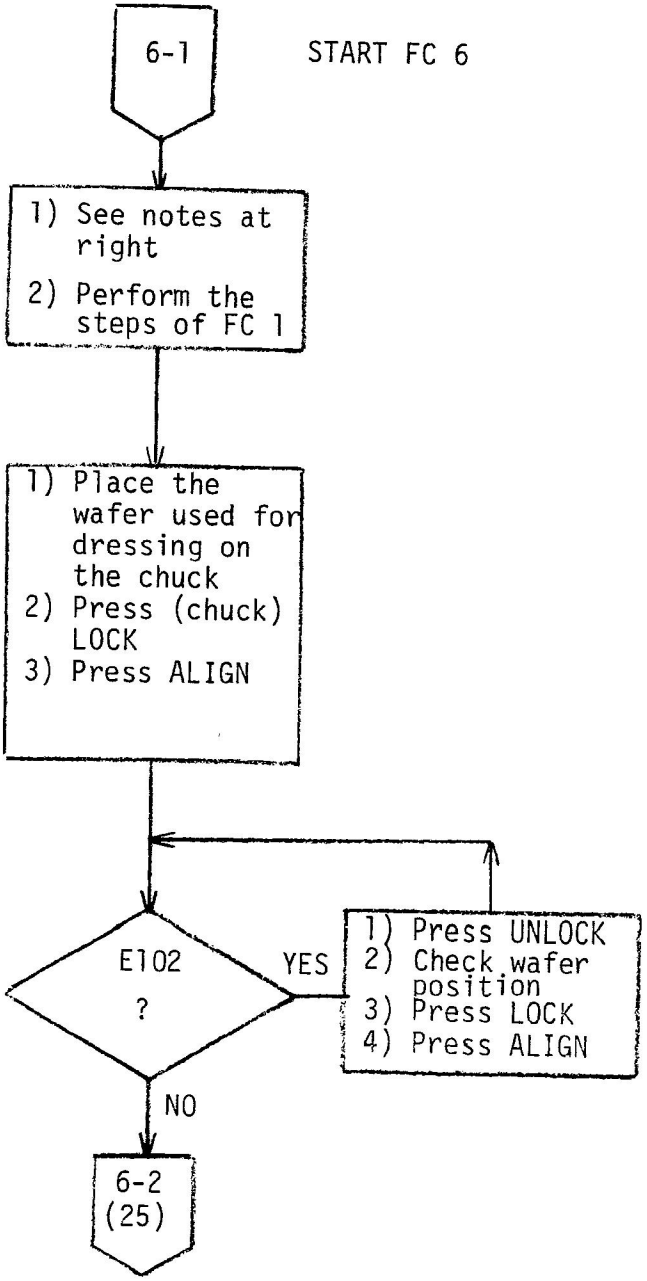
4-15. Flow Chart 5. Reading the Labels of Programs Stored in Memory



When ENTER is pressed, the next highest label is displayed. After all labels are displayed, the display shows blank.

4-16. Flow Chart 6. Automatic Blade Dressing in Silicon

The MAI Model 1006 and 1006A Wafer Dicing Saws feature a built-in blade dressing program. This program is to be used for dressing blades in silicon only. If you use this program to dress blades in carbide dressing blocks, excessive blade wear will result.



NOTES

1) You must enter a value (not zero) for each cutting parameter except CUT COUNT in order to exit the program mode.

2) Use the thickness and diameter of the dressing wafer (length and width if a rectangular wafer is used).

3) Set HEIGHT (thickness minus depth of cut) so that the blade penetrates to the same depth that it will penetrate in production cutting.

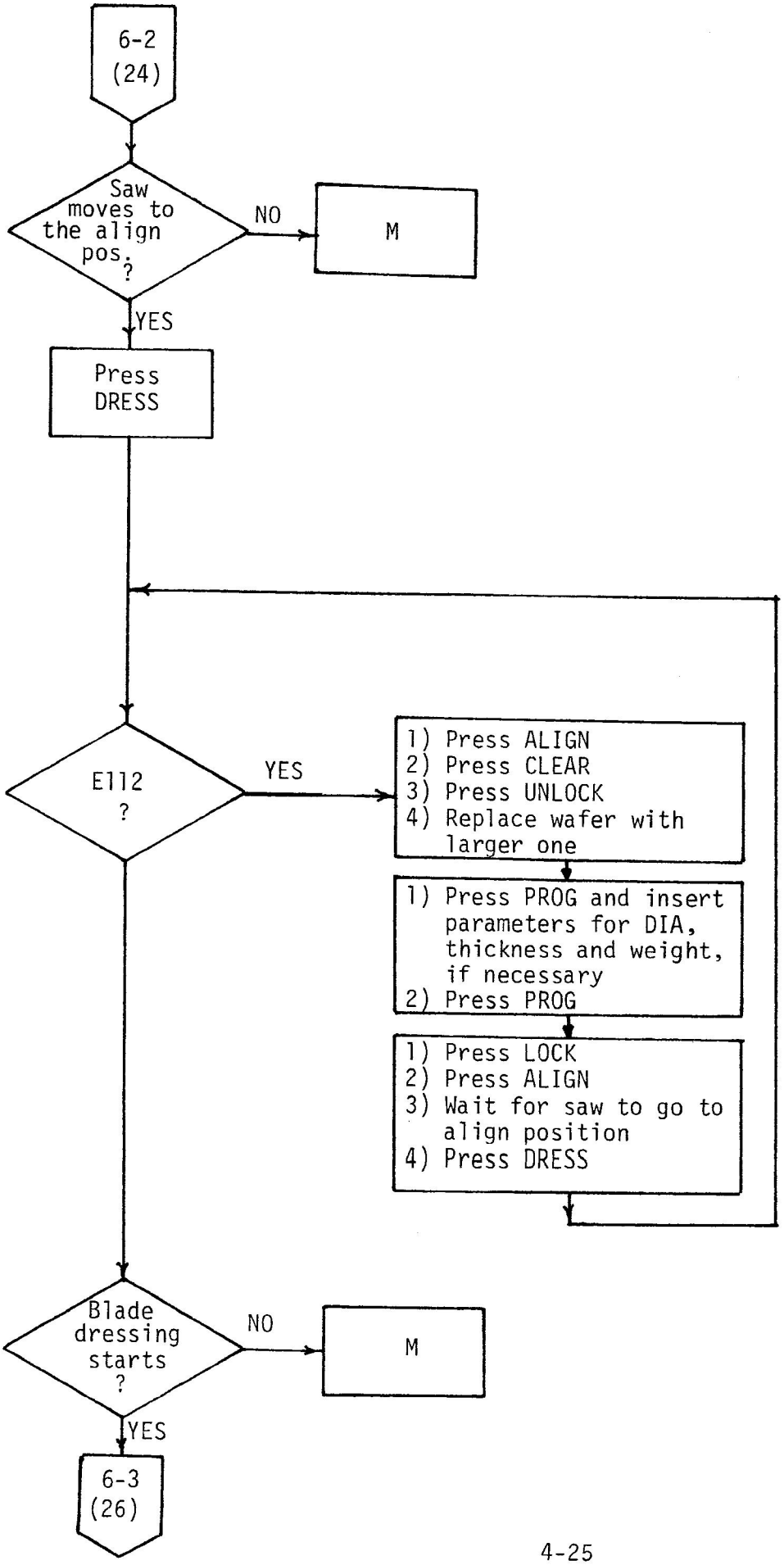
4) Set SPEED to the production cutting speed.

5) Set ANGLE to a value greater than 30°. MAI recommends that the angle be set at 90°.

6) First and second index numbers are overridden by the dressing program, but they must be entered.

7) Do not use Y offsets.

E102 means that the vacuum chuck was not locked. If this condition persists, call maintenance.



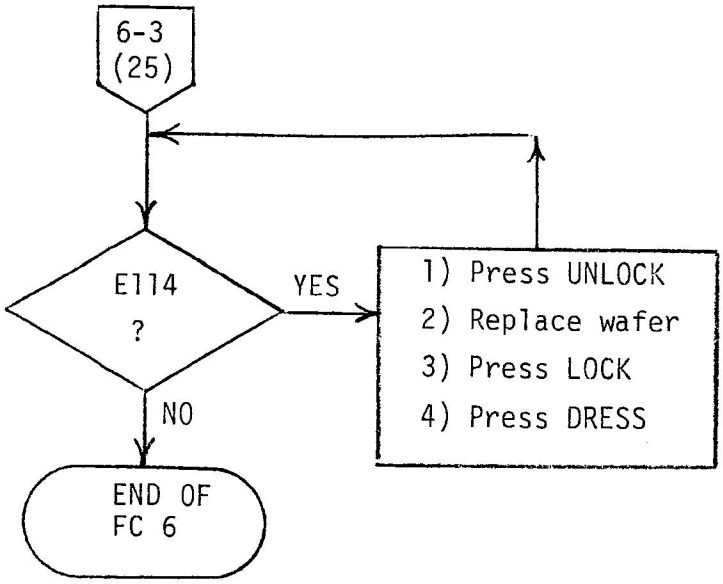
Align position is:
1) Chuck under optics
2) Blade centered front to back.

NOTE

If the blade is not centered, it may be that Y-offsets are stored in the working file. Go to FC 9 (page 4-32) to clear Y-offsets from the file.

E112 means that the number entered into the saw for wafer diameter is less than 1.9 in. (or that length or width was less than 1.9 in.)

The blade dressing program starts cutting at a very slow rate, then gradually increases the speed until the SPEED set in the program is reached. The display shows the speed that the saw is cutting at any moment.



E114 means that the dressing wafer has been 'used up'. The saw returns to the home position.

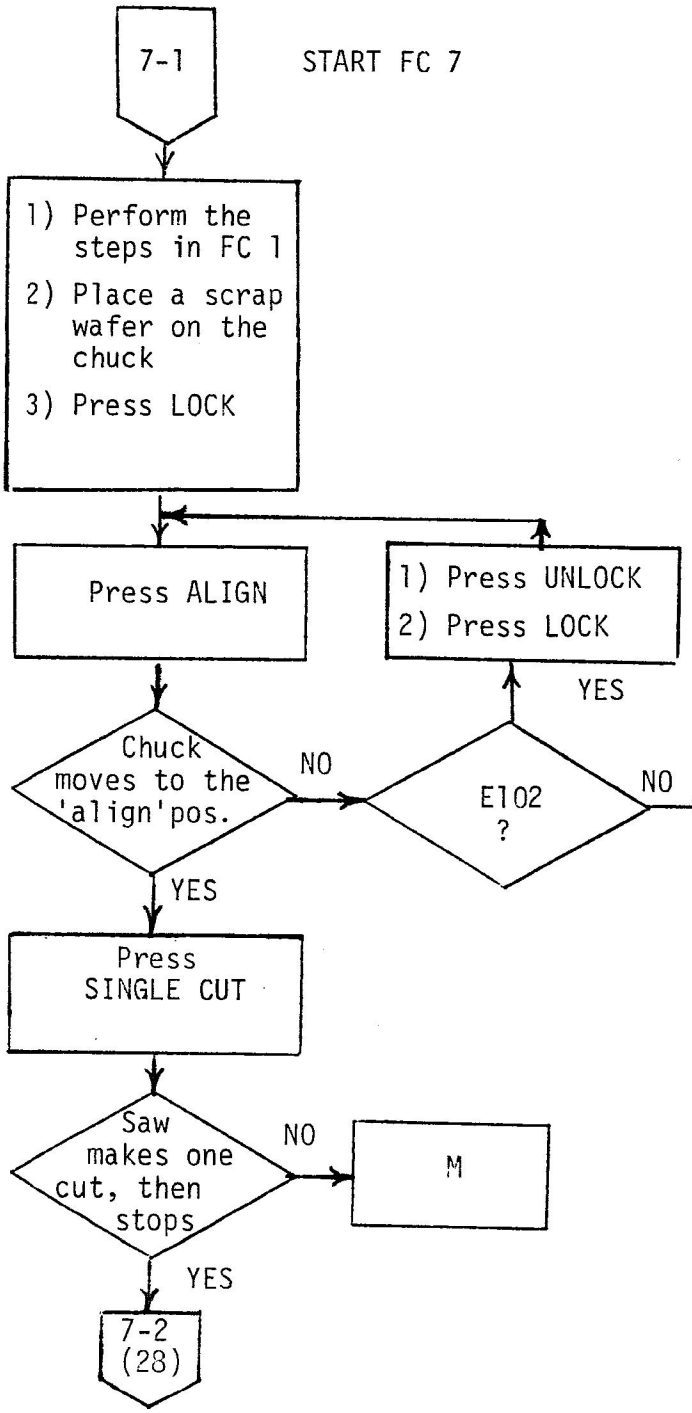
When blade dressing is complete, a signal is sounded.

NOTE

After blade dressing a chuck zero operation must be performed before the saw can be operated. This is necessary because the dressing may change blade diameter slightly. E104 will be displayed if an attempt is made to operate without a new chuck zero.

4-17. Flow Chart 7. Alignment of Optics to Blade - Model 1006

Following the steps in this flow chart will align the monocular optics on the Model 1006 to the plane of the blade. This will ensure that the saw will cut exactly down the street that is lined up under the cross hairs of the microscope. Alignment is generally necessary when changing blade types, or alignments can be performed as periodic maintenance. Alignment must be checked after optics are replaced.



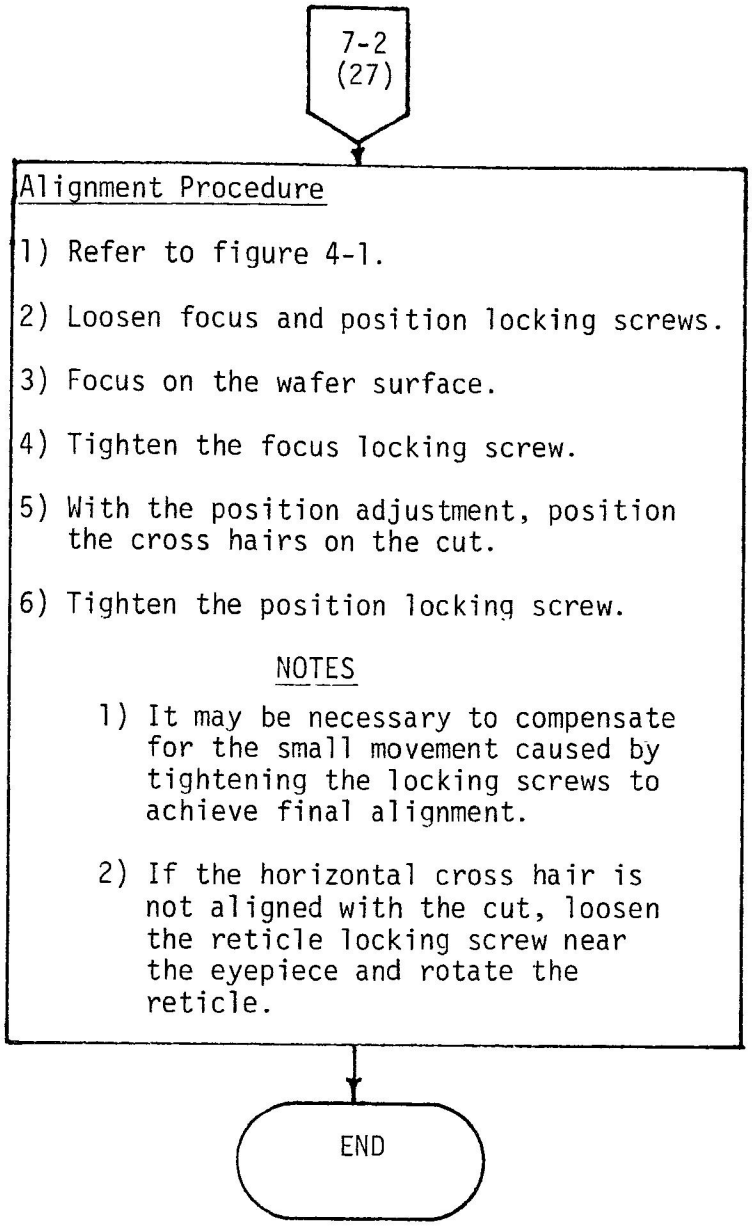
Program the saw for the desired cutting pattern, except set SPEED to 500 mils/sec (13 mm/sec).

Chuck moves so that the wafer is under the optics.
Align position:
1) Wafer under optics
2) Blade centered

E102 shows that chuck lock was not done. If this condition persists, call maintenance.

Saw will make a single cut then return the chuck to the align position.

FC 7 - Continued



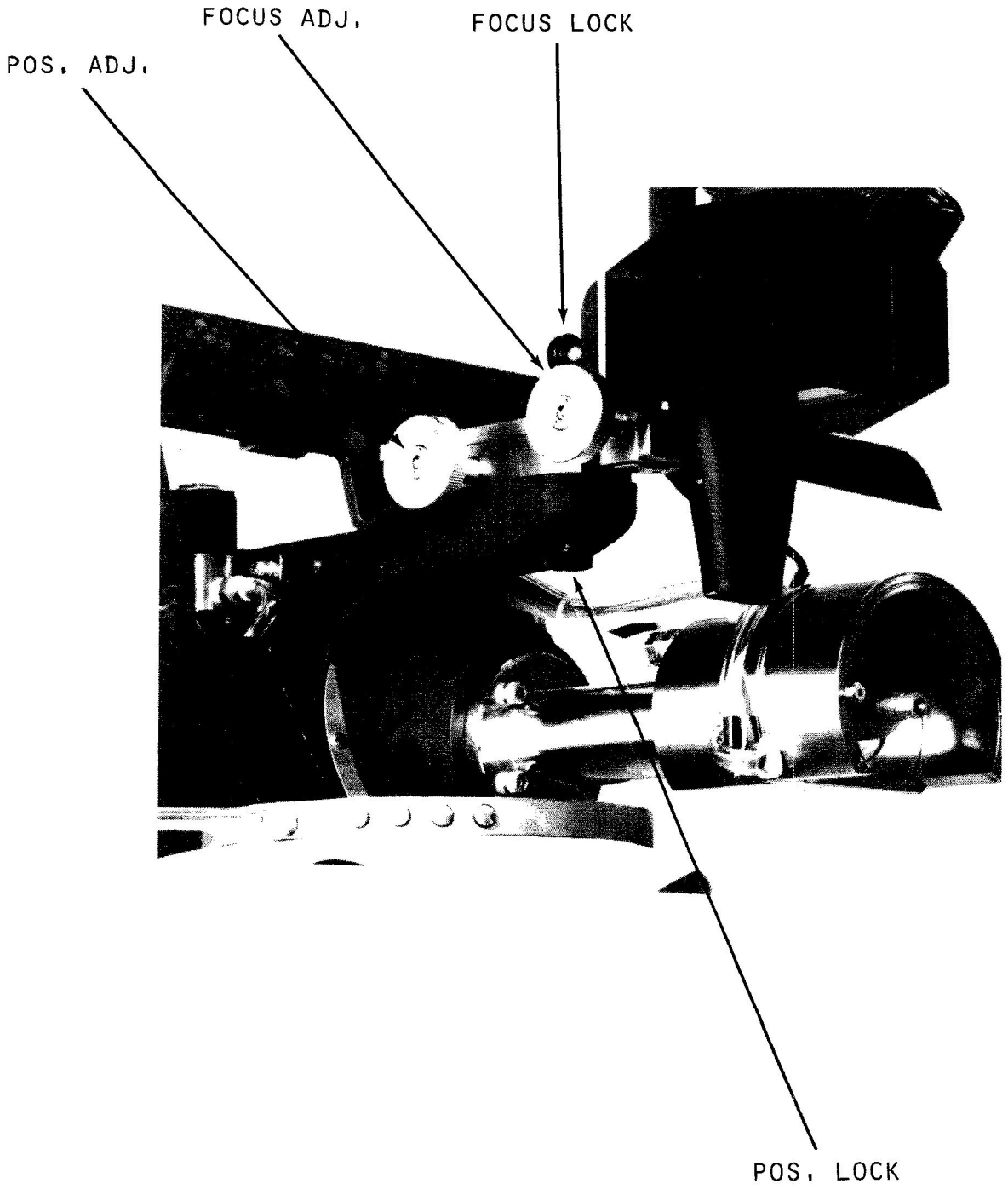
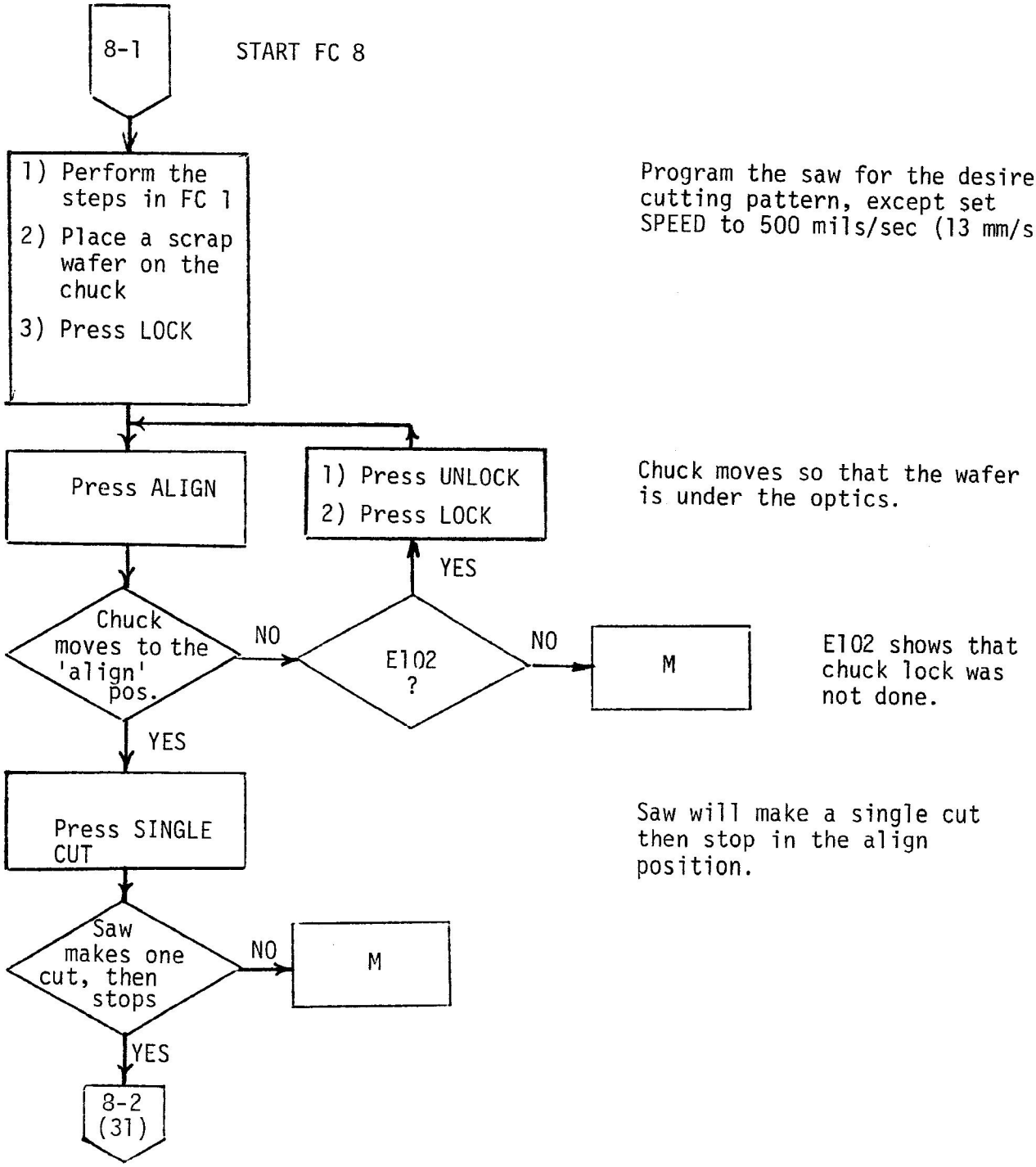


Figure 4-1. Monocular Optics Adjustments

4-18. Flow Chart 8. Aligning Optics to Blade, Model 1006A

Following the steps in this flow chart will align the television split-field optics on the Model 1006A to the plane of the blade. This will ensure that the saw will cut exactly down the street that is lined up under the reticle.



FC 8 - Continued

8-3
(30)

Alignment Procedure

1) Refer to figure 4-2.

2) Adjust focus adjustment until a clear image of the wafer surface is obtained.

3) Loosen the mounting screws and move the entire camera assembly until the reticle is centered in the cut, and the cut appears continuous across the screen.

4) Tighten the screws. It may be necessary to compensate for movement when the screws are tightened.

NOTES

1) For find adjustment of the reticle position, the camera is provided with position up and down controls on the right side of the camera.

2) There are also some spacing controls to allow use of a two-line reticle.

3) The WHT and BLK controls change the reticle line or lines white or black without changing the position.

4) The reticle will return to the center and a single black line if power is removed.

END

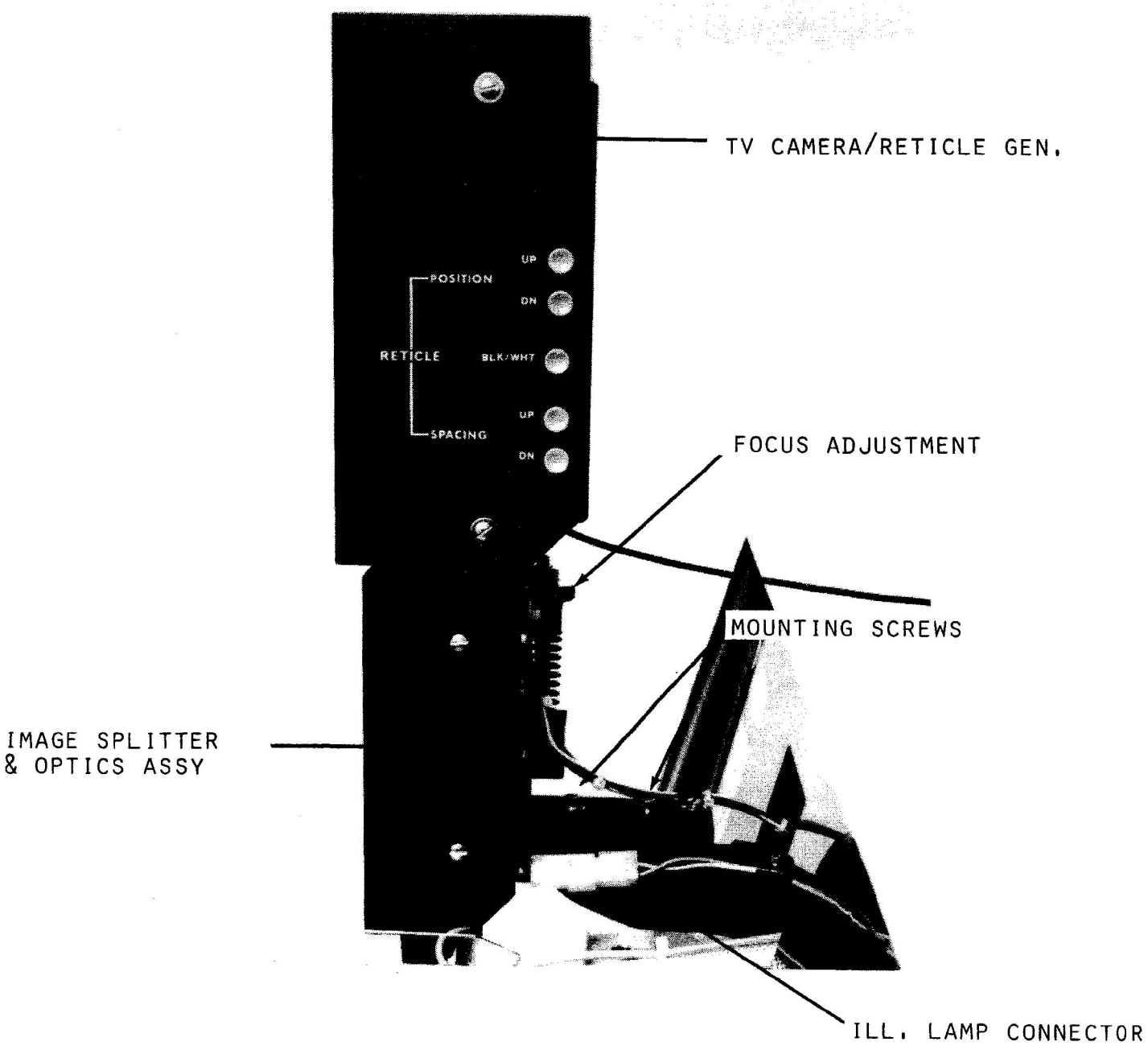


Figure 4-2. Split Image TV Adjustments

4-19. Flow Chart 9. Inserting and Clearing Y-offsets

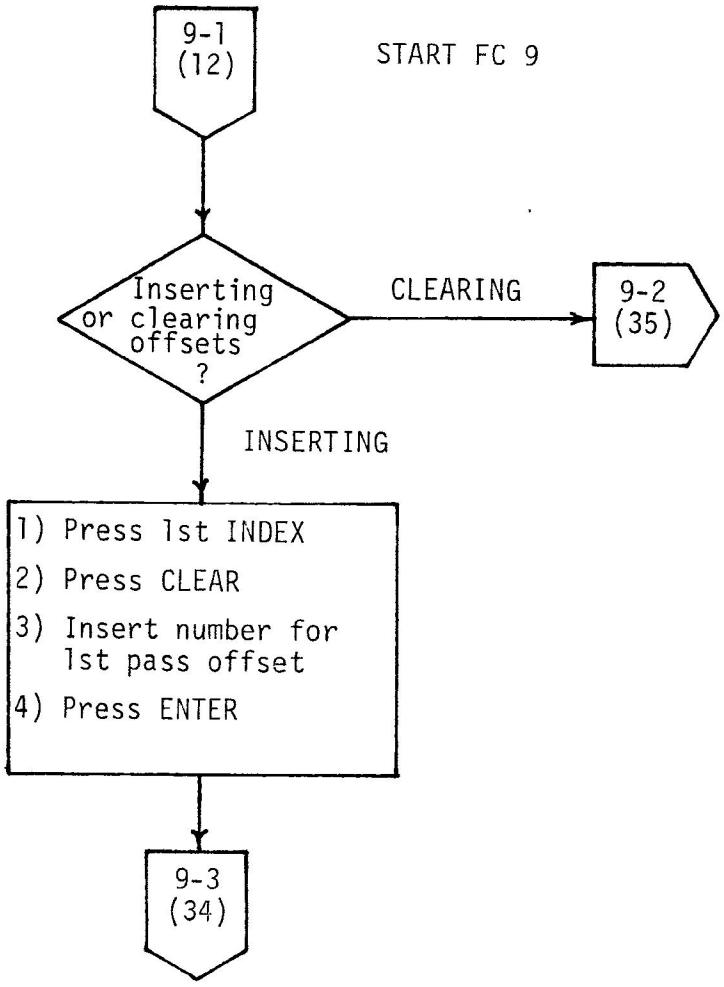
Y-offsets are inserted to cause the Y axis to go to a position other than the center of the wafer during alignment. Following is a list of characteristics of Y-offsets.

1) Offset is always toward the operator.

2) Y-offset values are cleared when the saw is turned off or put into STANDBY.

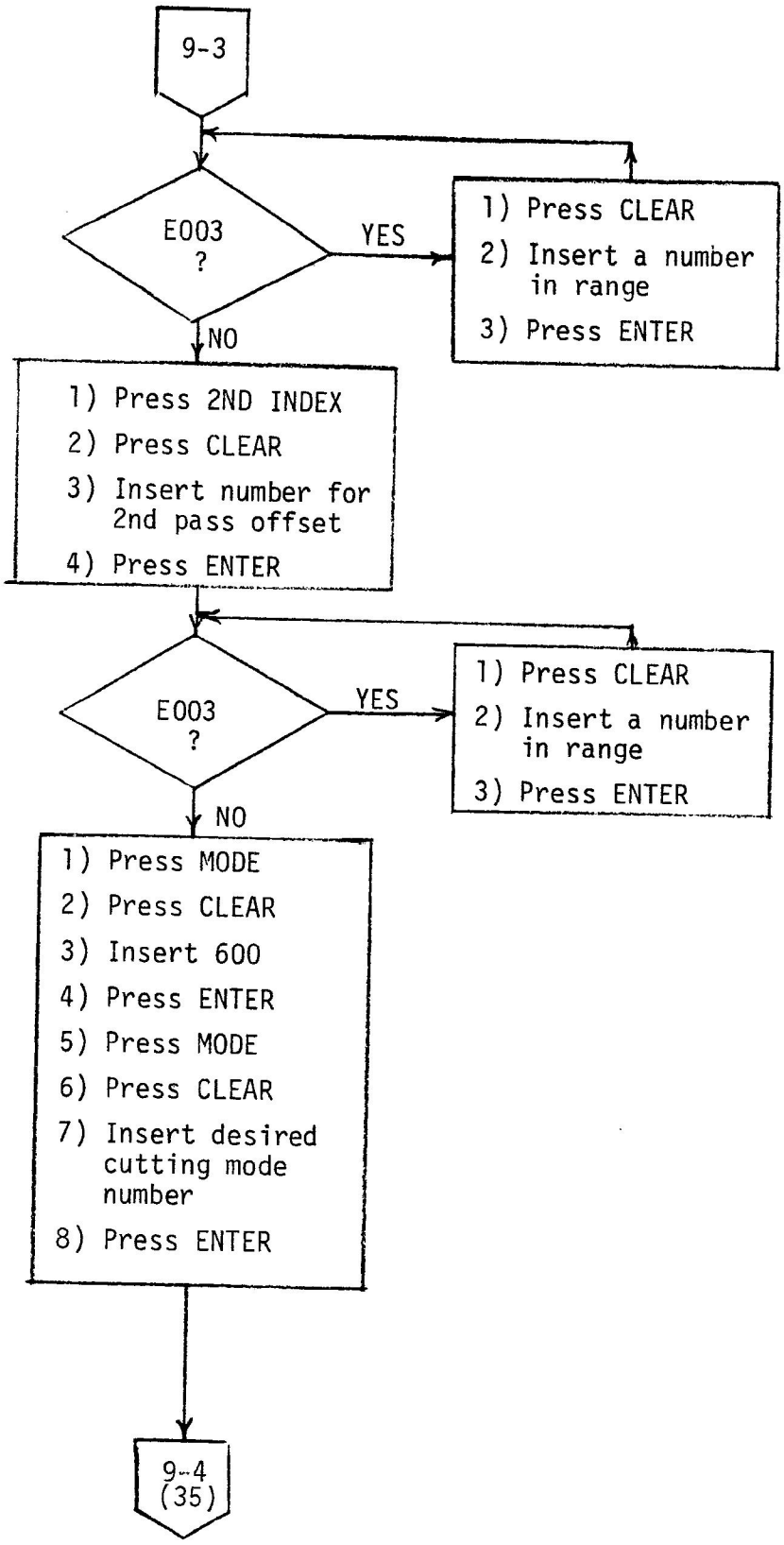
3) If a new program is inserted into the working file, Y-offsets will be applied to the new 1st and 2nd index values. This is true whether the saw is programmed from the panel or a program is recalled from storage.

4) Y-offset values are programmed in the index position.



Enter this FC from FC 1. Offsets are inserted before 1st or 2nd index. If you insert offsets after programming 1st or 2nd index numbers, index numbers will go to zero, and you cannot exit from the program mode. E103 will be displayed.

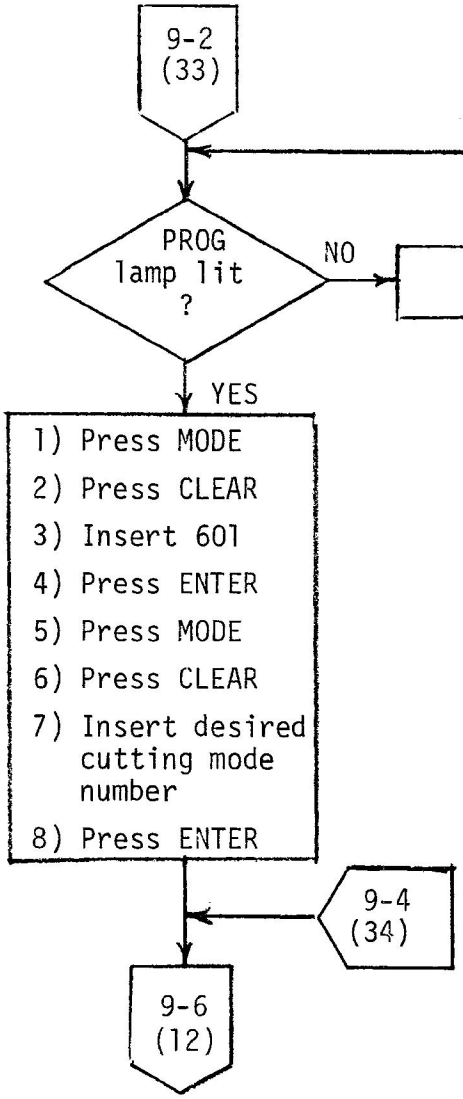
The offset value is the distance forward of the wafer center where you want to align. Numbers are entered in mils (Eng) or mm (metric).



E003 means that the number inserted is outside the range for Y-offset. Y-offset must be between 0.125 and 4000 mils (0.003 to 102 mm).

See note above.

When ENTER was pressed after 600 was inserted, the offsets were put into the working file. It is necessary to press MODE again and to clear the 600 mode before operating the saw.



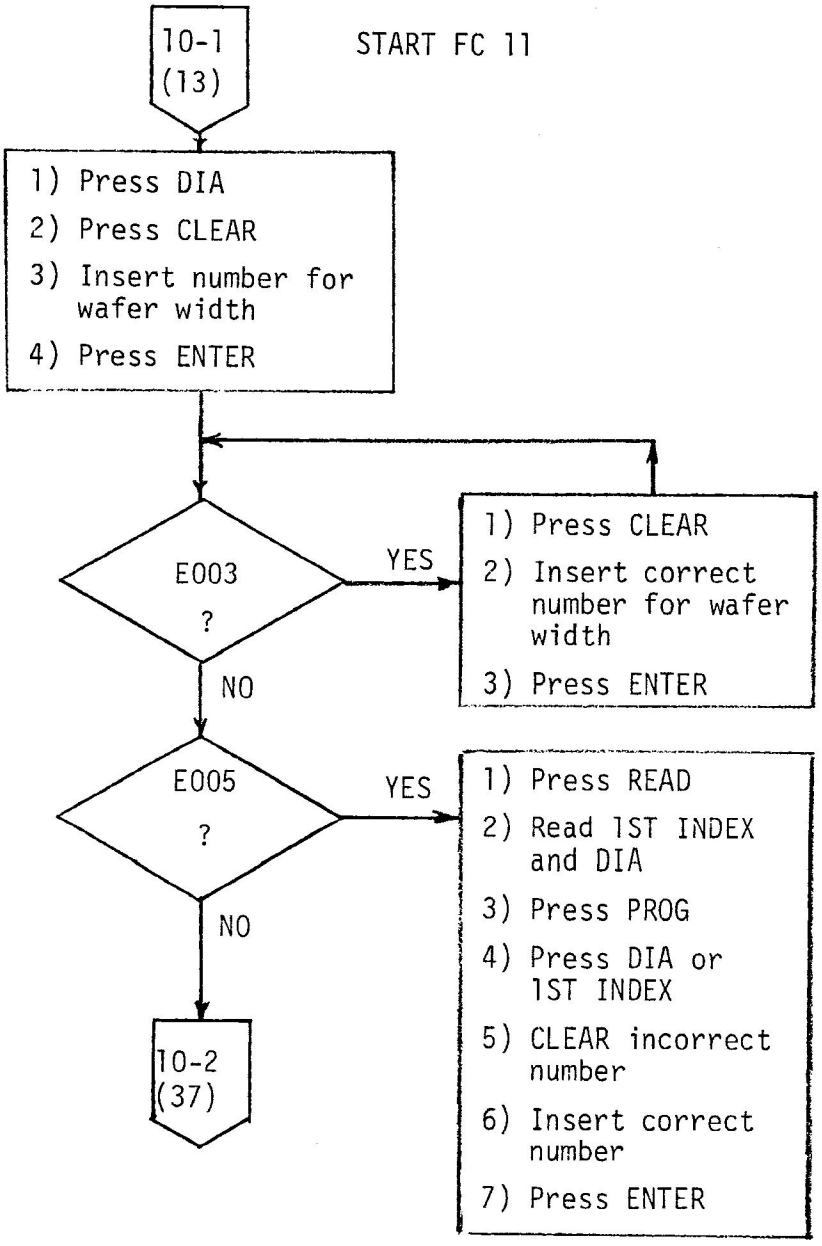
Start here to clear Y-offsets.

When ENTER was pressed after 601 was inserted, the Y-offsets were cleared.

Reenter FC 1
Page (12)

4-20. Flow Chart 10. Cutting Rectangular Wafers

Cutting square or rectangular wafers requires that a dimension be entered for wafer length. During programming the saw stores the wafer width (right-to-left dimension) when DIA is entered, and the length when the asterisk (*) dimension is entered.



This FC is entered from FC 1.

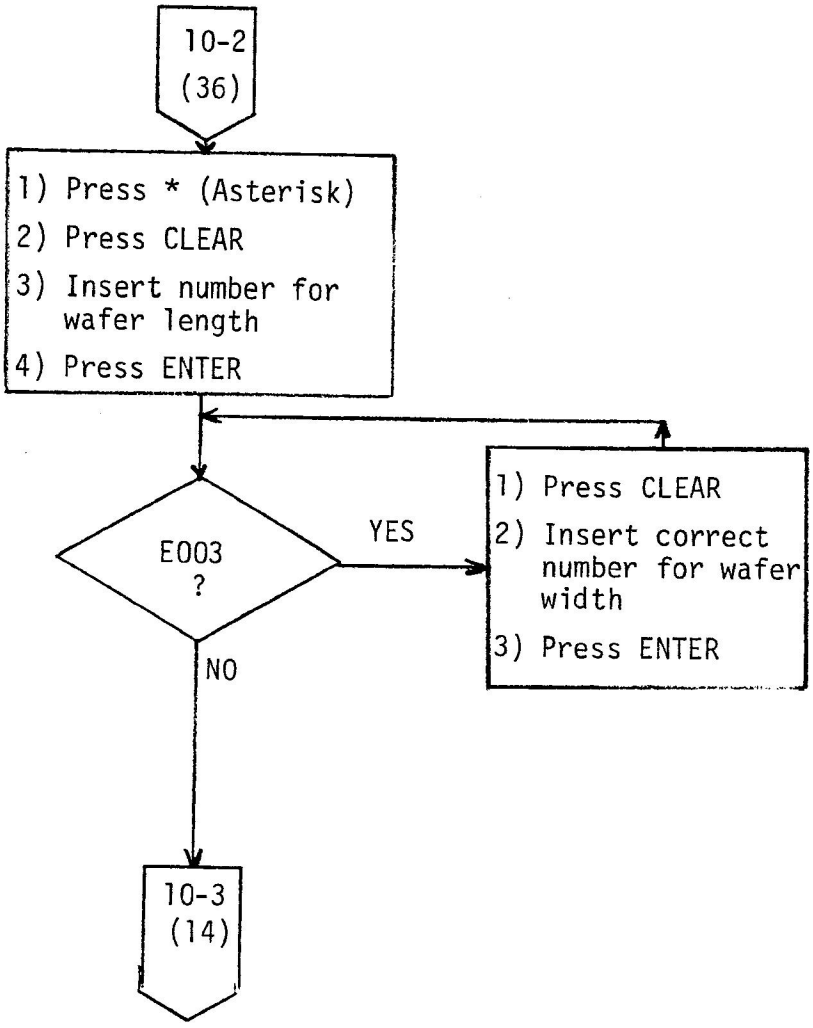
Wafer width is defined as the dimension from right to left (the cutting stroke on the first pass).

E003 means number out of range. Diameter must be between 0.25 and 6000 mils (0.006 and 152 mm).

E005 means that the number inserted for the first index back on FC 1 is too large for the number you have just entered for wafer width.

This procedure corrects the 1ST INDEX or DIA number.

FC 10 - Continued



Pressing * at this time tells the saw's computer that the next number entered will be the length of the 2nd pass. It also tells the computer that you are cutting a rectangular wafer.

E003 means number out of range. The wafer length must be between 0.25 and 6000 mils (0.006 and 152 mm).

Reenter FC 1

4-21. Flow Chart 11. Basic Dicing and Scribing Procedures for Round Wafers

This flow chart shows the steps to perform in aligning and cutting round wafers. There are three methods of wafer alignment that can be used. These are: single pass, dual pass, and no pattern alignment. These methods are described below.

NOTE

This flow chart does not cover cutting wafers with hexagonal dies or progressive cutting. See the appropriate charts for these operations.

1) Single Pass Alignment (Mode 10). The operator aligns the streets to the blade using the monocular or TV optics, then presses AUTOCUT. The saw makes all the cuts for the first pass, rotates the wafer through the programmed angle, returns the wafer to the align position, and sounds a signal. The operator aligns the wafer for the second pass and again presses AUTOCUT. The saw then cuts the second pass and goes to the home position. Again the audible signal is sounded to indicate that dicing or scribing is complete.

2) Dual Pass Alignment (Mode 10). In this operation, the operator aligns the wafer for pass 1, then rotates the wafer and aligns the streets in the other direction. When AUTOCUT is pressed, the saw cuts both passes without operator intervention. At the end of the dicing or scribing operation a signal is sounded.

3) No Pattern Alignment (Mode 11). This method of cutting is used on blank wafers. In No Pattern mode the saw chuck rotates through the programmed angle after cutting the first pass and makes the second pass without pausing for alignment. This is not the same as dual pass alignment, since there is no provision for alignment on the second pass. The program uses the center of the chuck for an alignment reference.

You can stop the saw during the cutting operation by pressing EMERGENCY OFF, STANDBY, RESET, INDEX or ALIGN. What these switches do, and the steps to take to resume sawing, are listed below.

1) EMERGENCY OFF. This is the red pushbutton switch located below the programming panel. This is a 'panic button' to shut down everything. Under normal circumstances, the saw is stopped by pressing STANDBY.

2) STANDBY. The saw immediately goes through the homing sequence and returns to standby status; that is, power is removed from the motors, but the logic power remains on. Chuck zero reference is lost, but the working file program is preserved. Spindle is turned off.

3) RESET. Similar to STANDBY, but stepping motor power is left on, and spindle continues to run.

4) INDEX. The saw finishes the cut it is making, then returns to the Index position. When AUTOCUT is pressed, the cutting will start at the next street to the back. See figure 4-1. Chuck zero is retained.

5) ALIGN. The saw finishes the cut and stops in the Align position. However when AUTOCUT is pressed, sawing commences at the front of the wafer. See figure 4-1. Chuck zero is retained.

NOTE

When SINGLE CUT is pressed, only X and Z axes move, and the cut is made in the position the wafer is in. This is true when SINGLE CUT is pressed with the saw in ALIGN or INDEX.

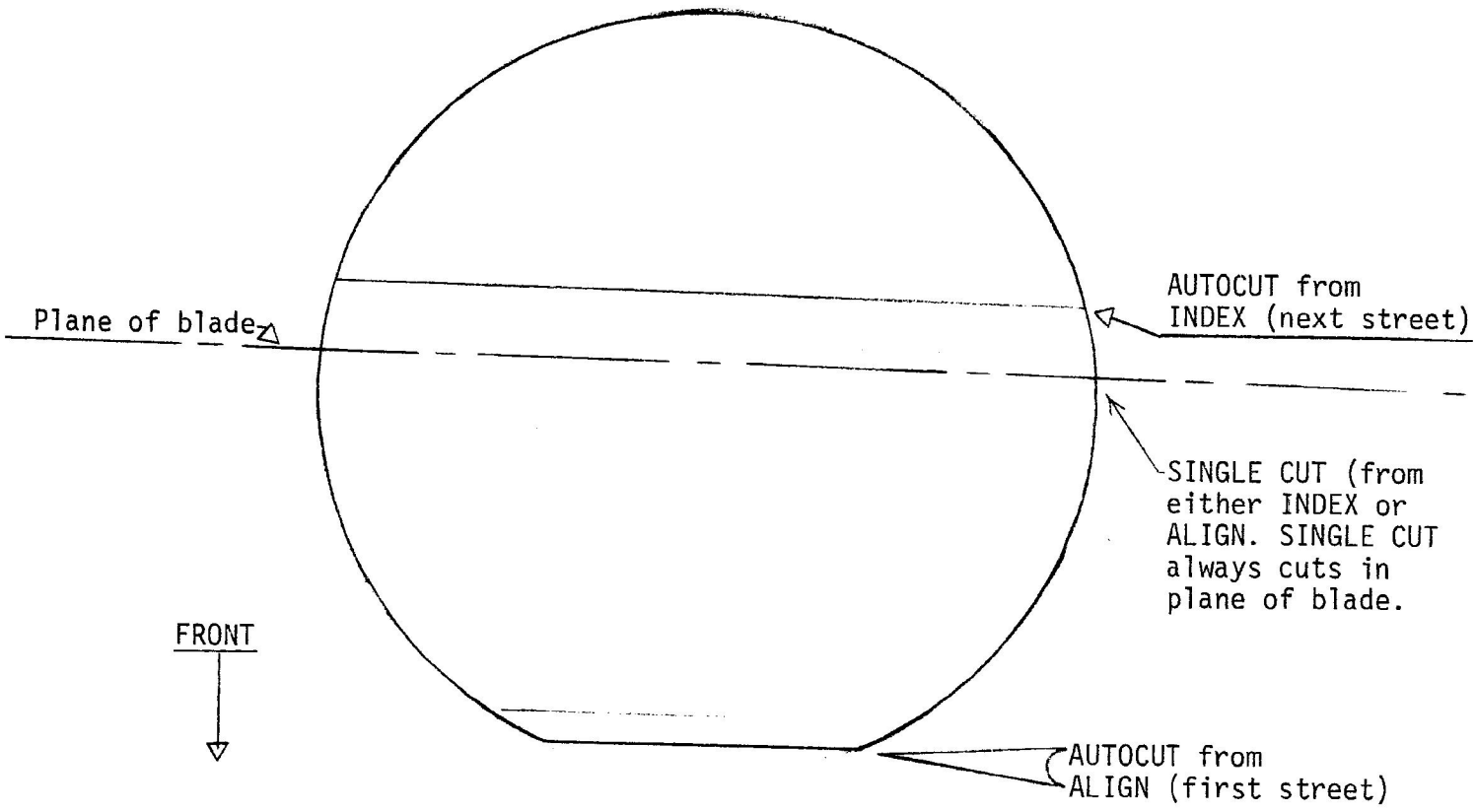
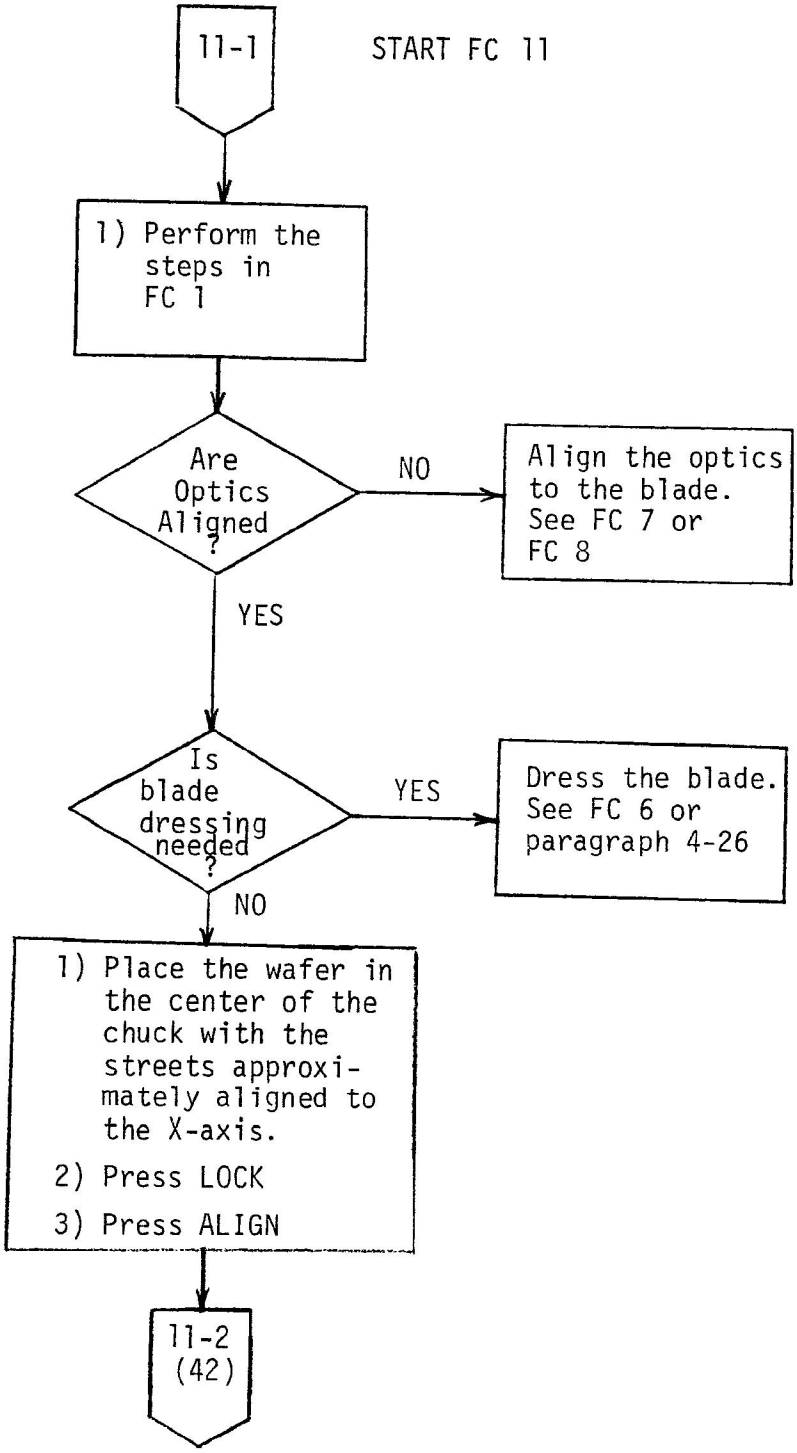


Figure 4-3. Starting Points of First Cut When AUTOCUT or SINGLE CUT is pressed



The conditions of the saw should be :

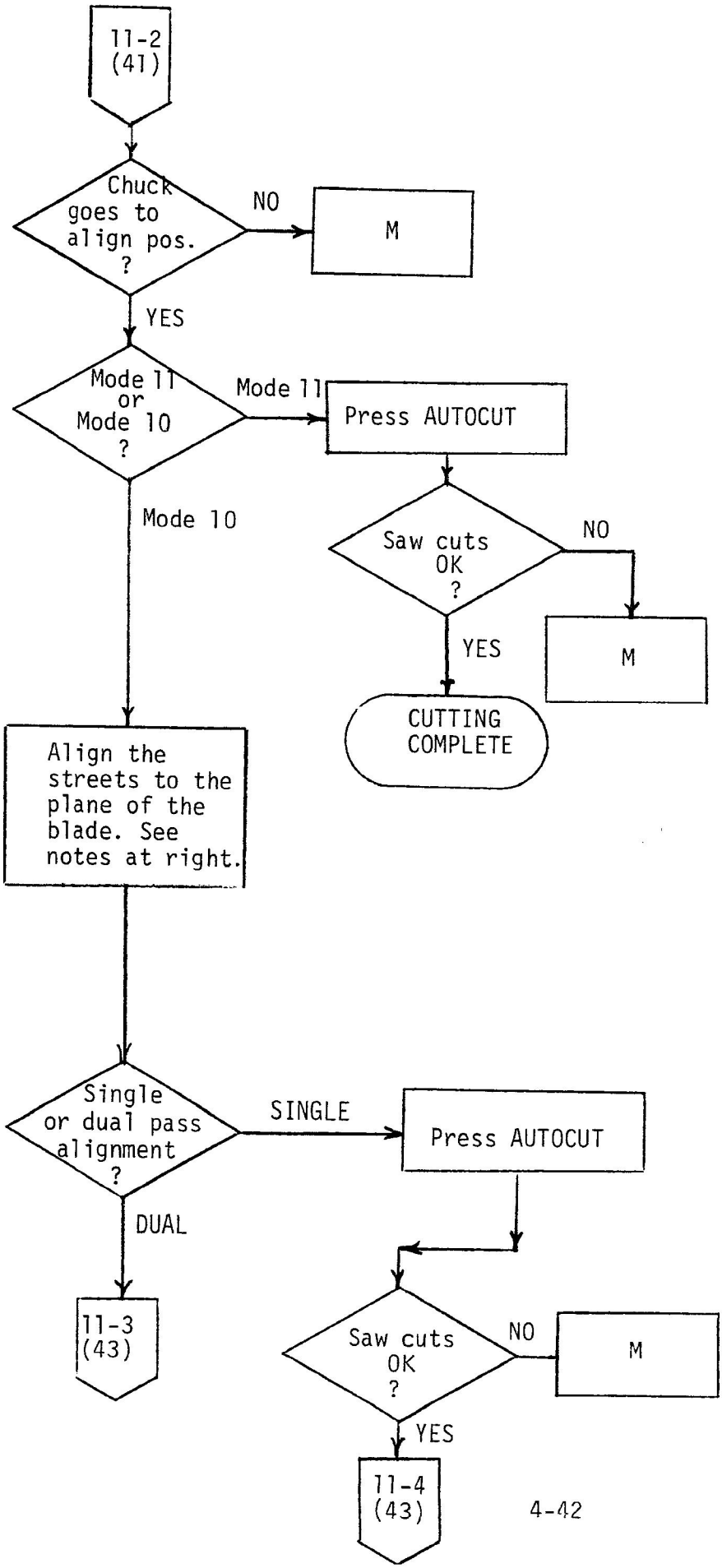
1) Spindle running
2) Chuck zero performed (chuck zero lamp lit)
3) Chuck should be 'home'.

FC 6 covers automatic blade dressing.

Paragraph 4-26 covers manual blade dressing.

NOTE

If wafers are mounted on film frames, placing the frame so that it engages the pins on the film frame adapter will quickly align and center the wafer.

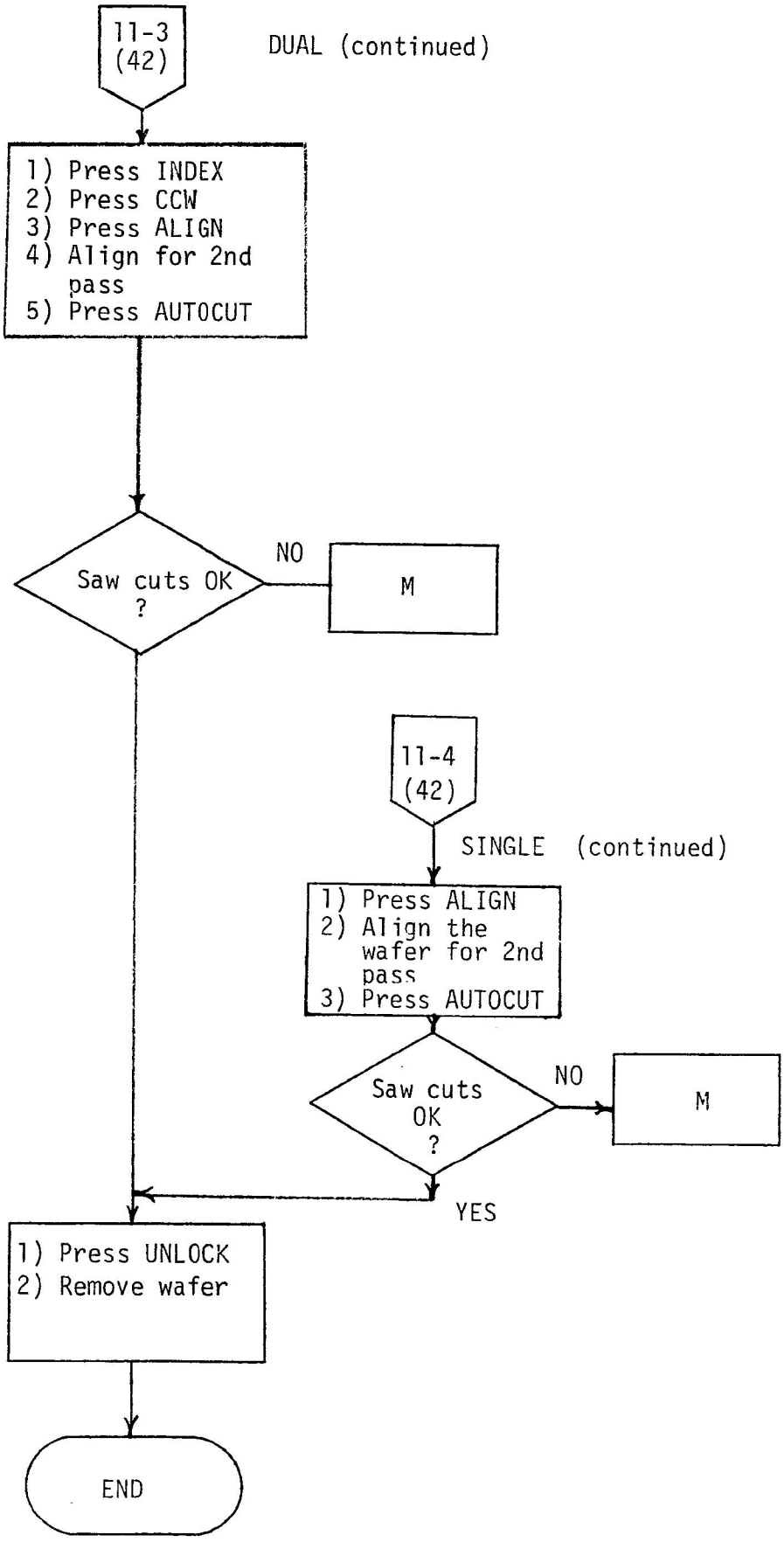


Align position: Wafer under optics, and blade centered front-to-back (unless Y-offsets are used).

Mode 11 is used to cut blank wafers. After AUTOCUT is pressed the saw will scribe or dice the wafer for one pass, rotate the wafer through the programmed angle, then cut the other pass. Chuck will 'home' after cuts are made, and the signal will be sounded.

Alignment procedures for monocular optics are given in paragraph 4-24. Procedures for the TV split field optics are given in paragraph 4-25.

The saw will cut the first pass, rotate through the programmed angle, and return to the align position.



1) The chuck rotates through the programmed angle for alignment.

2) When AUTOCUT is pressed the saw will cut the streets just aligned. Then the chuck rotates back through the programmed angle and the cross streets are cut. When cutting is finished, the saw returns to 'home' position and the signal is sounded.

The saw will cut the streets, return the chuck to the 'home' position, and sound the signal.

This completes the procedure for cutting the first wafer. Other wafers with the same geometry may be cut by repeating this procedure.

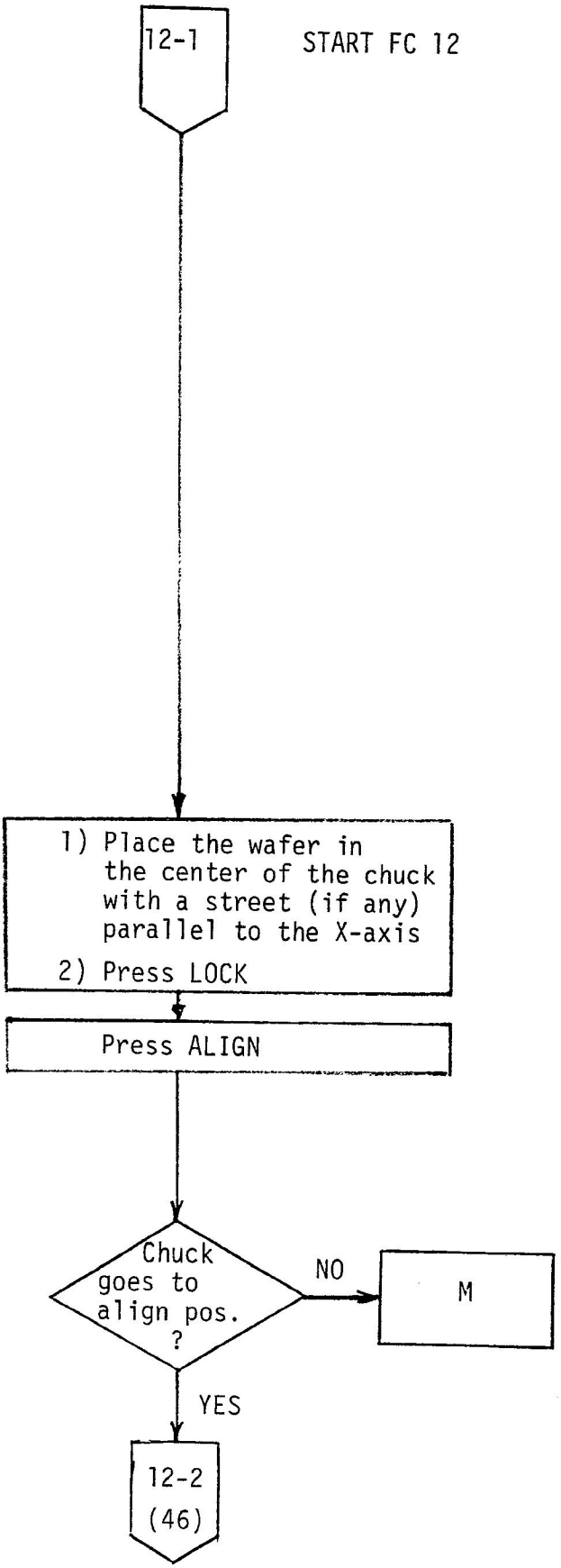
4-22. Flow Chart 12. Cutting Hexagonal Dies

Cutting hexagonal dies requires three passes, each separated from the last pass by 60 degrees. Three operating modes are provided in the MAI saws: manual, automatic, and semiautomatic. These modes are described below.

1) Manual Mode (Mode 20). Manual alignment of all three axes one at a time. Triple alignment can be made where all three passes are aligned before cutting begins.

2) Automatic Mode (Mode 21). No pattern alignment.

3) Semiautomatic Mode (Mode 22). Semiautomatic, no pattern alignment where no alignment is required for passes 1 and 2 and pass 3 is aligned to the intersection of 1 and 2. To cut unpatterned wafers you should cut the first wafer in this mode and then all subsequent wafers can be run in Mode 21.



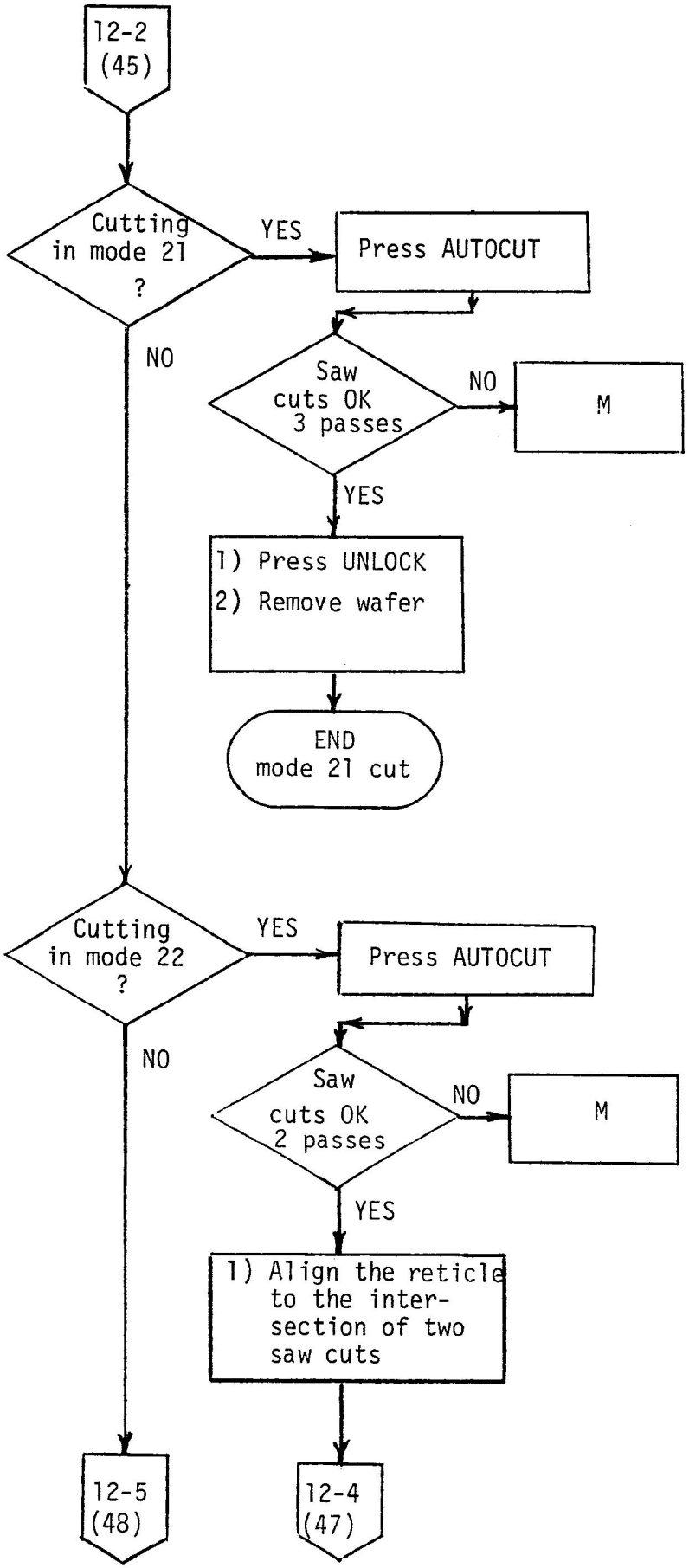
Saw conditions should be:

1) Spindle running
2) Chuck zero performed (lamp associated with chuck zero lit).
3) The chuck should be 'home'.
4) Optics aligned.
5) A dressed blade should be mounted.
6) A hex cutting program should be in the working file.

NOTE

If wafers are mounted on film frames, placing the frame so that it engages the pins on the film frame adapter chuck will accurately align and center the wafer.

Align position: Wafer under optics and blade centered front-to-back (unless Y-offsets are used).

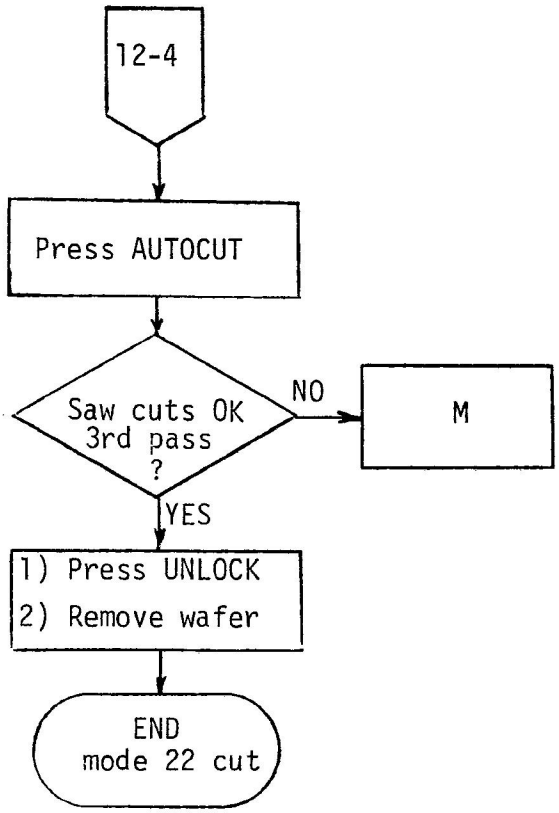


The saw will cut the first pass. Then the chuck will rotate 60° CCW and the second pass will be cut. The chuck will rotate another 60° and the third pass will be cut. Saw will return to 'home' position.

This process may be repeated by placing another wafer on the chuck, pressing LOCK, ALIGN, then AUTOCUT.

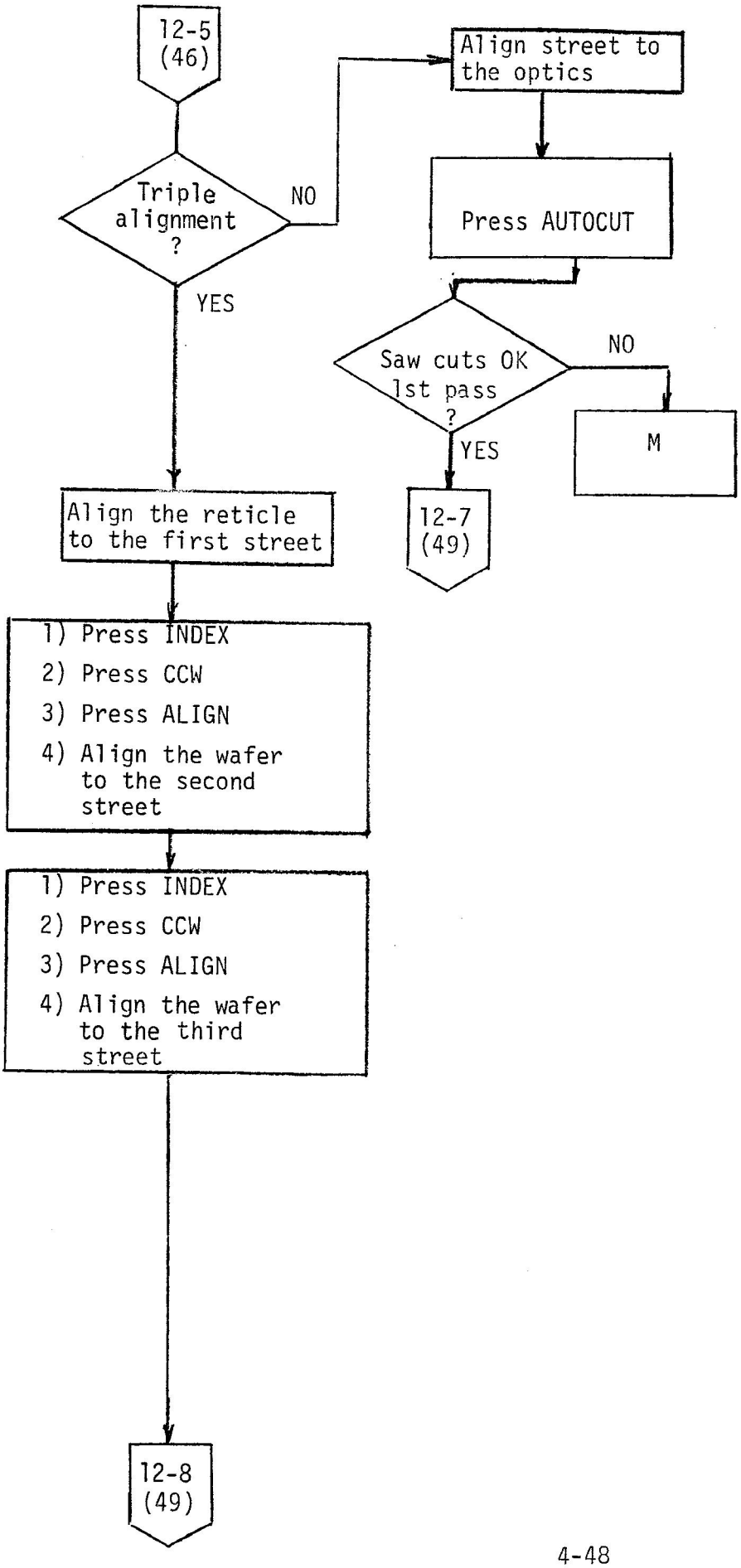
The saw will cut two passes 60° apart, then return to the align position (wafer under optics).

This increases the accuracy of the third cut. Align to the intersection of any two cuts. Alignment to any other part will produce shapes that are not hexagons.



Saw will cut the third pass. The change you put in Y in the last step will be remembered by the saw. After the pass, the saw returns 'home'.

Now that the Y correction is in the memory, subsequent wafers can be cut in the full automatic mode 21. Change to mode 21 and repeat the steps above to cut more wafers to this pattern.

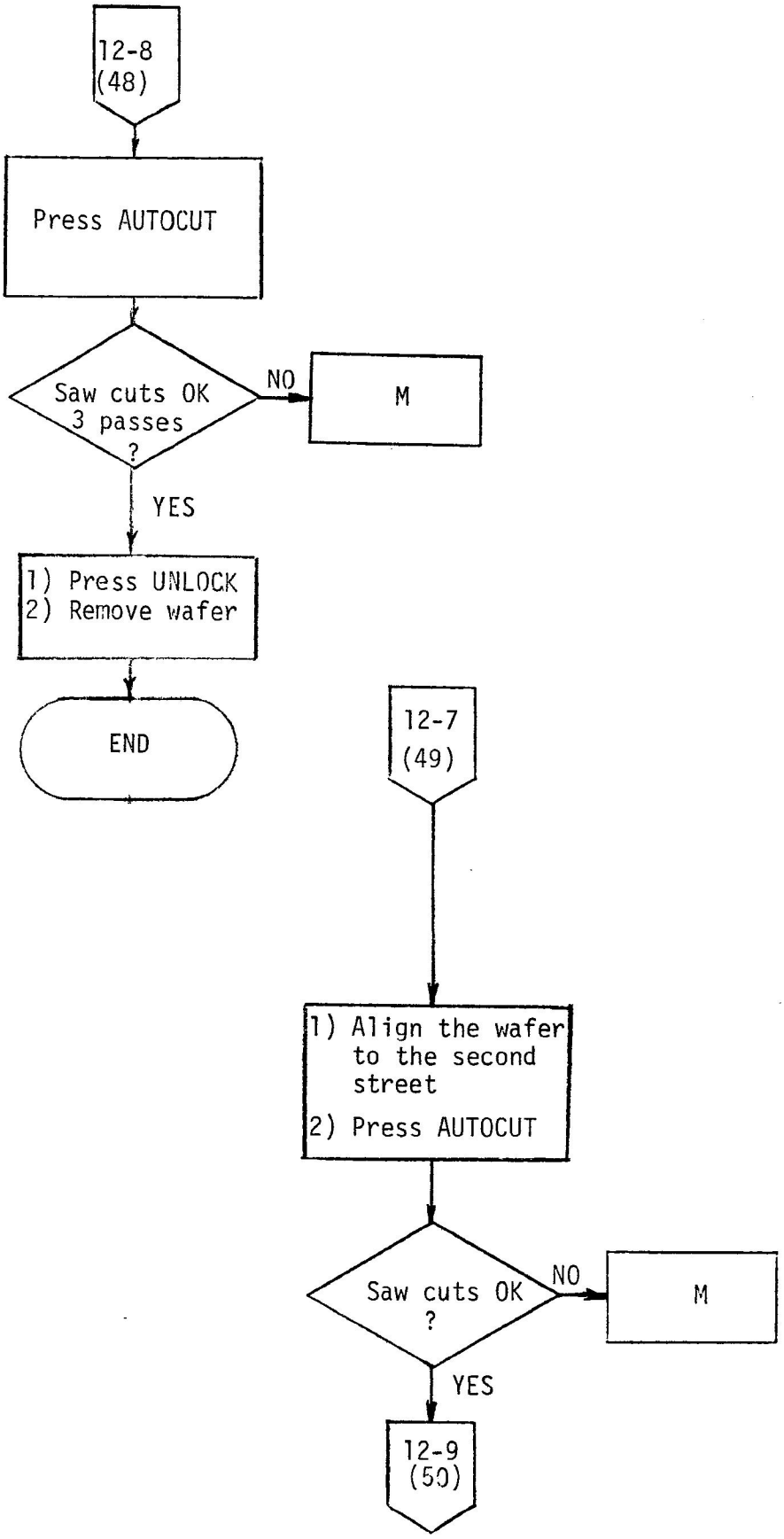


This starts the manual (mode 20) cutting procedure. As in cutting round or rectangular dies, all passes may be aligned before cutting, or the alignments can be made before each pass.

The saw will cut the first pass, rotate 60°, and return to the align position.

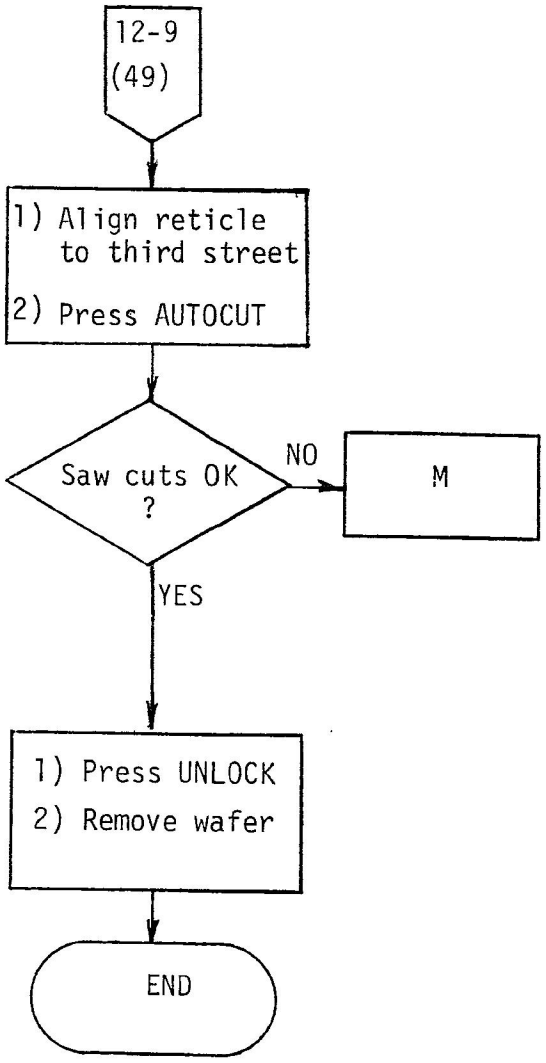
The chuck will rotate 60° for alignment to the second street.

This aligns the chuck for the third pass. The saw will remember this alignment and the previous one and automatically cut all three passes.



The saw will cut all three passes, then return to 'home'.

This completes the procedure for cutting hexagonal wafers with triple automatic alignment. Other wafers with the same geometry may be cut by repeating this procedure.



CAUTION

Be sure to line up on an intersection, rather than on a street. Aligning on a street for the third pass will cause the saw to cut through dies.

The saw will cut the third pass. All axes will 'home'.

This completes the procedure for cutting hexagonal IC dies from round wafers. Other wafers with the same geometry may be cut by repeating this procedure.

4-24. Wafer Alignment Using the Monocular Microscope

The MAI Model 1006 Wafer Dicing Saw is provided with a monocular microscope to align the streets on a wafer to the plane of the blade. When properly adjusted, the horizontal line on the reticle indicates where the cut will be made. (See paragraph 4-17 for instructions on checking and adjusting the microscope.)

To align a wafer prior to cutting, follow the steps below.

1) Make sure the saw is programmed for the geometry of the wafer you are going to scribe or dice.

2) The saw should be in the RESET condition:

   a) Spindle running

   b) Chuck zero performed (lamp on)

   c) All axes in 'home' position.

3) Place the wafer in the center of the chuck with the streets in approximate alignment. (If film frames are used, place the frame so that it engages the pins on the chuck adapter.)

4) Press LOCK.

5) Press ALIGN. The saw will place the center of the wafer under the microscope.

6) Use the focus adjustment (see figure 4-1) to get a clear image of the wafer.

7) Figure 4-4 is a sketch of a typical wafer as seen through the microscope. In figure 4-4 neither the Y axis nor the theta axis is aligned.

8) Press FAST, then BACK or FWD to bring the center of the street under the cross hairs. See figure 4-5.

NOTE

The FAST switch works only on the next switch pressed. When that switch is released, the movement of the axes is slowed for fine adjustment.

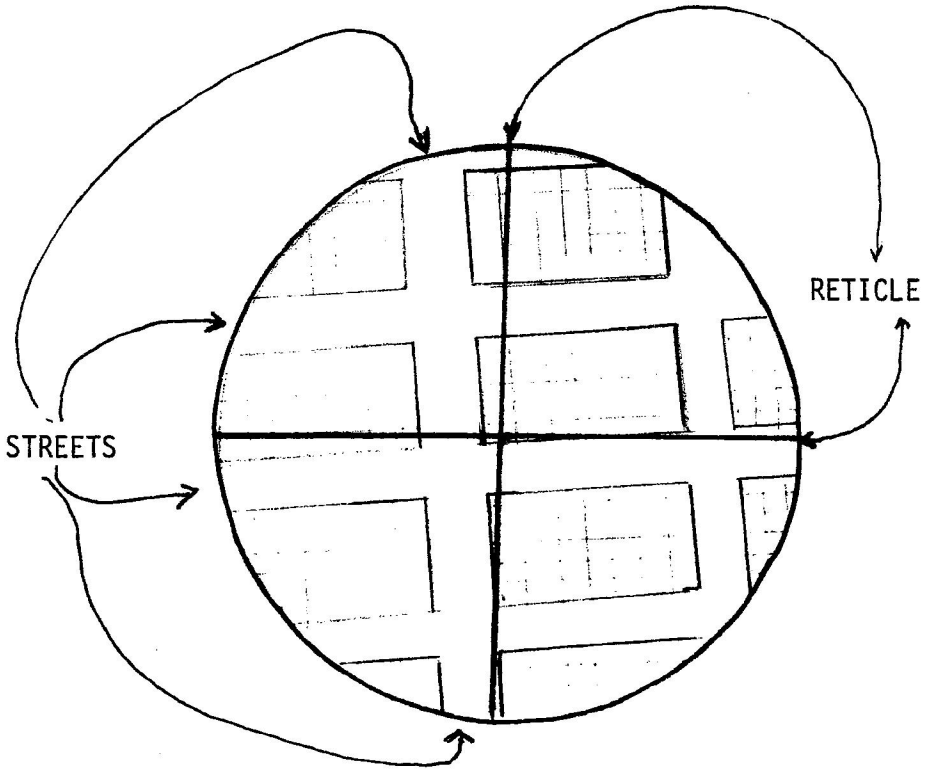


Figure 4-4 Wafer Misaligned in Y and Theta

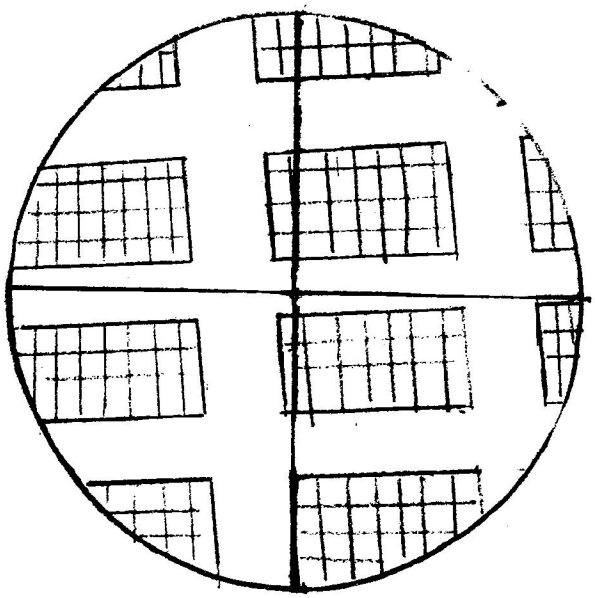


Figure 4-5 Wafer Aligned in Y, but not in Theta

9) Press ALIGN again. The X axis will move the wafer so that the edge of the wafer is under the microscope.

10) Press FAST, then CW or CCW to align theta until the center of the street is under the cross hairs as in step 8.

11) Press ALIGN again and repeat steps 8, 9, and 10 until wafer is aligned. See figure 4-6.

12) Press INDEX, then FWD or BACK. The Y axis will step the programmed index distance each time INDEX is pressed. This is a check to see that the INDEX value is correct.

NOTE

If you press FAST before INDEX, the Y axis will continue to step the programmed distance as long as the INDEX pushbutton is held down or until the end of the wafer is reached.

13) Press ALIGN. The saw is now ready to cut the first pass. See paragraph 4-21 for dual alignment procedures.

4-25. Wafer Alignment Using the Split-field TV Optics System

The MAI 1006A Wafer Dicing Saw is equipped with split-field television optics. With this system, images of the left and right sides of the wafer are presented on a split-image TV monitor. This system is faster than the monocular system and reduces operator fatigue.

To align a wafer using the TV system, follow the steps below.

1) Make sure that the saw is programmed for the geometry of the wafer to be scribed or diced.

2) The saw should be in the RESET condition:

a) Spindle running
b) Chuck zero performed
c) All axes in 'home' position.

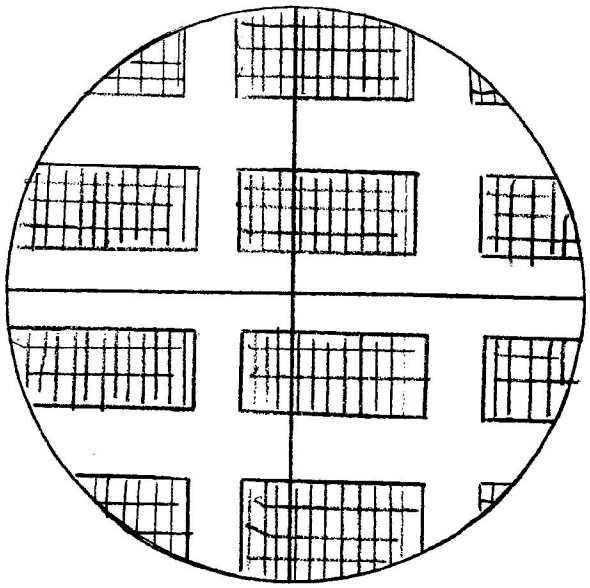


Figure 4-6. Wafer Properly Aligned in Y and Theta

3) Place the wafer in the center of the chuck with the streets approximately aligned to the X-axis. (If the wafer is mounted on a film frame, place the frame so that it engages the alignment pins on the chuck adapter.)

4) Press LOCK.

5) Press ALIGN. The saw will place the wafer under the TV lenses so that the left and right sides of the wafer are displayed on the monitor.

NOTE

If the wafer diameter is 1.9 inches or less (48.3 mm), the saw software will position the wafer for monocular alignment. In this case, follow the alignment procedure in paragraph 4-24.

6) Use the FWD, BACK, CW and CCW controls to align the wafer to the reticle. Figures 4-7A through 4-7D show a wafer in and out of alignment. When aligned the street should appear continuous across the TV screen and centered over the reticle.

The saw is now ready to cut the first pass. See paragraph 4-21 for dual alignment procedures.

4-26. Manual Blade Dressing

The object of blade dressing is to condition the cutting wheel so that it produces a narrow kerf with minimum chipping. The MAI saws have a built-in automatic blade dressing routine for dressing blades in silicon (see paragraph 4-16), but some users may want to use their own methods. This paragraph outlines the basic techniques involved. Individual requirements, blade manufacturer's instructions, and user experience may modify these instructions.

1) Truing the blade. New blades, especially unmounted blaces, may have burrs on the cutting edge. In order to make the cutting edge concentric with the spindle, one or two shallow cuts (1 or 2 mils deep) should be made.

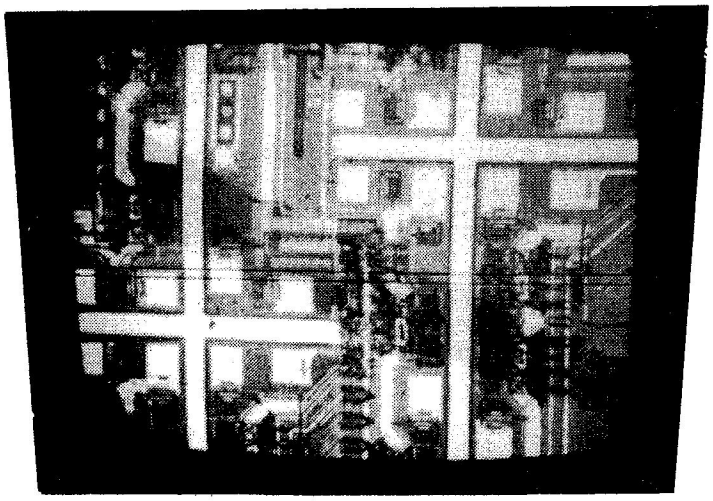


Figure 4-7A. Wafer as Placed on Chuck

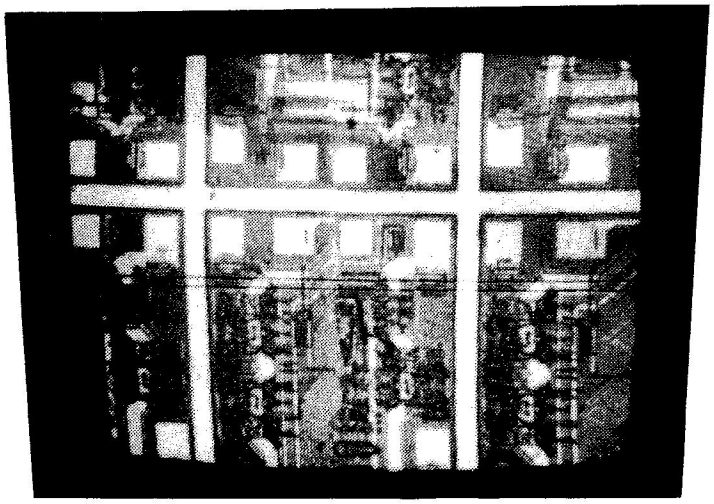


Figure 4-7B. Wafer with Theta Aligned

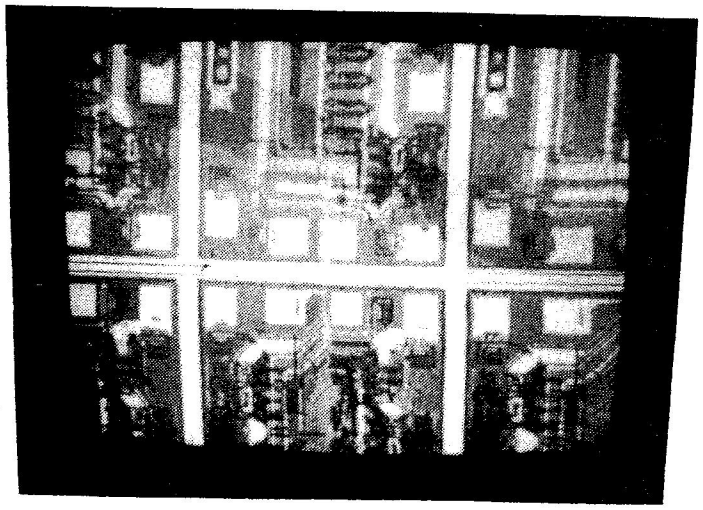


Figure 4-7C. Wafer with Y Aligned. Now Ready to Cut

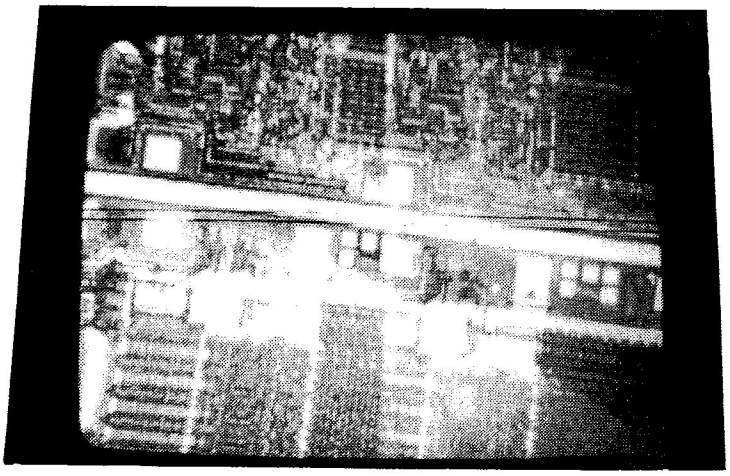


Figure 4-7D. Improper Alignment

2) Depth of cut. The blade should be dressed with cuts 1 mil deeper than the expected production cuts.

3) Starting speed. The first few cuts should be made at a slow rate of X travel. The recommended number of cuts in silicon is five cuts at 50 mils/sec.

4) Inspection. After the first few cuts are made, press INDEX. Inspect the cuts already made. Normally, the first cuts will show excessive chipping and kerf width. When chipping and kerf width are acceptable, increase speed to 100 mils/sec. Make a few cuts, and inspect again.

5) Increasing speed. After determining the approximate number of cuts necessary at each speed, increase the speed in increments of 100 mils/sec to 500 mils/sec. After 500 mils/sec is reached, increase the speed in 500 mils/sec increments until production speed is reached.

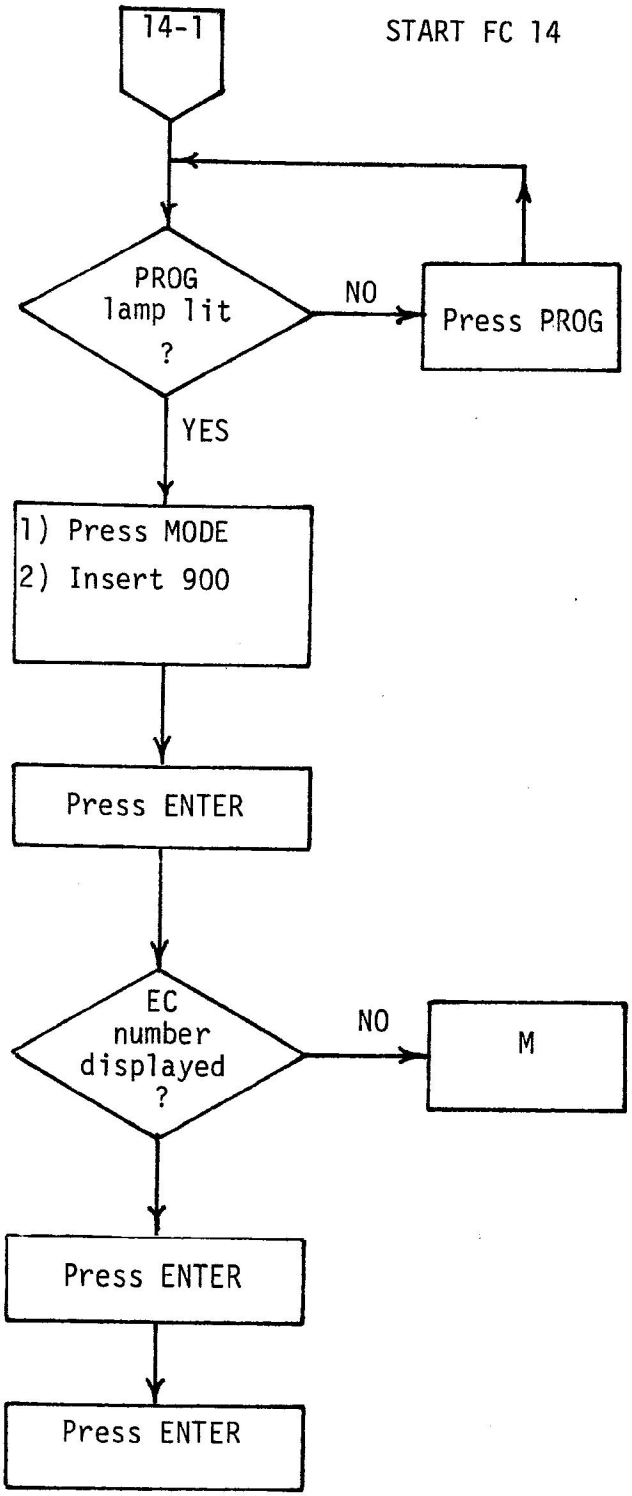
NOTE

These instructions do not apply
to dressing blades in carbide blocks.
Carbide blocks are so abrasive that
a total of 5 cuts should be sufficient
to dress a blade.

4-27. Flow Chart 14. Checking Engineering Change (EC) Levels

Micro Automation, Inc., is constantly improving the software in the microprocessor controlled saws. Each improvement or modification has an Engineering Change (EC) number associated with it.

The saws have a feature that allows you to find the EC level of the software installed in your saw without removing the cover. The following flow chart tells you how to read the software level of each PC board in your saw.

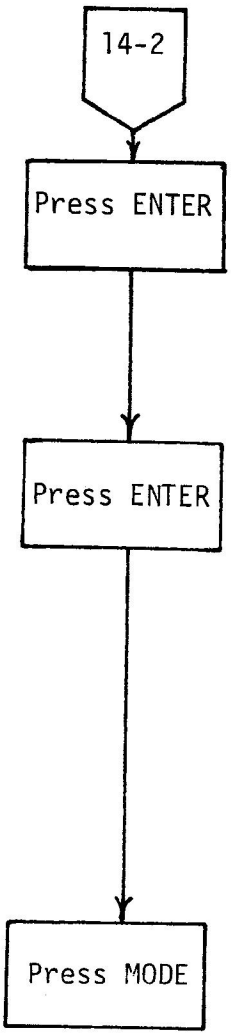


This check can be made at any time while the saw is in PROG mode.

1) The first time ENTER is pressed, the EC level of card 1 is displayed as 1 ECXXX. (XXX = some 3-digit number.)

2) Pressing ENTER again displays 2 ECXXX - the EC level of card 2.

3) Press ENTER again. Display reads 3 ECXXX. This is the EC level of card 3.



4) Pressing ENTER again will display either 4 ECXXX or 4 EC---. If the display reads 4 EC---, it means that your saw does not have the optional memory expander card installed. See Appendix B.

5) Press ENTER again. The display will read 5 ECXXX or 5 EC---. If the display shows 5 EC---, it means that your saw does not have a bus interface card installed. (This card is necessary when the saw is used as part of the Series 3000 wafer dicing system or if the saw is equipped with the MICROEYE automatic alignment system. See Appendix B.

6) When all EC levels have been read, pressing MODE allows you to go into another operational mode.

APPENDIX A

ERROR AND FAULT CODES

This Appendix lists, in alpha-numeric order, error and fault codes which may be displayed, the meanings of each code, and the probable cause(s) and remedies.

ERROR CODES

Error codes are displayed as an 'E' followed by three digits. Error codes generally mean that the operator has made a mistake while programming or operating the equipment. Error codes can usually be cleared by pressing CLEAR and returning to proper operating procedures. If the error code persists, however, a hardware problem may be involved and a maintenance technician should be called.

FAULT CODES

Fault codes are three digit numbers preceded by the letter 'F'. Fault codes generally indicate that there is a mechanical or electrical failure, a loss of some facility, or a sensor failure. In some cases a power supply or wiring harness fault may give the same indication as a sensor, facility, or hardware fault.

ERROR/FAULT CODES

E/F Code	Definition	Cause/Corrective Action
E001	Saw is in STANDBY.	RESET must be pressed before attempting to turn on spindle or otherwise operating the saw.
E002	Operator tried to operate the machine while in PROGRAM (or in READ).	See if PROG or READ lamps are lit. Press switch to extinguish lamps.
E003	Number out of range.	An attempt was made to enter a numerical parameter which is outside the design capability of the equipment. An example of this would be programming the saw to cut 25 inches per second. Press CLEAR and program an acceptable number.
E004	The dimension entered for height is greater than the dimension for wafer thickness. This would result in no dicing or scribing of the wafer.	Press CLEAR. Enter correct dimensions.
E005	Dimension entered for index is greater than the dimension entered for wafer size. This implies that the dies are larger than the wafer.	Press CLEAR. Enter correct dimensions.
E006	The programmed wafer thickness dimension is too large for the saw to perform a chuck zero.	Press CLEAR. Enter correct thickness.
E007	A theta angle greater than 60.5° was programmed while the saw was in hex mode (Mode 20, 21, or 22).	Press CLEAR. Program an angle less than 60.5°.
E101	More than one switch pressed at one time.	Press CLEAR. If E101 is displayed there may be a shorted switch or connector. Call a maintenance technician.
E102	An attempt has been made to operate the saw without the chuck locked.	Press CHUCK LOCK, then proceed. If condition persists, call a maintenance technician.

E/F Code	Definition	Cause/Corrective Action
E103	An attempt has been made to operate the machine with one or more parameters missing. E103 will also come up if an attempt is made to exit PROG while in a 800 or 900 series mode.	Make sure all parameters have been programmed into the saw. Check the asterisk (*) entry if in the 30, 31 rectangular modes. Check the decimal (.) if in 60, 61, 70, 71 progressive depth of cut modes.
E104	Chuck zero is required.	Place the 0.109 inch gauge block on the chuck and perform a chuck zero. Chuck zero is required when coming out of STANDBY, RESET, or BLADE DRESS.
E105	Chuck zero was attempted before spindle was up to speed.	Wait until spindle is up to speed.
E106	A switch was pressed while spindle was coming up to speed.	Wait until spindle is up to speed.
E108	Program storage is full.	E108 indicates that all memory spaces are full. If it is still desired to store the program it is necessary to erase or write over an existing program to make room for the new one.
E109	An attempt was made to retrieve a program that does not exist from storage.	Check program ID number requested.
E110	There is already a program stored in the memory location requested, and if you continue, you will alter a program in the memory.	E110 is a warning that an existing program is about to be altered.
E111	An attempt was made to turn on the spindle while the machine was in a service mode.	Spindle will not run while in a service mode. Select the proper mode.
E112	An attempt was made to use the blade dress program on a wafer less than 1.9 inches (1.93 cm).	Use a wafer with a diameter over 1.9 inches (1.93 cm).

E/F Code	Definition	Cause/Corrective Action
E113	The chuck was not unlocked after a chuck zero operation.	Press UNLOCK and remove the gauge block.
E114	During an automatic blade dress program the blade dressing material was used up.	1) Unlock chuck. 2) Replace dressing material. 3) Lock chuck. 4) Press DRESS.
F201	Chuck zero circuit is open.	Upon checking the chuck zero circuits, it was found that no signal has been detected. (Refer to MM Pg. 106.)
F202	Chuck zero circuit shorted.	Water shorting the spindle to the casting is a common cause of this failure. (Refer to MM Pg. 107.)
F211	Theta motor sensor failure.	CPU did not detect motion when a motor command was sent (MM Pg. 108.)
F212	Y motor sensor failure.	CPU did not detect a motor movement when the motor was commanded to step. See the maintenance manual Pg. 108.)
F213	X motor sensor failure.	CPU did not detect a motor movement when the motor was commanded to move. (MM Pg. 109.)
F214	Vacuum service missing.	Check plant vacuum. Check hoses and connections. Check vacuum sensor.
F215	Water pressure low or missing.	Check water supply. (MM Pg. 111.)
F220	Saw is at left X limit.	The CPU has sensed that the X-axis is at the left limit when it should not be. (MM Pg. 111.)
F221	Saw is at right X limit.	The CPU has sensed that the X-axis is at the right limit when it should not be. (MM Pg. 112.)
F222	Saw is at Y rear limit.	The CPU has sensed that the Y-axis is at the rear limit when it should not be. (MM Pg. 113.)
F223	Saw is at a Y front limit.	The CPU has sensed that the Y-axis is at the front limit when it should not be. (MM Pg. 114.)

ERROR/FAULT CODES (Cont)

E/F Code	Definition	Cause/Corrective Action
F224	Saw is at theta CCW limit.	The CPU has sensed that the theta axis is at the CCW limit when it should not be. (Refer to MM Pg 115.)
F225	Saw is at theta CW limit.	The CPU has sensed that the theta axis is at the CW limit when it should not be. (MM Pg 115.)
F226	Machine is at Z down limit.	The CPU has detected that the Z axis is at the lower limit. (MM Pg 117.)
F230	Saw has run the maximum distance without hitting the X limit sensor.	The X-axis CPU has detected a number of pulses from the X motor sensor without the X-axis limit being encountered. This probably means that the motor was turning but the X axis was not moving. (MM Pg 117.)
F232	Saw has run the maximum distance without hitting the Y rear sensor.	The Y-axis CPU has detected a number of pulses from the Y motor sensor without the Y-axis rear limit being encountered. (MM Pg 118.)
F234	Saw has run maximum distance without hitting a theta CW limit.	The theta-axis CPU has detected a number of pulses from the theta motor sensor without the theta-axis CW limit being encountered.(MM Pg 118.)
F236	Machine has run maximum distance without hitting Z lower limit.	The Z-axis CPU has detected a number of pulses from the Z motor sensor without the Z-axis lower limit being encountered. (Refer to M1006, pg.119, M2006, Pg. 39).
F240	Saw has not left the left limit.	The X-axis has been commanded to move a number of steps but the CPU has not detected that the X-axis has moved out of the left limit. See the Maintenance Manual Fault Analysis Section. (Refer to MM Pg. 120.)

E/F Code	Definition	Cause/Corrective Action
F242	Saw has not left Y rear limit.	The Y-axis has been commanded to move a number of steps but the CPU has not detected that the Y-axis has moved out of the rear limit. See the Maintenance Manual Fault Analysis Section. (MM Pg. 120.)
F244	Saw has not left theta CW limit.	The theta axis has been commanded to move a number of steps but the CPU has not detected that the theta axis has moved out of the CW limit. See the Maintenance Manual Fault Analysis Section. (MM Pg 121.)
F246	Machine has not left Z lower limit.	The Z-axis has been commanded to move a number of steps but the CPU has not detected that the Z-axis has moved out of the lower limit. See the Maintenance Manual Fault Analysis Section. (MM Pg. 122.)
F255	Chuck CCW sensor malfunction.	Chuck CCW limit has failed to switch. (MM Pg. 43.)
F256	Chuck CW sensor malfunction.	Chuck CW limit has failed to switch. (MM Pg. 43.)
F310	EPROM failure	Indicates a potential EPROM failure. (MM Pg. 123.)
F311	RAM failure.	Indicates a potential RAM failure. (MM Pg. 123.)
F330	CMOS Memory failure.	Indicates a potential CMOS memory failure. (MM Pg. 124.)
F331	Spindle Speed failure.	Indicates that the spindle up to speed signal (TP5-14) has changed to 5VDC when it should be 0VDC. 1) Verify that air pressure is @ 85 PSI. 2) Verify that water pressure is 10 PSI minimum when flowing. 3) Refer to MM Pg. 124.

ERROR/FAULT CODES (Cont)

E/F Code	Definition	Cause/Corrective Action
F412	Y or Z motors have not completed homing sequence.	This code appears when a 'ready' signal is not received by the housekeeper CPU. This occurs if read or program is pressed while the Y or Z motor is still moving. (Refer to MM Pg. 128.)
F413	X or theta motors have not completed homing sequence.	This code appears when a 'ready' signal is not received by the housekeeper CPU. This occurs if read or program is pressed while the X or theta motor is still moving. (Refer to MM Pg 128.)

APPENDIX B

M1006 AND M1006A

DICING SAWS

OPTIONS AND ACCESSORIES

MAI Part Number	Model Number	Description
10004000	M-4000	MicroEye Automatic Wafer Alignment module. Automatically aligns wafers for dicing. Provides more accurate and faster alignment.
29011530	LS-106	Low speed option. An X lead screw that permits sawing at feed rates down to 0.0125 inches/second. A saw with this option is designated as a Model 1006L.
29012906	SA-106	Panel-mounted spindle speed adjustment. This option allows spindle speed adjustment from the front panel.
12005646	XM-060	Expander memory board. Provides for storage of 60 additional cutting programs. A lithium battery protects against memory loss when the saw is not in use.
12005645	XM-120	Same as XM-060, except 120 storage spaces are provided.
12005644	XM-180	Same as XM-060 and XM-120, except 180 storage spaces are provided.
		CHUCKS
29005810	FC-114	4 inch film frame adapter chuck. Allows cutting of wafers up to 4 inch diameter when wafers are mounted on film frames.
29018440	FC-115	Same as above except handles 5 inch wafers. Used on saws having side blade cooling.
29018560	FC-115A	Same as above but used with saws having front and back blade cooling.
29018410	PC-103	Allows scribing of pieces of wafers up to 3 inches diameter.
29006890	CC-103	Chip chuck adapter. Allows scribe cutting of unmounted wafers to 3 inch diameter or to dice wafers mounted on rings.
29007460	CC-104	Same as CC-103 except allows cutting up to 4 inch diameters.
29018020	CC-105	Same as CC-103 except allows cutting 5 inch wafers.
		BLADE ADAPTERS
11006880	BA-100	Blade adapter, 40 mm ID x 49.53 mm OD Disco blade adapter.
11007410	BA-101	Blade adapter, 1 inch ID x 1.950 OD. Allows 25 mil exposure when used with a 2 inch blade.

MAI Part Number	Model Number	Description
11007420	BA-102	Blade adapter, 1 inch ID by 1.960 OD. Allows 20 mil exposure when used with a 2 inch blade.
11007430	BA-103	Blade adapter, 1 inch ID x 1.920 inch OD. Allows 40 mil exposure when using a 2 inch blade.
11007440	BA-104	Blade adapter 1 inch ID x 1.880 inch OD. Allows 60 mil exposure when used with a 2 inch blade.
37511900	BA-105	Blade adapter, 40 mm ID x 54.81 mm ID (ACC F1 flange).
37511910	BA-106	Blade adapter, 40 mm ID x 54.05 mm ID (ACC F2 flange).
		BLADE REMOVAL TOOLS
11007480	RT-25	Removal tool for 1 inch ID blade adapters.
13003850	RT-40	Removal tool for 40 mm ID blade adapters.