King Tester Corporation

King Portable Brinell Hardness Tester

User's Manual

"The Name Behind the Standard"

Website: www.kingtester.com

Email: King@kingtester.com

Phone: +1 (610) 279-6010

Address: 308 Schell Lane
Phoenixville PA 19460

King Portable Brinell Hardness Tester

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King Portable Brinell Hardness Tester

1. Introduction

King Portable Brinell Hardness Tester is the finest portable hardness tester in the world. It tests up to 3000kg of test force using a 10mm carbide ball indenter. The indentation results reflect the hardness of the material. The tester may be used on most metals and is particularly suitable for testing nonuniform materials. The testing results are accurate with excellent repeatability and correlate with tensile strength. The test conditions and accuracy meet the requirements of ISO 6056 and ASTM E110 and can be used to test rough castings, forgings, nonferrous metals and semi-finished products after heat treatment.

2. Features

2.1 Portable Testing

The King Portable Tester is suitable for use in the lab or in the plant. It is easy to operate and convenient to carry. It can be used to test all sizes of parts and parts in any direction (like upside down, underside, or side face). When the part cannot be moved easily, the King Tester is the answer.

2.2 Permanent indentation & easy inspection

By applying 3000kg test force and 10mm ball indenter, the permanent indentation can be inspected at any time after testing, and the existence of the indentation shows that the part has been tested.

2.3 Accurately testing real results

The King Tester applies the same principle as a bench type Brinell hardness tester. The result is far more accurate and repeatable than other portable Brinell hardness testers. The calibrated accuracy of the test force is 1% which confirms to ASTM E10.

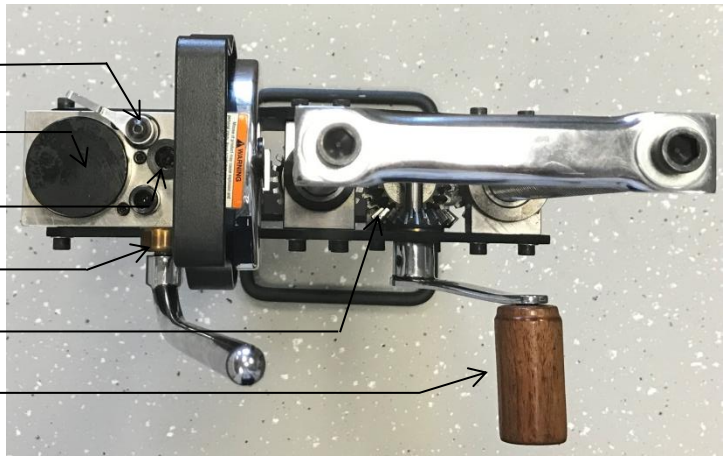
2.4 Optional test conditions with wide testing range

You are not limited to a 10mm ball and 3000kg test force. You have options of a 2.5mm, or 5mm ball and different test loads from 187.5kg-3000kg. The tester has multiple testing forces and indenters so that the King Tester can test all kinds of material and its testing range is 16-650 HBW.

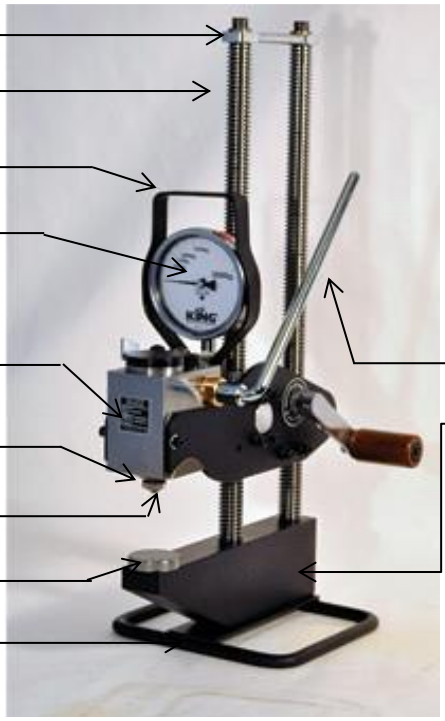
King Portable Brinell Hardness Tester

Fig. 1 King Tester Components (with part #'s)

1. Pressure Release Valve (43-26)
2. Cylinder Cap (14)
3. Calibration Valve
4. Pump Segment (43-7)
5. Gears
6. Crank (SB-16C)



7. Carrying Handle (15)
8. Elevating Screws (SB-21, SB-22)
9. Handle (15)
10. Gauge (9)
11. Pump Handle (8)
12. Standard Base (C1)
13. Test Head (B1)
14. Ball Retainer (10mm, 5mm, 10-2.5mm)
15. Ball (10mm, 5mm, 2.5mm)
16. Anvil (SB-25,SB-26,SB-27)
17. Basket



3. Technical Parameters

Test Force:	3000kg (500kg, 750kg, 1000kg, and 1500kg are optional)
Accuracy of Test Force:	1%
Indenter:	10 mm carbide ball indenter (2.5mm & 5mm ball optional)
Testing Range:	16-650 HBW
Max. Specimen Height:	13" or 20"
Throat Depth:	4" or 6" (unlimited with Chain Adapter)
Repeatability:	ISO 6506/ASTM E110
Error:	ISO 6506/ASTM E110
Net Weight:	34 lbs.

4. Principle & Components

The King Tester uses a hydraulic principle with hand-operation to apply the 3000kg test force. The central part of King Tester is a small hydraulic system in which a release valve is used to control the test force. When the force reaches 3000kg, the release valve will open and the pressure will begin to drop. The tester should be pumped an additional 3 times after reaching 3000kg. The components of the tester are shown as Fig. 1.

The tester consists of a base and a test head.

The base is composed of carriage, anvil, anvil holder, throat, handle, and elevating system. The base with anvil is easy to use to clamp parts or to test piping. The test head is installed between the side plates which hold the tester. The screw elevating system is controlled by the hand crank which can be moved up and down to select the proper height for the test head. The base is constructed and designed to eliminate deflection.

The test head is comprised of a gauge, pump handle, indenter, oil cylinder, pressure release lever, pump handle, and calibrating valve.

The test head is a sophisticated hydraulic system. By pumping a small number of times, the cylinder (indenter) will produce a large force. The function of the dial gauge is to indicate the approximate test force. The pump handle is used to create the test force; and the indenter applies the force onto the workpiece and result is a standard Brinell indentation. The cylinder stores the oil; the pressure release lever is similar to an on/off switch used to initiate the creation of the test force. The calibrating assembly controls how much pressure is created.

5. Operations

5.1 Preparation

5.1.1 Prepare the part

Choose an appropriate part to test and clean any rust, scale or dirt from around the test point before testing. If the surface of the sample is rough or has a coating, hardened layer, or decarbonized layer, the operator needs to grind the surface of the workpiece properly until the substrate part of the workpiece is exposed.

5.1.2 Calibration of the tester

The King Tester is calibrated before leaving the factory. A calibration certificate is attached to the tester. Before using the tester, verify the accuracy of the tester with a test block.

5.1.3 Select and Install the Anvil

The standard tester package includes 3 anvils:

a) The flat anvil fits most parts and test blocks;
b) The V anvil is used to test cylinder and convex specimens;
c) The dome anvil is used to test concave surfaces and tubes.

Selecting the correct anvil is important to avoid unstable loading and assure the accuracy and reliability of the test.

5.1.4 Check the Indenter

Check the indenter before testing and make sure the indenter holder is fastened tightly; otherwise it may damage the indenter ball.

a) Install the pump handle;
b) Open the pressure release valve;
c) Raise the test head to appropriate height.

Check the ram before testing to make sure the ram is retracted. If not, turn the crank, lower the test head until it is pressing on the workpiece then apply a test force. The length of the exposed part of the indenter cannot be more than 3/8 inches.

5.2 Operation

Put the part in the throat of the tester; turn the crank in order to make the test head move down and clamp the specimen between the test head and the anvil. Now close the pressure release lever and load the test force on the specimen and watch the gauge. Continue to move the pump handle. When the gauge indicates 3000kg, the calibrating valve will work and the pressure will begin to fall. Make 3 more pumps using the pump handle. Open the pressure release lever, raise the test head and move the tester away from the part. Use a KingScope™ or KingScan® to measure the diameter of the indentation. Check the tables in the appendix for Brinell hardness test results.

6. Introduction of Main Parts

6.1 Indenter

The indenter is composed of indenter body, indenter ball and indenter holder.
The ram body is the hydraulic system which transfers the test force onto the part.
Make sure the indenter is not extended more than 10mm before loading test force. If the indenter is extended more than 10mm, it will not create a valid indentation because the test force is not able to reach 3000kg.
Don't use the pump handle until the indenter is in contact with the part.
The instrument uses the carbide ball for testing. The advantage of the carbide ball is it is hard, durable, and highly accuracy. However it will not test the steel harder than 60 HRC.
The carbide ball replacements can be purchased from King Tester.

6.2 Gauge

The gauge is an indicator of the test force and lets the operators see the test force as it increases and decreases. However, the gauge does not control the test force and while it is representative of the load it does not fully capture the dynamic of the test.
Make sure to protect the gauge.

6.3 Pump Handle

The function of the pump handle is to make the hydraulic system produce a test force.
The reciprocating motion of the pump handle forces a small piston in the hydraulic system to press oil into the cylinder, and the pressure transfers to the indenter. The indenter will respond to this process by moving and increasing the test force.

6.4 Pressure Release Lever

The pressure release lever is the on/off switch of the hydraulic system. When the pressure release lever is open and the pressure will decrease to 0. Close the pressure release lever and the hydraulic cylinder will hold pressure. As the operator moves the pump handle, the hydraulic cylinder will place force on the indenter.

Required procedures:

a) When not using the tester, keep the pressure release lever open.
b) Do not pump the handle unless the indenter is in contact with a part or test block.
c) After testing, open the pressure release lever and raise the test head immediately.

6.5 Calibration Valve

The calibration valve is the auto control pressure switch of the hydraulic system. Before leaving the factory, the calibration valve is calibrated accurately to 3000kg, with a tolerance of less than 1%. When the pressure in the cylinder reaches 3000kg, the calibration valve will instantly open releasing the pressure. Once pressure drops below 3000kg, the calibration valve closes.
Do not remove the calibration screw or the tester will lose accuracy.

6.6 Oil Cylinder

The oil cylinder contains a cover, locking nut for the oil sac, oil sac, and sump.
If the cylinder does not have adequate oil the tester will not achieve pressure. If the test force does not reach 3000kg, you need oil. (Refer to Maintenance Section)
The process of replacing the oil in sump is complicated; any carelessness will result in the tester needing to be returned to the manufacturer for service and repair. Adding or changing the oil should be done by either the manufacturer or a properly trained and King certified technician.

6.7 Test Head Carriage

The test head carriage is composed of the base, carrying handle, elevating system, and crank.
The tester can test most parts. If the part can be clamped between the indenter and the anvil, it can be tested, and even when the tester is upside down, it will give you accurate results.
The tester is made of high grade alloy steel making sure not to deform or bend under 3000kg test force.
The elevating screw system consists of a crank, gear seat and multiple gears. Turning the crank will move the side mounts up and down.

7. Standard Package	8. Optional Accessories
1 Tester (A1)	KMTB (2x6 King Master Test Blocks)
1 Pump Handle (8)	K4MTB (4x4 King Master Test Blocks)
1 V anvil (SB-26)	10mm carbide ball indenter
1 Flat anvil (SB-25)	5mm carbide ball indenter
1 Dome anvil (SB-27)	2.5mm carbide ball indenter
1 Calibration certificate	Indenter holder
1 User manual	V anvil (SB-26)
1 Warranty certificate	Flat anvil (SB-25)
	Dome anvil (SB-27)
	KingScope (ASTM Type B) Manual Reader
	KingScan (ASTM Type A) Automatic Reader
	Maintenance tools and accessories
	Pressure gauge (9, 9LP)
	Sac (43-6)
	Sac nut (25)
	Cylinder cap (14)
	Pump Handle (8)
	Buna-N O ring for Bronze Bushing (50-111)
	Sump bronze bushing (43-14)
	Pop-off copper gasket (43-46)

9. Maintenance

Some tester parts may wear with long term use. For example, you may experience seals leaking, difficulty achieving full force, inaccurate test results, difficulty in retracting the indenter, a deformed or worn indenter, a loose support frame, coming out of calibration and so on. If these problems occur, the tester needs to be repaired.
Some of the maintenance tasks must be done by the manufacturer. While others can be performed by certified King Service Technicians.

Problems and handling:

9.1 Hard to reach test force

If it is hard to reach full load test force, the probable cause is a one of the following:

9.1.1 Indenter is over-extending

When the indenter is over extended open the release valve, turn the crank and force the indenter to retract into the test head body.

9.1.2 Oil shortage

After long term use, the remaining oil volume is not enough to produce full load test force on the part. Oil needs to be added. Contact King or a certified King Service Technician.

9.1.3 Checking the hydraulic sump

Remove the Pump Handle and check if there is oil near the bronze bushing. If there is, it means the O-ring in the bronze bushing is worn. Both the O-ring and the bushing need to be changed for new ones. Contact King or a certified King Service Technician.

9.2 Verification of test head

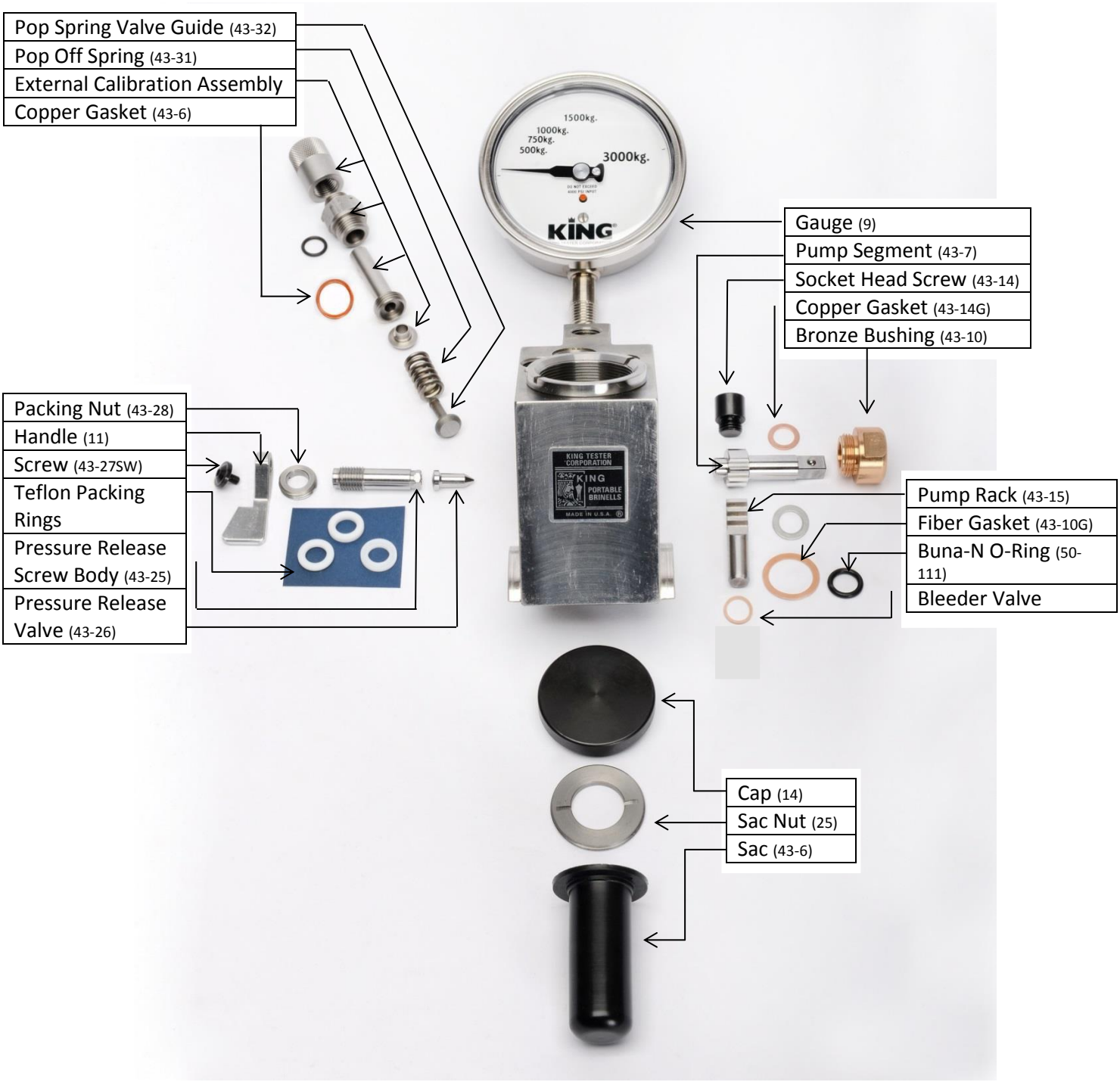
9.2.1 Expired block

The test block is inspected before leaving factory and the hardness value is marked on the front face of the block and its inspection date is on the certificate. The certification is valid for one year and it should be replaced after a maximum of one year. New test blocks can be bought from King Tester.

9.2.2 Deformed and worn ball

The carbide ball is durable and highly accurate. After a long term use or testing on hard material, the ball may become worn.
New carbide balls can be bought from King Tester.

Fig. 2 Test Head



9.2.3 Inaccurate test force

After eliminating the test blocks and balls as possible explanations, the machine has likely came out of calibration.

The 3000kg test force is controlled by the control valve. If the 3000kg test force needs to be recalibrated, the procedure is:

a. Pump the Pump Handle in order to make the indenter extend ¼". Then, use an allen wrench to remove the control valve cover and take off the copper gasket, then oil can be seen through the hole of control lever, and a calibrating screw is underneath.

b. Use straight screwdriver to search for the calibrating screw under the oil and turn it a little. If the hardness is a little higher, turn the calibrating screw clockwise; otherwise, turn the calibrating screw counter-clockwise. The screw for calibration valve can be adjusted only a little. Make sure not to turn the screw more than 15° otherwise it is hard to find the original calibrating point and the test force may be out of the secure range causing damage to the tester.

c. After adjusting, fill the hole with oil.

d. Replace the copper gasket with a new one and screw the cover tightly.

e. After adjusting the screw for calibration valve, verify the tester with the test block.

f. If it is out of tolerance, repeat the processes above until it is accurate.

If the tester is out of tolerance please contact the King Tester or a certified King Technician.

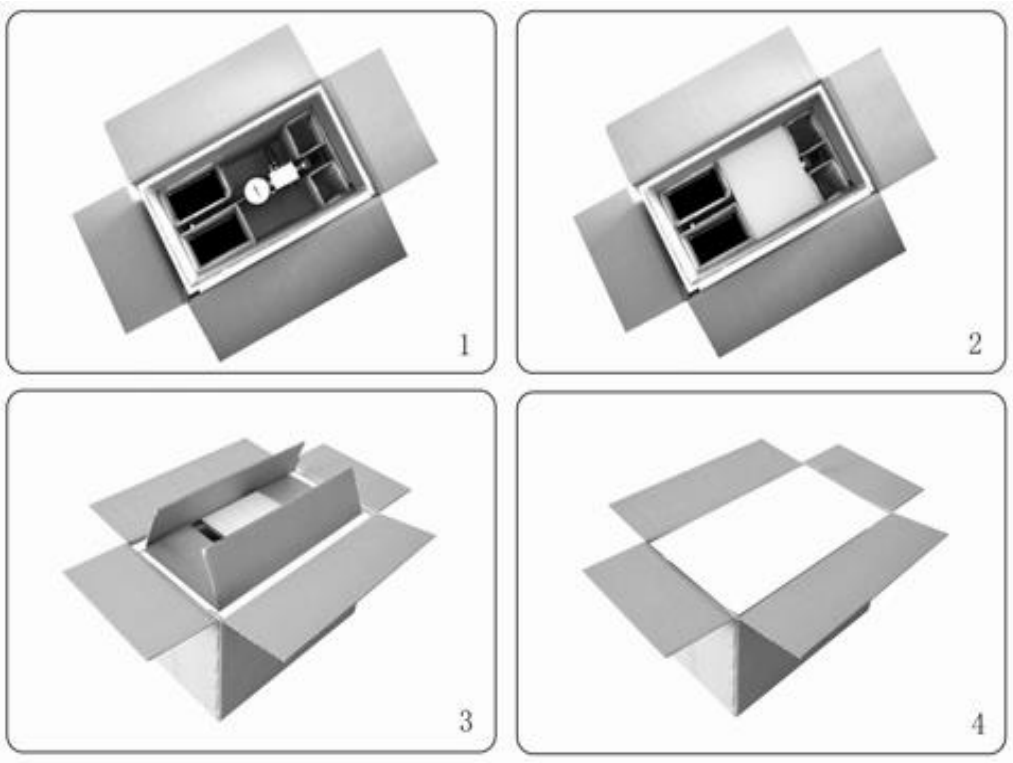
10. Packing and Transportation

King Brinell Portable Hardness Tester is a mechanical instrument which will be damaged by any carelessness caused by packing and transportation.

The user should check carefully that the packaging is in good condition when receiving the tester. If not, contact King Tester.

The packing of the tester when it leaves factory is specially designed, customized and cannot be substituted. The user should keep original case for future shipping.

Fig. 3 Original Packing of the Tester



Caution:

Only the maintenance tasks listed in this manual can be done by users. Any other maintenance tasks or disassembling of the tester not listed in this manual will void the warranty and may result in higher service fee.

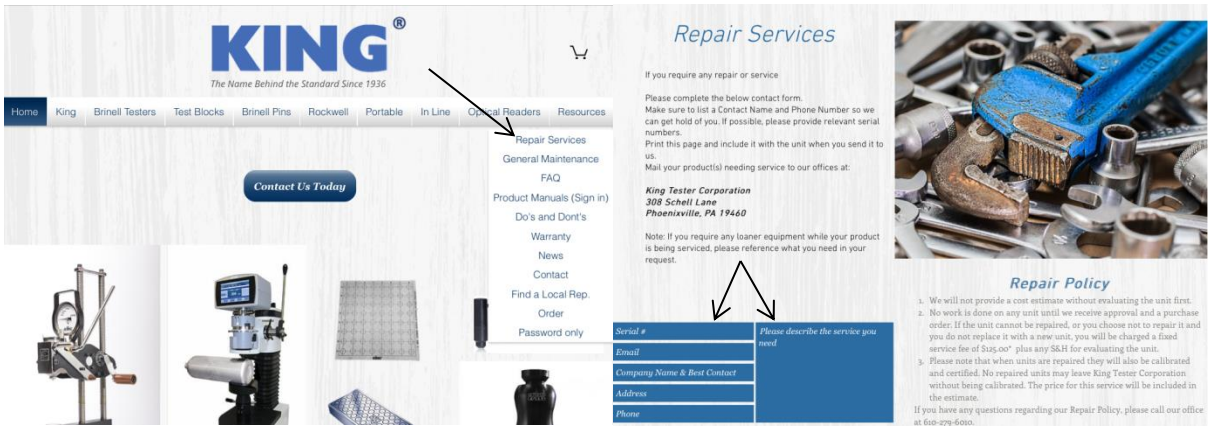
11. Warranty

1. The warranty period of the King Tester is 12 months after it leaves the factory.
2. If the instrument is in the warranty period and the problem is the result of a manufacturing defect, King will repair the tester for free. The instrument should be delivered to King or its authorized agent. The user is responsible for the shipping charges and insurance.
3. The following situations are not included in the warranty:

Inappropriate operation, natural losses, operation carelessness, chemical corrosion and force majeure which violate the procedures presented in the operation manual.

12. Repairs

To access the repair center for King Tester Corporation, go to the website http://www.kingtester.com/repair-services and fill out the contact form. Read over the repair policy and follow the appropriate steps to make sure the repair of your equipment goes smoothly.



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Appendix: Table 1: Brinell Hardness Table

Ball Diameter D/mm		$0.102xF/D^2$			
		30	15	10	5
		Test Force F/N (kg)			
10	5	29.42kN (3000) 7.355kn (750)	14.71kN (1500)	9.807Kn (1000)	4.903Kn (500)
Indentation Diameter D/mm		Brinell Hardness (HBW)			
2.40	1.200	653	327	218	109
2.41	1.205	648	324	216	108
2.42	1.210	643	31	214	107
2.43	1.215	637	319	212	106
2.44	1.220	632	316	211	105
2.45	1.225	627	313	209	104
2.46	1.230	621	311	207	104
2.47	1.235	616	308	205	103
2.48	1.240	611	306	204	102
2.49	1.245	606	303	202	101
2.50	1.250	601	301	200	100
2.51	1.255	597	298	199	99.4
2.52	1.260	591	296	197	98.6
2.53	1.265	587	294	196	97.8
2.54	1.270	582	294	194	97.1
2.55	1.275	578	289	193	96.3
2.56	1.280	573	287	191	95.5
2.57	1.285	569	284	190	94.8
2.58	1.290	564	272	188	94.0
2.59	1.295	560	270	187	93.3
2.60	1.300	555	278	185	92.6
2.61	1.305	551	276	184	91.8
2.62	1.310	547	273	182	91.1
2.63	1.315	543	271	181	90.4
2.64	1.320	538	269	179	89.7
2.65	1.325	534	267	178	89.0
2.66	1.330	530	265	177	88.4
2.67	1.335	526	263	175	87.7
2.68	1.340	522	261	174	87.0
2.69	1.345	518	259	173	86.4
2.70	1.350	514	257	171	85.7
2.71	1.355	510	255	170	85.1
2.72	1.360	507	253	169	84.4
2.73	1.365	503	251	168	83.8
2.74	1.370	499	250	166	83.2
2.75	1.375	495	248	165	82.6
2.76	1.380	492	246	164	81.9
2.77	1.385	488	244	163	81.3
2.78	1.390	485	242	162	80.8
2.79	1.395	481	240	160	80.2
2.80	1.400	477	239	159	79.6
2.81	1.405	474	237	158	79.0
2.82	1.410	471	235	157	78.4
2.83	1.415	467	234	156	77.9
2.84	1.420	464	232	155	77.3

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Ball Diameter D/mm		$0.102xF/D^2$			
		30	15	10	5
		Test Force F/N (kg)			
10	5	29.42kN (3000) 7.355kn (750)	14.71kN (1500)	9.807Kn (1000)	4.903Kn (500)
Indentation Diameter D/mm		Brinell Hardness (HBW)			
2.85	1.425	461	230	154	76.8
2.86	1.430	457	229	153	76.2
2.87	1.435	454	227	151	75.7
2.88	1.440	451	225	150	75.1
2.89	1.445	448	224	149	74.6
2.90	1.450	444	222	148	74.1
2.91	1.455	441	221	147	73.6
2.92	1.460	438	219	146	73.0
2.93	1.465	435	218	145	72.5
2.94	1.470	432	216	144	72.0
2.95	1.475	429	215	143	71.5
2.96	1.480	426	213	142	71.0
2.97	1.485	423	212	141	70.5
2.98	1.490	420	210	140	70.1
2.99	1.495	417	209	139	69.6
3.00	1.500	415	207	138	69.1
3.01	1.505	412	206	137	68.6
3.02	1.510	409	205	136	68.2
3.03	1.515	406	203	135	67.7
3.04	1.520	404	202	135	67.3
3.05	1.525	401	200	134	66.8
3.06	1.530	398	199	133	66.4
3.07	1.535	395	198	132	65.9
3.08	1.540	393	196	131	65.5
3.09	1.545	390	195	130	65.0
3.10	1.550	388	194	129	64.6
3.11	1.555	385	193	128	64.2
3.12	1.560	383	191	128	63.8
3.13	1.565	380	190	127	63.3
3.14	1.570	378	189	126	62.9
3.15	1.575	375	188	125	62.5
3.16	1.580	373	186	124	62.1
3.17	1.585	370	185	123	61.7
3.18	1.590	368	184	123	61.3
3.19	1.595	366	183	122	60.9
3.20	1.600	363	182	121	60.5
3.21	1.605	360	180	120	60.1
3.22	1.610	359	179	120	59.8
3.23	1.615	356	178	119	59.4
3.24	1.620	354	177	118	59.0
3.25	1.625	352	176	117	58.6
3.26	1.630	350	175	117	58.3
3.27	1.635	347	174	116	57.9
3.28	1.640	345	173	115	57.5
3.29	1.645	343	172	114	57.2

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Ball Diameter D/mm		$0.102xF/D^2$			
		30	15	10	5
		Test Force F/N (kg)			
10	5	29.42kN (3000) 7.355kn (750)	14.71kN (1500)	9.807Kn (1000)	4.903Kn (500)
Indentation Diameter D/mm		Brinell Hardness (HBW)			
3.30	1.650	341	170	114	56.8
3.31	1.655	339	169	113	56.5
3.32	1.660	337	168	112	56.1
3.33	1.665	335	167	112	55.8
3.34	1.670	333	166	111	55.4
3.35	1.675	331	165	110	55.1
3.36	1.680	329	164	110	54.8
3.37	1.685	326	163	109	54.4
3.38	1.690	325	162	108	54.7
3.39	1.695	323	161	108	53.9
3.40	1.700	321	160	107	53.4
3.41	1.705	319	159	106	53.1
3.42	1.710	317	158	106	52.8
3.43	1.715	315	157	105	53.5
3.44	1.720	313	156	104	53.3
3.45	1.725	311	156	104	51.8
3.46	1.730	309	155	103	51.5
3.47	1735	307	154	102	51.2
3.48	1.740	306	153	102	50.9
3.49	1.745	304	152	101	50.6
3.50	1.750	302	151	101	50.3
3.51	1.755	300	150	100	50.0
3.52	1.760	298	149	99.5	49.7
3.53	1.765	297	148	98.9	49.4
3.54	1.770	295	147	98.3	49.2
3.55	1.775	293	147	97.7	48.9
3.56	1.780	292	146	97.2	48.6
3.57	1.785	290	145	.96.6	48.3
3.58	1.790	288	144	96.1	48.0
3.59	1.795	286	143	95.5	47.7
3.60	1.800	285	142	95.0	47.5
3.61	1.805	283	142	94.4	47.3
3.62	1.810	282	141	93.9	46.9
3.63	1.815	280	140	93.3	46.7
3.64	1.820	278	139	92.8	46.4
3.65	1.825	277	138	92.3	46.1
3.66	1.830	275	138	91.8	45.9
3.67	1.835	274	137	91.2	45.6
3.68	1.840	272	136	90.7	45.4
3.69	1.845	271	135	90.2	45.1
3.70	1.850	269	135	89.7	44.9
3.71	1.855	268	134	89.2	44.6
3.72	1.860	266	133	88.7	44.4
3.73	1.865	265	132	88.2	44.1
3.74	1.870	263	132	87.7	43.9

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Ball Diameter D/mm		$0.102xF/D^2$			
		30	15	10	5
		Test Force F/N (kg)			
10	5	29.42kN (3000) 7.355kn (750)	14.71kN (1500)	9.807Kn (1000)	4.903Kn (500)
Indentation Diameter D/mm		Brinell Hardness (HBW)			
3.75	1.875	262	131	87.2	43.6
3.76	1.880	260	130	86.8	43.4
3.77	1.885	259	129	86.3	43.1
3.78	1.890	257	129	85.8	42.9
3.79	1.895	256	128	85.3	42.7
3.80	1.900	255	127	84.9	42.4
3.81	1.905	253	127	84.4	42.4
3.82	1.910	252	126	83.9	42.0
3.83	1.915	250	125	83.5	41.7
3.84	1.920	249	125	86.0	41.5
3.85	1.925	248	124	82.6	41.3
3.86	1.930	246	123	82.1	41.1
3.87	1.935	245	123	81.7	40.9
3.88	1.940	244	122	81.3	40.6
3.89	1.945	242	121	80.8	40.4
3.90	1.950	241	120	80.4	40.2
3.91	1.955	240	121	80.0	40.0
3.92	1.960	239	119	79.5	398
3.93	1.965	237	119	79.1	39.6
3.94	1.970	236	118	78.7	39.4
3.95	1.975	235	117	78.3	39.1
3.96	1.980	234	117	77.9	38.9
3.97	1.985	232	116	77.5	38.7
3.98	1.990	231	116	77.1	38.5
3.99	1.995	230	115	76.7	39.3
4.00	2.000	229	114	76.3	38.1
4.01	2.005	228	114	75.9	37.9
4.02	2.010	226	113	75.5	37.7
4.03	2.015	225	113	75.1	37.5
4.04	2.020	224	112	74.7	37.3
4.05	2.025	223	111	74.3	37.1
4.06	2.030	222	111	73.9	37.0
4.07	2.035	221	111	73.5	36.8
4.08	2.040	216	110	73.2	36.6
4.09	2.045	218	109	72.8	36.4
4.10	2.050	217	109	72.4	36.2
4.11	2.055	216	108	72.0	36.0
4.12	2.060	215	108	71.1	35.8
4.13	2.065	214	107	71.3	35.7
4.14	2.070	213	106	71.0	35.5
4.15	2.075	212	106	70.6	35.3
4.16	2.080	211	105	70.2	35.1
4.17	2.085	210	105	69.9	34.9
4.18	2.090	209	104	69.5	34.8
4.19	2.095	208	104	69.2	34.6

King Portable Brinell Hardness Tester

Ball Diameter D/mm		$0.102xF/D^2$			
		30	15	10	5
		Test Force F/N (kg)			
10	5	29.42kN (3000) 7.355kn (750)	14.71kN (1500)	9.807Kn (1000)	4.903Kn (500)
Indentation Diameter D/mm		Brinell Hardness (HBW)			
4.20	2.100	207	103	68.8	34.4
4.21	2.105	205	103	68.5	34.2
4.22	2.110	204	102	68.2	34.0
4.23	2.115	203	102	67.8	33.9
4.24	2.120	202	101	67.5	33.7
4.25	2.125	201	101	67.1	33.6
4.26	2.130	200	100	66.8	33.4
4.27	2.135	199	99.7	66.5	33.2
4.28	2.140	198	99.2	66.2	33.1
4.29	2.145	198	98.8	65.8	32.9
4.30	2.150	197	98.3	65.5	32.8
4.31	2.155	196	97.8	65.2	32.6
4.32	2.160	195	97.3	64.9	32.4
4.33	2.165	194	96.8	64.6	32.3
4.34	2.170	193	96.4	64.2	32.1
4.35	2.175	192	95.9	63.9	32.0
4.36	2.180	191	95.4	63.6	31.8
4.37	2.185	190	95.0	63.3	31.7
4.38	2.190	189	94.5	63.0	31.5
4.39	2.195	188	94.1	62.7	31.4
4.40	2.200	187	93.6	62.4	31.2
4.41	2.205	186	93.2	62.1	31.1
4.42	2.210	185	92.7	61.8	30.9
4.43	2.215	185	92.3	61.5	30.8
4.44	2.220	184	91.8	61.2	30.6
4.45	2.225	183	91.4	60.9	30.5
4.46	2.230	182	91.0	60.6	30.3
4.47	2.235	181	90.6	60.4	30.2
4.48	2.240	180	60.1	60.1	30.0
4.49	2.245	179	89.7	59.8	29.9
4.50	2.250	179	89.3	59.5	29.6
4.51	2.255	178	88.9	59.2	29.5
4.52	2.260	177	88.4	59.0	29.3
4.53	2.265	176	88.0	58.7	29.2
4.54	2.270	175	87.6	58.4	29.7
4.55	2.275	174	87.2	58.1	29.1
4.56	2.280	174	86.8	57.9	28.9
4.57	2.285	173	86.4	57.6	28.8
4.58	2.290	172	86.0	57.3	28.7
4.59	2.295	171	85.6	57.1	28.5
4.60	2.300	170	85.2	56.8	28.4
4.61	2.305	170	84.8	56.5	28.3
4.62	2.310	169	84.4	56.3	28.1
4.63	2.315	168	84.0	56.0	28.0
4.64	2.320	167	83.6	55.8	27.9

King Portable Brinell Hardness Tester

Ball Diameter D/mm		$0.102xF/D^2$			
		30	15	10	5
		Test Force F/N (kg)			
10	5	29.42kN (3000) 7.355kn (750)	14.71kN (1500)	9.807Kn (1000)	4.903Kn (500)
Indentation Diameter D/mm		Brinell Hardness (HBW)			
4.65	2.325	167	83.3	55.5	27.8
4.66	2.330	166	82.9	55.3	27.6
4.67	2.335	165	82.5	55.0	27.5
4.68	2.340	164	82.1	54.8	27.4
4.69	2.345	134	81.8	54.5	27.3
4.70	2.350	163	81.4	54.3	27.1
4.71	2.355	163	81.0	54.3	27.0
4.72	2.360	161	80.7	53.8	26.9
4.73	2.365	161	80.3	53.5	26.8
4.74	2.370	160	79.9	53.3	26.6
4.75	2.375	159	79.6	53.0	26.5
4.76	2.380	158	79.2	52.8	26.4
4.77	2.385	158	78.9	52.6	26.3
4.78	2.390	157	78.5	52.3	26.2
4.79	2.395	156	78.2	52.1	26.1
4.80	2.400	156	77.8	51.9	25.9
4.81	2.405	155	77.5	51.6	25.8
4.82	2.410	154	77.1	51.4	25.7
4.83	2.415	154	76.8	51.2	25.6
4.84	2.420	153	76.4	51.0	25.5
4.85	2.425	152	76.1	50.7	25.4
4.86	2.430	152	75.8	50.5	25.3
4.87	2.435	151	75.4	50.3	25.1
4.88	2.440	150	75.1	50.1	25.0
4.89	2.445	150	74.8	49.8	24.9
4.90	2.450	149	74.4	49.6	24.8
4.91	2.455	148	74.1	49.4	24.7
4.92	2.460	148	73.8	49.2	24.6
4.93	2.465	147	73.5	49.0	24.5
4.94	2.470	146	73.2	48.8	24.4
4.95	2.475	146	72.8	48.6	24.3
4.96	2.480	145	72.5	48.3	24.2
4.97	2.485	144	72.2	48.1	24.1
4.98	2.490	144	71.9	47.9	24.0
4.99	2.495	143	71.6	47.7	23.9
5.00	2.500	143	71.3	47.5	23.8
5.01	2.505	142	71.0	47.3	23.7
5.02	2.510	141	70.7	47.1	23.6
5.03	2.515	141	70.4	46.9	23.5
5.04	2.520	140	70.1	46.7	23.4
5.05	2.525	140	69.8	46.5	23.3
5.06	2.530	139	69.5	46.3	23.2
5.07	2.535	138	69.2	46.1	23.1
5.08	2.540	138	68.9	45.9	23.0
5.09	2.545	137	69.6	45.7	22.9

King Portable Brinell Hardness Tester

Ball Diameter D/mm		$0.102xF/D^2$			
		30	15	10	5
		Test Force F/N (kg)			
10	5	29.42kN (3000) 7.355kn (750)	14.71kN (1500)	9.807Kn (1000)	4.903Kn (500)
Indentation Diameter D/mm		Brinell Hardness (HBW)			
5.10	2.550	137	68.3	45.5	22.8
5.11	2.555	136	68.0	45.3	22.7
5.12	2.560	135	67.7	45.1	22.6
5.13	2.565	135	67.4	45.0	22.5
5.14	2.570	134	67.1	448	22.4
5.15	2.575	134		44.6	22.3
5.16	2.580	133	66.9	44.4	22.2
5.17	2.585	133	66.6	44.2	22.1
5.18	2.590	132	66.3	44.0	22.0
5.19	2.595	132	65.8	43.8	21.9
5.20	2.600	131	65.5	43.7	21.8
5.21	2.605	130	65.2	4.5	21.7
5.22	2.610	130	64.9	43.3	21.6
5.23	2.615	129	64.7	43.1	21.6
5.24	2.620	129	64.4	42.9	21.5
5.25	2.625	128	64.1	42.8	21.4
5.26	2.630	128	63.9	42.6	21.3
5.27	2.635	127	63.6	42.4	21.2
5.28	2.640	127	63.3	42.2	21.1
5.29	2.645	126	63.1	42.1	21.0
5.30	2.650	126	62.8	41.9	20.9
5.31	2.655	125	62.6	41.7	20.9
5.32	2.660	125	62.3	41.5	20.8
5.33	2.665	124	62.1	41.4	20.8
5.34	2.670	124	61.8	41.2	20.6
5.35	2.675	123	61.5	41.0	20.5
5.36	2.680	123	61.3	40.9	20.4
5.37	2.685	122	61.0	40.7	20.3
5.38	2.690	122	60.8	10.5	20.3
5.39	2.695	121	60.6	40.4	20.2
5.40	2.700	121	60.3	40.2	20.1
5.41	2.705	120	60.1	40.0	20.0
5.42	2.710	120	59.8	39.9	19.9
5.43	2.715	119	59.6	39.7	19.9
5.44	2.720	119	59.3	39.6	19.8
5.45	2.725	118	59.1	39.4	19.7
5.46	2.730	118	58.9	39.2	19.6
5.47	2.735	117	58.6	39.1	19.5
5.48	2.740	117	58.4	38.9	19.5
5.49	2.745	116	58.2	38.8	19.4
5.50	2.750	116	57.9	38.6	19.3
5.51	2.755	115	57.7	38.5	19.2
5.52	2.760	115	57.5	38.3	19.2
5.53	2.765	114	57.2	38.2	19.1
5.54	2.770	114	57.0	38.0	19.0

King Portable Brinell Hardness Tester

Ball Diameter D/mm		$0.102xF/D^2$			
		30	15	10	5
		Test Force F/N (kg)			
10	5	29.42kN (3000) 7.355kn (750)	14.71kN (1500)	9.807Kn (1000)	4.903Kn (500)
Indentation Diameter D/mm		Brinell Hardness (HBW)			
5.55	2.775	114	56.9	37.9	18.9
5.56	2.780	113	56.6	37.7	18.9
5.57	2.785	113	56.3	37.6	18.8
5.58	2.790	112	56.1	37.4	18.7
5.59	2.795	112	55.9	37.3	18.6
5.60	2.800	111	55.7	37.1	18.6
5.61	2.805	111	55.5	37.0	18.5
5.62	2.810	110	55.2	36.8	18.4
5.63	2.815	110	55.0	36.7	18.3
5.64	2.820	110	54.8	36.5	18.3
5.65	2.825	109	54.6	36.4	18.2
5.66	2.830	109	54.4	36.3	18.1
5.67	2.835	108	54.2	36.1	18.1
5.68	2.840	108	54.0	36.0	18.0
5.69	2.845	107	53.7	35.8	17.9
5.70	2.850	107	53.5	35.7	17.8
5.71	2.855	107	53.3	35.6	17.8
5.72	2.860	106	53.1	35.4	17.7
5.73	2.865	106	52.9	35.3	17.6
5.74	2.870	105	52.7	35.1	17.6
5.75	2.875	105	52.5	35.0	17.5
5.76	2.880	105	52.3	34.9	17.4
5.77	2.885	104	52.1	34.7	17.4
5.78	2.890	104	51.9	34.6	17.3
5.79	2.895	103	51.7	34.5	17.2
5.80	2.900	103	51.5	34.3	17.2
5.81	2.905	103	51.3	34.2	17.1
5.82	2.910	102	51.1	34.1	17.0
5.83	2.915	102	50.9	33.9	17.0
5.84	2.920	101	50.7	33.8	16.9
5.85	2.925	101	50.5	33.7	16.8
5.86	2.930	101	50.3	33.6	16.8
5.87	2.935	100	50.2	33.4	16.7
5.88	2.940	99.9	50.0	33.3	16.7
5.89	2.945	99.5	49.8	33.2	16.6
5.90	2.950	99.2	49.6	33.1	16.5
5.91	2.955	98.8	49.4	32.9	16.5
5.92	2.960	98.4	49.2	32.8	16.4
5.93	2.965	98.0	49.0	32.7	16.3
5.94	2.970	97.7	48.8	32.6	16.3
5.95	2.975	97.3	48.7	32.4	16.2
5.96	2.980	96.9	48.5	32.3	16.2

5.97	2.985	96.6	48.3	32.2	16.1
5.98	2.990	96.2	48.1	32.1	16.0
5.99	2.995	95.9	47.9	31.0	16.0
6.00	3.000	95.5	47.7	31.8	15.9

Table 2: Testing Accuracy of Brinell Hardness Tester

Hardness Value of Standard Block (HBW)	Allowable Max. Repeatability of Hardness Testers (mm)	Allowable Max. Error of Hardness Tester /% (relative to H)
≤ 125	0.030 $\overline{d}$	± 3
125 < HBW ≤ 225	0.025 $\overline{d}$	± 2.5
> 225	0.02 $\overline{d}$	± 2
$\overline{d}$ - mean diameter of indentations		

In accordance with International Standard ISO5606-1999

Table 3: Testing Conditions of Brinell Hardness Tester

Hardness Symbol	Ball Diameter D/mm	Test Force F/kg	0.102 x F/D^2
HBW 10/3000	10	3000	30
HBW 10/1500	10	1500	15
HBW 10/1000	10	1000	10
HBW 10/500	10	500	5
HBW 5/750	5	750	30
HBW 5/250	5	250	10
HBW 5/125	5	125	5

Note: The hardness symbol HBW 10/3000 denotes using a carbide ball indenter with 10mm diameter and applying 3000kg test force.

Table 4: Selection of Testing Conditions for Brinell Hardness Testers

Material	**Hardness (HBW)**	**Ball Diameter D/mm**	**Test Force F/kg**	**0.102 F/D^2**
Steel		10 5	3000 750	30
Cast Iron	≥ 140 < 140	10	3000 1000	30 10
Bronze	> 200	10	3000	30
Brass, Red Copper, Aluminum alloy	80 - 200	10	1000	10
Red Copper, Aluminum alloy, aluminum	16 - 80	10	500	5

In accordance with International Standard ISO6506-1999

Table 5: Conversion of Brinell Hardness and Tensile Strength

Material	Brinell Hardness (HBW)	Tensile Strength (MN/m^2)
Steel	>175 125-175	$\sigma_b \approx 0.363$ HBW x 10 $\sigma_b \approx 0.343$ HBW x 10
Quenched brass, Quenched bronze		$\sigma_b \approx 0.40$ HBW x 10
Annealed brass, Annealed bronze		$\sigma_b \approx 0.55$HBW x 10
Cast Aluminum alloy		$\sigma_b \approx 0.26$ HBW x 10