APPENDIX A

APPENDIX B

APPENDIX C

APPENDIX D

APPENDIX E

APPENDIX F

APPENDIX G

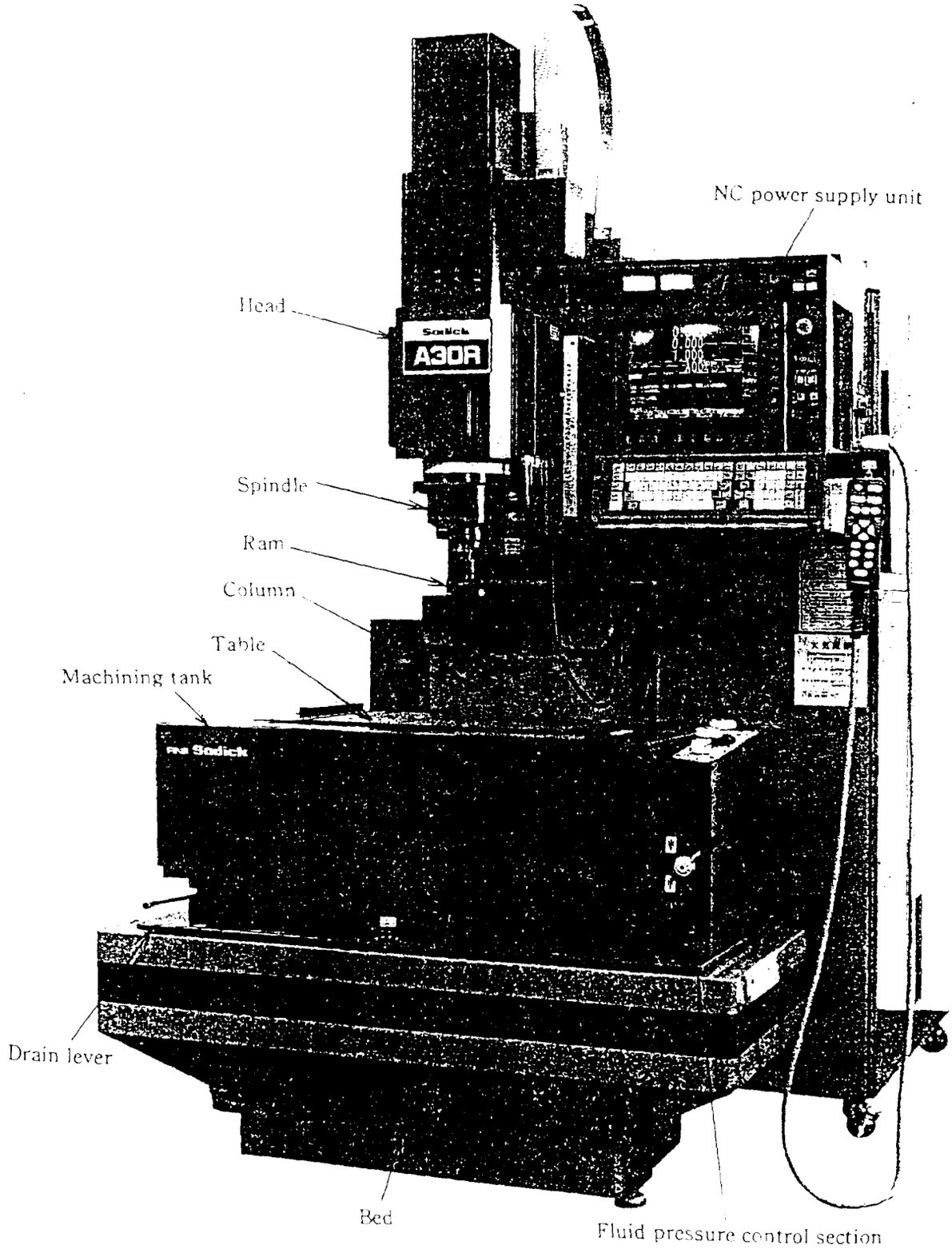
All the experimental data in Appendix A, Appendix B, Appendix C, Appendix D, Appendix E, Appendix F and Appendix G is given in the attached disc below.

APPENDIX H

EDM Specifications

CHAPTER 2. SPECIFICATIONS

2-1 Appearance of Machine and Designation of Its Components



(The photo shows A30R including options.)

A30

:hine

Table size (width × depth)	520 × 350 (ceramic surface table) mm
Machining tank size (width × depth × height)	662 × 492 × 250mm
Fluid level control range (from table top)	65～200mm
Maximum machining tank capacity	77 ℓ
Table longitudinal travel (X aixs)	300mm
Table cross travel (Y axis)	250mm
Spindle vertical travel (Z axis)	250mm
Maximum electrode weight	25 (10 when ATC is used) kg

(The maximum electrode weight varies according to the discharge area and the roughness of the machined surface.)

Maximum workpiece weight	400kg
Electrode holder dimension	φ 100mm
Distance from electrode holder surface to table top	240～490mm
Distance from TP-02 to table top	188～438mm
Distance from floor to table top	900mm
Machine size (width × depth × height)	1,270 × 1,905 × 2,125mm
Area required for installation (width × depth)	1,400 × 2,030mm
Machine weight	2,000kg

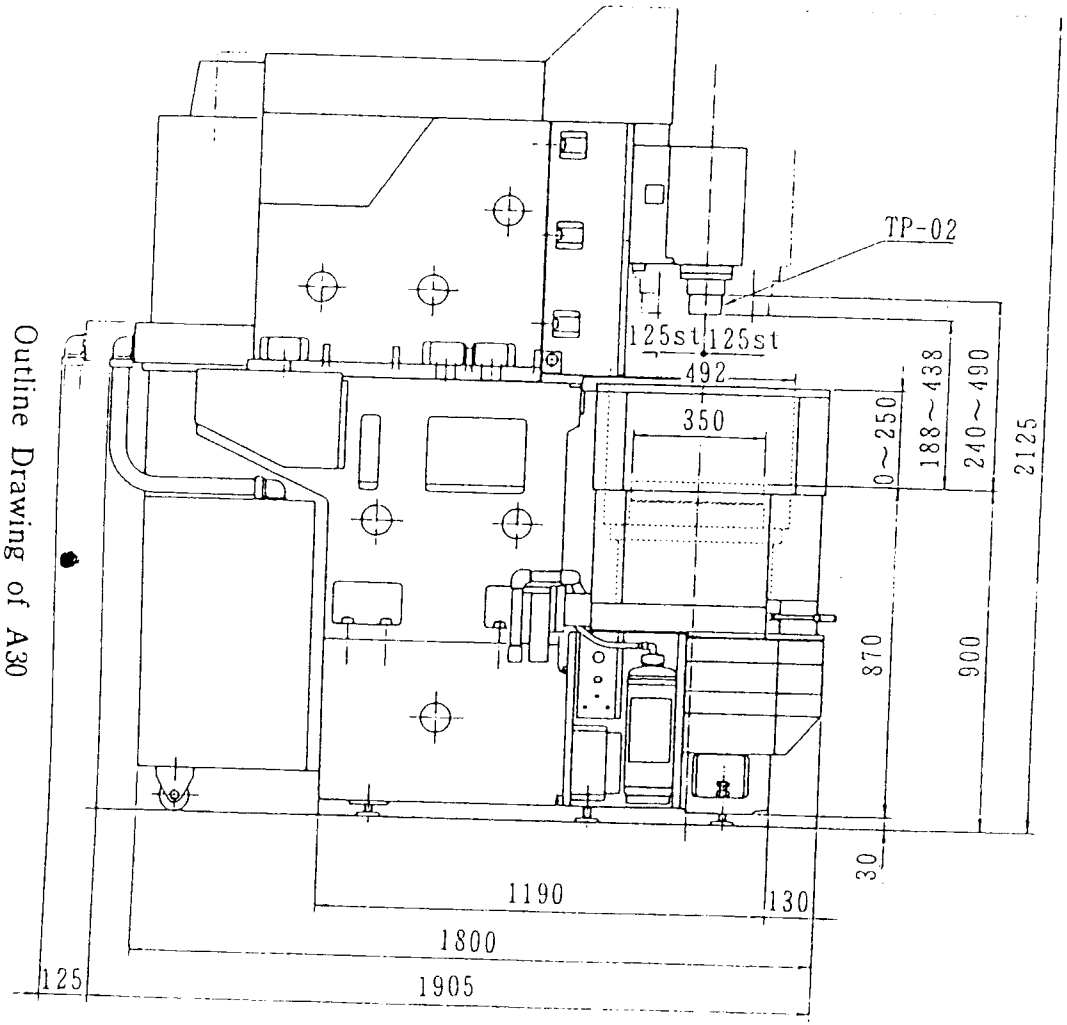
ervice tank

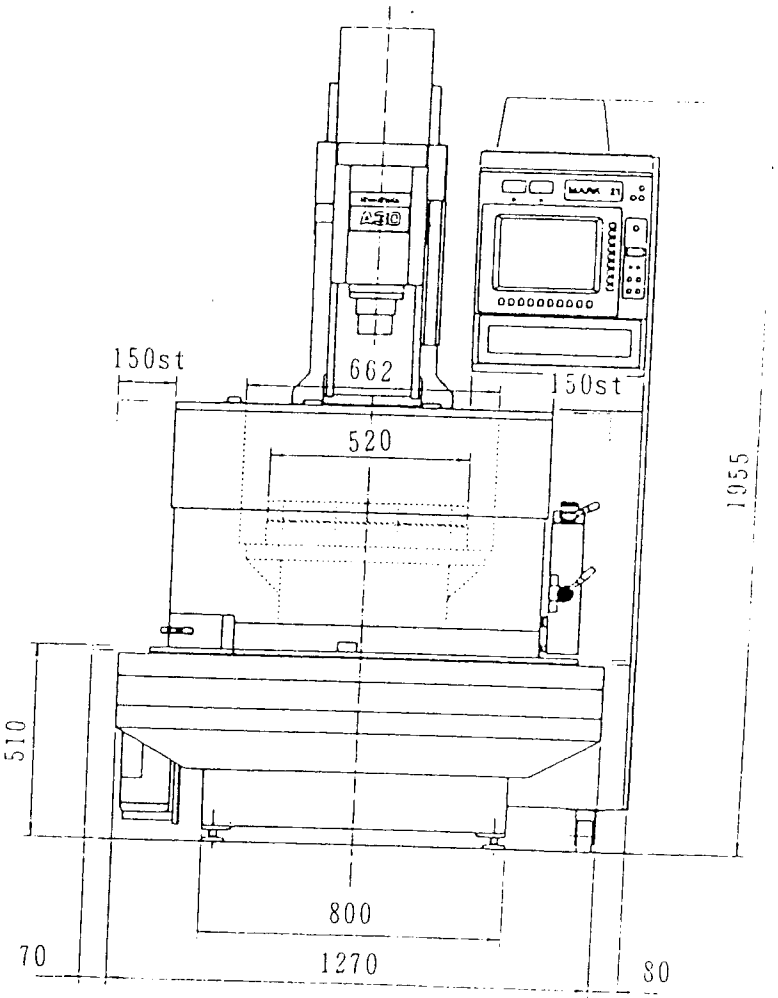
External dimensions (width × depth × height)	440 × 1,100 × 800㎜
Weight	(empty) 100kg
Capacity	191 ℓ
Fluid filtration method	Replaceable paper filter (MF-2400 internal pressure system)

ATC (Automatic Tool Changer) ※Option

Number of tool holders	Up to 8
Applicable tool holder type	Sodick TP Series
Maximum static electrode weight	10 (including TP holder) kg
Distance between tool pots	152㎜
Power	Pneumatic

Outline Drawing of A30





2-3 A30R

Machine

Table size (width×depth)	520×350(ceramic surface table) ㎜
Machining tank size (width×depth×height)	662×492×250㎜
Fluid level control range (from table top)	65~200㎜
Maximum machining tank capacity	77 ℓ
Table longitudinal travel (X aixs)	300㎜
Table cross travel (Y axis)	250㎜
Spindle vertical travel (Z axis)	250㎜
Maximum electrode weight	25 (15 when SNT holder is used) kg (10 when ATC is used)

(The maximum electrode weight varies according to the discharge area and the roughness of the machined surface.)

Maximum workpiece weight	400kg
Distance from electrode holder surface to table top	165~415㎜ 900㎜
Machine size (width×depth×height)	1,270×1,905×2,365㎜

(The machine height varies according to the Z axis stroke.)

Area required for installation (width×depth)	1,450×2,030㎜
Machine weight	2,100kg

Spindle rotation mechanism

Spindle taper	NT-35 taper
Spindle rotation speed	200~1,700rpm
Indexing resolution	64,800 (20 sec)

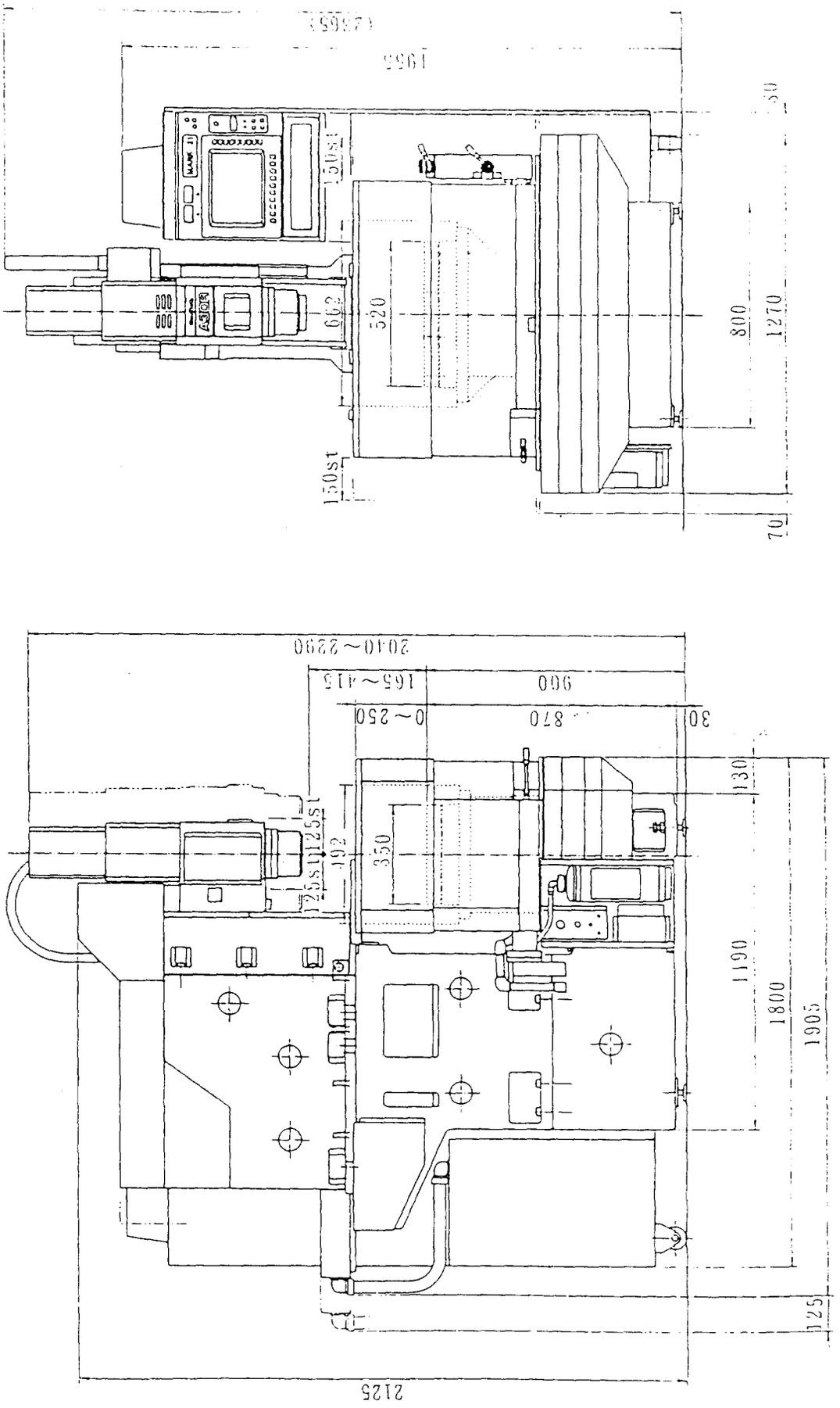
vice tank

External dimensions (width × depth × height)	440 × 1,100 × 800㎜
Weight	(empty)100kg
Capacity	191 ℓ
Fluid filtration method	Replaceable paper filter (MF-2400 internal pressure system)

C (Automatic Tool Changer) ※Option

Number of tool holders	Up to 16
Applicable tool holder type	Sodick SNT Series
Maximum static electrode weight	10 (including SNT holder) kg
Distance between tool pots	76㎜
Power	Pneumatic

※When an electrode with a weight of more than 15kg is to be used, use a heavy electrode faceplace of φ90㎜.

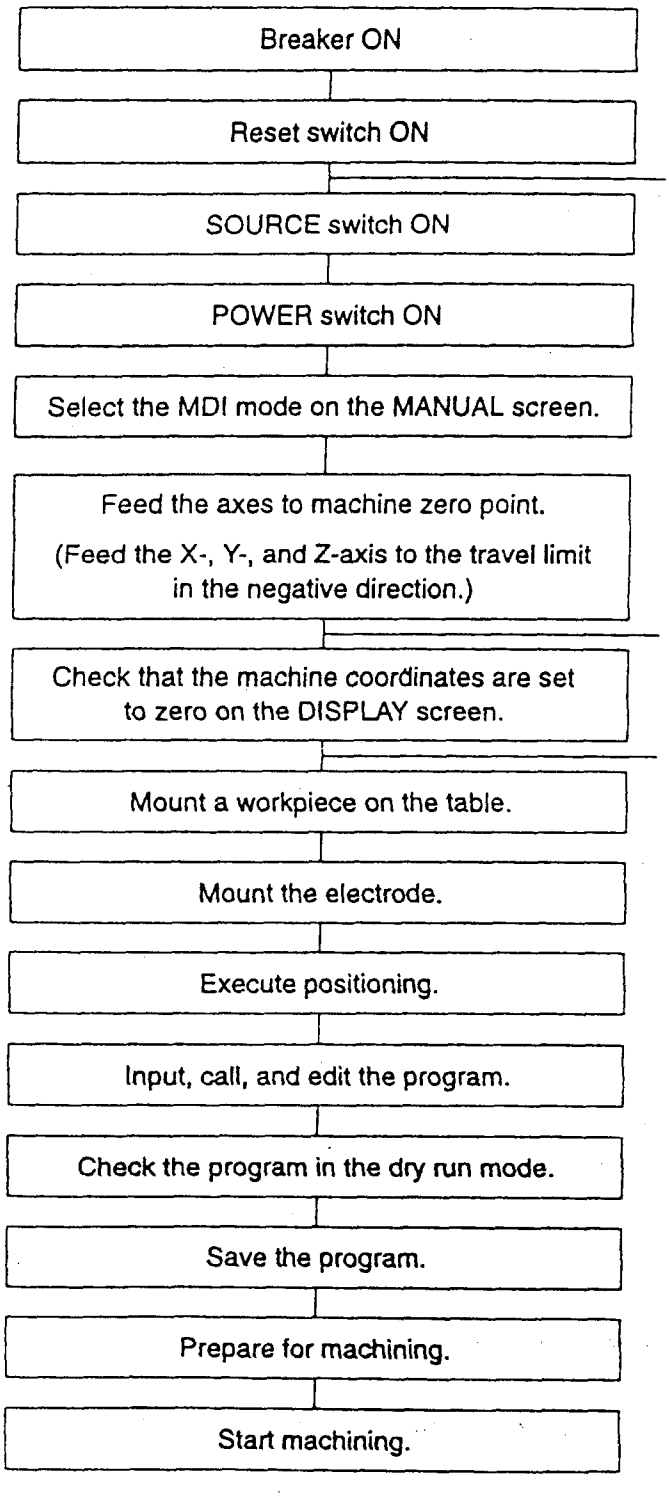


Outline Drawing of A30R

BEFORE YOU START MACHINING

-1 Before Starting the Machining

The steps you should follow before you start machining with Sodick's mold making EDM machine are indicated below in flowchart form.



Check the floppy disks are set correctly (not necessary if a hard disk is installed).

Note: The Z-axis may alternatively be fed to the travel limit in the positive direction.

Note: If the Z-axis is at the positive travel limit, the axis stroke is displayed.

The following gives you the detailed procedure for the steps indicated above.

1-9 Inputting, Calling and Editing a Program

To input a program to the NC, you can select any of the following methods:

- Input using paper tape
- Input using the RS-232C interface
- Input using the keyboard
- Calling a program from the user disk

<Inputting a program using the keyboard>

Use the following procedure to create a new program.

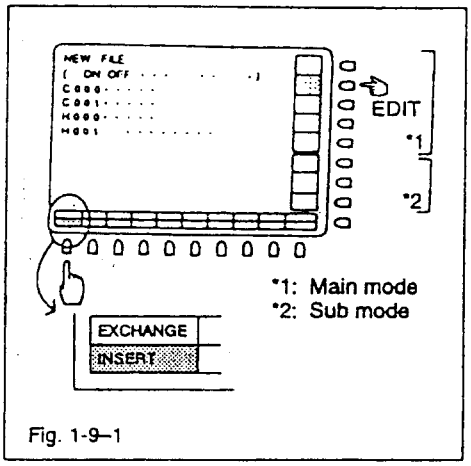


Fig. 1-9-1

Procedure:

1) Select the edit mode.
2) Move the cursor to NEW FILE using the cursor keys.
3) Select EXCHANGE by pressing the [HF1] key under the screen.
4) Input a program from the keyboard.

   After entering each line of the program, press the [↵] key to start a new line.

<Calling a program from the user disk>

Use the following procedure to call a program created using an automatic programming system other than that supplied by Sodick, or a program created previously and saved, from a floppy disk.

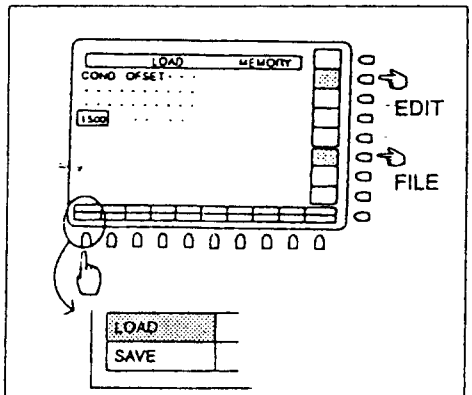


Fig. 1-9-2

1) Select the [EDIT] main mode and then select the [FILE] sub mode.
2) Select LOAD by pressing the [HF1] key under the screen.
3) Locate the cursor at the file name of the file to be loaded.
4) Press the [ENT] key.

   The selected file name will appear in the MEMORY column on the right side of the screen.
5) Press the [EDIT] main mode selection key again.

   The program will be displayed on the screen.

<Frequently used keys>

Key	Function
ENTER	Used to execute an operation.
OFF	Used to stop an operation.
ACK	Cancel key
HALT	Used to make a temporary stop.
RST	Restart
ST	Disabies contact detection.
MFR 0 - 3	Used to select the table feed speed.
UN CLAMP (R type only)	Used to remove an SNT holder.
CLAMP (R type only)	Used to mount an SNT holder.
↵	Return key (used to move to a new line in a program)
SPACE	Used to input a space equivalent to one character.
BS	Backspace key: deletes one character to the left of the current cursor position.
SHIFT	Used to input the upper character in the case of keys marked with upper and lower characters.

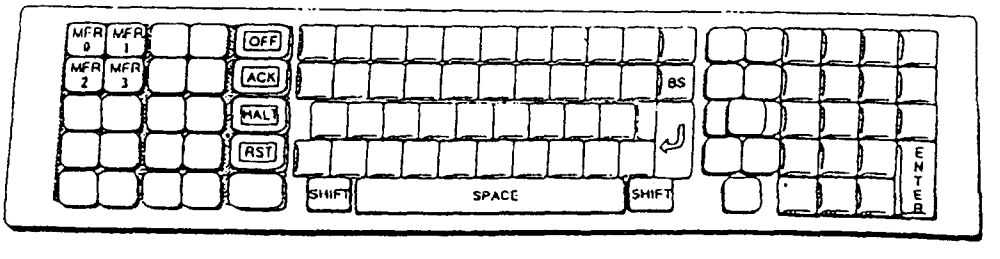


Fig. 1-12-2

BASIC PROGRAMS

-1 Commands and Basic Operations Used for Machining

<Program Input In the MDI Mode>

Procedure:

1) Select the manual mode by pressing the [M'AL] main mode selection key. The, press the [MDI] submode selection key.
2) Manually feed the electrode to the machining position.
3) Key in as indicated below.

   G80 Z– [⏎]

   This will bring the electrode into contact with the top surface of the workpiece.
4) Key in as indicated below.

   G92 Z0 [⏎]

   This sets "0" as the Z coordinate for the actual position.
5) Key in as indicated below.

   G00 M05 Z1.0 [⏎]

   This moves up the electrode 1 mm above the surface of the workpiece.
6) Key in as indicated below.

   G90 G54 G01 C∗∗∗Z–5.0 M04 [⏎]

   This means "machine to –5.0 mm level on the Z-axis in the absolute coordinate system specified by G54".
7) Key in M02.

   This ends machining.
8) Press the [ENT] key.

   The keyed in program is executed.

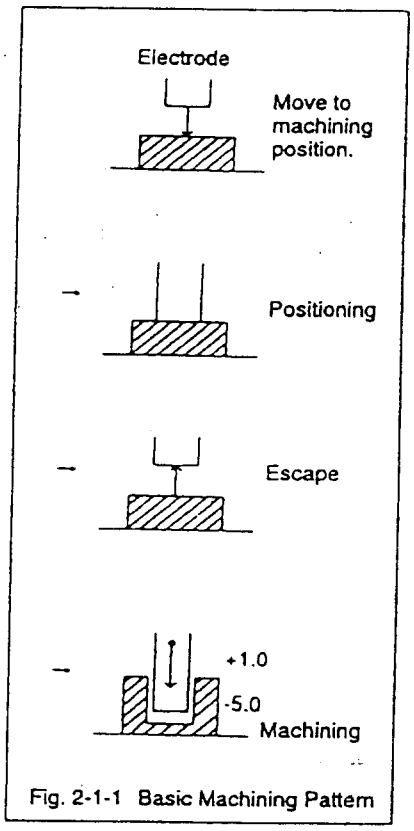


Fig. 2-1-1 Basic Machining Pattern

<Description of Codes>

G80: Feed until the contact detection function operates.
G92: Coordinate setting command
G00: Feed command
G90: Absolute coordinates
G54: Specifies work coordinate system 0
C∗∗∗: Calls machining conditions
G01: Linear interpolation (machining command)
M04: Return to the machining start position.
M05: Disable the contact detection function.

NOTE: It is possible to input and execute simple programs in the MDI mode, but more complex programs have to be input in the edit mode and executed in the run mode.

MACHINING CONDITIONS

1 Description of Parameters

ON: Discharge pulse time

This parameter is used to set the pulse ON duration (the duration for which voltage is applied across the poles).

Setting of a larger value causes higher energy to be generated.

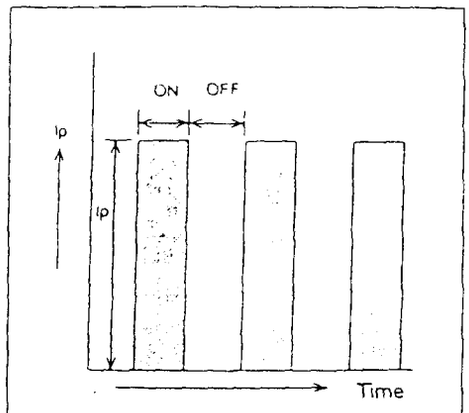


Fig. 3-1-1 Parameters ON and OFF

OFF: Pause duration

This parameter is used to set the pulse OFF duration (the duration for which voltage is not applied across the poles).

Setting of a larger value causes a longer pulse OFF duration, which stabilizes machining but decreases the machining speed.

MA: Pause duration magnification

This parameter is used to extend the pause duration by multiplying it by an integral value up to 10; it is adjusted in accordance with the machining status.

IP: Main power supply peak value

This parameter is used to set the peak value of the current to be supplied (current wave height value).

The energy of one pulse is determined by the setting for IP, V (main power supply voltage), and ON (discharge pulse time).

SV: Servo reference voltage

This parameter is used to set the servo reference voltage between the electrode and the workpiece.

The larger the set value, the higher the average machining voltage applied, which makes machining more stable but decreases the machining speed and increases the gap across which discharge occurs.

With the G type power supply unit, the voltage value is set directly.

UP: Jump ascent time

DN: Discharge continuation time (jump descent time)

LN: Pattern selection for LORAN operation

These parameters are used to set the pattern for LORAN operation, the LORAN plane and servo conditions, and the LORAN format.

STEP: Eccentric distance from the head center line for LORAN operation (2 to 9999)

This parameter is used to set the amount of orbiting motion in LORAN operation. The set value is the orbiting distance for one side.

PL: **Polarity switching**

This parameter is used to set the polarity of the electrode and the workpiece.

Example:

+: Reverse polarity (electrode is positive)

Used for no-wear machining in Cu - St or Gr - St, where the electrode (Cu) is fed on the Z-axis and the workpiece (steel) is mounted to the table.

–: Normal polarity (electrode is negative)

Used for high-wear machining in CuW - WC (cemented carbide), where the electrode (CuW) is fed on the Z-axis and the workpiece (WC) is mounted to the table, and other types of high-wear machining.

V: **Main power supply voltage**

This parameter is used to set the main voltage.

It determines the energy of discharge pulses along with the IP parameter.

HP: **Auxiliary power supply circuit**

This parameter is used to select the auxiliary power supply according to the combination of materials and the purpose of machining.

PP: **ON/OFF status of breaker circuit, selection of PIKADEN pulse**

This is a discharge circuit that considerably reduces electrode wear in Cu - St.

C: **Gap capacitor circuit**

This parameter is used to select the capacitor circuit. This gives the pulse impact, giving it the exceptional power required for machining such as fine hole machining and machining of cemented carbide.

For no-wear machining with systems such as Cu-St, this parameter must be set to zero (C = 0).

S: **Servo speed**

This parameter sets the axis speed for infeeding the electrode. It is normally set in the range 1 to 3.

L: **LORAN speed**

This parameter sets the speed for orbiting motion. It is usually set in the range 1 to 3.

LP: **Quadrant LORAN pattern**

This parameter enables you to set different LORAN patterns for each quadrant.

APPENDIX I

EPMA Analysis Print Out

Pb	0.0003	1.7982
Si	0.0015	2.8441
Bi	0.0007	1.7257
Mg	0.0053	1.0384
Al	0.8157	1.1144
Mn	0.0000	1.1723
Fe	0.0003	1.1516
Co	0.0153	1.4050
Mo	0.0001	1.8726
Ag	0.0000	NaN
V	0.0003	1.2025
Ti	0.0002	1.2024
Cr	0.0000	NaN
Ni	0.0001	1.1320
Sb	0.0000	NaN
Cd	0.0000	NaN

iteration : 3

Analysis no. 7 within metal1

Elt.	Conc. (wt%)	Norm Conc. (wt%)	Norm Conc. (at%)
C	0.0000	0.0000	0.0000
O	0.7815	0.8217	1.3974
Sn	0.0000	0.0000	0.0000
Cu	0.0000	0.0000	0.0000
Zn	0.0000	0.0000	0.0000
Pb	0.0451	0.0474	0.0062
Si	0.4356	0.4580	0.4437
Bi	0.1243	0.1307	0.0170
Mg	0.5477	0.5758	0.6446
Al	90.9020	95.5789	96.3843
Mn	0.0007	0.0008	0.0004
Fe	0.0351	0.0369	0.0180
Co	2.1542	2.2650	1.0457
Mo	0.0103	0.0108	0.0031
Ag	0.0000	0.0000	0.0000
V	0.0403	0.0424	0.0226
Ti	0.0208	0.0219	0.0124
Cr	0.0000	0.0000	0.0000
Ni	0.0091	0.0096	0.0044
Sb	0.0000	0.0000	0.0000
Cd	0.0000	0.0000	0.0000
total :	95.1068	100.0000	100.0000

be carful, strong correction for C (0.00)
be careful, strong correction for Sn (0.00)
be careful, strong correction for Cu (0.00)
be careful, strong correction for Zn (0.00)
be careful, strong correction for Ag (0.00)
be careful, strong correction for Cr (0.00)
be careful, strong correction for Sb (0.00)
be careful, strong correction for Cd (0.00)