BAQ

Automatisierung und Qualitätssicherung

MV-100A

MICRO-VICKERS HARDNESS TESTER

MV-102A

AUTO-TURRET MICRO-VICKERS HARDNESS TESTER

OPERATING INSTRUCTION

BAQ GMBH

GENERAL SAFETY PRECAUTIONS

Material testing systems are potentially hazardous.

Material testing involves inherent hazards from high forces, rapid motions and stored energy. You must be aware of all moving and operating components that are potentially hazardous, particularly the indenter.

Carefully read all relevant manuals and observe all Warnings and Cautions. The term **Warning** is used where a hazard may lead to injury or death. The term **Caution** is used where a hazard may lead to damage to equipment or to loss of data.

Ensure that the test set-up and the actual test you will be using on materials, assemblies or structures constitute no hazard to yourself or others. Make full use of all mechanical and electronic limits features. These are supplied to enable you to prevent movement of the system components beyond desired regions of operation. Limits provide protection for your specimen and machine and reduce potential hazard.

The following pages detail various general warnings that you must heed at all times while using materials testing equipment. You will find more specific Warnings and Cautions in the text whenever a potential hazard exists.

Your best safety precautions are to obtain training in the testing equipment that you are using and to read your Operating Instructions and Reference Manual(s) to gain a thorough understanding of that equipment.

Warnings

Wear eye protection and use protective shields or screens whenever any possibility exists of a hazard from the failure of a specimen, assembly or structure under test.

Wear eye protection and use protective shields or screens whenever any possibility exists of a hazard from the failure of a test specimen or assembly, particularly where explosive disintegration may occur. Due to the wide range of specimen materials or assemblies that may be tested, any hazard resulting from the failure of a test specimen or assembly is entirely the responsibility of the owner and the user of the equipment.

Protect electrical cables from damage and inadvertent disconnection.

Protect all electrical cables from damage. Never route cables across the floor without protection, nor suspend cables overhead under excessive strain. Use padding to avoid chafing where cables are routed around corners or through wall openings.

Wear protective clothing when handling equipment at extremes of temperature.

Material testing is often carried out at non-ambient temperatures using ovens, furnaces or cryogenic chambers. Extreme temperature means an operating temperature exceeding 60℃ (140℉) or below 0℃ (32℉). You must use protective clothing, such as gloves, when handling equipment at these temperatures. Display a warning notice concerning low or high temperature operation whenever temperature control equipment is in use. You should note that the hazard from extreme temperature can extend beyond the immediate area of the test.

Take care when installing or removing a specimen, assembly or structure.

Installation or removal of a specimen, assembly or structure involves working inside the hazard area between the indenter and the specimen mounting stage. Keep clear of the hazard area between the indenter and the specimen mounting stage during system

component movement. Ensure that all indenter and stage movements necessary for installation or removal are slow and, where possible, at a low force setting.

	**Power supply should be well earthed, otherwise it could influence the test accuracy and even result in personnel injure or property damage!**

TABLE OF CONTENT

GENERAL INFORMATION

Purpose

MV-100A/102A is a modern micro-Vickers hardness testing machine which integrates a sophisticated precision mechanism and a photoelectrical computer software system. It is a best choice in testing hardness either in Vickers or in Knoop. Vickers or knoop hardness value can be calculated and obtained by inputting the measured diagonal length into an integrated calculator.

MV-100A/102A is especially designed to test the structure of tiny or minute metal parts, thin plate, metallic foil, high quality cord, thin hardening layers and electroplated layers. In addition, it can also find wide applications in testing non-metallic materials such as glass, jewelry, ceramics etc., which can hardly be measured with Rockwell or other hardness testing machine using relatively large test force. In particular, it can manage to measure the internal hardness of induction hardening material or carburized material by following the metal structure.

The test is performed in two steps. First, the diamond indenter is driven into the surface of the tested material by applying a known test force. Second, the user measures the diagonal(s) length of the resulting indentation and input the measured length of diagonal(s) to the integrated calculator, by which hardness value could be obtained either in Vickers scale (HV) or Knoop scale (HK).

The difference between Vickers test and Knoop test lies in the different type of diamond indenters. The Vickers indenter is in the form of a right pyramid with a square base, while the Knoop indenter is in the form of a right pyramid with a rhombic base. Vickers test measures two diagonals, while the Knoop test measures only one. Details on shape and geometric characteristics would be discussed later in this chapter.

Difference between MV-102A and MV-100A

In **MV-102A**, the testing machine will switch the turret automatically in the process of observation, test and measurement.

In **MV-102A**, the turret also can be manually switched.

In **MV-100A** the user has to switch the turret manually in the process of observation, test and measurement.

About Test

The Vickers indent hardness test is to measure the resistance of a material which is relative to permanent indentation. Figure 1-1 illustrates a conceptual view of the test force application.

From the start of the test, the testing machine drives the indenter until it just contacts the surface of the specimen. A test force, which ramps up to the total selected force, will be applied at this point and the testing machine then holds this force for the duration of the selected dwell time.

At the end of the dwell time, the test force returns very fast to zero. The user turns the turret to have the objective 40× to measure the diagonal(s). The user measures the diagonal length and inputs the measured result into the integrated calculator. The calculator then computes and displays the Vickers or Knoop hardness value by using the formulas presented later in this chapter.

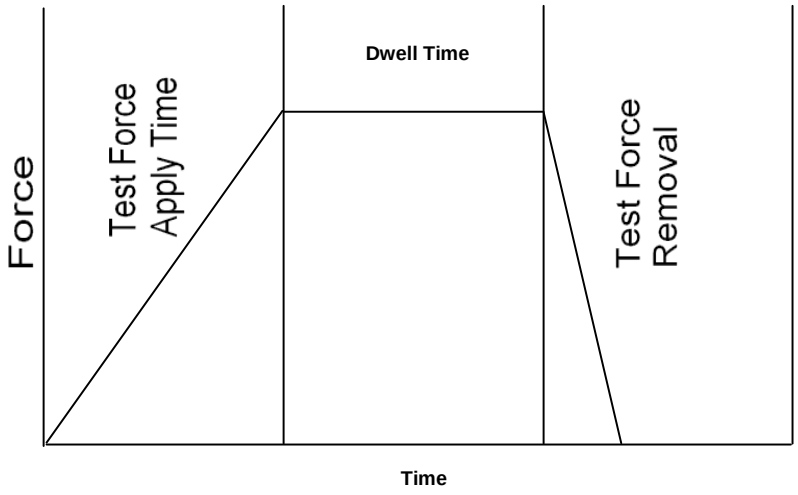

Figure 1-1 Test Cycle Profile

About Testing Machine

Figure 1-2 illustrates major components of the micro-hardness testing machine **MV-100A/102A**.

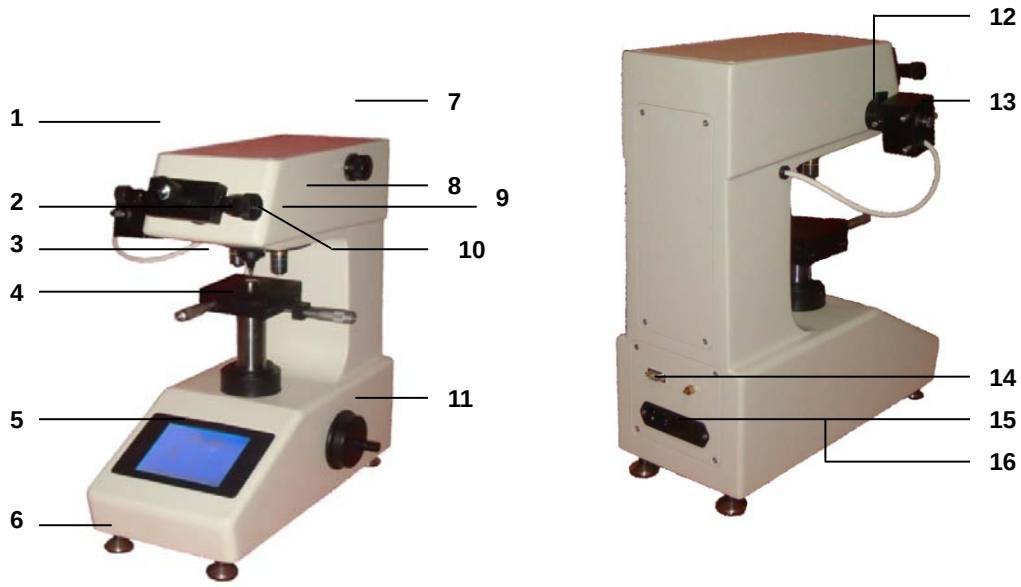

Figure 1-2 Configuration

1	Measuring microscope	2	Objective 10×	3	XY-stage
4	Spindle	5	Touch screen	6	Leveling screw
7	Load selection knob	8	Turret	9	Objective 40×
10	Indenter	11	Thumbwheel	12	Filter glass
13	Light house	14	RS232	15	Power switch
16	Socket				

Principle of Operation

The testing machine will exert test forces on a specimen by using deadweights and a lever mechanism (force amplification).

After selecting a test force, the user should touch **<STAR>** on the main screen. The motor drives the lever to release deadweights corresponding to the selected test force. Then the released deadweights press indenter down to make an indent on the specimen in a specified period which is preset in the software system by the user.

After the indenter has left the specimen to travel back to the starting position, the user turns the turret to objective 40× to measure the diagonal(s). The user measures the diagonal length and then input the measured result to the integrated calculator. The calculator then computes and displays the Vickers or Knoop hardness value by using formulas presented in this chapter.

Principle of Test Method

Vickers

The top of the Vickers indenter is in the form of a right pyramid with a square base and with a face angle of 136°. The depth of the indent it makes is about 1/7 of its diagonal length. Refer to Figure 1-3.

The Vickers indenter can penetrate into the specimen about twice as deep as that by Knoop indenter. Therefore, the Vickers testing machine is less sensitive to surface than the Knoop test is. Because the indent is less influenced by the flatness and parallelism of the specimen surface and their finish, it could be used on materials that are not suited for Knoop test. However, because of the deeper indent, the Vickers test is not suited for testing very thin metal foils and thin (coating) layers. In these cases Knoop test could perform better. Under condition of equal test force, the Vickers indenter (due to its shorter length) is more sensitive to errors in measuring the indent.

Vickers test is generally divided into two types:

- Micro = 10 to 1000 grams
- Macro = above 1000 grams

The Vickers hardness value could be calculated from the following formula:

$$HV = 0.1 \frac{F}{S} = 0.1 \frac{2F \sin(\frac{\theta}{2})}{D^2} = 0.1 \frac{1.8544F}{D^2}$$

Where:

HV-------Vickers hardness value

F---------Test force, N

S---------Surface area of indent, mm^2

D---------Mean diagonal length of indent, mm

θ---------Face angle of indenter = 136°0’

Sometimes the load unit used is kgf. If kgf is used, the equation for Vickers hardness value can be expressed as:

$$HV = \frac{F}{S} = \frac{2F \sin(\theta/2)}{D^2} = 1.8544 \frac{F}{D^2}$$

Knoop

The top of the Knoop indenter is in the form of pyramid with a rhombic based face. The indent perpendicular to the specimen surface is rhombic in shape, it has two diagonals with an approximate ratio of 7 to 1 (Refer to Figure 1-4). Because of Knoop indenter’s geometric characteristics, high accuracy would be obtained in measuring diagonals when loads are small.

The depth of the indent is very shallow, about 1/30 as much as the longer diagonal. It has found wide applications in testing very thin layers of plating, hardening surface, thin metal and foils, thin layers of decarburization and brittle hard materials.

The indenter is very sensitive to the flatness of the test specimen’s surface, the parallelism of the top and bottom surfaces, and especially to the surface finish.

Perfect angles for the Knoop indenter are:

- Included longitudinal angle - 172°30'00"
- Included transverse angle - 130°00'00"

The indenter constant, which is used to calculate the Knoop hardness value in the formula, is the ratio of projected area of the indent to the square of the length of long diagonal. This constant could be calculated from the following formula:

$$C = \frac{\tan\left(\frac{B}{2}\right)}{2\tan\left(\frac{A}{2}\right)} = \frac{\left(\tan\left(\frac{130°0'0}{2}\right)\right)}{\left(2\tan\left(\frac{172°30'0}{2}\right)\right)} = 0.07 \quad \textbf{(1)}$$

Where:

A = included longitudinal edge angle, 172°30'

B = included transverse edge angle, 130°0'

C =indenter constant: projected area of the indentation to the square of the length of the long diagonal

The Knoop hardness value is computed from the following equation:

$$HK = 0.1 \frac{F}{S} = 0.102 \frac{F}{C^2 D^2} = 1.451 \frac{F}{D^2}$$

Where:

HK------Knoop hardness value

F--------Test force, N

S--------Projected area of indent, mm^2

C--------Indenter constant (calculated from equation (1) above)

D--------Length of long diagonal, mm

Sometimes the load units used are kgf. If kgf is used, the equation for Knoop hardness value could be expressed as:

$$H = \frac{F}{S} = \frac{F}{C^2 D^2} = 1.424 \frac{F}{D^2}$$

About this Manual

This manual covers a brief system description, operation, control, preparation for use, and operating instructions. It also contains information on installation, specifications, option list, and maintenance and servicing.

Terminology Conventions

This manual uses the following terminology conventions:

Table 1-1

Term	Usage
Testing machine	Micro-hardness testing machine **MV-100A/102A**
Specimen	A piece of material you are testing
Indenter	The diamond point that the testing machine drives into the specimen to make an indent.

Typographical Conventions

The following typographical conventions are used in this manual:

Table 1-2

Item	Typography
Controls and labels on LCD screen	Same as appearance on screen, bold For example, **LANGUAGE, 10gf**
Keys on the touch screen	Bold, with **<>** For example, **<STAR>, <EXIT>**

TECHNICAL SPECIFICATIONS

1. Vickers Scales:

HV0.01	HV0.025	HV0.05	HV0.1	HV0.2	HV0.3	HV0.5	HV1

2. Unit of Test force: gf / mN
3. Test Force:

(gf)	10	25	50	100	200	300	500	1000
(mN)	98	245	490	980	1960	2940	4900	9800

4. Test Force Selection: The test force will be displayed on the screen by turning the force selection knob.
5. Load Control: Automatic (load/dwell/unload)
6. Dwell time: 5~99 Sec (1 second increments)
7. Test Mode: HV/HK
8. Conversion standard： GB, ASTM and ISO
9. Scale conversion: GB (26 scales), ASTM (25 scales) and ISO (26 scales)
10. Hardness value: By manually measuring and inputting the diagonal(s) length, the hardness value will be automatically calculated and displayed on the main screen.
11. Optical system:

Objective	10× (observation)	40× (measurement)
Eyepiece	10×	
Total magnification	100× (observation)	400× (measurement)
Measuring Range		200μm
Resolution		0.25μm

12. X-Y Stage:

Dimensions:	100×100mm
Travel Range:	25×25mm
Resolution:	0.01mm

13. Specimen:

Maximum Height:	90mm
Maximum Depth:	120mm (from the center)

14. Energy Saving Mode: Automatic standby after a period of inactivity (5~180 minutes).
15. Screen Contrast: Adjustable

16. Light source：12V/20W
17. Light volume: 16 levels (adjustable)
18. Load Motor: 3W, 100V AC, 4rpm
19. Drive mode of Load Motor: Non-contact SSR
20. Language: Chinese and English;
21. Statistics：

1	Standard value/maximum value/ minimum value
2	Average value
3	Standard deviation
4	Range
5	Number of test

22. Time format：24H
23. Power supply：110V/220V, 60/50Hz
24. Power Consumption:

MV-102A	≤ 60W
MV-100A	≤ 30W

25. Overall Dimension: 500×330×560mm
26. Weight: 36kg
27. Turret movement：

MV-102A	Automatically/manually switch
MV-100A	Manually switch

INSTALLATION

Guidelines

Requirements

To install the testing machine, you must

- Unpack the testing machine
- Take the testing machine onto a work bench
- Level the testing machine and connect it to the power supply

Before You Begin

Check the following conditions before you install the testing machine:

- The workbench is strong enough to support the testing machine and its accessories; the workbench should keep in good level.
- The workbench is free from interference of mechanical vibrations. If the floor is “noisy” or prone to vibrate, the workbench should be placed on vibration isolation pads.
- There is an adequate clearance between the testing machine and adjacent walls to allow for routine service.
- Power supply is located 1m (3 ft.) around the testing machine, with stable voltage and good earthing (grounding), and free from surges and interference.
- Ambient temperature is 23±5℃.
- Relative humidity is ≤65%。
- There is no corrosive medium in the working room.

	**WARNING!**
	Power supply should be well earthed, otherwise it could influence the test accuracy and even result in personnel injure or property damage!

Unpacking

The testing machine is shipped upright on a wooden pallet encased in either a cardboard box or in a wooden crate. Handle the shipping package carefully.

	**WARNING!**
	Be careful when handling the crate or box. The drop of the crate/ box, nail, or strapping bands could possibly result in personnel injury or property damage!

Tool

You need the following tools:

- adjustable wrench
- pry bar
- scissors

Before You Begin

Check the following conditions:

- The testing machine is at the test site
- A place for putting underused package safely
- You have already reviewed the installation guidelines

Procedure

1. Use the scissors to cut off the strapping bands securing the crate or box to the shipping pallet and remove them. Refer to Figure 3-1.
2. Use the pry bar to remove the top cover of the crate or box. Refer to Figure 3-1.
3. Take out the document bag. Open the document bag and read INSTALLATION chapter in this Operating Instruction carefully to understand steps of unpacking. Refer to Figure 3-2 to see the inside of the crate or box.
4. Remove the EPS plate.

5. Take out the accessory box.
6. Remove the middle EPS plate.
7. Loosen the nuts.
8. Move away the crate or box upward. Take care of the testing machine during this operation. Don't damage the testing machine.
9. Take away the moisture-proof bag on the testing machine.
10. Put the testing machine onto the workbench.
11. Check all the items according to packing list.
12. Properly dispose the abandoned package.

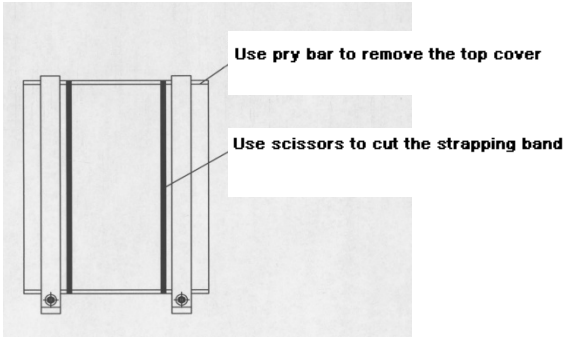

Figure 3-1 Remove Straps and Top Cover

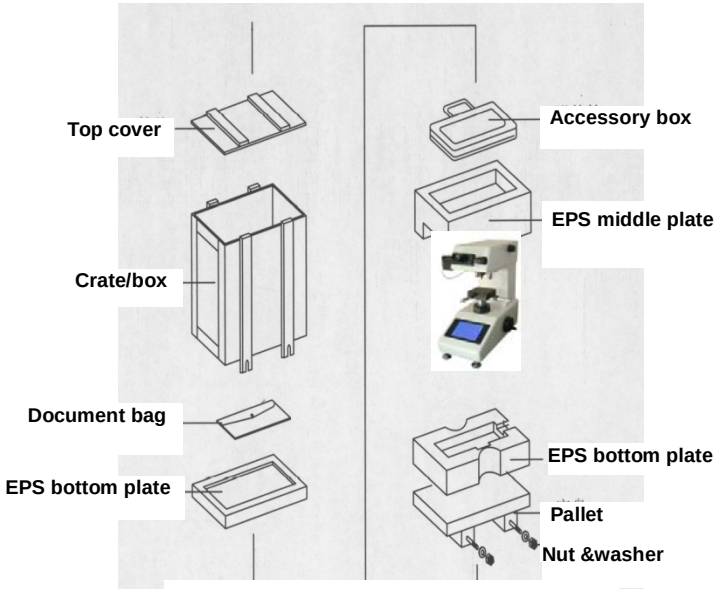

Figure 3-2 Inside of the Crate or Box

Installation

Tool

You need the following tools:

- Philips screwdriver (in the accessory box)
- Sucker (in the accessory box)

Before You Begin

Check the following conditions:

- The workbench for the testing machine is strong, stable and free from vibration.
- You have already reviewed the installation guidelines.

Procedure

1. Put the testing machine on a workbench.
2. Install four leveling screws (in the accessory box) into holes in the bottom of the testing machine. Refer to Figure 3-3.

Fig 3-3a Install back screw

Fig 3-3b Install front screw

Fig 3-3c Adjust level screw

3. Install the measuring microscope (in the accessory box) in the eyepiece tube as Figure 3-4 illustrates.
4. Turn the thumbwheel counterclockwise to lower the spindle to appropriate position. Then put the XY-stage (in the accessory box) in the hole of screw spindle. Fix the stage with a set screw. Refer to Figure 3-

5.

Figure 3-4 Install Measuring Microscope

Figure 3-5 Install XY-Stage

5. Put a level gauge (in the accessory box) on the XY-stage. Level the testing machine by adjusting four leveling screw. Take off the adhesive tape on the indenter.
6. Remove the screws on the top cover and remove the top cover by using sucker. Take out the desiccant bag.
7. Set the Force Selection Knob to the position of 10gf. Carefully remove the padding between lever and deadweight container. Check if the lever edge reliably seats in the supporting groove.

	**CAUTION!**
	If the lever edge is not exactly in the support groove, the indenter may be forced down and touch the specimen. In this case, the indenter will have no acction when the test starts.

8. Put the weights (in the accessory box) in weight container in the right sequence. Refer to Figure 3-6.

Fig 3-6 Put the deadweight

Note:

Before putting weights, the force selection knob should be in the position of 10 gf. Put the lightest weight first, then put others according to the right sequence. Be

careful when putting weights. Do not make any shock.

	**CAUTION!**
	Use sucker when putting weights. Putting weights directly by hands may cause corrosion to weights！When putting weights, the user should take great care in order to prevent the weights from dropping.

9. After assembling the weights, you should turn the Force Selection Knob several turns to check if there is any friction between weights and weight container.
10. Install the top cover and tighten screws on top cover.
11. Check that the power switch is in “O” (off) position. Use power cable (in the accessory box) to connect testing machine with the power supply.

	**WARNING!**
	Before connecting the plug with the power supply, you must check whether the voltage settings of testing machine match the power supply. **Change voltage settings according to “Setting Power” section in this chapter.** **Failure to observe the instruction will damage the testing machine.**

12. Set power switch to “I” position to turn on the testing machine.
13. Remove the Scotch tape which is on the light house, and insert the filter glass. (Refer to Figure 1-2)
14. Conduct the hardness tests on standard test block. Refer to APPENDIX A TESTING MACHINE INDIRECT TEST for detailed steps.

NOTE:

There are 1 or 2 test block(s) equipped with the testing machine.
If the test results of the test block are out of the tolerance in Table A-1 Testing machine Repeatability, contact BAQ as soon as possible.

15. Set power switch to “O” position to turn off the testing machine.
16. Cover the testing machine with a dustproof cloth cover (in the accessory box).

Setting Power

You are allowed to alter the testing machine power connector to adopt power supply from 90 to 240 V AC, 47 to 63 Hz.

A white pin on the connector indicates the current voltage setting as Figure 3-7 illustrates.

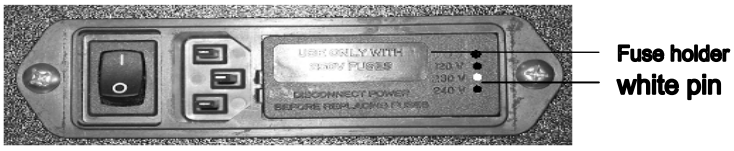

Figure 3-7 Power Connector

The voltage setting is normally 220V AC. Reading the following subsections if the setting does not match the power supply.

	**WARNING!**
	The power cable and connector must have ground wire or ground connection. Failure to properly ground the testing machine could result in your exposure to dangerous voltage levels.

Tool

You need the following tools:

- small slotted screwdriver or probe
- long nose pliers

Before You Begin

Check the following conditions:

- The power switch is set to O (off) position.
- There is no cable connecting the testing machine to the power supply.

Note:

If you are changing the switch setting, you may need change a power cable to match the power supply.

	**WARNING!**
	Shut off the main power switch and disconnect the power cable to the testing machine before you change the power setting. There are dangerous voltage levels inside the fuse holder.

Procedure

1. Insert a small flat-headed screwdriver or probe into the middle of the connector and pry out the fuse holder as Figure 3-8 illustrates.
2. Remove the fuse holder from the connector as Figure 3-9 illustrates.
3. Use long nose plier to move the voltage selector card as Figure 3-10 illustrates.
4. Position the voltage selection card so that the white indication pin is pointing upwards as Figure 3-11 illustrates.
5. Rotate the card until you read the voltage that the testing machine requires at the bottom of the card.
6. Position the card so that the white pin is pointing the direction away from the connector.
7. Insert the card in the connector. Make sure the card is fully seated.
8. Install the fuse holder in the connector. Check that the indicator pin now indicates the correct input voltage.

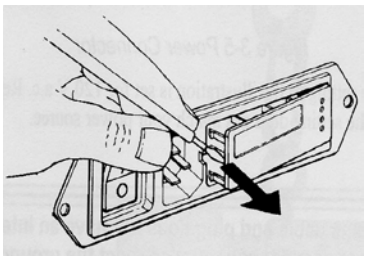

Figure 3-8 Pry out fuse holder

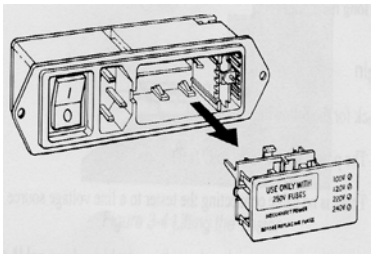

Figure 3-9 Remove fuse holder

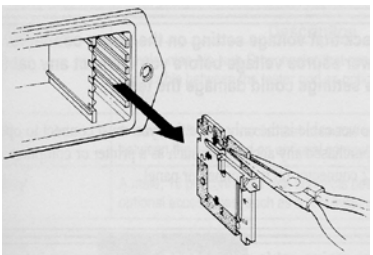

Figure 3-10 Remove Voltage selector

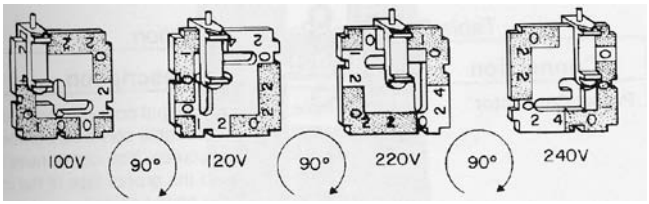

Figure 3-11 Voltage selector

FUNCTION OF KEYS

Figure 4-1 illustrates the touch screen of **MV-100A/102A**. The function would be explained in the following chapter of this operating instructoin. **MV-100A** does not have the auto-turret function.

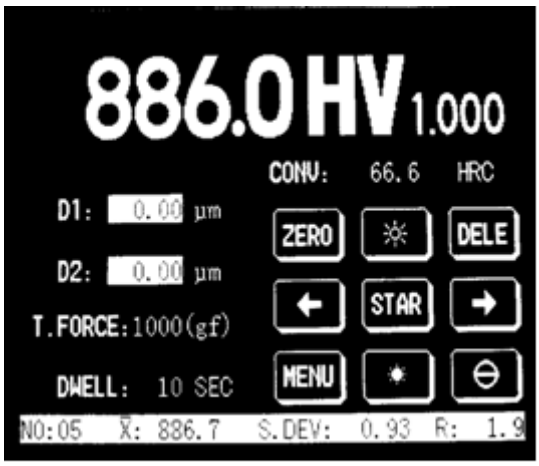

Figure 4-1a* MV-102A *Touch Screen

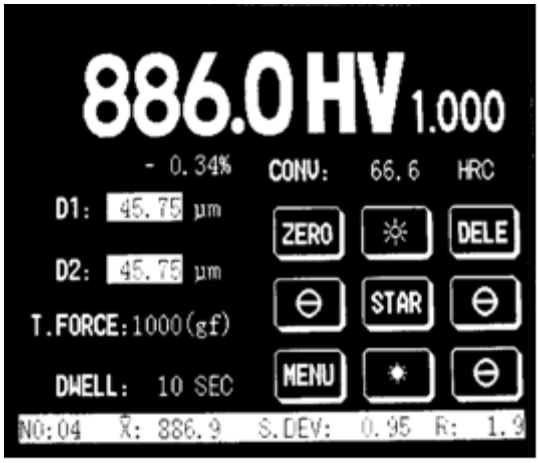

Figure 4-1b* MV-100A *Touch Screen

What is Main Screen?

In Figure 4-1, the menu on the touch screen is the Main Screen. It contains (from top to bottom, left to right) hardness value, test scale, conversion scale, diagonal length, test force, dwell time, zero, bright, delete, auto-turret (turn left), start, auto-turret (turn right), menu, dark and statistics etc. Statistics includes: number of tests, mean value, standard deviation and range. Icon "Θ" is the non-function key.

The Main Screen would be mentioned many times in the latter chapters. Keep it in mind when main screen is mentioned, it always refers to the menu here.

How to return to the main screen?

After you set the dwell time or delete the submenu, the system will directly return to the main screen.

In any other submenu, you can return to the main menu by touching **<EXIT>** or **<OK>**.

In the main menu, you can return to the main screen by touching **<EXIT>**.

<ZERO>

In order to ensure the accurate test, you should zero the system bofore a test starts.*（**Refer 4-2**）*

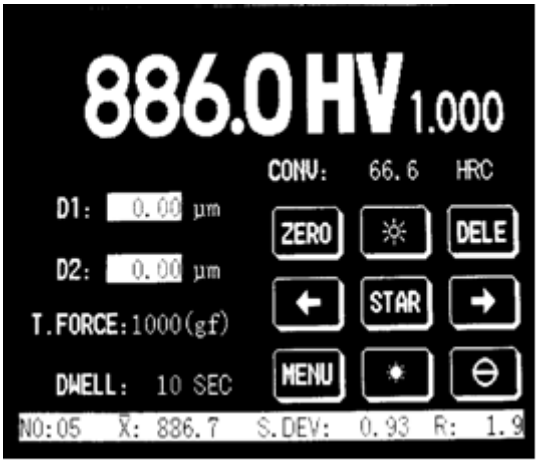

Figure 4-2 ZERO

<DELE>

In the main screen, you can touch **<DELE>** to access the delete screen.(Refer to 4-3)

There are 3 options:

- Delete the last record
- Delete all records
- Exit

Figure 4-3 DELETE

<STAR>

In the main screen, you can touch **<STAR>** to start a Vickers or Knoop test. Refer to Figure 4-4.

Figure 4-4 START

<☼> and <●>

In tne main screen, you can touch <☼> to increase the illumination of the light source.

In tne main screen, you can touch <●> to decrease the illumination of the light source.

There are 16 levels of brightness which are adjustable. Refer to Figure 4-1.

<←> and <→>

In the main screen, you can touch **<←>** to turn the turret leftwards.

In the main screen, you can touch **<→>** to turn the turret rightwards. Refer to Figure 4-1a.

MV-100A does not support this function. Refer to Figure 4-1b.

<MENU>

In the main screen, you can touch **<MENU>** to access the submenu. Refer to Figure 4-5.

You can choose any of these items by touching them.

You can touch **<EXIT>** to return to the main menu.

Figure 4-5 Menu

Following are the items:

1. Hardness Conversion

You can touch **<HARDNESS CONVERSION>** to access the hardness conversion menu. Refer to Figure 4-6.

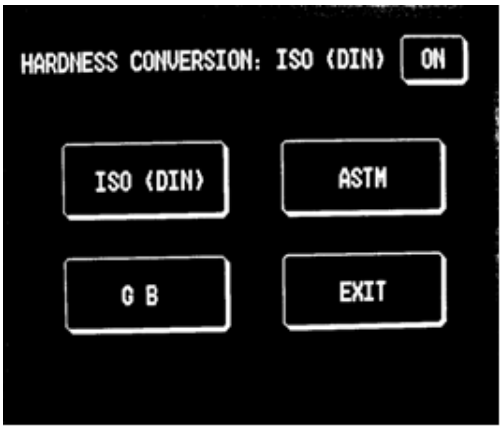

Figure 4-6 Hardness conversion

There are 3 standards:

ISO/ ASTM /GB

When the hardness conversion function is on, you can make the hardness conversion.

When the hardness conversion function is off, you cannot make the hardess conversion and main screen does not display the conversion hardness value.

After you choose the standard, the screen display the scales accordingly. Refer to Figure 4-7.

Figure 4-7 Hardness conversion

The system automatically saves your current setting in case you turn off the testing

machine.

2. Θ

MV-100A and MV-102A does not support data output function.

3. Date/time

You can touch **<DATE/TIME>** to access the setup screen. Refer to Figure 4-8.

You can touch the white block and then enter the numbers accordingly.

You can touch **<OK>** for confirmation and return to the main menu.

You can tocuh **<O>** to setup the current time.

The system uses 24 hours format. The date/time still works when the testing machine is off.

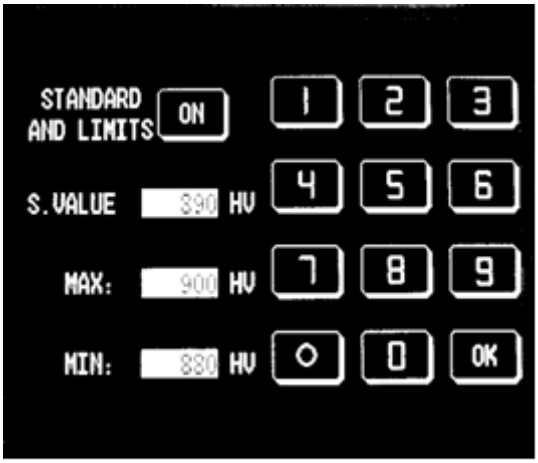

Figure 4-8 Date and time

4. Buzzer

Touch **<BUZZER>** to access the setup screen. Refer Figure 4-9.

Touch **<ON>** to activate the buzzer and **<OFF>** to deactivate the buzzer.

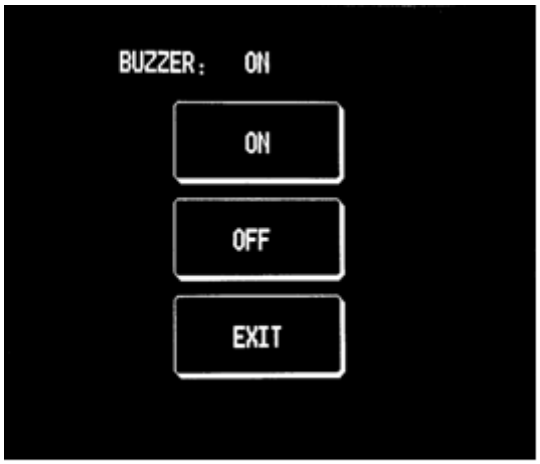

Figure 4-9 Buzzer

The system automatically saves your current setting in case you turn off the testing machine.

5. Standard and limits

Touch **<STANDARD AND LIMITS>** to access the setup menu. Refer to Figure 4-10.

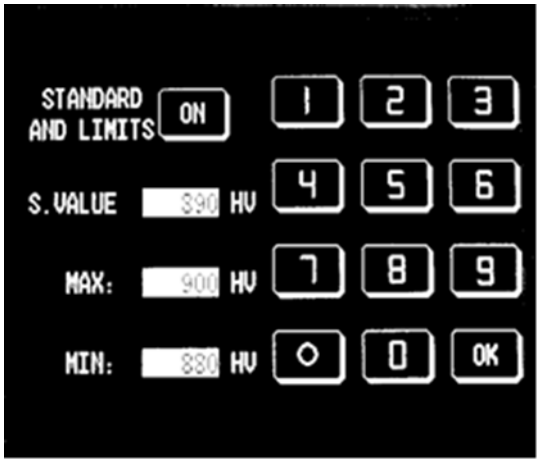

Figure 4-10 Standard and limit

Touch **<ON>/<OFF>** to activiate or deactiviate the function.

Touch the white block of the S.value/max/min and then enter the numbers.

Touch **<OK>** for confirmation and return to the main menu.

Touch **<O>** to zero all the nubmers and activate the standard and limit function.

The system automatically saves your current setting in case you turn off the testing machine.

6. Language

You can touch **<LANGUAGE>** to access the setup menu. You can select the language

you want. Refer to Figure 4-11

Figure 4-11 Language

If you don't want to change the current language, you can touch **<EXIT>** to return to the main menu.

The system automatically saves your current setting before you turn off the testing machine.

7. Energy-saving

Touch **<ENGERGY>** to access the setup menu. Refer to Figure 4-12.

Figure 4-12 Energy-saving

Touch **<ON>/<OFF>** to activiate or deactiviate the function.

Touch **<ON>** or **<O>** to activate the function and then touch the white block to enter the nubmer.

Touch **<OK>** for confirmation and return to the main menu.

The system automatically saves your current setting before you turn off the testing

machine.

8. Exit

You can touch **<EXIT>** to return to the Main Screen.

Test mode

Touch the HV/HV on the main screen to choose the test mode. Refer to Figure 4-13.

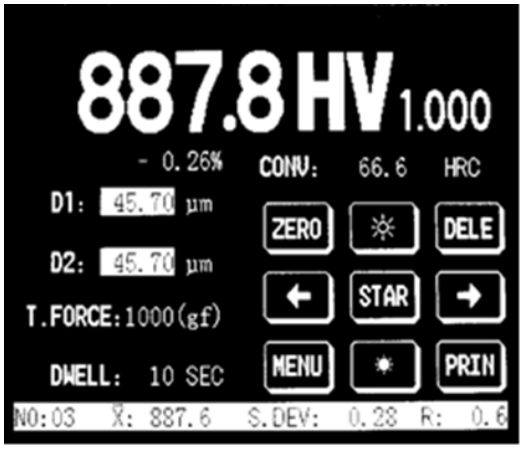

Figure 4-13 Test mode

The system automatically saves your current setting in case you turn off the testing machine.

Enter D1/D2 (diagonal length)

Touch the D1/D2 in the main screen to access the setup screen. Refer to Figure 4-14.

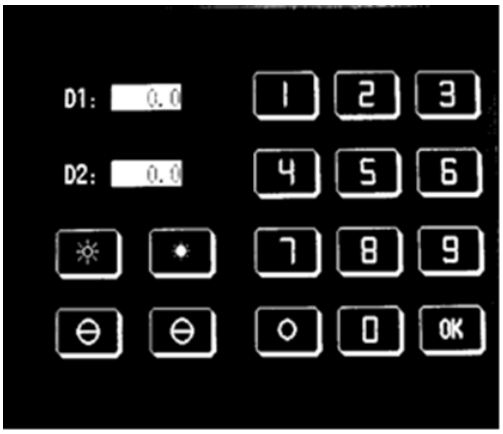

Figure 4-14 Test mode

The system will automatically access this setup screen when the indent has been made.

Touch **<O>** to clear all of the values.

Touch the white block of D1/D2 and then enter the numbers. Touch **<OK>** for confirmation and return to the main menu.

You can touch <☼> and <●> to increase or decrease the illumination.

You can touch **<←>** and **<→>** to turn the turret. (MV-100A does not support this function)

Note:

In the following conditions, the hardness testing machine does not show the hardness value.

- ***No hardness test has been made after the machine turns on.***
- ***The objective is not in the correct position.***

Test force selection

You can use the test force selection knob to choose the test force. There are 8 test forces.

The test force will blink 3-5 seconds on the main screen when it has been chosen.

The previous hardness value, statistics, mean value and hardness conversion will be zeroed.

Force Unit

You can touch gf/mN In the main screen to select the force unit of **gf** or **mN**. (Refer to Figure 4-13)

The system automatically saves your current setting in case you turn off the testing machine.

Dwell

Touch the 10 seconds on the main screen to access to the dwell time setup screen (Refer to Figure 4-15) . Touch **<O>** to setup the default of the dwell time 10 second. After you enter the dwell time, you can touch **<OK>** for confirmation and return to the main screen.

Figure 4-15 Dwell time

The system automatically saves your current setting in case you turn off the testing machine.

HOW TO PERFORM A TEST

This chapter details how to operate the testing machine. Because Knoop test is very similar to Vickers test, here we only take Vickers test for example.

Selecting a Scale

Before You Begin

Check the following conditions:

- The testing machine has been leveled.
- The voltage setting on the testing machine matches the power supply.

Procedure

1. Select "**I**" on the master switch to turn on the testing machine. The system will beep and display the company logo about 3 seconds as Figure 5-1, which shows that the system is under proper condition. Then the system shows the Main Screen.

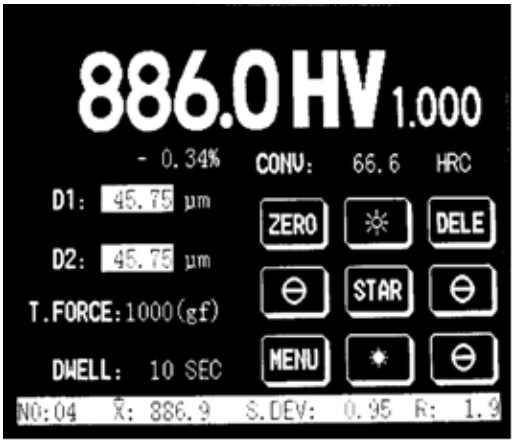

Figure 5-1 **MV-102A** ***Main Screen***

1. Select a test force by using the force selection knob.
2. If necessary, change the dwell time by touching **<DWELL>**.
3. Turn the eyepiece sleeve until you get two filar lines in the view field

which seems quite clear.

4. When the two lines are in the critical state of no optical gap, touch **<ZERO>** in the main screen.

Starting a Test

The **<STAR>** is used to begin a hardness test on a specimen after all test parameters have been set. The display must be at the main screen when the test will start.

Before You Begin

Check the following conditions:

- The testing machine displays the main screen.
- There is no more other part than specimen on the XY stage.

	**CAUTION!**
	Do not start a test program if there is no specimen on the stage. Both would be damaged if driving an indenter onto a stage.

MV-100A Procedure

1. Put the specimen on the stage.
2. Turn the objective lens 40× to the working position.
3. Move the specimen to make it just under the objective lens 40×. Turn the thumbwheel clockwise to elevate the spindle to focus the optical system until you are satisfied.
4. If necessary, you can turn the objective lens 10× to the working position to observe and choose the test point. Then you can perform the focus. After that you can turn the objective lens 40× to the working position for the fine focus. The texture of the specimen should be clear in the view field after fine focus.

	**CAUTION!**
	Avoid the specimen to hit the indenter or the objective lens during the course of focus. This will damage these components.

5. Turn the indenter to the working position for the hardness test.
6. In the main screen, touch **<STAR>**. The system starts a test and displays a waiting message on the screen as Figure 5-2.

Figure 5-2 Waiting message

Note: However, if you fail to carry out step 5, the system will display a warning message: "ROTATE TURRET TO INDENTER POSITION" as Figure 5-3 illustrates. You should touch <OK> and rotate the turret to the test position. Press <STAR> to proceed with the test.

Figure 5-3 Messsage

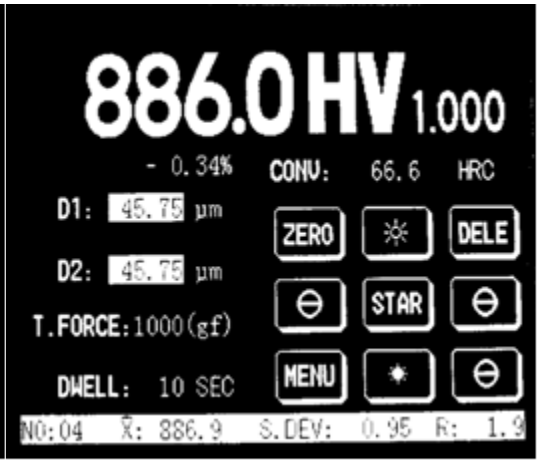

Figure 5-4 Test Completes

7. After the test completes, the system diaplays as Figure 5-5 and objective 40× return to the working position.

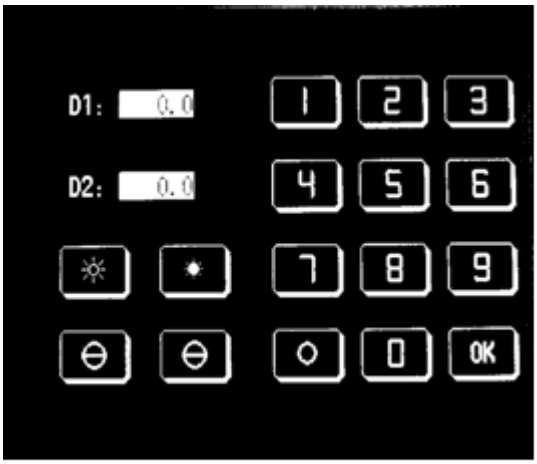

Figure 5-5 Message

8. Measure the diagonal length and then enter the value, touch **<OK>** for confirmation and return to the main screen.
9. The main screen displays the hardness value. Refer to Figure 5-4. If you enter the wrong number, you can touch the white block of D1/D2 on the main screen and enter the correct number.

Note: in the following conditions, the hardness testing machine does not show the hardness value.

- ***No hardness test has been made after the hardness machie is on.***
- ***The objective is not in the correct position.***

MV-102A Procedure

1. Put the specimen on the stage.
2. Touch **<⟶>** to turn the turret and have the 40× objective to the working position.
3. Move the specimen to make it just under the objective lens 40×. Turn the thumbwheel clockwise to elevate the spindle to focus the optical system until you are satisfied.
4. If necessary, you can turn the objective lens 10× to the working position to observe and choose the test point. Then you can perform the focus. After that you can turn the objective lens 40× to the working position for the fine focus. The texture of the specimen should be clear in the view field after fine focus.

	**CAUTION!**
	Avoid the specimen to hit the indenter or the objective lens during the course of focus. This will damage these components.

5. Touch **<STAR>**. The system starts a test and displays a waiting message on the screen as Figure 5-2.
6. After the test is completed, the objective 40 × will automatically return to the working position. The testing machine will display as Figure 5-5.

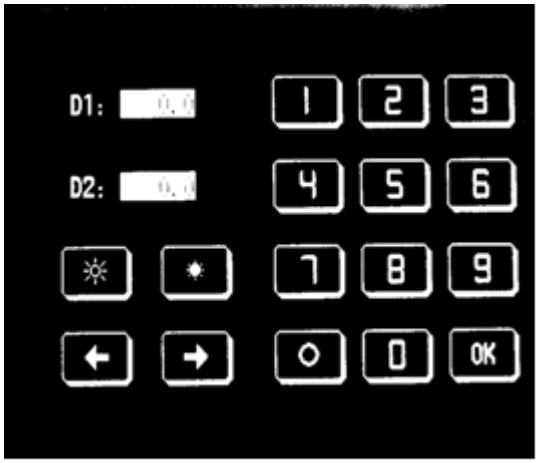

Figure 5-5 Input the Diagonal

7. Measure the diagonal and then input the readings, touch **<OK>** for confirmation and return to the main screen.
8. The main screen display the hardness value (Figure 5-4). If you enter the wrong number, you can touch the white block of D1/D2 in the main screen and enter the correct value.
9. **MV-102A** turret operation is same as **MV-100A.**

Measuring the Diagonals

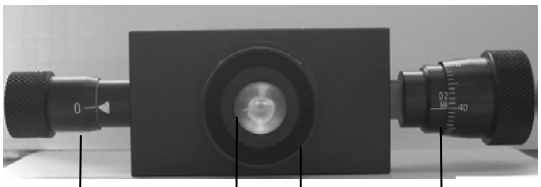

Figure 5-6 Measuring Microscope

Measuring Microscope

The measuring microscope, shown in Figure 5-6, is a part of the optical system in the testing machine which allows you to view the real indent and to measure its diagnoals. The microscope has two filar lines inside it, one of which remians stationary after it is set on one end of the indent's diagnoal, and the other line is moveable, place it on the opposite end of the indent's diagnoal by adjusting the micrometer. When you are satisfied that the two lines are exactly on the ends of the diagnoal, you can read the graduation on the micrometer and input the measured result through number keys.

How to read the graduation on micrometer will be illustrated later in this chapter.

Zero position adjustment

Zero position for microscope is very critical to the measuring accuracy. When the testing machine is shipped out, it has already been adjusted in the correct zero position. If the testing machine is used for several months, or the eyepiece is experienced an impact, you should perform a thorough check on the zero position. If the testing machine has offset, you can adjust it according to the following procedure.

Tool

You need the following tools:

- Hex. Wrench (inside the accessory box)

Procedure

1. Turn objective 40× to the working position and turn the eyepiece sleeve until the two filar lines inside the eyepiece are very sharp (See Figure 5-7).

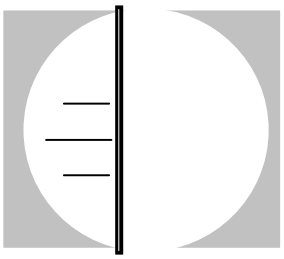

Figure 5-7 Two lines get closer

2. Turn the micrometer to move the two filar lines closer. The gap between the two filar lines will be increasingly narrowed until reaching the critical state of no gap. At that moment, the light between two lines are very weak. Refer to the Figure 5-7
3. Make sure that the reading on the micrometer is 0. Refer to Figure 5-8.

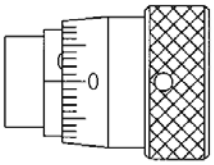

Figure 5-8 The reading is"0"

4. If "0" is already offset, use the hex. wrench to loosen the screw and turn the micrometer until the reading on the micrometer is "0". Then you tighten the screw.
5. Recheck the zero position. If offset occurs again on the micrometer, repeat the above operation.

Before you start

Check the following condition:

- The specimen already has an indent on it.
- The microscope has the correct zero position.

Procedure

1. Turn objective 40× to the working position and turn the eyepiece sleeve until the two

filar lines inside the eyepiece are very sharp (Refer to Figure 5-9).

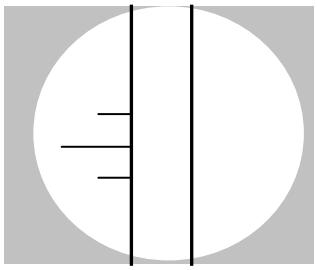

Figure 5-9 Sharp Image

2. Turn the eyepiece sleeve until the two filar lines are very sharp. Refer to Figure 5-8.
3. Turn the filar positioning knob of the measuring microscope to move the left line to the left indent tip and perpendicular to it as Figure 5-10 illustrates. This operation will move both lines simultaneously .

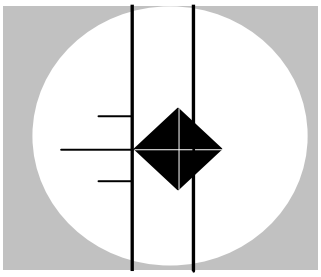

Figure 5-10 Move Left Filar Line to left tip

4. Turn the micrometer to move the right filar line to the right tip as Figure 5-11 illustrates.

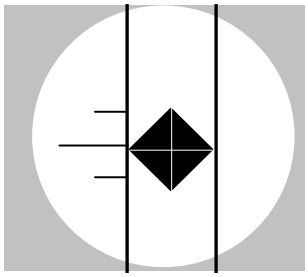

Figure 5-11 Move Right Filar Lineto Right Tip

5. Read the value on the micrometer and enter it to the D1. How to read the value on the micrometer will be detailed later in this chapter.
6. If you enter a wrong value, you can touch **<O>** to delete this value and re-enter the correct value.
7. Rotate the eyepiece assembly 90° clockwise. Observe the image through the eyepiece. The filar line is now perpendicular to the other dianogal（Refer to Figure ***5-12***）.

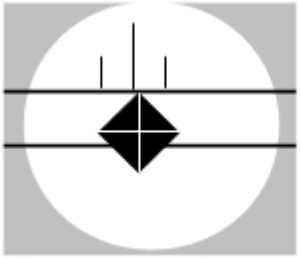

Figure 5-12 Move Top Filar Line to Top Tip

8. Turn the filar positioning knob to move the top line to the top tip of indent. This operation moves both lines simultaneously. Refer to Figure 5-12.
9. Turn the measuring micrometer to move the bottom filar line to the bottom tip as Figure 5-13 illustrates.

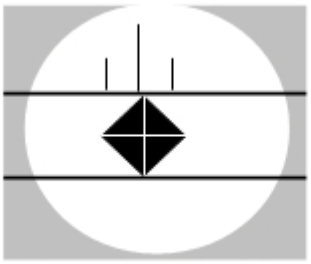

Figure 5-13 Move Bottom Filar Line to Bottom Tip

10. Read the value on the micrometer and enter it to the D2. Touch **<OK>** for confirmation. How to read the value on the micrometer will be detailed later in this chapter. The system then displays the calculated hardness value.
11. If you are not satisfied with the test result, you can clear the current test result by touching **<DELE>**. Then you can re-measure and re-input the length of diagonals. Refer to Figure 4-3.

How to Read Micrometer

Figure 5-14 Measured result on the Micrometer

Figure 5-14 illustrates a graduation on the micrometer.

The graduation on the primary ruler is more than 2, therefore, the graduation on the primary ruler is 200. On the secondary ruler, the scale line of 40 aligns with the

horizontal line on the primary ruler, therefore, the measured result on the secondary ruler is 40. You can calculate that the total length of the diagnoal is 200+40=240.

Note: The measured result is not the true length of the diagonal. It is the result after being magnified. However, you only need to input what you read and the system will take the magnification into consideration during the course of calculation.

Points for Attention

1. The diamond indenter is a very important component on the testing machine. Please be careful when operating. Don't touch the indenter with your finger.
2. Keep the indenter clean. When there are some oil or dirty on it, use degreased cotton with industrial alcohol or ether to clean it. Be careful when cleaning the indenter.
3. There is a red point on the outer circle of the indenter. When assembling the indenter, you must keep the red point toward the front.
4. Because of the difference of individual's eyesight, the filar lines will become vague when operator is changed. Under this condition, operator should turn the eyepiece sleeve slightly to make the filar line clear.
5. When you put measuring microscope into eyepiece tube, or rotate it 90 degrees, you must keep the microscope in close touch with the tube without gap, otherwise the accuracy of the test will be affected.
6. The position of the lamp will affect the image quality directly. If the image is vague or the lighting is not even, the lamp needs adjusting. You can adjust the two screws on the light house to find the appropriate position.
7. Keep the specimen clean. If there are some oil or dirt on it, the test result will be influenced. Use industrial alcohol or ether to clean the speciemn.
8. When photography is required, you can take off the top cover and put the photography tube in the mount. After mounting the camera into the tube, you can take photos.

RS232 Interface

The testing machine has a RS232 interface which has 2 functions:

1. You can write the latest software version for the testing machine through this interface to upgrade your testing machine.
2. You can use it as an interface for a CCD video filar system.

Parameters of RS232 interface are shown in Table 5-15.

Table 5-15

	STANDARD SETTING
DATA TRANSFER SPEED	9600 BAUD
START BIT	1
DATA BITS	8
STOP BIT	1
PARITY	NO
FLUID CONTROL	XON/XOFF

RS232 interface has a 9-pin connection with the following assignment:

- pin 2： T×D
- pin 3： R×D
- pin 5: GND

MAINTENANCE

Cleaning

The testing machine is a precision instrument that requires regular cleaning. How often you clean the testing depends on the operating environment.

Tool

You need the following items:

- A soft cloth
- Mild liquid detergent
- Light-weight oil

Before You Begin

	**WARNING!**
	Turn off the power switch and disconnect the power cable before you perform any maintenance. There are hazardous voltages inside the testing machine.

Check the following conditions:

- The power switch is off.
- The power cable is disconnected from the power supply.

Procedure

Non-metallic Surfaces

	**CAUTION!**
	Do not use excessive deterdent. It could seep inside the testing machine and cause component damaged.

Gently clean the components by using a soft cloth dipped (not soaked) with mild liquid detergent.

Metallic Surfaces

	**CAUTION!**
	Do not use excessive oil, which would attract dirt and other abrasive particles that could cause damage to the testing machine.

Gently clean the components by using a soft cloth dipped (not soaked) with light-weight oil.

Replacing a Fuse

The fuse housed in the power connector protects the testing machine from damage attributing to the over voltages or the short circuits. If the fuse breakdowns repeatedly, please contact **BAQ** without delay.

	**WARNING!**
	Turn off the power switch and disconnect the power cable before you replace the fuse. There are dangerous voltages inside the testing machine.
	**CAUTION!**
	Replace a fuse with the same specification as the original. Installing the wrong fuse could damage the testing machine.

Tool

You need the following items:

- A small flathead screwdriver
- A replacement fuse

MV-102A	2A, 250V, Φ6×30mm
MV-100A	1A, 250V, Φ6×30mm

- An ohmmeter (optional)

Before You Begin

Check the following conditions before you replace a fuse:

- The power switch is off.
- The power cable is disconnected from the power supply.

Procedure

1. Insert a small flathead screwdriver into the middle of the connector and pry out the fuse holder as Figure 6-1 illustrates.

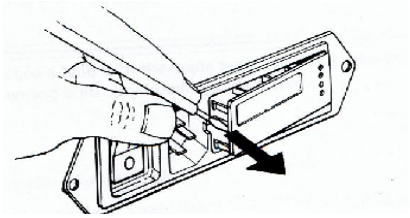

Figure 6-1 Fuse Holder Removal

2. Remove the fuse holder from the input-line connector as Figure 6-2 illustrates.

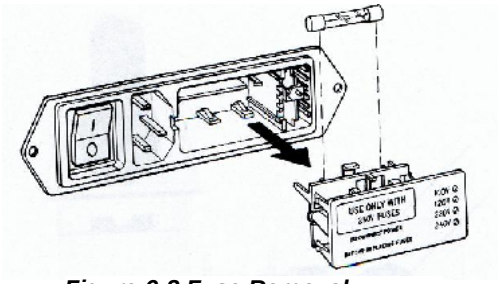

Figure 6-2 Fuse Removal

3. Remove the fuse from the cap to inspect if the filament is broken. If you are not sure about it, use an ohmmeter to determine if the filament is intact or not.
4. Install the replacement.
5. Return the fuse holder.

Replacing a Bulb

Should the microscope light bulb burn out, you can purchase a new bulb as replacement from **BAQ** and replace the damaged one by yourself.

	**WARNING!**
	Turn off the power switch and disconnect the power cable before you replace the bulb. There are dangerous voltages inside the testing mahine.

	**CAUTION!**

	Replace a bulb with the same specification as the original. Installing the wrong bulb could damage the testing machine.

Tool

You need the following items:

- A replacement bulb (halogen lamp, 12V, 20W)
- A soft and dry cloth

Before You Begin

Check the following conditions before you replace the bulb:

- The power switch is off.
- The power cable is disconnected from the power supply.

Procedure

1. Turn screw 1 counterclockwise to loosen it. Refer to Figure 6-3.

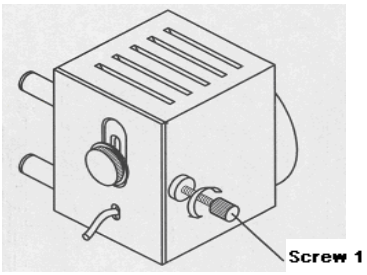

Figure 6-3 Loosen the Screw

2. Push the back cover in the direction of arrow 1 indicated in Figure 6-4. Then open the bulb house in direction of arrow 2 in Figure 6-4.

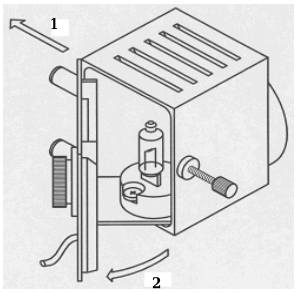

Figure 6-4 Open the back cover

3. Take off the damaged bulb and install a new one. Refer to Figure 6-5.

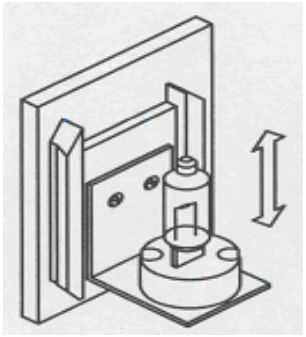

Figure 6-5 Change a New Bulb

4. Use soft dry cloth to clean the new bulb.
5. Push the back cover in the direction of arrow 1 indicated in Figure 6-6. Then close the bulb house in the direction of arrow 2 in Figure 6-6.

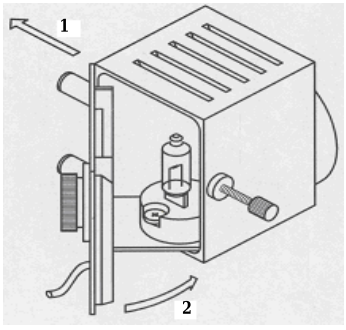

Fig 6-6 Close the Bulb House

6. Turn on the power switch.
7. Observe through the measuring microscope. Turn screw 1 clockwise to tighten it and adjust it to make the light in view field as even as possible (If necessary, you can adjust screw 2). Refer to Figure 6-7.

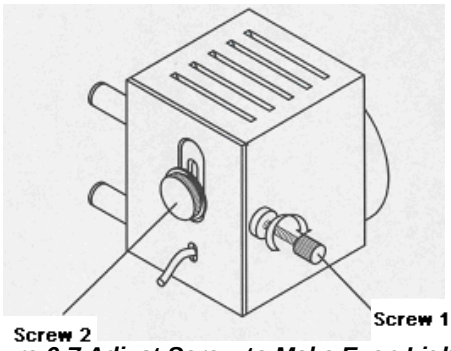

Figure 6-7 Adjust Screw to Make Even Light

Centering the image

MV-100A/102A has the optical magnification 100× and 400×. If the top of the indenter has a slight deviation, the image will be apparently off-center. The transportation, vibration or changing the indenter will cause this situation.

If the off-center is within the view field, you can adjust it according to the following instruction. Refer to Figure 6-8.

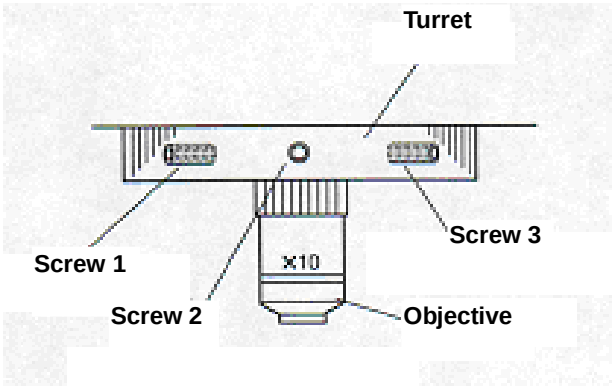

Figure 6-8 Adjust the Screw

Tools

You need the following tools

- Hex. Wrench (inside the accessory box)

Before you start

Check the following condition:

- There is an off-center image in the view field.
- You have already read the CENTERING THE IMAGE chapter.

Procedure

1. The image is above the center. Refer to Figure 6-9.

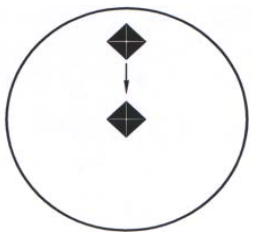

Figure 6-9 Image isabove the

a) Slightly loosen the screw 1
b) Slightly loosen the screw 2
c) Slightly tighten the screw 1 and screw 3 to move the image around the center.
d) Tighten the screw 1, 2 and 3 to center the image.

2. The image is beneath the center. Refer to Figure 6-10.

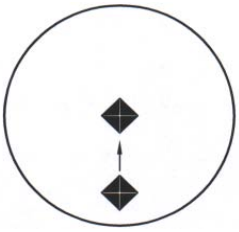

Figure 6-10 Image is beneath the center

a) Slightly loosen the screw 1 and screw 3.
b) Slightly tighten the screw 2 to move the image around the center.
c) Tighten the screw 1, 2 and 3 to center the image.

3. The image is on the left side of the center. Refer to Figure 6-11.

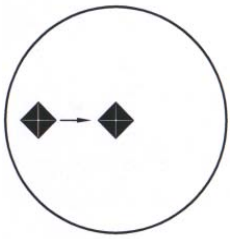

Fig 6-11 Image is on the left side of the center

a) Slightly loosen the screw 3.
b) Slightly loosen the screw 2.
c) Slightly tighten the screw 1 to move the image around the center.
d) Tighten the screw 1, 2 and 3 to center the image.

4. The image is on the right side of the center. Refer to Figure 6-12.

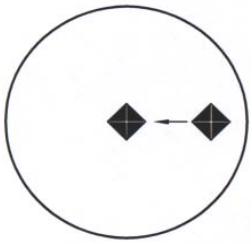

Figure 6-12 Image is on the right side of the center

a) Slightly loosen the screw 1.
b) Slightly loosen the screw 2.
c) Slightly tighten the screw 3 to move the image around the center.
d) Tighten the screw 1, 2 and 3 to center the image.

5. The image is randomly scattered. Refer to Figure 6-13.

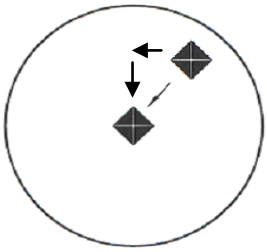

Figure 6-13 Image is randomly scattered

a) Move the image around the center according to the above description.
b) Center the image according to the above description.

During the image centering, you need the patience.

Note:

The image centering operation should be done in the view field.

Caring for Indenters

Micro-indent hardness testing is a sensitive, critical procedure. In order to ensure the accurate results, it is essential to keep the indenter clean and free from wear and damage. You should check the indenter every day, and replace the indenter that shows sign of wear or damage. You must also be aware of the following:

- Indenter house should keep clean and free from foreign matters and scrape. Before installing an indenter to the indenter house, always carefully clean both the intenter and the house.
- After testing the hard material or experencing an accident, indenter edges may get cracked or worn. If you are not sure of the indenter, please send it to **BAQ** for inspection and/or replacement.
- The indenter is very sensitive to the specimen surface. The testing surface of the specimen should keep clean and the surface polish should be in accordance with specification for test type (Vickers or Knoop).
- It is prohibited to hit the indenter when it is not in work.

Installing an indenter

When **MV-100A/102A** is shipped out, the Vickers indenter is already correctly installed. If you dismantle the indenter for the purpose of checking, cleaning or replacing, you have to mount the indenter again.

Tools

You need the following tools

- Hex wrench (inside the accessory box)

Before you start

Check the following condition

- The indenter is good

Procedure

1. Carefully insert the indenter shank into the installing hole and the red point should face towards you. Refer to Figure 6-14.

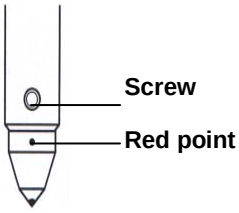

Figure 6-14 Installing an indenter

2. Tighten the screw .
3. Make a hardness test.
4. Observe the image through objective 40×, one of the diagonals should be horizontal as Figure 6-15 illustrated.

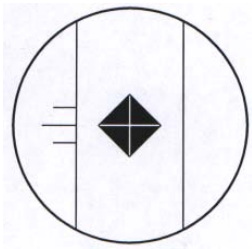

Figure 6-15 Correct image

5. If the image is as Figure 6-16 illustrates, you have to loosen the screw and slightly turn the indenter, conduct the step 2-4 until you get the correct image.

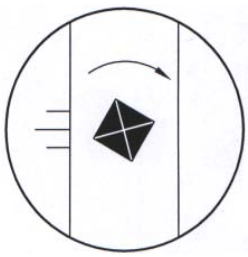

Figure 6-16 Incorrect image

Verifying System Accuracy

Periodic Verification with Test Block

It is quite important to use the certified test block to monitor the performance of your testing machine. There is one or two test blocks in accessory box as standard delivery. Test blocks that have the approximate hardness value as your specimens are available from **BAQ**. Please contact **BAQ** for further information.
Verification procedure is as follows:

1. Choose a test block that is close in hardness to your specimen.
2. Place the test block on the anvil in the way you place a specimen on the testing machine.
3. Make an indent on the test block, get the hardness value to see if the result is within the tolerance.
4. If the test results are within the tolerance, it shows your testing machine is under proper working condition, and you can proceed with test.
5. If your test result is significantly different from that on test block, check if your test setup and test methods are conforming to the accepted practice and specifications.
6. If trouble remains unsolved, make a series of indentations and take measurements and see if the results are scattered over a wide range or are grouped closely together. Please contact **BAQ**.

Indirect Verification

To ensure that your testing machine remains accurate over time, you should at least perform annually a testing machine verification procedure. The importance of this procedure will be described in ***Appendix A Testing Machine Verification***.

It is highly recommended that you have a **BAQ** service engineer to perform this verification, since it is a complex procedure and it must be performed with extreme care. It also provides an opportunity to have your testing machine thoroughly inspected for overall condition and potential problems.

APPENDIX A --- TESTING MACHINE VERIFICATION

Indirect verification of the hardness testing machine is conducted by making a series of indents on a standard test block. How often verification test should be performed depends on the laboratory conditions or whenever doubt exists about the accuracy of the testing machine due to misuse or accident.

Before you perform a verification test, make sure you already completed the following:

- Always use the top surface of the test block. The bottom and side surfaces will not yield the proper hardness values.
- Always use a test block that is in good condition. Check that its thickness is larger than 2.5x the diagonal length of the indentation.
- Always use a test block that has its original surface finish. Grinding off old indents and machining the surface will invalidate the block's original hardness designation.

Following is the procedure to perform an indirect verification test :

1. The indirect verification test should be performed on the certified test block which is certified according to ISO6507-3. Temperature for test is 23±5 ℃,
2. Make five indents on a certified test block . Set the dwell time in a range between 10 to 15 seconds.
3. The hardness testing machine is acceptably verified if, under the certain test force, the parameters of the five indentations meet the requirements defined in the sections on ***Repeatability*** and ***Errors*** below.
4. If, under the certain test force, the diagonal length of the indentation is less than 20μm long, indirect verification by using standard test blocks is not recommended. In these cases, the indentation measurement error represents a significant proportion of the diagnoal length, which could lead to substantial deviation in hardness from the specified value.

Repeatability

1. Five indentations should be made and measured on each standard test block according to ISO6507-1.
2. d_1, d_2, d_3, d_4, d_5, the mean values of diagonal length on each standard test block should be listed in sequence from small to big.
3. Under the specified testing conditions, the repeatability error of the hardness testing machine is determined by the difference d_5-d_1. The repeatability of hardness testing machine after verification should meet the specifications in following Table A-1.

Table A-1

Hardness of the reference block	Repeatability of the testing machine max						
	r_{rel}, %			r HV [b]			
	HV 5 to HV 100	HV 0,2 to < HV 5	< HV 0,2	HV 5 to HV 100		HV 0,2 to < HV 5	
				Hardness of the reference block	HV	Hardness of the reference block	HV
⩽ 225 HV	3,0 [a]	6,0 [a]	9,0 [a]	100	6	100	12
				200	12	200	24
> 225 HV	2,0 [a]	4,0 [a]	5,0 [a]	250	10	250	20
				350	14	350	28
				600	24	600	48
				750	30	750	60
[a] or 0,001 mm, whichever is greater.							
[b] HV: Vickers hardness.							

The above content in the table is taken from ISO6507-2.

Indication Errors

1. Under the specified testing condition, the indication error of the testing machine hardness could be characterized by the following difference:

$$\overline{H} - H$$

Where：

$$\overline{H} = \frac{H_1 + H_2 + H_3 + H_4 + H_5}{5}$$

In the above formula：

H_1, H_2, H_3, H_4, H_5 is the hardness value which is in relation to d_1, d_2, d_3, d_4, d_5：

H is the standard hardness value of the test block.

The maximium error of the harndess testing machine is designated as percentage of standard hardness value, which should not be beyond the specifications in Table A-2.

Table A-2

Hardness symbol	Maximum permissible percentage error E_{rel}, of the hardness testing machine															
	Hardness, HV															
	50	100	150	200	250	300	350	400	450	500	600	700	800	900	1 000	1 500
HV 0,01																
HV 0,015	10															
HV 0,02	8															
HV 0,025	8	10														
HV 0,05	6	8	9	10												
HV 0,1	5	6	7	8	8	9	10	10	11							
HV 0,2		4		6		8		9		10	11	11	12	12		
HV 0,3		4		5		6		7		8	9	10	10	11	11	
HV 0,5		3		5		5		6		6	7	7	8	8	9	11
HV 1		3		4		4		4		5	5	5	6	6	6	8
HV 2		3		3		3		4		4	4	4	4	5	5	6
HV 3		3		3		3		3		3	4	4	4	4	4	5
HV 5		3		3		3		3		3	3	3	3	3	4	4
HV 10		3		3		3		3		3	3	3	3	3	3	3
HV 20		3		3		3		3		3	3	3	3	3	3	3
HV 30		3		3		2		2		2	2	2	2	2	2	2
HV 50		3		3		2		2		2	2	2	2	2	2	2
HV 100				3		2		2		2	2	2	2	2	2	2

NOTE 1 Values are not given when the length of the indentation diagonal is less than 0,020 mm.

NOTE 2 For intermediate values, the maximum permissible error may be obtained by interpolation.

NOTE 3 The values for microhardness testing machines are based on a maximum permissible error of 0,001 mm or 2 % of the mean diagonal length of indentation, whichever is the greater.

The contents of the table A-2 is taken from ISO6507-2.

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