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OMEGA-HB-3000
Brinell Hardness Tester

INSTRUCTION MANUAL

3601 E. 34th St. Tucson, AZ 85713 USA Tel. +1 520-882-6598 Fax +1 520-882-6599 email: pace@metallographic.com Web: http://www.metallographic.com

Equipment Type:	Brinell Hardness Tester
Model:	***OMEGA-HB-3000***
Electrical Requirements:	110 Volts (single-phase)
Frequency:	50/60 Hz
Manual Revision Date:	April 24, 2022

Please read this instruction manual carefully and follow all installation, operating and safety guidelines.

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WARRANTY

Terms and Conditions applying to all PACE Technologies Products

1. LIMITED WARRANTY AND DISCLAIMER:
PACE Technologies microscopes and hardness testers are warranted for one year from the purchase date to be free from defects in material and workmanship under correct use, normal operating conditions, and proper application. PACE Technologies obligation under this warranty shall be limited to the repair or exchange, at PACE Technologies option, of any PACE Technologies Product or part which proves to be defective as provided herein. PACE Technologies reserves the right to either inspect the product at Buyer's location or require it to be returned to the factory for inspection. Buyer is responsible for freight to and from factory on all warranty claims. The above warranty does not extend to goods damaged or subjected to accident, abuse or misuse after release from PACE Technologies warehouse, nor goods altered or repaired by anyone other than specifically authorized PACE Technologies representatives. PACE Technologies shall not in any way be responsible for the consequences of any alteration, modification or misuse unless previously approved in writing by an officer of PACE Technologies. Note: Corrosion is considered a maintenance issue and not a warranty issue.
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PACE Technologies maximum aggregate liability for loss and damage arising under, resulting from or in connection with the supply or use of the Equipment and Consumables provided under this purchase, or from the performance or breach of any obligation (s) imposed hereunder, whether such liability arises from any one or more claims or actions for breach of contract, tort, (including negligence), delayed completion, warranty, indemnity, strict liability or otherwise, unless otherwise limited by the terms hereof, shall be limited to one hundred percent (100%) of the purchase price.

3. DELIVERY:
Customer assumes and shall bear the risk of all loss or damage to the Products from every cause whatsoever, whether or not insured, and title to such Products shall pass to Customer upon PACE Technologies delivery of the Products to the common carrier of Pace Technologies choice, or the carrier specified in writing by Customer, for shipment to Customer. Any claims for breakage, loss, delay, or damage shall be made to the carrier by the

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Customer and Pace Technologies will render customer reasonable assistance in prosecuting such claims.

4. ACCEPTANCE:
Customer shall inspect the Products promptly upon receipt of delivery. Unless customer objects in writing within thirty (30) business days thereafter, customer shall be deemed to have accepted the Products. All claims for damages, errors, or shortage in Products delivered shall be made by Customer in writing within such five (5) business day period. Failure to make any claim timely shall constitute acceptance of the Products.

5. PAYMENT:
Customer agrees to provide timely payment for the Products in accordance with the terms of payment set forth on the reverse side hereof or in any proposal submitted herewith. If any payment is not paid on or before its due date, Customer shall pay interest on such late payment from the due date until paid at the lesser of 12% per annum or the maximum rate allowed by law.

6. DEFAULT:
If Buyer is in default (including, but not limited to, the failure by Buyer to pay all amounts due and payable to Seller) under the work or purchase order or any other agreement between Buyer and Seller, Buyer 's rights under the warranty shall be suspended during any period of such default and the original warranty period will not be extended beyond its original expiration date despite such suspension of warranty rights.

7. MISCELLANEOUS PROVISIONS:
This agreement has been made in and shall be governed by the laws of the State of Arizona. All disputes arising under or relating to the purchase of the equipment shall be brought and resolved solely and exclusively in the State of Arizona, Pima County . These terms and conditions and the description of the Products on the reverse side hereof or in any proposal submitted herewith constitute the entire agreement and understanding of the parties with respect to this sale and supersede all prior and contemporaneous agreements or understandings, inducements or representations, expressed or implied, written or oral, between the parties with respect hereto. Any term or provision of this Agreement may be amended, and any observance of any term of this Agreement may be waived, only by a writing signed by the party to be bounds. The waiver by a party of any breach shall not be deemed to constitute a waiver of any other breach. Should suit be brought on this Agreement, the prevailing party shall be entitled to recover its reasonable attorneys' fees and other costs of suit including costs and attorneys' fees incurred on appeal or in collection of any judgment., errors, or shortage in Products delivered shall be made by Customer in writing within such five (5) business day period. Failure to make any claim timely shall constitute acceptance of the Products.

8. RESTOCKING FEE:
All Returns are subject to a restocking charge equal to 15% (fifteen percent) of the Invoice, unless the Goods are proved to be non-conformed by PACE Technologies.

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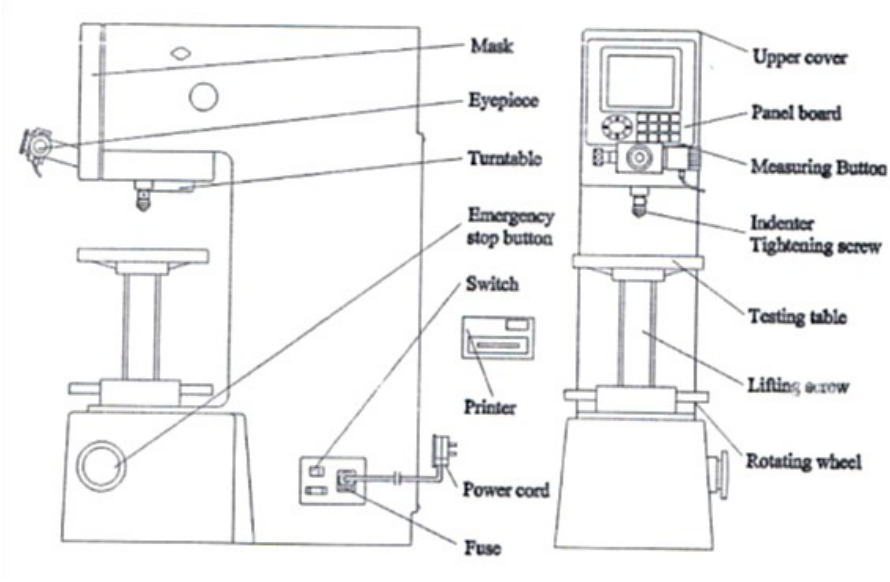
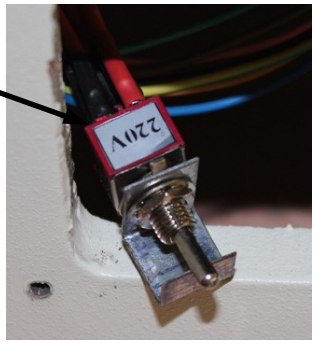
1.0 Product Description

1.1 General Description



Transformer switch for matching incoming voltage



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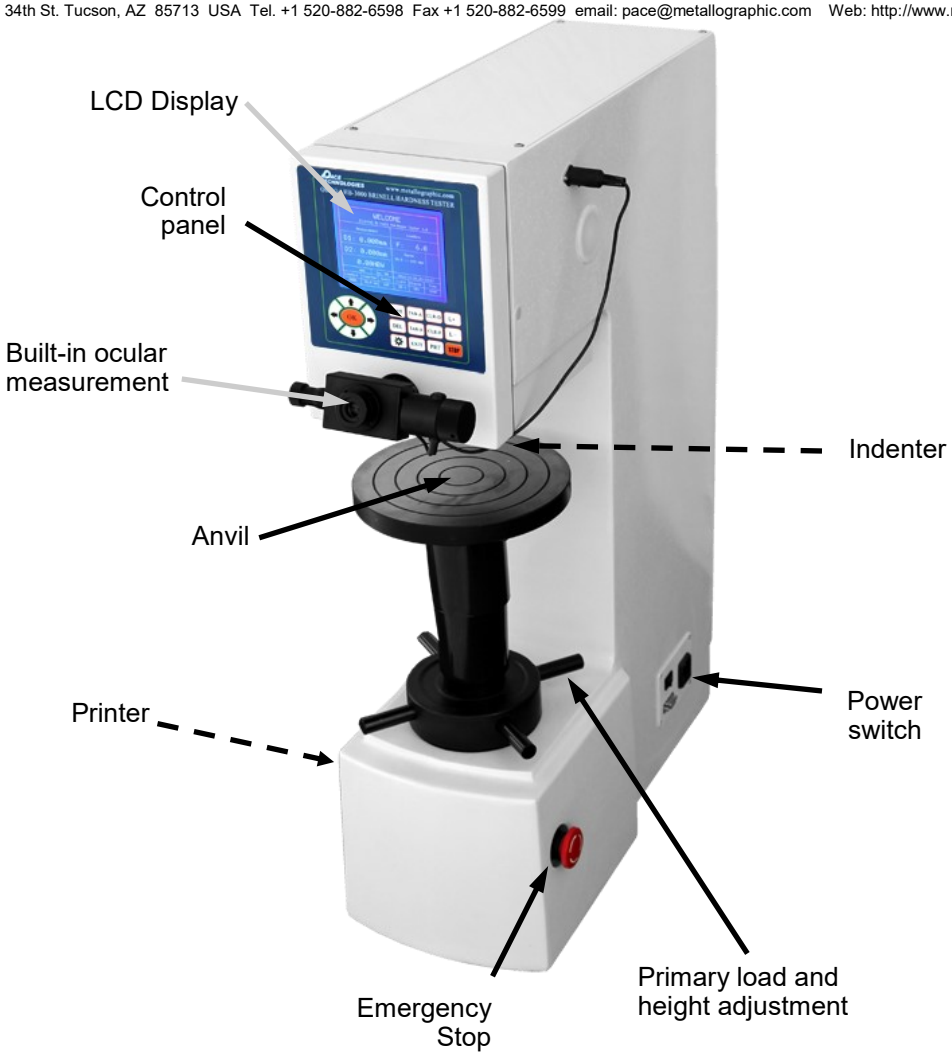

The BRN-3000 Brinell hardness tester is a ball indenter designed to evaluate metallographic specimen hardness.

The BRN-3000 Brinell hardness tester has a load ranging from 62.5 kg to 3000 kg.

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1.2 Technical Specifications

Electrical specifications:	110 or 220V single-phase (50/60 Hz) - toggle switch
Test forces:	Brinell 62.5 kg (612.9 N) 100 kg (980 N) 125 kg (1226 N) 187.5 kg (1839 N) 250 kg (2452 N) 500 kg (4900 N) 750 kg (7335 N) 1000 kg (9800 N) 1500 kg (14700 N) 3000 kg (29400 N)
Hardness Range (HBW)	8 ~ 650 HBW
Dwell time of test force:	2-60 seconds
Max. height of specimen:	225 mm (8.9-inches)
Max width of the specimen:	135 mm (5.3-inches)
Weight:	Approx. 290 lbs (130 kg)
Dimensions (LxWxH):	Approx. 26” x 17” x 40” (655 mm x 430 mm x 1025 mm)
Working temperature:	70° - 85°F (23 - 28°C)

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2.0 Unpacking, Shipping and Installation

2.1 Unpacking

Unit is delivered in a box. Unpack and check for completeness of parts.

Measures WxHxD: Approx. 26” x 17” x 40”
(655 mm x 430 mm x 1025 mm)

Weight: Approximately 350 lbs (160 kg)

2.2 Shipping

When moving box, lift from bottom.

! **Caution:** Heavy equipment. Take care to avoid bodily injury.

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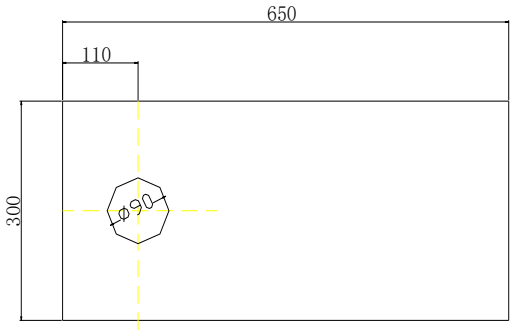
2.3 Installation

! Install unit carefully! Improper installation voids warranty.

The ***BRN-3000*** should be placed on a flat stable vibration free surface. If tall or high samples are to be tested so that the up / down lead screw is lowered significantly, a hole will need to be made in the table (see drawing for specifications - mm)



2.3.1 Install leveling feet

Attach four leveling feet and use bubble level on anvil to level unit

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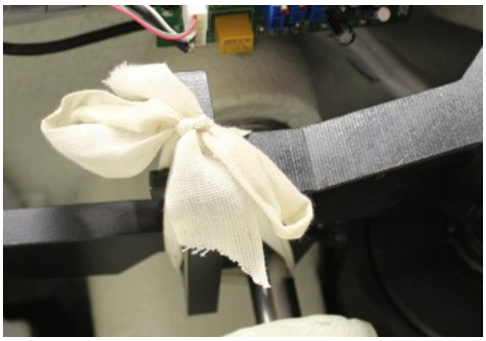
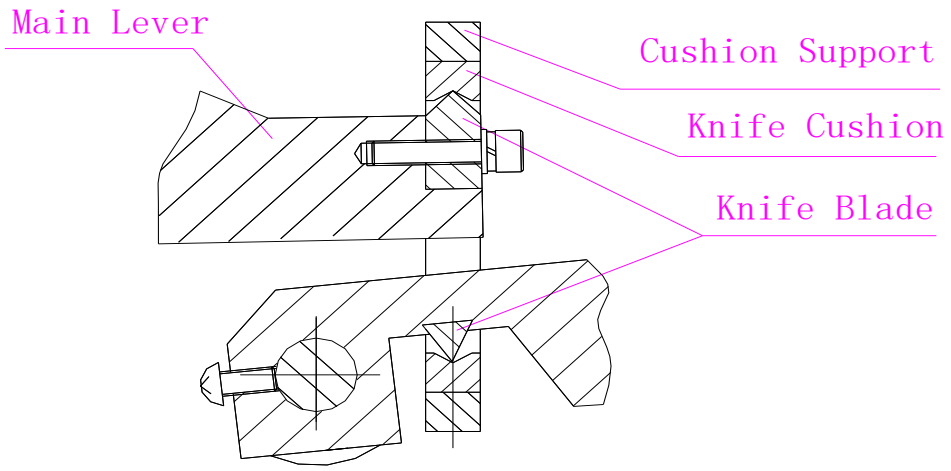
2.3.2 Installation

2.3.2.1 Open the upper cover. Remove the tie string

2.3.2.2 Check the knife support to insure that knife blade or "V" is positioned so it is resting in the groove of the support bar. If the blade is not being supported on the cushion (caused by severe shaking and vibration during transport), push down the main lever by hand and slide the blade into the groove (see Fig. 3-2). Replace upper cover.





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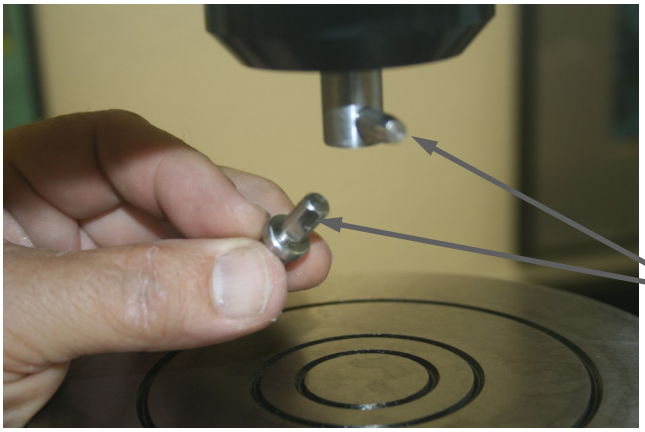
2.3.3 Indenter Installation

2.3.3.1 Rotate the turret so indenter hole is in the front and insert the indenter and lightly tighten the set screw.

2.3.3.2 Place a specimen directly onto the lifting screw, and raise it up so that the specimen contacts the indenter. Align so that the set screw is aligned with the flat face of the indenter shank.

2.3.3.3 Release the force and the installation of indenter is complete.



Align flat end of indenter shank with the holding screw

After loading indenter - it is good practice to run a sample indent at 3000 kgf to properly set the indenter

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2.3.4 Installing filar eyepiece

Remove cap from eyepiece tube

Attach filar eyepiece / measurement device

Plug in communication cable

Focus eyepiece so filar lines are sharp and in focus

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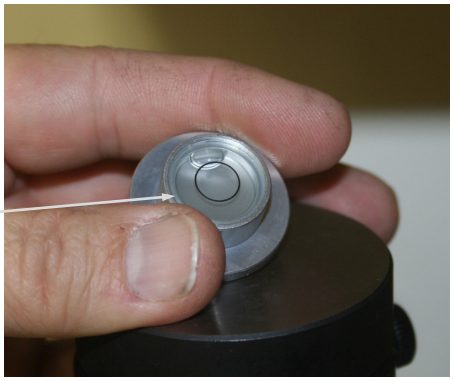
2.3.5 Installing Anvil Stage

Insert anvil into up/down screw feed

Raise cover and tighten thumb screws

2.3.6 Leveling unit

Place bubble level on stage and adjust feet height to level the unit



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2.3.8 Key Pad Functions

SAVE	SAVE key：saves file. Saving a file stores the current test data into memory as a whole page. Up to 5 pages can be stored and the pages will be automatically numbered by 00~05 for retrieval. When the 6th page is stored, the earliest stored page (No. 00) will be erased. It you want to retain this page, press TAB-B to enter the DATA SAVE page, then press SAVE and the data. Up to 20 groups of data can be stored in a single page (additional data will be automatically deleted).

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DEL	DEL key: deletes the current data and/or current page. If the data from the current test is not acceptable it can be deleted by pressing DEL key. If the data for the entire current page are no longer needed, press TAB-B to enter DATA SAVE page, then press DEL key to delete data (i.e. deletes the entire page) and returns back to the home page.
TAB-A	TAB-A key: enter the force & indenter type. Press individual arrow keys to choose required test force and indenter as shown in the Figure below. Pess OK/ESC key after confirmation to escape and return back to home page.

<table>
<tr><td colspan="6">Digital Brinell Hardness Tester</td></tr>
<tr><td colspan="3">Measurement</td><td colspan="3">Loading</td></tr>
<tr><td colspan="3">D1： 0.000mm</td><td colspan="3">F： 0.0</td></tr>
<tr><td colspan="3" rowspan="2">D2： 0.000mm
HBW</td><td colspan="3" rowspan="2">Range
95.5—653HBW</td></tr>
<tr></tr>
<tr><td colspan="2">HRC</td><td>NO. 00</td><td colspan="3">2005/3/15_15:15:58</td></tr>
<tr><td>Loading</td><td>Indenter</td><td>Dwell</td><td>Light</td><td>Change</td><td>Time</td></tr>
<tr><td>3000</td><td>10mm</td><td>10s</td><td>40%</td><td>HRC</td><td>YEAR</td></tr>
</table>

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TAB-B	TAB-B key: DATA SAVE page. This page shows NO (number of tests), D（in mm, average of D1 and D2） and HB (hardness value). To retrieve or save data, press the TAB-B key to enter DATA SAVE page, then find the desired page by pressing ↑ or ↓ arrow keys. Pressing OK/ESC will return to home page, data unsaved. Press the SAVE key and current page will be saved and returns to the home page.
EXIT	EXIT key: Exit the system. This key turns off power to the CPU.
CLR-D	CLR-D key: Calibration key. Used to set the zero value for graduation lines on filar ocular lens.
CLR-F	CLR-F key: Clear key. If there is a residual test force left on display when the test force is removed (the indenter is separated from specimen), use this key to reset force.
PRT	PRT key: Print and serial interface data loading key. Press this key to print out the data of current test or send the data through RS232 to PC's COM interface. **Note: Refer to section for the setting of PC's Hypertrm.**
L+	L+ and L- key: Increase and decrease light intensity. A beep will sound by depressing L+ or L- key to indicate that brightness is changing. Values range from 10% to 100% are displayed at the bottom line of the home page. When the beep sounds continuously it means maximum or minimum brightness has been reached.
STOP	STOP key: Emergency stop/display of original data. Depress this key to stop operation during the tester's loading period. The tester will stop loading and return back to initial settings. The STOP key should not be carelessly depressed other than during the loading period, or the program's original data will be displayed as F= XXX.X. In such case CLR-F needs to be depressed to return the display back to set working state (original data are only used for design and later extension of functions, and have no significance to the use of the tester).

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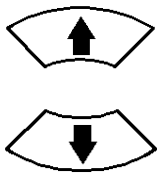
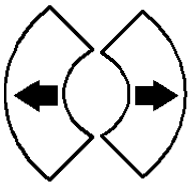
	OK/ESC key: When TAB-A or TAB-B page is on display, depressing this key will exit page and return back to home page. Depressing OK/ESC key on home page producing the cursor to flash at Dwell, Light, Change, Time, and Loading etc. The arrow keys can then be used to adjust these parameters. Press OK/ESC again to end the selection and the cursor to will disappear. **Note: Do not depress the arrow keys when cursor is flashing at Loading because this function is provided only for the apparatus adjustment at factory, careless use of this function can cause damage or decrease accuracy. Depress OK/ESC key to end or left arrow key to exit.**
	UP and DOWN key: Arrow keys. When cursor is flashing at the positions of Dwell, Light, Change and Time, depressing arrow keys will increase or decrease the value in years, months, days, hours and minutes (Time), change the hardness conversion scale, change intensify the brightness of light source (Light), or modify the load holding time (Dwell). Press these arrows on the TAB-A page to choose larger test force and press TAB-B page to retrieve the previous page from memory.
	LEFT and RIGHT arrow key. Moves cursor left or right on home page or TAB-A page.

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3.0 Safety Guidelines

3.1 Warning Sign

! This sign points to special safety features on the machine.

3.2 Safety Precautions

! Careful attention to this instruction manual and the recommended safety guidelines is essential for the safe operation of the ***BRN-3000***.

! Proper operator training is required for operation of the ***BRN-3000***. Any unauthorized mechanical and electrical change, as well as improper operation, voids all warranty claims. All service issues need to be reported to the manufacturer / supplier.

! Operate unit as specified in this manual.

! Disconnect power before opening unit.

! Lower stage to avoid damaging indenter when not in use.

! Cover unit with dust cover when not in use to eliminate dust contamination.

3.3 Emergency Statement

Always follow proper operational guidelines and avoid contact with lubricants and abrasives.

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4.0 Operation

4.1 Turn on BRN-3000 tester power.

4.2 Home page

Digital Brinell Hardness Tester					
Measurement			Loading		
D1： 0.000mm			F： 0.0		
D2： 0.000mm			**Range 95.5—653HBW**		
HBW					
HRC	NO. 00		2005/3/15_15:15:58		
Loading	Indenter	Dwell	Light	Change	Time
3000	10mm	10s	40%	HRC	YEAR

4.3 TAB-A key, select test force and indenter by using arrow keys as needed. Depress OK/ ESC key after all selections are completed to return back to Home Page.

Digital Brinell Hardness Tester							
F/D^2	30	15	10	5	2.5	1.25	1
D (mm)	TESTER FORCE						
10	3000	1500	1000	500	250	125	100
5	750		250	125	62.5		
2.5	187.5		62.5				
HRC		NO. 00	2005/3/15_15:15:58				
Loading	Indenter	Dwell	Light	Change	Time		
3000	10mm	10s	40%	HRC	YEAR		

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4.0 Operation (continued)

4.4 Home Page default settings:
Test force F (Loading)：3000kgf
Hardness range: (653-95.5)HBW
Indenter: φ10mm
Holding time (Dwell): 10s
Brightness (Light): 40％
Conversion scale (Change) HRC
Date: 2005/3/15 15：15：58

To modify, press OK/ESC key. Cursor will flash on the Dwell field. Use ↑ or ↓ key to select value and press OK/ESC to confirm. Repeat for other field. Press OK/ESC to exit.

TAB A to select ball diameter, and force. Press OK

4.5 RECOMMEDATION: Run 2-3 indents at 3000kgf load to set the loading mechanism and to confirm that electronic components are working properly.

4.6 Rotate Hand Wheel clockwise to move sample into indenter **(INDENTER must be in the FORWARD position on the TURRET).**

-Continue to turn wheel slowly to apply the initial test load.

IMPT: if wheel is difficult to turn, STOP and verify that the turret is rotated so the indenter is in front.

-When the buzzer sounds stop turning the initial load and let the servo motor apply the test force for the preset Dwell time (If the initial load is too fast or a buzzer produces a long sound, this indicates an error in the measurement. For this situation lower the sample and move the sample to a new location and then re-apply the initial load).

IMPT: Do not rotate the hand wheel or move the specimen during application of the main load as this may damage the instrument.

TO STOP INDENT during indenting process. Press STOP

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Turn rotating wheel counter-clockwise to lower the sample below the indenter.

-Rotate turret to view indent. Focus on indent and measure D1 and D2 (perpendicular axis) widths.

-Measure indent.

10 test loads are available in this tester with two preliminary load settings:

- 62.5kgf～250kgf the preliminary load is 30kgf
- 500kgf～3000kgf the preliminary load is 90kgf.

If the preliminary load is too high no measurement will be made, remove load and move to new location and re-apply the load.

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4.0 Operation (continued)

4.7 EXAMPLE (3000 kgf):

- Place specimen on anvil under the indenter
- Rotate the hand-wheel clockwise slowly to apply preliminary load (beeper will sound when load of 90kgf is reached). Stop rotating of hand-wheel.
- The primary load will be automatically applied (display shows a flashing downward arrow). DO NOT MOVE SAMPLE or TURNTABLE.
- When the 3000kgf load is reached the motor stops and the tester holds the load for the pre-set DWELL time.
- After the DWELL time is completed, the force is gradually removed and a flashing upward arrow appears on the display.
- After the flashing arrow stops, remove the load by turning the wheel counterclockwise so the indenter is 1 mm from sample.
- Focus on the indent and measure D1 and D2 (90° or perpendicular to each other) pressing the button on the filar after each measurement.
- The resulting data is shown below.

<table>
<tr><td colspan="6">Digital Brinell Hardness Tester</td></tr>
<tr><td colspan="3">Measurement</td><td colspan="3">Loading</td></tr>
<tr><td colspan="3">D1： 3.421mm</td><td colspan="3">F： 3002.0</td></tr>
<tr><td colspan="3" rowspan="2">D2： 3.423mm
316.26 HBW</td><td colspan="2" rowspan="2">Range
95.5—653HBW</td><td></td></tr>
<tr><td colspan="3">33.6 HRC NO. 06</td><td colspan="3">2005/3/15_15:15:58</td></tr>
<tr><td>Loading</td><td>Indenter</td><td>Dwell</td><td>Light</td><td>Change</td><td>Time</td></tr>
<tr><td>3000</td><td>10mm</td><td>10s</td><td>40%</td><td>HRC</td><td>YEAR</td></tr>
</table>

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4.8 The test cycle is finished. Press TAB-B key to enter the DATA SAVE page to store the present data. Press SAVE key to save this page and return back to Home Page. If more tests are required press OK/ESC key.

Digital Brinell Hardness Tester								
No	D(mm)	HB						
01	**3.428**	**315.11**						
02	**3.426**	**315.49**						
03	**3.412**	**318.19**						
04	**3.423**	**316.00**						
05	**3.420**	**316.77**						
06	**3.422**	**316.26**						
MIN=315.11		**AV=316.30**		**MAX=318.19**		**P=05**		
34.6 HRC		NO. 06		2005/03/15_15:15:58				
Loading		Indenter		Dwell		Light	Change	Time
3000		10mm		10s		40%	HRC	YEAR

No: number of tests
D（mm）: average of dent diameter
MIN: minimum value
AV: average value
MAX: maximum value
P: pages

4.9 If a print-out is needed, press PRT key.

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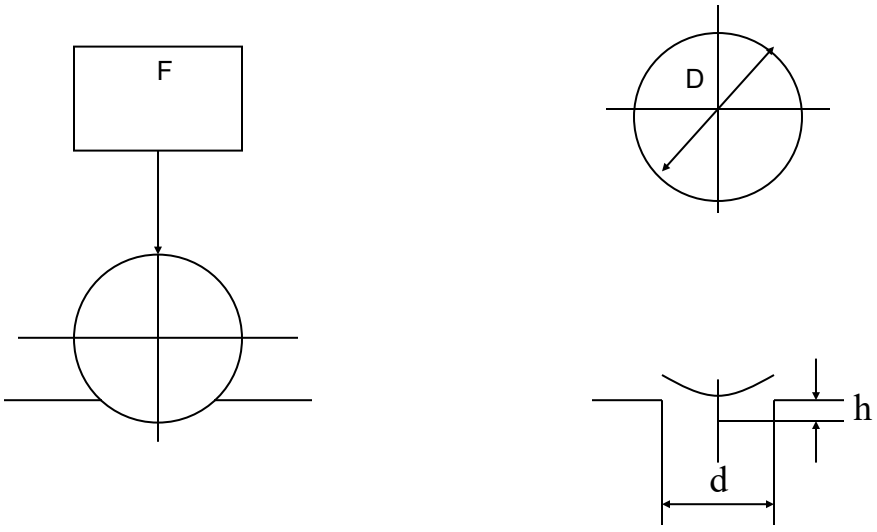
5.0 Brinell Testing Basics

Hardness Testing provides useful information, which can be correlated to tensile strength, wear resistance, ductility, and other physical characteristics of the material. Hardness testing is therefore useful for monitoring quality control and for aiding in the materials selection process.

BRINELL HARDNESS (ASTM E10, ISO 6506)

To determine a Brinell hardness number (BHN), a 10 mm diameter steel ball is typically used as an indenter with a 3,000 kgf (29 kN) force. For softer materials, a smaller force is used; for harder materials, a tungsten carbide ball is used. The BHN can also be converted into the ultimate tensile strength (UTS), although the relationship is dependent on the material, and therefore is only an empirically based value.

Hardness testing is accomplished with a ball of specified diameter (D) being pressed by a specified force (F) into surface of the object to be tested (see figure below). The test force is removed after holding for a specific period of time. The indent diameter (d) is measured with an optical filar and the average pressure (N/mm2) acted on spherical surface can be calculated as a hardness value.



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5.0 Brinell Testing Basics (conti.)

The indentation is measured and hardness calculated as:

$$\mathrm{BHN} = \frac{2P}{\pi D\left(D - \sqrt{D^2 - d^2}\right)}$$

where:
P = applied force (kgf)
D = diameter of indenter (mm)
d = diameter of indentation (mm)

The BHN can be converted into the ultimate tensile strength (UTS), although the relationship is dependent on the material, and therefore determined empirically. The relationship is based on Meyer's index (n) from Meyer's law. If Meyer's index is less than 2.2 then the ratio of UTS to BHN is 0.36. If Meyer's index is greater than 2.2, then the ratio increases.

BHN is designated by the most commonly used test standards (ASTM E10-08[2] and ISO 6506–1:2005[3]) as HBW (H for hardness, B for Brinell and W for the material of the indenter, tungsten carbide. In former standards HB or HBS were used to refer to measurements made with steel indenters. HBW is calculated in both standards using the SI units as

$$\mathrm{HBW} = 0.102\frac{2F}{\pi D\left(D - \sqrt{D^2 - d^2}\right)}$$

where:
F = applied force (N)
D = diameter of indenter (mm)
d = diameter of indentation (mm)

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5.0 Brinell Testing Basics (conti.)

5.1 Technical Data for Hardness Evaluation

5.1.1 The degree of loading 1.02F/D² is important because different results can be obtained depending on which degree of loading was used.

For example: a Brinell hardness value determined with a 10 mm ball and 9,807N (degree of loading 10) for a material is different from the hardness value determined with a 10 mm ball and 4,903N (degree of loading 5).

However, if the same material is measured with a 2.5 mm ball and a total test load of 612,9N (degree of loading 10) the resulting hardness value is the same as in the first measurement because the degree of loading is the same (provided that the material is homogeneous and has no layers of different hardness').

$$0.24D < d < 0.6D$$ (d - dent diameter, D – ball diameter)

Table for Selection of Value $0.102F/D^2$

Material	Ball Hardness	$0.102F/D^2$
steel & cast iron	<140	10
	⩾140	30
copper & cupric alloys	<35	5
	35~130	10
	>130	30
light metals & their alloys	35	2.5
	35~80	5,10
	>80	10

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5.1.2 For the following materials there are standard Brinell tests:

Steel: typically HBW x | 3000 (x=ball diameter).
For steel, the Brinell method is very important because there is a constant, quite accurate relation between the Brinell hardness and the tensile strength (with a ratio of 3.53 for carbon steel, chromium steel and chromium-manganese steel; for chromium-nickel steel it is 3.33).
Example: 225 HBW x | 3000 e.g. 225 x 3.53 = 794.3 N/mm² (see DIN 50150)

This is the only acceptable method for determining the tensile strength of steel non-destructively.

However, the Brinell method cannot be used for hardened steel. As there is no diamond penetrator intended for the Brinell procedure. Tests on treated steel with hardness greater than than 1765 N/mm² is not acceptable.

Soft iron is usually tested with HB x | 3000, although the indentation diameter exceeds 0.6 of the ball diameter.

Cast iron: HBW x | 3000. Due to the smaller homogeneity, it is recommended to use the highest total test load of 29,420 N.

Soft metals: typically HBW x | 10 or HBW x | 5; for very soft alloys, however, it is also possible to use HBW x | 2.5. The fact that it is possible to use different degrees of loading for medium hardness values might easily cause confusion. Thus, it is important to indicate the test used.

Copper alloys: For bronze use HBW x | 10 (if it is very hard, use HBW x | 30), and HBW x | 10 or HBW x | 5 for brass. Apart from that, also consider the principles mentioned for soft metals above. For the following materials there are standard Brinell tests:

5.1.3 Nomenclature
When quoting a Brinell hardness number (BHN or more commonly HB), the conditions of the test used to obtain the number must be specified. The standard format for specifying tests can be seen in the example "HBW 10/3000".

HBW - tungsten carbide ball indenter
HB or HBS - hardened steel ball.

10 is the ball diameter in millimeters.

3000 is the force in kilograms force.

The hardness may also be shown as XXX HB YYD2. The XXX is the force to apply (in kgf) on a material of type YY (5 for aluminum alloys, 10 for copper alloys, 30 for steels). Thus a typical steel hardness could be written: 250 HB 30D2.

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5.1.4 Multiple Scales of test load are available for this tester, and they shall be properly selected as the nominal values specified below.

Relationship between Ball Diameter and Test Load

Hardness	Ball Diameter mm	$0.102F/D^2$ (F/D^2)	Test Load F N(kgf)
HBW 10/3000	10	30	29400(3000)
HBW 10/1500	10	15	14700(1500)
HBW 10/1000	10	10	9800(1000)
HBW 10/500	10	5	4900(500)
HBW 10/250	10	2.5	2450(250)
HBW 10/100	10	1	980(100)
HBW 5/750	5	30	7350(750)
HBW 5/125	5	5	1225(125)
HBW 2.5/187.5	2.5	30	1837.5(187.5)
HBW 2.5/62.5	2.5	10	612.5(62.5)

5.1.5 Dwell times

Ferrous (steel) metals: 10-15 seconds
Non-ferrous metals: 30 seconds (60 seconds for <35 HBW)

5.1.6 Distance from sample edge and in-between indents

At least 2.5X indent diameter
3X the indent size in-between indent

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5.1.7 Surface preparation

More consistent results are obtained with better surface finishes, however, as a minimum, 600 grit finish is recommended.

Also it is suggested that any surface scale, rust, contamination of other debris should be removed from the surface before testing.

5.1.8 Minimum specimen thickness

In general, the specimen thickness should be >8 X the depth of the indent. (see following table)

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Minimum Thickness of Specimen

Average Dent Diameter, d	Minimum Specimen Thickness			
	Ball Diameter			
	D=1	D=2.5	D=5	D=10
0.2	0.10			
0.3	0.23			
0.4	0.41			
0.5	0.68			
0.6	0.8	0.36		
0.7		0.50		
0.8		0.66		
0.9		0.84		
1		1.04		
1.1		1.28		
1.2		1.54	0.73	
1.3		1.83	0.86	
1.4		2.15	1.00	
1.5		2.5	1.15	
1.6			1.31	
1.7			1.49	
1.8			1.68	
1.9			1.88	
2			2.09	
2.2			2.55	
2.4			3.08	1.47
2.6			3.65	1.73
2.8			4.29	2.00
3			5.00	2.30
3.2				2.62
3.4				2.98
3.6				3.35
3.8				3.75
4				4.18
4.2				4.63
4.4				5.10
4.6				5.60
4.8				6.14
5				6.70
5.2				7.29
5.4				7.91
5.6				8.58
5.8				9.28
6				10.00

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6.0 Maintenance

6.1 General

6.1.1 A coat of light lube oil is routinely applied on lifting screw, anvil and other moving surfaces of the tester.

6.1.2 Turn off power after finishing.

6.1.3 Turn the hand-wheel in counter direction to lower it away from lens.

6.1.4 When the tester is not in use cover with a dust cover.

6.1.5 If the tester has not been used for a long period, allow the unit to warm up several minute to ensure the apparatus accuracy.

6.2 Adjustment of the Tester

The apparatus has been comprehensively tested at the factory to conform to all technical requirements and standards. However some variation may be caused by transportation, disassembly or voltage difference etc, therefore the user may need to make the following adjustments:

6.2.1 The surface of specimen and the indenter may need to be cleaned of any oil or dust. Use IPA or ethanol to clean specimen and indenter.

6.2.2 If the tester has been moved or not used for some time, make several indents at a test load of 29400N(3000kgf) to eliminate gaps between different parts and to insure proper function of electronic components.

6.2.3 Electrostatic interference can affect the Loading/unloading sensor. Place tester in an area that is free from strong electromagnetic interferences. If the unit needs to be reset after the load has been applied and a reading cannot be obtained:

Press EXIT
Then turn off power

6.2.4 After start up, the lever will make automatic adjustment and enter the initial operation position. If the lever does not make this movement, turn off the power and open the rear cover

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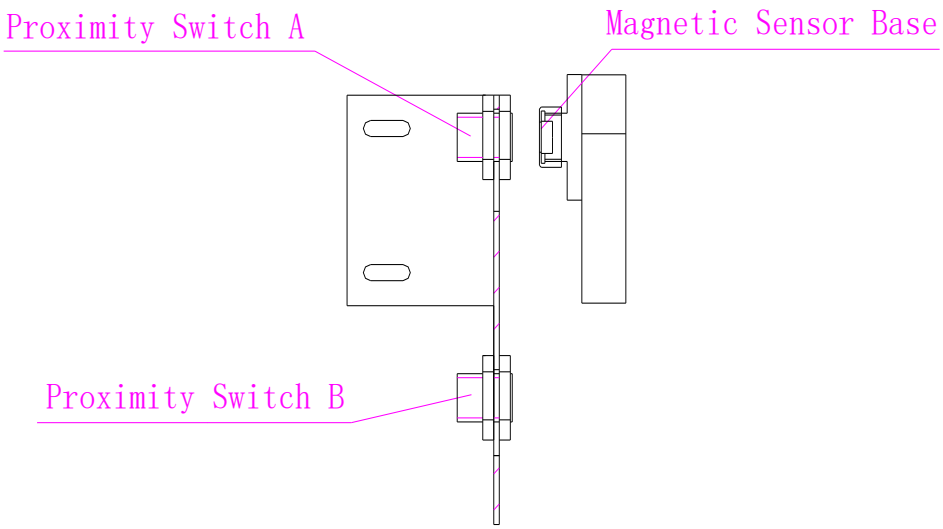
and upper cover to find a mount board at the rear side with two proximity switches on it (refer to Figure).



The proximity switches are designed to control the initial position of the main lever and has been adjusted at the factory. In case that the position was shifted during transportation and handling, the signal transmission between proximity switches may be interfered and can not achieve proper position control. In such case, loosen the lock nut on the upper proximity switch (A) and make distance adjustment, then start up the tester again to check the signal transmission. The lever shall be able to return to its original position if the signal is properly received. Replace the upper and rear covers after adjustment. (Note that the initial lever position should be 25 mm (1-inch) above the main body of the tester).

6.2.5 All screws and lock nuts have been tightened at factory. However they may loosen during

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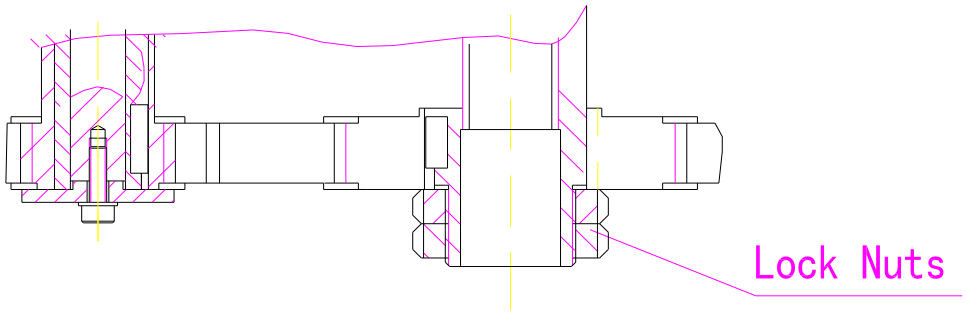
operation due to the repeated rotation in both directions. If an abnormal sound is heard during the rotation, check if the two lock nuts on the pulley for looseness and tighten them with proper tool as necessary (refer to figure).



6.3 Special Attentions

6.3.1 Do not tamper with the installation position of electronic components, switches and sockets etc. This may void the warranty.

6.3.2 The turntable should never be rotated during the test cycle, otherwise the apparatus may be damaged. Only rotate the turntable after the beep sounds indicating the end of test cycle.

6.3.3 When measuring the indent, reflected light or shadowing may be observed in the indent. This is a normal physical phenomenon and will not impact the measurement accuracy.

6.3.4 Test load should not be applied when the tester is in the measurement mode. If a wrong key is depressed (other than EXIT key) the beeper will sound and other pages may appear on display. In such case just press OK/ESC key to return Home Page and the tested data will not be affected. If EXIT key is pressed by mistake, the tester will be shut down and unsaved data are lost.

6.3.5 When cursor is flashing at Dwell, Light, Change or Time on the Home Page, the tester is not in ready state to start test. Press OK/ESC key and wait for disappearance of the cursor, then the apparatus is ready for normal test operation.

6.3.6 Some slight clicking sound may be heard during loading/unloading. This is a normal phenomenon caused by the self adjustment for the loading mechanism.

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6.3.7 The two graduation lines in filar lens should be calibrated before the first measurement. During the sequential tests no more calibration will be needed even if the test load or indenter is changed.

6.3.8 Data in memory is backed up by a lithium battery and may also be lost if the battery is exhaused. We suggest to transfer all data in the apparatus to an external device through the RS232 interface. After replacement of battery, the tester will restore the Home Page by pressing SAVE key. However since no data is retrievable in the memory, you must carry out tests and save the data to enable the retrieve function or SAVE key.

6.4. Working Principle of the Electric Parts

The BRN-3000 Ball Hardness Tester employs a new loading procedure other than the conventional pendulum loading. The new loading system uses a closed loop control system, which is controlled by CPU. A sensor controls the signal and step motor for loading. PHILIPS P89C51RD2 is used as the CPU. AD 574 chip is used as AD converter, with a typical conversion time of 25μs and non-linearity of ±1/2LSB. BB company's INA114AP is used as the algorithm amplifier.

The electric working principle can be described as following: Electronic signals are collected by LF-3T spoke type sensor and, after being amplified by INA114, output to AD574 for AD conversion. Then the analogue voltage signals are changed into the 12-digit signals and sent to CPU for computation processing and finally used to control the motor's loading, dwell and unloading actions.

There are 10 test loads (62.5, 100, 125, 87.5, 250, 500, 750, 1000, 1500, and 3000 kgf) available for use on BRN-3000 Digital Ball Hardness Tester, the lower 5 load (62.5～250 kgf) have a resolution of 0.1kgf, and the upper 5 loads (500～3000 kgf) have a resolution of 1 kgf, to ensure the test loading force is more stable and reliable,

The tester uses a Japan made DMF-50081 320×240 LCD as display, user may choose desirable test load and indenter on the display after start-up of the tester. Other data including D1 and D2 (indent diameter), HBW hardness and corresponding converted value are also shown on the display. After completion of the test cycle, the data may be output through RS232 serial interface into a PC's Hypertrm terminal for display or printing out, or directly saved into CPU's internal memory for permanent storage.

There are two limit switches for the ascending and descending movement of lifting screw respectively. A magnetic sensor base is installed at rear of the main lever (see figure). Two proximity switches are installed on the right side near to the rear cover to control the initial position of main lever and the total stroke. Both proximity switches (A and B) are placed in adjacent positions near the switch A. After powering on the tester the motor lifts the lever whereby the switch A will receive signal from magnetic

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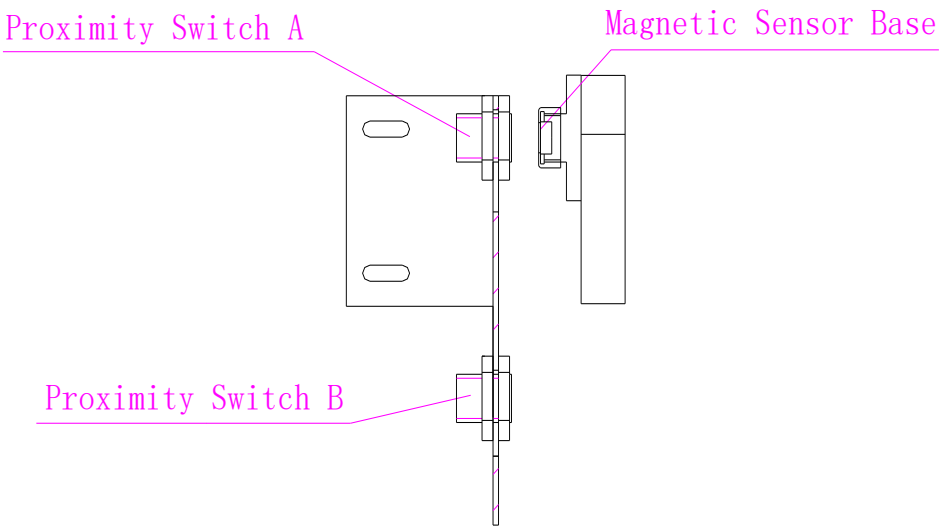
sensor and is feed to the CPU. Thereafter the motor will stop at first and then rotate in counter direction for several turns to return the lever back to its original position. DO NOT change the position of proximity switches. Switch B is the lower limit switch for lever's movement, i.e. when the lever moves approaching to B switch during the loading period, .the switch will stop the motor and cause it to rotate in the counter direction, thus providing the automatic unloading and return of the lever to its original position.



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7.0 Trouble Shooting

Phenomenon	Possible Causes	Method Used
LCD does not turn on	1. No power 2. The fuse is blown.	1. Check the power cable. 2. Change the fuse.
When the tester is on, the keys do not work	The instrument is not in working state.	When the tester is turned on, wait until the instrument returns to the working state.
The Up / Down Lead Screw is hard to move	The space between the Up / Down Lead Screws are blocked by the thread ends or dirt	Remove the protecting cover for the Up / Down Lead Screw and clean the screw threads
No movement in Lever	Sensor Limit switch issue	Refer to 5.2.4 for procedure to correct
Force not zeroing or hardness value off by a large amount	PC board and screen not communicating properly	Hold the filar measurement button down while turning off the machine. Restart and test again

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8.0 Spare Parts

Part no.	Description	Image
	Electrical components	
BRN-1015	Brinell front panel control input board	
BRN-1020	Brinell motor	
BRN-1030	Brinell transformer	
BRN-1040	BRN-3000 Brinell load cell	
BRN-Sensor	Brinell tester sensor	
BRN-1000	BRN-3000 Brinell filar eyepiece	
BRN-1010	Brinell control driver board driver	

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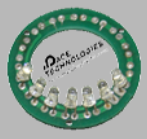
Part no.	Description	Image
	Electrical components	
BRN-LED	LED light for BRN-3000 Brinell tester	
CORD-110	110V USA power cord	
CORD-220R	220V round prong power cord	
CORD-220F	220V flat prong power cord	

Part no.	Description	Image
	Mechanical components	
BRN-M-LS	Load shaft	
P4025	2.5 mm Brinell ball indenters (each)	
P4050	5 mm Brinell ball indenters (each)	

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Part no.	Description	Image
	Mechanical components	
P4100	10 mm Brinell indenter ball (each)	
P3025	2.5 mm Brinell carbide ball (each)	
P3050	5 mm Brinell carbide ball (each)	
P3100	10 mm Brinell carbide ball (each)	
BRN-501	Brinell Small anvil table (65 mm)	
BRN-541	Brinell Large anvil table (200 mm)	
BRN-511	Brinell 80 mm V-anvil table	
BRN-S	Precision screw feed height adjustment unit for Brinell hardness testers	
823-905	Dust cover for Brinell tester	

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Part no.	Description	Image
	Mechanical components	
811-100-1	Printer paper rolls for MHT-1 printer (2.25-inch width)	
811-100-2	Printer paper rolls for MHT-2 printer (1.75-inch width)