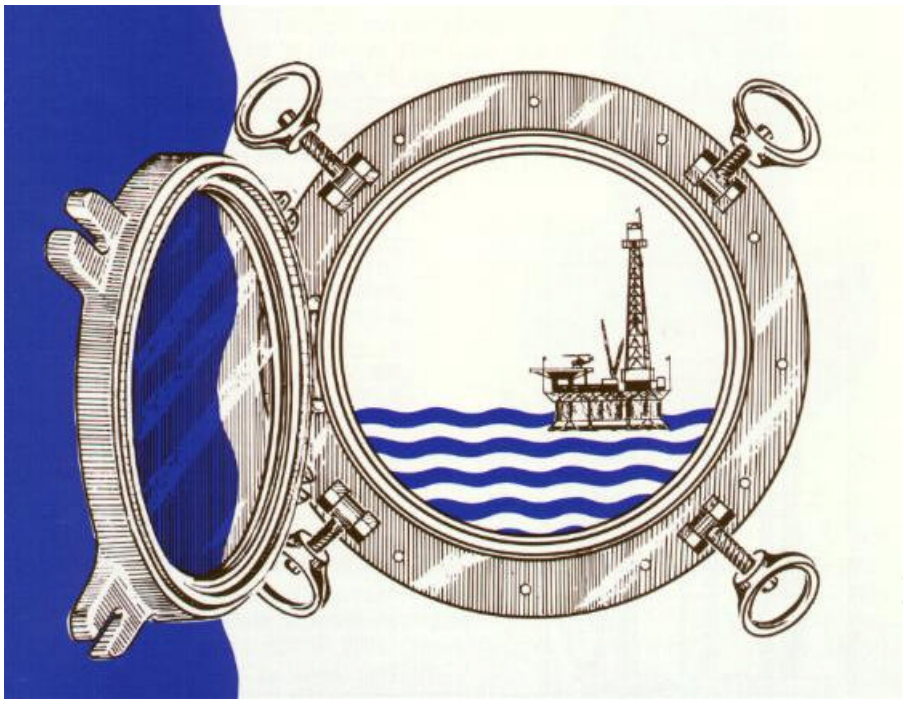

Field Service Manual

for

Vulcan Air/Steam Offshore Hammers

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Bulletin 165

Table of Contents

1.0 GENERAL

1.1 Purpose and Use of Manual

The field service manual has been prepared to provide helpful and necessary instructions for the operation, and maintenance of your Vulcan pile hammers. Read the information carefully, follow the instructions properly and your pile hammers will deliver thousands of hours of dependable service. The instructions given herein are the result of careful correlation between factory and field experience, and cover the best methods for operation, maintenance, lubrication and overhaul of Vulcan Hammers.

Care has been taken to avoid undue emphasis of minor details, but when minor items have been emphasized it is because experience has indicated the wisdom of giving these points special attention.

For safe operation and correct maintenance procedure, it is recommended that the instructions given herein be followed implicitly. Service and repair, other than those covered in this manual, are not recommended to be attempted outside of the factory. The manufacturer advocates that major overhaul of a hammer be accomplished by and authorized representative of VULCAN IRON WORKS INC. or shipped directly to the factory. IT IS IMPORTANT THAT NO UNNECESSARY OR AMATEUR SERVICE BE PERFORMED ON THE HAMMERS AS THIS TYPE OF SERVICE HAS, IN MOST CASES, BEEN FOUND TO BE DETRIMENTAL.

1.2 Notice of Supplemental Pages

Supplementary pages will be issued if changes are made to the models covered in this manual or whenever improved methods have been developed and proven.

It has been the aim of the manufacturer to build a hammer to give maximum service with minimum attention other than proper lubrication and adjustments. The latest engineering knowledge and design has been combined with the best materials obtainable and the finest workmanship possible to attain high quality products.

DETAILED OPERATION, MAINTENANCE AND LUBRICATION INSTRUCTIONS IN THIS MANUAL ARE VERY IMPORTANT, and you cannot expect good service from your hammer unless the instructions are followed carefully. Neither can you expect good service unless the manual is available to everyone who works on the hammer.

All of the instructions have been made as concise as possible and the few minutes required to read them can save down time and dollars in the future.

2.0 INTRODUCTION

In addition to the safety, operation, maintenance and parts information included in the body of the manual, the following documents are included (when applicable) in the back of the manual to further assist you in the operation of your Vulcan Hammer:

1. Specification brochure, a Bulletin of the #65 Series.
2. Vulcan Air/Steam Pile Hammer User's Guide to Safe Operation.
3. General Arrangement of the Hammer.
4. General Arrangement of the Pipe Cap.
5. General Arrangement of the Leaders (when applicable).

3.0 SAFETY

As mentioned in Section 2.0, included with this manual is the User's Guide to Safe Operation for the Vulcan Pile Hammer. Although safety and other notices of importance concerning the equipment are spread through the text, this manual especially deals with the safety aspects of the use of Vulcan equipment. WE URGE YOU TO READ THIS MANUAL AND TO BECOME FAMILIAR WITH ITS CONTENTS. The exercise of safe operating procedures with Vulcan Hammers will prevent injures and property damage related with accidents. Additional copies of this manual for use by personnel working around the equipment can be obtained from VULCAN IRON WORKS INC.

4.0 OPERATION

4.1 BASIC ASSEMBLY

The basic operational assembly for the Vulcan Offshore Hammer is shown in Figure 4.1.1 with the major components labeled. The easiest method to assemble this package is as follows:

1. Lay the leaders perfectly flat on the ground.
2. Remove the lifting bale from the leaders.
3. Grease the leader tracks where the hammer and cap jaws slide.

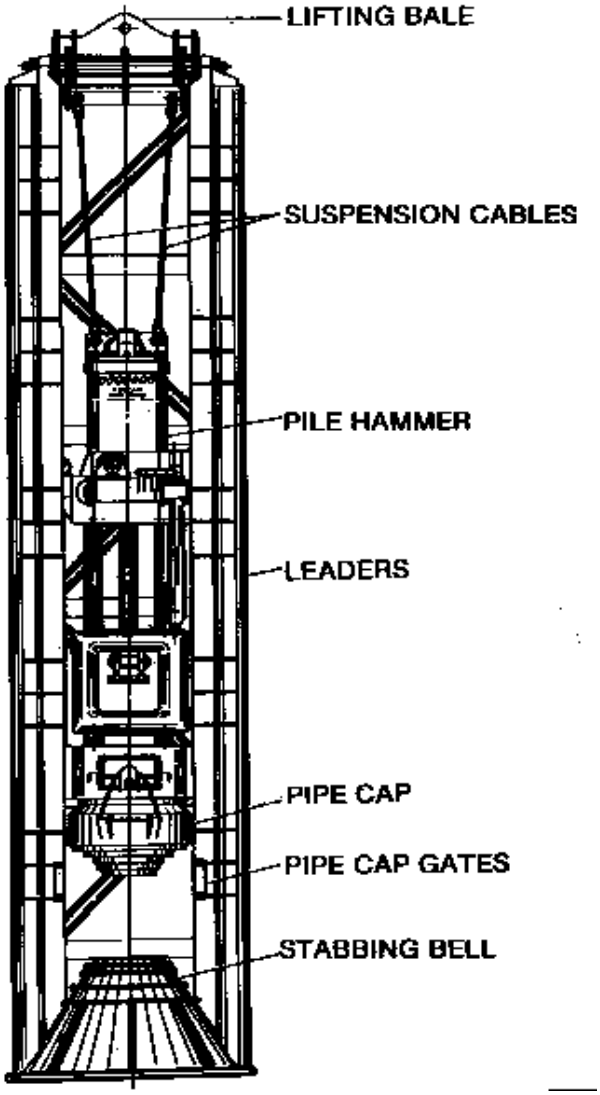


Figure 4.1.1 General Arrangement of Vulcan Hammer Assembly

4. Load the pipe cap with cushion material (Section 5.8), making sure that the cushion material and top plate are secured to the pipe cap so that these will not fall out when the cap is on its side.
5. Insert the Pipe Cap through the gates. The operation of the Pipe Cap gates is shown in Figure 4.1.2 Pipe Cap Installation and Removal. Pipe Caps can be changed out during the life of the assembly by simply removing and inserting them through the gates. The Pipe Cap should be lowered vertically using the lifting lug in the center of the Pipe Cap body. Replace the pipe cap gates.
6. With both hammer and leaders perfectly horizontal and in line, lift the hammer and slide it into the leaders through the lifting bale end. Draw the hammer and pipe cap together removing any obstructive securing tackle. WARNING: DO NOT STAND UNDER HAMMER OR CAP DURING THIS OPERATION.

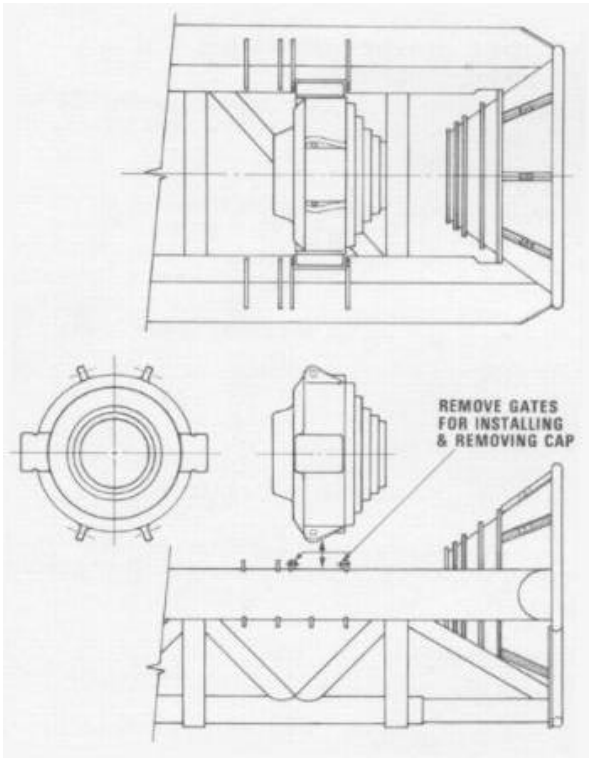


Figure 4.1.2 Pipe Cap Installation and Removal

7. Cable the hammer to the pipe cap, using the base lugs on the hammer and the two (2) side lugs on the pipe cap. Make sure this assembly is secure.
8. Replace the lifting bale.
9. Attach the suspension cables to the leaders and to the suspension head. These should be open spelter sockets of the Crosby type, matched to the suspension head of the hammer and the leads. Shackles are not

recommended since these will be loose during driving and can damage the cylinder head studs. Dimensions of the cylinder head suspension parts are given in Figure 4.1.3. Slide the hammer and cap until all suspension cable slack is removed.

10. Check all cables, pins and other connections to make sure that these are completely secure. The hammer should not be taken out of the horizontal position unless all assembly cabling is complete.

4.2 HOSE CONNECTIONS & RECOMMENDATIONS

All Vulcan Offshore Hammers are equipped with female pipe inlets, either single or manifold, to admit the steam or air into the cylinder for hammer operation.

Before connecting steam or air hoses, examine the exterior of the hose to be sure it is in good, serviceable condition. Blow steam or air through the hose to ensure that no obstructions exist. Remove all protective tape from the openings in the hammer cylinder. If the openings were not covered, check the inside of the opening for cleanliness.

IMPORTANT!

IF AIR OR STEAM LINES ARE NOT PROPERLY SECURED, OR IF THEY FAIL DURING OPERATION, THEY CAN BE EXTREMELY DANGEROURS.

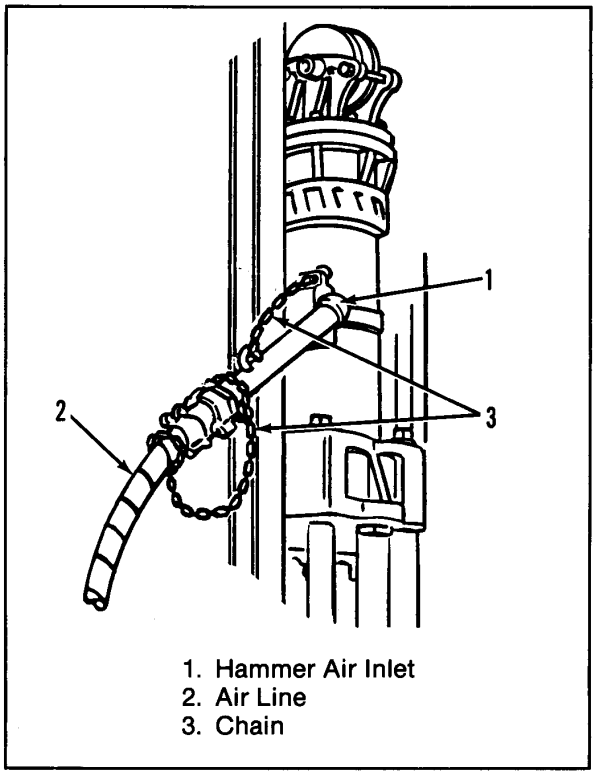
Steam will cause hoses to deteriorate sooner than air. Because of the heat involved, use caution when handling hoses.

IMPORTANT!

NEVER USE AIR HOSES TO CONVEY STEAM.

Air and Steam lines should be connected to the hammer air inlet and secured by a chain or piece of wire rope. The chain or rope should suspend the line in a manner, which will relieve the weight of the hose at the coupling, and help eliminate the jarring motions that occur during operation.

(See Figure 4.2.1)



1. Hammer Air Inlet
2. Air Line
3. Chain

Figure 4.2.1

	Bar and Suspension Heads				Suspension Head Only		
Hammer	A	B	C	D	E	F	G
020/030/530	4 ½	6	6	7 ½	2 5/8	3	2 3/8
340/540	5 ½	7	8	9	2 7/8	4	2 7/8
360/560/5110	6 ½	8	7 5/8	10	2 7/8	5	2 7/8
5100	6 ½	8	7 3/8	10	4	6	3 ½
5150	7	7 ½	9 ¾	10	4 7/8	7 1/2	5

All dimensions are in inches.

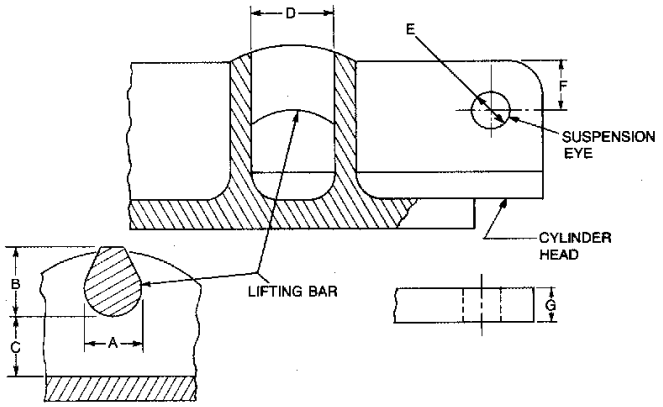


Figure 4.1.3
Lifting Hole Dimensions

4.3 SET-UP AND STARTING PROCEDURE

4.3.1 DAILY CHECK LIST

The following items should be checked in the hammer assembly each day the hammer is in use and especially when the hammer has not been used and it is about ready to start driving:

1. Remove all protective tape found in or over port openings of any kind in the cylinder. Should any of the port openings be found to be unprotected, check to be sure that no foreign material has entered through the opening.
2. Check clearance between hammer and pipe cap jaws and the leader tracks, especially where the leader tracks have been bent. Hammer and cap must slide freely in the leaders. Make sure that the jaws and tracks are fully greased.
3. Check the columns and piston rods for nicks, burrs, and welding or burning slag.
4. Consult the Lubrication Section of the manual (See Section 5.1) for lubrication instructions. It is very important that the hammer be fully lubricated whenever operated.
5. Fill the steam line oiler, following the lubrication recommendations in the manual. Make sure the line oiler is properly operating and injecting lubricant into the steam line.
6. Fill the cushion pot on the pipe cap with cushion material and top plate (See Section 5.8).
7. Make sure the steam line and hoses are completely clear of foreign matter before attaching these to the hammer.
8. Secure the steam or air supply line to the hammer (See Section 4.2)
9. Check all fasteners for tightness (See Section 5.2.1).
10. Check all gaskets for breaks or leaks.
11. Check the tie cables for tightness. Make sure that the Hydra-Nuts or Auto-Jacks are up to their specified pressure and are not leaking any grease (See Section 5.2.3). Check all suspension and wrap cables for their integrity.
12. Check ram keys and ram key retainers or set screws for tightness (See Section 5.5) DO NOT OVERTIGHTEN THE RAM KEYS. DO NOT MODIFY THE RETAINERS IN ANY WAY.
13. Check slide bar to make sure that it is secure (See Section 5.3).

When the leaders are fully secured to the crane line, the hammer may be lifted onto the pile. For plumb pile, even though the hammer alignment must always be correct, the specific rotation of the hammer is not critical; however, with batter pile, the hammer should be positioned in such a way that the weight of the ram is evenly distributed on at least two (2) columns. Failure to do so will result in the one (1) column being galled and scored.

4.3.2 HAMMER BREAK-IN AND INITIAL START-UP

1. Allow the steam or air to enter the cylinder slowly for a few minutes without lifting the ram. This will remove any condensation from the supply line, allow for proper expansion of the metals and warming of the cylinder walls, and introduce a good supply of lubricant. Do not attempt to operate the hammer until all condensation has been expelled.
2. Raise the steam pressure and allow the hammer to run at half stroke for about ten (10) minuets.
3. Run the hammer at full speed for about thirty (30) minutes.
4. Remove the hammer from the pile and re-check it completely.

All of the above steps must be followed when the hammer is new, or when it has not been used for sometime. However, for a hammer in use it is not necessary to run it at

half speed for start-up, unless the ambient temperature is below 40°F (5°C).

4.4 MAJOR OVERHAUL

When a hammer becomes in need of major overhaul, or for major repair work, it is recommended that an authorized service representative from Vulcan be present to oversee the work and recommend the needed repair.

After the hammer has been completely cleaned and then disassembled, all parts should be cleaned and carefully inspected. Using this manual, check all parts to see if there is any excessive wear or damage and to replace those parts which are no longer usable. The most important consideration in any overhauling procedure is the cleanliness of the work and environment. This is true in both disassembly and reassembly. AVOID DIRT, GRIT, WELDING SLAG, AND ALL FOREIGN MATTER, AND PROPERLY LUBRICATE AND SEAT THE PARTS AS THEY ARE REASSEMBLED.

4.5 STORAGE

When the hammer is placed in storage or will not be used for a long period of time, the following tasks should be performed on the hammer:

1. Lubricate the cylinder internally; then, tape or plug all intake, exhaust, and relief ports. When taping use waterproof tape and take care not to create holes or tears.
2. Apply grease to the column and piston rods (See Section 5.1 for type). On 340, 540, 360, 560, 5100 and 5150 hammers, there are grease fittings provided in the ram column bore pockets to facilitate this. Make sure these pockets are filled with grease.
3. Remove piston and rod packing.

When taking a hammer out of storage make sure that, in addition to the normal start-up procedure, all grease is removed from the columns and piston rod. Only the columns should be regreased.

After reassembly, the hammer should be given the same start-up and break-in as a new hammer (See Sections 4.3.1 and 4.3.2).

5.0 MAINTENANCE

5.1 LUBRICATION

Probably the most important aspect of hammer maintenance is proper lubrication. The recommended lubricants are given in Table 5.1.1 and their locations are shown in Figure 5.1.1. the proper state of the hammer should be checked daily (See Section 4.3.1 and Item 4 and 5). Suggested steam or air line oiler sizes for the different hammers are given in Table 5.1.2.

Table 5.1.1 Lubrication specifications for the Vulcan Offshore Pile Hammers.

Application Point		Lube Type	Oil Viscosity SUS, 212°F	Oil Viscosity cSt, 100°C	Flash Point (min) °F	Flash Point (min) °C	Other Requirements
A	Cylinder and Base Jaws	NLGI EP2 Grease	70-100	13-20	450	235	a. Permitted Thickeners
B	Trip Faces						1. Lithium 12 Hydroxy-Stearate
C	Slide Bar Wedges						2. Lithium Complex
D	Slide Bare Dovetail						3. Calcium Complex
E	Columns/Ram Grease Fittings*						4. Polyurea
F	Columns/Exposed Surfaces*						b. MoS_2 Anti-Wear Additive
G	Hydra-Nuts & Auto-Jacks						c. Anti-Rust Additive
H	Relief Ports (Steam Opr.)	Steam Cylinder Oil AGMA 8	160-190	34-41	550	290	10% Tallow or Lard Oil Content
I	Steam Line Oiler						
J	Relief Ports (Air Opr.)	Air Compressor	40-50	4.25-7.5	400	200	Anti-Oxidant
K	Air Line Oiler	AGMA 1					
L	Outboard Bearing	Gear Oil	80-105	15-21.5	400	200	
M	Open Steam Chest Bearing	AGMA 5 EP					

It is important to keep your Vulcan Hammer properly lubricated to insure the maximum possible hammer life and driving performance. Also for the threads of the cable fittings, use an anti-seize compound to prevent galling and freezing of the threads.

*NLGI EP2 greases will vary widely in the results for this application. Another alternative to this is a heavy open gear lubricant with MOS_2 anti-wear additive such as TS Moly TS-201 or equivalent. This should be applied directly to the exposed columns and into the ram pockets.

Table 5.1.2 Steam Air Line Oiler Capacity Recommendations

	Recommended Line Oiler Capacity	
Hammer Size	gal/hr	L/hr
020, 030, 530	2	8
340	3	12
540, 360	4	16
560, 5110	5	20
5100	8	32
5150	10	40

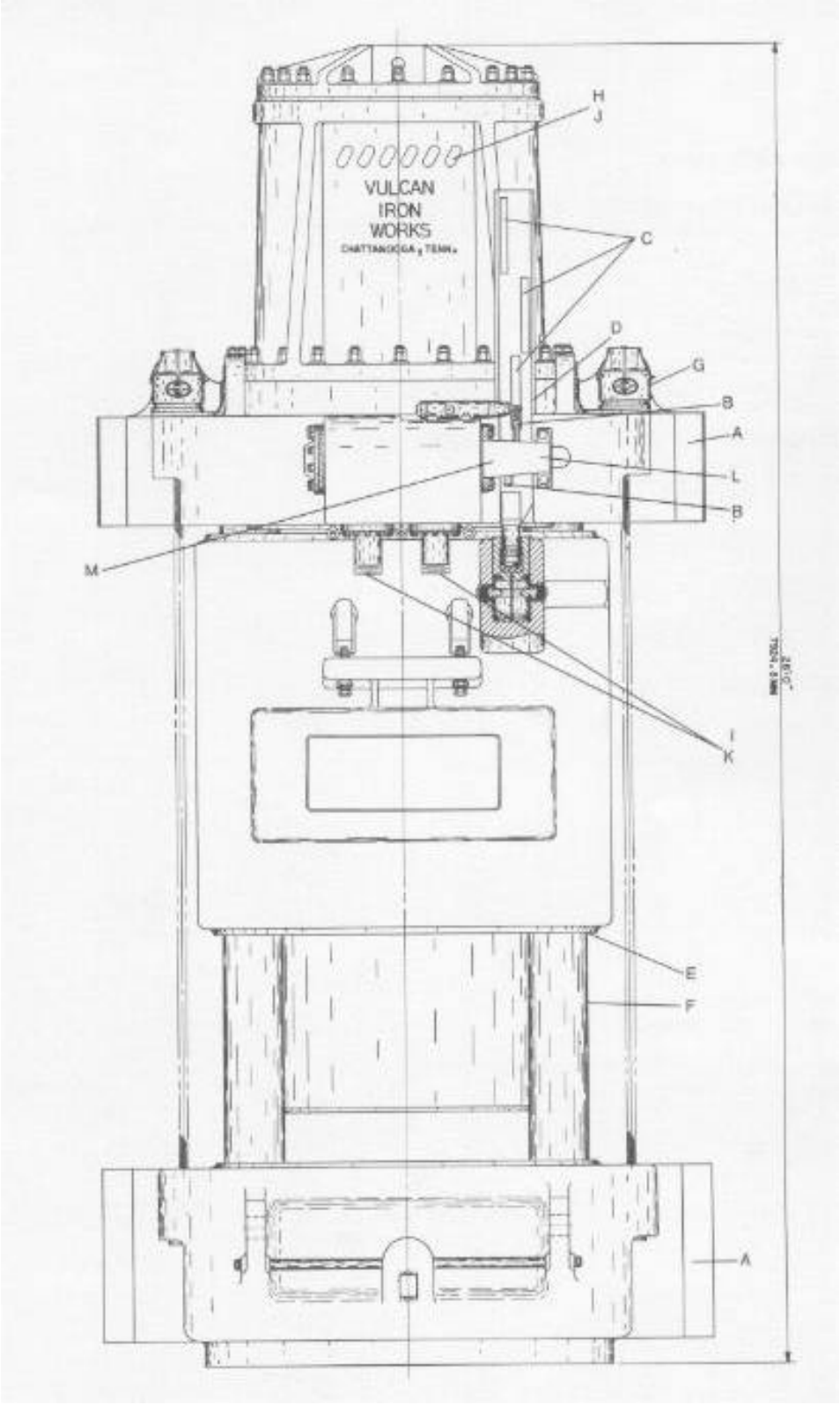


Figure 5.1.1 Lubrication Locations

5.2 CYLINDER

5.2.1 STUDS AND NUTS

5.2.1.1 TORQUE RECOMMENDATIONS

Proper torquing for studs and nuts on Vulcan Hammers is very important. For the different locations of studs and nuts, the tables showing the recommended torque values are as follows:

Table 5.2.1.1.1 Cylinder Head Stud Torque Specifications

	Torque	
Hammer Size	in-lbs.	kg-m
020, 030, 530, 340, 540, 360, 560 & 5110	8700	100
5100 & 5150	11,196	130

Table 5.2.1.1.2 Steam Chest Head Stud Torque Specifications

	Torque	
Hammer Size	in-lbs.	kg-m
All Hammers	1728	20

Figure 5.2.1.1.1 shows the correct assembly for all cylinder stud/nut arrangements.

IMPORTANT: Packing Gland Studs are not torqued with a torque wrench (See Section 5.2.4)

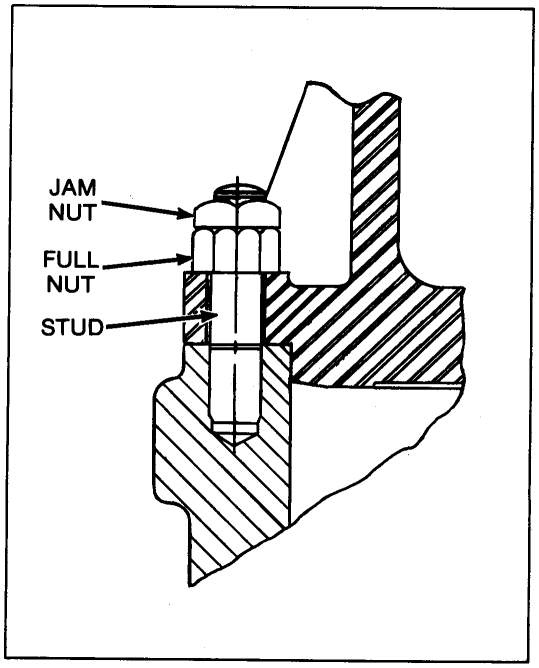


Figure 5.2.1.1.1 Cylinder Stud Arrangements

5.2.1.2 STUD REMOVAL AND REPLACEMENT

If broken or damaged studs are encountered during assembly or disassembly, the following procedures will aid in replacement.

1. A broken stud can be removed by applying a generous portion of penetrating oil around stud threads. Let it stand overnight if possible.
2. Drill a hole in the broken stud (See Figure 5.2.1.2.1) Refer to Table 5.2.1.2.1 for drill sizes.

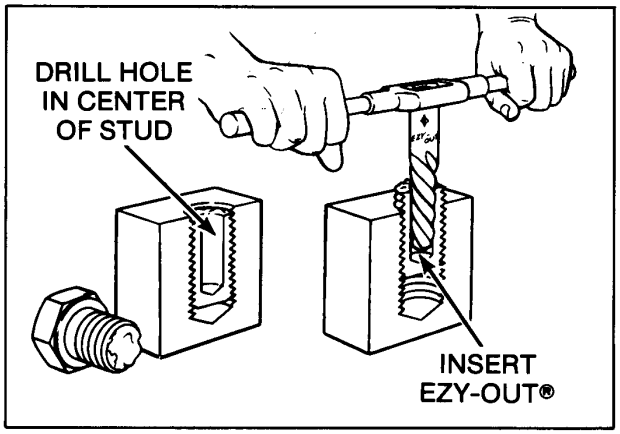


Figure 5.2.1.2.1 Stud Removal

Ezy-Out® No.	Drill Size	Stud/Screw Size
5	17/64"	9/16" - ¾"
6	13/32"	¾" - 1"
7	17/32"	1" - 1-3/8"
8	13/16"	1-3/8" - 1 ¾"
9	1-1/16"	1 ¾" - 2 1/8"
10	1-5/16"	2 1/8" - 2 ½"
11	1-9/16"	2 ½" - 3"
12	1-15/16"	3" - 3 ½"

Table 5.2.1.2.1 Drill Sizes

EZY-OUT® IS THE REGISTERED TRADE MARK OF THE CLEVELAND TWIST DRILL COMPANY.

Stud installation requires certain precautions.

1. All Vulcan studs have an unthreaded portion between the threaded ends (See Figure 5.2.1.2.2). DO NOT use a pipe wrench to install the stud. Thread damage is possible and the pipe wrench marks or notches will create stress riser points in the stud.

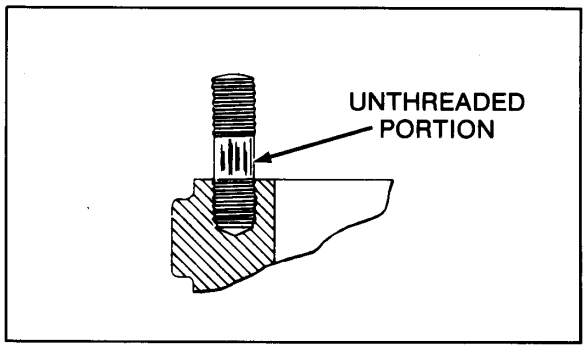


Figure 5.2.1.2.2 Vulcan Stud

2. Install studs by threading a jam nut on the stud. Place a flat washer over the jam nut. Thread a full nut on top of the washer (See Figure 5.2.1.2.3). The washer prevents the nuts from turning and an impact wrench or hand wrench can be used to install the stud.

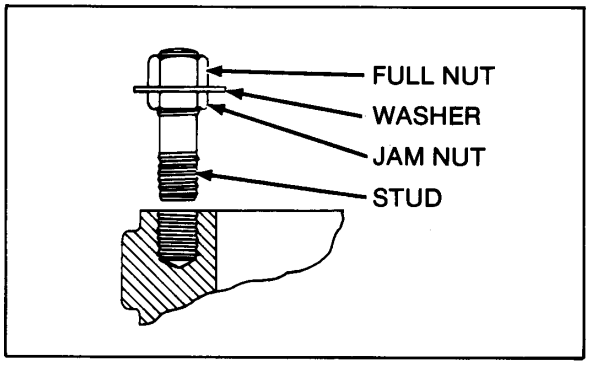


Figure 5.2.1.2.3 Stud Installation

3. Use care not to insert the stud into the thread until it bottoms-out. If the stud is in too far, stress will be incorrect and failure will be accelerated (See Figure 5.2.1.2.4).

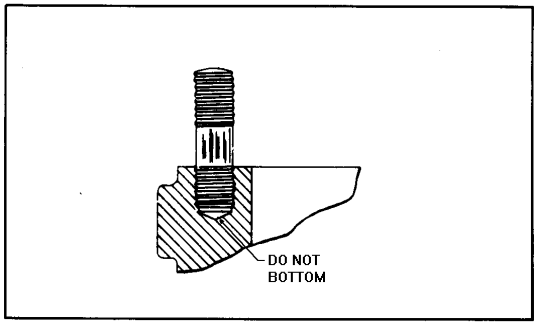


Figure 5.2.1.2.4 Correct Position of Stud

5.2.1 VALVE SETTING & LINER INSTALLATION

5.2.2.1 ALL HAMMERS EXCEPT 5150

When installing a new valve mechanism, the following steps should be observed:

1. With the valve liner in the cylinder and the blind steam chest head removed, place the valve stem and valve into the valve chest with the square end towards the open end of the valve chest. Rotate the vale and stem until the match marks on both valve and liner are together as shown in Figure 5.2.2.1.1. Once this is done, the valve stem is backed away and the trips are installed, first the fixed and then the movable. The valve and stem is then re-inserted to the outboard bearing bracket busing and the movable trips connected to the vari-cycle. The trips should then be as shown in Figure 5.2.2.1.2.

2. Replace the blind steam chest head, gasket, studs and nuts. Check all bearings for proper lubrication.

Setting the valve is important on any hammer to insure maximum efficiency.

When replacing the liner it is very important to rotate the liner to the correct angular position. This is accomplished by the dowel pin arrangement shown in Figure 5.2.2.1.1. The dowel pin hole in both cylinder and liner should be aligned with each other and the dowel pin driven through both.

Should the Cylinder require replacing, a new liner is required with the factory set angular position.

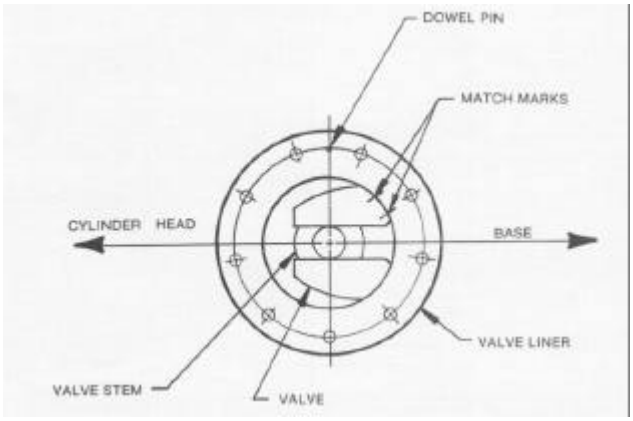


Figure 5.2.2.1.1

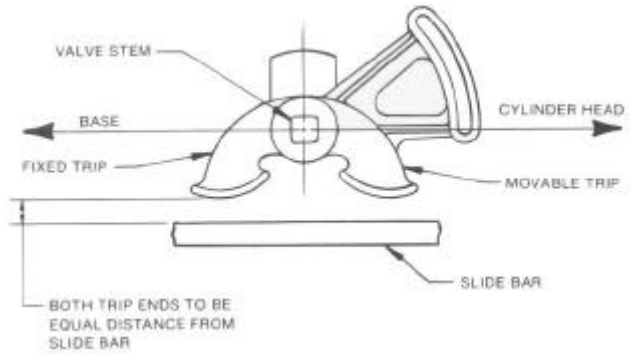


Figure 5.2.2.1.2

5.2.2.2 5150 HAMMERS

The same procedure and comments apply to this except that the figures for Steps 1 and 2 are Figures 5.2.22.2.1 and 5.2.2.2.2 respectively.

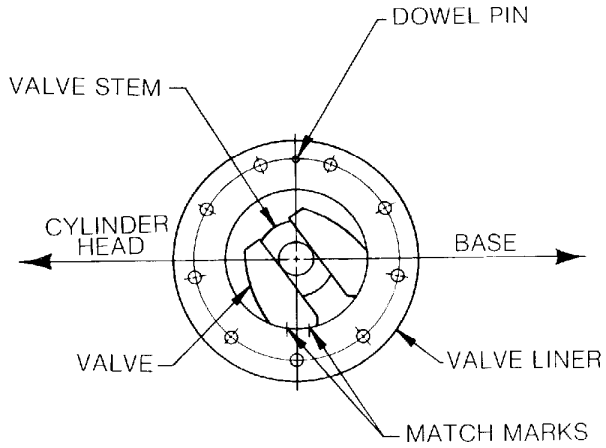


Figure 5.2.2.2.1

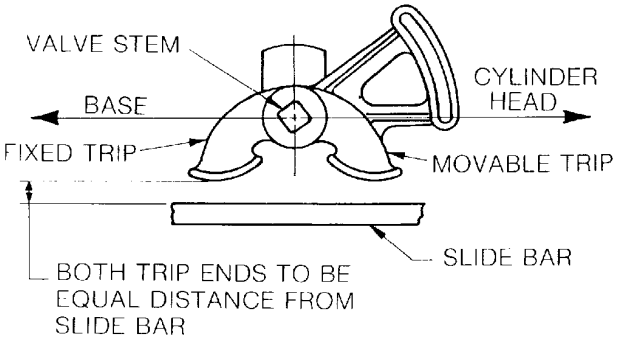


Figure 5.2.2.2.2

5.2.3 HYDRA-NUTS, AUTO-JACKS AND TIE CABLES

All Vulcan Offshore Hammers are held together by two (2) or four (4) (depending on the hammer size) tie cables, tensioned by the Hydra-Nuts or Auto-Jacks (For instructions on installing the Auto-Jack, see Section 7.0 Parts). These devices tension the cable by the use of a pressurized grease acting in an annular cylinder, similar in action to a hydraulic jack. The importance of tensioning the cables properly is great, since the loosening of the cables during driving will cause the misalignment of the cylinder, ram, columns and base, which in turn, leads to excessive wear on the column ends and seats and scoring on the ram bores and columns.

5.2.3.1 HYDRA-NUTS GENERAL

Although there are detail and parts differences between different Hydra-Nuts produced at different times, the basic principle is the same for all types of nuts. The general arrangement for the Hydra-Nut is shown in Figure

5.2.3.1.1. Grease is introduced through the high-pressure grease fittings (1) into the chamber, and is pumped until the desired cable tension and nut pressure is achieved. If at any time cable tension and nut removal is desired, the bleed nuts (20) are backed out until the exhaust port is opened to the atmosphere. On a new hammer, while mating parts are still seating themselves and the cables are still stretching to their final length, it will be necessary to check and to add grease to the Hydra-Nuts to bring the cables to their proper tension. This not unusual and should not be regarded as a sign of difficulty. The only depressurization cause that is a sign of trouble is leakage.

As with all hydraulic components, cleanliness is essential for operation. Any dirt or grit introduced through dirty grease fittings or any other source can lead to jamming of the grease fittings or damage to the internal seals, both of which will lead to leakage. ALL GREASE FITTINGS AND MATING GREASE GUN NIPPLES SHOULD BE CLEANED THOROUGHLY BEFORE INJECTING GREASE INTO THE HYDRA-NUT. LIKEWISE DISASSEMBLY MUST BE CARRIED OUT IN A CLEAN ENVIRONMENT.

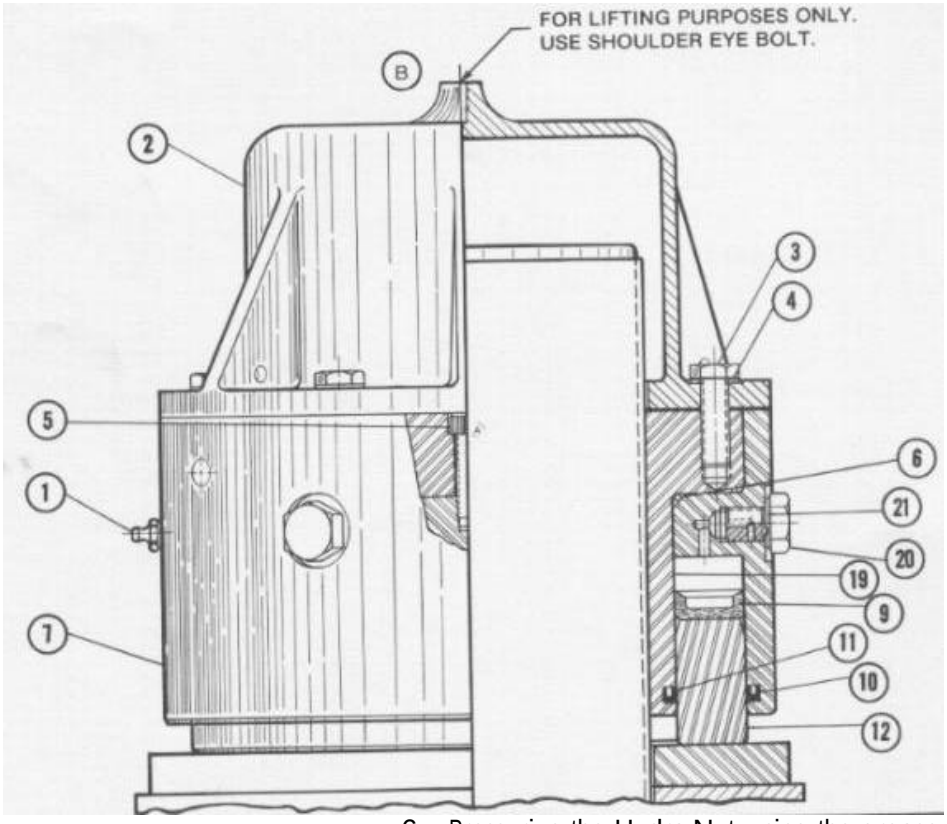


Figure 5.2.3.1.1

5.2.3.2 HYDRA-NUT INSTALLATION & REMOVAL

All instructions in this section refer to Figure 5.2.3.2.1. To tension a completely relaxed cable perform the following steps:

1. Screw the Hydra-Nut down by hand as much as possible onto the cable fitting. Use the spanner wrench holes (1) with the spanner wrench to assist in this process.
2. Looking at view "E", screw the jack nut (2) onto the cable fitting until the tops of both pieces are flush with each other; then, install the jack plate (3) and jacking bolts (4) onto the jack nut with the jacking nut studs and nuts (10).
3. With the jacking assembly together, screw the jacking bolts down evenly onto the wear plate (5). Continue to do this until the cable is taunt.
4. Turn the Hydra-Nut down until it touches the wear plate. Line up the two scribed lines (6) and (7) - this is to insure that the flats on the cable fitting and the thread protector cap line up.
5. Removal of the manual jack assembly.
6. Pressurize the Hydra-Nut, using the grease fittings and the pressures and cable tensions shown in Table 5.2.3.2.1.
7. Remove the grease gun and install the thread protector cap (11).

The maximum distance between the jack body and the wear plate (distance 8) should not exceed 1" (25mm).

Removal is done in reverse order; however, take care to depressurize the Hydra-Nuts using the bleed nuts (10).

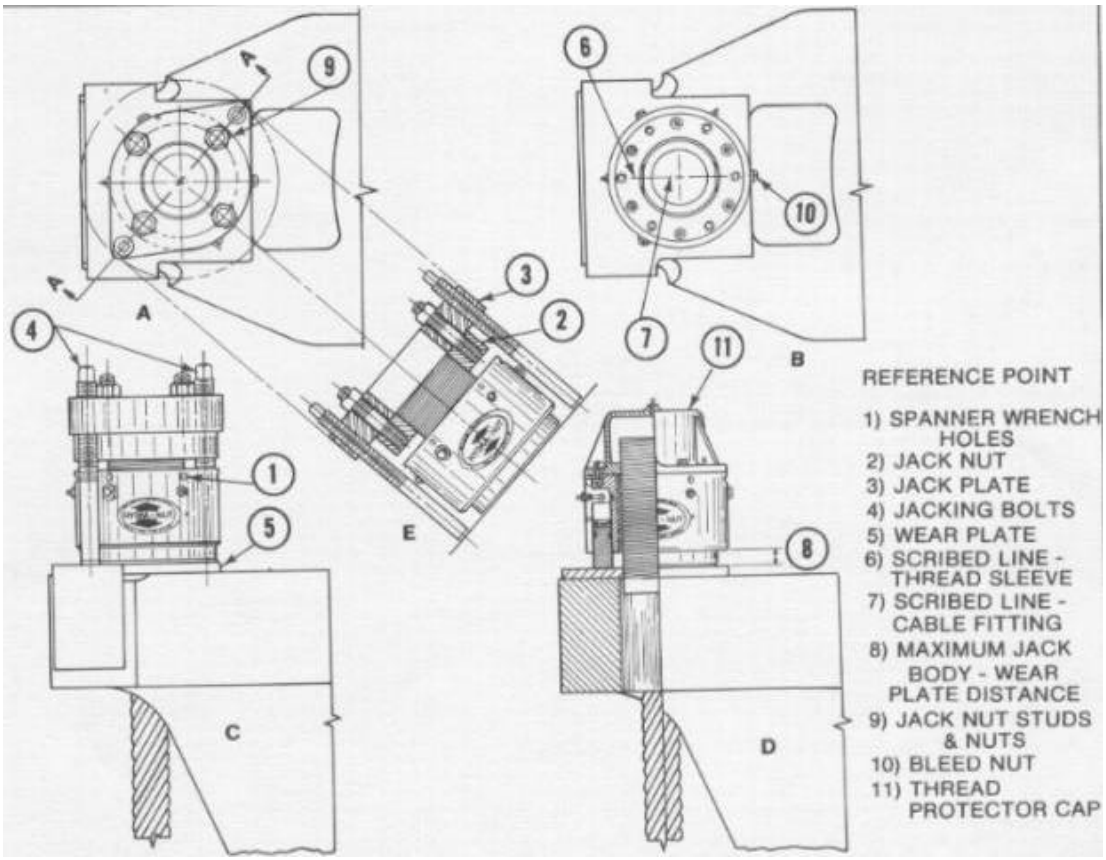


Figure 5.2.3.2.1 Hydra-Nut Installation

Table 5.2.3.2.1 Hydra-Nut Tension Specifications

	Pressure		Cable Tension
Hammer Size	psig	kp/cm^2	tons
020, 030, 530, 5100	3000	211	40
340, 540	3950	278	60
360, 560, 5110, 5150	3500	246	60

5.2.3.3 Hydra-Nut Disassembly

Once removed from the hammer the Hydra-Nuts can be disassembled using the following procedure (See Figure 5.2.3.1.1):

1. Remove the thread protector cap (2) by unfastening the thread protector cap bolts (3).
2. Remove the piston (12) and seal (9). Remove the two (2) wipers (10) and (11).
3. Remove the grease fittings (1) and bleed nuts (20).
4. Separate the jack body (7) and thread sleeve (19) by removing the thread sleeve cap screws (5).

All seals in the Hydra-Nut should be replaced at each disassembly. Assembly is in reverse order.

5.2.3.4 TIE CABLES

Tie cables should be checked periodically for their general condition, and replaced when scored, nicked, or when strands are broken.

5.2.4 PACKING GLAND

Most Vulcan Offshore Hammers are provided with a packing gland around the piston rod as shown in Figure 5.2.4.1. To install this the following procedure is used:

1. Install Junk Ring (1).
2. Install Packing (2). Install the Gland Studs.
3. Install the Gland Bushing (3), orienting the split to "A-A".
4. Install the Gland (4), rotated to "B-B".
5. Install the Gland Washer (5), rotated to "C-C". It is important that these orientations of the splits be followed to avoid uneven gland compression and leakage.
6. Install the Gland full and jam nuts, making sure that the Gland Washer surface is an even distance from the Cylinder boss at all points around. These should be simply tightened with a wrench. It is not necessary to tighten the packing so that no steam or air escapes. Overtightening of the packing can lead to excessive scoring on the Piston Rod and even to hanging the ram up. A small amount of leakage is permissible and even desirable to insure packing lubrication.

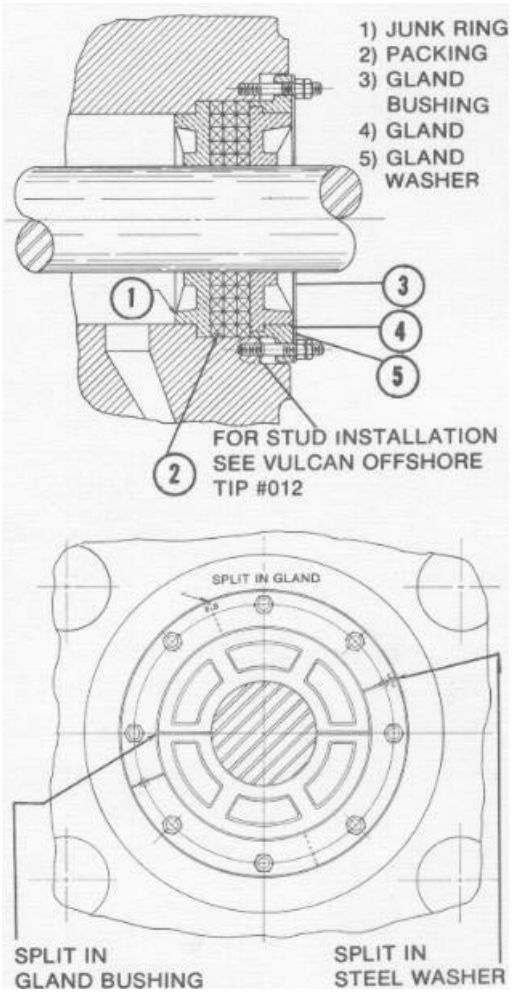


Figure 5.2.4.1 Packing Gland Installation

There are some variances to the above in certain Vulcan Hammers, which are as follows:

1. Many older Hammers have a one-piece gland in them. For these hammers it will be necessary to remove the piston from the ram and slip the gland over the small end of the piston rod.
2.
3. Many 5150 Hammers have a gland housing arrangement in them as shown in Figure 5.2.4.2. These install similarly to the ones described in the main procedure except that it will be necessary to secure the gland housing independently to the cylinder, using the studs and nuts provided.

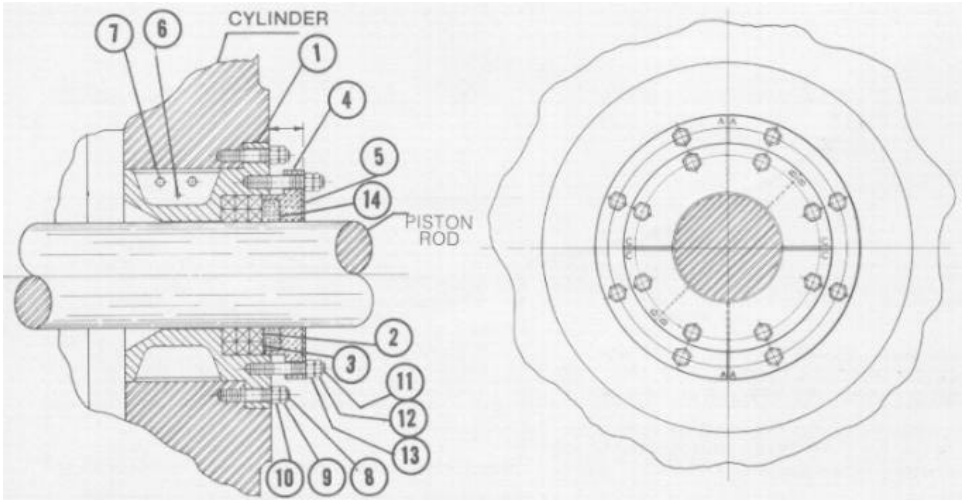


Figure 5.2.4.2 Gland Housing Assembly - 5150

5.2.5 VARI-CYCLE INSTALLATION & OPERATION

The Vari-Cycle is a mechanical accessory that can be installed on the hammer to allow the operator to attain different levels of rated energy from the hammer. Consult the factory to determine if this option can be installed on your hammer. Later hammers have this feature as a standard part of the hammer; in this case, no installation is necessary. To add the Vari-Cycle:

1. Remove the blind head, the valve, valve stem, trip, dovetail insert, slide bar and trip spacer bushing.
2. Install a three-wedge slide bar, fixed trip, movable trip, valve, valve stem and the blind head.
3. Remove the four hex-head bolts from the main cylinder pads and bolt on the Vari-Cycle cylinder using the cap screws furnished. Bolt the movable trip to the Vari-Cycle piston rod. (See Figure 5.2.5.1).
4. Drill two ¼" (6.35mm) holes, one in each foot of the Vari-Cycle, through into the cylinder pads. These holes should be as far away from the holes and edges of the feet as possible. Drive dowel pins into each of these holes.
5. Attach air or steam hose as shown in Figure 5.2.5.2. Hoses are not provided.

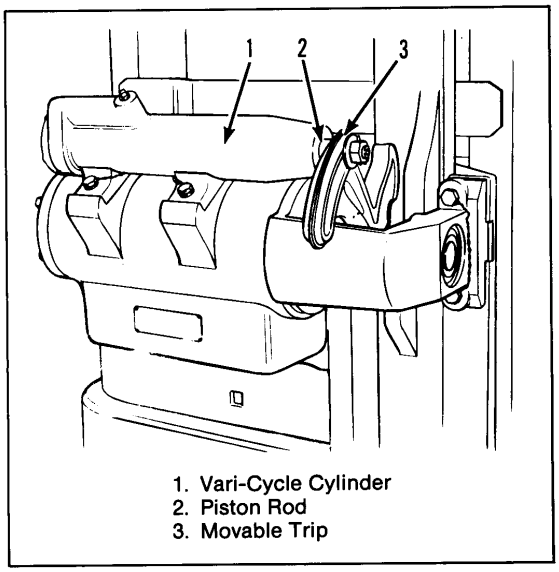


Figure 5.2.5.1

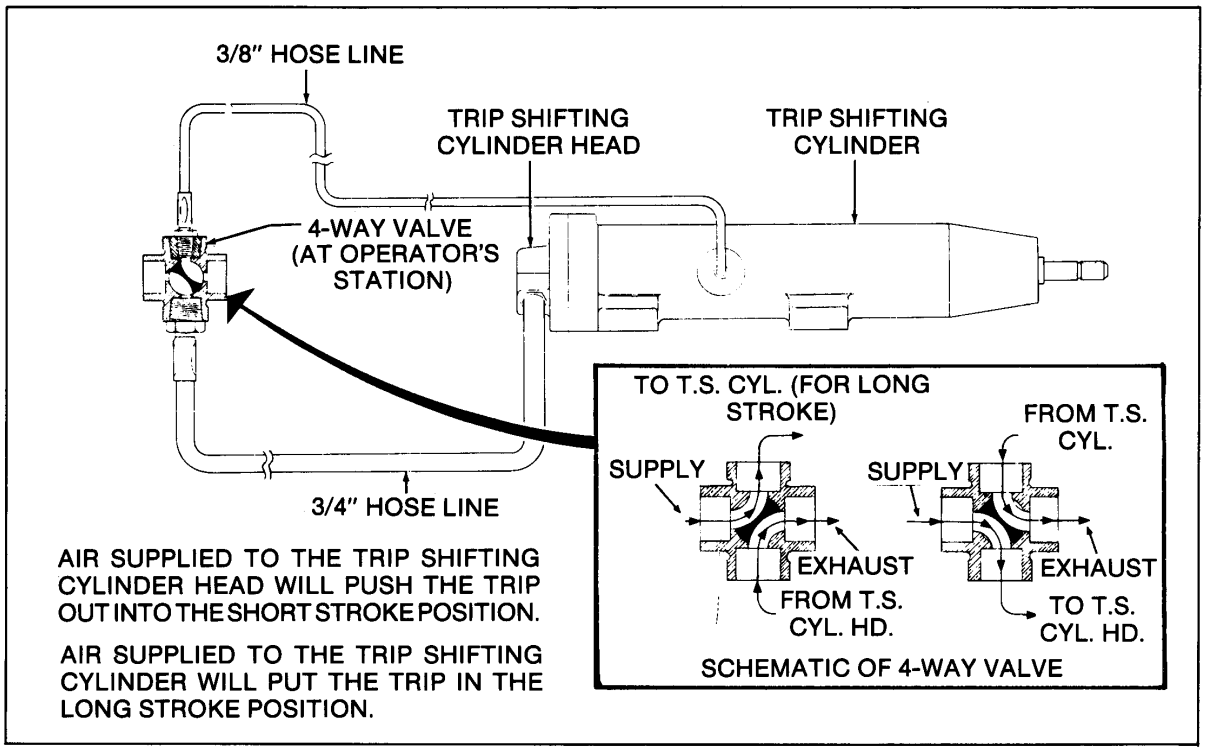


Figure 5.2.5.2 Vari-Cycle Piping Schematic

Air supplied to trip shifting cylinder head will push the trip out into the short stroke position. Air supplied to the trip shifting cylinder rod end will put the trip into the long stroke position. DO NOT shift trips while hammer is in operation.

NOTE: Vulcan does not supply the valve or hose.

Generally, two energy levels are selected, full and one-half rated energy. Any combination of energy pairs is available, from full rated to one-third rated energy.

5.2.6 OUTBOARD BEARING BRACKET

Vulcan Pile hammers equipped with the Vari-Cycle require an outboard bearing bracket o the open steam chest head. The bracket functions as a guard to protect the slide bar from damage and as an outboard bearing for the extended valve stem (See Figure 5.2.6.1).

The bracket must be installed with the outboard bearing directly in line with the open steam chest head bushing. Shims are required under the bracket foot to obtain the correct alignment. Shim thickness requirements are stamped on the cylinder on either side of the tongue and groove bracket joint. Do not deviate from the shim sizes specified on the cylinder casing.

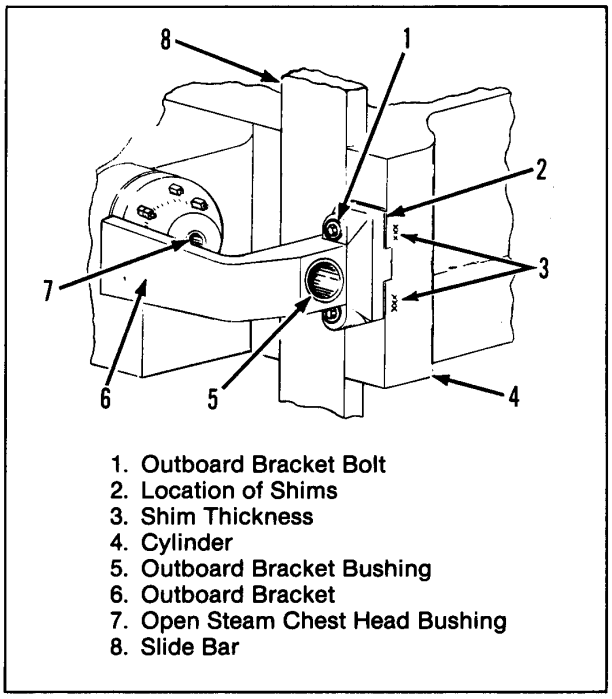


Figure 5.2.6.1 Outboard Bracket

5.3 SLIDE BAR

The slide bar is the cam that governs the operation of the hammer and as such is a very important item to install and adjust properly.

Slide Bar are retained in one of two ways (1) by use of a key bearing either directly or indirectly onto the slide bar (020, 030, 530, 360), or (2) by the use of the patented slide bar gripper (340, 540, 560, 5100, 5110, 5150). The various assemblies and operations are described below:

SLIDE BARS WITHOUT GRIPPERS

020, 030, 530: The arrangements for these hammers is shown in Figure 5.3.1.1, where a key is driven through the center of the slide bar butt. This key bears on a bushing which in turn holds the slide bar in place.

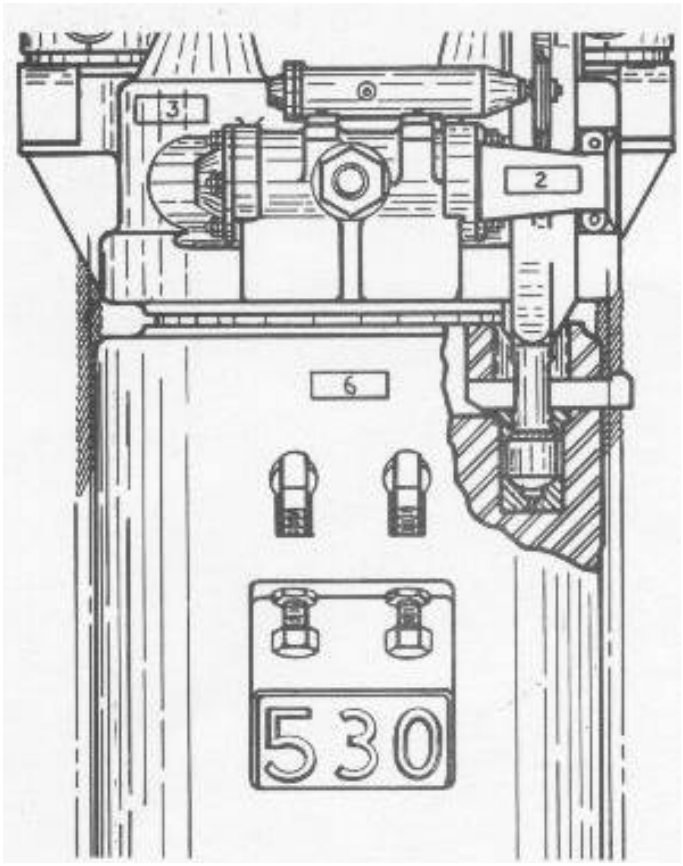


Figure 5.3.1 1

360: For this hammer the arrangement is given in Figure 5.3.1.2. The key bears on a block which in turn bears on the slide bar center slot. On this arrangement, it is especially important that the key not be overdriven, let excessive pressure be brought to bear on the slide bar leading to breakage.

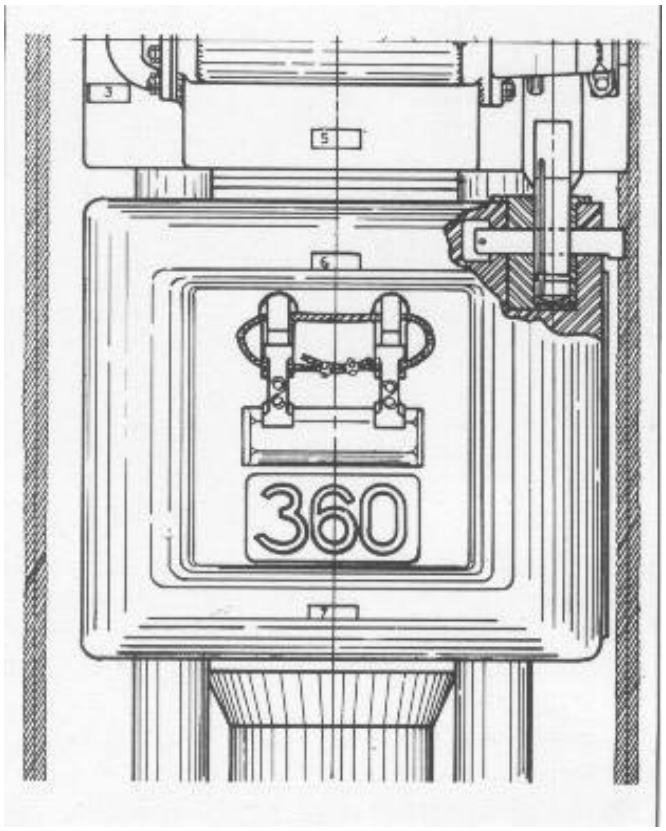


Figure 5.3.1.2

5.3.2 SLIDE BARS WITH GRIPPERS

340, 540, 560, 5110: These hammers use a gripper which retains the slide bar. This in turn is held in place by a key. The assembly for this is shown in Figure 5.3.2.1.

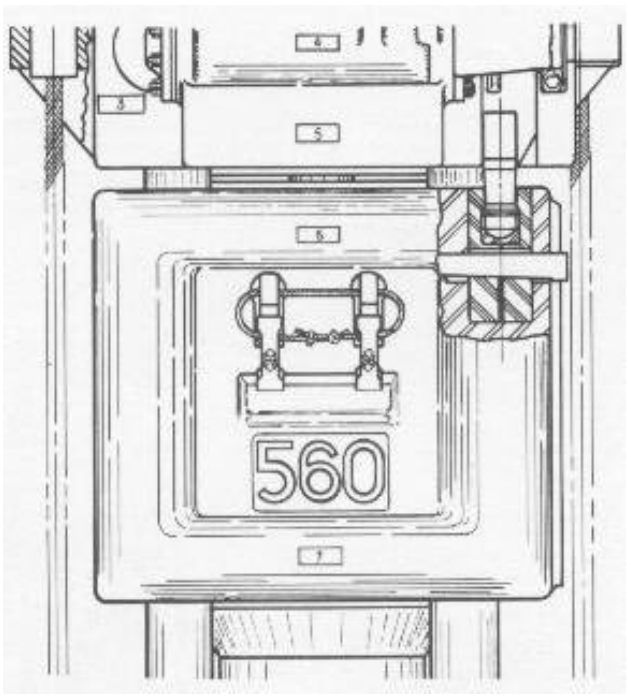


Figure 5.3.2.1

5100, 5150: The gripper for these hammers is held in place by a plugged arrangement which is shown in Figure 5.3.2.2. The assembly instructions for this are as follows:

1. Assemble the end block (A) and slide bar (B) into the gripper (C).
2. Install the gripper (C) into the ram.
3. Install the gripper retaining wedges (D) as shown.
4. Install the retaining pugs (E) and tighten. Use a pipe wrench with a long (36" or 1 meter) handle.
5. Install the set screws (F) into the retaining plugs (E) and tighten the set screws. Doing this causes the wedges to tighten against the slot in the gripper, thus securing the gripper into place.
6. Install the locking set screws (G) as shown.

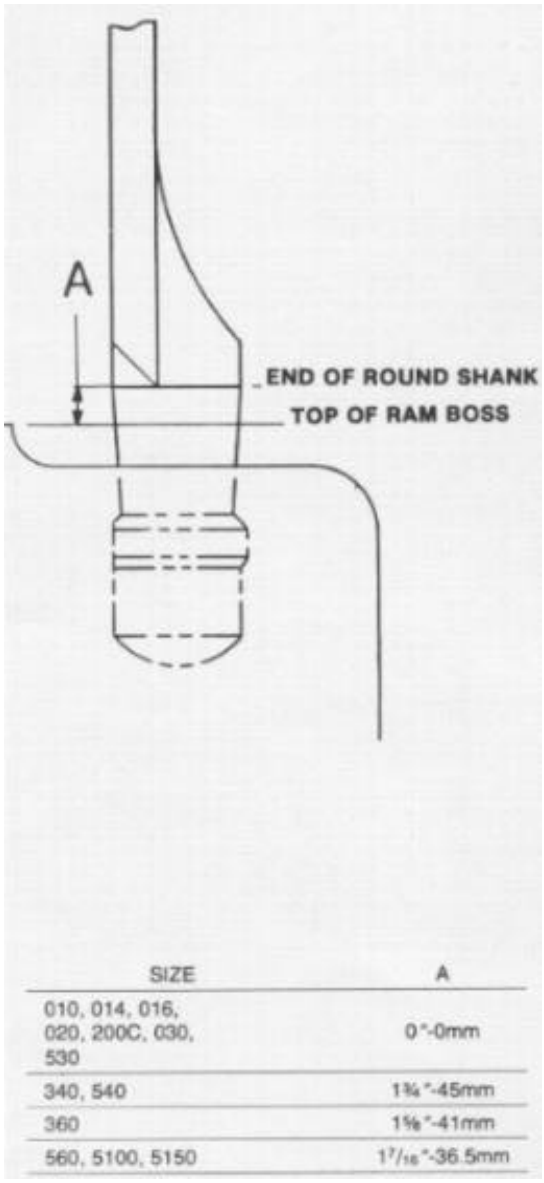
To remove the wedges utilize the tapped holes provided for this purpose. Disassembly is the reverse procedure to the above.

If there are difficulties in keeping this assembly tight welding should be avoided. Use a thread locking compound instead.

5.3.3 ADJUSTMENT

It is important that the slide bar be in the correct position for timing purposes. Figure 5.3.3.1 shows that correct

position relative to the top of the ram boss. Keyed slide bars may be adjusted by using shims under the end block. Make sure that before any shims are installed that he key and key block are of the correct width.



SIZE	A
010, 014, 016, 020, 200C, 030, 530	0"-0mm
340, 540	1¾"-45mm
360	1⅝"-41mm
560, 5100, 5150	1 7/16"-36.5mm

Figure 5.3.3.1 Slide Bar Adjustment Dimensions

5.4 PISTON & ROD

All Vulcan Offshore Hammers use a single piece piston and rod with two piston rings. Gap specifications for these are given in Table 5.4.1. This should be checked whenever new piston rings are installed or old one reinstalled. If the gap on standard piston rings is too large because the bore

is 3/32" (2.4mm) too large, then standard oversize piston rings can be fitted to the hammer. For hammer with a bore 3/16" (4.8mm) oversize a new cylinder is required or, in the case of the 5150 hammer, a new cylinder liner can be used. This replacement should also be carried out if the cylinder bore is excessively scored.

Table 5.4.1 Piston Ring Gap Specifications

	inches		millimeters	
Hammer Size	maximum	minimum	maximum	minimum
020, 030, 530	.126	.102	3.20	2.59
340, 540	.192	.162	4.88	4.11
360, 560, 5110	.215	.183	5.46	4.65
3100, 5100, 5150	.288	.240	7.32	6.10

5.4.1 PISTON & ROD REMOVAL

The piston and rod should be replaced only when the hammer is in the vertical position. Once the hammer has been placed in this position, the following parts are to be removed in the order specified in order to ultimately remove the old piston and rod:

1. Cylinder Head and Gasket
2. Gland Assembly (See Section 5.2.4)
3. Ram Keys
4. Split Bushing
5. Old Piston & Rod

Reassembly is in reverse order.

5.4.2 RAM CUSHION

Figure 5.4.2.1 shows the piston and rod retainer assembly. It is important to note that the spit bushing / ram key assembly does not bear directly on the piston and rod; rather, the piston and rod ram cushion (and perhaps also a ram plate or plug) are simply trapped with a small amount of clearance between the ram point and split bushing. Thus, when the ram cushion is replaced, extreme care must be taken to insure proper dimensional control over the assembly.

To replace the ram cushion, the hammer must be fully assembled. The following procedure is to be adhered to in fitting a new ram cushion:

1. Remove the old ram cushion and any plates, plugs, or shims. Clean all parts, along with the bore and ram point neck surface. If any plates or plugs are deformed, replace these at this point.
2. Place a new ram cushion into the ram.
3. Install the piston and rod, seating it snugly to the cushion. Install the split bushing snugly against the seat. Check accurately the distance between the top of the piston and rod and the bottom of the split bushing. This distance should be between .015" and .020" (0.38mm to 0.51mm). If it is greater than this, place a steel shim of correct thickness underneath the ram cushion. If it is less than this, machine the ram cushion until this dimension is achieved. In either case machining of the surfaces of either the cushion or the shim must be parallel. If a shim is necessary then it should be no thinner than 1/8" (9mm). This is true even if this requires machining the cushion.

With the ram keys installed, the piston and rod should be able to freely move within the ram, the split bushing's shoulder clamped tightly to the ram.

5.5 RAM KEYS

All offshore Vulcan Hammers use tapered ram keys to retain the split bushing and thus the piston and rod in the ram. In order for these to function properly they must be tightened properly. To do this use the following procedure (you may use Figure 5.4.2.1 to help in identifying the parts):

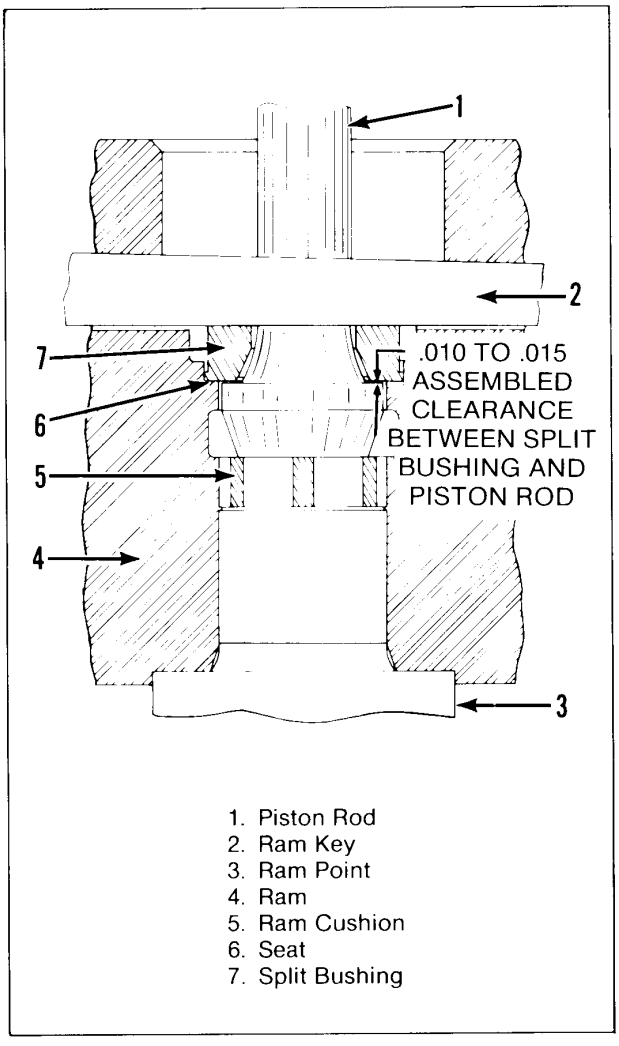


Figure 5.4.2.1 Ram Cushion & Key Assembly

1. Position the split bushing properly, making sure that it and the ram cushion are in good condition.
2. With the hammer either vertical or horizontal, insert the ram keys into the slots, large end to valve chest side.

3. Using a large hammer (such as a 20 lb. (9kg) mall), drive the keys into place until tight. The method used to determine proper tightness is to take a .002" (0.05mm) feeler gauge and insert it between the top of the key and the top of the ram key slot (machined surfaces). This feeler gauge should just slip into the gap created by the slight bending of the keys.
4. Install the ram key retainers. There are several types, listed below:

- 020: Roll Pin, inserted through the back of the key.
- 030, 530, 340, 540, 5110, 5150: Angled ram key retainer bolt. Make sure this seats firmly against the key.
- 360, 560, 5100: Ram key retainer wedges. These are inserted between the ram keys and an angled pad on the ram itself, and held into place by retainer bolts. These should also be tight when installed.

IT IS VERY IMPORTANT NOT TO ALLOW THE KEYS TO BECOME LOOSE DURING DRIVING. This will shorten the life of the ram keys and key slots. They keys must be kept tight at all times. Do not use any other retainer system other than the one provided.

DO NOT over tighten the keys. This will shorten the life of the keys and slots.

5.6 COLUMNS

Column maintenance is essential to the successful operation of the hammer. All columns should be lubricated as shown in the Lubrication Section, Section 5.1. Hammers larger than the 340 are provided with grease fittings in the ram to facilitate filling up the ram pockets with grease.

Both column seats and butts must be maintained in good condition. Failure to do so will result in columns, cylinder and base misalignment and damage to any or all three. All column lengths must be equal in any given set of four columns. Likewise column seat locations must be maintained at their original lengths.

5.8 PIPE CAP

The pipe cap is loaded with cushion material as shown in Figure 5.8.1 if it has a standard pot and 5.8.2 if it is fitted with a capblock follower. If the latter is used, in addition to the cabling procedure described in Section 4.1, the hammer must be cabled to the follower and the follower to the pipe cap.

Whenever the cushion pot ring is cracked or broken, it must be replaced with a repair ring. Consult the factory for this procedure. Care must be taken when welding adapters of any kind onto pipe caps, since these are for the most part alloy steel castings and require special welding procedures and care.

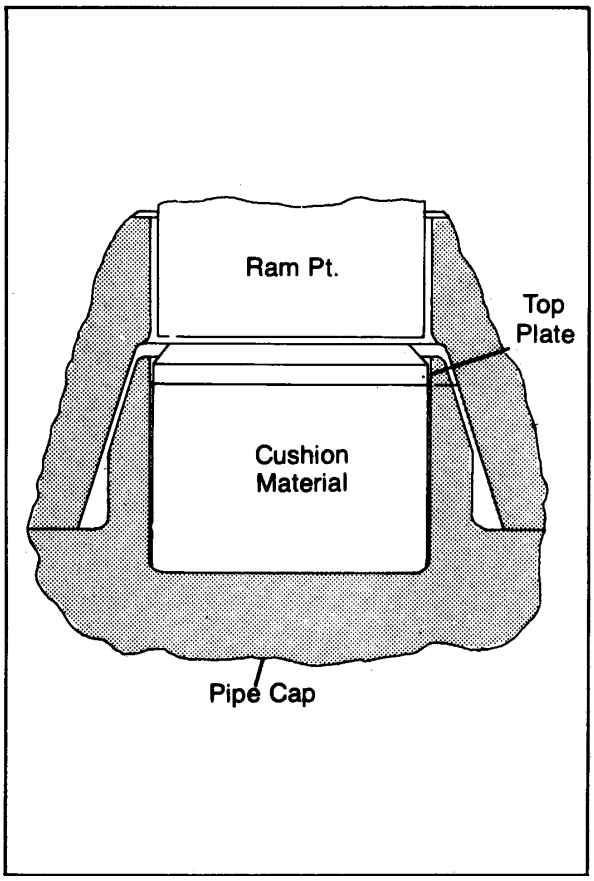


Figure 5.8.1 Integral Ring Cushion Pot

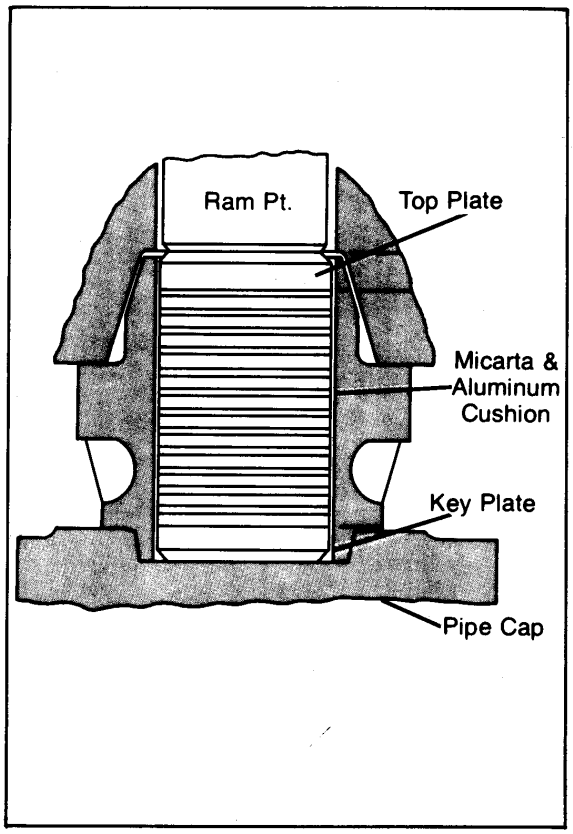


Figure 5.8.2 Capblock Follower Assembly

6.0 TROUBLESHOOTING

Symptom	Possible Cause	Remedy
Hammer Runs too slow	1. Steam Pressure too low. 2. Steam supply line too long or not proper size. 3. Steam supply line restricted in some manner. 4. Lack of lubrication 5. Worn piston rings or scored cylinder wall. Check this by allowing enough steam to enter the cylinder to hold the ram in about a half-raised position and note whether excessive steam is blowing out of exhaust ports at top of cylinder. 6. Piston rod packing too tight. 7. Leakage or using steam for other purposes while hammer is running. 8. Badly worn slide bar wedges.	1. Check pressure at boiler. Due to line loss, the pressure at boiler should be greater than the manufacturers required pressure at hammer. 2. Use specified line size or larger. Supply line from the boiler to the hammer should be only as long as necessary. 3. Try new hose. Check throttle valve to see that it opens properly. Eliminate all hose kinks and as many elbows and bends as possible in the steam supply line. 4. Check oil level in lubricator and see that lubricator is functioning properly. Check hammer columns for burrs and lubricate columns properly. 5. Replace piston rings. Be sure rings have required gap. Machine scores from cylinder wall. 6. Loosen packing gland nuts until they are just hand tight against the packing gland. Lock the two nuts against each other to keep them in place. A small amount of steam leakage from the packing gland is not objectionable. 7. Stop leaks and other waste of steam while hammer is operating. 8. Replace slide bar.
Hammer Runs Too Fast	9. Excessive steam pressure on hard driving indicated by bouncing of hammer on up-stroke. 10. Ram not making full stroke.	1. Slow down by partially closing throttle valve. 2. Check for bent or twisted valve stem. Check valve setting.
Excessive Slide Bar Breakage	11. Slide bar key or retainer wedge or plug loose. 12. Tie Cables loose or unequally tensioned	1. Check slide bar key or wedge or plug and key seat for proper fit. Key must be kept tight at all times. Wedge or plug must also

	tensioned. 13. Worn Dovetail.	be kept fit. 2. Tighten tie cables to prescribed tension. 3. Replace dovetail insert.
Hammer Changes Speed While Operating	14. Boiler not large enough or improperly fired. 15. Boiler feed water allowed to drop too low. 16. Loose or torn hose lining. 17. Intermittent lubrication caused by defective line lubricator. 18. Loose slide bar.	1. Larger boiler. Do not use steam for other purposes while hammer is operating. 2. Check water level and fireman. 3. Replace with new hose. 4. Replace lubricator. 5. Replace slide bar, slide bar key or gripper.
Hammer Leaks Steam at Main Exhaust Port Constantly	19. Valve not seating properly. 20. Scored or broken steam chest liner.	1. Check to see if valve is broken or scored. Replace with new valve. 2. Replace steam chest liner.
Hammer Leaks Steam Excessively from Exhaust Ports at Top of Cylinder on Up-Stroke	21. Worn or broken piston rings. 22. Scored Cylinder wall.	1. Replace piston rings. 2. Machine Scores out of cylinder wall.
Ram Hangs and Hammer Stops Operating	23. Loose or unequally tensioned Cables. 24. Rust or burrs on columns. 25. Piston Rings too large and seized up in cylinder. 26. Piston packing too tight.	1. Retension cables to specified tension. 2. Dress columns to smooth finish. 3. Check ring dimensions and see that the have sufficient gap. 4. Loosen packing gland nuts until they are just hand tight against packing gland. Lock the two nuts against each other to keep them in place.
Cable Breaking	27. Pile running out from under hammer causing ram to strike base. 28. Cables injured by burning or welding. 29. Cables injured by carelessness. 30. Unequal tensioning causing one cable to do all of the work. 31. Insufficient cushion material allowing ram to strike base.	1. Distance from top of pile to bottom of leads should be sufficient to keep the hammer on top of the pile at all times. 2. Cables should be protected whenever burning or welding is being done close to the hammer. 3. Cables should be protected from sharp or falling objects while hammer is lying on deck. 4. Keep cables tensioned equally

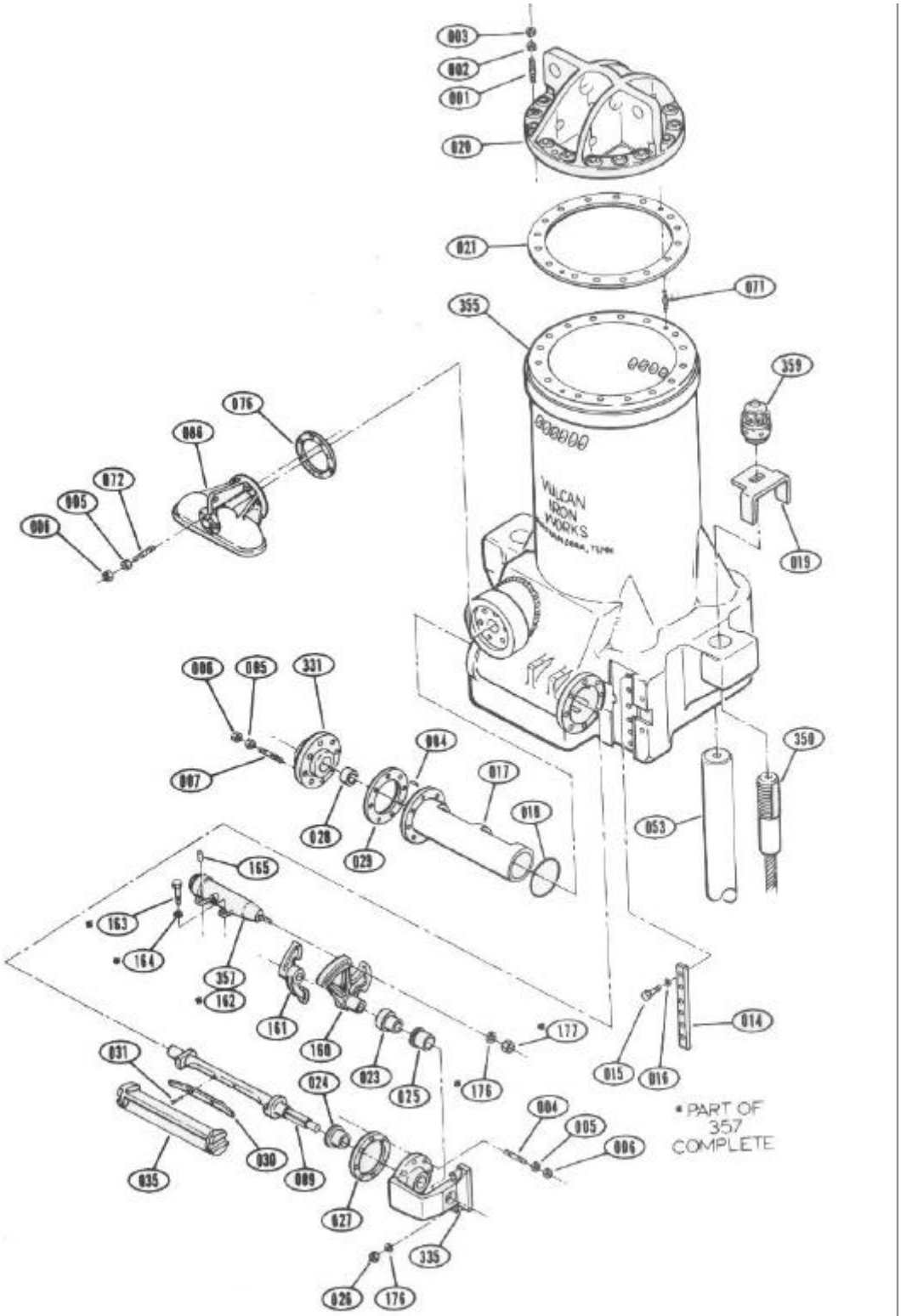
		according to our specifications. 5. Cushion material should never be allowed to get lower than 3" from the top of the cushion container.

7.0 PARTS

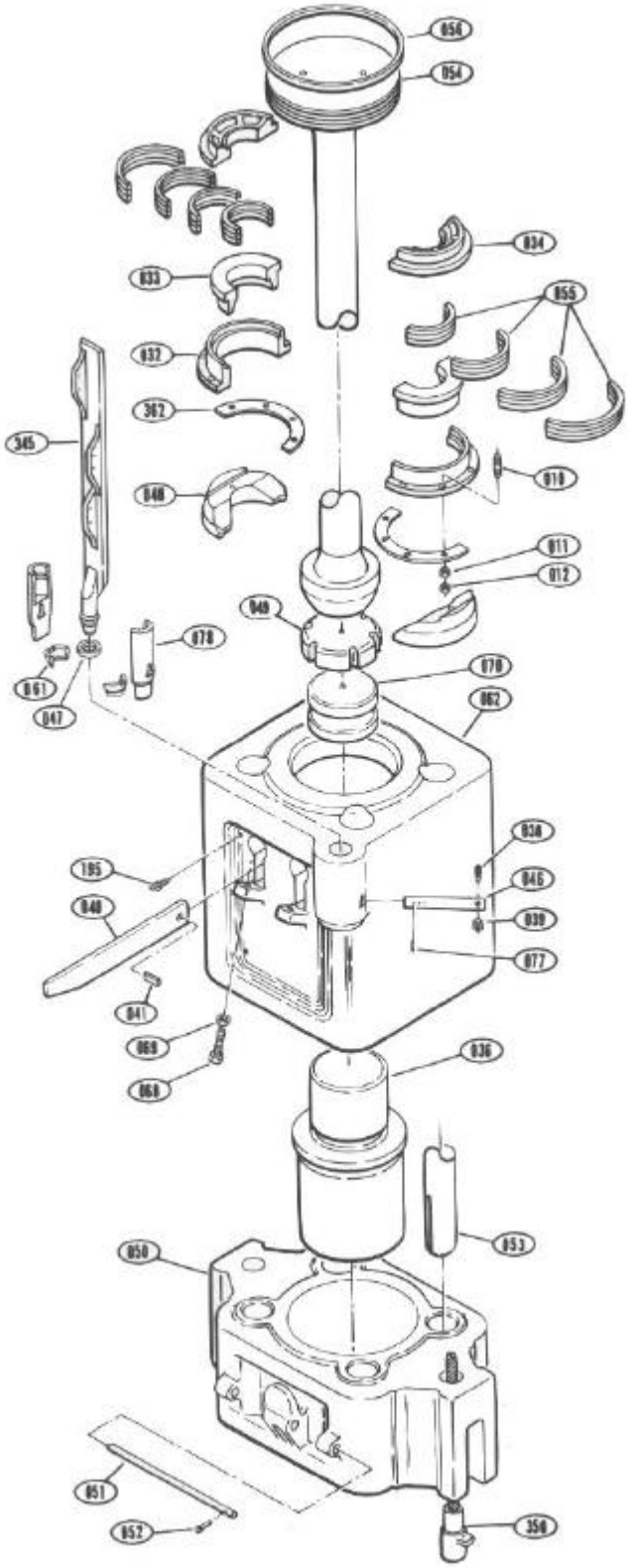
Refer to the parts drawing in this section of the manual that identifies the part or assembly with the key number and a line pointing to the part or assembly. Refer to the name of the part or assembly as given in this manual. Use this name and part number in ordering parts. PARTS ORDERS SHOULD INCLUDE THE FOLLOWING INFORMATION.

1. Model and Serial Number of the Hammer.
2. Part Number and Name. Do not use the key number.
3. Quantity required.
4. Specific Shipping instructions.
5. Purchase order number, if any.

HAMMER SIZE 020, 030, 340, 540, 530



HAMMER SIZE 020, 030, 340, 540, 530



Hammer Size - 020, 030, 340, 540, 530

Key No.	Description	Part No. 020	Part No. 030	Part No. 340	Part No. 540	Part No. 530
001	Cylinder Head Stud	08F0101	09F0101	18F0101	20F0101	38F0101
002	Cylinder Head Stud Nut - Jam	08F0102	09F0102	18F0102	20F0102	38F0102
003	Cylinder Head Stud Nut - Full	08F0103	09F0103	18F0103	20F0103	38F0103
004	Open Steam Chest Head Stud	08F0104	09F0104	18F0104	20F0104	38F0104
005	Open Steam Chest Head Stud Nut - Jam	08F0105	09F0105	18F0105	20F0105	38F0105
006	Open Steam Chest Head Stud Nut - Full	08F0106	09F0106	18F0106	20F0106	38F0106
007	Blind Steam Chest Head Stud	08F0107	09F0107	18F0107	20F0107	38F0107
005	Blind Steam Chest Head Stud Nut - Jam	08F0108	09F0108	18F0108	20F0108	38F0108
006	Blind Steam Chest Head Stud Nut - Full	08F0109	09F0109	18F0109	20F0109	38F0109
010	Stuffing Box Stud	08F0110	09F0110	18F0110	20F0110	38F0110
011	Stuffing Box Stud Nut - Jam	08F0111	09F0111	18F0111	20F0111	38F0111
012	Stuffing Box Stud Nut - Full	08F0112	09F0112	18F0112	20F0112	38F0112
014	Dovetail Insert	08F0114	09F0114	18F0113	20F0113	38F0114
015	Dovetail Insert Fastener Bolt	08F0115	09F0115	18F0114	20F0114	38F0115
016	Dovetail Insert Fastener Bolt - Lock Washer	08F0116	09F0116	18F0115	20F0115	38F0116
017	Cylinder Valve Liner	08F0117	09F0117	18F0116	20F0116	38F0117
018	Cylinder Valve Liner - O-Ring Gasket	08F0118	09F0118	18F0117	20F0117	38F0118
019	Cylinder Wear Plates	08F0147	09F0148	18F0119	20F0119	38F0120
020	Cylinder Head- Suspension	08F0148	09F0157	18F0152	20F0120	38F0149
021	Cylinder Head- Gasket	08F0122	09F0121	18F0121	20F0121	38F0121
023	Open Steam Chest Head Outboard Bushing Spacer	08F0124	09F0123	18F0123	20F0123	38F0123
024	Open Steam Chest Head Inboard Bushing	08F0125	09F0124	18F0124	20F0124	38F0124
025	Open Steam Chest Head Outboard Bushing	08F0126	09F0125	18F0125	20F0125	38F0125
026	Bolt - Outboard Bearing Bracket	08F0127	09F0126	18F0126	20F0126	38F0126
027	Open Steam Chest Head Gasket	08F0131	09F0130	18F0130	20F0130	38F0130
028	Open Steam Chest Head Bushing	08F0133	09F0132	18F0132	20F0132	38F0132
029	Blind Steam Chest Head Gasket	08F0134	09F0133	18F0133	20F0133	38F0133
030	Valve Spring	08F0135	09F0134	18F0134	20F0134	38F0134
031	Valve Spring Rivets	08F0136	09F0135	18F0135	20F0135	38F0135
032	Gland	08F0138	09F0137	18F0137	20F0137	38F0137
033	Gland Bushing	08F0139	09F0138	18F0138	20F0138	38F0138
034	Junk Ring	08F0140	09F0139	18F0139	20F0139	38F0139
035	Valve	08F0141	09F0140	18F0140	20F0140	38F0140
005	Pipe Flange Stud Nut - Jam			18F0145	20F0145	
006	Pipe Flange Stud Nut - Full			18F0146	20F0146	
036	Ram Point	08F0201	09F0201	18F0201	20F0201	38F0201
040	Ram Key	08F0205	09F0205	18F0203	20F0203	38F0205
046	Slide Bar Key	08F0210	09F0210	18F0208	20F0208	38F0210
047	Slide Bar End Block	08F0211	09F0211	18F0209	20F0209	38F0211
048	Split Bushing	08F0212	09F0212	18F0210	20F0210	38F0212
049	Ram Cushion	08F0213	09F0213	18F0211	20F0211	38F0213
050	Base	08F0304	09F0304	18F0300	20F0300	38F0300
051	Lock Bar	08F0301	09F0301	18F0301	20F0301	38F0301
052	Lock Bar Pin	08F0302	09F0302	18F0302	20F0302	38F0302
053	Columns	08F0303	09F0303	18F0303	20F0303	38F0303
054	Piston & Rod	08F0400	09F0400	18F0400	20F0400	38F0400
055	Piston & Rod Packing	58V0945	58V0945	10F0945	10F0945	38F0945
056	Piston Rings	08F0404	09F0404	18F0404	20F0404	38F0404
057	Piston Rings Std. Oversize	08F0405	09F0405	18F0406	20F0406	38F0405
062	Ram	08F0200	09F0200	18F0200	20F0200	38F0200
068	Ram Key Set Screw		09F0214	18F0212	20F0212	38F0214
069	Ram Key Set Screw Lock Nut - Jam		09F0215	18F0213	20F0213	38F0215
070	Ram Plug		09F0216	18F0216	20F0217	38F0216
071	Cylinder Head Pilot Pin			18F0143	20F0143	
072	Pipe Flange Stud			18F0144	20F0144	
076	Double Pipe Flange Gasket			18F0149	20F0149	
077	Slide Bar Key - Roll Pin			18F0215	20F0215	
078	Gripper			18F0218	20F0217	
084	Cylinder Valve Liner Dowel Pin	08F0119	09F0119	18F0118	20F0118	38F0119

086	Triple Pipe Flange				20F0152	
089	Valve Stem	08F0137	09F0136	18F0136	20F0136	38F0136
176	Open Steam Chest Head Bracket - Washer	08F0128	09F0127	18F0127	20F0127	38F0127
195	Ram Grease Fitting			18F0217	20F0216	
331	Blind Steam Chest Head	08F0132	09F0131	18F0131	20F0131	38F0131

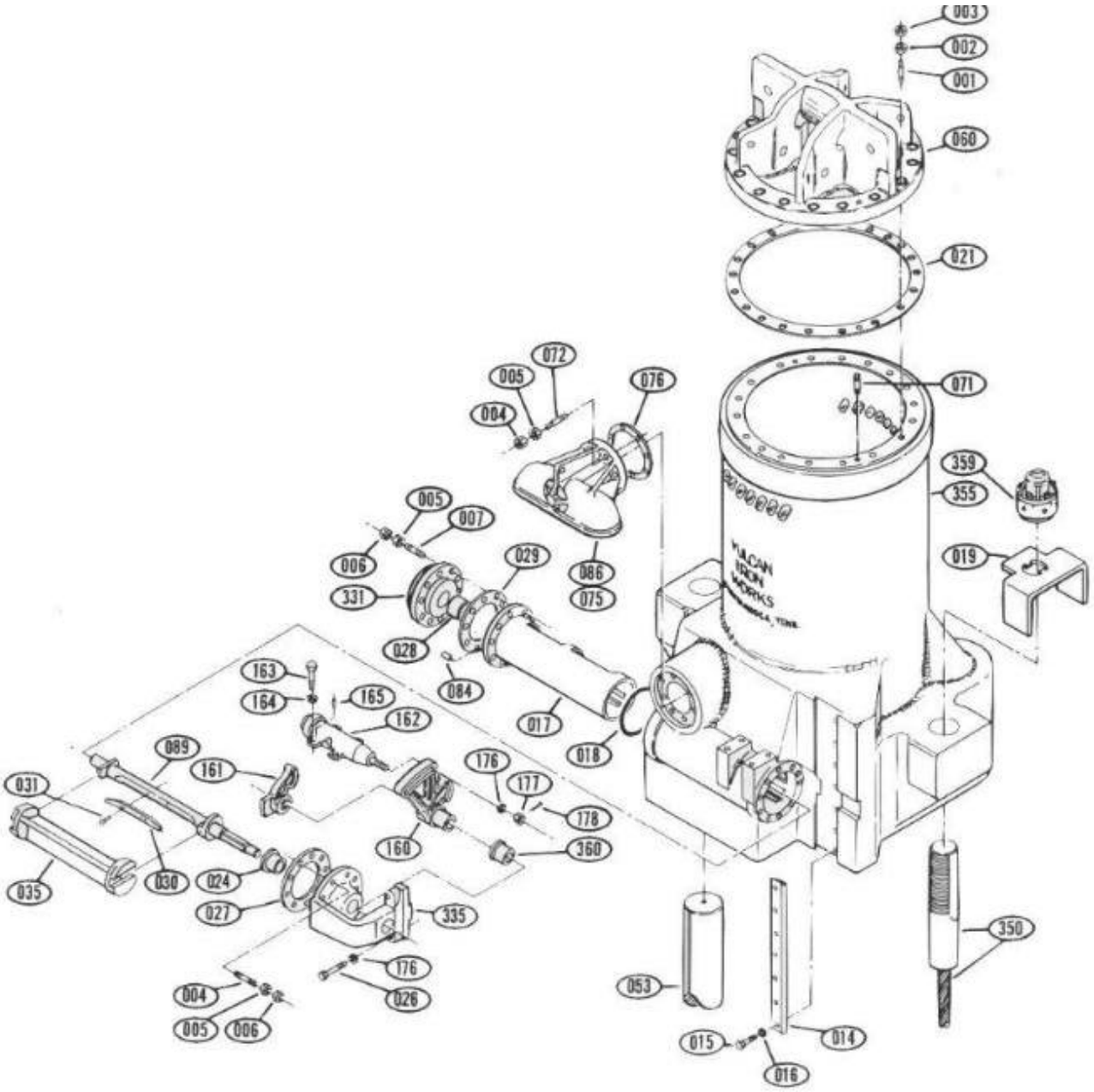
Hammer Size - 020, 030, 340, 540, 530

Key No.	Description	Part No. 020	Part No. 030	Part No. 340	Part No. 540	Part No. 530
335	Open Steam Chest Head Bracket	08F0130	09F0129	18F0129	20F0129	38F0129
350	Cable Assembly Complete	08F0922	09F0921	18F0923	20F0921	38F0910
355	Cylinder	08F0146	09F0147	18F0100	20F0100	38F0100
362	Split Washer	08F0158	09F0158	18F0154	20F0153	38F0158
160	Movable Trip	08F0734	09F0734	18F0700	20F0700	38F0700
161	Standard Trip	08F0123	09F0122	18F0122	20F0122	38F0122
162	Cylinder - Trip Shifting	08F0702	09F0702	18F0702	20F0702	38F0702
163	Cylinder Bolts - Trip Shifting	08F0703	09F0703	18F0703	20F0703	38F0703
164	Cylinder Bolts Washer - Trip Shifting	08F0704	09F0704	18F0704	20F0704	38F0704
165	Cylinder Dowel Pins - Trip Shifting					
177	Piston Nut - Trip Shifting	08F0718	09F0718	18F0718	20F0718	38F0718
355	Cylinder Complete - Incl. 1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 71, 72	08F0924	09F0925	18F0900	20F0900	38F0900
355	Cylinder Only - Incl. 355, 14, 15, 16, 17, 18, 84	08F0923	09F0924	18F0917	20F0915	38F0904
335	Open Steam Chest Head Bracket - Incl. 335, 24, 25	08F0901	09F0901	18F0901	20F0901	38F0901
331	Blind Steam Chest Head - Incl. 331, 28	08F0902	09F0902	18F0902	20F0902	38F0902
054	Piston & Rod Complete - Incl. 54, 55, 56	08F0903	09F0903	18F0903	20F0903	38F0903
062	Ram Complete - Incl. 62, 36, 40, 68, 69	08F0905	09F0905	18F0905	20F0905	38F0905
050	Base Complete - Incl. 50, 51, 52	08F0925	09F0926	18F0906	20F0906	38F0907
345	Slide Bar Complete (Nylon) 3-Wedge	08F0931	09F0935	18F0927	20F0927	38F0923
359	Hydra-Nut Complete	08F0913	09F0913	18F0913	20F0913	38F0913
350	Cable W/End Fittings	08F0922	09F0921	18F0923	20F0921	38F0910
357	Vari-Cycle Complete 162 thru 181 (see Vari-Cycle drawing)	08F0929	09F0933	18F0925	20F0925	38F0921
089	Valve Stem Complete - Incl. 30, 31, 89	08F0910	09F0910	18F0910	20F0910	38F0906
345	Slide Bar Complete (Nylon) 2-Wedge	08F0909	09F0909	18F0909	20F0909	38F0909
038	Set Screw - Slide Bar Key	08F0203	09F0203			38F0203
039	Lock Nut - Jam - Set Screw	08F0204	09F0204			38F0204
041	Ram Key Pin	08F0206				
061	Slide Bar Key Block Split	08F0214	09F0217			38F0217

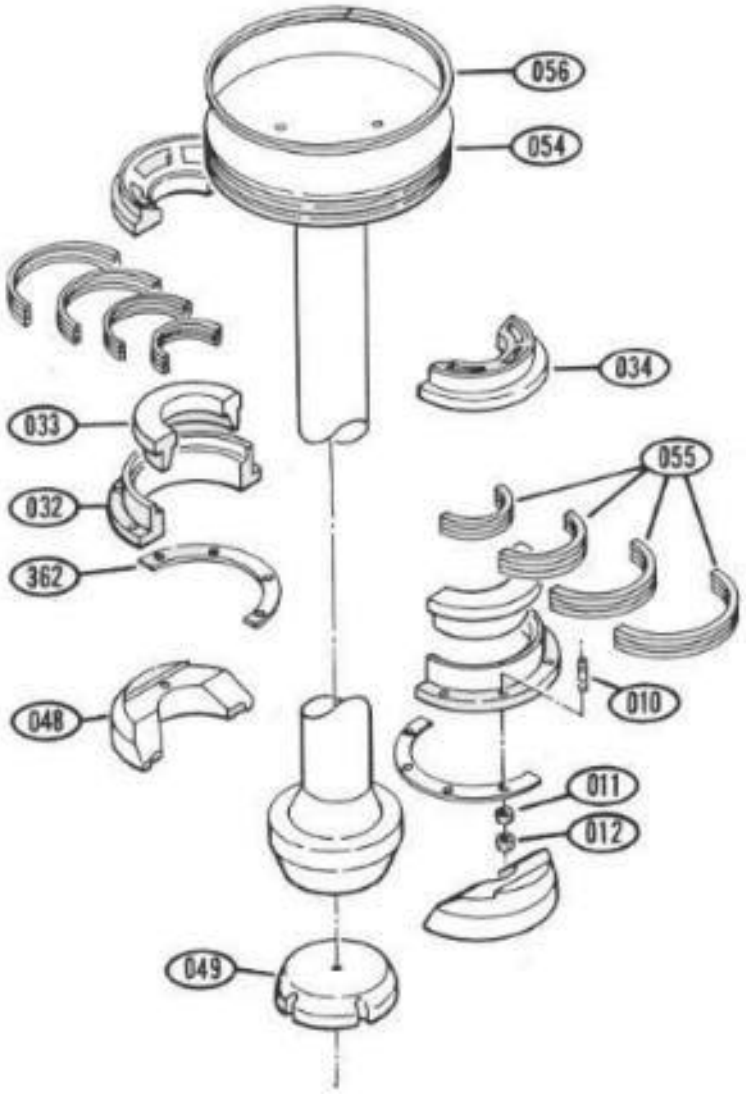
VULCAN IRON WORKS INC.

(800) 742-6637 or (423)698-1581

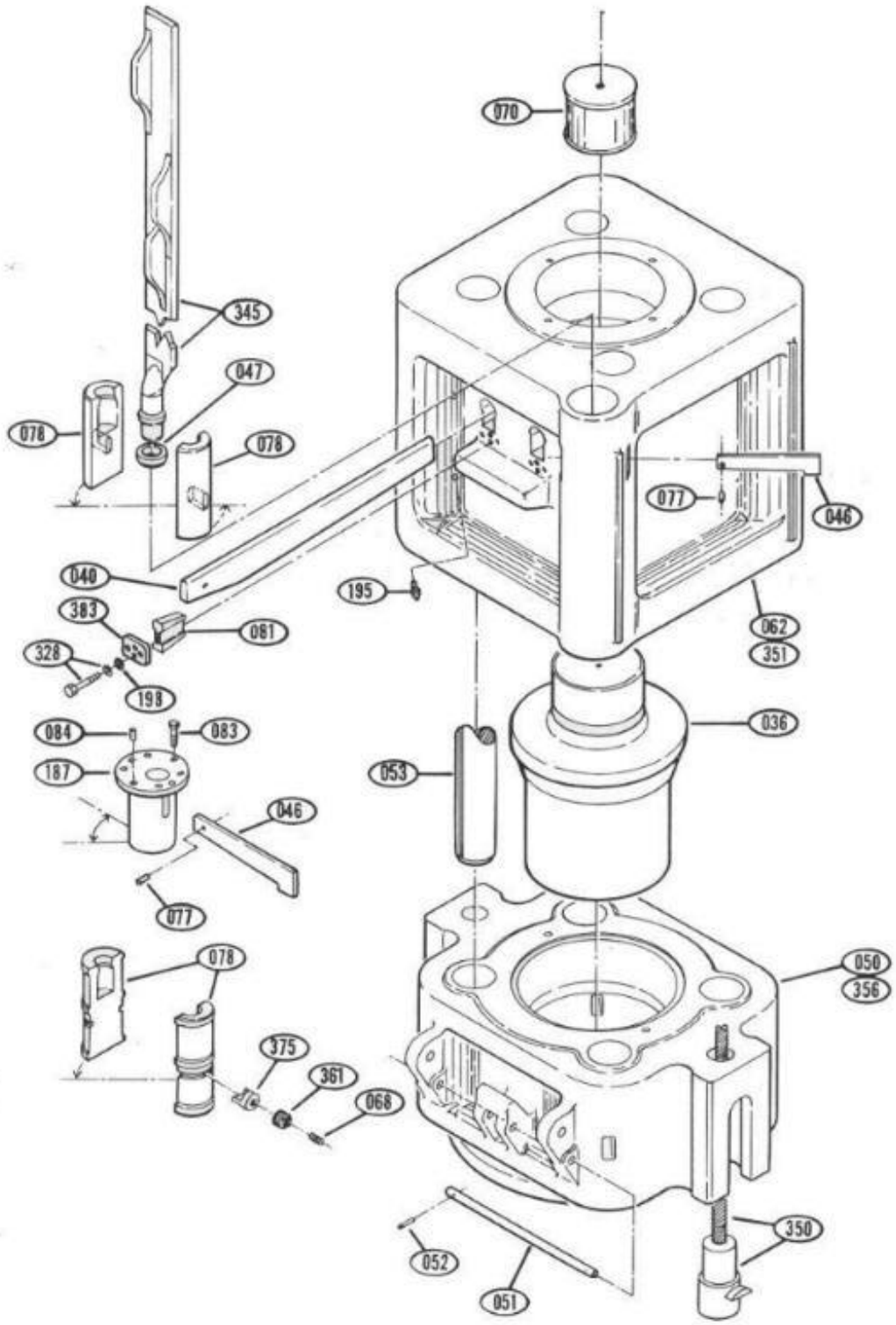
HAMMER SIZE 360, 560, 5100, 5110



HAMMER SIZE 360, 560, 5100, 5110



HAMMER SIZE 360, 560, 5100, 5110



VULCAN IRON WORKS INC.

(800) 742-6637 or (423)698-1581

Hammer Size - 360, 560, 5100, 5110

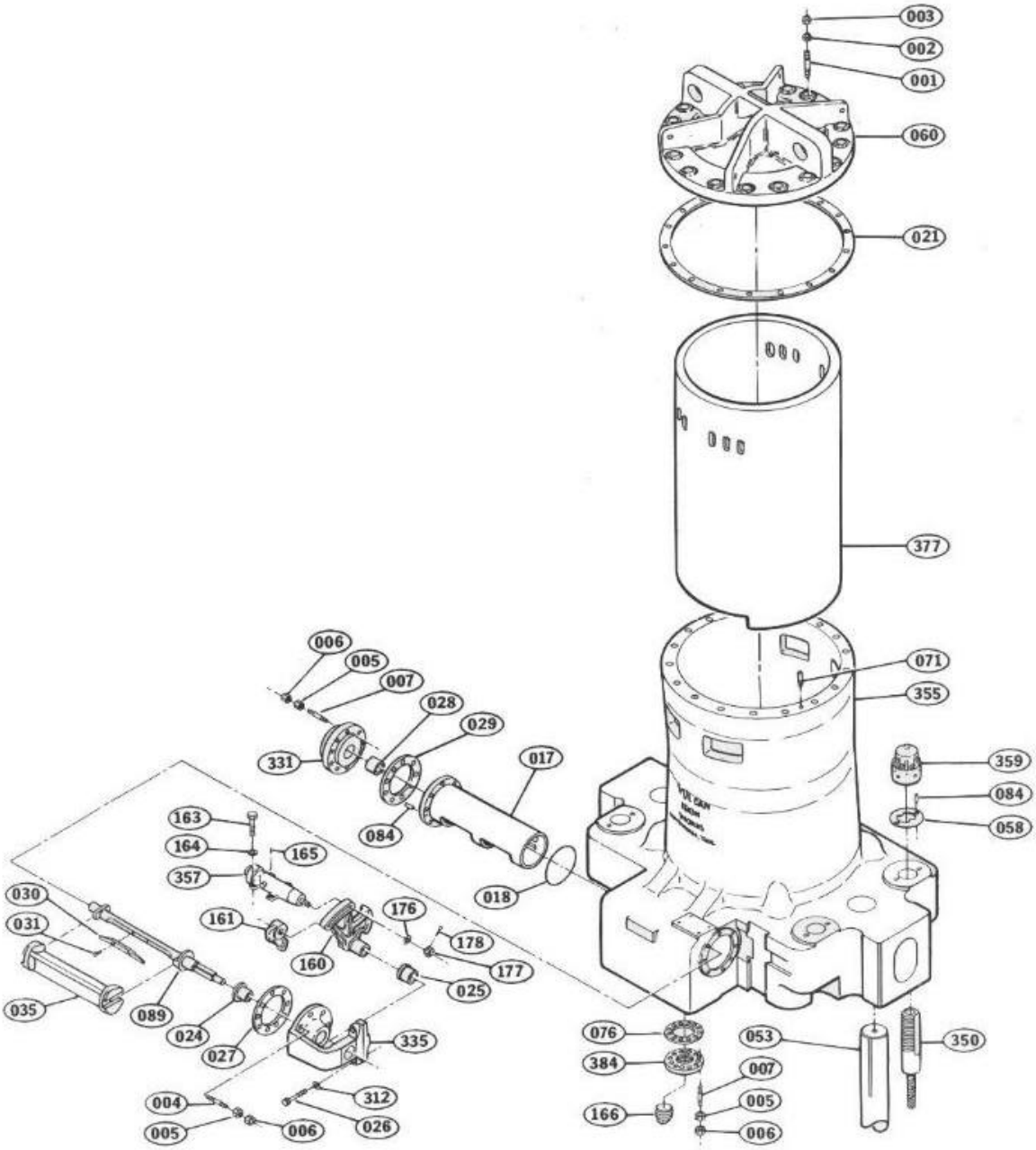
Key No.	Description	Part No. 360	Part No. 560	Part No. 5100	Part No. 5110
001	Cylinder Head Stud	23F0101	22F0101	29F0101	22F0101
002	Cylinder Head Stud Nut - Jam	23F0102	22F0102	29F0102	22F0102
003	Cylinder Head Stud Nut - Full	23F0103	22F0103	29F0103	22F0103
004	Open Steam Chest Head Stud	23F0104	22F0104	29F0104	22F0104
005	Open Steam Chest Head Stud Nut - Jam	23F0105	22F0105	29F0105	22F0105
006	Open Steam Chest Head Stud Nut - Full	23F0106	22F0106	29F0106	22F0106
007	Blind Steam Chest Head Stud	23F0107	22F0107	29F0107	22F0107
005	Blind Steam Chest Head Stud Nut - Jam	23F0108	22F0108	29F0108	22F0108
006	Blind Steam Chest Head Stud Nut - Full	23F0109	22F0109	29F0109	22F0109
010	Stuffing Box Stud	23F0110	22F0110	29F0110	22F0110
011	Stuffing Box Stud Nut - Jam	23F0111	22F0111	29F0111	22F0111
012	Stuffing Box Stud Nut - Full	23F0112	22F0112	29F0112	22F0112
014	Dovetail Insert	23F0113	22F0113	29F0113	22F0113
015	Dovetail Insert Fastener Bolt	23F0114	22F0114	29F0114	22F0114
016	Dovetail Insert Fastener Bolt - Lock Washer	23F0115	22F0115	29F0115	22F0115
017	Cylinder Valve Liner	23F0116	22F0116	29F0116	22F0116
018	Cylinder Valve Liner - O-Ring Gasket	23F0117	22F0117	29F0117	22F0117
084	Cylinder Valve Liner - Dowel Pin	23F0118	22F0118	29F0118	22F0118
019	Cylinder Wear Plates	23F0119	22F0119	29F0119	22F0119
060	Cylinder Head- Suspension	23F0153	22F0120	29F0120	22F0120
021	Cylinder Head Gasket	23F0121	22F0121	29F0121	22F0121
024	Open Steam Chest Head Inboard Bushing	23F0123	22F0123	29F0123	22F0123
360	Open Steam Chest Head Outboard Bushing	23F0124	22F0124	29F0124	22F0124
026	Bolt - Outboard Bearing Bracket	23F0125	22F0125	29F0125	22F0125
176	Open Steam Chest Head Bracket - Washer	23F0126	22F0126	29F0126	22F0126
335	Open Steam Chest Head Bracket	23F0128	22F0128	29F0128	22F0128
027	Open Steam Chest Head Gasket	23F0129	22F0129	29F0129	22F0129
331	Blind Steam Chest Head	23F0130	22F0130	29F0130	22F0130
028	Blind Steam Chest Head Bushing	23F0131	22F0131	29F0131	22F0131
029	Blind Steam Chest Head Gasket	23F0132	22F0132	29F0132	22F0132
030	Valve Spring	23F0133	22F0133	29F0133	22F0133
031	Valve Spring Rivets	23F0134	22F0134	29F0134	22F0134
089	Valve Stem	23F0135	22F0135	29F0135	22F0135
032	Gland	23F0136	22F0136	29F0136	22F0136
033	Gland Bushing	23F0137	22F0137	29F0137	22F0137
034	Junk Ring	23F0138	22F0138	29F0138	22F0138
035	Valve	23F0139	22F0139	29F0139	22F0139
071	Cylinder Head Pilot Pin	23F0142	22F0142	29F0142	22F0142
072	Pipe Flange Stud	23F0143	22F0143	29F0143	22F0143
005	Pipe Flange Stud Nut - Jam	23F0144	22F0144	29F0144	22F0144
006	Pipe Flange Stud Nut - Full	23F0145	22F0145	29F0145	22F0145
075	Double Pipe Flange	23F0146	22F0146	29F0146	22F0146
076	Double and Triple Pipe Flange Gasket	23F0148	22F0148	29F0148	22F0148
080	Trip Spacer				
023	Outboard Bushing Spacer				
086	Triple Pipe Flange		22F0152	29F0152	22F0152
075	Single Pipe Flange	23F0154	22F0153		22F0153
362	Split Washer	23F0155	22F0154	29F0155	22F0154
062	Ram	23F0200	22F0200	29F0200	13702
036	Ram Point	23F0201	22F0201	29F0221	22F0201
040	Ram Key	23F0203	22F0205	29F0205	13704
	Ram Key Set Screw		10F0212		10F0212
	Ram Key Set Screw Lock Nut - Jam		10F0213		10F0213
081	Ram Key Wedge	23F0214	22F0206	29F0206	
328	Ram Key Wedge Bolt	23F0215	22F0203	29F0203	
328	Wedge Bolt Plate Washer	23F0216	22F0204	29F0204	
198	Wedge Bolt Lock Washer	23F0217	22F0207	29F0207	
044	Slide Bar Key Block	23F0208			
046	Slide Bar Key	23F0209	22F0208		22F0208
047	Slide Bar End Block	23F0210	22F0209	29F0208	22F0209
048	Split Bushing	23F0211	22F0210	29F0209	22F0210

049	Ram Cushion	23F0212	22F0211	29F0210	22F0211
077	Slide Bar Key Roll Pin	23F0213	22F0213		22F0213
195	Ram Grease Fitting	23F0225	22F0225	29F0214	22F0225
045	Slide Bar Key Block Seat	23F0226			
078	Gripper - Slide Bar		22F0226	29F0216	22F0226
187	Eccentric Sleeve - Slide Bar	23F0227			
083	Eccentric Sleeve Bolt	23F0228			
084	Eccentric Sleeve Dowel Pin	23F0229			
383	Keeper - Ram Key Wedge			29F0215	
375	Gripper Retaining Wedge			29F0217	
361	Wedge Retaining Plug			29F0218	
068	Wedge Plug Set Screw			29F0219	
068	Set Screw - Plug Set Screw			29F0220	
070	Ram Plug			29F0222	13703
050	Base	23F0300	22F0300	29F0300	22F0300
051	Lock Bar	23F0301	22F0301	29F0301	22F0301
052	Lock Bar Pin	23F0302	22F0302	29F0302	22F0302
053	Columns	23F0303	22F0303	29F0303	13708
054	Piston and Rod	23F0400	22F0400	29F0400	22F0400
055	Piston and Rod Packing	23F0945	22F0945	29F0945	22F0945
056	Piston Rings	23F0404	22F0404	29F0404	22F0404
057	Piston Rings Std. Oversize	23F0406	22F0406	29F0407	22F0406
355	Cylinder	23F0100	22F0100	29F0100	22F0100
350	Top - Cable Fitting	23F0503	22F0503	29F0503	22F0503
350	Wire Rope	23F0504	22F0504	29F0504	22F0504
350	Bottom - Cable Fitting	23F0505	22F0505	29F0505	22F0505
160	Movable Trip	23F0700	22F0700	29F0700	22F0700
161	Fixed Trip	23F0701	22F0701	29F0701	22F0701
162	Cylinder - Trip Shifter	23F0702	22F0702	29F0702	22F0702
163	Cylinder Bolts	23F0703	22F0703	29F0703	22F0703
164	Cylinder Bolt Washers	23F0704	22F0704	29F0704	22F0704
165	Cylinder Dowel Pins	23F0706	22F0706	29F0706	22F0706
176	Piston Washer	23F0717	22F0717	29F0717	22F0717
177	Piston Nut	23F0718	22F0718	29F0718	22F0718
178	Cotter Key - Piston Nut	23F0719	22F0719	29F0719	22F0719
355	Cylinder Complete Inc. 1, 2, 3, 4, 5, 6, 7, 5, 6, 10, 11, 12, 71, 72, 5, 6	23F0900	22F0900	29F0900	22F0900
355	Cylinder Only Inc. 355, 14, 15, 16, 17, 18, 84	23F0915	22F0915	29F0904	22F0915
335	Open Steam Chest Head Bracket Inc. 24, 25, 335	23F0901	22F0901	29F0901	22F0901
331	Blind Steam Chest Head Inc. 331, 28	23F0902	22F0902	29F0902	22F0902
354	Piston and Rod Complete Inc. 54, 55, 56	23F0903	22F0903	29F0903	22F0903
351	Ram Complete Inc. 62, 36, 40, 81	23F0905	22F0905	29F0905	13835
356	Base Complete Inc. 50, 51, 52	23F0906	22F0906	29F0906	22F0906
346	Valve Stem Complete Inc. 30, 31, 89	23F0910	22F0909	29F0909	22F0909
359	Hydra-Nut Complete	23F0913	22F0913	29F0913	22F0913
328	Ram Key Wedge Bolt Inc. 328, 198	23F0923	22F0921	29F0921	22F0921
350	Cable w/End Fittings	23F0924	22F0922	29F0925	13709
357	Vari-Cycle Cylinder Complete	23F0926	22F0926	29F0927	22F0926
345	Slide Bar Complete - Nylon	23F0928	22F0928	29F0929	22F0928
357	Vari-Cycle Cylinder - Inc. 162, 179	23F0927	22F0927	29F0928	22F0927

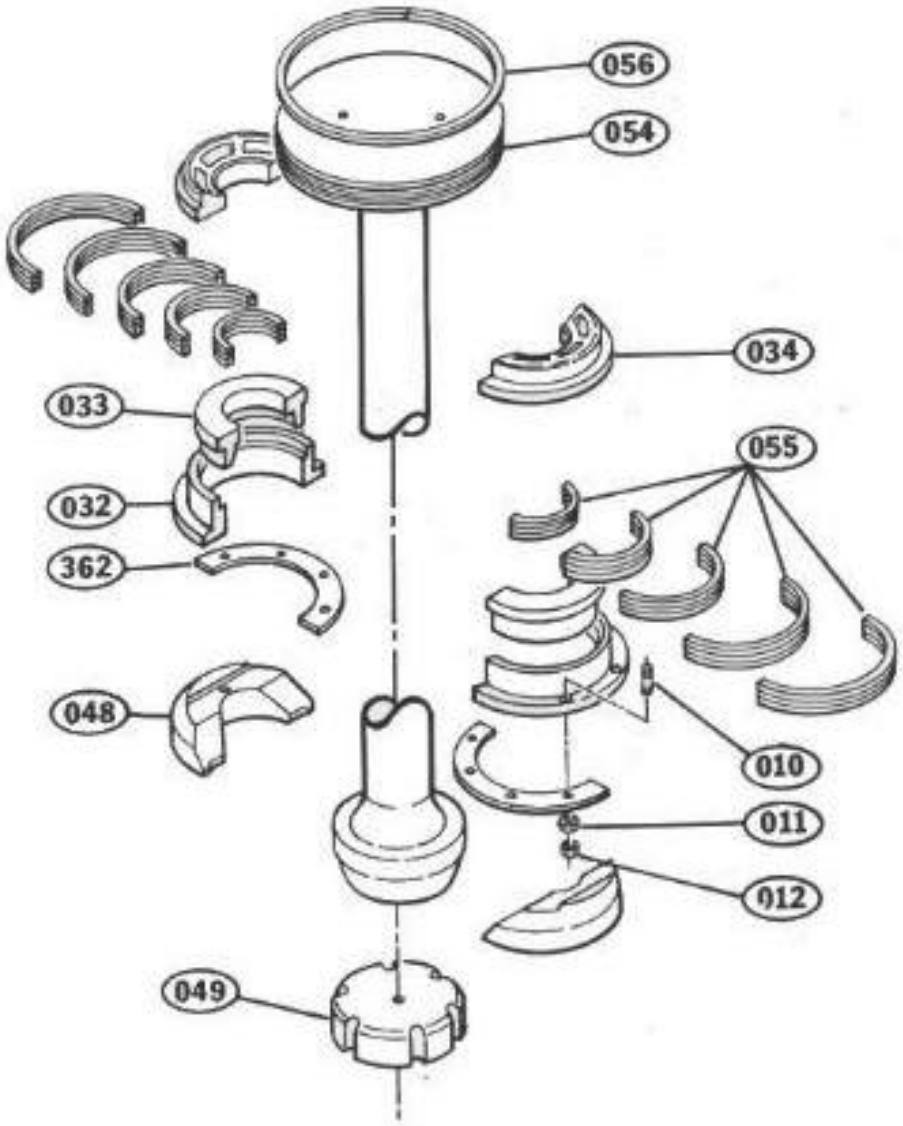
VULCAN IRON WORKS INC.

(800) 742-6637 or (423)698-1581

HAMMER SIZE 5150



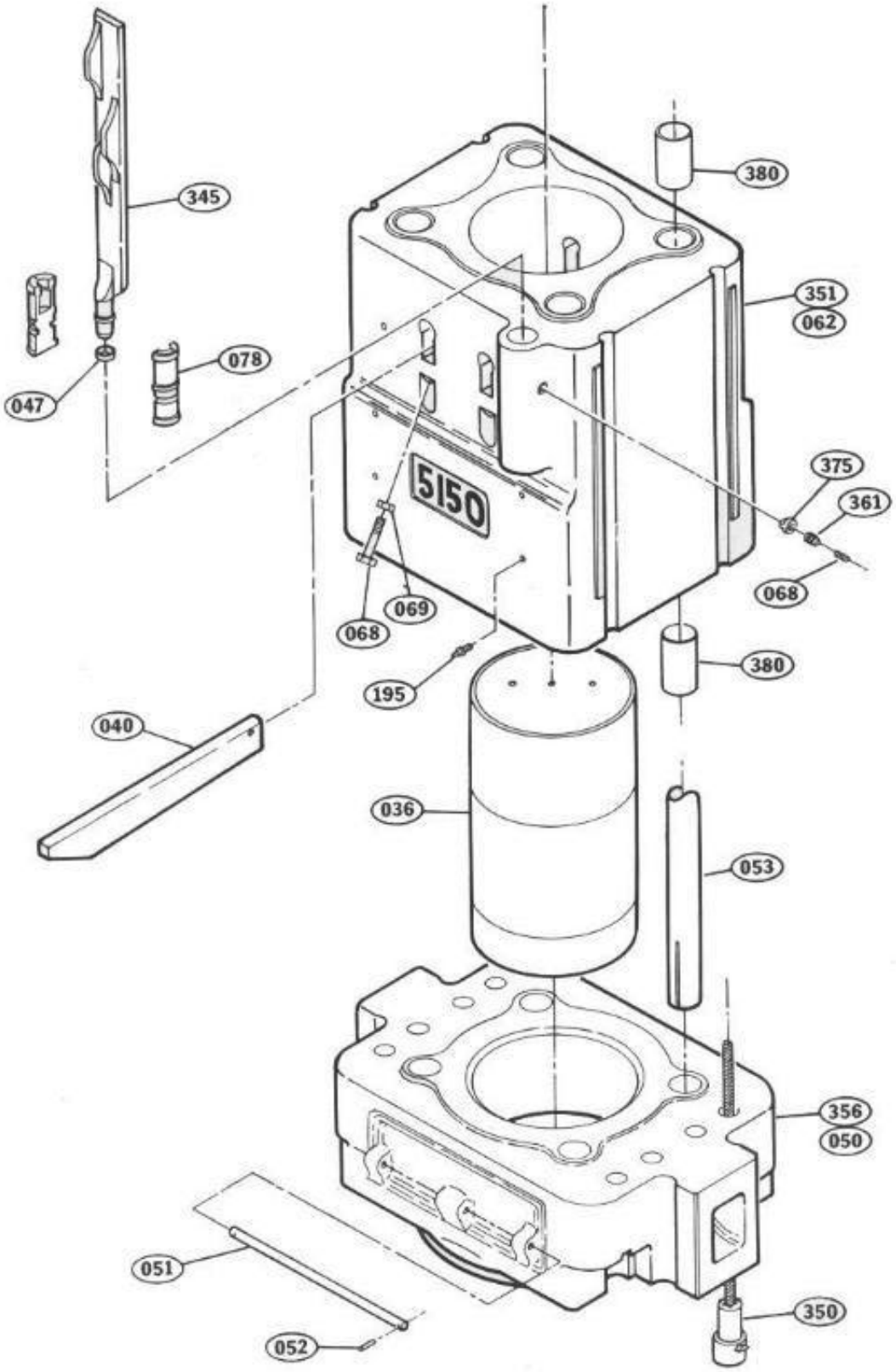
HAMMER SIZE 5150



VULCAN IRON WORKS INC.

(800) 742-6637 or (423)698-1581

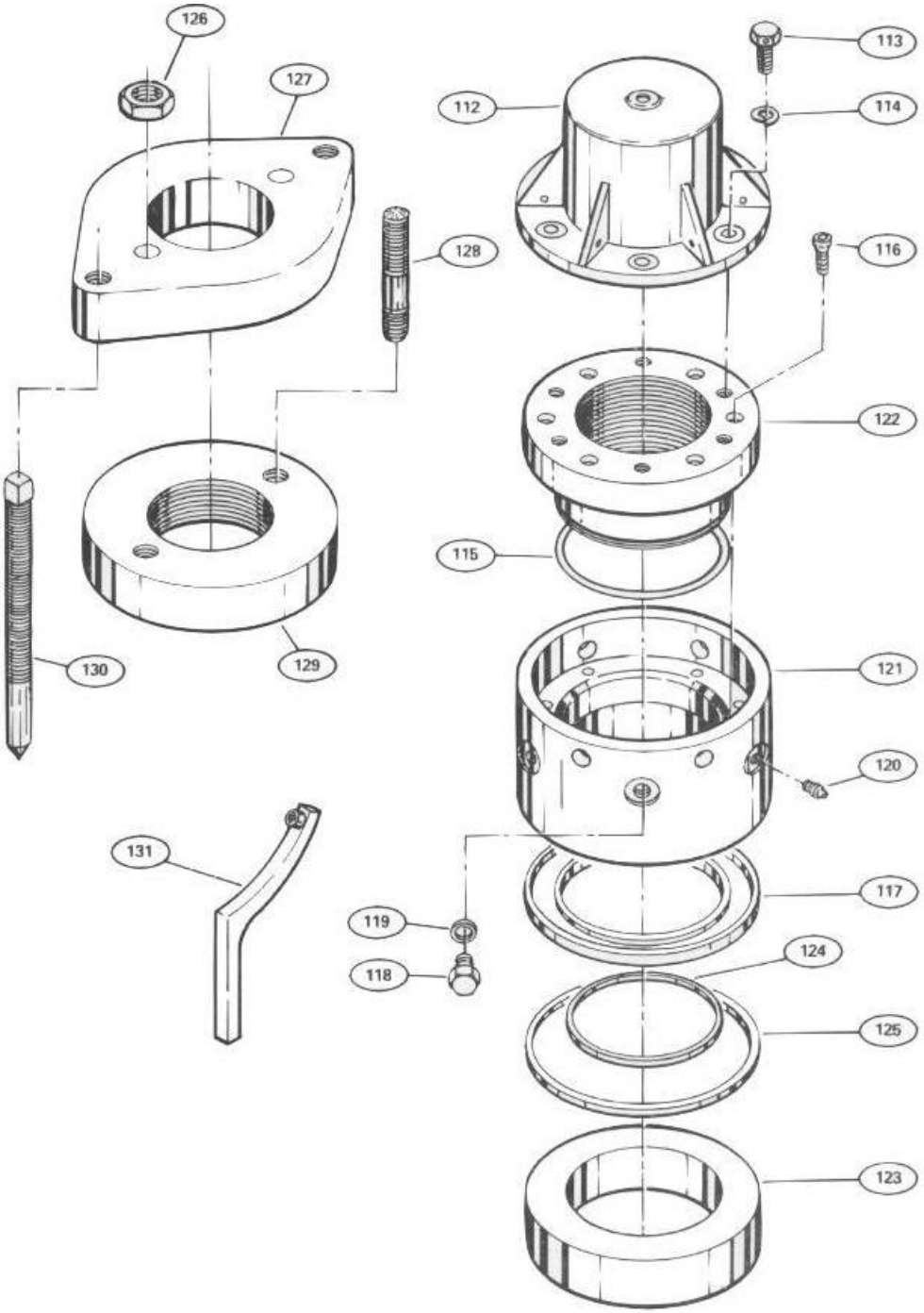
HAMMER SIZE 5150



Hammer Size - 5150

Key No.	Description	Part No. 5150
001	Cylinder Head Stud	36F0101
002	Cylinder Head Stud Nut - Jam	36F0102
003	Cylinder Head Stud Nut - Full	36F0103
004	Open Steam Chest Head Stud	36F0104
005	Open Steam Chest Head Bracket Stud Nut - Jam	36F0105
006	Open Steam Chest Head Bracket Stud Nut - Full	36F0106
007	Blind Steam Chest Head	36F0107
005	Blind Steam Chest Head Stud Nut - Jam	36F0108
006	Blind Steam Chest Head Stud Nut - Full	36F0109
011	Stuffing Box Stud Nut - Jam	36F0111
012	Stuffing Box Stud Nut - Full	36F0112
017	Cylinder Valve Liner	36F0113
018	Cylinder Valve Liner "O" Ring Gasket	36F0114
084	Cylinder Valve Liner Dowel Pin	36F0115
377	Cylinder Liner	36F0116
060	Cylinder Head - Suspension	36F0117
024	Open Steam Chest Head Inboard Bushing	36F0119
025	Open Steam Chest Head Outboard Bushing	36F0120
335	Open Steam Chest Head Bracket	36F0121
027	Open Steam Chest Head Bracket Gasket	36F0122
026	Open Steam Chest Head Bracket Bolt	36F0123
312	Open Steam Chest Head Bracket Bolt Washer	36F0124
331	Blind Steam Chest Head	36F0126
028	Blind Steam Chest Head Bushing	36F0127
029	Blind Steam Chest Head Gasket	36F0128
035	Valve	36F0129
089	Valve Stem	36F0130
030	Valve Spring	36F0131
031	Valve Spring Rivets	36F0132
071	Cylinder Head Pilot Pin	36F0142
384	Inlet Fitting	36F0143
076	Inlet Fitting Gasket	36F0144
007	Inlet Fitting Stud	36F0145
005	Inlet Fitting Stud Nut - Jam	36F0146
006	Inlet Fitting Stud Nut - Full	36F0147
116	Inlet Fitting Stud Pipe Plug	36F0148
355	Cylinder (144" Jaws)	36F0158
355	Cylinder (120" Jaws)	36F0157
010	Stuffing Box Stud	36F0159
032	Gland	36F0160
033	Gland Bushing	36F0161
034	Junk Ring	36F0162
362	Split Washer	36F0163
021	Cylinder Head Gasket	36F0164
062	Ram	36F0200
036	Ram Point	36F0201
380	Ram Bushing	36F0202
047	Slide Bar End Block	36F0209
049	Ram Cushion	36F0211
195	Ram Grease Fitting - ¼"	36F0212
078	Slide Bar Gripper	36F0213
375	Gripper Retaining Wedge	36F0214
361	Gripper Retaining Wedge Plug	36F0215
068	Retainer Wedge Plug Set Screw	36F0216
068	Set Screw Plug Set Screw	36F0217
068	Ram Key Set Screw	36F0218
069	Ram Key Set Screw Lock Nut - Jam	36F0219
040	Ram Key	36F0220
048	Split Bushing	36F0221
050	Base (120" Jaws)	36F0300
051	Lock Bar	36F0301
052	Lock Bar Pin	36F0302
053	Columns	36F0303
050	Base (144" Jaws)	36F0304
354	Piston & Rod	36F0406
056	Piston Rings	36F0401
055	Piston & Rod Packing	15F0945
056	Piston Rings Std. Oversize	36F0404
058	Lock Washer - Cylinder Cable	36F0503
084	Dowel Pins - Lock Washer Cylinder	36F0504
160	Movable Trip	36F0700
161	Fixed Trip	36F0701
357	Cylinder - Trip Shifter	36F0702
163	Cylinder Bolts	36F0703
164	Cylinder Bolt Washer	36F0704
357	Cylinder - Dowel Pins	36F0706
357	Cylinder - Pipe Plug	36F0707
357	Cylinder Head - Trip Shifter	36F0708
357	Cylinder Head Gasket - Trip Shifter	36F0709
357	Cylinder Head - Cap Screw	36F0710
357	Cylinder Head - Cap Screw Washer	36F0711
357	Cylinder Head - Pipe Plug	36F0712
357	Piston - Trip Shifter	36F0713
357	Piston Rings	36F0714
357	Piston Seals O-Rings	36F0715
357	Piston Collar	36F0716
176	Piston Washer	36F0717
177	Piston Nut	36F0718
178	Cotter Key - Piston Nut	36F0719
357	Cylinder Sleeve - Trip Shifter	36F0720
357	Compression Spring	36F0721
357	Compression Spring Seat	36F0722
335	Open Steam Chest Head Bracket Complete Incl. 335, 24, 25	36F0901
331	Blind Steam Chest Head Complete Incl. 331, 28	36F0902
351	Ram Complete Incl. 351, 380, 40	36F0905
351	Ram Only Incl. 62, 36	36F0906
356	Base Complete Incl. (120" Jaws) 50, 51, 52	36F0911
345	Valve Stem Complete Incl. 89, 30, 31	36F0912
350	Cable Column W/End Fittings	36F0913
359	Hydra-Nut Complete	36F0914
356	Base Complete Incl. 50, 51, 52	36F0918
355	Cylinder Only (120" Jaws) 355, 17, 18, 84	36F0923
355	Cylinder Complete Incl. (120" Jaws) 355, 1, 2, 3, 4, 5, 6, 7	36F0924
355	Cylinder Only Incl. (144" Jaws) 355, 17, 18, 84	36F0925
355	Cylinder Complete Incl. (144" Jaws) 355, 1, 2, 3, 4, 5, 6, 7	36F0926
354	Piston & Rod Complete Incl. 354, 55, 56	36F0927
357	Vari-Cycle Complete 162 thru 181	36F0928
357	Vari-Cycle Cylinder Incl. 162, 179	36F0929
345	Slide Bar 3-Wedge Complete	36F0930

HYDRA-NUT & MANUAL JACK



Hydra-Nut and Manual Jack
020, 030, 340, 530, 360, 540, 560, 5100, 5150

Key No.	Description	Part No. Size 020	Part No. Size 030	Part No. Size 340	Part No. Size 530	Part No. Size 360	Part No. Size 540	Part No. Size 560	Part No. Size 5100	Part No. Size 5150
112	Cap	08F5001	09F5001	18F5001	38F5001	23F5001	20F5001	22F5001	29F5001	36F5001
113	Cap Screw	08F5002	09F5002	18F5002	38F5002	23F5002	20F5002	22F5002	29F5002	36F5002
114	Lock Washer	08F5003	09F5003	18F5003	38F5003	23F5003	20F5003	22F5003	29F5003	36F5003
115	O-Ring	08F5042	09F5042	18F5042	38F5042	23F5042	20F5042	22F5042	29F5042	36F5042
116	Cap Screw	08F5008	09F5008	18F5008	38F5008	23F5008	20F5008	22F5008	29F5008	36F5008
117	Seal	08F5010	09F5010	18F5010	38F5010	23F5010	20F5010	22F5010	29F5010	36F5010
118	Bleed Off Valve	08F5021	09F5021	18F5021	38F5021	23F5021	20F5021	22F5021	29F5021	36F5021
119	Seat - Bleed Off Valve	08F5027	09F5027	18F5027	38F5027	23F5027	20F5027	22F5027	29F5027	36F5027
120	Grease Fitting	08F5035	09F5035	18F5035	38F5035	23F5035	20F5035	22F5035	29F5035	36F5035
121	Jack Body	08F5037	09F5037	18F5037	38F5037	23F5037	20F5037	22F5037	29F5037	36F5037
122	Thread Sleeve	08F5038	09F5038	18F5038	38F5038	23F5038	20F5038	22F5038	29F5038	36F5038
123	Piston	08F5039	09F5039	18F5039	38F5039	23F5039	20F5039	22F5039	29F5039	36F5039
124	Seal Wiper - U-Cup Outer	08F5040	09F5040	18F5040	38F5040	23F5040	20F5040	22F5040	29F5040	36F5040
125	Seal Wiper - U-Cup Inner	08F5041	09F5041	18F5041	38F5041	23F5041	20F5041	22F5041	29F5041	36F5041
126	Jack Stud Nut - Full	08F5031	09F5031	18F5031	38F5031	23F5031	20F5031	22F5031	29F5031	36F5031
127	Manual Jack Plate	08F5028	09F5028	18F5028	38F5028	23F5028	20F5028	22F5028	29F5028	36F5028
128	Jack Nut Stud	08F5030	09F5030	18F5030	38F5030	23F5030	20F5030	22F5030	29F5030	36F5030
129	Jack Nut	08F5029	09F5029	18F5029	38F5029	23F5029	20F5029	22F5029	29F5029	36F5029
130	Jack Bolt	08F5024	09F5024	18F5024	38F5024	23F5024	20F5024	22F5024	29F5024	36F5024
131	Spanner Wrench	08F5026	09F5026	18F5026	38F5026	23F5026	20F5026	22F5026	29F5026	36F5026
000	Gauge (Not Shown)	08F5103	09F5103	18F5103	38F5103	23F5103	20F5103	22F5103	29F5103	36F5103
000	Hydra-Nut Complete (Incl. 112 thru 125)	08F0913	09F0913	18F0913	38F0913	23F0913	20F0913	22F0913	29F0924	36F0914
000	Manual Jack Complete (Incl. 126 thru 130)	08F0926	09F0932	18F0924	38F0915	23F0925	20F0922	22F0925	29F0924	36F0920
000	Grease Gun Complete (Not Shown)	08F0914	09F0914	18F0914	38F0914	23F0914	20F0914	22F0914	29F0914	36F0921

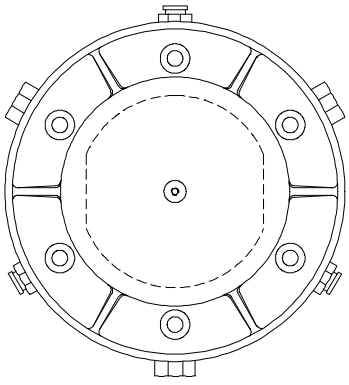
Auto-Jack

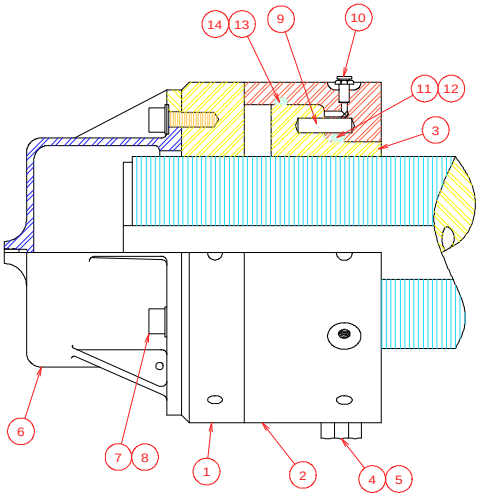
Key No.	Description	Part No. For 020, 030, 520, 530, 535, 5100, 3100	Part No. For 060, 360, 560, 5150, 5110	Part No. For 040, 340, 540
	Auto-Jack Complete	08F0937	22F0937	10F0937
1	Lock Nut	08F0801	22F0801	10F0801
2	Cylinder	08F0802	22F0802	10F0802
3	Piston	08F0803	22F0803	10F0803
4	Bleed Off Valve	08F0804	22F0804	10F0804
5	Seat - Bleed Off Valve	08F0805	22F0805	10F0805
6	Cap	08F0806	22F0806	10F0806
7	Cap Screw	08F0807	22F0807	10F0807
8	Lock Washer - Cap Screw	08F0808	22F0808	10F0808
9	Dowel Pin	08F0809	22F0809	10F0809
10	Grease Fitting	08F0810	22F0810	10F0810
11	O-Ring	08F0811	22F0811	10F0811
12	Back-Up Ring	08F0812	22F0812	10F0812
13	O-Ring	08F0813	22F0813	10F0813
14	Back-Up Ring	08F0814	22F0814	10F0814

Installation and Jacking Instructions

1) Screw Piston and Cylinder Assembly (Key No. 1) onto Cable Fitting.
2) Using Manual Jack, Take up Slack From Cable.
3) Using Grease Gun, Pump to Required Pressure.
4) Screw Lock Nut Tight Against Auto-Jack Cylinder.
5) Install Thread Protector Cap.

Hammer Size	Pressure (PSIG)	Tons
020, 030, 520, 530, 535, 3100, 5100	3925	40
040, 340, 540	3950	60
060, 360, 560, 5110, 5150	3500	60





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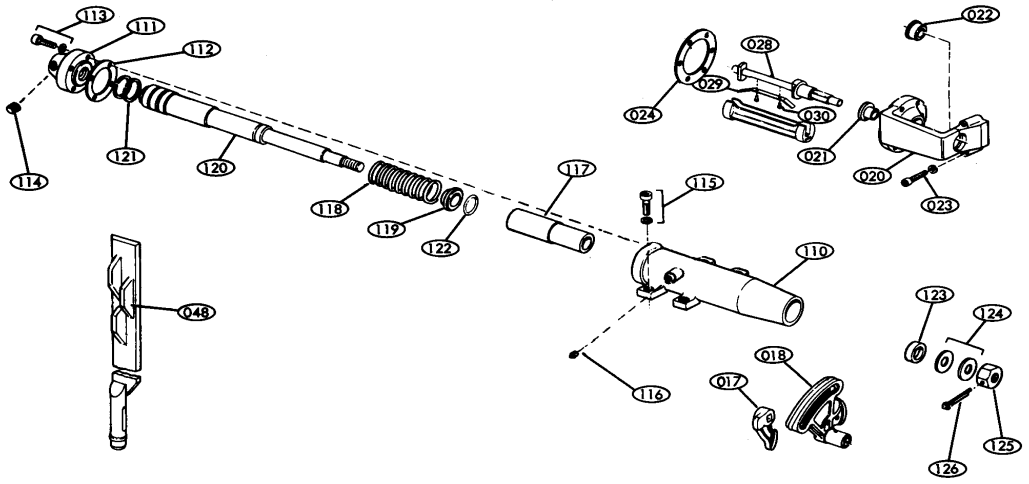
(800) 742-6637 or (423)698-1581

Vari-Cycle for Model No's. 020, 030, 340, 530, 360, 540, 560, 5100, 5150

Key No.	Description	Part No. Size 020	Part No. Size 030	Part No. Size 340	Part No. Size 530	Part No. Size 360	Part No. Size 540	Part No. Size 560	Part No. Size 5100	Part No. Size 5150
017	Fixed Trip	08F0701	09F0701	18F0701	38F0701	23F0701	20F0701	22F0701	29F0701	36F0701
018	Movable Trip	08F0734	09F0734	18F0700	38F0700	23F0700	20F0700	22F0700	29F0700	36F0700
110	Cylinder - Trip Shifter	08F0702	09F0702	18F0702	38F0702	23F0702	20F0702	22F0702	29F0702	36F0702
111	Cylinder Head - Trip Shifter	08F0708	09F0708	18F0708	38F0708	23F0708	20F0708	22F0708	29F0708	36F0708
112	Cylinder Head Gasket - Trip Shifter	08F0709	09F0709	18F0709	38F0709	23F0709	20F0709	22F0709	29F0709	36F0709
113	Cylinder Head Cap Screws	08F0710	09F0710	18F0710	38F0710	23F0710	20F0710	22F0710	29F0710	36F0710
113	Cylinder Head Cap Screws Washers	08F0711	09F0711	18F0711	38F0711	23F0711	20F0711	22F0711	29F0711	36F0711
114	Cylinder Head Pipe Plug	08F0712	09F0712	18F0712	38F0712	23F0712	20F0712	22F0712	29F0712	36F0712
115	Cylinder Bolt	08F0703	09F0703	18F0703	38F0703	23F0703	20F0703	22F0703	29F0703	36F0703
115	Cylinder Bolt Washer	08F0704	09F0704	18F0704	38F0704	23F0704	20F0704	22F0704	29F0704	36F0704
116	Cylinder Pipe Plug	08F0707	09F0707	18F0707	38F0707	23F0707	20F0707	22F0707	29F0707	36F0707
117	Cylinder Sleeve - Trip Shifter	08F0720	09F0720	18F0720	38F0720	23F0720	20F0720	22F0720	29F0720	36F0720
118	Compression Spring	08F0721	09F0721	18F0721	38F0721	23F0721	20F0721	22F0721	29F0721	36F0721
119	Compression Spring Seat	08F0722	09F0722	18F0722	38F0722	23F0722	20F0722	22F0722	29F0722	36F0722
120	Piston - Trip Shifting	08F0713	09F0713	18F0713	38F0713	23F0713	20F0713	22F0713	29F0713	36F0713
121	Piston Rings	08F0714	09F0714	18F0714	38F0714	23F0714	20F0714	22F0714	29F0714	36F0714
122	Piston Seal O-Ring	08F0715	09F0715	18F0715	38F0715	23F0715	20F0715	22F0715	29F0715	36F0715
123	Piston Collar	08F0716	09F0716	18F0716	38F0716	23F0716	20F0716	22F0716	29F0716	36F0716
124	Piston Washers	08F0717	09F0717	18F0717	38F0717	23F0717	20F0717	22F0717	29F0717	36F0717
125	Piston Nut	08F0718	09F0718	18F0718	38F0718	23F0718	20F0718	22F0718	29F0718	36F0718
126	Cotter Key for Piston Nut	08F0719	09F0719	18F0719	38F0719	23F0719	20F0719	22F0719	29F0719	36F0719
110	Vari-Cycle Cylinder Complete	08F0929	09F0933	18F0925	38F0921	23F0926	20F0925	22F0926	29F0927	36F0928
048	Slide Bar - Nylon Complete	08F0931	09F0935	18F0927	38F0923	23F0929	20F0927	22F0928	29F0929	36F0930



Since 1852

VULCAN IRON WORKS INC.

Specifications for Offshore Pile Hammers

INTRODUCTION

In using a pile hammer to install ocean and coastal structures, the marine construction industry requires that the hammer

be economical to purchase and operate

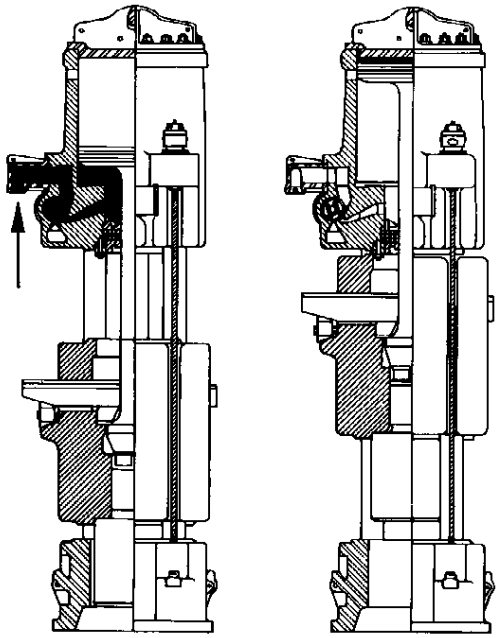
be free of breakdowns and thus eliminate expensive downtime

be readily serviceable when service is necessary

As a product of many years of experience and development in all fields of pile driving, Vulcan air/steam powered pile hammers meet the above requirements with a design that is simple and rugged, manufactured to demanding specifications and field service that is available whenever and wherever needed.

The hammers described in this bulletin have been developed specifically for marine construction. They are single acting type hammers, and rely on gravity through a distance to achieve their striking energy. Single acting hammers are by far the most common in use, having proven their driving abilities on many structures throughout the world. There are five (5) standard sizes, with striking energies ranging from 100,000 to 500,000 ft-lbs (13.8 to 69.2 tonne-meters), capable of driving piles up to 96" (2438 mm) in diameter.

Concerning the operation of these, the cycle begins at impact, the valve is rotated in such a way as to admit steam or air into the cylinder and below the piston. This accelerates the ram upward as shown in View 1. This continues until the exhaust wedge on the slide bar actuates the trip and rotates the valve to close off the steam or air inlet and opens the area of the cylinder below the piston to the atmosphere where the compressed air or steam is exhausted. The ram continues its free rise upward, decelerating with gravity until the top of the piston passes the relief ports and closes in the dashpot at the top of the cylinder. This trapped air, shown in View 2, compresses and brings the rising ram to a halt. The ram then makes a free drop to impact. Shortly before impact the intake wedge rotates the valve to admit steam or air to the cylinder and the cycle starts once again.



1 2

WARRANTY

Vulcan Iron Works Inc. warrants these products to be in accordance with our published specifications or those specifications agreed to by Vulcan in writing at the time of sale. Vulcan makes no other warranty, express or implied. THE IMPLIED WARRANTIES OF MERCHANTABILITY AND OF FITNESS FOR ANY PARTICULAR PURPOSE ARE EXCLUDED FROM THIS WARRANTY. Our obligation and liability under this warranty is expressly limited to repairing or replacing, at Vulcan's option, any product which fails to meet these specifications within 180 days from date of initial use, but not to exceed one year from date of delivery. This remedy is *exclusive* and Vulcan's obligation does not include any transportation charges or costs of installation or any liability from direct, indirect or consequential damage or delay. If requested by Vulcan, products or parts for which a warranty claim is made are to be returned, transportation prepaid to Vulcan. Any improper use, operation beyond rated capacity as stated in the written specifications, substitution of parts not approved by Vulcan in writing, or any alteration or repair by anyone other than a duly authorized representative of Vulcan shall void this warranty.

BLOW COUNT SPECIFICATION

Vulcan hammers are designed to withstand a continuous driving resistance of 120 blows/foot (400 blows/meter). In addition to this, Vulcan hammers will withstand refusal driving resistance of 300 blows/foot (1000 blows/meter) for five (5) consecutive feet (1500mm), or 800 blows/foot (2600 blows/meter) for one (1) foot (300mm) or penetration. Any resistances experienced in excess of these are beyond rated capacity and will void the warranty. This definition is not an exclusive definition of excess of rated capacity and other criteria may apply.

SPECIFICATIONS

		Hammer Size				
OPERATING DATA		**520**	**530**	**540**	**560**	**5100**
Rated Striking Energy, ft-lbs	ft-lbs	100,000	150,000	204,500	312,500	500,000
	tonne-meters	*13.83*	*20.74*	*28.27*	*43.21*	*69.13*
Blows Per Minute -- Normal Stroke, No Set		42	42	48	47	48
Normal Stroke	in.	60	60	60	60	60
	mm	*1524*	*1524*	*1524*	*1524*	*1524*
Rated Operating Pressure @ Hammer	psig	102	150	130	150	150
	bar	*7.04*	*10.34*	*8.96*	*10.34*	*10.34*
Steam Consumption, from & at 212° F *(100° C)*	lbs/hr	7,160	8,064	14,126	20,897	35,977
	kg/hr	*3,248*	*3,658*	*6,407*	*9,479*	*16,319*
Boiler Horsepower, from & at 212° F *(100° C)*		208	234	409	606	1043
Boiler Horsepower, 60°F *(16°C)*		250	300	500	750	1300
Air Consumption (Adiabatic)	cfm	1,652	2,076	3,755	5,410	9,326
	m3/min	*46.8*	*58.8*	*106.3*	*153.2*	*264.1*
DIMENSIONAL DATA						
Length of Hammer (overall)	ft.-in.	20'-4 7/8"	20'-4 7/8"	22'-7"	23'-0"	27'-4"
	mm	*6220*	*6220*	*6880*	*7010*	*8330*
Length of Hammer Assembly/Leaders (overall)	ft.	40'	40'	47'	50'	61'
	mm	*12,220*	*12,220*	*14,330*	*15,240*	*18,600*
Largest Diameter Pile Permitted by Standard Jaws	in.	48" (72")	48" (72")	72"	72"	96"
	mm	*1219 (1829)*	*1219 (1829)*	*1829*	*1829*	*2438*
Size and Number of Hoses		4" (1)	4" (1)	4" (2)	4" (3)	4" (3)
WEIGHT DATA						
Weight of Striking Parts	lbs.	20,000	30,000	40,900	62,500	100,000
	kg.	*9,072*	*13,608*	*18,552*	*28,350*	*45,359*
Net Weight of Hammer	lbs.	47,860	57,860	102,980	134,060	219,000
	kg.	*21,709*	*26,245*	*46,711*	*60,809*	*99,337*
Weight of Pipe Cap	lbs.	10,000	10,000	30,982	32,055	69,500
	kg.	*4,536*	*4,536*	*14,053*	*14,540*	*31,525*
Weight of Leaders	lbs.	15,500	15,500	29,700	53,500	96,000
	kg.	*7,031*	*7,031*	*13,472*	*24,267*	*43,575*
Assembled Weight	lbs.	73,360	83,360	163,662	219,615	384,500
	kg.	*33,276*	*37,811*	*74,236*	*99,615*	*174,406*

Note: Weights for 520 and 530 Hammers are for jaws suited for 48" (1219 mm) maximum diameter pile, which are standard. Any hammer listed can be furnished with alternate jaw and pile size specification; please consult the factory or authorized representative for information and specifications.

ACCESSORIES AND SUPPORT

Shown at right is the basic assembly for Vulcan Offshore Type Pile Hammers, with the component parts. Vulcan offers all of these and more for its customers. These include:

Pipe caps -- configured to adapt the hammers to various sizes of pipe piles up to the maximum size allowed by the leaders. Standard sizes for these are as follows:

Hammer Size	Pipe Cap Step Sizes
520 & 530 (48" max.)	24", 30", 36", 42", & 48"
520 & 530 (72" max.); 540, 560	42", 48", 54", 60" & 72"
5100	54", 60", 72", 78", 84", & 96"

When ordering, specify wall thicknesses of pipe piles. Accessories for other types and sizes of piles such as concrete piles are available upon request.

Leaders -- Vulcan manufactures light weight, pipe construction leaders for low lift weight and maximum rigidity and ease on deck wear.

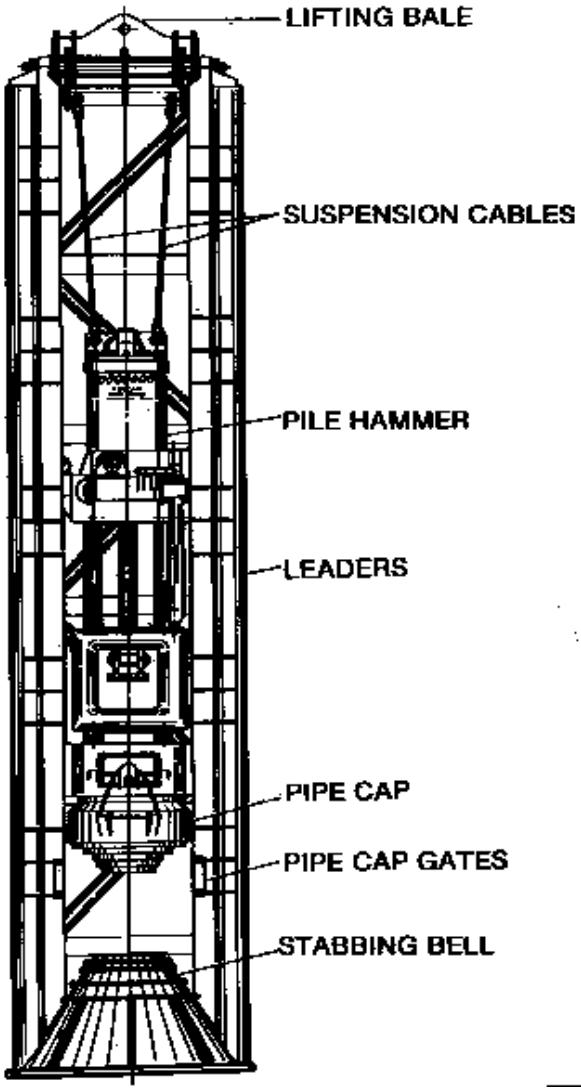
Cushion Material -- Vulcan can furnish Hamortex cushion material for integral ring cushion pots or micarta and aluminum for capblock followers. To assist cushion ordering and wave equation data, these are the dimensions for the cushion in inches/*millimeters*:

Hammer Size	Diameter	Depth, IR	Depth, CBF
520 ,530	22.5/*572*	5/*127*	25/*635*
540	27.25/*692*	7.5/*191*	25/*635*
560	31.25/*794*	7.5/*191*	31/*787*
5100	41.25/*1048*	7.5/*191*	-

IR = Integral Ring; CBF = Capblock Follower

Other Accessories -- Vulcan can also furnish such accessories as suspension cables, steam or air hose, and line oilers.

Field Service and Parts -- Vulcan maintains a qualified field service staff for worldwide service and support of Vulcan pile driving equipment. Vulcan also maintains a large inventory of spare parts for all offshore hammers.



Since 1852

VULCAN IRON WORKS INC.

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Bulletin 65J

Authorized Representative

USER'S GUIDE TO SAFE OPERATION
Air/Steam Pile Hammers

Vulcan Iron Works Inc.

NOTICE: This guide contains important information about the use and characteristics of the Vulcan Pile Hammers. Because misuse of this machinery may result in injuries to personnel and the loss of property, this guide should be carefully reviewed by all maintenance, operating and support personnel.

INTRODUCTION

Today's Vulcan Pile Hammer is the product of over one hundred years of engineering and manufacturing experience. Every component of the machine has been designed for maximum reliability and is fabricated from the most suitable materials available. Although we feel this machine has earned a reputation within the construction industry for both reliability and safety, we also feel that it is our duty to convey to you potential hazards associated with its use.

This User's Guide presents a discussion of each of the general types of hazards which must be considered for the successful use of the Vulcan Pile Hammer. Although considerable effort has been made to identify situations which may involve risk to personnel or property and to suggest how these risks may be avoided, nothing will substitute for good maintenance and well trained operators.

I. OPERATING TECHNIQUES

The pile hammer should be used only by well trained and experienced personnel. Before using the hammer all instruction and safety manuals should be thoroughly reviewed by all operating and maintenance personnel. These references are an invaluable source of information and should be retained by the owner for future study and to train new employees. Copies of these manuals should be kept with the hammer at the construction site for ready access. Additional copies are available from Vulcan.

Safe use of the pile hammer, as with any machine, is dependent upon the skill, knowledge and concern of those who maintain and use it. Because of the wide variety of environments and applications in which this machine may be used, a comprehensive description of detailed rigging and operating techniques within this booklet is not possible. (Specific requirements should be addressed to Vulcan's engineering department in Chattanooga, Tennessee.)

For reasons mentioned elsewhere, no one should be any closer to the hammer during driving than is absolutely essential. All workmen should wear safety clothing including hard hats, safety shoes, safety glasses and hearing protection.

Before, and periodically during usage, a complete inspection should be performed on the hammer and all associated equipment to insure operational integrity. The associated equipment includes items such as the compressor and/or boiler, hoses and hose couplings, leaders, support and lifting equipment and all rigging, etc. On the hammer, particular attention should be given to sheaves, pins, retaining bolts, hose couplings, the valve mechanism, all keys, ram point, pile cap, and the lifting points. Supervisors should be certain that all inspection and maintenance is properly done.

During the driving operation and whenever the hammer is moved, constant supervision and inspection should be provided. If abnormalities are observed, driving should be stopped immediately. One example would be that of the loss of one or more ram keys. If both keys are missing, then the ram would obviously no longer be connected to the piston. Without the ram to slow the acceleration of the piston on the up stroke, the piston may impact into the cylinder head with catastrophic effects. Another dangerous situation would be to continue hammer operation without a piling seated in the pile cap. In this event, the entire force of the falling ram could be absorbed by the hammer's columns, base and pile cap. Few such strokes could be sustained without severe damage to the hammer. Obviously, such destruction would be hazardous to anyone in the vicinity. Also, the cylinder head lifting points (sheave, axle, pins, keys and nuts) should be continuously checked for worn, loose or missing parts. Damaged or missing components oif this assembly could cause hammer to disconnect from rigging and fall.

The effects of unregulated steam or air pressure may also create a risk. As noted elsewhere, failure of any of the hose couplings, while under pressure, could be very dangerous. In addition, operation at pressures either higher or lower than specified design should be avoided since structural damage to the hammer or inefficient operation may result. Obviously, all air or steam supply hoses must be properly sized to avoid undue flow restrictions.

Damage to the pile, pile cap, ram point and piston can occur if the alignment of the hammer and the pile is not correct. That is, the central axis of the hammer should be in alignment with the central axis of the pile and the pile end should be square and uniform. If the error in alignment is great, the hammer will receive an unbalanced structural loading which could result in either a fatigue failure in the hammer or a significant shortening of its useful life. Obviously, this type of condition could

be both expensive and dangerous, but can be avoided with reasonable care.

A common pile driving criterion is to drive until a certain number of blows per foot of pile insertion is achieved. This measure is based on the amount of energy delivered with each stroke of the ram. In a single acting hammer, the energy is dependent upon the falling weight and stroke length. Since falling weight is constant, only changes in stroke length can affect the energy delivered. Therefore, if a variable stroke hammer is used, it should be noted that the blow count taken is compared to the proper stroke energy, i.e., the blow count criterion will vary with the stroke length used. The supervisor should correlate the blow count criterion and the stroke length. Otherwise, pile damage, added expense, or inadequate pile installation could result. It should also be noted that significant deviations in pressure delivered to the hammer from the recommended pressure may affect the actual operating stroke length and thus influence the energy in each blow of the hammer.

Since the pile hammer is such an extremely powerful machine, it is conceivable that even with normal operation, surroundings at the driving site could be damaged. Operators should take every precaution to see that exhaust from the hammer and vibration of the earth are not a threat to the area surrounding the driving site. Failure to do so could be unsafe and possibly lead to expensive property damage.

As an additional precautionary measure, a pre-pile driving survey could be made.

Given the respect it deserves, the pile hammer should provide years of safe service. However, the ultimate safety and reliability of the hammer rest in the hands of the user.

II. FALLING OBJECTS AND PROJECTILES

The pile hammer is a relatively large and heavy machine which is normally used in a suspended position. Consequently, gravity can propel the hammer or any of its parts downward with great force. Therefore, every effort should be made to see that neither the machine or any of the hammer's component parts are permitted to fall.

Supporting and lifting tackle should be of sufficient capacity to safely lift the weight of the hammer and to withstand the vibration of its operation. (See gross weight label on machine.) Likewise, all rigging should be heavy enough to handle the load safely and the entire system should be thoroughly inspected to insure its integrity before it is used. Refer to relevant standards-A.N.S.I. B-305; O.S.H.A. 1926.550 and 251; P.S.C.A.#1.

Since the hammer may be suspended well above the work level, all personnel should remain clear of the area. Barricades could be set up around the area for additional safety. Even an object such as a stone, bolt, or scrap may adhere to the hammer when laid down and if dropped from the hammer's suspended height could cause harm. In addition to remaining clear of the area, steps should be taken to prevent any parts from dropping into the system. Such things as bolts, nuts, keys, fasteners, wedges and couplings should be tightened and checked before each use and after each drive during use. Good maintenance cannot be overemphasized in promoting the safe and efficient use of the hammer.

In addition to free falling objects, it is possible that projectiles can be thrown out during operation. Any foreign material in the lubricant, supply hose or cylinder may be ejected through the exhaust at high velocity. Personnel should therefore remain clear of the exhaust to avoid this risk as well as to avoid being burned by the exhaust steam or air.

If the air or steam lines are either not properly secured by chain or heavy rope, or if they fail in use they can become extremely dangerous. To reduce the risk of this occurring, all couplings should be checked before use and all hoses must be secured to the hammer just below the couplings. Refer to O.S.H.A. Standards 1926.603 (a) (9) (10). This will prevent the hose from whipping wildly over a great distance if the coupling should fail.

The ram point and the pile cap take a lot of punishment during driving. With use, fragments of metal may be broken or spalled off and ejected with the speed of a bullet. The risk can be reduced by repairing or replacing worn ram parts and pile caps, assuring that the pile is squarely cut, seating the pile in the cap properly while driving, assuring that the hammer is driving squarely, and using the appropriate pile cap. After each drive, a visual inspection of the ram point and cap should be made, staying well clear of the hammer when in use.

III. PRESSURE AND WEAR FAILURES

Although unlikely to occur under normal operating conditions, hose failure can cause substantial

injuries to personnel and property since the steam or air pressure used is typically over 100 PSI. This line pressure, when distributed over a few square inches of area, generates a tremendous force which will cause an unsecured broken hose to whip in a violent unpredictable way. Since such a condition could produce a substantial injury, precautions must be taken to see that this does not occur.

The air/steam supply hose should be secured to the hammer by heavy chain or rope of adequate strength (refer to O.S.H.A. Standards 1926.251), attached to the anchor point on the hammer with a shackle. Inspection of this connection should be made at the beginning of each shift and after the driving of each pile.

Another critical point of the hammer is its valve mechanism and as such, requires regular inspection and maintenance. With normal functioning, air or steam is admitted to the cylinder and released in alternating cycles. After release, the ram falls and impacts with the pile cap. If steam or air is not permitted to enter the cylinder freely or if it is not relieved, there is a possibility that a major structural problem could occur.

The valve mechanism could be jammed by foreign material or it could be broken through misuse or improper handling. However, regular inspection, cleaning and lubrication will reduce the likelihood of trouble. Nevertheless, special attention should be given to the slide bar and wedges, the valve, and the actuating levers at each opportunity. At all times, personnel should stay clear of the hammer until the ram is resting on the base.

Complete inspection and maintenance should be performed at the beginning of each shift and/or after the hammer has been inoperative for over an hour. Cylinder head nuts, the head itself, the cylinder and columns should be given attention. All keys wear and loosen with use and should therefore be checked and secured after each drive. Since they are heavy, a key could be dangerous if it should be dislodged and fall from the hammer. In addition, if both ram keys should be lost during use, the ram would not be secured to the piston and without the inertia and weight of the ram to retain it, the piston could be driven through the cylinder head. Therefore, key condition is obviously very important for safe operation and should be carefully maintained.

Because of wear that occurs during prolonged use, the ram point and pile cap may fragment from metal fatigue. This fragmentation will be accelerated by improper use, such as by misalignment of the hammer axis with the pile and by using a pile cap of inappropriate size. The fragments may be violently ejected during driving and could be a threat to personnel safety. Therefore, both the ram point and pile cap should be checked after each drive and if excessive spalling or cracking is found, should be repaired or replaced. It is essential that the axis of the hammer be closely aligned with the axis of the pile and that the pile cap should be matched to the size of the pile being used. All personnel should remain well clear of the hammer during use, reducing the risk of being struck if fragmentation should occur.

IV. EXPOSED MECHANICAL HAZARDS

Probably the most obvious danger in working around the pile hammer is that of its exposed mechanical parts. Crushing, pinching or shearing can occur if workmen contact moving or movable parts of the hammer. Even the small parts of the hammer are heavy and can cause serious injury if they shift position. Workmen should remain well clear of the exhaust, valve mechanism and slide bar, columns, supporting rig, the ram, pile cap, and the ram point during the operation of the hammer. These areas should be avoided at all times. Failure to do so may result in serious injury or death. If it becomes necessary to work on the hammer, it should be cooled after use, the ram should be blocked, residual air or steam in the cylinder and steam or air lines should be relieved, after having been shut off. Steam or air pressure lines should be disconnected and the hammer should be in a secured position.

V. HIGH TEMPERATURE HAZARDS

Although the pile hammer is constructed of non-flammable materials, the high temperature generated during use can pose a threat to the user if caution is not used. The types of hazards that may be produced are, first, the combustion of materials associated with the use of the hammer and, second, burns from contacting the heated parts of the machine. During use, the hammer will get hot as a result of the tremendous energy that is expended with the expansion of steam or air in the cylinder and with each blow of the ram. Although it is unlikely, it is possible that the heat will be sufficient to ignite some lubricants that may be

used on or around the hammer. Information regarding the combustibility of the lubricants can be found either on the container or can be obtained from the manufacturer. Keeping the machine reasonably clean and avoiding the build-up of dirt that could absorb oil and grease will reduce the risk of fire.

Cushion material, having been subjected to impact of the ram does experience very high temperatures. There is little chance of most materials actually flaming during use if they are the ones recommended by Vulcan and used in the recommended manner. However, when the material is removed and has access to open air, some materials may burn or come in contact with another material that will burn. Therefore, used cushion material should be stored or disposed of in a place and in such a way that it will not create a risk as a source or transmitter of fire.

During use, for reasons previously mentioned, the hammer can become hot and this heat can be retained for a long while after use. Consequently, during or just after the use of equipment, workmen should exercise caution when in the vicinity of the hammer to avoid being burned by contact with hot metal parts.

When steam is being used, special caution should be used. High pressure steam is extremely dangerous if not treated with respect. Also, condensed steam may drip off the hoses or the hammer and could cause serious burns.

Since there is some chance of fire, an approved type fire extinguisher should be kept on hand at all times and a burn treatment kit should be kept with first aid materials. Being alert and aware of the hazards is a good defense against them.

VI. AIR CONTAMINATION

When working in the vicinity of an operating pile hammer, some consideration should be given to the possibility of air contamination.

Almost without exception, the exhaust of a hammer will contain contaminants. The most common of these are traces of lubricant emitted in the form of oil droplets or vapor. Two hazards are associated with this emission. First, the contaminant may be harmful to the respiratory system and second, it may cause damage to material that it contacts if the contamination is very great. Consequently, one should not get into the exhaust stream, and steps should be taken to avoid letting the exhaust spray get onto surrounding buildings, vehicles, etc.

Since the exhaust is merely the release of air or steam that is used to drive the hammer, any contaminants associated with the generating of compressed air or steam and transporting it to the hammer may be present in the exhaust. This system should be checked,maintained,and cleaned to prevent such contamination. The system includes the air compressor or steam boiler and the hoses running to the hammer.

Possibly the least likely source of air contamination is the cushion material that is used beneath the ram point. Because of the tremendous energy that must be transmitted by this material, it tends to fragment, decompose and sometimes burn. For most materials, this should not be a significant problem, but there are exceptions. One material that is commonly used by cushion manufacturers contains asbestos. When the material decomposes in use, the asbestos fibers are free to become airborne. If the asbestos fibers are inhaled, permanent lung damage known as asbestosis may occur. The material should be inspected and if there is any suspicion that the asbestos or the fibers are becoming airborne, an approved filter mask should be worn by all workmen in proximity of the material. WARNING: Use in "confined spaces" may be hazardous to health. Refer to O.S.H.A. Standards 1910.1000, Air Contaminants, and 1910.134, Respiratory Protection.

For each cushion material, lubricant, or other fluid used, the health hazards should be identified by the user and appropriate precautions should be taken. If the hazards are not readily identifiable, the user should consult with the manufacturer of the material or with a certified Industrial Hygienist.

VII. HEARING DAMAGE

There are two primary types of noise which are produced by any pile hammer. The first is impact noise produced by the ram striking the pile. The second type of noise is produced by the operating steam or air as it is exhausted from the cylinder. In both cases, depending upon hammer size, it is possible to produce noise levels which are potentially damaging to the auditory mechanism in the ear.

At present, there are not too many practical ways to

reduce these noise levels. In the case of impact noise, cushion material can be used to reduce the noise levels as well as modify the impulse duration as required by soil type and piling composition. The exhaust noise can also be reduced through the use of an exhaust muffler. However, if it is impractical to mufflethe exhaust, there are other alternatives which will provide construction personnel with adequate hearing protection. Because sound intensity decreases rapidly as the distance from the hammer increases, simply keep all personnel as far from the hammer as is practical. Obviously, there are many other safety reasons whyno one should be near the hammer when it is in use. However, if personnel cannot be stationed far enough from the hammer to adequately reduce the noise, earmuffs or earplugs should be used. If there is concern about the noise level at any job site, it is advisable to use a sound level meter to establish what abatement procedure is needed. It is obvious that the user must give more attention to the noise problem as ever more stringent environmental safety restrictions are imposed by government authorities. Refer to O.S.H.A. Standards 1910.95 and 1926.52, Occupational Noise.

VIII. SHIPPING PRECAUTIONS

The foremost source of difficulty in shipping or moving the pile hammer is its size and weight. Whether the hammer is laid on a platform, vehicle, or a vessel, it should be determined that its support is adequate and that the hammer is well secured. Likewise, the hammer should be lifted only by equipment of sufficient capacity and all rigging should be thoroughly inspected beforehand. Before lifting, check gross weight label, located on machine. If any tilting, vibration or aaccelerative loading is anticipated, such as on a vessel or vehicle, the hammer should be secured in position. This can be more easily done with the aid of a shipping skid which can be supplied by Vulcan. Of course, it is essential that the ropes, chains or fasteners used for securing the hammer be sized adequately to withstand the load. If the hammer will be subjected to any tilting, vibration or accelerative loading, it is necessary to block the ram in order to prevent the ram from sliding and impacting without a piling to absorb the shock. A sliding ram can transmit a large impulse or shock to the securing devices that hold the hammer in place which may cause the hammer to break free and thus pose a threat to the safety of the crew, transporting vehicle or vessel. At all times, when not in use, secure the ram at the lower extremity of its travel and shim or brace it in place with wood or steel blocks and wedges. If a Vulcan designed shipping skid is used, it will provide proper support areas and a secure relationship between ram, base and piston.

Another consideration is that the carrier, whether vessel or vehicle, must be of sufficient capacity to handle the load and that the carrier should observe the operating limitations of the vessel or vehicle with that load (more than one flatbed trailer has been collapsed from improper loading of a hammer). Always refer to the gross weight label on the machine before attempting to move, load or transport.

If it is expected that the shipment will take an extended period of time, the same precautions should be taken as for storage.

These include inspection, lubrication, rust proofing

and sheltering of the hammer. After shipment and before being placed in operation, a thorough inspection should again be performed to assure that no shipping damage was done and that the hammer is in operable condition. This will preclude the possibility of placing a damaged or defective hammer into use and thereby creating a hazardous situation.

IX. STORAGE PRECAUTIONS

If the pile hammer is to be stored or out of service for an extended period of time, certain precautions should be taken to prevent damage to the hammer and risk to personnel.

A storage or resting place should be selected which will adequately support the weight of the hammer. The site should be level, firm, and a protected area. Keep the hammer off the ground. This can be done by using the original shipping skid or resting the hammer on two 8" x 8" wood beams. In addition, because of the hammer's great weight it should be secured to preclude damage from unexpected movement. The ram shold be properly blocked in the down position. This is accomplished by using a 4" x 4" timber wedged between the cylinder and the ram and securing the timber to a column with banding iron. The 4" x 4"'s should be used on diagonally opposite columns.

After its use, a thorough inspection should be performed. If any defects are found, they can be

repaired during the storage period,thus preventing malfunction, danger or on the job downtime.

Before storage, a complete lubrication and rust proofing should be done in order to protect the hammer from the elements and subsfequent corrosion. For further protection, a cover of canvas or plastic can be used to provide shelter, and thus reduce the effects of exposure to the environment.

When the storage period has ended and it is time to put the machine back into service, another thorough inspection, cleaning and lubrication will assure that the hammer is ready for service.

By taking these few precautions, the life of the hammer can be extended, its efficiency can be maintained, and its safety greatly enhanced. Detailed instructions on preparation for storage including inspection procedures and lubrication requirements are given in the Field Service Manual, supplied with each hammer by Vulcan.

X. MAINTENANCE AND REPAIRS

Repairs by anyone other than Vulcan Iron Works Inc. or its authorized representatives or use of replacements parts other than Vulcan Iron Works Inc. parts will void all warranties covering the hammer.

By closely following the Owner's Field Service Manual and the User's Guide, many years of reliable operation will be possible. However, the manufacturer will not be responsible for improper maintenances or use not in accord with recommendations given here or in the Vulcan Field Service Manual.

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