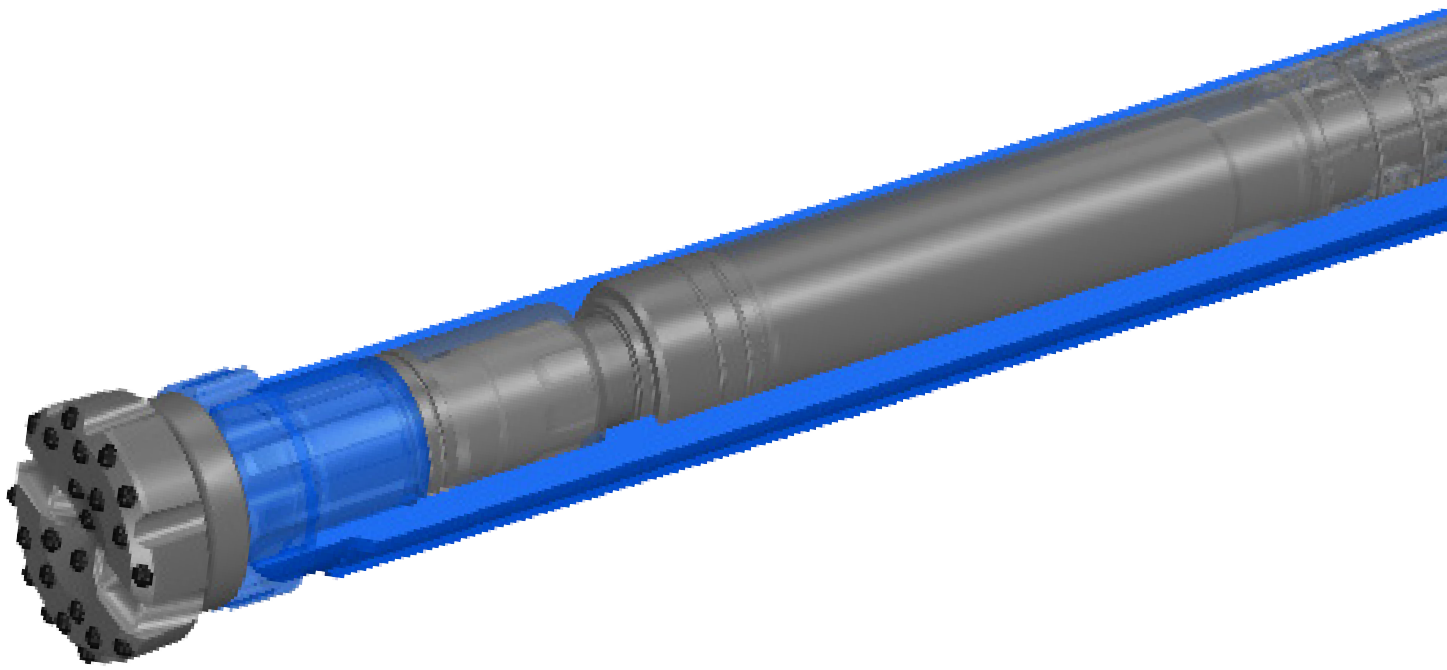
Drill King International

WAI 60I Hammer Series



Technical Manual

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Table of Content

Introduction

Drill King International was founded back in 2004 by Randy Broseh in Arlington, Texas. A year later, the business turned into a real family affair when brother Larry Broseh acquired the business. The brothers used their extensive industry knowledge to create a unique company with the best customer service in mind.

Continued growth and customer demand saw Drill King in 2008 decide to build a 60,000 sq.ft (5,575 sq.m) facility in Mansfield Texas. From this point the company has gone from strength to strength creating innovative drilling tolls and solutions for a variety of customer projects around the globe.

WAI Hammer Introduction

The WAI series hammer is designed to operate efficiently on fluid pressure. Compressed fluid is directed to the hammer via the rotation spindle and drill pipe. Exhaust fluid from the hammer passes through blow-holes in the drill bit and is used to flush the drilled hole. Rotation is provided by a rotation unit on the drill rig and transferred to the hammer via the drill pipe.

The drill pipe is threaded so that the drill string can be extended as the drilling advances and the hole becomes deeper. Feed force is also transmitted to the hammer via the pull-back/pull-down unit and the weight of the drill pipe.

- Premium Alloy developed using a proprietary chemistry for the longest lasting tools in the market
- Low Maintenance: Simple service ECO kits for self service schedules
- Hi-frequency drilling for the fastest penetration rates
- Customizable to optimize performance in open hole or cased hole projects
- Optional smooth wear sleeve or with integrated stabilizing ribs
- Integrated stabilizing ribs for minimized hole deviation

Safety Recommendation & Precautions

The safety Recommendations listed below are intended to alert the hammer operators and maintenance personnel to the possible physical dangers inherent in the various phases of operating and maintaining equipment of this kind.

We recommend that all operators and maintenance personnel read and thoroughly understand the safety precautions before attempting to operate or perform maintenance on the drilling equipment. We put "**SAFETY FIRST**" and suggest this must always be the primary consideration of all personnel while operating or maintaining the equipment.

Since the Safety Recommendations can't cover every potential situation, it is suggested that everyone exercises good judgernent and common sense while operating, servicing, or working near the equipment.

NOTE:
SAFETY STATEMENTS ARE INCLUDED THROUGHOUT THE MANUAL WHERE IT MAY APPLY SPECIFICALLY TO INDIVIDUAL COMPONENTS OR ASSEMBLIES. FAILURE TO COMPLY WITH SAFETY WARNING CAN RESULT IN SERIOUS OR FATAL INJURY. IMPROPER OPERATION AND MAINTENANCE CAN CASUE SEVERE EQUIPMENT DAMAGE OR EXCESSIVE WEAR ON THE HAMMER AND HAMMER BIT.

- ☑ Be equipped with appropriate attire, hard hat, gloves, safety shoes, eye and ear protection. Don't wear loose clothing that could get caught in the equipment.
- ☑ Safety goggles or safety glasses are required. Rocks, dust, and loose particles from drilling may be blown into the as during drilling. Also, use safety glasses when sharpening bits.
- ☑ Handle all equipment with care.
- ☑ Operating the hammer at extreme pressures or speeds may cause failure or excessive wear. Please follow the instructions in the technical manual and use the recommended procedures for operation and maintenance of the hammer.

☑ Compressed air or fluid used for cleaning purposes should be utilized with extreme caution:

- Do not apply directly to your skin
- Do not use for cleaning directly from your clothing
- Do not direct it at another person
- Be careful not to blow directly into the equipment
- Wear safety glasses **AT ALL TIMES** of the operation

☑ Check the drill rod to power head spindle joint and make sure it is securely tightened before running the rotary head in reverse rotation. If you have a loose connection, it could result in the drill rod becoming disconnected cornpletely. If the drilling rod becomes disconnected, it could strike personnel.

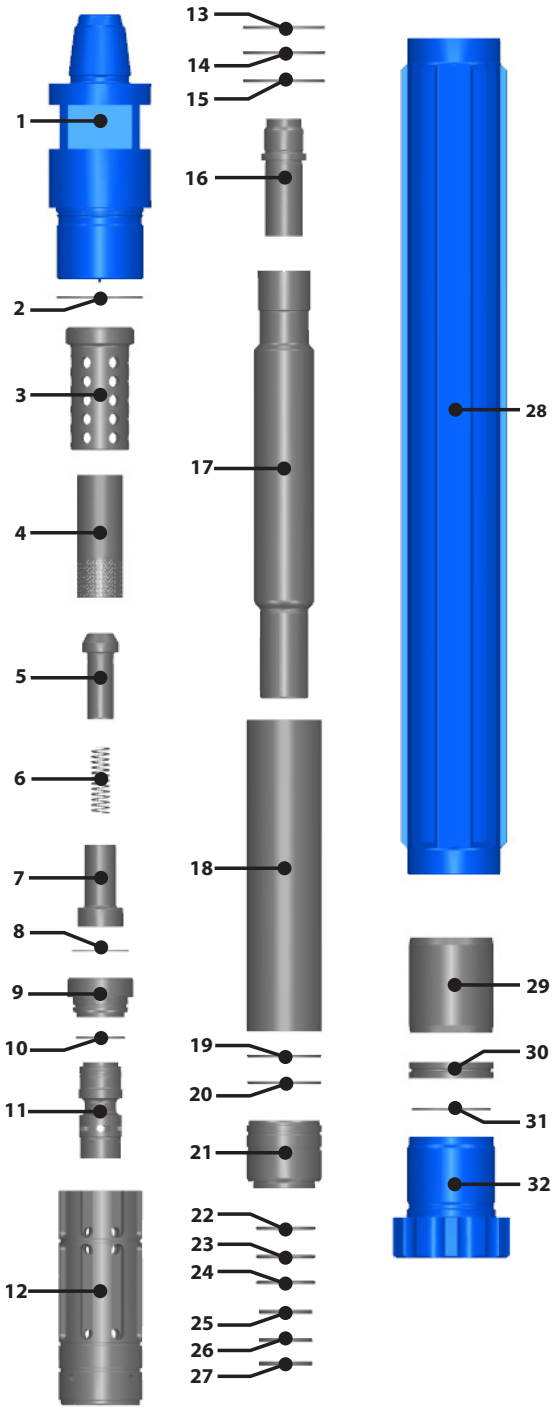
☑ Be cautious about getting under the downhole hammer for inspedion. The downhole hammer could unexpectedly cycle, forcing the piston to drop out of the downhole hammer. This could cause bodily injury to anyone under the downhole hammer.

☑ When using solvents to clean parts, make sure that they are nonflammable, and that it meets current OSHA and International Standards; be sure to use the solvent in a well-ventilated area.

☑ Be sure all downhole hammer components are properly lubricated and maintained, while in storage. Failure to follow lubrication recommendations could cause damage and wear to the downhole hammer, its components, and /or personnel injury.

☑ Never heat up any parts of the hammer or weld on it. Use extreme care when breaking loose the top and bottom connections, using either a spanner wrench or a flat wrench that properly fits the driver and top sub.

WAI 60I Fluid Hammer View and Parts List



NO	Part Name	Qty	Part Number
1	Top Sub	1	HPDK-W6002
2	Top Sub O-Ring	1	See Sealkit
3	Filter Cage	1	HPDK-W6027
4	Filter	1	HPDK-W6026-2
5	Check Valve	1	HPDK-W6004
6	C.V. Spring	1	HPDK-W6003
7	C.V. Seat	1	HPDK-W6005
8	Upper Valve Cap	1	See Sealkit
9	Valve Cap	1	HPDK-W6025
10	Valve Cap O-Ring	1	See Sealkit
11	Valve	1	HPDK-W6007
12	Valve Housing	1	HPDK-W6010
13	Valve Housing Seal	1	See Sealkit
14	Valve Housing Seal	1	See Sealkit
15	Valve Housing Seal	1	See Sealkit
16	Inner Tube	1	HPDK-W6009
17	Piston	1	HPDK-W6014
18	Cylinder	1	HPDK-W6012
19	Piston Bushing Seal OD	1	See Sealkit
20	Piston Bushing Seal OD	1	See Sealkit
21	Piston Bearing	1	HPDK-W6021
22	Piston Bushing Seal ID	1	See Sealkit
23	Piston Bushing Seal ID	1	See Sealkit
24	Piston Bushing Seal ID	1	See Sealkit
25	Piston Bushing Seal ID	1	See Sealkit
26	Piston Bushing Seal ID	1	See Sealkit
27	Piston Bushing Seal ID	1	See Sealkit
28	Wear Sleeve	1	HPDK-W6001
29	Bit Bearing	1	HPDK-W6020
30	Bit Ret. Ring	1	HPDK-W6018
31	Bit Ret. O-Ring	1	See Sealkit
32	Drive Sub	1	HPDK-W6022
	Sealkit (Items 2, 8, 10, 13-15, 19, 20, 22-27, 31)	1	HPDK-W60SEALKIT
	Complete Hammer		HADK-W60I

Dimensions & Weights	
Top Sub	3 ½" API REG PIN
Effective Length (in / mm)	58.89 / 1496
OD Range (in / mm)	6.29 / 160
Weight w/o bit (lbs / Kg)	325 / 148
Piston Weight (lbs / Kg)	50 / 23

WAI 60I Hammer Fluid Consumption at Min-Max PSI

Consumption at Min-Max PSI	
New	Worn
55 - 93 Gal/Min	85 - 145 Gal/min

In difficult drilling conditions, extra flushing can be obtained by changing the choke in the check valve. This might be desirable, e.g. when there is a large influx of water into the hole, when there is a big difference between the diameter of the drill bit and the diameter of the drill pipes, or when penetration rates are abnormally high.

Friction between the drill pipes and the hole wall can sometimes reduce the penetration rate. Increasing the air pressure to give more impact power and faster penetration can often counteract this.

WAI 60I Hammer Assembly

The WAI 60I Hammer assembly process is identical to the disassembly process yet in reverse.

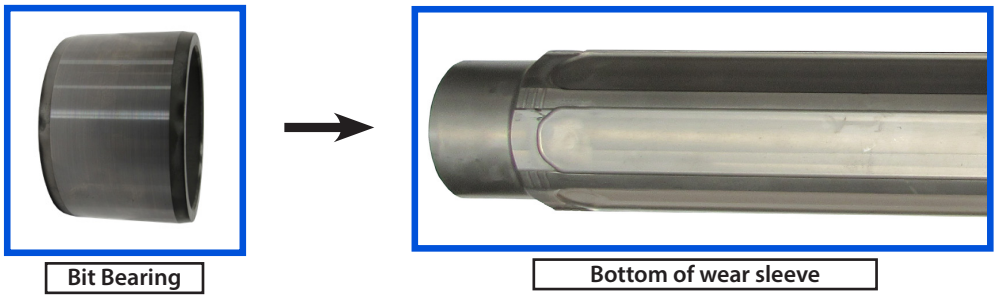
The following guideline should be used;

- All parts should be clean and free of grit, dirt, and other foreign material.
- All nicks and burrs on parts should be removed.
- All parts should be coated with rock drill oil & threads with thread grease and preferably the same type to be used on the drilling rig.
- All damaged O-rings' should be replaced. All seals should be oiled or greased to avoid cutting or tearing.
- Make sure the threads are clean and dry, and that sufficient drying time is allowed.

Assembly

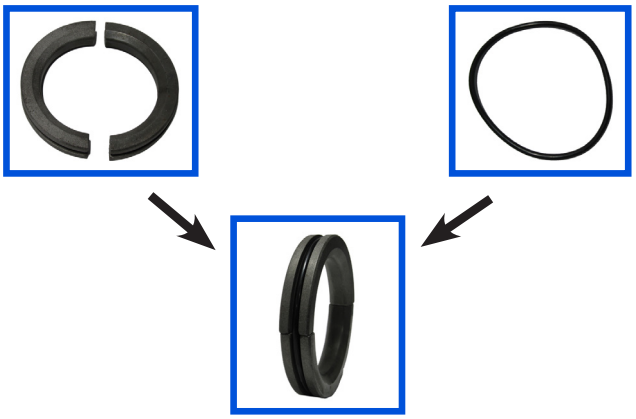
Bit Bearing

1. Insert the ***Bit Bearing*** into the bottom of the ***Wear Sleeve*** as shown.



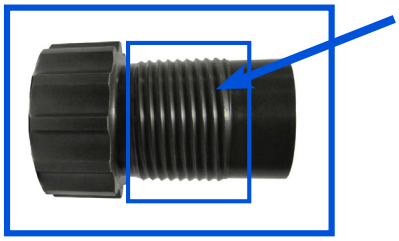
Bit Retaining Ring

2. Place the two halves of the ***Bit Retaining Ring*** together and place the ***Bit Retaining O-Ring*** around the edge in the groove of the ***Bit Retaining Ring***.

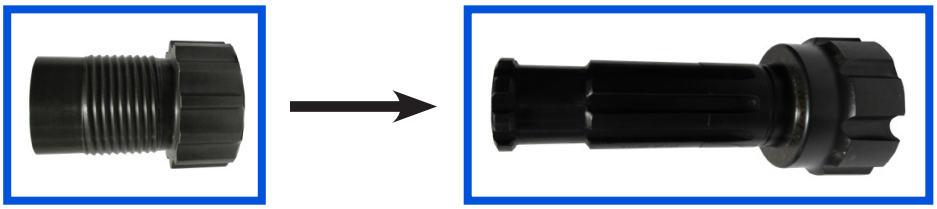


Chuck Installation

3. Apply pipe threading lubricant on the thread of the ***Chuck***.
   (Drill King Copper Coat[Part Number: 630010])

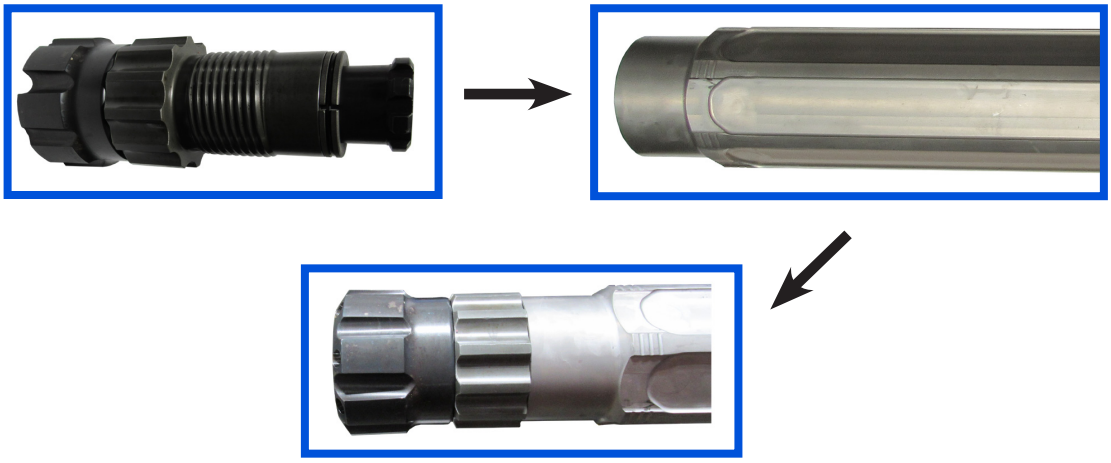


4. Place the ***Chuck*** over the bit.



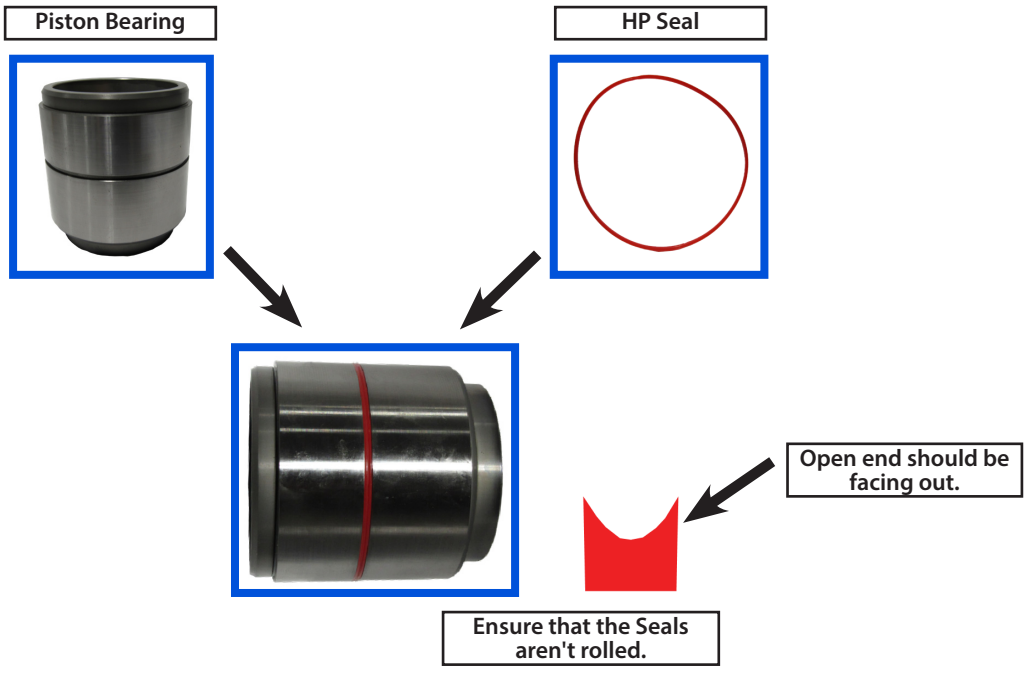
5. Spread the ***Bit Retaining Ring*** and place over the ***Bit***.

6. Thread the ***Chuck*** into the bottom of the ***Wear Sleeve***.

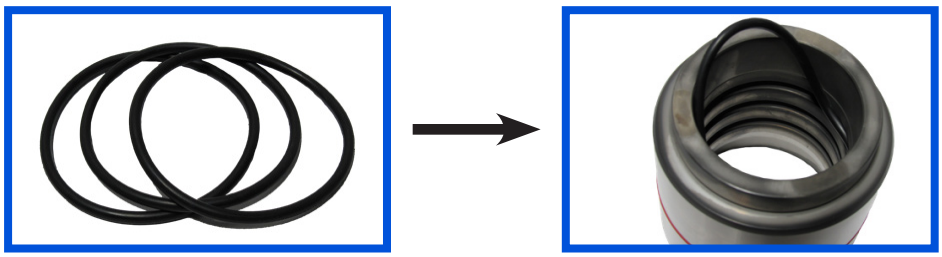


Piston Bearing

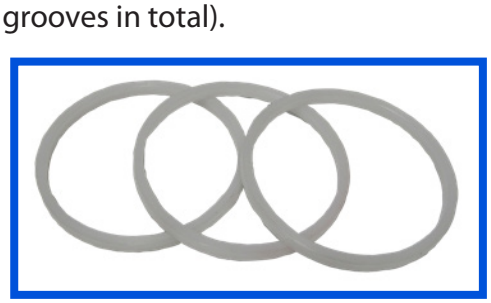
7. Place the Red HP (High Pressure) seal in the groove on the ***Piston Bearing***.



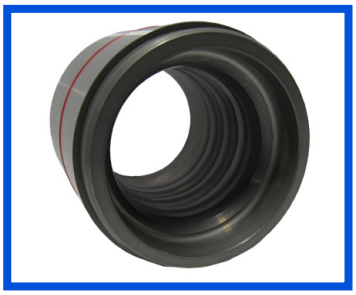
8. Take 1 ***O-ring*** and insert into each internal groove of the ***Piston Bearing***.
   (3 grooves in total).



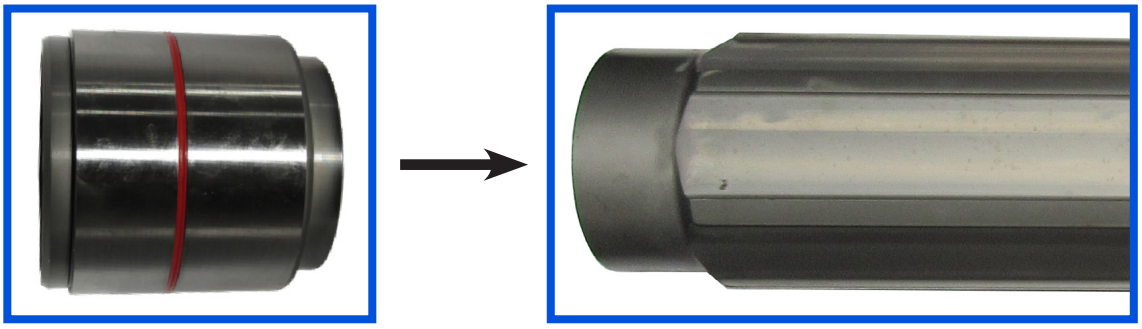
9. Take 1 Poly Seal and insert into each internal groove of the ***Piston Bearing***.
   (3 grooves in total).



Complete



10. Place the ***Piston Bearing*** into the top of the ***Wear Sleeve*** with the smaller diameter down and chamfer on top.



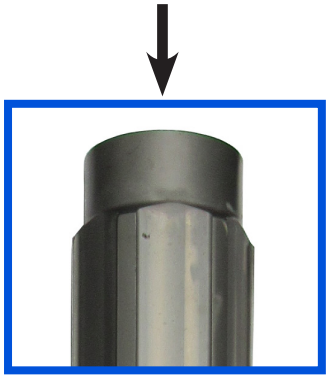
Piston Installation

11. The ***Piston*** can be assembled in an upright or horizontal state depending on the tools on hand and current workstation.

12. Place the ***Piston*** in the top of the ***Wear Sleeve*** into the ***Piston Bushing***.

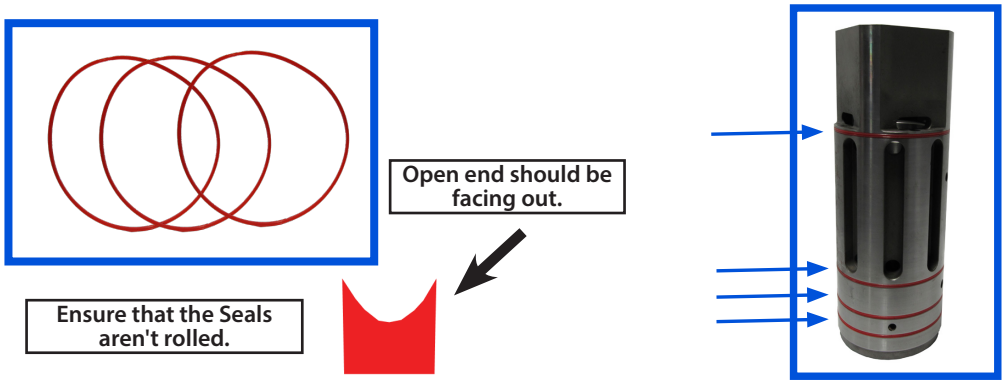
13. Place the ***Cylinder*** over the ***Piston.***

14. Press the ***Cylinder*** with enough force to push the pieces so they slide down into the ***Wear Sleeve***.



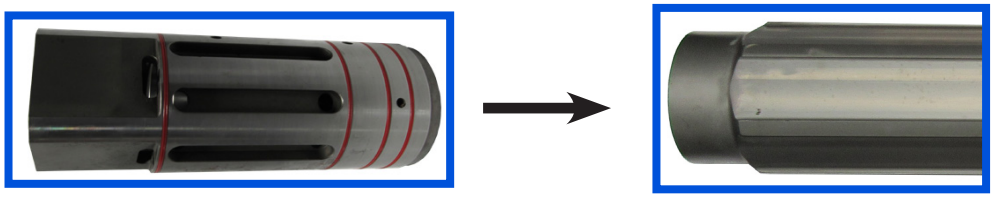
Valve Housing Installation

15. Take 4 Red ***HP Rings*** and place them in the grooves of the ***Valve Housing***.



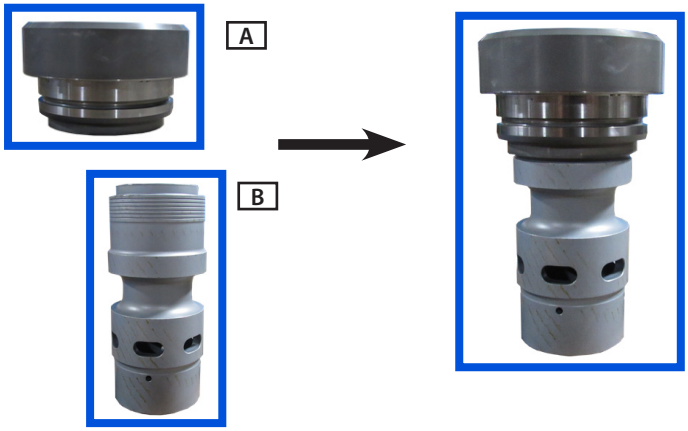
16. Place the ***Valve Housing*** in the ***Wear Sleeve*** with the single groove on top.

17. Press the ***Valve Housing*** with enough force down until the ***Valve Housing*** slides down into the ***Wear Sleeve*** and bottoms out.



Wear Bearing

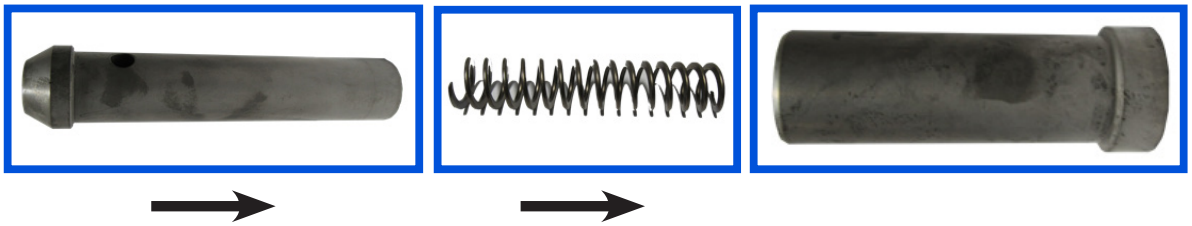
18. Take the ***Valve Cap*** (A) and place onto the ***Valve***. (B)



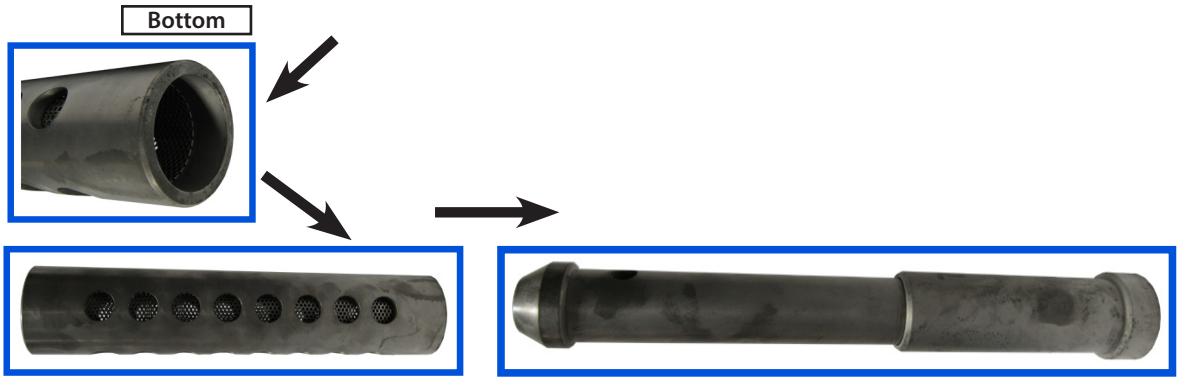
19. Take the ***Wear Bearing*** and ***Valve*** and place into the ***Valve Housing***. Raise the ***Valve*** several times and let go to listen for a clicking sound to ensure that no debris is causing the ***Valve*** to stick.

Check Valve and Filter Cage

20. Place the ***Check Valve*** over the ***Check Valve Spring*** and place both into the ***Check Valve Seat***.

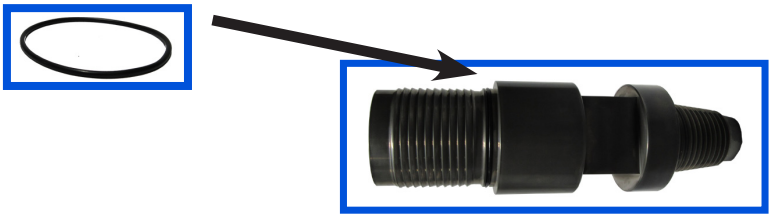


21. Place the Filter Cage over the ***Check Valve*** assembly with the empty filter space down.



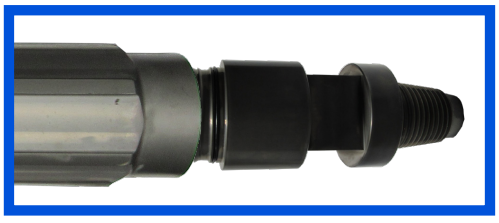
Top Sub Installation

22. Place the ***O-Ring*** on the slot marked on the ***Top Sub***.



23. Apply pipe threading copper cote on the thread of the ***Chuck*** and thread the ***Top Sub*** into the ***Wear Sleeve***.

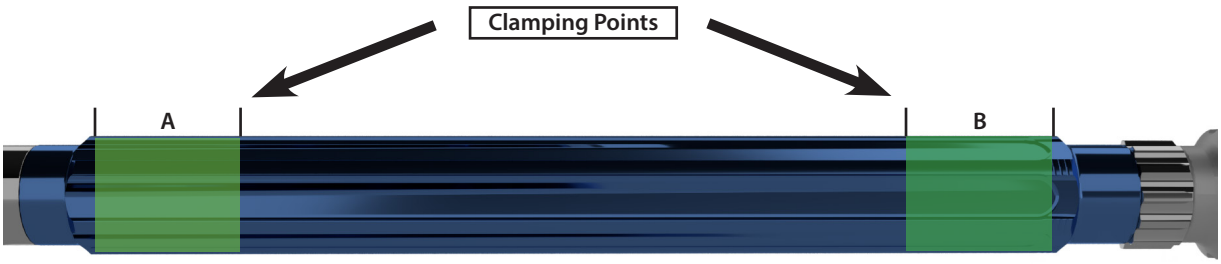
24. Hand tighten the ***Top Sub*** until the top sub stops. Measure the standoff to ensure it is between 0.30" - 0.80". This will ensure proper hammer makeup.



WAI 60I Hammer Disassembly

Disassembly of the hammer is similar to the assembly except the parts are taken off in reverse. After disassembly the wear limits on the parts will need to be checked to ensure that the dimensions are still within the operating parameters, or if a part is needing to be replaced. To disassemble:

1. Hold the parts at the clamp points.
2. Unscrew the top sub (1) counter clock wise. If the hammer is hard to break open and you purchased the hammer with break out rings, you can cut them with a grinding blade.
3. Remove the filter cage (2) & check valve components.
4. Remove the valve cap (7)
5. Extract the wear bearing (8) and valve (9)
6. Remove the driver sub and bit at the opposite end by holding onto the clamp points and rotating counter clockwise.
7. Remove the bit ret rings (17) and bit bearing (16)
8. Press the piston and piston bushing from the driver sub end though the top end. Be careful to catch the valve house, cylinder, piston, inner tube, and the piston bearing.
9. Remove the O-rings and seals. The hammer parts should be washed, preferably in a high-pressure washer, before inspection of the parts.
10. Visual inspection of the parts. Check for erosion, corrosion, and cracks.
11. Measure the hammer parts and change them according to the service instruction. O-rings and seals should be replaced at every servicing.



When clamping onto the wear sleeve grip in locations listed and according to the measurements.

A	B
4.3”	4”

Wear Limits

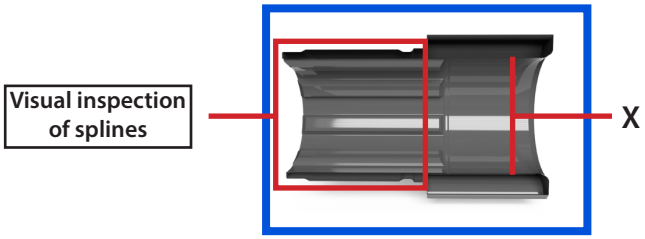
We recommend parts to be replaced when the wear on the part in question gives a measurement that is larger than (>) or smaller than (<) the measurements for the part in questions.

Example: X<5.5" indicates that the part would be replaced if the measurement at the location with wear falls below 5.5"

Component: **Driver Sub**

If the splines have too much wear, or if the wear pattern is not occurring uniformly, the driver sub must be replaced. If the driver sub is not replaced in time the driver may damage the splines on the bit and vice-versa.

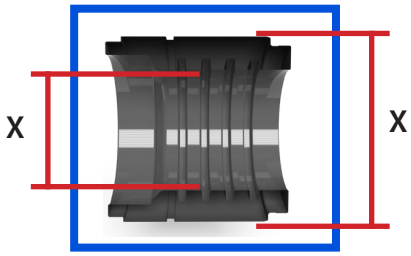
Inside Diameter (X) is greater than 4.008" (101.80mm)



Component: **Piston Bearing**

Inner diameter is greater than 2.933" (74.50mm).

Outer Diameter is less than 4.4873"(113.97mm).



Component: **Inner Tube**

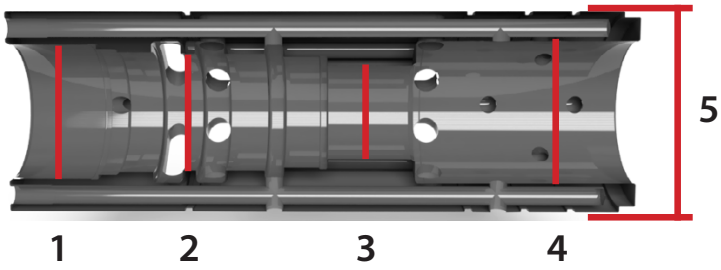
Outside diameter is less than 2.0472" (51.99mm)

Visual Inspection: Change the part when the damage is visible on the surface.

Component: **Valve House**

Visual Inspection: Change the part when the bottom guide surface is damaged by erosion, or if cracks are found.

Measurement 1 X > 2.9531" (75.00mm)
Measurement 2 X > 2.2965" (58.33mm)
Measurement 3 X > 2.1264" (54.01mm)
Measurement 4 X > 3.1516" (80.05mm)
Measurement 5 X < 4.4863" (113.95mm)



Component: **Piston**

Check for damage on the striking face of the piston.

Measurement 1 X < 3.1475" (79.95mm)
Measurement 2 X > 2.0489" (52.04mm)
Measurement 3 X < 2.9109" (73.94mm)

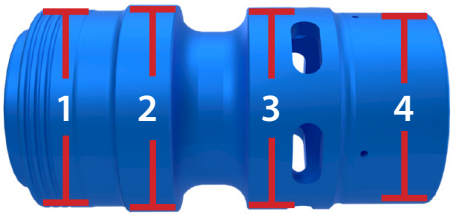
Component: **Cylinder**

Length is less than 18.634" (449.80mm) or if the part is cracked or corroded

Component: **Valve**

Visual Inspection: Change the part when the surface is damaged by erosion. Always replace the valve if the valve housing is replaced, or vice-versa.

Measurement 1 X < 2.2380" (56.84mm)
Measurement 2 X < 2.3475" (59.62mm)
Measurement 3 X < 2.2935" (58.25mm)
Measurement 4 X < 2.1813" (55.40mm)



Component: **O-Rings and Seals**

Replace with new items at every service occasion.

Component: **Filter**

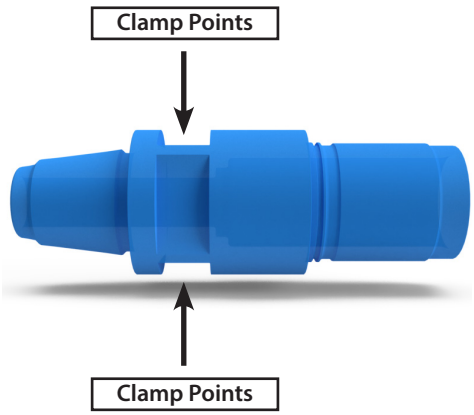
Clean the filter at every service occasion by running air through it. The filter should be replaced when the filter holes are blocked or when the filter is damaged.

Component: **Bit**

If the splines have too much wear, or if the wear pattern is not occurring uniformly, the bit must be replaced. If the bit is not replaced in time, the bit may damage the splines on the driver sub and vice-versa.

Component: **Top Sub**

The top sub is replaced when the wear on the tapered thread or the wrench grip is unacceptable according to practice.



Drilling Parameters

The following section is to give the user the best running parameters during the typical operations. These parameters are to be used as guidelines as running in different formations and minerals will need different parameters to run. The operator is the most valuable asset on the drill site and is the most knowledgeable about the current operational conditions.

Working Pressure

Recommended working pressure is between 750 - 2150 PSI.

Friction between the drill pipes and the hole wall can sometimes reduce the penetration rate. Increasing the water pressure to give more impact power and faster penetration can often counteract this.

Weight on Bit

When working with water pressure the recommended weight on the bit is more than when working with air hammers. The rule of thumb is typically to run at 500 lbs. (226 kg.). per inch of diameter. An example given is for a 6 inch bit would have a typical weight of 3000 lbs. (1360 kg.). Since this formula has been simplified to allow for quicker calculation, you may find that these values will need to be slightly altered due to ground conditions.

Lubrication

Water hammers do not use lubrication during normal use; however, a thread protectant is used to protect the threaded areas. The recommended thread protectant to use is Drill King Copper Coat [(Part Number: 630010) (1-gallon pail)]

RPM

Recommended rotations speed would normally vary between 40-65 RPM for most applications. As the feed pressure is increased or decreased as rock conditions change, the rotation speed needs to be monitored and adjusted to maintain correct indexing of the bit face to new rock and maintain the largest chip size. To determine the correct rotation in relation to the feed pressure, adjust the rotation so that it is 1/2" to 5/8" (12-16mm) of penetration per rotation.

Troubleshooting

Fluid hammers are precision controlled mechanical tools where the smallest foreign particle can alter the efficiency, or even halt the production of the hammer. Be sure to install a 5 micron filter inline prior to the hammer.

Fault	Cause	Remedy
Impact mechanism does not operate.	Water supply throttled or blocked.	Check the water pressure & flow and check that all passages leading to the hammer are open.
Valve Stuck	Hammer Clogged	Disassemble the hammer and wash all components.
Piston Bushing Worn	O-Ring in bushing are worn or damaged.	Disassemble the hammer and replace the O-rings.
Excessive Water Consumption	Valve parts damaged.	Disassemble and replace worn parts.
	Too large clearance (wear) between the valve and valve housing.	Disassemble the hammer and inspect the wear (See "Wear Limits"). Replace worn parts.
Lost Drill Bit and Chuck	Impact mechanism has been operated without rotation to the right.	Fish out the lost equipment using a fishing tool. Remember to always use a right-hand rotation both when drilling and when lifting the drill string. Ensure proper torque is used.
	Hammer getting stuck together.	Increase the up hole velocity.

Storage

When storing Drill Hammers, it is important to blow the hammer clear of all water. After disassembling the hammer, all internal parts are liberally coated with rock drill oil. Store the hammer horizontally in a clean dry place.

Warranty

NOTICE TO CUSTOMER: READ CAREFULLY, THESE TERMS AND CONDITIONS CONTAIN DISCLAIMERS OF WARRANTIES AND STRICT LIMITATIONS OF LIABILITIES AND REMEDIES. NO WARRANTY IS TRANSFERRABLE WITHOUT THE EXPRESS PERMISSION OF DRILL KING INTERNATIONAL.

Drill King International LP warrants to the original purchaser that its products are free from defects in material and workmanship for a period of:

- ☑ Percussion Bits — One year from the date of purchase.
- ☑ DTH Hammers — Six months from the date of purchase.
- ☑ WAI Hammers — Three months from the date of purchase.

Claims of defects in material and workmanship are subject to review and physical inspection of the returned product. Failure of the purchaser to provide relevant operational details to assist in the investigation will result in the denial of the claim. Until resolution, the purchaser must retain and appropriately store the claim. part. Upon request, the claimed part must be sent to Drill King for assessment. Any part or product sent to Drill King must be accompanied with a "Return Authorization Form" issued, in advance, by the Sales Department at Drill King. All return packaging must clearly be marked with the return authorization number. Freight for the return must be pre-paid by the purchaser. Failure to abide by these instructions will result in refusal to accept the returned product at the Drill King facility.

To begin a warranty claim a 'Product Evaluation Report' must be fully completed and submitted within the above mentioned time frame or warranty life

The report must be completed and submitted within (14) days of either the time of discovery of defect or when reasonable discovery of defect should have been made.

Warranty Claims will only be accepted on products still within their warranty life.

Drill King International expressly excludes the following from the terms of this warranty:

- ☑ Incidental or consequential damages connected with the use of their products
- ☑ Claims of parts issued under concession.
- ☑ Claims of lost time
- ☑ Performance outside of the standard scope provided by Drill King International
- ☑ Effects of corrosion and/or normal wear
- ☑ Hammer seals and/or items intended to wear
- ☑ Any part that shows evidence of improper application
- ☑ Fitness for use other than the intended purposes of the product
- ☑ Proprietary design where the design control is retained by the customer, particularly when design parameters are outside Drill King Internationals recommended specifications (E.X. Oversized bits or hole openers.)
- ☑ Evidence of abuse, localized heating, welding, galling, corrosion, inadequate lubrication, physical alteration, wrench marks, lack of proper maintenance, operating outside recommended specifications, bending or otherwise distorting, excessive wear, improper storage or transportation, and chipped or crushed carbides must result in denial of claims
- ☑ Damage caused as a result of using incorrect servicing tools or procedures
- ☑ Evidence from wear shows the product has achieved at least 7596 of its expected life.
- ☑ Any part that is described as "No Warranty" in the quote, order acknowledgement, order, packing list, or invoice
- ☑ Special warranties described in the quote, order acknowledgement, order, packing list, or invoice

Conclusion

In the event of finding a defective product, a full or pro-rated credit will be issued provided that the end user has demonstrated that the product has been stored, installed, maintained and operated in an acceptable manner.

Drill King International will not accept any remedies to the user other than those set out under the provisions of the warranty above. **Drill King international will only ever be liable for damages that are liquidated and set at the original purchase price for any said item or part in dispute**

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