

CNC TURRET PUNCH PRESS

AE NT SERIES ^{EU} ^{US}
_{EX}
AE 255NT/2510NT
(AMNC-F)

PROGRAMMING MANUAL

AMADA[®]

Programming Manual:

AE NT Series CNC Turret Punch Press

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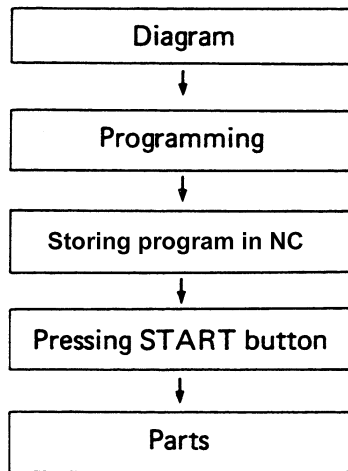
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Programming

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PROCESS FROM DIAGRAM TO PARTS



PROGRAMMING

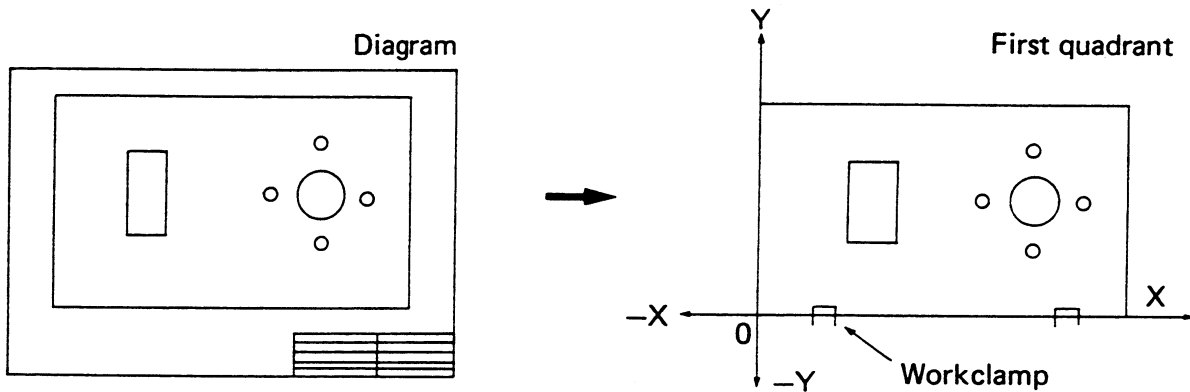


Diagram → First quadrant of X-Y coordinate system

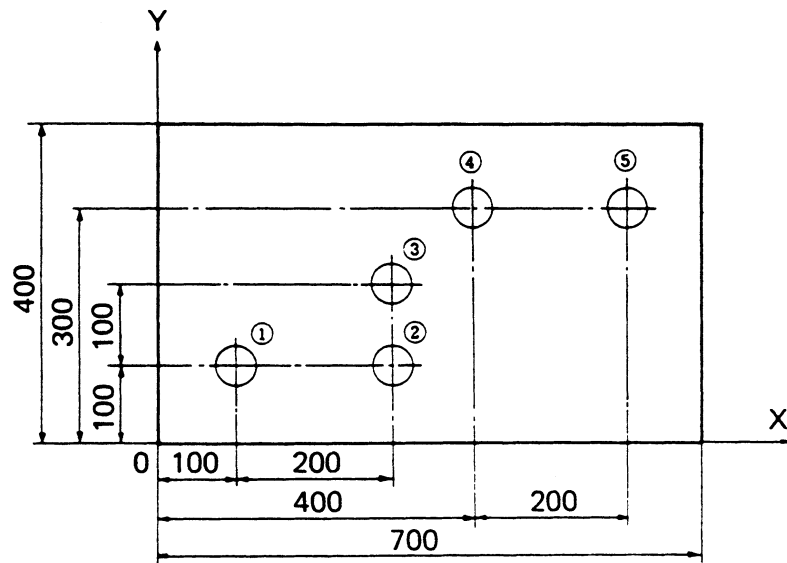
Unit of measurement for programs

All dimensions for programs are based on units of 0.01 mm (millimeters) or 0.001" (inches).

Dimension	Calculation	Program
100 mm	100.00	10000 (100.)
35.5 mm	35.50	3550 (35.5)
0 mm	0	0

Dimension	Calculation	Program
50"	50.000	50000 (50.)
12.7"	12.700	12700 (12.7)
0"	0	0

CALCULATION OF COORDINATES



X- and Y-coordinates

Absolute value: Distance from origin

Incremental value: Distance from previous position

Hole	X-coordinate	Y-coordinate	Method
①	100.00	100.00	Absolute
②	300.00	100.00	
③	300.00	200.00	
④	400.00	300.00	
⑤	600.00	300.00	

Hole	X-coordinate	Y-coordinate	Method
①	100.00	100.00	Absolute
②	200.00	0*	Incremental
③	0*	100.00	
④	100.00	100.00	
⑤	200.00	0*	

*In the case of zero, no decimals are needed.

PROGRAMMING PROCEDURE

1. Determining punching method

2. Determining positions of workclamps

NOTICE

ℓ Before changing the workclamp position, press and illuminate the MANUAL button on the main control panel. If the workclamp position is changed in the NC mode other than MANUAL, the workclamp position may not be read in the next automatic operation, causing the workclamp to be punched.

Position the workclamps as far apart as possible and check the "dead zone".

3. Checking tools and station numbers

Example:

- a) 150 mm dia. round hole → nibbling with a 30 mm dia. punch
- b) 500 mm × 600 mm square opening
→ shear-proof punching with a 50 mm × 50 mm square punch
- c) Check to ensure that all tools are mounted on the turret.

4. Determining punching sequence

This must be determined by taking into consideration both punching time and accuracy. Observe the following general precautions:

- a) Begin and finish with the upper right corner of the diagram.
- b) Begin with small holes, then square holes, and notching; extrusion and countersinking come last.
- c) The tools should not be selected more than twice except when the procedure requires only a change of striker position.
- d) In multiple-part punching, shearing of the worksheet should be done last.

5. Calculating coordinates

Calculate the coordinates in units of 0.01 mm (millimeters) or 0.001" (inches).

6. Checking

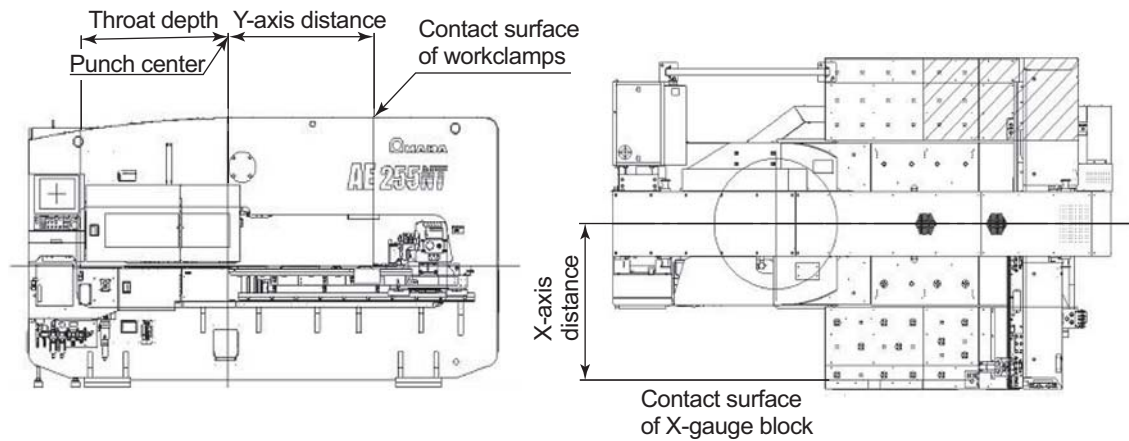
Check the workclamp positions, punching sequence and coordinates.

PUNCHING RANGE

The punching range is as listed below. When the X-coordinate exceeds the punching range, automatic repositioning is required.

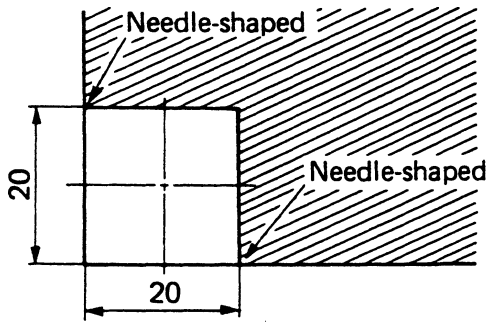
Unit: mm

Model	Throat depth	Origin (X-axis distance)	Origin (Y-axis distance)	X-axis travel distance	Y-axis travel distance by track		
					100's (inner)	200's (center)	300's (outer)
AE255NT	1320.	1210.	1270.	-70. to 1220.	30. to 1340.	-10. to 1300.	-50. to 1260.
AE2510NT	1320.	2500.	1270.	-10. to 2510.	30. to 1340.	-10. to 1300.	-50. to 1260.

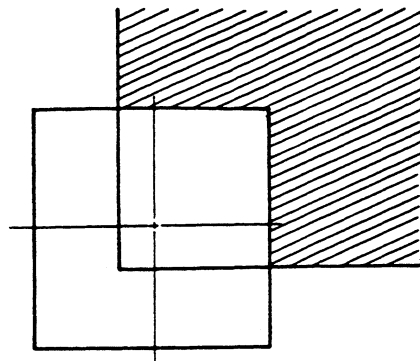


CAUTIONS ON PUNCHING

- a) Notching should not be performed with a punch of the same size as the notch.

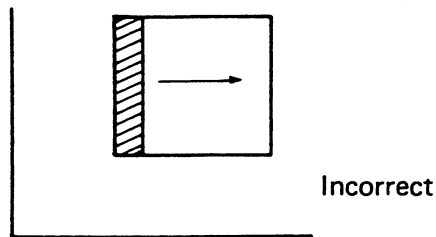


Incorrect
(20 mm x 20 mm square punch is used.)



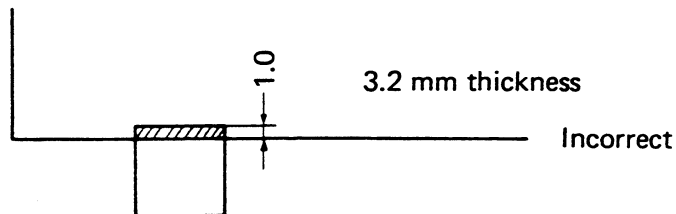
Correct
(30 mm x 30 mm square punch is used.)

- b) Do not punch along the shorter punch side when using a long rectangular punch.



- c) When shear-proof punching is performed, the feed pitch should be larger than 1/2 the punch width, but smaller than the entire punch width minus 0.5 mm.

- d) The depth of notching should not be less than the worksheet thickness.



- e) Determine the punching method so that the stripper plate holds the worksheet as much as possible.

- f) The force required to punch the worksheet must not exceed the press capacity. The required punching force is obtained by the following formula:

P: Force required
 A: Length of cut edge
 t: Thickness of worksheet
 τ : Shearing strength of worksheet

- g) Do not punch in the workclamp dead zone. Punching in the workclamp dead zone may punch the workclamp or distort the worksheet.

BASIC FUNCTION CODES

GOO	"G" function (Preparatory function)
MOO	"M" function (Miscellaneous function)
T___	"T" function (Tool function)
NOOOOO	Sequence number
OOOOO	Program number

NOTE

- ℓ O program numbers are not used for creating normal punching programs, but for creating subprograms and maintenance programs. The punching programs are named in 32 or less alphanumeric characters to distinguish each of them.

TAPE FORMAT

Arrange the function codes as follows:

NOOOOO GOO GOO X±OOOOOOO Y±OOOOOOO T___ C±OOOOOO MOO

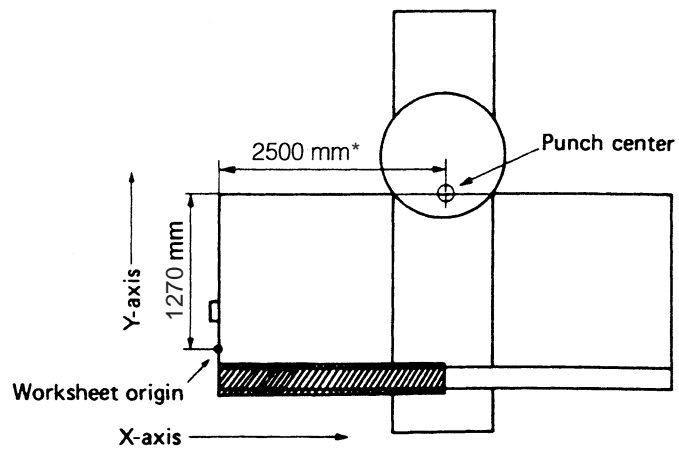
NOTE

- ℓ Unnecessary codes need not be entered.
- ℓ Enter only necessary digits of X, Y, C and N.
- ℓ The plus sign (+) of X, Y and C can be omitted.

G92: ESTABLISHING COORDINATE SYSTEM

This code is used to designate the distance from the worksheet origin to the punch center. Enter "G92" and the distances in the X- and Y-axis direction.

Model	Metric-specification machine	Inch-specification machine
AE255NT	G92 X1210.00 Y1270.00	G92 X47.638 Y50.000
AE2510NT	G92 X2500.00 Y1270.00	G92 X98.425 Y50.000



*1210 mm for AE255NT

G06: DESIGNATION OF WORKSHEET THICKNESS AND MATERIAL

G06 A B

This code is used to designate the worksheet thickness and material. Enter "G06" at the beginning of the program. When "G06" is omitted, the thickness is 6.3 mm and the material is mild steel.

A: Worksheet thickness 0.1 to 6.3 mm (0.002" to 0.248")

B: Worksheet material 0: Mild steel (SPC or CRS)
1: Stainless steel (SUS)
2: Aluminum (AL)

The decimal point in the thickness data is handled as follows:

Command data	Effective data
1.6	1.6 mm
2.36	2.3 mm (Omit the numerals below the second place of decimals.)
63	0.6 mm (Omit the numerals below the second place of decimals.)

Example:

OOOOO

G06 A1.0 B0 (1-mm thick mild steel worksheet is designated.)

G92 X Y

•
•
•

G90: ABSOLUTE PROGRAMMING

When the absolute values are used for coordinates, enter "G90" prior to the coordinates. If the absolute values are used at the subsequent blocks of the program, it is not necessary to enter "G90" again until incremental values are used. The value of the X- or Y-axis which does not move can be omitted.

Example:

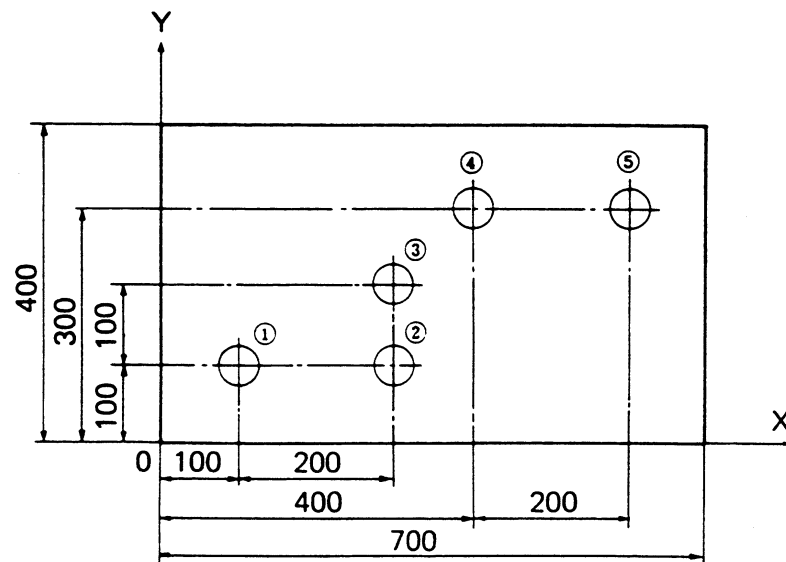
- ① G90 X100.00 Y100.00 (Absolute)
- ② X300.00 Y100.00 (Absolute)
- ③ X300.00 Y200.00 (Absolute)
- ④ X400.00 Y300.00 (Absolute)
- ⑤ X600.00 Y300.00 (Absolute)

G91: INCREMENTAL PROGRAMMING

When the incremental values are used for coordinates, enter "G91" prior to the coordinates. If the incremental values are used at the subsequent blocks of the program, it is not necessary to enter "G91" again until absolute values are used. The value of the X- or Y-axis which does not move can be omitted.

Example:

- ① G90 X100.00 Y100.00 (Absolute)
- ② G91 X200.00 Y0 (Incremental)
- ③ X0 Y100.00 (Incremental)
- ④ X100.00 Y100.00 (Incremental)
- ⑤ X200.00 Y0 (Incremental)



G20/G21: INCH/METRIC SELECT FUNCTION

The unit of the input program can be set either to the metric or inch system. When the inch unit is used, enter "G20" directly before the worksheet thickness and material designation command G06 as a single block; when the metric unit is used, enter "G21" as a single block. Observe the following general precautions:

- a) The commands G20 and G21 should always be entered as a single block.
- b) Do not enter the "G20" or "G21" anywhere within the program.
- c) When entering the "G92", enter it after the "G20" or "G21". Be sure that the unit to be used in operation is selected by the "G20" or "G21" and that the distance values at the "G92" are set in the corresponding unit.
- d) The origin setting values differ between the metric-specification and inch-specification machines. Keep this fact in mind before using the inch-metric select function.

Model	Metric-specification machine	Inch-specification machine
AE255NT	X1210.00 (47.638)* Y1270.00 (50.000)	X47.638 (1210.00)** Y50.000 (1270.00)
AE2510NT	X2500.00 (98.425)* Y1270.00 (50.000)	X98.425 (2500.00)** Y50.000 (1270.00)

* The numerals in parentheses indicate the origin setting values when the unit mode has been changed from metric to inch.

** The numerals in parentheses indicate the origin setting values when the unit mode has been changed from inch to metric.

- e) When the NC coordinate system is already set to the inch or metric unit dimensions, the corresponding "G20" or "G21" need not be entered.
- f) To confirm whether the NC coordinate system is set to the inch or metric unit dimensions, return the X- and Y-axes to their origins in the RETRACT mode, at this point, check the displayed values and consult the values shown in the table above for identification.
- g) When the "G20" or "G21" is commanded without the A-axis (press axis) at the top dead center, an alarm occurs.
- h) When the unit mode is changed, perform trial punching and check the processing conditions before actual punching.

TOOO: DESIGNATION OF TOOL NUMBER

This code is used to designate the turret station number in order to select the tool to be used. If the same tool is to be used continuously, it is not necessary to enter this code again until a different tool is needed.

Example:

```
G92 X2500.00 Y1270.00
G90 X500.00 Y300.00 T102
G91 X50.00 (T102 is omitted.)
      X50.00 (T102 is omitted.)
G90 X700.00 Y450.00 T201
```

G50: HOME RETRACT

When "G50" is entered, the X- and Y-axes return to their origins, and the striker moves to the center position. No punching occurs during the retraction. The offset values designated by "G93," "G94" and "G98" are canceled. "G50" must be entered as a single block at the end of the program; however, the sequence number can be entered along with it.

BLOCK DELETION

Basic format of BLOCK DELETION
/ X___ Y___
G90 X___ Y___ T___

If a slash character is entered at the beginning of a block and if the BLOCK SKIP button is pressed and its lamp is turned on, the block command following the slash character is disregarded. If the lamp is turned off, the command is not disregarded but is executed.

Example:

```
G90 X320.00 Y210.00 T203
G91 X50.00
/ X100.00 Y100.00 T304
G90 X570.00 Y310.00 T304
```

If the block following the block deletion command is entered in incremental coordinates, the position where the lamp of the BLOCK SKIP button is turned on is different from that where the lamp is turned off. If T304 is omitted for the reason that the same tooling is used, the block following the block deletion command is executed using T203 when the lamp of the BLOCK SKIP button is turned on.

OOOOO: PROGRAM NUMBER

When some programs are to be stored in memory, a maximum of 4-digit numeral (from 0 to 7999) is added directly after "O," at the beginning of the program for identification of individual programs. Zeros which directly follow "O" may be omitted.

This program number can also be input from the keyboard of the NC unit when storing the programs in memory.

Example:

```
O0014
G06 A___ B___
G92 X2500.00 Y1270.00
.
.
.
G50
```

NOTE

- ℓ Subprograms cannot be called unless preregistered in the NC memory. Program numbers that can be used for subprograms are O100 to O7999.
- ℓ Program numbers O8000 to O9999 are used by AMADA for its custom macro programs. Do not use them for your punching programs.
- ℓ Program names to be used for calling or editing punching programs on the screen are 32 or less alphanumeric characters.
- ℓ After a punching program is called on the screen, it is automatically assigned the number O1 and can be executed.

NOOOOO: SEQUENCE NUMBER

Any numeral (from 1 to 99999), with five or less digits, beginning with "N" can be entered at the beginning of each block. This code is used for indexing each block.

The sequence number need not be entered if it is not necessary. Entry at key points instead of all blocks will be useful. Zeros which directly follow "N" may be omitted.

Example:

```
G06 A___ B___
G92 X2500.00 Y1270.00
N0001 G90 X500.00 Y300.00 T102
N0002 G91 X50.00
N0003 X50.00
N0004 G90 X650.00 Y450.00 T306
N9999 G50
```

C±θ: TOOL ANGLE COMMAND

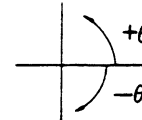
X____ Y____ T____ C±θ

This code is used to control the angular orientation of punches and dies installed in the Auto-index station.

Auto-index punching is performed after the X-, Y-, T- and C-axes have been positioned. In the C-axis command, the value and sign of θ determine the angle of the punch and die with respect to the X-axis.

T: Auto-index station number

C: Tool angle " $\pm\theta$ " Counterclockwise: positive (+),
Clockwise: negative (-)



When using this code, keep the following in mind:

- a) The angular input must be in the absolute angular value, referenced to the X-axis. The minimum angular input is 0.01°.
- b) If both X- and Y-coordinates are not entered, the Auto-index station and tool angle will be selected, but punching will not be performed.
- c) When the C-axis commands are used within pattern command blocks G26, G29, G68, and G78, the Auto-index tool angle will be automatically compensated in the tangential direction with the progress of hole punching.
- d) When the C-axis commands are used within the following commands, the C-axis commands will be ignored and machine operation will continue.
G92, G93, G94, G72, G25, G27, G98, G75, G76, G04, U, V and W
- e) For stations other than Auto-index stations, trying to use a C-axis command will cause a program error.
- f) When a program block with commands to use a different station follows the Auto-index punching commands, the C-axis will be returned to its zero degree position after the punching operation at the Auto-index station is finished, then the next station will be selected.

G90 X500.00 Y600.00 T____ C45.00 → Punching operation at Auto-index station.

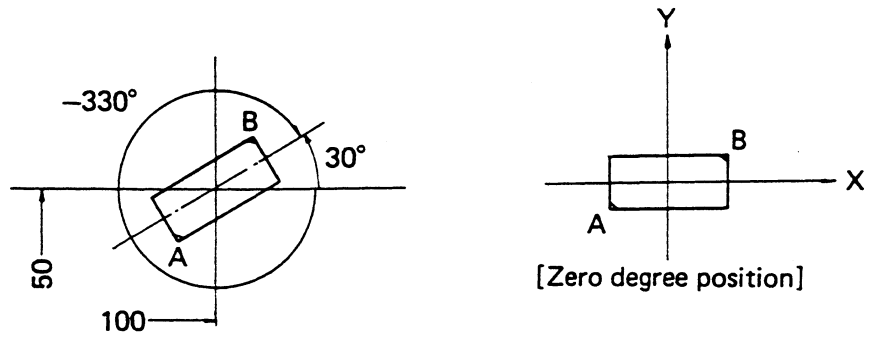
X350.00 Y200.00 T201 → T201 is selected after C-axis has returned to its zero degree position.

- g) When the same Auto-index station is to be used two or more times in succession with the same tool angle, the T- and C-axis commands may be omitted in the second and subsequent blocks.

G90 X500.00 Y600.00 T____ C45.00

X350.00 Y200.00 → Punched with T____ and C45.00

Example:



G90 X100.00 Y50.00 T___ C30.00 (or C-330.00)

The punch and the die will be positioned 30° (or -330°) with respect to the X-axis.

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G FUNCTION CODES

G70: PUNCH OFF (NO PUNCHING)

This code is used to position the worksheet without punching so that the workclamps will move away from the die or the workholders can hold the worksheet when automatic repositioning is performed. Enter "G70" prior to entering X____Y____.

Example:

G90 X100.00 Y100.00

G70 X300.00

The axes move at a position of "X300.00 Y100.00" without punching.

"G70" can be entered with "G90" or "G91."

G90 X100.00 Y100.00 (Punching)

G70 G91 X200.00 (No punching)

G90 Y300.00 (Punching)

G27: AUTO-REPOSITIONING

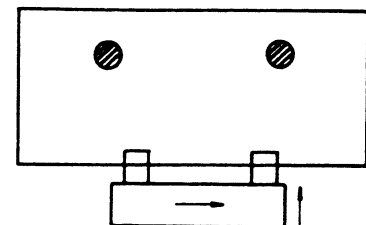
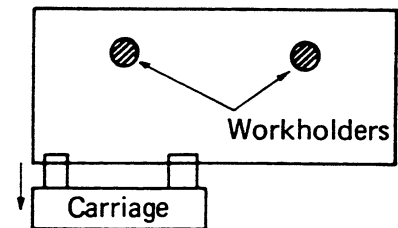
This code is used to extend the punching range in the X-axis direction. Enter "G27" and the X-axis travel distance. The X-axis travel distance must be designated by an incremental value.

Example:

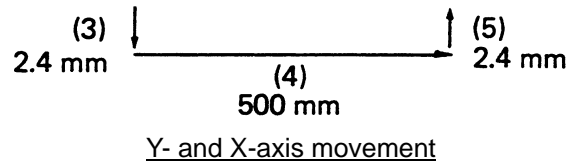
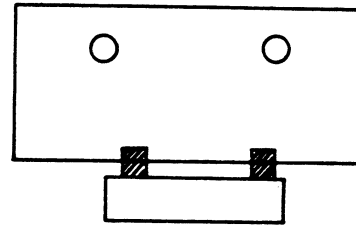
G27 X500.00

The following show the repositioning cycle for a G27 X500.00 command.

- (1) Work hold: The workholders hold the worksheet.
- (2) Unclamp: The workclamps open.
- (3) G91 Y2.40: The Y-axis moves 2.40 mm in the positive direction from the current position.
- (4) X-500.00: The X-axis moves 500.00 mm in the negative direction from the current position.
- (5) Y-2.40: The Y-axis moves 2.40 mm in the negative direction.

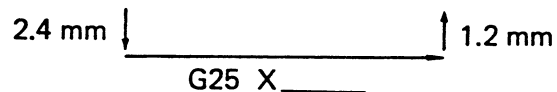


- (6) Clamp: The workclamps close.
- (7) Work release: The workholders release the worksheet.



G25: AUTO-REPOSITIONING

When the worksheet edge which is clamped has a bend or curves, and excessive burrs, enter "G25" instead of "G27" to ensure accurate repositioning. These factors can cause inaccurate worksheet positioning when automatic repositioning is performed, unless "G25" is commanded. When "G25" is entered, the same movement will be obtained as in the following:



First the Y-axis moves 2.40 mm in the positive direction from the current position. Then the X-axis moves "X____" from the current position and the Y-axis moves 1.20 mm in the negative direction. Next, the X-Y coordinate system is offset by "Y1.20" to compensate for the difference between the Y-axis positions before and after the automatic repositioning.

After "G25" is commanded, the punching range along the Y-axis is moved 1.20 mm in the negative direction from the standard punching range.

$$-11.2 \text{ mm} \leq Y \leq 1298.8 \text{ mm}$$

HINTS ON AUTO-REPOSITIONING

- a) X-axis travel distance → as small as possible
[Maximum punching position (X-coordinate)] – 2510 mm*
- b) Workclamp positions → as far apart as possible
Consider the following:
 - Dead zone
 - Worksheet size
 - Notches
- c) First punching range → as large as possible
- d) Reposition
 - Ensure that the worksheet is under the workholders.
 - Ensure that the workclamps do not pass between the upper and lower turret disks when automatic repositioning is done.
Y200.00 (min.)
 - Ensure that the X absolute coordinate is greater than the X-axis travel distance. (Overtravel will occur.)
- e) Coordinates after "G27" or "G25"
Use dimensions as per diagram. Mode of "G90" and "G91" does not change.
- f) Avoid changing tools immediately after automatic repositioning to save punching time.
- g) Punching range after automatic repositioning
[–10 mm + X-axis travel distance] ≤ X ≤ [2510 mm* + X-axis travel distance]
If a G27 X500.00 command has been executed, the punching range after automatic repositioning is as follows:
490 mm ≤ X ≤ 3010 mm**

*1280 mm for AE255NT

**1780 mm for AE255NT

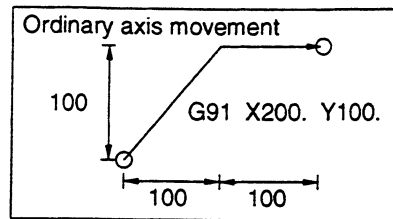
G01: LINEAR INTERPOLATION START

G00: LINEAR INTERPOLATION CANCEL

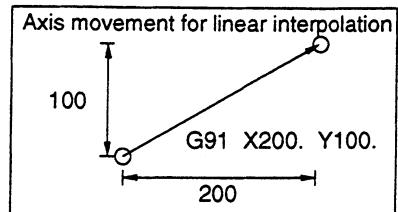
Example:

G01	F8000	Linear interpolation start	} Linearly interpolated
•		(Slitting program)	
•			
G00		Linear interpolation cancel	

Usually, the X- and Y-axes move at the same speed. When there is a command to position the two axes simultaneously, the X- and Y-axes first move in the direction of 45° and then move parallel in the direction of the greater movement. (See the upper right figure.)



"G01" is a command to complete these axis movements in the X-Y coordinate system over the shortest distance. (See the lower right figure.)



"G01" is modally valid until canceled by "G00." In the G01 block, set the F-code at 8000 (8 m/min.) or less.

NOTE

- ℓ Linear interpolation is specified for slitting at a given angle (refer to page II-42). Do not specify it for any other purpose.
- ℓ When linear interpolation is specified, the travel distance is minimized, but since the maximum axis speed is lowered, the total positioning time is increased.
- ℓ A program error is caused when the F-code is not entered in the G01 block or when the T- and C-codes are entered between "G01" and "G00."

G04: DWELL

When "G04" is commanded, operation stops during the time specified by "X." The minimum programmable increment of the value following "X" is 0.01 sec.

Example:

G04 X10.00 → Operation stops for 10 sec.

G72: PATTERN ORIGIN

G90 G72 X___ Y___
G91 G72 X___ Y___

This code is used to designate the origin of a pattern. The pattern origin can be entered in absolute or incremental coordinates.

NOTE

- ℓ If incremental coordinates are given after a pattern command, they must refer to the final pattern point.

Example:

G90 G72 X500.00 Y300.00

"G72" merely specifies the coordinates; neither positioning nor punching is performed. Do not enter the M- or T-code in a block with "G72." For example, never enter:

G90 G72 X300.00 Y200.00 T201

G91 G72 X150.00 Y250.00 M00

G26: BOLT HOLE CIRCLE [BHC]

G26 Ir J±θ K±n T_____

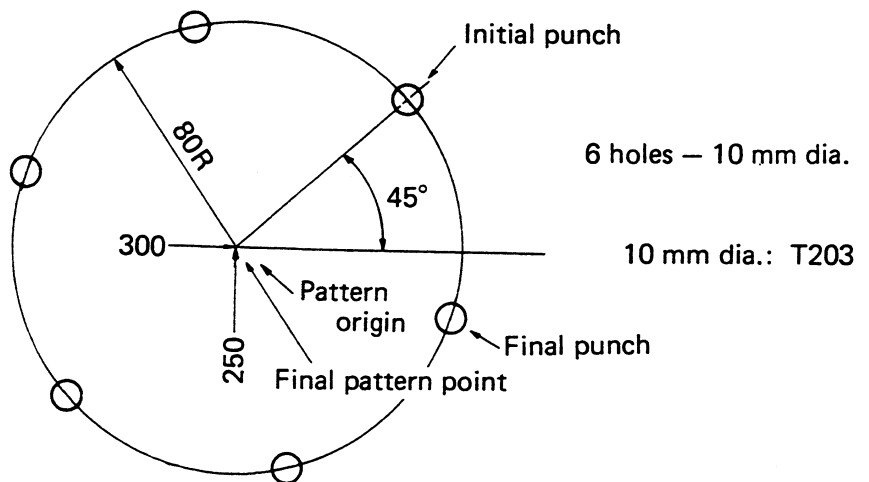
On the circumference of a circle having a radius "r" with either the current position or a point designated by "G72" as the center, "n" holes dividing the circumference into "n" equal parts are punched, starting from a point at an angle of "θ" to the X-axis.

I: Radius of circle "r," positive value

J: Starting angle "±θ" Counterclockwise: positive,
Clockwise: negative

K: Number of holes "±n" Counterclockwise: positive,
Clockwise: negative

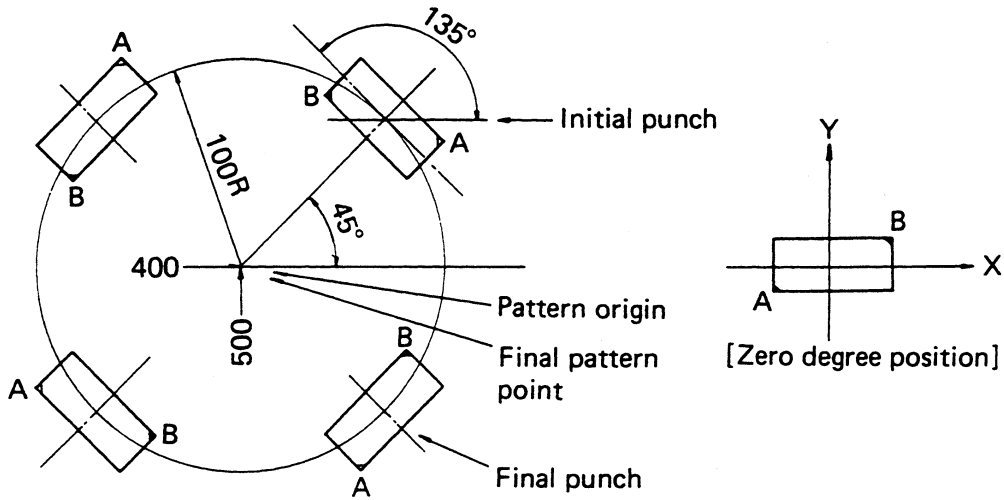
Example:



G72 G90 X300.00 Y250.00
G26 I80.00 J45.00 K6 T203

- When punching the same hole at the pattern origin (X300.00, Y250.00), omit "G72" and enter "T203" in the upper command block.
- The final pattern point coincides with the pattern origin.

Program example using Auto-index station



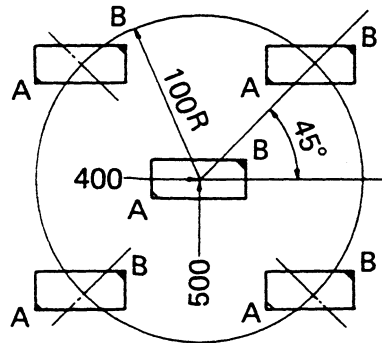
```
G72 G90 X400.00 Y500.00
      G26 I100.00 J45.00 K4 T___ C135.00 (or C-225.00)
```

The first punching will be performed with the tool angle positioned 135° (-225°) with respect to the X-axis and the second and subsequent punchings will be performed with the tool angle automatically compensated in the tangential direction.

- When the pattern origin (X400.00, Y500.00) is to be punched also, omit "G72" and enter "T___ C±θ" in the upper command block.

```
G90 X400.00 Y500.00 T___ C±θ
G26 I100.00 J45.00 K4 C135.00
```

- When there is no C-axis command in the pattern command block, the pattern punching will be performed without compensation of the tool angle.



```
G90 X400.00 Y500.00 T___ C0
G26 I100.00 J45.00 K4
```

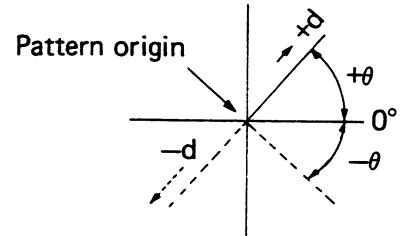
G28: LINE AT ANGLE [LAA]

G28 I±d J±θ Kn T_____

Starting from either the current position or a point designated by "G72," "n" holes are punched with an interval of "d" at an angle of "θ" to the X-axis.

I: Interval "±d"

When "d" is negative, punching is performed in the opposite direction from that of the positive "d."



J: Angle "±θ"

Counterclockwise: positive,
Clockwise: negative

K: Number of holes "n" (not including the pattern origin)

NOTE

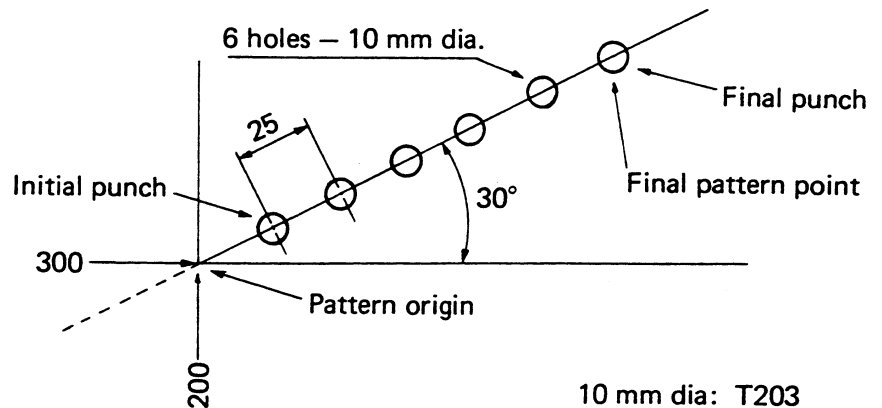
ℓ "d" and "θ" must be given as follows:

d = 200 mm → 200.00 (d = 20" → 20.000)

θ = 45°30' → 45.50

θ = 45° → 45.00

Example:

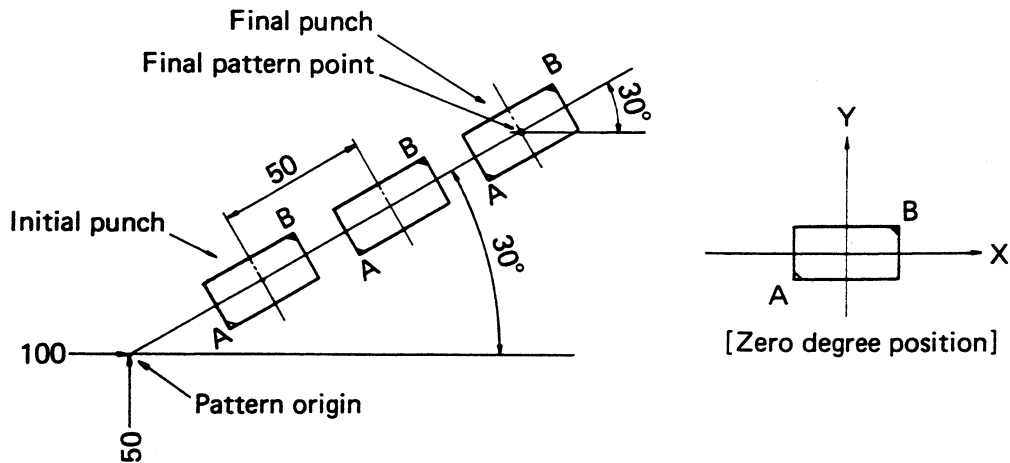


G72 G90 X300.00 Y200.00

G28 I25.00 J30.00 K6 T203

- When punching the same hole at the pattern origin (X300.00, Y200.00), omit "G72" and enter "T203" in the upper command block.
- When "I25.00" becomes "I-25.00," punching is performed in the direction of 180° symmetry (210°).

Program example using Auto-index station



```
G72 G90 X100.00 Y50.00
      G28 I50.00 J30.00 K3 T___ C30.00 (or C-330.00)
```

The punch and die will be positioned 30° (-330°) with respect to the X-axis and the Auto-index punching will be performed according to the G28 command.

- When the pattern origin (X100.00, Y50.00) is to be punched also, omit "G72" and move "T___ C30.00" to the end of the upper command block.

```
G90 X100.00 Y50.00 T___ C30.00
G28 I50.00 J30.00 K3
```

G29: ARC [ARC]

```
G29 Ir J $\pm\theta$  P $\pm\Delta\theta$  Kn T___
```

On an arc having a radius "r" with either the current position or a point designated by "G72" as the center, "n" holes with an angle interval of " $\Delta\theta$ " are punched, starting from a point at an angle of " θ " to the X-axis.

I: Radius of circle "r," positive value

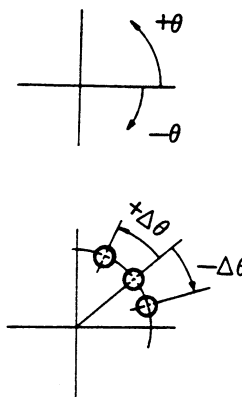
J: Starting angle " $\pm\theta$ "

Counterclockwise: positive,
Clockwise: negative

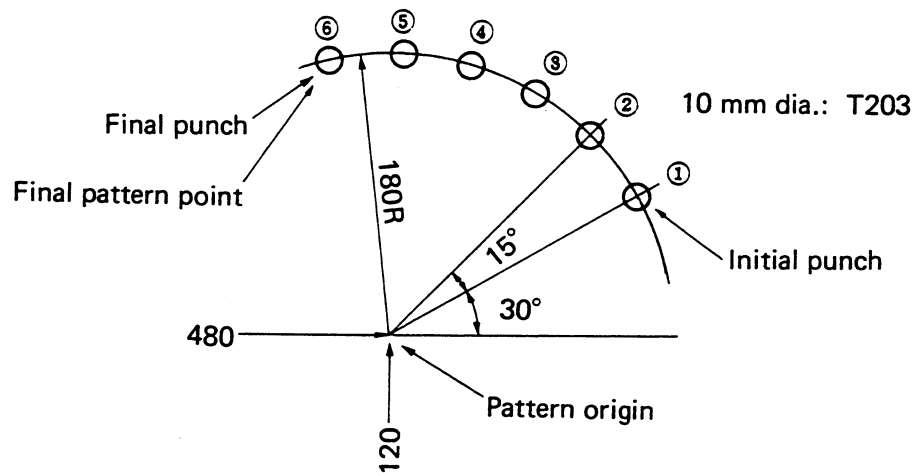
P: Angle interval " $\pm\Delta\theta$ "

Counterclockwise: positive,
Clockwise: negative

K: Number of holes "n"



Example:



```
G72 G90 X480.00 Y120.00
G29 I180.00 J30.00 P15.00 K6 T203
```

- When punching the same hole at the pattern origin (X480.00, Y120.00), omit "G72" and enter "T203" in the upper command block.
- When "P15.00" becomes "P-15.00," punching is performed in a clockwise direction beginning with the starting point.

G36: GRID-X [GRD-X]

G37: GRID-Y [GRD-Y]

G36	I ±d ₁	Pn ₁	J ±d ₂	Kn ₂	T _____
-----	-------------------	-----------------	-------------------	-----------------	---------

G37	I ±d ₁	Pn ₁	J ±d ₂	Kn ₂	T _____
-----	-------------------	-----------------	-------------------	-----------------	---------

Starting from either the current position or a point designated by "G72," a grid pattern of "n₁" holes with an interval of "d₁" parallel to the X-axis and "n₂" holes with an interval of "d₂" parallel to the Y-axis is punched. Command "G36" to start punching along the X-axis and "G37" to start punching along the Y-axis.

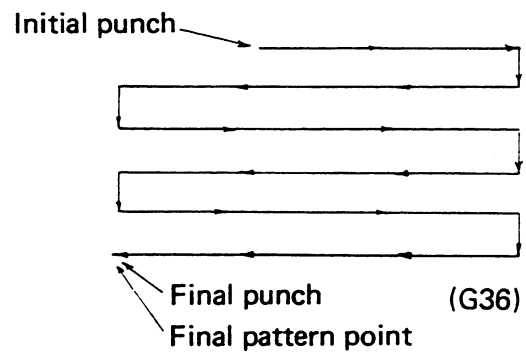
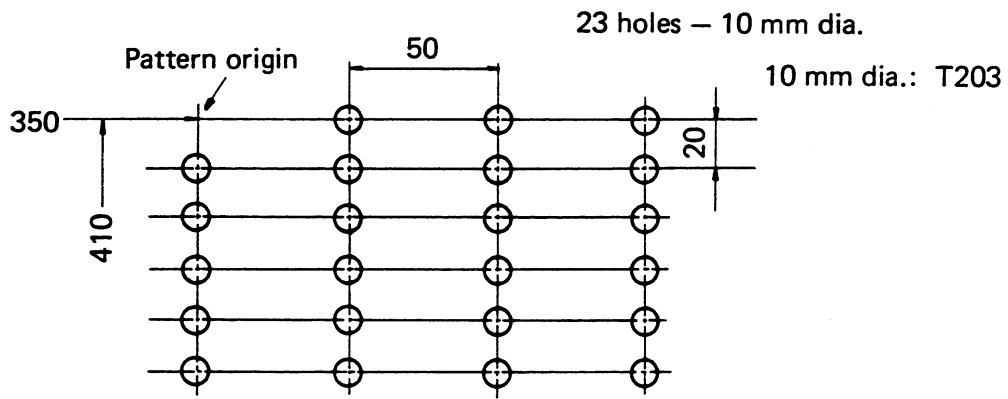
I: Interval "±d₁" +X direction: positive,
-X direction: negative

P: Number of holes in X-axis direction "n₁"
(not including the pattern origin)

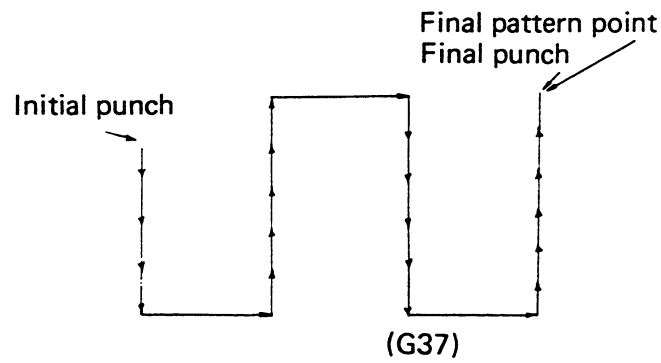
J: Interval "±d₂" +Y direction: positive,
-Y direction: negative

K: Number of holes in Y-axis direction "n₂"
(not including the pattern origin)

Example:



```
G72 G90 X350.00 Y410.00
G36 I50.00 P3 J-20.00 K5 T203
```



```
G72 G90 X350.00 Y410.00
G37 I50.00 P3 J-20.00 K5 T203
```

- When punching the same hole at the pattern origin (X350.00, Y410.00), omit "G72" and enter "T203" in each upper command block.

G66: SHEAR PROOF [SHP]

G66 I ℓ J $\pm\theta$ P $\pm w_1$ Q $\pm w_2$ D $\pm d$ T_____

Starting from either the current position or a point designated by "G72," a shear proof with a length of " $\ell \pm 2d$ " and a punch width of " $w_1 \times w_2$ " is performed at an angle of " θ " to the X-axis.

I: Punching length " ℓ "

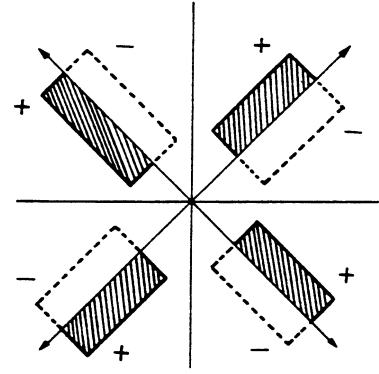
J: Angle " $\pm\theta$ " Counterclockwise:
positive,
Clockwise: negative

P: Punch width " $\pm w_1$ "
(the width in the angle " θ "
direction)

Q: Punch width " $\pm w_2$ "
(the width in the direction of 90°
to " θ ")

D: Compensation value " $\pm d$ "
(in relation to the punching length
" ℓ ")

If $d = 0$, "D" can be omitted.



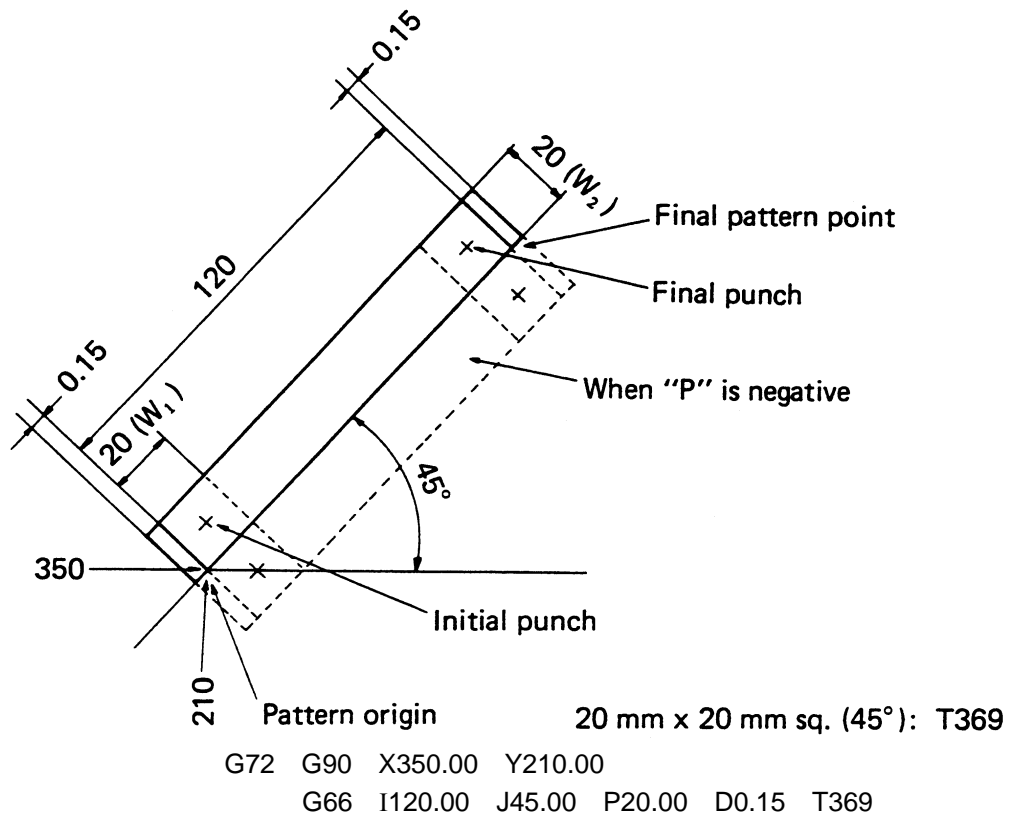
Sign of " w_1 " and " w_2 "

NOTE

ℓ The values of " w_1 " and " w_2 " must have the same sign.

ℓ When a square punch is used ($w_1 = w_2$), "Q" can be omitted.

Example:



- When "G72" is omitted and "T369" is entered in the upper command block, the pattern origin (X350.00, Y210.00) is also punched.
- When "P20.00" becomes "P-20.00," a shear proof is performed in the direction of the dotted line.
- "I" must be at least 1.5 times as large as "P."
- The final pattern point does not coincide with the final punch center.
- When "D0.15" becomes "D-0.15," the overall punching length "I" is 0.3 mm shorter as determined by $0.15 \times 2 = 0.3$.

G67: SQUARE [SQR]

G67 I $\pm l_1$ J $\pm l_2$ Pw T_____

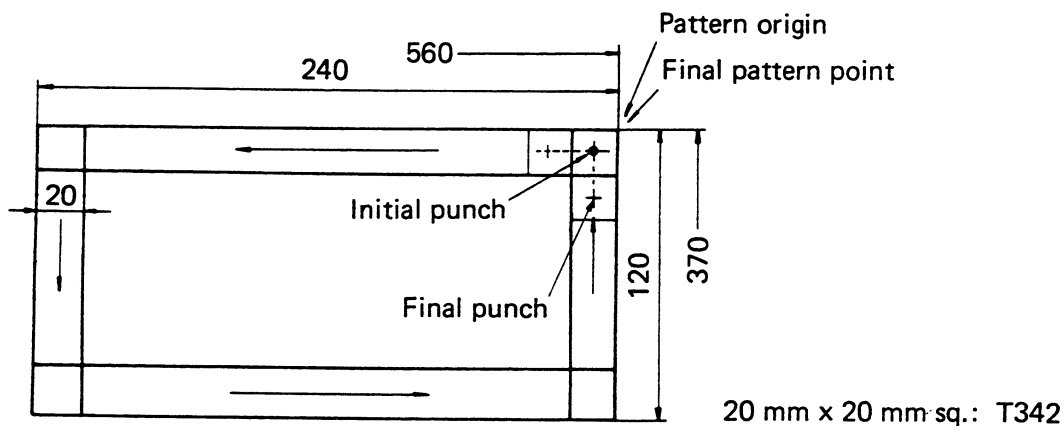
Starting from either the current position or a point designated by "G72," a rectangular opening with a length of " l_1 " parallel to the X-axis and a length of " l_2 " parallel to the Y-axis is punched, using a square punch with a width of "w."

I: Opening length in X-axis direction " $\pm l_1$ " +X direction: positive,
-X direction: negative

J: Opening length in Y-axis direction " $\pm l_2$ " +Y direction: positive,
-Y direction: negative

P: Punch width "w," positive value only
Use a square punch only.

Example:



```
G72 G90 X560.00 Y370.00
G67 I-240.00 J-120.00 P20.00 T342
M00
```

- When "G72" is omitted and "T342" is entered in the upper command block, the pattern origin (X560.00, Y370.00) is also punched.
- When "G67" is commanded, "M00" or "M01" should be entered in order to remove scrap.
- The pattern origin should normally be designated in the upper right corner of the rectangular opening in order to remove the scrap easily.
- Both "I" and "J" must be at least three times as large as "P."

G68: NIBBLING ARC [NBL-A]

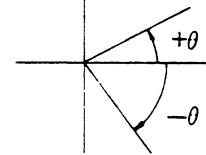
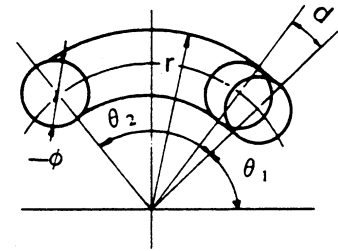
G68 Ir J $\pm\theta_1$ K $\pm\theta_2$ P $\pm\phi$ Qd T_____

On the circumference of a circle having a radius "r" with either the current position or a point designated by "G72" as the center, nibbling with an interval of "d" is performed by using a punch with a diameter of " ϕ ," starting from a point at an angle of " θ_1 " to the X-axis and moving up to an incremental angle of " θ_2 ."

I: Radius "r," positive value
r < 57000.00 mm

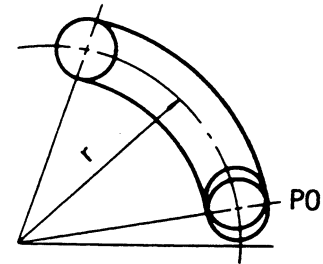
J: Starting angle " $\pm\theta_1$ "
Counterclockwise: positive,
Clockwise: negative

K: Angle in which nibbling occurs
" $\pm\theta_2$ "
Counterclockwise: positive,
Clockwise: negative



P: Punch diameter " $\pm\phi$ "

Enter the positive value when nibbling the outer side of the circle and the negative value when nibbling the inner side. Enter zero when nibbling on the arc with the radius "r."

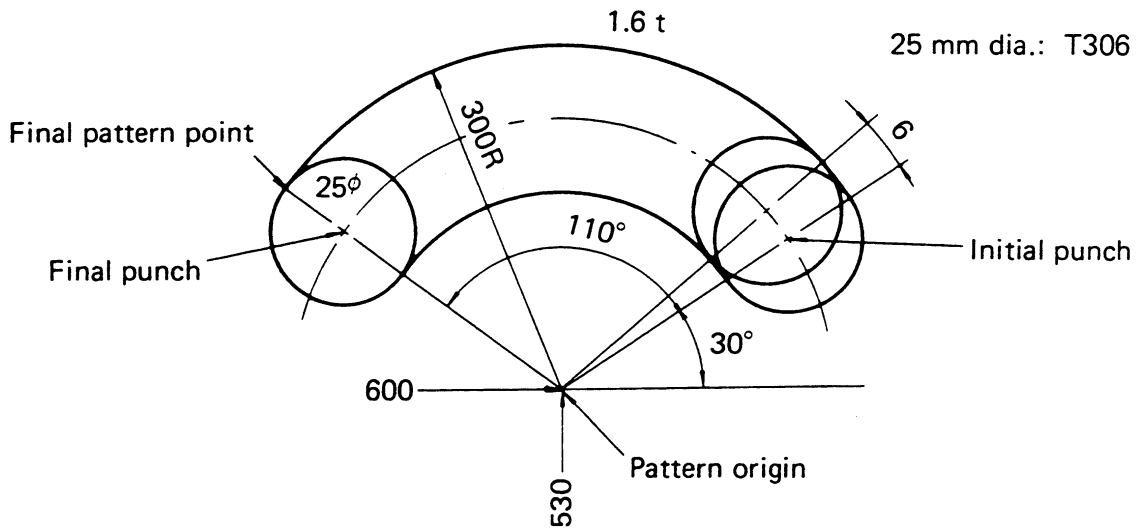


Q: Nibbling interval "d," positive value only
Worksheet thickness < d ≤ 8 mm

NOTE

ℓ Maximum worksheet thickness for nibbling: 3.2 mm

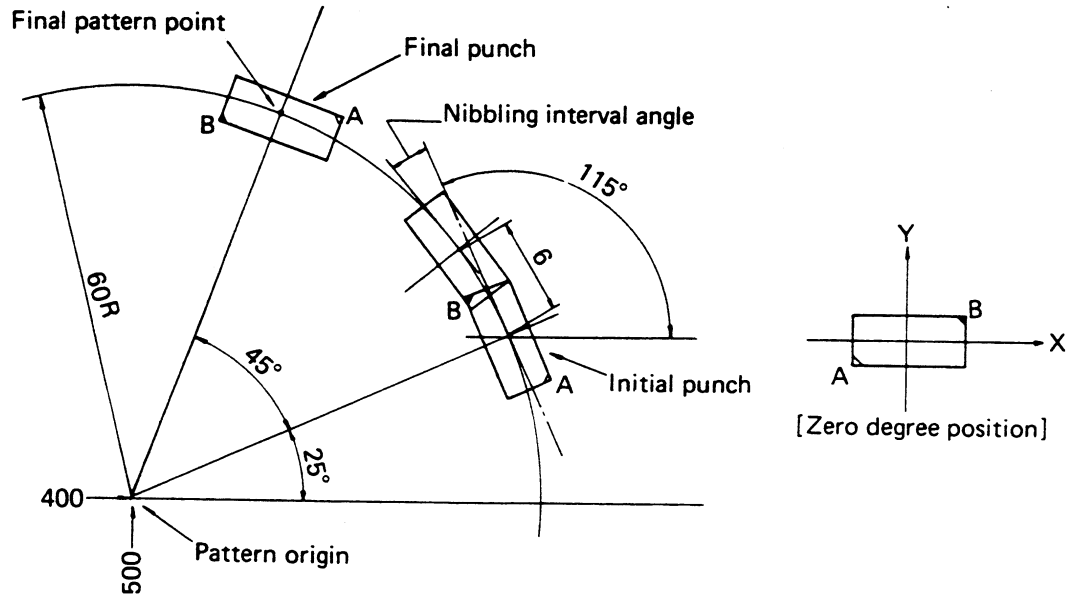
Example:



```
G72 G90 X600.00 Y530.00
      G68 I300.00 J30.00 K110.00 P-25.00 Q6.00 T306
```

- When "G72" is omitted and "T306" is entered in the upper command block, the pattern origin (X600.00, Y530.00) is also punched.
- When nibbling a worksheet with a thickness of more than 3.2 mm, use the G29 (ARC) or G78 (PUNCHING ARC) command.
- When scrap remains inside, make "J" 90° or 45° and enter "M00" or "M01" in order to remove the scrap.

Program example using Auto-index station



```
G72 G90 X400.00 Y500.00
      G68 I60.00 J25.00 K45.00 P0 Q6.00 T___ C115.00 (or C-245.00)
```

The tool angle is positioned 115° (-245°) with respect to the X-axis and it will be automatically compensated in the tangential direction with the progress of hole nibbling.

- When the pattern origin (X400.00, Y500.00) is to be punched also, omit "G72" and enter "T___ C $\pm\theta$ " in the upper command block.

```
G90 X400.00 Y500.00 T___ C $\pm\theta$ 
```

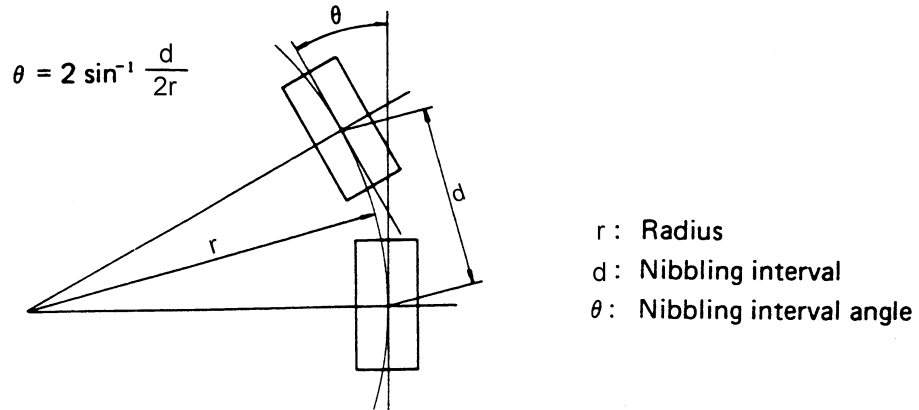
```
G68 I60.00 J25.00 K45.00 P0 Q6.00 C115.00
```

- When the nibbling interval "d" or nibbling interval angle " θ " exceeds the following maximum value, a program error will occur.

Maximum nibbling interval: 8 mm

Maximum nibbling interval angle: 8°

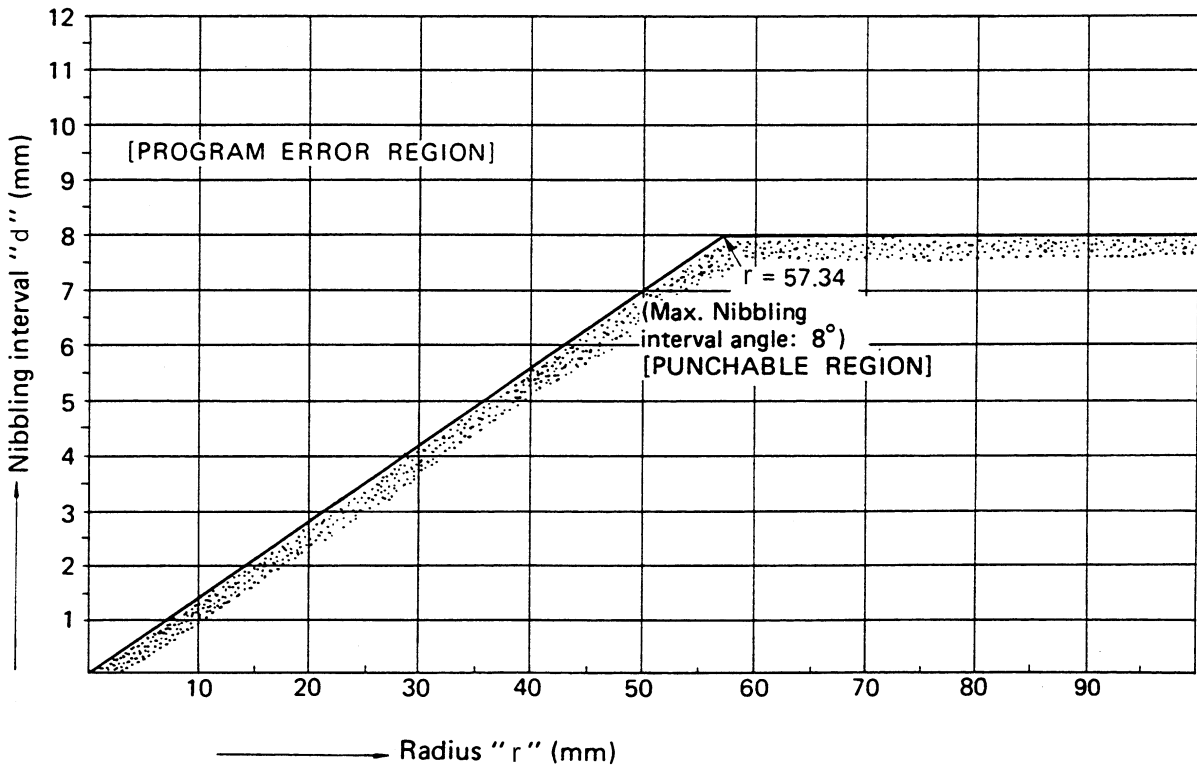
Relation between nibbling interval and nibbling interval angle:



Even if the nibbling interval "d" is within its limit, the calculated nibbling interval angle " θ " may exceed its limit when the radius "r" is small ($r < 57.34$).

- When the radius "r" is 25 mm and the nibbling interval "d" is 6 mm

$$\begin{aligned} \theta &= 2 \sin^{-1} (6/50) \\ &= 2 \times 6.89^\circ \\ &= 13.78^\circ \rightarrow \text{Program error} \end{aligned}$$



- When the radius "r" is 50 mm, the largest nibbling interval "d" is 6.97 mm.

G69: NIBBLING LINE [NBL-L]

G69 I ℓ J $\pm\theta$ P $\pm\phi$ Qd T_____

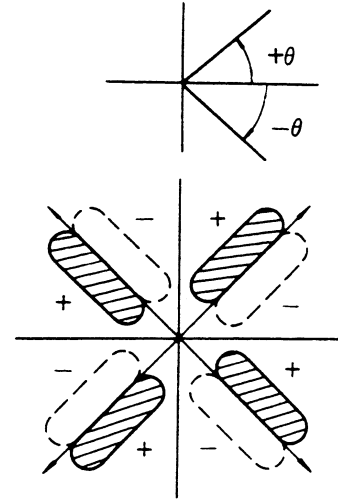
Starting from either the current position or a point designated by "G72," nibbling with an interval of "d" and a length of " ℓ " at an angle of " θ " to the X-axis is performed using a punch with a diameter of " ϕ ."

I: Length " ℓ "
(from the initial punch center to the final punch center)

J: Angle " $\pm\theta$ "
Counterclockwise: positive,
Clockwise: negative

P: Punch diameter " $\pm\phi$ "
When the value is positive, nibbling is performed on the left side of the straight line (on the hatched side in the figure); when it is negative, nibbling is performed on the right side of the straight line.

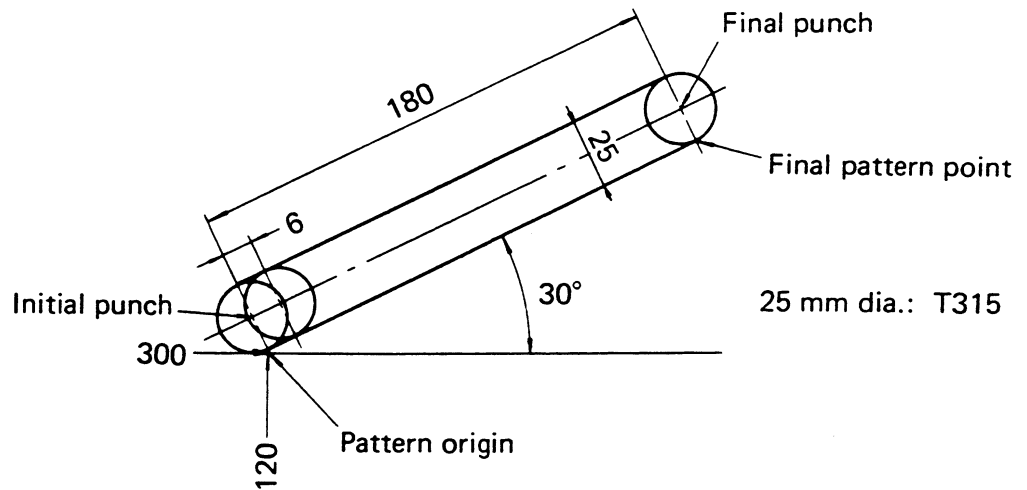
Q: Interval "d," positive value only
Worksheet thickness $< d \leq 8$ mm



NOTE

ℓ Maximum worksheet thickness for nibbling: 3.2 mm

Example:



G72 G90 X300.00 Y120.00

G69 I180.00 J30.00 P25.00 Q6.00 T315

- When "G72" is omitted and "T315" is entered in the upper command block, the pattern origin (X300.00, Y120.00) is also punched.
- When $P = 0$, the initial punch center coincides with the pattern origin.
- When nibbling a worksheet with a thickness of more than 3.2 mm, use the G28 (LINE AT ANGLE) or G79 (PUNCHING LINE) command.

G78: PUNCHING ARC [PNC-A]

G78 Ir J±θ₁ K±θ₂ P±φ Qd Dt T

On the circumference of a circle having a radius "r" with either the current position or a point designated by "G72" as the center, a punching operation which is the same as the NIBBLING ARC (G68) is performed at an interval of "d," using a punch with a diameter of "φ," starting from a point at an angle of "θ₁" to the X-axis and moving up to an incremental angle of "θ₂."

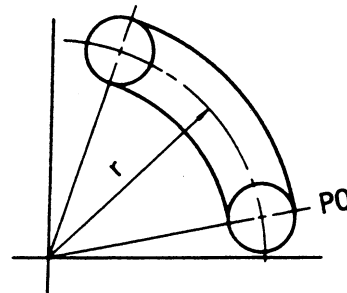
I: Radius "r," positive value

J: Starting angle "±θ₁" Counterclockwise: positive,
Clockwise: negative

K: Angle in which punching occurs "±θ₂" Counterclockwise: positive,
Clockwise: negative

P: Punch diameter "±φ"

Enter the positive value when punching the outer side of the circle and the negative value when punching the inner side. Enter zero when punching on the arc with the radius "r."



Q: Punching interval "d," positive value only

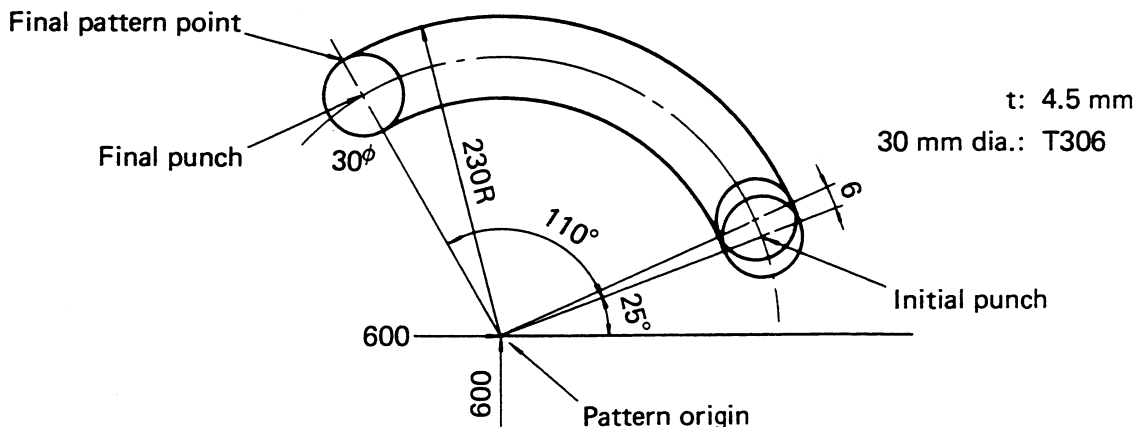
Worksheet thickness < d

D: Worksheet thickness "t"

NOTE

ℓ When "t" is larger than "d", it is regarded as a program error.

Example:



G72 G90 X600.00 Y600.00
G78 I230.00 J25.00 K110.00 P-30.00 Q6.00 D4.50 T306

- When "G72" is omitted and "T306" is entered in the upper command block, the pattern origin (X600.00, Y600.00) is also punched.
- When scrap remains inside, make "J" 90° or 45° and enter "M00" or "M01" in order to remove the scrap.

G79: PUNCHING LINE [PNC-L]

G79 I ℓ J $\pm\theta$ P $\pm\phi$ Qd Dt T_____

Starting from either the current position or a point designated by "G72," a punching operation which is the same as the NIBBLING LINE (G69) is performed at an interval of "d," using a punch with a diameter of " ϕ ," in a length of " ℓ " at an angle of " θ " to the X-axis.

I: Length " ℓ " (from the initial punch center to the final punch center)

J: Angle " $\pm\theta$ " Counterclockwise: positive,
Clockwise: negative

P: Punch diameter " $\pm\phi$ "

When the value is positive, punching is performed on the left side of the straight line; when it is negative, punching is performed on the right side of the straight line. Refer to the NIBBLING LINE (G69) on page II-19.

Q: Interval "d," positive value only

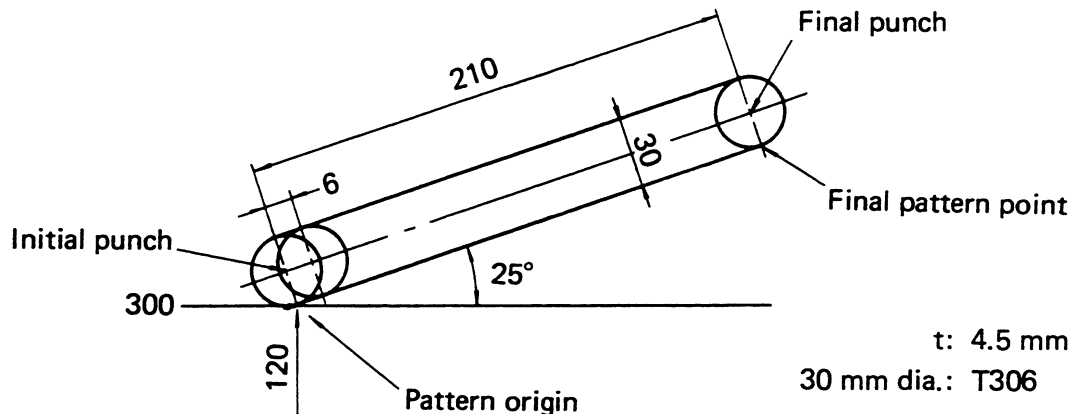
Worksheet thickness < d

D: Worksheet thickness "t"

NOTE

ℓ When "t" is larger than "d", it is regarded as a program error.

Example:



G72 G90 X300.00 Y120.00

G79 I210.00 J25.00 P30.00 Q6.00 D4.50 T306

- When "G72" is omitted and "T306" is entered in the upper command block, the pattern origin (X300.00, Y120.00) is also punched.
- When P = 0, the initial punch center coincides with the pattern origin.

G93: OFFSET-1 [OFS-1]

G90	G93	X___	Y___
G91	G93	X___	Y___

This code designates the origin of a local coordinate system. The code is merely for establishing the local coordinate system; it is not to be used for positioning or punching. Do not enter the T- or M-code with "G93." For example, never enter:

```
G90 G93 X50.00 Y100.00 T201
```

Basic format of a program using "G93"

```
G06 A___ B___  
G92 X2500.00 Y1270.00  
G90 G93 X___ Y___  
      X___ Y___ T___  
.  
.  
.  
G50
```

Example:

X-Y coordinate system: Basic coordinate system (Global coordinate system)

X'-Y' coordinate system: Local coordinate system

X"-Y" coordinate system: Local coordinate system

a) When designating the X'-Y' coordinate system

```
G90 G93 X50.00 Y75.00
```

b) When designating the X"-Y" coordinate system

```
G90 G93 X200.00 Y125.00 or G91 G93 X150.00 Y50.00
```

- c) Method of designating point A
- G90 X300.00 Y205.00 T203
 - G90 G93 X50.00 Y75.00
X250.00 Y130.00 T203
 - G90 G93 X50.00 Y75.00
G93 X200.00 Y125.00 (or G91 G93 X150.00 Y50.00)
X100.00 Y80.00 T203
- d) When returning from the local coordinate system to the global coordinate system
- G90 G93 X0 Y0

G94: OFFSET-2 [OFS-2]

G94	Xax	Yay	Pnx	Kny	Qt	D α
-----	-----	-----	-----	-----	----	------------

This code is used to designate the origin of a local coordinate system when taking "bending factor" into consideration.

X: Bending length in X-axis direction "ax"

Y: Bending length in Y-axis direction "ay"

P: Number of bends in X-axis direction "nx"

The number of bends on the origin side should be entered by a positive number.

K: Number of bends in Y-axis direction "ny"

The number of bends on the origin side should be entered by a positive number.

Q: Worksheet thickness "t," positive

D: Bending coefficient " α ," positive and entered by percentage

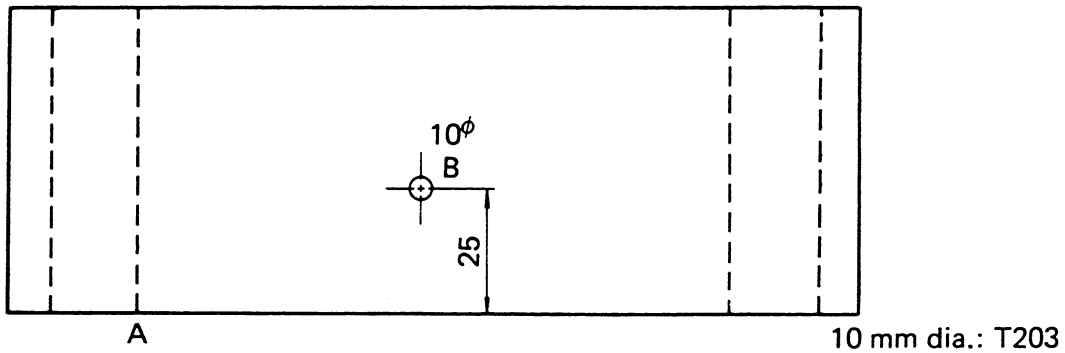
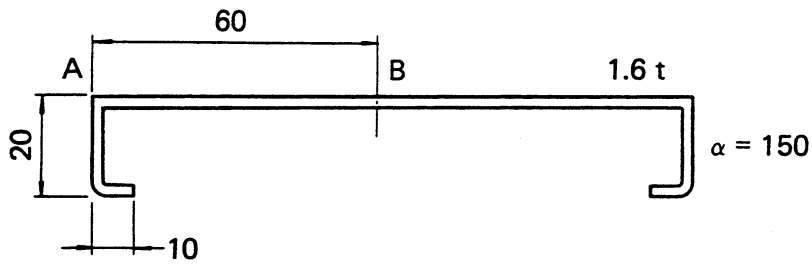
Basic format of a program using "G94"

```

G06 A___ B___
G92 X2500.00 Y1270.00
G90 G94 X___ Y___ P___ K___ Q___ D___
      X___ Y___ T___
.
.
.
G50

```

Example:

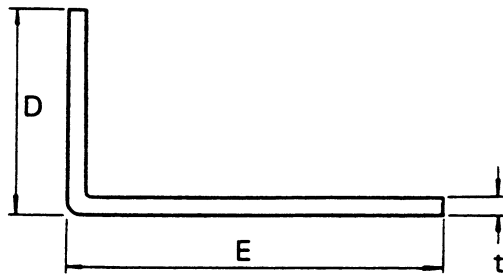


```
G90 G94 X30.00 Y0 P2 K0 Q1.60 D150 (Setting point
A as origin)
X60.00 Y25.00 T203
```

Method for returning to the global coordinate system is the same as that of "G93."

```
G90 G94 X0 Y0
```

Determining "α"



L: Developed length

$$L = (D + E) - \alpha t$$

Example:

When the worksheet thickness "t" is 2.0 mm, the bending coefficient " α " is obtained using the following formula:

$$\begin{aligned} & \times 100\% \quad (\text{The developed length "L" is obtained by subtracting 3.6 mm from "D + E."}) \\ & = 3.6/2.0 \times 100\% \\ & = 180 \rightarrow \text{Therefore, } \alpha = 180 \end{aligned}$$

G73: SYMMETRY (OPTION)

G73 Xa Yb Qn Ww

When patterns of holes to be punched are symmetrical, they can easily be programmed by using this command and the macro function (see page II-46).

X: Distance from specified-pattern reference point O to symmetrical pattern reference point along X-axis (dimension "a")

Y: Distance from specified-pattern reference point O to symmetrical pattern reference point along Y-axis (dimension "b")

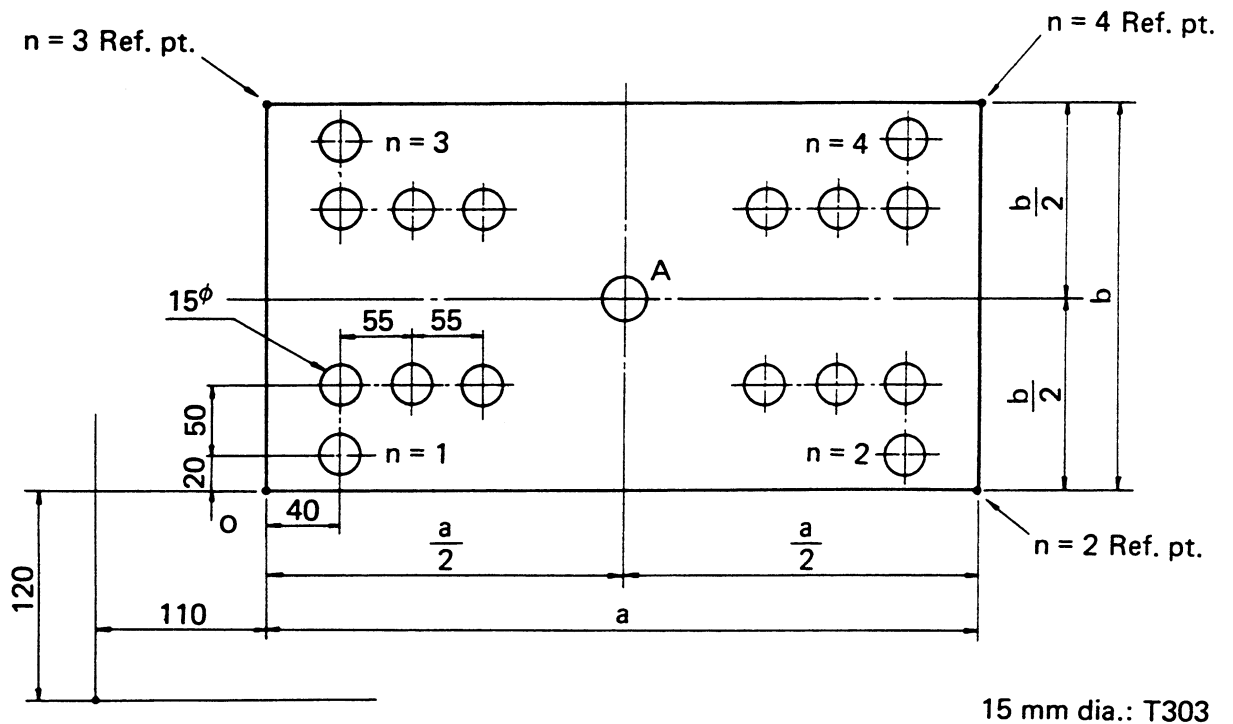
Q:n = 1: Specified pattern punching

n = 2: Symmetrical pattern punching along X-axis, centered on "a"/2

n = 3: Symmetrical pattern punching along Y-axis, centered on "b"/2

n = 4: Symmetrical pattern punching along both X- and Y-axes, centered respectively on "a"/2 and "b"/2

W: Macro number storing specified pattern



Program example:

When "a" is 600 mm and "b" is 400 mm in the diagram on the preceding page, the program is as follows:

```
G06 A___ B___
G92 X___ Y___
N001 G90 G93 X110.00 Y120.00 → Specified pattern (n
= 1) reference point
is defined.

U1
N002 X40.00 Y20.00 T303 } → Specified pattern (n = 1)
Y70.00 } is punched and these
G28 I55.00 J0 K2 } data are simultaneously
V1 } stored.

N003 G73 X600.00 Y400.00 Q4 W1 → Symmetrical
pattern (n = 4)
is punched.

N004 G73 Q3 W1 → Symmetrical pattern (n = 3) is
punched.

N005 G73 Q2 W1 → Symmetrical pattern (n = 2) is
punched.

N006 G91 X300.00 Y200.00 → Hole A is punched.
G50
```

- Once "X" and "Y" are entered in the G73 block, they may be omitted in the second and subsequent G73 blocks if the symmetrical axes are the same (see blocks N004 and N005 in the above program).
- When the block following "G73" is an incremental statement, the incremental dimensions start from the specified-pattern reference point (see block N006 in the above program).

- "G73" can be commanded within a macro in the multiple-part program (see below).

```
G98 X___ Y___ I___ J___ P___ K___
Uxx
```

```
_____
_____
_____
```

```
Vxx
```

```
UOO
```

```
G73 X___ Y___ Q___ Wxx
```

```
G73 Q___ Wxx
```

```
G73 Q___ Wxx
```

```
G73 Q___ Wxx
```

```
VOO
```

```
G75 WOO Q___
```

```
•
```

```
•
```

```
•
```

```
xx: Macro number 60 to 89
OO: Macro number 01 to 59
```

- M- and T-codes cannot be entered with "G73".

M FUNCTION CODES

M-code list

M-code	Function
M00	Program stop
M01	Optional stop
M02	Program end
M08	Beginning of punching completion signal delay
M09	End of punching completion signal delay
M10	Work hold and unclamp
M11	Work hold and release
M12	Nibbling pattern
M13	Press mode cancel
M30	End of tape
M31	Rear workholder and cassette cylinder lower*
M32	Side table bearings lower*
M33	Loading command*
M34	Unloading command*
M35	Job search end*
M36	Unloading preparation command*
M37	Penultimate worksheet signal*
M38	Job end signal*
M39	Total job end signal*
M80	Workchute open*
M81	Workchute close*
M96	Subprogram recall command
M97	Subprogram end command
M120	Mild mode on
M121	Mild mode cancel

*Optional function

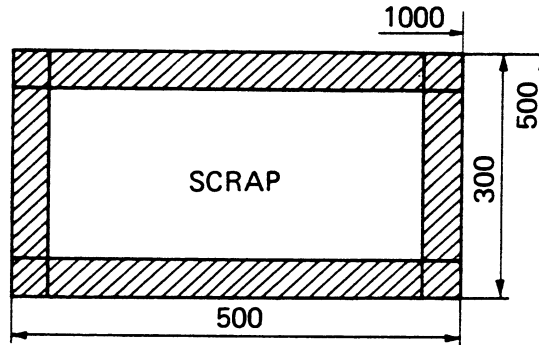
M-code	Function
M500	Punching pattern (punch without shear angle)
M501	Punching pattern (punch with shear angle)
M502 to M505 M570 to M575	Knockout pattern
M506 to M509	Slitting pattern
M510 to M559 M800 to M999	Forming pattern
M560 to M569	Marking pattern
M681 to M683	Punching speed
M686	Punching speed command cancel
M687	Standby position compensation cancel (for forming patterns)
M690	Press air blow
M691	Press air blow cancel
M692	Press raise
M693	Press raise cancel
M696	NEX tool punching mode on
M697	NEX tool punching mode cancel

M00: PROGRAM STOP

Enter "M00" if a program stop is desired.

Example:

Punching a 300 mm × 500 mm rectangular opening with a 50 mm × 50 mm square punch.



```
G72 G90 X1000.00 Y500.00  
G67 I-500.00 J-300.00 P50.00 T219  
M00 (Machine stops here)
```

When "M00" is read, the machine stops. When the START button is pressed after scrap has been removed, the machine will continue the punching operation. "M00" must be entered as a single block; however, the sequence number can be entered with it.

M01: OPTIONAL STOP

This code has the same function as "M00"; however, the machine will stop only when the OPTIONAL STOP button is pressed and its lamp is turned on. (Refer to the OPERATOR'S MANUAL.)

M08: BEGINNING OF PUNCHING COMPLETION SIGNAL DELAY
M09: END OF PUNCHING COMPLETION SIGNAL DELAY

These codes are used for forming, marking and knockout. They are also used for punching thick worksheets. The timing at which axis travel starts after punching is delayed between "M08" and "M09."

```
G06 A___ B___
G92 X___ Y___
G90 X___ Y___
.
.
.
M510
M08
G90 X___ Y___
.
.
.
G28 I___ J___ K___
.
.
.
M09
M13
.
.
.
G50
```

} → Punching completion signal delay

Do not place any nibbling command between "M08" and "M09."

M80: WORKCHUTE OPEN
 (usable on machine equipped with workchute)
M81: WORKCHUTE CLOSE
 (usable on machine equipped with workchute)

These codes are used to open and close the workchute.

```
M692 → Press raise command
M80 → Workchute open
G04 X___
M81 → Workchute close
M693 → Press raise cancel command
```

When closing the workchute, enter the dwell command (G04 X___) to delay the workchute close timing. Enter the press raise command (M692) to raise the press to the top dead center.

M120: MILD MODE ON
M121: MILD MODE CANCEL

These codes are used to change from the mild mode to the normal mode and vice versa. "M120" and "M121" must be entered as a single block.

NOTE

ℓ "M120" and "M121" are commanded for punching in the mild mode. Their functions are the same as turning on and off the lamp of the FEEDRATE FA button on the control panel. The X- and Y-axes are accelerated or decelerated more slowly between "M120" and "M121" than specified in other portions of the program.

Example:

```
•  
•  
•  
M120                                → Mild mode on  
X___ Y___ T___                      }  
X___                                } → Punching in mild mode  
G28 I___ J___ K___                  }  
M121                                → Mild mode cancel  
•  
•  
•  
•                                } → Punching in normal mode
```

M681 TO M683: PUNCHING SPEED COMMAND M686: PUNCHING SPEED COMMAND CANCEL

"M681" to "M683" correspond to the PRESS SPEED buttons labeled F1 to F3, respectively. The punching speed can be designated only in the punching press mode. A punching speed commanding M-code remains effective until "M686" or another punching speed command is executed. These M-codes must be entered as a single block.

NOTE

- ℓ If an M-code command is different from a PRESS SPEED button selection, the lower punching speed becomes effective.
- ℓ When the PRESS SPEED AUTO button is lighted and the program has no punching speed command or has the punching speed command canceled, the punching speed is automatically set for each punching.

Example: (Punching speed selection by M-code)

```
G06 A___ B___  
G92 X___ Y___  
G90 X200. Y100. T345  
G28 I20. J0 K3  
M683  
G90 X500. Y500. T201  
G36 I100. P2 J40. K3 } → Punching at "F3"  
G50
```

M687: STANDBY POSITION COMPENSATION CANCEL (FOR FORMING PATTERNS)

The punch standby position (top stroke end) in a forming pattern is always compensated to the highest position to avoid interference between the worksheet and tools.

After M687 is specified and the compensated punch standby position is reset, processing starts at the standby position of the subsequently specified press mode recall M-code. M687 is used for rapid processing at a lower standby position after forming.

Example

```
      :  
M510;   Forming pattern      }  
      :   (Processing program) } Standby position  
M13;    Press mode cancel   } compensated to  
G27 X_; Auto-repositioning  } highest position  
M687;   Standby position compensation cancel  
M500;   Punching pattern    }  
      :   (Processing program) } Newly specified  
                                      } standby position
```

When M687 is specified after auto-repositioning, processing is done with the high standby position canceled.

NOTICE

ℓ After M687 is specified, processing starts at another standby position despite the previous forming operation. The worksheet may consequently interfere with the tools, depending on the relationship between the forming dimensions and standby position.

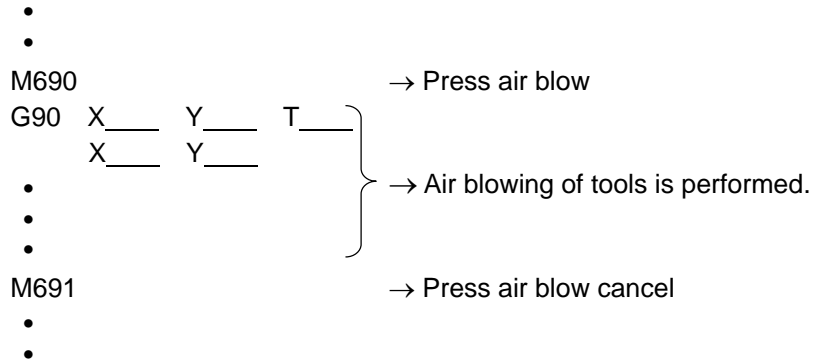
In a press pattern after M687, check the forming dimensions and processing sequence, and set an appropriate standby position.

NOTE

ℓ Before specifying M687, cancel the forming pattern by M13.

M690: PRESS AIR BLOW
M691: PRESS AIR BLOW CANCEL

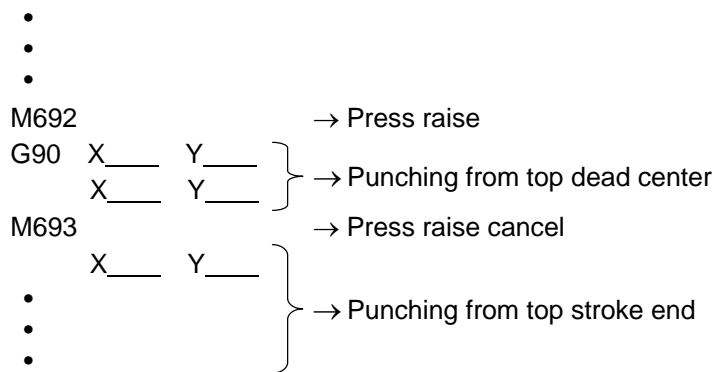
"M690" or "M691" must be entered as a single block. When "M690" is commanded, the air blowing of the tools is performed. When "M691" is commanded, the air blowing of the tools is canceled.



In the nibbling and slitting press modes, the air blowing of the tools is always performed, including the period of axis travel, between "M690" and "M691." When the PRESS TOP DEAD CENTER button is lighted or when the press raise command (M692) is executed and the press is punching from the top dead center, the air blowing of the tools is performed as long as the punching operation is performed. In a press mode other than nibbling and slitting, the air blowing of the tools is performed as long as the punching operation is performed.

M692: PRESS RAISE
M693: PRESS RAISE CANCEL

"M692" or "M693" must be entered as a single block. When "M692" is commanded, the press starts punching from the top dead center, while "M693" is commanded, the press raise command is canceled and the press starts punching from the top stroke end.



"M692" has the same function as when the PRESS TOP DEAD CENTER button is lighted.

M696: NEX TOOL PUNCHING MODE ON
M697: NEX TOOL PUNCHING MODE CANCEL

These codes are used to use NEX tools. "M696" and "M697" must be entered as a single block. When "M696" is commanded and "T_" is entered in the lower command block, the press starts punching from the top stroke end for a NEX punch, which can be set on the PROCESSING CONDITION display. When "M697" is commanded, the NEX tool punching mode on command is canceled and the press starts punching from the top stroke end.

```

•
•
•
M696
G28 I____ J____ K____ T____ } →NEX tool punching mode on
X____ Y____ } →Punching from top stroke
                    } end for NEX punch
M697
X____ Y____ } →NEX tool punching mode
                    } cancel
•
•
•
                    } →Punching from top stroke
                    } end

```

Press mode recall and cancel

M000	Press mode recall
•	
•	
•	
M13	Press mode cancel

To recall a press mode registered on the PROCESSING CONDITION display, enter the M-code for the press mode in question (refer to the following pages). The press mode recalled by the M-code remains effective until "M13" is entered or another press mode is recalled. These M-codes must be entered as a single block.

Basic Program:

```
G06 A___ B___
G92 X___ Y___
G90 X___ Y___
G36 I___ P___ J___ K___
M000                                → Press mode recall
G72 X___ Y___
G66 I___ J___ P___ Q___ T___
M13                                  → Press mode cancel
G50
```

M500, M501: PUNCHING

"M500" is entered for punching with a standard punch having a flat edge and "M501" is entered for punching with a punch having a shear angle.

NOTE

ℓ You can confirm or set punching parameters on the PROCESSING CONDITION display.

```
M500                                → For standard punch
G90 X100. Y150. T342 (standard punch)
G28 I20. J45. K5
G90 X200. Y350. T255 (standard punch)
G36 I50. P3 J75. K2
M13                                  → Mode cancel
M501                                → For punch with shear angle
G72 X120. Y100.
G66 I200. J0 P110. Q10. T201 (punch with shear angle)
M13                                  → Mode cancel
```

"M500" and "M501" can be omitted in the program when the "SHEAR TOOL" of the tooling data parameters is set for the turret station to be used. If the parameter setting is different from the M-code in the program, the press performs the punching operation in the same way as when "M501" is commanded.

NOTE

ℓ You can confirm or set the tooling data parameters on the TOOLING DATA display.

M12: NIBBLING

When "M12" is entered, the press performs the punching operation without decelerating above the worksheet.

NOTE

ℓ You can confirm or set nibbling parameters on the PROCESSING CONDITION display.

M12 → Nibbling mode
G90 X230. Y300. T303
G36 I150. P3 J40. K2
M13 → Mode cancel

When the nibbling command "G68" or "G69" is entered in the block following "M12," the nibbling interval "Q" must not exceed the permissible pitch limit of 8 mm.

M12 → Nibbling mode
G72 X300. Y400.
G69 I200. J45. P20. Q3. T306
M13 → Mode cancel

M510 TO M559: FORMING

M800 TO M999: FORMING

When performing a forming operation, an M-code that meets the content of the forming operation to be performed is entered. The press operation in the block following the M-code is performed according to the data set for the parameters of the M-code.

NOTE

ℓ You can confirm or set the forming parameters on the PROCESSING CONDITION display.

M510	→ Forming
(M08)	→ Beginning of punching completion signal delay
G90 X500. Y300. T201 (Forming tool)	
G28 I30. J0 K10	
(M09)	→ End of punching completion signal delay
M13	→ Mode cancel
M511	→ Forming
(M08)	→ Beginning of punching completion signal delay
G90 X20. Y150. T333	
G36 I800. P1 J400. K1	
(M09)	→ End of punching completion signal delay
M13	→ Mode cancel

"M08" and "M09" are entered as required.

M560 TO M569: MARKING

When performing a marking operation, an M-code that meets the content of the marking operation to be performed is entered. The press operation in the block following the M-code is performed according to the data set for the parameters of the M-code.

NOTE

ℓ You can confirm or set the marking parameters on the PROCESSING CONDITION display.

M560	→ Marking
(M08)	→ Beginning of punching completion signal delay
G90 X130. Y280. T201 (Marking tool) X350.	
(M09)	→ End of punching completion signal delay
M13	→ Mode cancel

"M08" and "M09" are entered as required.

M502 TO M505: KNOCKOUT M570 TO M575: KNOCKOUT

When performing a knockout operation, an M-code that meets the content of the knockout operation to be performed is entered. The press operation in the block following the M-code is performed according to the data set for the parameters of the M-code.

NOTE

ℓ You can confirm or set the knockout parameters on the PROCESSING CONDITION display.

M502	→ Knockout
(M08)	→ Beginning of punching completion signal delay
G90 X350. Y180. T246 (Knockout tool) Y350.	
(M09)	→ End of punching completion signal delay
M13	→ Mode cancel

"M08" and "M09" are entered as required.

M506 TO M509: SLITTING

When performing a slitting operation, an M-code that meets the content of the slitting operation to be performed is entered. The press operation in the block following the M-code is performed according to the data set for the parameters of the M-code.

NOTE

- ℓ Slitting is performed by using dedicated tools. For the programming method for slitting, refer to the operator's manual of slitting tools. Also refer to the operator's manual of slitting tools for the set values of slitting parameters.
- ℓ You can confirm or set the slitting parameters on the PROCESSING CONDITION display.

1. When slitting feed direction is 0°, 90°, 180° or 270°

M690	→ Press air blow
M506 (M507, M508, M509)	→ Slitting mode
G90 Xa Yb T____ C____	
G28 Id ₁ Jθ Kn	
M13	→ Mode cancel
G28 Id ₂ Jθ K1	→ Final cutting punch
M691	→ Press air blow cancel

a: X-coordinate of initial punch center

b: Y-coordinate of initial punch center

θ: Angle corresponding to slitting feed direction (0°, 90°, 180°, 270°)

d₁: Feed pitch

The feed pitch is set according to the worksheet thickness and material and the punch to be used. (It is initially set at about 5 mm and is then adjusted as required according to the check results of the slit product.)

n: Feed frequency

[Slitting length (L) – Wide-side length of punch (H)] / Feed pitch

When the calculated value is a fraction, omit the numerals below the first place of decimals.

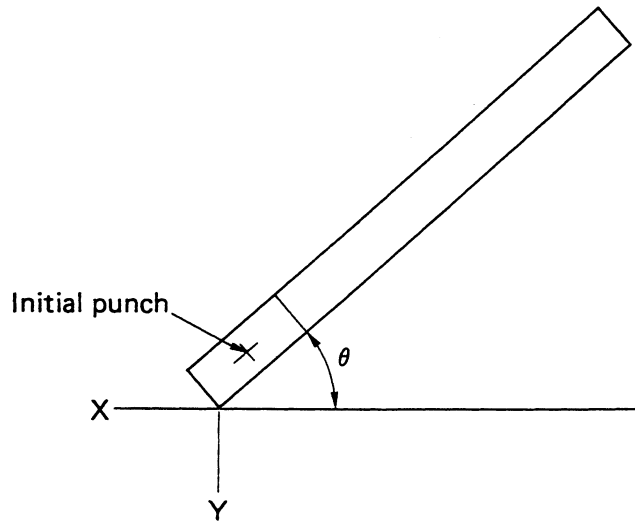
d₂: Feed pitch

[Value omitted at the feed frequency "n"] × [Feed pitch "d₁"]

When the value calculated at the feed frequency "n" is an integer, enter zero.

2. When slitting feed direction is arbitrary angle

Since a chip not separated from the worksheet occurs in the die, a linear interpolation is required.



M690	→ Press air blow
M506 (M507, M508, M509)	→ Slitting mode
G90 Xa Yb T___ Cθ	
G01 F8000	→ Linear interpolation start
G28 Id ₁ Jθ Kn	
M13	→ Mode cancel
G28 Id ₂ Jθ K1	→ Final cutting punch
G00	→ Linear interpolation cancel
M691	→ Press air blow cancel

a: X-coordinate of initial punch center

b: Y-coordinate of initial punch center

θ: Angle corresponding to slitting feed direction

d₁: Feed pitch

The feed pitch is set according to the worksheet thickness and material and the punch to be used. (It is initially set at about 5 mm and is then adjusted as required according to the check results of the slit product.)

n: Feed frequency

[Slitting length – Wide-side length of punch] / Feed pitch
When the calculated value is a fraction, omit the numerals below the first place of decimals.

d₂: Feed pitch

[Value omitted at the feed frequency "n"] × [Feed pitch "d₁"]
When the value calculated at the feed frequency "n" is an integer, enter zero.

G01 F___: Linear interpolation start
Positioning becomes linear interpolation (over the shortest distance).
G00: Linear interpolation cancel
Positioning becomes normal positioning.

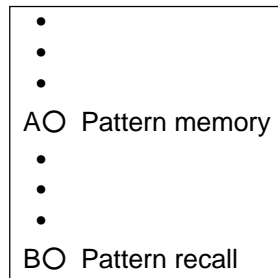
NOTE

- ℓ When "G01" has no F-code, a program error occurs.
- ℓ The F-code is usually entered not to exceed "8000" (8 m/min). "8000" is normally entered.
- ℓ When the T- and C-codes are placed between "G01" and "G00," a program error occurs.

3. When single-stroke punching is performed with slitting punch

M690	→ Press air blow
M506 (M507, M508, M509)	→ Slitting mode
M13	→ Mode cancel
G90 X___ Y___ T___ C___	→ Single-stroke punching
M691	→ Press air blow cancel

PATTERN MEMORY AND RECALL

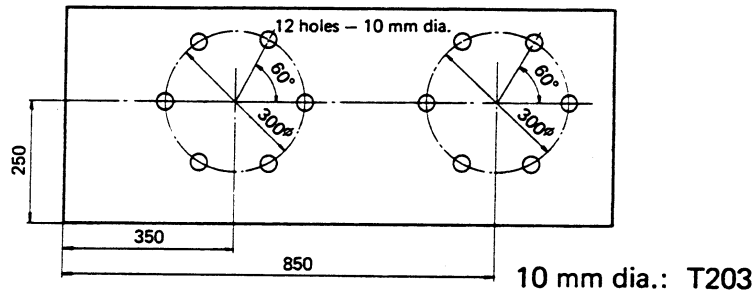


When a pattern specified by the command G26 (BHC), G28 (LAA), G29 (ARC), G36 (GRD-X), G37 (GRD-Y), G66 (SHP), G67 (SQR), G68 (NBL-A), G69 (NBL-L), G78 (PNC-A) or G79 (PNC-L) is to be punched repeatedly, the pattern can be memorized and recalled whenever required.

To memorize a pattern, enter the address letter "A" along with a one-digit numeral (from 1 to 5). To recall the pattern, enter the address letter "B" and the same one-digit numeral as used at "A."

"AO" should always be entered at the front of the pattern command block; "BO" must be entered as a single block by itself. "AO" and "BO" are only used for the pattern memory and recall. Memorization and recalling of coordinates are impossible with these.

Example:



```
G72 G90 X350.00 Y250.00
A1 G26 I150.00 J0 K6 T203 → Pattern memory
G72 X850.00
B1 → Pattern recall
```

FO: DESIGNATION OF AXIS FEED SPEED

The axis feed speed can be changed by this code. "FO" must be entered as a single block. The axis feed speed is decreased as the value following "F" is changed from 1 to 4 (1 → 2 → 3 → 4). This code has the same function as the FEEDRATE button. When there is a difference between the axis feed speed commanded by this code and that set by the FEEDRATE button, priority will be given to the slower axis feed speed. The command of the F-code remains effective until a new F-code is entered. If no F-code is commanded, the axes move at the feed speed set by the FEEDRATE button.

G90 X___ Y___ T___

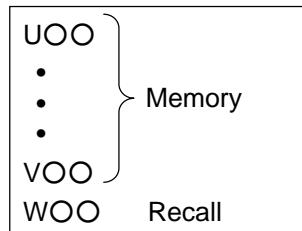
F3

X___ Y___ }
X___ Y___ } → Axis travel at "F3"

F1

X___ Y___ }
X___ Y___ } → Axis travel at "F1"

MACRO FUNCTION



1. Macro storing

Using the macro function, the contents of multiple blocks of data can be stored in memory as a single macro; and the stored data can be recalled whenever required. To store multiple blocks of data, enter the address letter "U" along with a two-digit numeral (from 01 to 99) as a single block, preceding the multiple blocks which you wish to memorize, and enter as a single block the address letter "V" and the same two-digit numeral as used at "U," after the multiple blocks which you wish to memorize.

The two-digit numeral following "U" or "V" is called the "macro number." This macro number comes in the following three types:

- 01 to 59: The blocks of data between "U" and "V" remain stored while they are simultaneously being executed.
- 60 to 89: The blocks of data between "U" and "V" are only stored in memory.
- 90 to 99: Storing of multiple macros is accomplished.

2. Macro recalling

The multiple blocks of data which were stored by "U" and "V" can be recalled by the address letter "W" along with the same two-digit numeral as used at "U" and "V."

3. Example

```

G06 A___ B___
G92 X2500.00 Y1270.00
.
.
.
U02
G90 X100.00 Y500.00 T345
G72 X150.00 Y700.00
A1 G66 I100.00 J30.00 P20.00
N100 M00
G72 X450.00 Y600.00
B1
V02
.
.
.
    
```

} → These commands remain stored while they are simultaneously being executed.

```

U70
G90 X200.00 Y100.00 T304
G37 I8.00 P3 J10.00 K10
G90 X1000.00 Y800.00
G28 I25.00 J-90.00 K6
V70
•
•
•
W02 → Recalling and executing commands stored between
      "U02" and "V02"
•
•
•
W70 → Recalling and executing commands stored between
      "U70" and "V70"
•
•
•

```

} → These commands are merely stored.

4. Multiple recalling of macro

The data which were stored as macro can be recalled, and the recalled data can also be stored and then be recalled again. This multiple recalling is possible up to triple level.

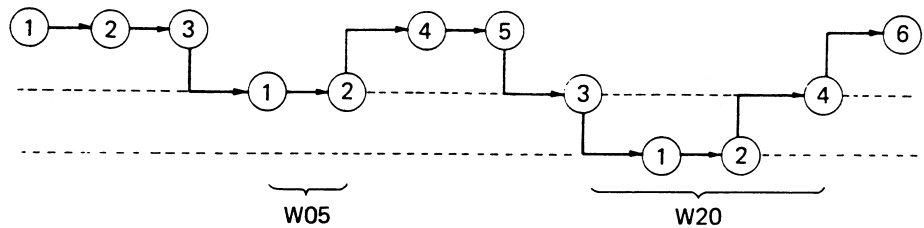
Example:

```

U05
.....①
.....②
V05
U20
.....③
W05
.....④
V20
U70
.....⑤
W20
.....⑥
V70
W70

```

The above commands are executed in the following sequence:



5. Memory capacity for macro (Macro numbers 01 to 89)

The maximum memory capacity for macro is 3100 characters. One character equals:

- One address letter (G, X, Y, T, M, etc.)
- One numeral (1, 2, 3,, 0)
- One symbol (CR, LF, -, /, etc.)

The delete, space, and other codes which are ignored by the NC are not considered as characters.

6. Storing and recalling of multiple macros

Multiple macros can be stored and recalled by using the macro numbers 90 to 99. These macro numbers are only capable of defining a group of multiple macros as one macro, and they are unable to store execution commands. The maximum number of single macros that can be stored by each of the macro numbers 90 to 99 is 15.

Example:

```
U90
U01
•
•
•
V01
U10
•
•
•
V10
U15
•
•
•
V15
G90 X100.00 Y200.00 → This block is not stored.
U02
•
•
•
V02
V90
•
•
•
W90 = { W01
        W10
        W15
        W02
```

7. Macro memory setting

When any of the following conditions (a) to (c) occurs, all stored macros will be erased from memory:

- (a) The NC power has been turned off.
- (b) The RESET key has been pressed.
- (c) "G50," "M02" or "M30" has been commanded.

However, the macros can be retained in memory under the above-mentioned conditions by setting the NC. For the NC setting procedure, refer to the OPERATOR'S MANUAL.

Part III

Multiple-Part Punching

General description and programming example.....	III-2
G98: Setting of reference point and layout for multiple-part punching.....	III-5
U00 to V00: Storing of part program.....	III-8
G75, G76 W00 Q0: Recalling and execution of part program	III-10
Inclusion and priority relations between G98 and G93.....	III-14
First punching, others punching, and all punching	III-14

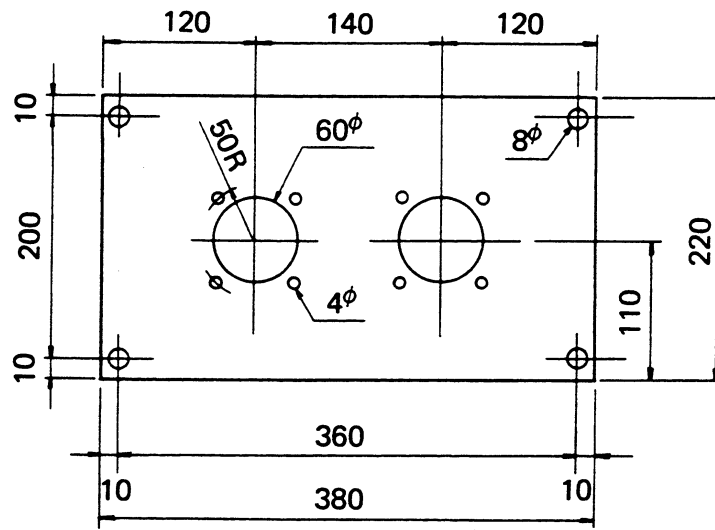
GENERAL DESCRIPTION AND PROGRAMMING EXAMPLE

1. Multiple-part punching function

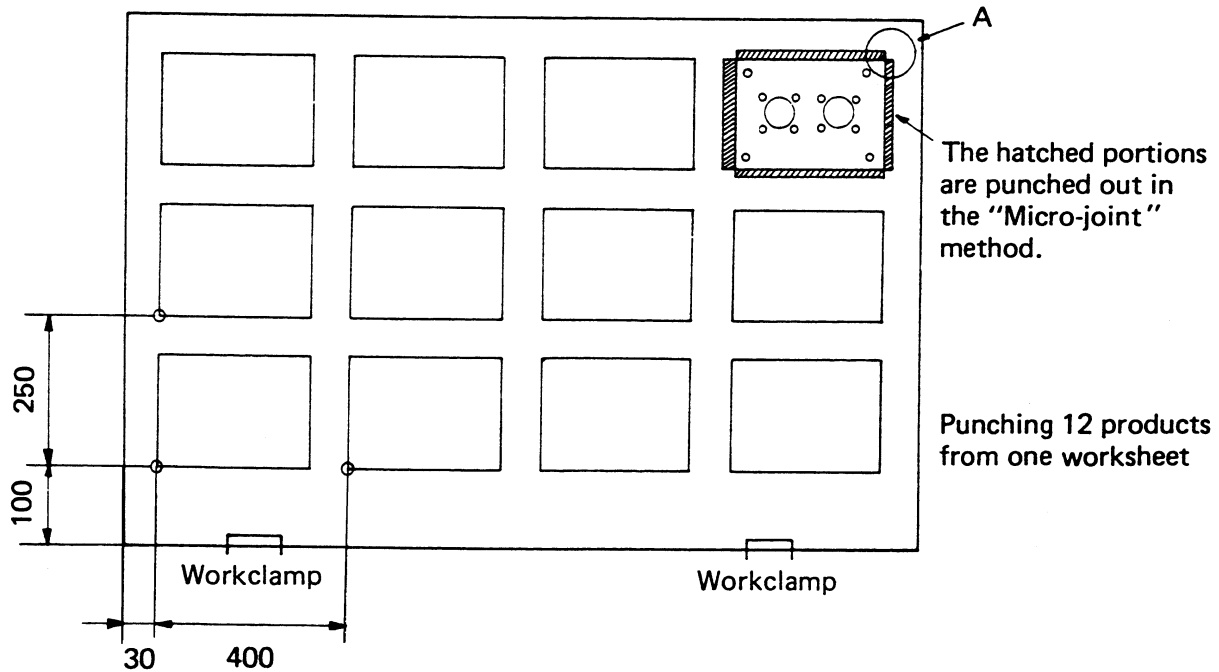
This function is used to punch multiple products which have the same punching pattern from one worksheet. Once the punching of only one product is programmed, the punching of multiple products with any desired layout on the worksheet can be performed by using simple commands.

2. Removal of each product after multiple-part punching

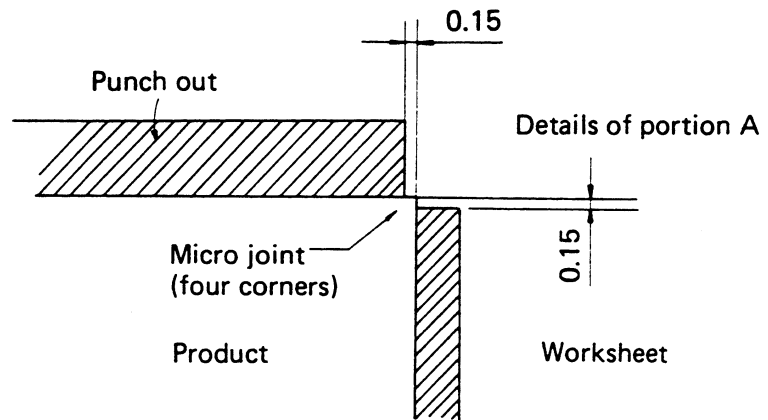
When punching twelve products from one worksheet, such as the one shown in the figure below, the following three removal methods can be used:



a. Micro-joint method

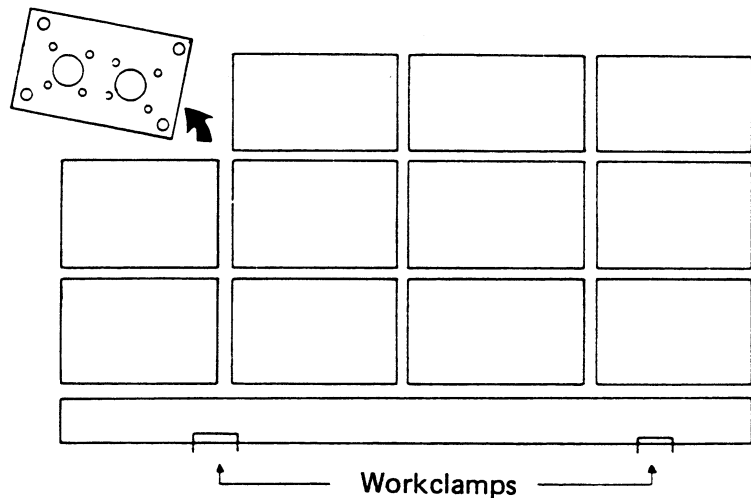


As shown in the figure, the hatched portions are punched out by rectangular punches in such a manner that the four corners of each product remain unpunched. The four corners are connected to the worksheet by means of an approx. 0.15 mm joint. After completing the entire punching process, the worksheet with punched products is unloaded from the machine, and each product is then separated from the worksheet.



b. Separation method

Each product is separated from the worksheet after punching. Each time one product is cut out, the operator stops the machine and removes the product using a magnet or by other means.



c. Workchute method

Each product which is separated from the worksheet automatically drops into the workchute.

3. Program example using multiple-part punching function

The program for punching the product shown in the figure on page III-2 using the "micro-joint" method is as follows:

```

G06 A1.6 B0
G92 X2500.00 Y1270.00
G98 X30.00 Y100.00 I400.00 J250.00 P3 K2 → (1) The reference point for
                                         multiple-part punching is set.

U1
G90 X370.00 Y210.00 T304 (8φ)
Y10.00
X10.00
Y210.00
G72 X120.00 Y110.00
A1 G26 I50.00 J45.00 K4 T203 (4φ)
G72 X260.00
B1
V1

U2
X260.00 Y110.00 T219 (60φ)
X120.00
V2

U3
G72 X380.00 Y220.00
G66 I220.00 J-90.00 P85.00 Q5.00 D-0.15 T255 (5 × 85 )
G72 X0 Y0
G66 I220.00 J90.00 P85.00 Q5.00 D-0.15
V3

U4
G72 X0 Y220.00
G66 I380.00 J0 P110.00 Q10.00 D-0.15 T201 (10 × 110 )
G72 X380.00 Y0
G66 I380.00 J180.00 P110.00 Q10.00 D-0.15
V4

G76 W1 Q4 ..... U1-V1 execution command
G76 W2 Q3 ..... U2-V2 execution command
G76 W3 Q2 ..... U3-V3 execution command
G75 W4 Q3 ..... U4-V4 execution command
G50
  
```

→ (2) Program (part program) for punching one product. This part program is stored.

→ (3) Program (part program) for punching the exterior shape of one product. This part program is stored.

→ (4) Recalling and execution of each part program for the specified punching layout.

After preparing the above program, one product in the lower left corner in the figure on page III-2 can be first-punched by button operation on the screen. After checking the dimensions of the product, the punching of multiple products over the entire surface of the worksheet can then be performed.

G98: SETTING OF REFERENCE POINT AND LAYOUT FOR MULTIPLE-PART PUNCHING

G98 XxA YyA I/x J/y Pnx Kny

x_A : X-coordinate of reference point

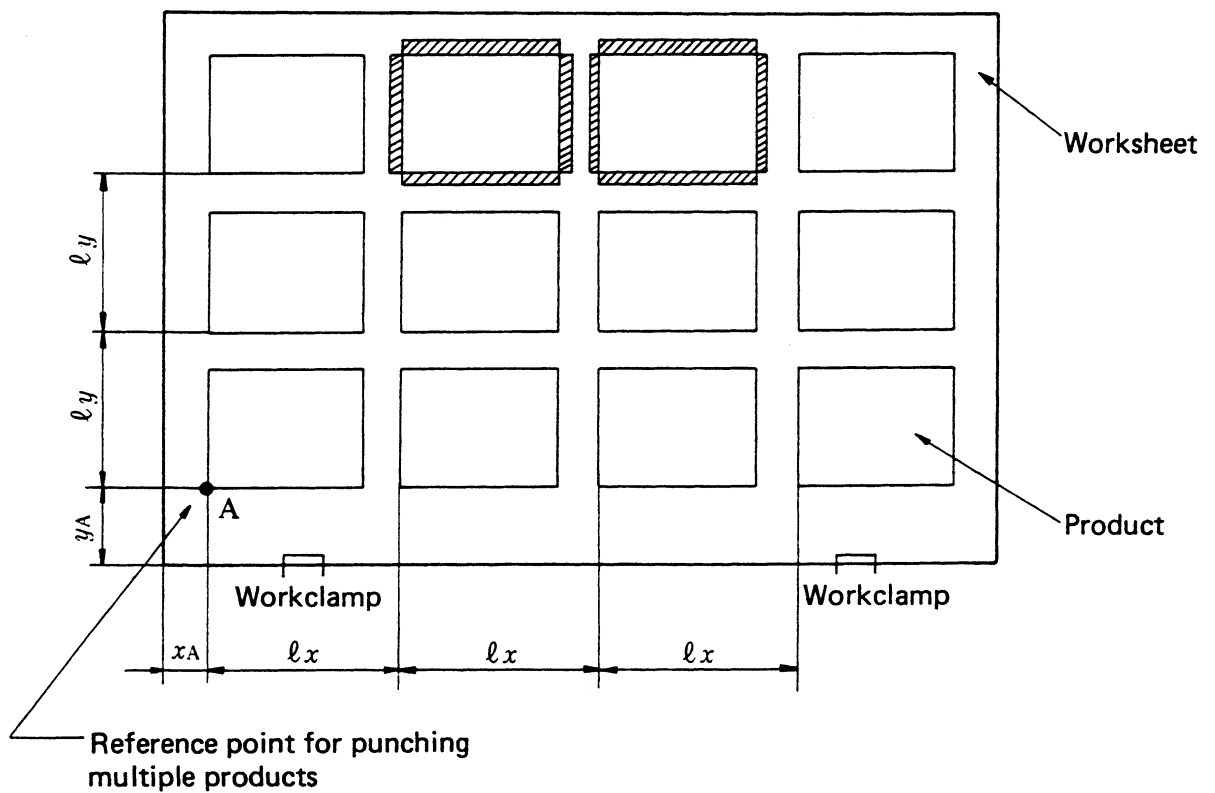
y_A : Y-coordinate of reference point

l_x : Pitch along X-axis

l_y : Pitch along Y-axis

n_x : Number of products in X-axis direction, excluding product at reference point

n_y : Number of products in Y-axis direction, excluding product at reference point



If $x_A = 30$ mm, $y_A = 80$ mm, $l_x = 400$ mm and $l_y = 250$ mm in the above figure, the program is:

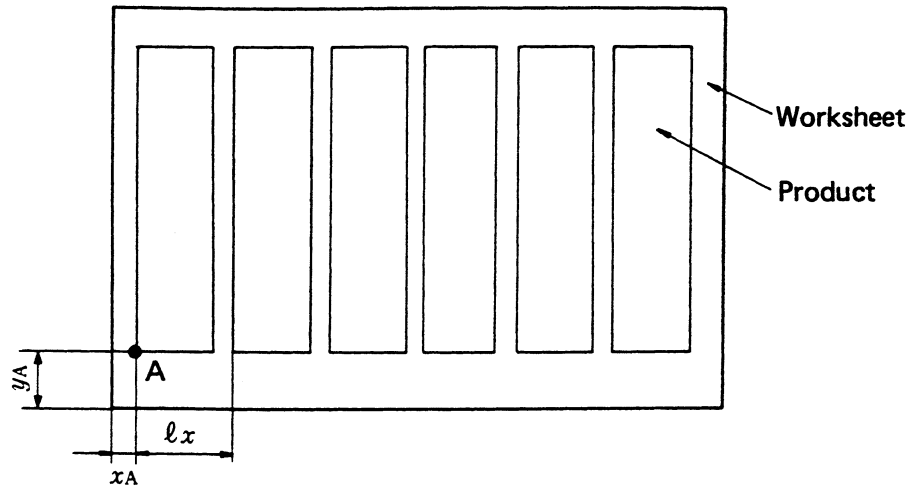
G98 X30.00 Y80.00 I400.00 J250.00 P3 K2

NOTE

- ℓ The reference point for punching multiple products must be located in the lower left corner of the product which is located at the lower left portion of the worksheet.
- ℓ The values " l_x ," " l_y ," " n_x " and " n_y " of I, J, P, K specified by "G98" must be either zero or positive values.

Example 1:

This shows the punching of products only in the X-axis direction.



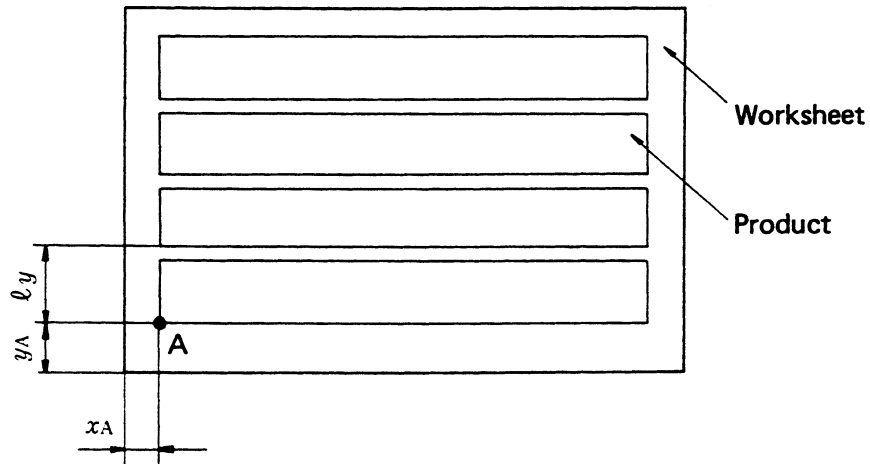
If $x_A = 30$ mm, $y_A = 80$ mm and $l_x = 250$ mm in the above figure, the program is:

```
G98 X30.00 Y80.00 I250.00 J0 P5 K0
```

As shown above, $Jl_y = 0$ and $Kny = 0$.

Example 2:

This shows the punching of products only in the Y-axis direction.



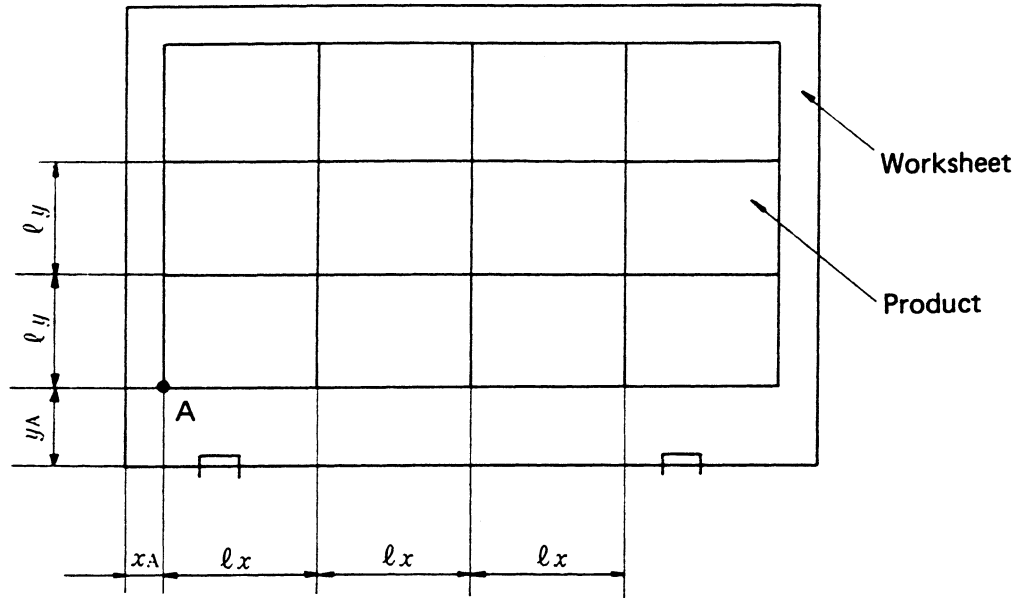
If $x_A = 30$ mm, $y_A = 80$ mm and $l_y = 150$ mm in the above figure, the program is:

```
G98 X30.00 Y80.00 I0 J150.00 P0 K3
```

As shown above, $Ilx = 0$ and $Pnx = 0$.

Example 3:

When there is no cutting area between products and the outer edges of each product are cut either by shearing or other procedures after punching (trimming will be necessary).

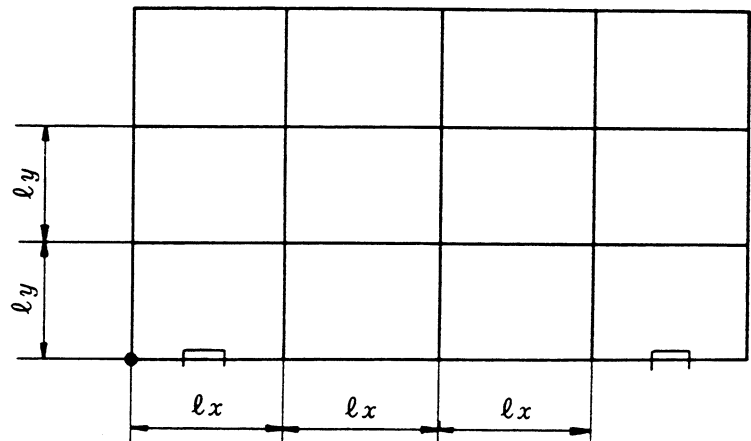


If $x_A = 20$ mm, $y_A = 100$ mm, $l_x = 450$ mm and $l_y = 260$ mm in the above figure, the program is:

```
G98 X20.00 Y100.00 I450.00 J260.00 P3 K2
```

Example 4:

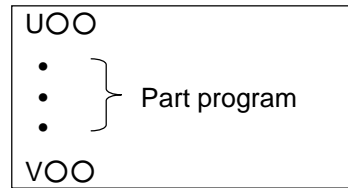
This is an example of a situation where there is neither a cutting area between products nor a clamping area and trimming is not performed.



If l_x (product length along X-axis) = 450 mm and l_y (product length along Y-axis) = 260 mm in the above figure, the program is:

```
G98 X0 Y0 I450.00 J260.00 P3 K2
```

UOO TO VOO: STORING OF PART PROGRAM



To store the part program for one product, "U" and a two-digit numeral (macro number) must be entered at the beginning of the part program to be stored, and "V" and the same two-digit numeral as used at "U" must also be entered at the end of the part program. The part program thus positioned between "UOO" and "VOO" is stored in memory.

NOTE

- ℓ The same macro numbers must be attached to "U" and "V" in order to store one part program.
- ℓ Three types of macro numbers are available; one type ranges from 01 to 59, another type from 60 to 89 and the other type from 90 to 99.
- ℓ The macro numbers 01 through 05 can be specified as one digit by omitting the leading zero.
- ℓ On the macro numbers 01 through 89, the maximum limit of the part program allowed to be stored is 3100 characters on one processing tape.

Program example 1:

In this example, the processing by one type of tool (also including tools which are selected by simply moving the striker) is stored as a part program.

In this program, the processing by one type of tool is performed on the whole surface of the worksheet. Then, the next type of tool is selected and the processing by it also is made on the whole surface of the worksheet. The time required for selection of tool can thus be reduced.

```
U1
X370.00 Y210.00 T304 (8φ)
Y10.00
X10.00
Y210.00
G72 X120.00 Y110.00
A1 G26 I50.00 J45.00 K4 T203 (4φ)
G72 X260.00
B1
V1

U2
X260.00 Y110.00 T219 (60φ)
X120.00
V2
```



```

U3
G72 X380.00 Y220.00
G66 I220.00 J-90.00 P85.00 Q5.00 D-0.15 T255 (5 × 85 )
G72 X0 Y0
G66 I220.00 J90.00 P85.00 Q5.00 D-0.15
V3
U4
G72 X0 Y220.00
G66 I380.00 J0 P110.00 Q10.00 D-0.15 T201 (10 × 110 )
G72 X380.00 Y0
G66 I380.00 J180.00 P110.00 Q10.00 D-0.15
V4

```

Program example 2:

In this example, the processing for one product by five types of tools is stored as a part program.

All processing of one product is performed by using five types of tools. Then, all processing of the next product is also performed by using the same five types of tools. The time for selection of tools increases. Although the program is simple, the processing time is greater than in example 1 above.

```

U50
X370.00 Y210.00 T304
Y10.00
X10.00
Y210.00
G72 X120.00 Y110.00
A1 G26 I50.00 J45.00 K4 T203
G72 X260.00
B1
X260.00 Y110.00 T219
X120.00
G72 X380.00 Y220.00
G66 I220.00 J-90.00 P85.00 Q5.00 D-0.15 T255
G72 X0 Y0
G66 I220.00 J90.00 P85.00 Q5.00 D-0.15
G72 X0 Y220.00
G66 I380.00 J0 P110.00 Q10.00 D-0.15 T201
G72 X380.00 Y0
G66 I380.00 J180.00 P110.00 Q10.00 D-0.15
V50

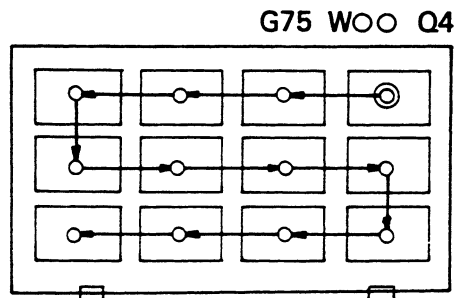
```

G75, G76 WOO QO: RECALLING AND EXECUTION OF PART PROGRAM

The part program for punching one product entered between "UOO" and "VOO" is recalled by "WOO," and the program is executed to process all products according to the punching layout designated by "G98."

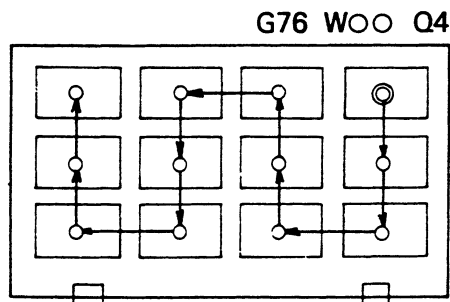
1. G75: Execution of horizontal (X-axis direction) grid

The part program entered between "UOO" and "VOO" is executed in the order shown below.



2. G76: Execution of vertical (Y-axis direction) grid

Execution is accomplished as shown below.

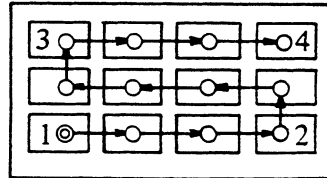


3. QO: Designation of starting point

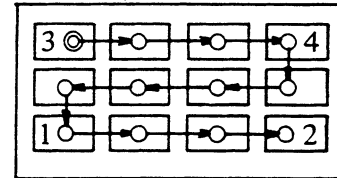
This designates the corner of the punching layout from which the punching operation will begin by "G75" or "G76."

Q1: Lower left corner Q3: Upper left corner

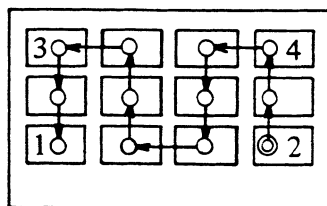
Q2: Lower right corner Q4: Upper right corner



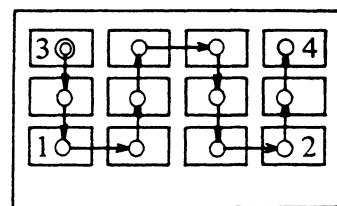
G75 WOO Q1



G75 WOO Q3



G76 WOO Q2

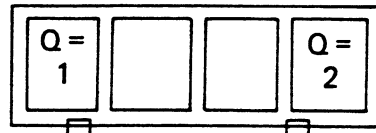


G76 WOO Q3

4. When punching multiple products in a single horizontal row

G: "G75" is used.

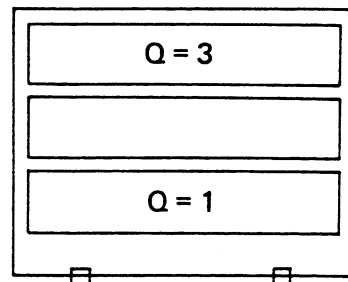
Q: 1 or 2 can be used.



5. When punching multiple products in a single vertical row

G: "G76" is used.

Q: 1 or 3 can be used.



6. Combination method of G75 and Q1 to Q4, or G76 and Q1 to Q4

- a) Either "G75" or "G76" must be selected so that the distance of movement can be minimized.
- b) If the processing of a part program starts from the upper right corner (Q4) and ends at the upper left corner (Q3), the processing of the next part program should start at the upper left corner (Q3) in order to guarantee efficient movement.
- c) When cutting the outside shape in the process of punching multiple products, it is desirable to start the punching at the upper portion of the worksheet and move lower in sequence. For such a procedure, enter the command of: G75 WOO Q4 or 3.

7. U90 to V90

If the starting point designated by "Q" is unchanged and either "G75" or "G76" is to be used alone, it is possible to represent multiple sets of "U OO and VOO" by a single "UOO and VOO." The macro number for this function is 90 to 99.

NOTE

ℓ In each of the macro numbers 90 to 99, it is possible to store a maximum of 15 types of part programs.

Application example of macro numbers in nineties (90 to 99):

G06 A___ B___	G06 A___ B___
G92 X2500.00 Y1270.00	G92 X2500.00 Y1270.00
G98 X30.00 Y100.00 I400.00 J250.00 P3 K2	G98 X30.00 Y100.00 I400.00 J250.00 P3 K2
U90	U1
U1	X370.00 Y210.00 T304
X370.00 Y210.00 T304	Y10.00
Y10.00	X10.00
X10.00	Y210.00
Y210.00	G72 X120.00 Y110.00
G72 X120.00 Y110.00	A1 G26 I50.00 J45.00 K4 T203
A1 G26 I50.00 J45.00 K4 T203	G72 X260.00
G72 X260.00	B1
B1	V1
V1	U2
U2	X260.00 Y110.00 T219
X260.00 Y110.00 T219	X120.00
X120.00	V2
V2	

```

U3
G72 X380.00 Y220.00
G66 I220.00 J-90.00 P85.00 Q5.00 D-0.15 T255
G72 X0 Y0
G66 I220.00 J90.00 P85.00 Q5.00 D-0.15
V3
U4
G72 X0 Y220.00
G66 I380.00 J0 P110.00 Q10.00 D-0.15 T201
G72 X380.00 Y0
G66 I380.00 J180.00 P110.00 Q10.00 D-0.15
V4
V90
G75 W90 Q4
G50

```

```

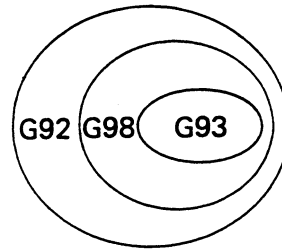
U3
G72 X380.00 Y220.00
G66 I220.00 J-90.00 P85.00 Q5.00 D-0.15 T255
G72 X0 Y0
G66 I220.00 J90.00 P85.00 Q5.00 D-0.15
V3
U4
G72 X0 Y220.00
G66 I380.00 J0 P110.00 Q10.00 D-0.15 T201
G72 X380.00 Y0
G66 I380.00 J180.00 P110.00 Q10.00 D-0.15
V4
G75 W1 Q4
G75 W2 Q4
G75 W3 Q4
G75 W4 Q4
G50

```

The left side program is an example of the application of the macro numbers in the nineties. These two programs (left and right sides) are equivalent in movement of the machine.

INCLUSION AND PRIORITY RELATIONS BETWEEN G98 AND G93

- a) The X- and Y-coordinates specified by "G98" are determined by the coordinate system which is set by "G92."
- b) The coordinate system set by "G98," once specified, cannot be canceled except by using the subsequent command "G98" or "G50," pressing the RESET key or turning off the power.
- c) The X- and Y-coordinates specified by "G93" are determined by the coordinate system which is set by "G98."
- d) "G93" which is specified prior to the setting of "G98" will remain effective even after "G98." The values obtained by adding the X- and Y-coordinates of "G98" and the X- and Y-coordinates of "G93," respectively, will determine the origin of this program.



FIRST PUNCHING, OTHERS PUNCHING, AND ALL PUNCHING

In the conventional method of multiple-part punching, punching must be accomplished over the whole surface of the worksheet, and then dimensional and accuracy checks must be conducted. Should the program contain any error, substantial worksheet and time losses would result. However, in this multiple-part punching function, selection between three types of processing is available by button operation on the screen, i.e. "first punching for one product," "multiple punching for remaining products after first punching" and "all punching." For details on this operation, refer to "Displays" in the OPERATOR'S MANUAL.

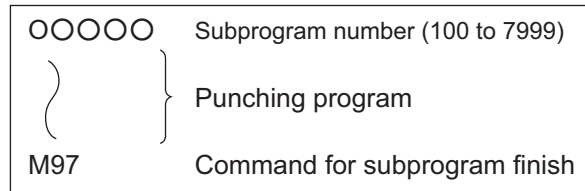
Part IV

Subprograms

Subprogram format.....	IV-2
Recalling format of subprogram.....	IV-2
Multiple recalling of subprogram.....	IV-2

When programs contain patterns which repeat frequently, these patterns can be stored in memory in advance as subprograms to be recalled as required.

SUBPROGRAM FORMAT



Enter a subprogram number "○○○○○" to the beginning of the punching program and enter "M97" to the end of the punching program.

RECALLING FORMAT OF SUBPROGRAM

M96 P___ L___

P: Program number to be recalled (100 to 7999)

L: No. of repetition times (up to a maximum of 9999)

The subprogram is recalled by programming "M96" followed by the program number designated by "P" and the number of repetition times designated by "L." When "L" is omitted, there will be only one recalling.

MULTIPLE RECALLING OF SUBPROGRAM

A subprogram can recall another subprogram as shown above.

Part V

References

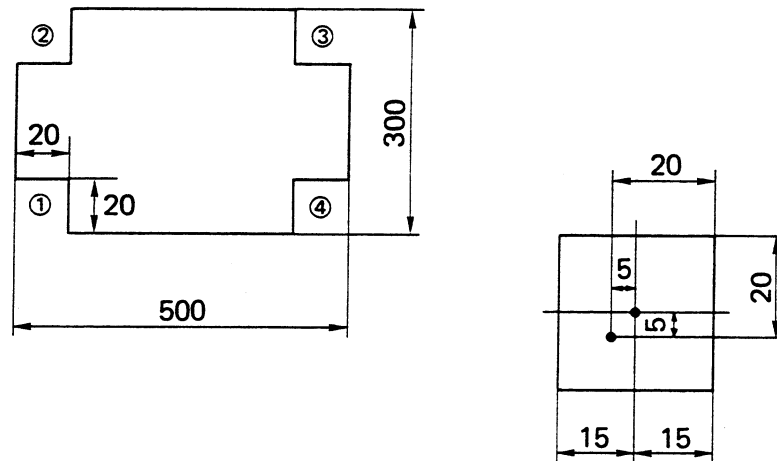
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3. Small rectangular opening.....	V-8
4. Long rectangular hole.....	V-9
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HINTS ON PROGRAMMING BY SHAPE

1. CORNER NOTCHES

Example:

When punching 20 mm × 20 mm notches in four corners of a 300 mm × 500 mm worksheet with a 30 mm × 30 mm sq. punch



When punching the corner notch ①, the center position of the punch is commanded in the program as follows:

$$X: 20 - 30/2 = 5 \text{ mm}$$

$$Y: 20 - 30/2 = 5 \text{ mm}$$

The center of the punch is thus located by:

G90 X5.00 Y5.00

When punching the corner notch ②, the center position of the punch is calculated as follows:

$$X: 5 \text{ mm as for } \textcircled{1}$$

$$Y: 300 - 20 + 30/2 = 295 \text{ mm}$$

When punching the corner notch ③, the center position of the punch is calculated as follows:

$$X: 500 - 20 + 30/2 = 495 \text{ mm}$$

$$Y: 295 \text{ mm as for } \textcircled{2}$$

When punching the corner notch ④, the center position of the punch is calculated as follows:

$$X: 495 \text{ mm as for } \textcircled{3}$$

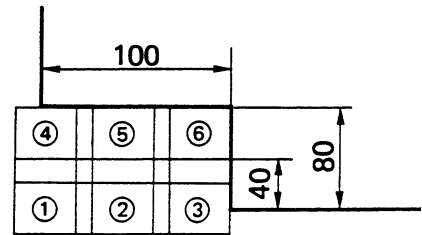
$$Y: 5 \text{ mm as for } \textcircled{1}$$

The program for punching the four corner notches is thus prepared as follows:

- ① G90 X5.00 Y5.00 T____ (30 mm × 30 mm sq. punch)
- ② Y295.00
- ③ X495.00
- ④ Y5.00

Example:

When punching an 80 mm × 100 mm notch with a 50 mm × 50 mm sq. punch



```
G90 G72 X-2.00 Y40.00
A1 G66 I102.00 J0 P-50.00 T____ (50 mm × 50 mm sq. punch)
G72 X-2.00 Y80.00
B1
```

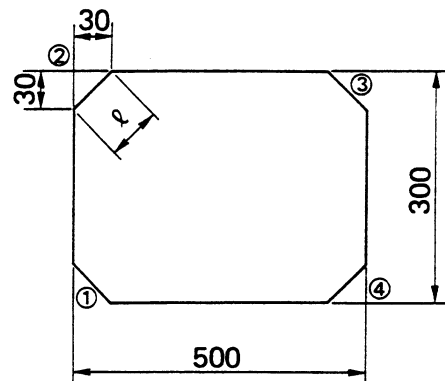
2. 45° CORNER NOTCHES

Example:

When a 45° notch can be punched in a single operation

- a) Determine the punch to be used.

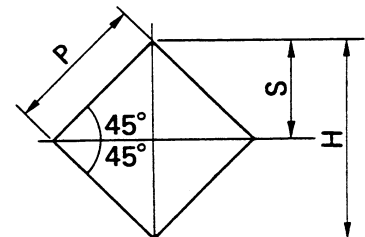
Since the length of the oblique side of the notch is $30 \times 1.414 = 42.42$ mm, the notch can be punched in a single operation with a 50 mm × 50 mm sq., 45° punch.



- b) Calculate the center position of the punch.

$$S = P \times \sin 45^\circ / 2 (= P \times \sin 45^\circ)$$

$$H = 2 \times S = P \times \sin 45^\circ (= 2 \times P \times \sin 45^\circ)$$



c) Determine the coordinates of the punch center.

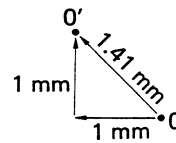
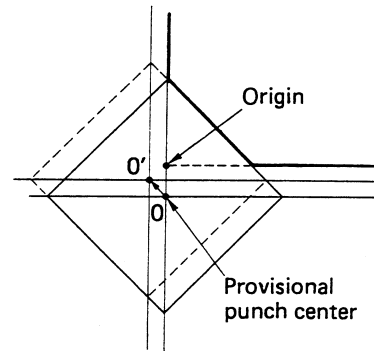
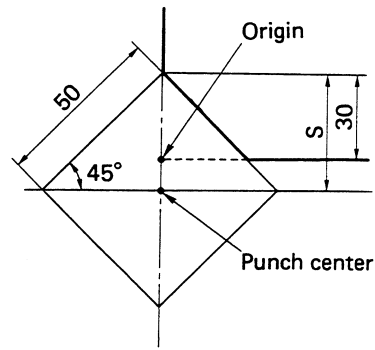
(1) For the notch ①, position the center of the punch on the Y-axis. The X-coordinate of the punch center is 0.

(2) Calculate the length S.
 $S = \text{punch width} \times \sin 45^\circ / 2$
 Thus,
 $S = 50 \times \sin 45^\circ / 2 = 35.35 \text{ mm}$

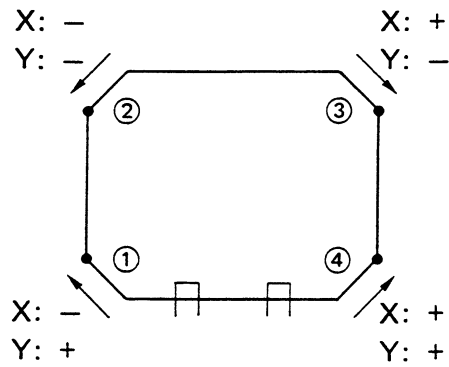
(3) The Y-coordinate of the punch center is
 $Y = 30 - S = 30 - 35.35 = -5.35$
 and the provisional punch center is
 $X=0 \quad Y=-5.35$

(4) Since a needlelike projection may occur on the edge of the worksheet in this condition, shift the punch by 1 mm each in the X-axis and Y-axis directions so that the edge of the punch does not coincide with the edge of the worksheet.

(5) Since the X-coordinate is shifted by 1 mm in the negative direction and the Y-coordinate is shifted by 1 mm in the positive direction, the center of the punch is
 $X: 0 - 1.00 = -1.00$
 $Y: -5.35 + 1.00 = -4.35$
 and the program is
 $G90 \quad X-1.00 \quad Y-4.35 \quad T____ (50 \text{ mm} \times 50 \text{ mm sq. punch})$



The notches ② to ④ are similarly programmed.



- Provisional coincidence point
- ← Shift direction

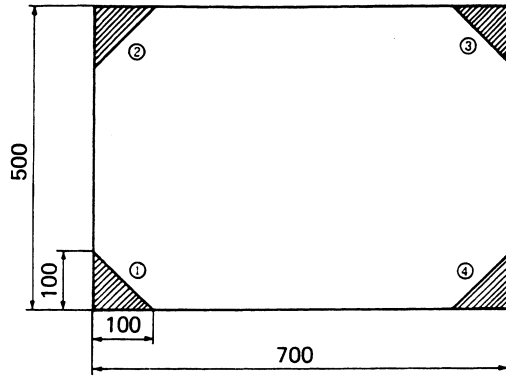
- ② $X: 0 - 1.00 = -1.00$
 $Y: 300 - 30 + 35.35 - 1.00 = 304.35$
- ③ $X: 500 - 30 + 35.35 + 1.00 = 506.35$
 $Y: 300 - 30 + 35.35 - 1.00 = 304.35$
- ④ $X: 500 - 30 + 35.35 + 1.00 = 506.35$
 $Y: 30 - 35.35 + 1 = -4.35$

The program thus becomes as follows:

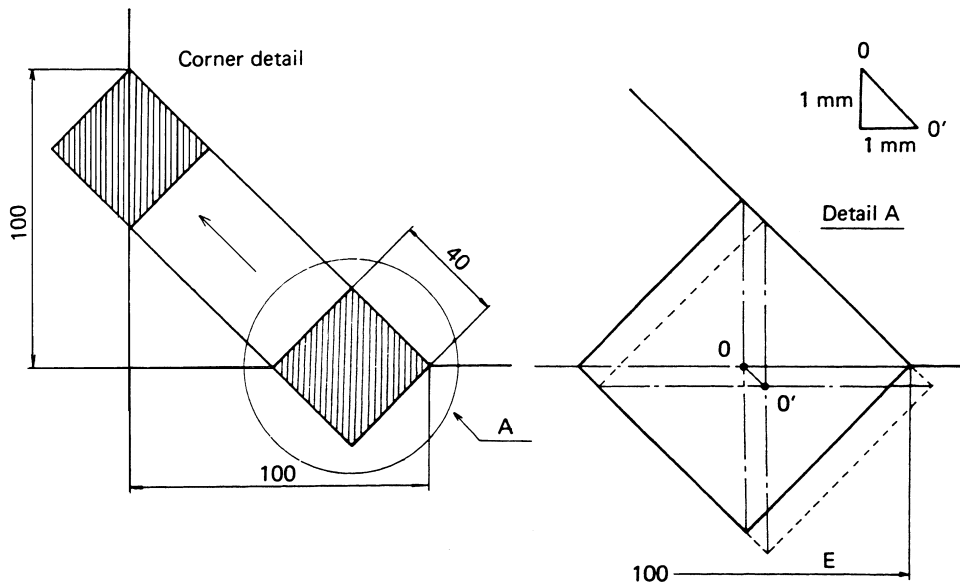
- ① G90 X-1.00 Y-4.35 T____ (50 mm × 50 mm sq.)
- ② Y304.35
- ③ X506.35
- ④ Y-4.35

Example:

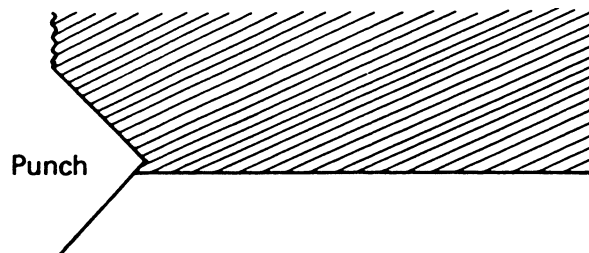
When a 45° notch cannot be punched in a single operation



40 mm x 40 mm sq. (45°): T219



The starting and finishing points of notching should be shifted about 1 mm in order to ensure accurate notching.

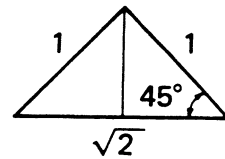
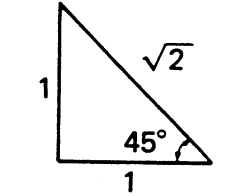
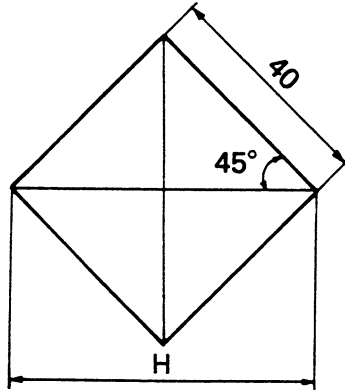


Notching lower left corner

- a) Provisional starting point (0) " X_1, Y_1 " (Absolute coordinates)

$$X_1 = [\text{Notch size "E"}] - 1/2 [\text{Diagonal punch size "H"}]$$

$$Y_1 = 0$$



(Diagonal punch size: H)

$$H = 1.414 \times 40 = 56.56 \text{ mm}$$

- b) Starting point (0) " X_0, Y_0 " (Absolute coordinates)

Shift both X- and Y-axes about 1 mm from (0).

$$X_0 = X_1 + 1 \text{ mm}$$

$$Y_0 = Y_1 - 1 \text{ mm} \quad (\text{In case of the lower left corner } \textcircled{1})$$

- c) Punching frequency and feed pitch

$$\text{Travel distance } L = [\text{Notch size "E"}] - H/2 + 2 \times 1 \text{ mm}$$

Punching frequency $N =$ When decimal numbers are obtained
Ex.: 2.3 \rightarrow 3

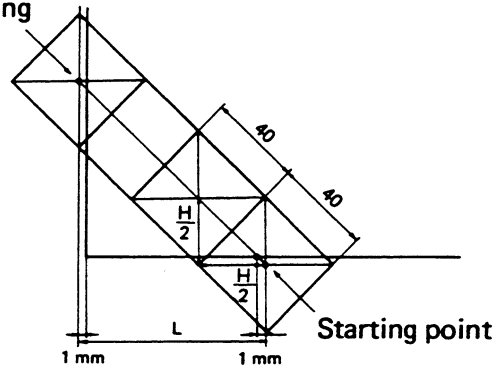
When integral numbers are obtained
Ex.: 3 \rightarrow 4

$$\text{Feed pitch } P = L/N$$

NOTE

ℓ The feed pitches of the X- and Y-axes should be equal and should be larger than $H/4$, but smaller than $H/2$ minus 0.5 mm.

Finishing point



- a) $X_1 = 100 - 1/2 \times 56.56 = 71.72 \text{ mm}$
 $Y_1 = 0 \text{ mm}$
- b) $X_0 = 71.72 + 1 = 72.72 \text{ mm}$
 $Y_0 = 0 - 1 = -1.00 \text{ mm}$
- c) $L = 100 - 28.28 + 2 = 73.72$
 $N = 74/28.28 = 2.62 \rightarrow 3 \text{ times}$
 $P = 74/3 = 24.67 \text{ mm}$

Therefore the program is:

G90 X72.72 Y-1.00 T219 (40 mm x 40 mm sq. 45°)
G91 X-24.67 Y24.67 (3 times)

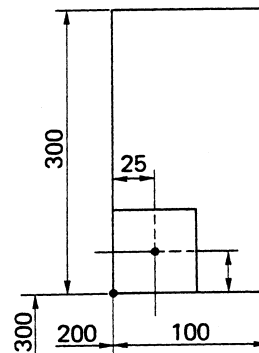
3. SMALL RECTANGULAR OPENING

"G36" or "G37" is commanded in place of "G67" for punching a small rectangular opening without any scrap.

Example:

When punching a 300 mm x 100 mm rectangular opening with a 50 mm x 50 mm sq. punch

- a) Determine the coordinates of the initial punch center.
 $X: 200 + 25 = 225 \text{ (mm)}$
 $Y: 300 + 25 = 325 \text{ (mm)}$
- b) Calculate the punching frequency "P" and feed pitch "I" in the X-axis direction.



50 mm x 50 mm sq.: T219

$= 1.0 \rightarrow 2$

$= 25 \text{ (mm)}$

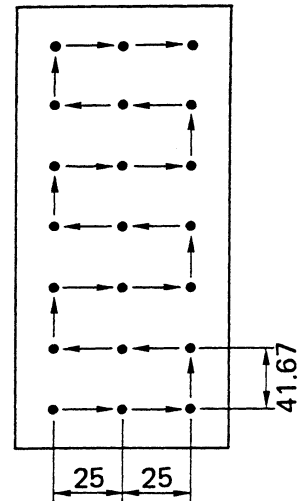
- c) Calculate the punching frequency "K" and feed pitch "J" in the Y-axis direction.

$= 5.0 \rightarrow 6$

$= 41.666 \rightarrow 41.67 \text{ mm}$

- d) The 100 × 300 mm rectangular opening can be punched on the grid shown at right and the program becomes as follows:

```
G90 X825.00 Y325.00 T219
G36 I25.00 P2 J41.67 K6
```



4. LONG RECTANGULAR HOLE

- a) First punch position " X_0, Y_0 " (Absolute coordinates)
 $X_0 = [X \text{ value at left end}] + 1/2 [\text{Punch length along X-axis}]$
 $Y_0 = [Y \text{ value at lower end}] + 1/2 [\text{Punch length along Y-axis}]$
- b) Travel distance "L"
 $L = [\text{Total length}] - [\text{Punch width}]$
- c) Punching frequency "N"

When decimal numbers are obtained
 Ex.: 6.2 → 7

When integral numbers are obtained
 Ex.: 9 → 10

- d) Feed pitch "P"

NOTE

"P" should be larger than 1/2 the punch width, but smaller than the entire punch width minus 0.5 mm.

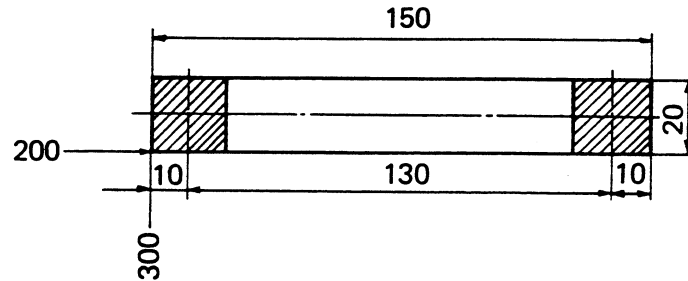
- d') Feed pitch "P' "

Round decimal fractions of 0.005 thru 0.009 to 0.01.

Example:

When punching a 20 mm × 150 mm rectangular hole with a 20 mm × 20 mm sq. punch (Punching begins with the left side of the hole)

20 mm × 20 mm sq.: T306



- a) $X_0 = 200 + 1/2 \times 20 = 210 \text{ mm}$
 $Y_0 = 300 + 1/2 \times 20 = 310 \text{ mm}$
- b) $L = 150 - 20 = 130 \text{ mm}$
- c) $N = 130/20 = 6.5 \rightarrow 7 \text{ times}$
- d) $P = 130/7 = 18.57 \text{ mm}$

Therefore the program is:

```
G90 X210.00 Y310.00 T306 (20 mm × 20 mm sq.)
G91 X18.57
      X18.57
      X18.57
      X18.57
      X18.57
      X18.57
      X18.57
```

The G66 command can be used for this long rectangular hole punching (see page II-13).

5. LARGE RECTANGULAR OPENING

a) Punching procedure

Finish punching at the upper right corner in order to remove scrap easily.

b) First punch position " X_0, Y_0 " (Absolute coordinates)

$$X_0 = [X \text{ value at right end}] - 1/2 [\text{Punch length along X-axis}]$$

$$Y_0 = [Y \text{ value at upper end}] - 1/2 [\text{Punch length along Y-axis}]$$

c) Punching frequency and feed pitch of ①

d) Punching frequency and feed pitch of ②

e) Prepare the program in accordance with the punching sequence.

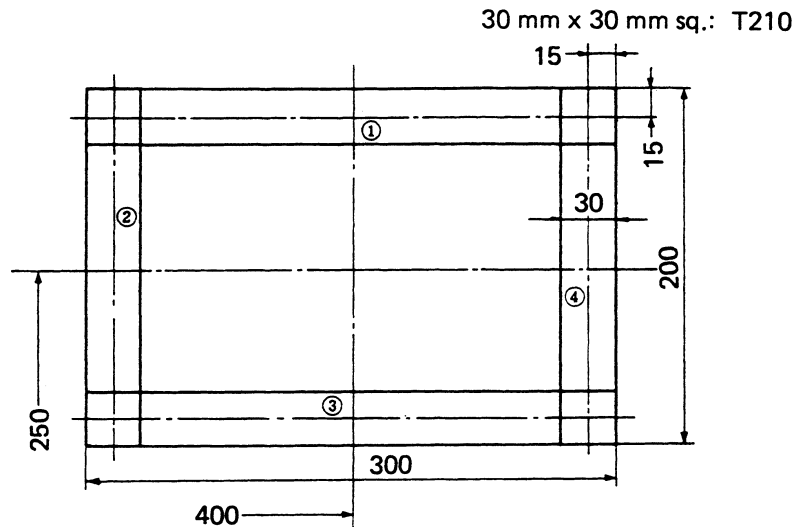
NOTE

ℓ Do not punch the final punch position because the last punch falls on the first punch position.

f) Enter "M00" or "M01" in order to remove the scrap.

Example:

When punching a 200 mm × 300 mm rectangular opening with a 30 mm × 30 mm sq. punch



a) ① → ② → ③ → ④

b) $X_0 = [400 + 1/2 \times 300] - [1/2 \times 30] = 535 \text{ mm}$

$Y_0 = [250 + 1/2 \times 200] - [1/2 \times 30] = 335 \text{ mm}$

c) $L = 300 - 30 = 270 \text{ mm}$

$N = 270/30 = 9.0 \rightarrow 10 \text{ times}$

$P = 270/10 = 27 \text{ mm}$

d) $L = 200 - 30 = 170 \text{ mm}$

$N = 170/30 = 5.6 \rightarrow 6 \text{ times}$

$P = 170/6 = 28.33 \text{ mm}$

Therefore the program is:

```
G90 X535.00 Y335.00 T210 (30 mm × 30 mm sq.)
G91 X-27.00 (10 times)
      Y-28.33 (6 times)
      X27.00 (10 times)
      Y28.33 (5 times)
M00
```

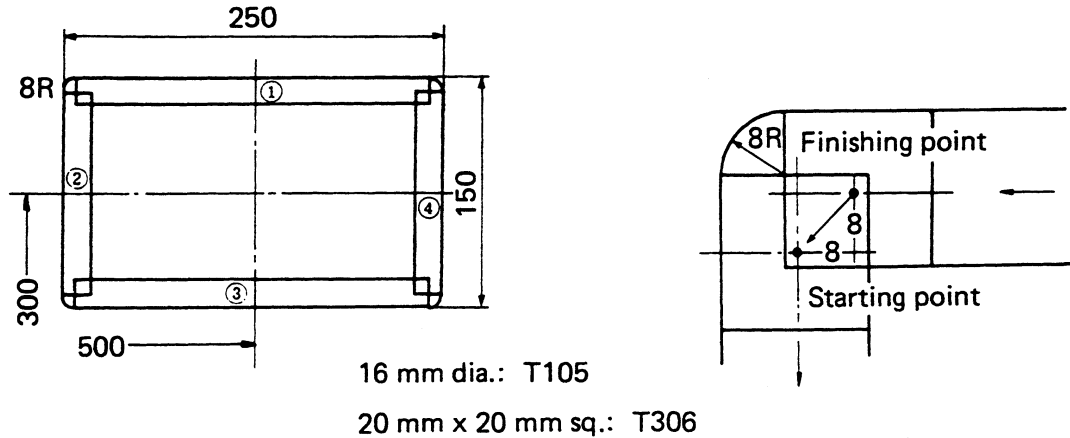
The G67 command can be used for this large rectangular opening (see page II-14).

6. RECTANGULAR OPENING WITH ROUNDED CORNERS

- a) Punching procedure
First, punch 4 corners of 8R.
Finish punching at the upper right corner.
- b) Punching positions for 4 corners.
Punching position for one corner → Absolute coordinates
Punching positions for other corners → Incremental coordinates
(Hole length – 2 × R)
- c) First punch position with a square punch (X_0, Y_0) → Absolute coordinates
- d) Punching frequency and feed pitch of ①
- e) Punching frequency and feed pitch of ②
- f) Travel distance from the finishing point on one side to the starting point on another side → Incremental coordinates
X value: Radius
Y value: Radius
- g) Prepare the program in accordance with punching procedures.
- h) Enter "M00" or "M01" in order to remove scrap.

Example:

When punching a 150 mm × 250 mm opening with rounded corners of 8R, using a 16 mm dia. round punch and a 20 mm × 20 mm square punch



a) 4 corners and then ① → ② → ③ → ④

b) Absolute coordinates (upper right corner)

$$X = [500 + 1/2 \times 250] - 8 = 617 \text{ mm}$$

$$Y = [300 + 1/2 \times 150] - 8 = 367 \text{ mm}$$

Incremental coordinates

$$X = 250 - [2 \times 8] = 234 \text{ mm}$$

$$Y = 150 - [2 \times 8] = 134 \text{ mm}$$

c) Position of the first square punching

$$X_0 = [500 + 1/2 \times 250 - 8] - [1/2 \times 20] = 607 \text{ mm}$$

$$Y_0 = [300 + 1/2 \times 150] - [1/2 \times 20] = 365 \text{ mm}$$

d) $L = [250 - 2 \times 8] - 20 = 214 \text{ mm}$

$$N = 214/20 = 10.7 \rightarrow 11 \text{ times}$$

$$P = 214/11 = 19.45 \text{ mm}$$

e) $L = [150 - 2 \times 8] - 20 = 114 \text{ mm}$

$$N = 114/20 = 5.7 \rightarrow 6 \text{ times}$$

$$P = 114/6 = 19 \text{ mm}$$

f) $X = 8 \text{ mm}$

$$Y = 8 \text{ mm}$$

Therefore the program is:

```
G90 X617.00 Y367.00 T105 (16 mm dia.)
G91 X-234.00
      Y-134.00
      X234.00
G90 X607.00 Y365.00 T306 (20 mm × 20 mm sq.)
G91 X-19.45      (11 times)
      X-8.00     Y-8.00
      Y-19.00   (6 times)
      X8.00     Y-8.00
      X19.45    (11 times)
      X8.00     Y8.00
      Y19.00   (6 times)
M00
```

REFERENCE DATA

1. Punching range

AE255NT

X-axis: -70 mm to 1220 mm

Y-axis: +30 mm to 1340 mm (inner track)

-10 mm to 1300 mm (center track)

-50 mm to 1260 mm (outer track)

AE2510NT

X-axis: -10 mm to 2510 mm

Y-axis: +30 mm to 1340 mm (inner track)

-10 mm to 1300 mm (center track)

-50 mm to 1260 mm (outer track)

2. Positions of workholders

3. Workclamp dimensions

AMADA CO., LTD.

200, Ishida, Isehara, Kanagawa, JAPAN

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