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THE WILLIAMS PATENT CRUSHER & PULVERIZER CO. ST. LOUIS, MO. U.S.A.
TRADE MARK

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GRINDERS
CONVEYORS
DRYER MILLS
AIR SEPARATORS

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Serial No. 17532

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WILLIAMS

GENERAL SAFETY PROCEDURES FOR OPERATION OF WILLIAMS EQUIPMENT

THE WILLIAMS PATENT CRUSHER & PULVERIZER CO. ST. LOUIS, MO. U.S.A.
TRADE MARK

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FORM 936

GENERAL SAFETY PROCEDURES FOR OPERATION OF WILLIAMS EQUIPMENT

Because each installation of Williams Equipment involves different uses and considerations it must be understood that these safety instructions are general in nature and that each specific installation must be reviewed by the owner or plant management to insure maximum safety precautions. It is the responsibility of the owner or plant management to provide complete safety instructions and procedures for the operation of all Williams equipment, which their personnel will be involved with in the performance of their duties, and to see that all the necessary precautions are followed. All personnel who will be involved in the operation or servicing of Williams equipment must be properly trained in the operation and servicing of such equipment and must be fully familiar with these general safety procedures and the safety precautions attached to the Williams equipment.

HAZARDOUS MATERIALS WARNING

OVERSIZE OR THE WRONG TYPE OF MATERIAL FED INTO A MILL CAN CAUSE SERIOUS PERSONAL INJURIES AND PROPERTY DAMAGE, INCLUDING DAMAGE TO THE EQUIPMENT ITSELF.

No explosive, flammable or similar hazardous material is to be fed into any operating Williams equipment under any circumstances.

If there is any possibility that hazardous material could be accidentally overlooked by the personnel feeding the Williams equipment, the owner must provide suitable protection such as listed below or mandated by Federal, State, or Local regulations.

A) Inert gas atmosphere in system.

B) Explosion vents for Williams equipment and building housing the equipment.

C) Explosion suppression system.

D) Operators station protected by blast panels and shielding.

E) Water deluge system for fires.

Heat and sparks generated during the operation of some Williams equipment can cause combustible materials to ignite unless precautions are taken by the owners.

1) When personnel are working inside the mill or near the rotor the power to the driver shall be de-energized and locked out with an approved safety tag on the controls or starter.

2) Never enter or service equipment through the conveyor, feed hopper, or discharge opening.

3) Only the specified size and type material which the mill was designed to handle shall be fed into the mill.

4) The inherent ballistic action of the grinding operation can cause pieces of the material being processed to be thrown out the feed or discharge openings and injure personnel in the vicinity. It is the owner's responsibility to provide and maintain proper screens and shrouds at all the mill openings to contain the material being processed inside the hopper or mill.

5) All personnel in the vicinity of an operating mill must wear a hard hat and safety glasses in addition to any special clothing or protective equipment the particular installation may require.

NEVER ALLOW PERSONNEL TO STAND IN LINE WITH OR IN THE IMMEDIATE VICINITY OF THE FEED OR DISCHARGE OPENING OF A MILL WHILE MATERIAL IS BEING PROCESSED.

6) **NEVER OPERATE A MILL FASTER THAN THE DESIGN SPEED.**

7) Before starting the equipment for the first time and for normal daily operation the following precautions should be followed:

A) Check to see that all alarm signals and emergency devices are functioning properly.

B) All access doors, covers, or inspections ports are closed and securely fastened in place.

C) Infeed conveyors or chutes cleared of all materials that could enter grinding chamber until the rotor attains operating speed.

D) Make a daily inspection of the rotor condition before the start of operations noting any badly worn or broken items that could fail and replace them before using the mill.

E) All protective covers or guards on the drive connection and flywheel or shaft end are fastened properly in place.

F) The mill is empty and clear of all debris or product so the rotor is free to turn without interference and the hammers can swing on their pivots.

G) All personnel are clear of any moving parts and positioned at their assigned operating stations.

8) **NORMAL OPERATING VIBRATION AND WEAR CAN CAUSE BOLTS TO LOOSEN AND ALLOW COMPONENTS TO FALL OFF THE MILL OR INTO THE ROTOR UNLESS A REGULAR REVIEW OF THE MILL IS MADE BY OPERATING PERSONNEL TO TIGHTEN ANY LOOSE BOLTS.**

9) Should the rotor become jammed or the feed chute plugged do not attempt to clear the chute or open the cover while the rotor is turning and the power is connected. Before any service operations on the mill, de-energize the driver and wait until all rotor movement has ceased. If entry to the rotor area is made, after the power is locked off and the rotor movement has ceased, care should be taken to secure the rotor from turning because the rotor could turn if stepped on or physically pushed thereby causing swing hammers to fall and strike the rotor, or anyone in the vicinity.

THE ABOVE LIST IS NOT INTENDED TO INCLUDE ALL PRECAUTIONS THAT CAN BE TAKEN TO INSURE SAFE OPERATION OF WILLIAMS EQUIPMENT, BUT TO SUPPLEMENT ANY EXISTING ORDINANCES, APPLICABLE REGULATIONS AND SPECIFIC SAFETY INSTRUCTIONS BY THE OWNER OR PLANT MANAGEMENT FOR THE PARTICULAR APPLICATION OF THE WILLIAMS EQUIPMENT.

THESE SAFETY INSTRUCTIONS SHOULD BE FRAMED AND POSTED IN ALL OPERATING LOCATIONS WHERE PERSONNEL ARE STATIONED.

WILLIAMS

CRUSHER FOUNDATIONS

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FORM 902R4

FOUNDATIONS

Contrary to appearance, machinery foundations can be the most problematic component in a machine system. The motors, crushers, turbines, control panels, and ancillary meters, valves, and others appear more complex than a block of reinforced concrete or a simple arrangement of steel beams and columns between them and the earth. That may be why many machine buyers and installers find themselves in an expensive quagmire with a new machine performing out of specifications. Not enough engineering horsepower was applied to the machinery foundation design.

Machines such as steam turbines, centrifugal compressors, reciprocating compressors, fans, shredders, crushers, and others require foundations that have been designed and installed by experienced and knowledgeable engineers. The time to avoid problems is in the planning and design stage. There are the usual considerations of adequate static stiffness, stability, alignment with internal and external components, force path to earth, isolation from external influences, and isolation of the external world from machine. Then, **there is the need to avoid high vibrations**.

High level vibrations are harmful for the machine because they damage its structure and, if left uncorrected, cause breakdown. Vibrations also harm the machine surroundings by generating continuum vibrations in the soil and in buildings, propagating over long distances, and damaging buildings or other installations. Vibrations can insidiously result in damage to neighboring machinery. Moreover, vibrations represent an additional soil loading at the location of the foundation, they shake the soil particles that may lead to compaction and possibly to dangerous subsidence or tilting of the machine foundation.

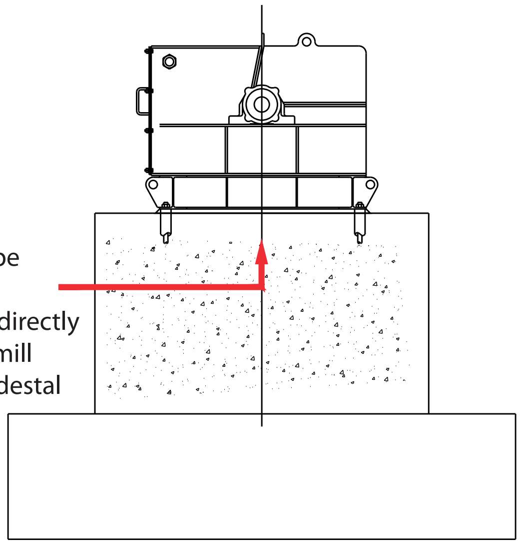
BASIC CONSIDERATIONS

The best foundation is provided by a poured in place reinforced concrete structure under the crusher and its driver. The foundation must have the required rigidity to sustain the alignment of machinery on it and with external ancillary devices.

A generally accepted rule-of-thumb is the foundation weight (mass) be at least three times the mass of supported machinery for centrifugal machines and four to five times for impacting (crushers) or reciprocating type of machines. The mass acts as an inertia block to stabilize the foundation. The optimum distribution of the foundation mass would be to have as much weight as possible directly under the crusher and its bearings to provide the maximum inertia damping next to the rotating equipment. The height of the foundation should never be greater than the width perpendicular to the rotor unless an integral pad or spread footing is used beneath the structure.

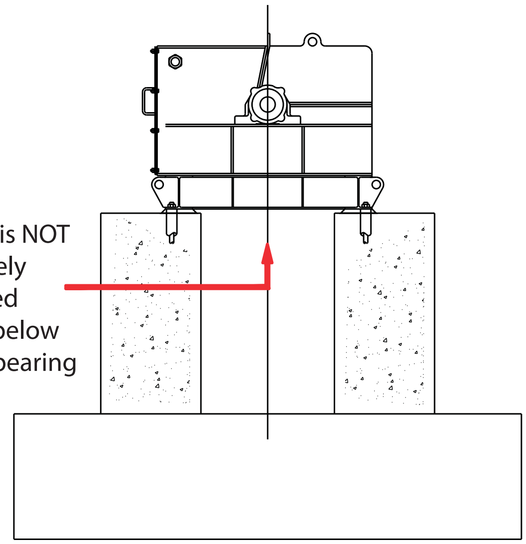
Whenever possible arrange the discharge from the crusher to be carried perpendicular to the rotor to allow solid support under the sides of the mill and the bearing pedestals.

RECOMMENDED



DO provide continuous support directly under the bearing pedestals.

NOT RECOMMENDED



DO NOT mount mill on a foundation that does not provide support directly under the bearing pedestal.

RECOMMENDED

NOT RECOMMENDED

The desirability of low soil loading under a foundation subject to vibration cannot be over-emphasized. It is not safe to use conventional static soil bearing support values for dynamic loading conditions.

The foundation should rest on bedrock or solid earth, completely independent of other foundations and separated from all adjacent concrete work by shock absorbing pads between the meeting surfaces. If necessary, pilings should be placed as the initial foundation layer. The tendency to consider pilings as a panacea for foundation/soil problems should be avoided. Their use also requires specialized engineering.

Batter piling may cause piles to lose the damping expected from them. Environmental considerations are important with their use as much as without them. Machinery center of gravity should be placed over a pile groupings' center of resistance to avoid rocking in operation, which can change the natural frequencies in a short time.

The foundation must be designed to avoid resonant vibration conditions, one of the most insidious problems because it amplifies normal vibrations and is usually expensive to cure. Engineering textbooks suggest foundation design include facility to change a foundation's properties (natural frequency , among others) after machine installation. That might include space for bracing, hollow columns to accept mass changing material, moisture control of subsoil (drainage), columnar collars for strengthening, etc.

Below is a plot showing how rapidly, as the operating frequency approaches a natural frequency, a vibration level is amplified at resonance:

E is the damping factor.

v is the floor natural frequency (cpm).

w is the operating speed (rpm).

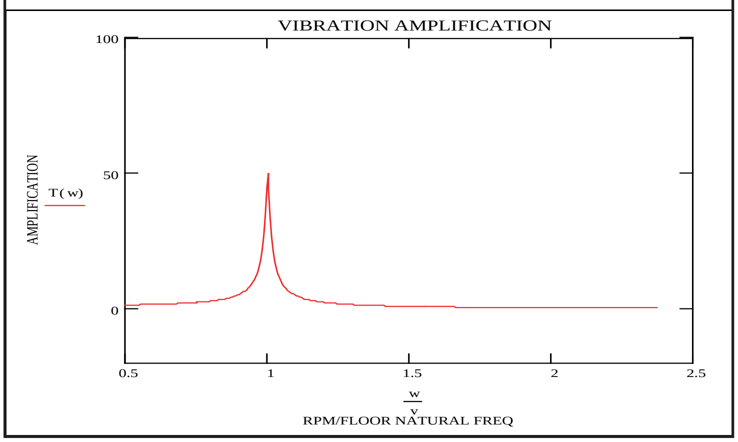
T is the amplification factor.

$E := .01$

$v := 1900$

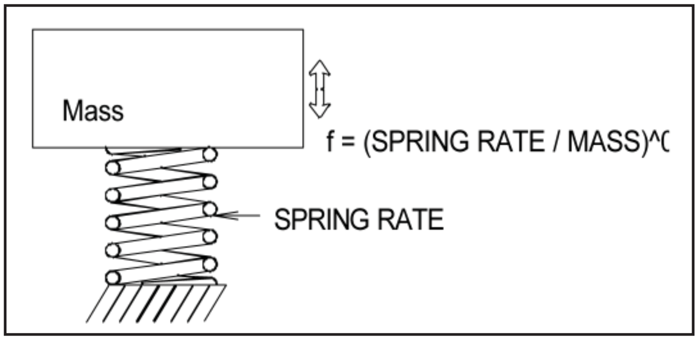
$w := 100, 110 .. 4500$

$$T(w) := \left[\frac{\left[1 + \left(2 \cdot E \cdot \frac{w}{v} \right)^2 \right]}{\left(1 - \frac{w^2}{v^2} \right)^2 + \left(2 \cdot E \cdot \frac{w}{v} \right)^2} \right]^{.5}$$



Resonance arises when the foundation or one of its major components has a natural frequency[1] at or close to the machinery running frequency. The most common vibration creator in machinery is the rotor unbalance that excites the rotor and from it the surrounding elements, at the rotor's turning speed (rpm). A crusher is especially susceptible to vibration problems because its unbalance changes and can become high, at a fast rate, due to the constant uneven wear on the hammers. That wear is a natural consequence of its work.

Any natural frequency (cpm or cycles per minute) of the foundation or a major component should be 20 to 25% away from the crusher's rotating speed (rpm or revolutions per minute). For example, if the crusher's rotating speed is 900 rpm, the foundation's natural frequency should be less than (900) – (900)(.25) cpm or greater than (900) + (900)(.25) cpm. "Greater than" is preferred since the crusher will not have to traverse the natural frequency to get to operating speed during start.[ii]



This is a simple model to demonstrate the basic concept of natural frequency. The mass will bounce (vibrate) up and down after being pushed down and released at a rate (frequency) determined by (spring rate (lbs/in) /mass (lb-sec^2))$^{.5}$.

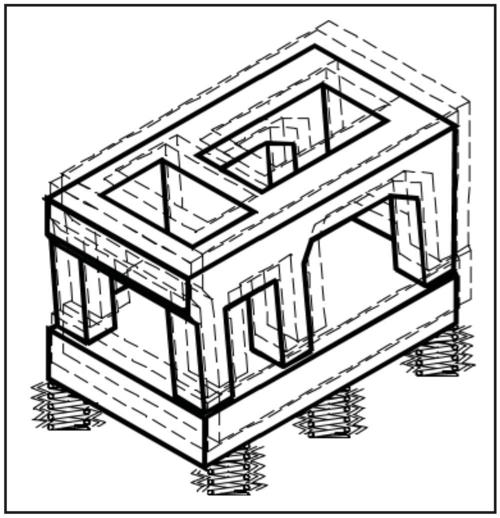
Avoiding the resonance situations requires competent engineering by all concerned. Williams Crusher Co. will supply the following information so that you can proceed with your foundation design.

- Certified drawing of machine assembly
- Functions of machine
- Weight of machine and its rotor components
- Location of center of gravity both vertically and horizontally
- Speed ranges of machine and components or frequency of unbalanced primary and secondary forces

Knowledge of the soil formation and its representative properties is required for static and dynamic analysis. The following parameters are generally required:

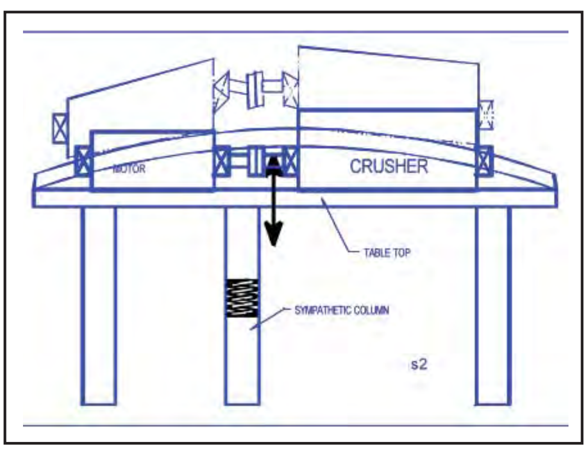
- Density of soil
- Poisson's ratio
- Shear modulus of soil at several levels of strain (or magnitude of bearing pressure)
- Coefficient of sub-grade reaction of soil, if the above parameters are not accurately known
- The foundation depth and the bearing pressure at which the above parameters are applicable
- Other information required for the static design of the footing

The soil becomes the spring for the entire machine system with the system as the mass. That translates into a situation similar to the one below. The coil springs show how the soil reacts and can form a condition of spring and mass bouncing as energetically as the small system mentioned previously.

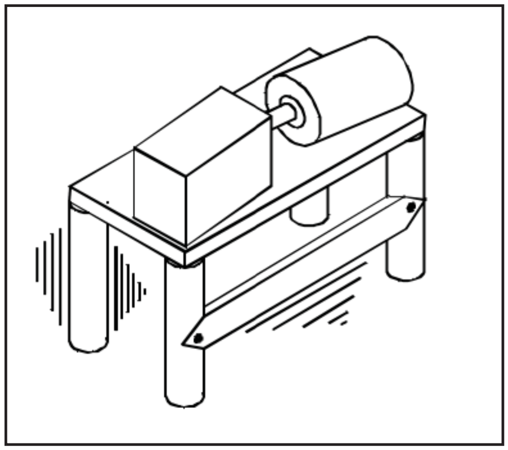


When that happens, it is usually time to start calculating the time and expense to change the mass and/or spring rates.

Vibration problems are not limited to the whole foundation and the supporting soil. Components of the foundation can have natural frequencies that will resonate with machine operating speeds. The drawing below shows the tabletop and a column beneath it vibrating together because their natural frequencies are close to the machine system operating speed.



Major components on a machine base are not the only trouble makers. A minor part can also resonate enough to cause problems to the mounted machinery and nearby personnel. The lower drawing suggests two of those.



STRUCTURAL STEEL FOUNDATIONS

If a structural steel foundation is required for any crusher installation, it should be carefully designed to avoid natural frequencies close to operating speed and its harmonics and sufficiently rigid to assure permanent alignment of the crusher and its driver. It must be designed to carry with minimum deflection the weight of the equipment, plus the loads imposed by the material handled and the dynamic forces set up from the crushing operation.

The crusher frame is to be rigidly connected to the structural foundations using shims to adjust for foundation and frame irregularities to prevent distortion of the crusher frame. The distortion can cause vibrations as problematic as vibrations from unbalance. Resilient mounting pads between the bottom flange of the crusher and the structural steel foundation are to be avoided at all times, unless they are beneath an inertia base supporting both the crusher and its driver. Vertical supports should be placed directly under the crusher bearings wherever possible. If this cannot be done, the bearing loads must be transferred properly to the nearest vertical load path.

Structural steel foundations are generally more sensitive to imbalance because more structural members are available to have natural frequencies matching the operating speed. Our crushers are dynamically balanced on a properly designed concrete foundation to 5 mils displacement or less prior to shipment from our factory. Crushers subsequently mounted on a structural steel foundation will most likely vibrate at a higher level if the steel foundation is more compliant than our balancing foundation.

All structural steel crusher foundation plans should be reviewed by a qualified structural engineer with experience and expertise in dynamic loading just as any other foundation plans.

SWING HAMMER CRUSHERS ON STRUCTURAL STEEL FOUNDATIONS

The unique characteristic of a swing hammer crusher that is different from all other rotating machinery is the starting pulse generated by hammers extending from their position of rest to a radial position on start-up. Even a perfectly weight matched set of hammers will have a significant starting pulse until they are extended to a rigid radial position. This pulse is transmitted to the support structure which responds at its natural frequency or critical and is further excited by several more heavy shocks in rapid order until the hammers are fully extended at about 200 rpm. As the crusher continues to accelerate to operating speed it rapidly passes through any foundation or structural criticals below the operating speed until it attains full speed where the vibration pattern can then be determined in a few seconds while the rotor is at a constant speed.

If the support structure is resonant at or near a multiple of the crusher operating speed the initial starting pulse is reinforced by the forcing frequency at operating speed to create a serious vibration disturbance in a non-uniform manner. This means that the vibration pattern of phase and amplitude is not the same on two consecutive starts of the crusher. This is particularly true if the critical frequency is at or near the crusher operation speed. A critical or resonant condition vibration pattern at or near operating speed is characterized by a significant increase in vibration amplitude for a very slight change in operating speed and a ninety degree or more shift in phase angle. This can best be demonstrated as the rotor coasts down from full speed and observed on the vibration analyzer meters in the filter out mode because the coast down time is considerably longer than the acceleration to full speed.

What a critical implies is that a very little force can be magnified significantly by the structures natural tendency to vibrate at or near the forcing frequency. This can be controlled sometimes by dynamic balancing to a more rigorous standard than normally required. When the crusher is mounted on a rigid or solid foundation that affords adequate damping of operating vibrations; criticals are seldom encountered. The crusher starting pulses are similar to bump test used to determine the structures natural frequencies. That test is performed by striking the structure with a sharp blow with sufficient energy to excite a vibration pulse or wave that can be measured and observed by a vibration analyzer. All structures have a natural frequency in both horizontal and vertical directions, which are influenced by their loading and sub-grade support. Steel structures have a much greater tendency to respond to vibration of equipment mounted on them because they have less inherent damping and are not normally designed to resist vibration. On the other hand concrete structures normally afford greater damping because of their lower natural frequencies due to the greater mass of concrete provided it is designed to meet nominal foundation criteria.

This is why a swing hammer crusher mounted on an elevated structural steel foundation can be easily dynamically balanced without hammers. Then when the matched weight set of hammers are installed on the rotor the vibration pattern changes dramatically where it is almost impossible to control the vibration or to see a repeat of the vibration pattern on two successive runs or starts.

The only effective answer for this situation is to provide a non-resonant foundation, which always entails considerable additional expense or to dynamically decouple the forcing frequency by changing the crusher operation speed. Options available for changing crusher speed include a different speed motor and changing to a belt drive that offers many possible speed variations by sheave combinations that permits operating the crusher out of the critical influence of the foundation.

ANCHOR BOLT LOCATIONS

Check the certified dimension drawings for the anchor bolt location and size. When anchor bolts or inserts are cast in the concrete, it is very important to construct a well braced template to accurately locate and position the anchor bolts or inserts in the foundation until the concrete has set. To compensate for small measuring errors, place a sleeve around each bolt to allow for adjustments when the concrete has set. The sleeve should have about an inch clearance around the bolt, which will require a plug at the top to keep out the concrete, and center the bolt in the sleeve.

BEDPLATES AND SHIMS

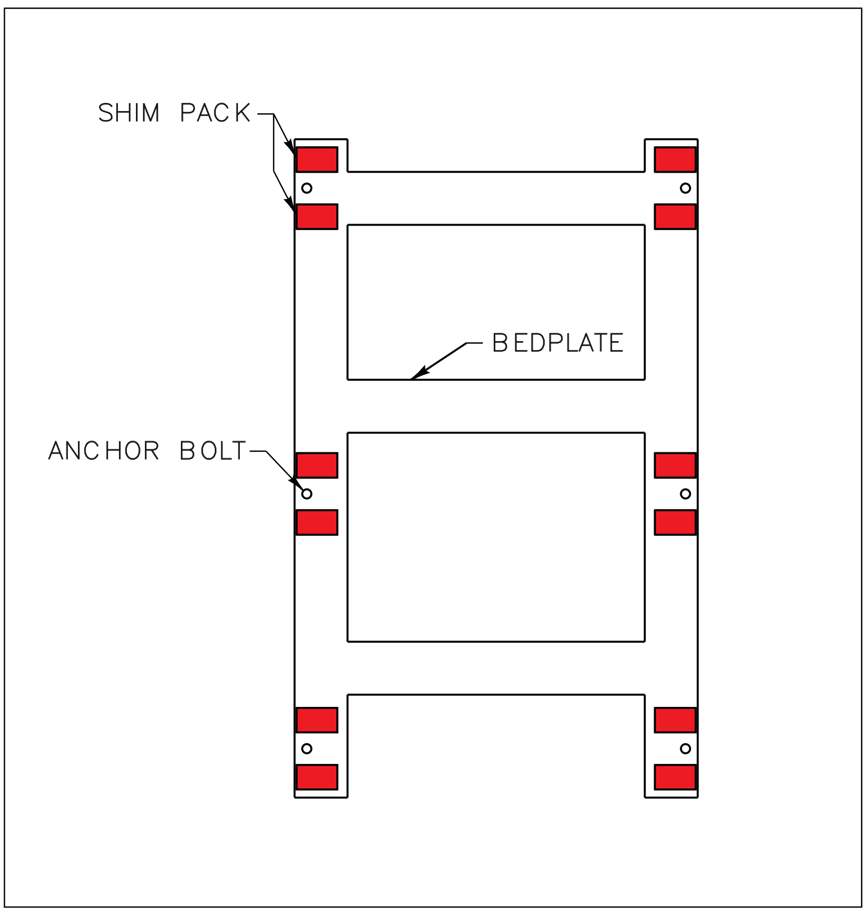
When the foundation design calls for a structural bedplate cast in the concrete foundation, the centerlines and elevation must be established by a survey so the crusher will be in the correct position called for on the certified dimension drawing when set on the bedplate.

To determine the necessary length the anchor bolt must project above the foundation, check the certified dimension drawings for shaft centerline elevation and its height above the foundation. Then allow for the grout or shim thickness, the crusher bottom flange thickness, the height of the nuts and washers and extra threads for draw-down.

When prepping the foundation area where the mill base or bed plate is to be installed. Make sure the anchor bolts were installed per the Williams supplied drawings and information.

Make sure the foundation area is level and clean of any dirt and debris. Confirm that base plates and foundations are installed and leveled to specifications.

Make sure that baseplates and machine feet are clean, deburred and free from dents in the areas to which machinery will be mounted.



Use clean, flat shims. If you must cut thicker shims from steel stock, be sure they are clean, flat and deburred, shims should be uniform in size and shape. Typical shim sizes are 3-4” wide, and the full length of the mill flange.

Install shim packs on each side of the anchor bolts as shown above and below. This provides a solid support of the equipment once the anchor bolts are tightened and will help provide a solid bond between the bed plate/mill base and the foundation. Select shim thickness that results in no more than 3-4 shims in a shim pack to prevent a spring effect.

NOTE: MINIMUM WIDTH OF SHIMS 3-4” LENGTH SHOULD BE THE SAME AS THE FLANGE OR THE WEB OF THE SUPPORT BEAM

GROUT

The crusher should be properly shimmed, leveled, aligned and grouted onto its foundation. Allow for 1 – 3 inches of grout to be placed between the crusher and its foundation. Look at your certified dimension print for depth of grout recommendation.

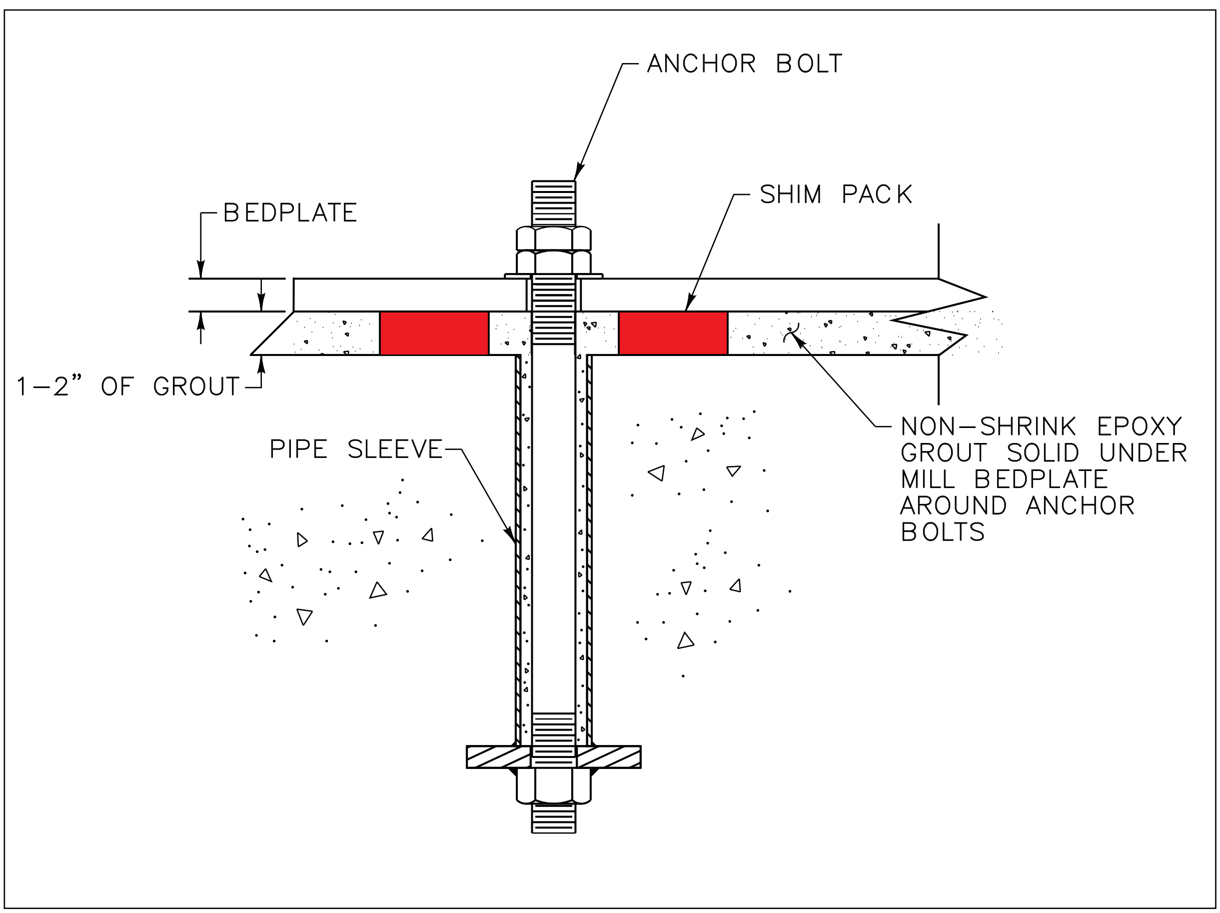
When new equipment is being commissioned, high vibrations often are caused by improper grouting performed by hurried construction crews. As equipment ages, many vibration problems arise that can again be traced to the foundation. Shims and hold-down bolts tend to loosen over the years, causing grout to turn to dust. Result is a condition known as "soft foot." Grout, therefore, is one of the keys to establishing and maintaining precise alignment of rotating equipment.

We only recommend a two-part epoxy grout.

Epoxy grouts offer quick curing, high tensile and compressive strengths, and the ability to bond to both concrete foundation and machinery steel.

Five Star Products Inc., Fairfield, Connecticut, offers a full line of epoxy grouts for your consideration.

Grout must be placed to provide for full support under the base flanges of the mill or the structural steel bedplate provided with the mill.



[ii] "Any beam, column, floor, or other material system (bearing pedestal, rotor/bearing/pedestal/foundation/earth, building/earth), having the properties of mass (weight) and elasticity is capable of making a free or natural vibration. If the system is displaced from its rest or unstrained (not stretched) configuration, elastic strain introduces internal forces and moments which oppose the strain. For brevity and by analogy with a simple mass-spring (weight hanging from a spring or a cantilevered beam or a tuning fork) system we shall refer to the effects of this elastic strain as a "restoring force." If, the system is suddenly released, the restoring force accelerated the system back toward its rest position but by the time it has arrived there it has acquired momentum and overshoots the rest position. This brings into action a restoring force in the opposite direction which resists the overshoot, brings the system momentarily to rest, and immediately accelerates it back again through the rest position, and so an. This free vibration goes on until the system is brought to rest by damping which dissipates (as heat) the energy of the free vibration.

The frequency of this free vibration is the "inherent **natural frequency**."

P.146, <u>Seismic Mountings for Vibration Isolation,</u> Macinante, Wiley Interscience, John Wiley & Sons, 1984.

"A bridge or, for that matter, any structure, is capable of vibrating with natural frequencies. If the regular footsteps of a column of soldiers were to have a frequency equal to one of the natural frequencies of a bridge which the soldiers are crossing, a vibration of dangerously large amplitude might result. Therefore, in crossing a bridge, a column of soldiers is told to break step."

P.376, <u>University Physics,</u> Sears and Zemansky, Addison Wesley, Reading, MA, 1962.

[ii] Decades ago resonance caused less trouble in engineering design than today, and it is precisely the higher probability of resonances that is a primary reason for this paper. Older type constructions, machines, buildings, and steel structures used thicker and more rigid parts, resulting in fairly high natural frequencies. At the same time machine speeds used to be relatively low, so that the troublesome high vibrations arising from resonance, that is, the coincidence of a speed of rotation with a natural frequency, occurred less often. With the progress of engineering techniques, structures became more slender and flexible, their natural frequencies decreased while machine speeds increased. Thus, the range of natural frequencies approached that of rotational speeds, leading more frequently to resonance and its associated high vibration levels and problems.

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Oldest and largest manufacturer of hammer mills in the world

LARGE CRUSHER ASSEMBLY AND INSTALLATION

THE WILLIAMS PATENT CRUSHER & PULVERIZER CO. ST. LOUIS, MO. U.S.A.

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WILLIAMS PATENT CRUSHER & PULVERIZER CO., INC.

2701 North Broadway • St. Louis, Missouri 63102, U.S.A.

FORM 895

LARGE CRUSHER
ASSEMBLY and INSTALLATIONS

Introduction

The erection of most large Williams crushers is essentially the same for both reversible and non-reversible crushers. Adequate installation, and safety instructions must be given by the contractor or owner to the personnel directly responsible for the erection of this crushing equipment.

On the job safety is the most important consideration in every portion of the installation of Williams crushing equipment and workmen are to wear proper safety equipment.

Because of the size and weight, most large Williams crushers are shipped in several sections or with the frame and rotor assembly separate.

Identification Of Parts

Before starting erection of the crusher and its auxiliary equipment, identify all the parts using the dimension drawing and identification tags as the reference. If more than one crusher is involved, separate the parts for each system to avoid confusion during assembly.

The front end or the drive side of the crusher base is identified by stamped or welded lettering so it can be properly oriented on the foundation. It is very important to identify the drive side of the crusher frame because the bolt holes in the bottom flange are symetrical and it is possible to reverse the crusher on the foundation. Non-reversible crushers have arrows on the sides of the frame just above the shaft opening that indicate the direction the rotor is to turn. The cutting tip of the hammers for non-reversible crushers are installed on the rotor facing the breaker plate, when the direction of the rotor travel is correct as indicated by the direction arrows on the sides of the frame.

Check Foundation

Determine that the foundation bolt locations agree with the dimension drawing, and the bottom flange of the crusher base. Determine the location on the foundation of the crusher centerline in both directions by a careful survey. The centerlines are used as a reference for all of the subsequent erection work. Establish the crusher shaft centerline height from the certified dimension drawing so the elevation of the crusher bottom flange can be located above the foundation or from a fixed reference point. The height of the driver centerline will also influence the finished foundation elevation with provisions for leveling and grouting both the driver and the crusher.

The driver is always set after the crusher has been erected complete with the rotor locked in its proper position so it is important to install the crusher frame correctly to insure the rotor will align with the driver when it is set in its indicated position.

Set Bottom Of Crusher

Refer to section on HANDLING AND STORAGE for proper lifting procedure. Lift the base section of the crusher frame into position using the holes or lifting eyes provided in the reinforced bearing support flange to attach the cable slings. The bottom flange bolt holes should be aligned with the foundation bolts or bolt sleeves.

It may be necessary to adjust the bolt holes in the bottom flange of the crusher or bedplate with a cutting torch because of minor variations in the foundation position.

When setting the crusher on fixed foundation bolts, protect the threads that enter the flange from damage by wrapping them with shim stock.

Several procedures can be used to set the elevation of the bottom flange of the crusher base, when erecting the frame. Normally it is desirable to have at least a three inch clearance between the bottom flange and the foundation to facilitate the placement of grout under the entire bottom flange.

Whichever system is used it is necessary to check the elevation and level of the rotor shaft before grouting the crusher to the foundation. When fixed anchor bolts are installed in the foundation or bedplate, it is desirable to use a horsehoe shape or slotted shim plates to straddle the anchor bolts. The shims must have sufficient area to carry the weight of the equipment so the bearing pressure on the concrete is never more than 300 psi. Some crusher bases are equipped with jacking bolts in the bottom flange to set the elevation and help in leveling the frame and shaft. The jacking bolts are run out of the flange nut the necessary distance to set the frame elevation before the crusher base is lowered onto the foundation.

Another method when fixed anchor bolts are installed in the foundation would be to use leveling nuts on the bolts that are set with a surveyors instrument to proper height for the botton of the flange before the crusher base is lowered onto the anchor bolts.

Where the anchor bolts are installed in sleeves in the bedplate or foundation after the crusher base is lowered into position the elevation can be set with a shim plate stack at each corner of the frame set to the proper height by a survey. Do not use more than 5 shims in a stack or shims less than .010" thickness to avoid a spongy shim pack.

Loosely tighten the nuts on the anchor bolts when the base is in position and the shims are in place. Secure tightening is done only after the rotor is installed and leveled. Final leveling of the crusher base is done after the rotor is installed so the shaft level, and alignment can be checked before the grout is placed.

Rotor Installation

On all but the very largest crushers, the rotor assembly is shipped on a skid complete with the bearings, hammer bolts, and hammers installed. When specified, the rotor coupling half is installed on the drive end of the shaft.

The rotor rests in saddles on the shipping skid and is held in place by tie bars, which must be removed before it can be lifted from the skid.

Remove the preservative from the bearing pedestal mounting surfaces and from the machined surfaces on the stop blocks as well as the ends and bottom of the bearing housing with a suitable solvent and wiping cloths. Remove any burrs from the top inside edges of the pedestal support blocks so the bearing housing will slide into place easily.

Stop Blocks

On rotors with 11 inch and larger bearings the stop blocks have machined slots and tapered keys to hold the bearing housing in position on the support flange. Make certain these machined slotes and keys are free of rust and other debris before lifting the rotor. Match up the tapered keys with the stop block by the number stamped on the front of the key and near the slot in the stop block.

Rotors with 8 inch bearings have a single tapered key that fits in the gap between the end of the bearing housing and a stop block. Before inserting the keys in their slots, coat them with a Never-Seez Compound so they can be removed if it is ever necessary to service the rotor.

Setting The Rotor

Non-reversible crushers require a section of the side liner on each side to be removed so the rotor can be installed. It is easiest to install the rotor before the cover is set in place on non-reversible crushers.

The cover of a reversible or non-reversible crusher can be opened with a crane when the hydraulic cylinders are in position provided the check valves are temporarily removed. If hydraulic power is not used to open the cover, place a block between the open cover and the frame as a safety precaution.

When erecting reversible crushers, the rotor is positioned on the base and locked in position and leveled before the rest of the frame is erected.

Lifting The Rotor

Refer to the section of HANDLING AND STORAGE before setting the rotor in position. Be certain that the direction arrows on the side of the non-reverisble crusher frames correspond to the hammer cutting directions. The fixed bearing is always on the drive side of the rotor for both reversible and non-reversible crushers. The drive side bearing is indicated by a stenciled or stamped marking on the bearing housing or the coupling half.

A spreader bar should be used when lifting the rotor with sufficient protection under the slings to keep from marking the shaft. Connect the slings to the rotor between the bearing housing and end disc.

When a spreader bar is not available use a sling sufficiently long enough to prevent the leg of the sling contacting the end disc. Good rigging practice requires the sling legs to make a 45 degree or larger angle with the rotor.

When an ordinary sling is connected to lift a non-reversible crusher rotor between the bearing housing and the end disc, the sides of the frame will interfer with the sling lowering the rotor onto the support pedestals. It will be necessary to use a large sling that will reach the step off on either end of the shaft beyond the bearing housings to lift the rotor into position. If the sling contacts the bearing housings when lifting the rotor, they will be tilted out of position, preventing them from setting properly on the support pedestal and possibly damaging the oil seals.

Carefully lift the rotor over the crusher base and lower it onto the bearing pedestals. Carry the rotor weight so only a moderate drifting force is required to align the bolt holes of the bearing housing with the mating holes in the pedestal block or sole plates.

Match Marks For Rotor Location

Align the match marks on the ends of the bearing housing flanges with the mating match marks on the surface of the bearing pedestal, which will properly locate the rotor in the crusher frame and insure the bearing housing opposite drive side is in its proper position to allow this bearing to move axially or "float". Centering the match marks on the ends of the bearing housing flanges with the match marks on the pedestal will properly align both sets of bolt holes, and the stop blocks will be in the correct position to install the tapered keys. Insert the high strength bolts shipped with the rotor in the holes of the bearing housing flanges from beneath the bearing support pedestal so the nuts will be on top for proper tensioning.

Before inserting the tapered bearing housing lock keys in the slots, coat them with a Never-Seez Compound so they can be removed when necessary. Check to make certain the number on the tapered key corresponds to the number on the stop block.

The precision machined bearing housing and pedestal support blocks will locate the bearings and the rotor in the proper position when the tapered keys are inserted in the slots of the stop blocks an equal depth on both sides of the bearing housing.

CAUTION: Do not drive or use excessive force to insert the tapered keys in their slots beyond a snug fit. Bolt the holder clips in place to secure the tapered keys in position.

Bearing Housing Hold Down Bolts

The bearing housing hold down bolts are tensioned when the tapered keys are in their proper location.

The large 700 Series Crusher hold down bolts are drilled for insertion of heaters (Fire-Rod) to electrically heat the bolts so they can be tensioned while elongated a half turn beyond a snug fit when cold. SEE APPENDEX A.

The bearing housing hold down bolts on the smaller size crushers are tensioned using conventional mechanical equipment.

Where torque measuring equipment is not available the Turn-of-Nut Technique will give satisfactory results. Tighten the nut as snug as it can be drawn with hand effort with a normal size wrench, and then force it another half turn for bolts eight inches long or less and two thirds turn for bolts longer than eight inches.

Level Tolerance For Erection Of The Crusher Frame

Before additional weight of the crusher cover and hopper is installed on the frame, it would be advisable to level and adjust the frame on the foundation using the top of the shaft to check side to side elevation alignment. The best check is a series of level readings using a surveyors level or transit with a machinists scale to determine the elevation on both ends of the shaft and the four corners of the top flange of the crusher frame. Adjust the leveling or jacking bolts and shims under the bottom flange as necessary to insure the top of the rotor shaft is level within .045" from bearing to bearing, and the frame is level within .250" front to rear. The drive will be aligned to the level crusher shaft when it is set, which is usually after the crusher and conveyor installation is complete.

Complete Erection Of Crusher Frame

The frame sections can be picked up by the lifting lugs when they are provided or else the slings can be attached to eye bolts temporarily installed in the flanges of the crusher cover, or base. Use the ratchet attachment pads on large reversible crusher covers for lifting, which holds them at the right alignment to install the cover hinge pins to hold the cover to the base and then pivot the cover closed when the hinge pins are in place. Tack weld the collar on the hinge pin.

Reinstall the side liner sections removed to install the rotor and close the cover of non-reversible crushers before erecting the hopper.

NOTE: Make certain the anchor nuts are secure on the bolts holding the liner sections in place when they are re-installed. Use MODERATE drifting to align the bolt holes if necessary and sometimes it may be necessary to elongate bolt holes with a torch. Install the connecting bolts in the flanges and loosely tighten the nuts until the entire crusher frame is in position. Draw down and tension the connecting bolts, when it has been determined all the parts line up.

When the reversible crusher is completely assembled, check the clearance between hammer tips and adjustable breaker plates. See section on ADJUSTMENT OF BREAKER PLATES.

Cover Opening Cylinders

Normally the cover opposite the infeed conveyor is opened for service on reversible crushers so the two hydraulic cylinders and clevis mounts are installed to open the cover on the back side of the crusher which permits greater access to change hammers and cage bars.

Grouting Completed Crusher

Check again to make certain the crusher frame and rotor are in their proper location and correctly leveled.

It will be necessary to construct a water-tight form inside the crusher base above the bedplate or foundation, the height of the shims, to hold the grout uniformly under the bottom flange.

A water-tight form outside the bottom flange of the crusher will also be required to contain the grout. Allow approximately a three inch opening between the edge of the flange and the face of the form for placing the grout in the cavity under the crusher. The form outside the crusher should be coated with a wax or wrapped with plastic sheet to permit form removal when the grout has set. With some installations the cross frame foundation is a structural member the width of the bottom flange. The grout forms will fit flush with the edge of this foundation so it will be necessary to cut 3 inch diameter holes in the bottom flange to place the grout. The holes will be located along the centerline of the flange equally spaced between the anchor bolts and frame gussets.

A high strength, non-shrink epoxy foundation grout similar or equal to Ceilcote epoxy or Five Star epoxy grout is recommended to fill the cavity between the foundation and the bottom flange of the crusher to securely hold the equipment in precise alignment.

Follow the manufacturers recommendations for mixing and placing the grout mixture, with care to insure all the voids are filled flush against bottom of the entire crusher flange.

From the dimension drawings, it is possible to calculate the cubic feet of grout required to fill the cavity under the crusher to insure the necessary quantity of grout will be on hand when the grouting operation is started. It would also be advisable to have solvent available for cleanup of mixing equipment and tools when the grouting operation is complete because the epoxy resin grout cannot be removed with water.

Completion Of Crusher

Install the shaft cover on the end of the rotor, and the coupling cover when the driver has been installed and its alignment and rotation checked out. The ratchet turnbuckles on the reversible crushers are connected to their attachment lugs on the side of the crusher so the clevis end is towards the cover that opens. Connect the lines from the hydrualic accumulators to the breaker plate hydraulic position cylinders on reversible crushers when the rest of the hydraulic system is installed along with the drain lines from the bearing housings.

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ALIGNMENT OF ROTATING EQUIPMENT

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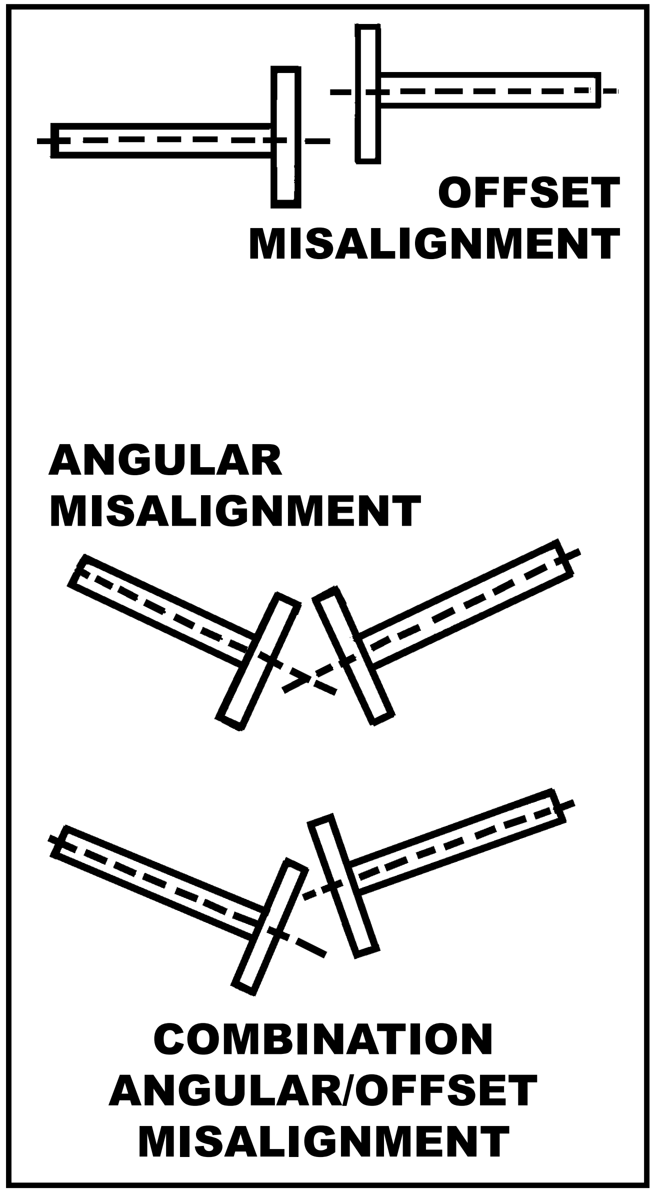
FORM 901

ALIGNMENT OF ROTATING EQUIPMENT



The reliable, trouble-free, and efficient operation of any type of rotating equipment depends a large extent upon its correct alignment with the driver, whether direct coupled or belt driven.

Perfect alignment is attained when the bearings of the rotating equipment are concentric with the bearings of the driving equipment and the shafts of both units are parallel.

The faster the rotating speed of the connected equipment, the more precise the alignment must be to avoid destructive vibrations and stresses.

Both belt driven and direct coupled rotating equipment require a careful alignment at installation and periodic checks on the alignment after it has been in operation for a few weeks.

Misalignment may be the cause of:

A) Excessive vibration, particularly in the axial direction.

B) Premature bearing failure.

C) Excessive coupling wear.

D) Noisy operation.

Factors that may change the alignment of rotating equipment are:

A) Settling of the foundation.

B) Distortion or deflection of the baseplate supporting the rotating equipment.

C) Shift of the driver or crusher on the foundation.

D) Temperature differences causing different shaft heights.

There are two types of misalignment, although the general case is a combination of both.

In offset misalignment, the shaft centerlines are parallel but do not intersect. This can be called “run out”.

In angular misalignment, the centerlines of the shafts intersect but the shafts are not on the same axis. This shows up as a gap difference across the coupling face.

NOTE: ***DO NOT*** **attempt balancing corrections on a machine until the alignment has been approved because the vibration pattern will be affected by alignment changes.**

SETTING THE DRIVE MOTOR

The motor is always aligned to the crusher after it has been leveled and securely bolted in place. The connection can either be a flexible coupling or a belt drive.

Follow the motor manufacturer's recommendations and specifications for setting the motor on the foundation with a height allowance for shim packs and installing the mating coupling half, when the motor is direct connected to the crusher.

It is recommended that the fabricated steel base or sole plates under the motor be provided with horizontal and axial jacking bolts to facilitate aligning the motor to the crusher.
Always set the motor so the gap between the faces of the coupling halves is at least the normal distance specified by the coupling manufacturer, but never less than .1250 inches, for protection from thrust or expansion.

Large motors are usually set lower than the crusher by a few thousandths to a maximum of four thousandths. When the driver heats up under normal operating conditions, it will expand and bring the coupling in line. The holes for the anchor bolts in the motor feet or baseplate should be at least a quarter inch larger in diameter than the anchor bolts to facilitate adjusting the motor for its alignment. After precise alignment, the motor should be securely bolted and doweled in place. Shear blocks are recommended when it is not practical to install dowel pins in the motor base.

PLACEMENT OF SHIMS

The baseplate under the motor should have a finished elevation that will provide room for at least 1/16" to 1/8" of shims in a mix of sizes from .010" to .060" thick beneath the motor feet for final adjustment.

Never use shims less than .010" thick, nor more than five pieces in a shim pack to avoid a "spongy" shim set.

Shims should be horseshoe-shaped to straddle the anchor bolts and large enough to support the weight of the equipment across the width of each foot.

LARGE CRUSHER ALIGNMENT TOLERANCE

The acceptable offset or parallel alignment of direct coupled large Williams crushing equipment shall be no greater than .005" in both horizontal and vertical directions.

Acceptable angular alignment or gap of direct coupled large Williams crushing equipment shall be within .004" per foot of coupling diameter.

Correct excessive offset (parallel) and angular (gap) misalignment by arranging the proper size shims under the drive motor. Retest alignment after each change of motor position or shim pack height when the anchor bolts have been drawn down tight. Check alignment using the methods outlined at the end of this Bulletin.

All readings must be taken with all of the anchor bolts tight and having about the same torque.

ALIGNMENT TOLERANCE OF OTHER SIZE EQUIPMENT

When equipment is received mounted on a structural base plate, it has been aligned at the factory. Experience has shown that structural bases, no matter how rugged or deep in section, will always twist in handling or shipping. Therefore, the alignment must always be checked across the coupling after installing the unit on the foundation and the drive motor has been shimmed until it is properly aligned with the crusher.

Couplings of smaller Williams equipment rotating at speeds of 1200 rpm or more must be aligned so the offset (parallel) alignment is within .006" Total Indicated Runout or actual .003" and the angular or gap is within .003" for the alignment to be acceptable.

All bolts used to mount the baseplate to the foundation should be SAE Grade 5 or better, and have a proper diameter to suit the mounting bolt holes. Use proper shimming between baseplate and foundation when tightening the anchor bolts to insure a level baseplate. After satisfactory alignment has been obtained, it would be advisable to operate the motor separately to check for the proper rotation and vibration. If the drive motor runs satisfactorily, close up the coupling following the manufacturer's recommended procedure and lubrication instructions when both driver and crusher are securely bolted to the bedplate.

To maintain proper alignment, it is recommended that the motor be doweled to the mounting base or be provided with shear blocks welded to baseplate when it has been determined to be operating satisfactorily. This will also make it easy to realign the motor if it should ever be removed for service.

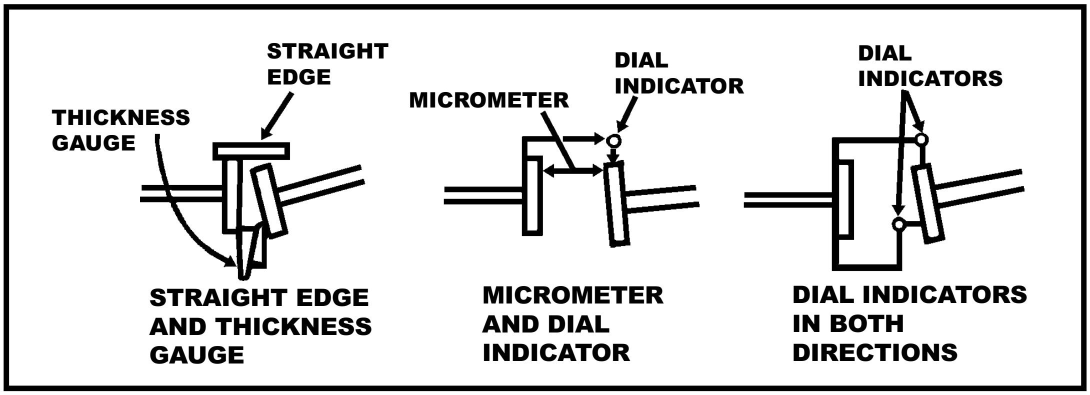
BELT AND CHAIN DRIVE ALIGNMENT

V-Belt drives do not require alignment to as close tolerances as direct coupled equipment, but unless the belts enter and leave the sheaves in a relatively straight line, wear is accelerated and vibration, primarily in the axial direction, results. To check alignment of a belt drive use a long straight edge or for longer centers between shafts use a taut steel wire. Position the straight edge or taut steel wire along the outside face of both sheaves and measure the offset to the straight line. Make sure that the width of the outside land is equal on both sheaves when using this method. The maximum gap or offset in sheave alignment should be no greater than 1/8" (.125") from the straight edge or line for drives with less than four belts. Drives that have four or more belts should be aligned with a gap of 1/16" (.0625") or less.

It is also important to check that the faces of the sheaves are parallel and mounted square on the shaft which can be determined by use of a spirit level. The same alignment check will apply to the sprockets of a chain drive such as used for an apron pan conveyor or similar equipment. Most belt misalignment is caused when moving the drive motor to tension the belts.

Belts should be tightened just enough to prevent slippage under rated load. Some belt slipping or squeal may be allowed in starting high inertia loads to avoid excessive belt tension which overloads the bearings of the connected equipment.

METHODS OF CHECKING COUPLING ALIGNMENT



Protect belts from grease and oil as well as chips that may shorten their life by an approved OSHA type enclosure.

Offset and angular misalignment can be measured by any of the methods shown above. Dial indicators must be securely mounted on the coupling to avoid errors in measurement which give more accurate readings than straight edges when used correctly.

Coupling alignment checks can be done by two methods: (1) with a dial indicator, or, (2) with a steel straight edge, feeler gauge, and taper gauge. It is recommended that both methods be used to cross check the alignment because each have advantages and conveniences. The dial indicator gives a better check on offset (parallel) alignment while the taper gauge is best for the angular (gap) check across the coupling faces.

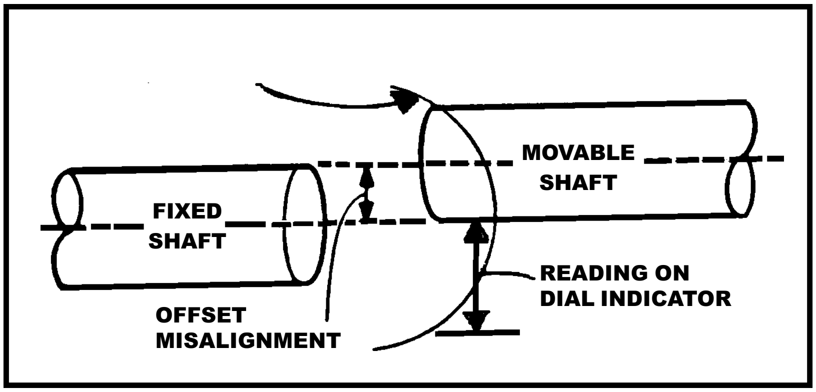
Since the location of the crusher half of the coupling is established when the crusher rotor is mounted, and the crusher has been grouted, any necessary adjustments will have to be made by moving the driver. When in correct alignment, the faces of the coupling halves are parallel and the hubs are concentric.

DIAL INDICATOR METHOD

(1) **Offset Alignment:** Fasten indicator bracket on driver coupling hub so the indicator dial button is perpendicular when it is contacting the alignment surface of the crusher coupling hub. Be sure the indicator mounting bracket is rigidly and securely attached to the driver coupling hub, which may require a special wrap connection bracket for the indicator.

Rotate the motor with the indicator mounted on the coupling half and take readings at four points: top, each side, and bottom on the crusher half of the coupling that remains stationary, when swing hammers are mounted on the rotor. When the rotor is without swing hammers, match mark the hubs and rotate both driver and crusher rotor together to measure parallel (offset) alignment to avoid any error from the hub being out of round.

Difference between the two side radial readings indicates the motor must be shifted sideways. Difference between the top and bottom readings indicates the driver must be raised or lowered by adding or removing the same thickness of shims under all four corners of the motor. The correction amount in each case is one half the difference between the two readings of the dial indicator.



**ARC SCRIBED BY ZERO
POSITION OF DIAL INDICATOR**

When the zero position of a dial indicator is rotated around the axis of the fixed shaft, the distance from the arc to the motor shaft is twice the actual misalignment of the shaft centerlines.

The indicator should always be set to “0” at the top position. If the indicator does not return to zero after the coupling has been turned through a
complete rotation, something is wrong, and the readings should be repeated until the indicator returns to zero.

(2) **<u>Angular Alignment:</u>** Position the dial indicator on the bracket attached to the motor hub by the above method so it will contact the shoulder of the crusher coupling hub perpendicularly in an axial direction. Rotate the motor with the indicator mounted and take readings at four points: top, each side and bottom. Adjust the motor position until the same reading is ob tained all around the coupling.This equalizes the clearance or gap between the hub faces.

Where the hubs of the coupling have been distorted by removal, dial indicator method is not practical.

STRAIGHT EDGE AND TAPER GAUGE METHOD

(1) **<u>Offset Alignment (parallel):</u>** Place a straight edge across the adjacent coupling halves. Raise or lower the motor by shimming until the straight edge lies true at top and bottom positions of the coupling. Placing the straight edge on each side of the coupling halves will show the required horizontal correction. Shift both ends of the motor sideways an equal amount to adjust horizontal offset. The vertical offset can be determined accurately only when the hori zontal offset has been corrected.

(2) **<u>Angular Alignment (gap):</u>** The clearance between the coupling faces at the four cardinal points can be equalized by adjusting the motor position until the readings on the taper gauge are equal at all four points. Since the coupling hub faces are more accurately machined than the shoulder of the hub, this method is not only easier and quicker, but more accurate than a dial indicator. Angular alignment can be checked best when the offset alignment has been corrected in both directions.

COUPLING LUBRICATION

The coupling should be lubricated or greased the same as any other power equipment. For type and amount of lubrication, follow the coupling manufacturer's recommendations.

Pack the space between and around the grid of Falk Steelflex type couplings with as much Mobilux #2 Grease or NLGI density 2 grease with EP additives as possible. Then wipe off excess grease flush with top of grid before assembly of coupling cover. All couplings should be inspected and re-greased annually for normal operating conditions. For extreme duty or dirty environment, inspection and re-greasing should be every six months or less. It is better to hand pack the grease into the coupling grid and between the faces before the cover halves are closed to insure the grease is uniformly distributed around the entire coupling rather than pumping grease through a fitting in the cover which often does not cover the entire grid and results in premature wear of the coupling grid.

<u>**NOTE:**</u> ***It is good practice to check alignment after operating the equipment under load for two or three weeks.***

All couplings are to be protected with an OSHA approved type guard which must be in place when the crusher is operating.

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FORM 896

UNITS SHIPPED DISASSEMBLED

The size and weight of most large crushing equipment requires that they be shipped in several pieces or with the rotor separate to facilitate handling.

Depending upon the destination and routing of the shipment, the equipment may be mounted on skids or crated in wooden boxes as directed by the customer.

Rotor assemblies are mounted on shipping skids, which are securely bolted to the bearing pillow blocks, with cleats or braces welded to the end discs to prevent motion while it is in transit. The rotor shipping skid will also have the crated taper keys and their keepers for mounting the bearing housings as well as the bearing housing drain lines with standpipes and fittings to connect the bearing housings to the lubrication circulating system piping that will be provided by others.

Leave the rotor mounted on its shipping skid until everything is ready to assemble the rotor into the crusher frame, which provides maximum protection for the bearings on the rotor.

HANDLING & UNLOADING

Examine the entire shipment upon arrival for damage and report any losses or shortages for the packing list to the delivering carrier immediately.

When lifting or transferring Williams crushing equipment, note the weight of the item marked on the crate or skid to insure suitable size equipment and slings will be used for its safe handling. Care must be taken to avoid supporting or lifting the crushing equipment or any component in a manner that would place excessive stress on parts that are not designed to support the unit weight.

Note the safe lifting locations marked on the crate or skid to avoid smashing the unbraced portion of the crate or protective covering which would cause storage problems.

The crusher base should be lifted by eyebolts installed in the holes provided in the reinforced bearing support flange or else by the special lifting lubs welded to the frame.

Reversible crusher cover sections can be lifted by slings attached to the ratchet turnbuckle eyes on either side of the cover section which will hold it at the ideal position for its assembly with the base hinge pins and then to pivot it closed. If the crusher cover is being lifted for placement into storage or it is being unloaded from the carrier, make certain it is adequately blocked to avoid damage to the hydraulic cushion cylinders or the hinge pieces.

Where lifting eyes or lugs are not provided on the crusher frame or cover, the individual pieces can be handled with eyebolts inserted in the flange bolt holes. The crusher rotor should remain on its shipping skid until it is ready to be installed in the frame. When lifting the crusher rotor, use a spreader bar with the sling so the legs of the sling can be attached to the shaft between the bearing housing and the end disc of the rotor. Always use a tag line that can be snubbed to prevent the rotor or large crusher component from swinging while it is being hoisted by crane for unloading or placement.

If a spreader bar is not available, it is not possible to set the rotor in a large non-reversible crusher when a sling is connected the shaft between the bearing housing and the end disc because the side of the frame will interfere with the sling. It will be necessary to use a sling sufficiently long enough to pick up when it is attached to the shaft outside the bearing housings. Good rigging practice calls for an included angle between each leg of the sling and the rotor of at least 45 degrees. If the sling contacts the bearing housing, the oil seals may be damaged and the bearing housings will not set flush with the bearing pedestal to align the bolt holes, which have only 1/8 inch diametrical clearance in both the bearing housing flange and support pedestal.

STORAGE

If assembly or installation of the crusher and the auxiliary components is to be delayed for more than a month after delivery to the job site, special corrosion preventative precautions must be taken.

Store in a dry, protect, well-drained area, making certain that the machined surfaces of the crusher frame and rotor or other components are protected against rust and corrosion. When outdoor storage is unavoidable, the crusher frame and rotor, as well as any auxiliary equipment, should be raised off the ground on skids, and should be covered by a tarp or equivalent protective covering. Store the skid mounted rotor in a level position with uniform support under the entire length of the skid. Insure that the rotor storage is sufficiently elevated to avoid snow cover or submergence under surface water.

If the shipping crate have sustained any damage in transit, make certain the contents are secure and undamaged and them cover the openings with a secure water-proof wrapping.

BEARING PROTECTION

Each crusher rotor has been test-run and balanced at the factory using the proper lubricant. The bearing housing assemblies on the rotor are shipped partially filled with a heavy duty oil for protection in transit or storage. If the rotor is to be stored or remain idle for a considerable amount of time, it is advisable to add lubricant to expel any air voids in the bearing housings, which may collect condensation and moisture. Fill the bearing housing with as heavy an oil as is possible to pour into the filler hole in the top of the bearing housing. Fill it completely and check the level periodically because some leakage is due to occur around the shaft seals of the bearing housing.

Prior to starting the lubrication circulation system, completely drain the bearing housings following prolonged storage. This will require removing an inspection plug at the bottom of the bearing housing or removing one of the drain lines which have a standpipe to completely empty the bearing housing of the protective lubricant. Provide a container to catch the drain oil because the bearing housing will hold anywhere from a quart to more than a gallon or so of oil.

It is not recommended that the bearing assembly be packed with grease during prolonged storage because of possible inclusion of contaminates or debris that would be difficult to flush.

During storage, the bearing housings, coupling section, and exposed portions of the shaft and all machined surfaces should be protected from the elements by a tarp or heavy plastic film, in addition to coating them with a rust protection coating.

SHAFT ROTATION

Where the crusher has been erected complete with the rotor but will not be operated for a considerable period of time, it is advisable to turn the rotor a quarter turn each week. The most simple procedure is to manually shift a row of hammers which will shift the balance and cause the rotor to move.

Mark on the inside of the crusher the direction the rotor is being turned so a complete revolution will be made in four weeks. This will lessen the chance for the shaft to develop a set and it repositions the bearing rollers to distribute the lubrication.

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FORM 911R
REV. 2008

BEARINGS

The purpose of this manual is to provide a guide for the operation and maintenance of the roller bearing pillow blocks used on the rotors of Williams equipment. The same principles will apply for the lubrication and maintenance of all anti-friction bearings in all types of Williams equipment.

Accordingly, this manual is divided into the following parts:

SECTION I. BEARING OPERATION AND INSPECTION

A properly installed anti-friction type pillow block bearing on a piece of Williams equipment requires no adjustments during its normal service life. The bearing mountings and pillow blocks are engineered to rigidly support the bearing and keep it aligned.

When the rotor is properly installed in the shredder housing (See ASSEMBLY AND INSTALLATION) the bearings will automatically be aligned and in proper position for a long service life.

Long life of bearings is assured by maintaining proper alignment with the drive, proper belt tension, and good lubrication at all times. Incorrect alignment of flexible couplings or belt drives can produce vibration and thrust. Too much belt tension often causes overheating of bearings.

Prolonged operation of a bearing with a severe vibration problem above 5 mils (.005”) will cause premature failure and expensive repairs. Excessive heat in a bearing (above 200^{o}F) when operating will quickly destroy the effectiveness of the lubricant, and will result in premature failure of the bearing.

When either heat or excessive vibration develops, corrective action should be undertaken immediately to find the cause and remedy the problem.

The oil level gauge on the side of the bearing housing should be inspected several times each operating shift. The oil level should be at the center of the glass when the rotor is stationary and slightly below halfway when operating. A higher oil level will cause heat and churning of the oil in the bearing housing, which will contribute to oil oxidation.

Note any change or discoloration in the oil, which would indicate contamination or oxidation is taking place. If so, drain and replace the oil immediately.

Roller bearings are less sensitive to over-lubrication than ball bearings, but under-lubrication can destroy them quickly.

The bearing housing oil seals should be included in the daily inspection to insure they are functioning properly to retain the lubricant and keep foreign matter out of the bearing. Oil seals require a small amount of lubricant to prevent frictional heat and subsequent destruction when the shaft is rotating. Oil seals should permit a slight seepage of oil past the sealing surfaces to minimize seal friction and heat. If the seal leaks excessively it can easily be replaced as described in the section on BEARING MAINTENANCE.

The slingers should be tight against the face of the bearing housing to protect the oil seals, and the inside slingers should be snug against inside faces of housing and cap to help prevent oil leaks. Most problems with slingers and oil seals are the result of mishandling the rotor during installation. When properly handled and installed the oil seals will function correctly for years.

Several times an operating shift, check the bearing housing temperature to note any abnormal rise in temperature. Normal bearing operating temperatures will be in the range of 160^{o} – 180^{o}F, which will allow the palm of the hand placed on the top of the bearing housing to remain for approximately 2 –3 seconds. If the bearing housing is warmer than this, remedial steps should be taken to insure proper service life of the bearing.

Periodically, check to see that the bearing housing hold down bolts are tight and the stop blocks are snugly in place, especially after a severe vibration or shock. A sudden rise in vibration can often be accounted for by the loosening of bearing housing hold down bolts, which should be re-torqued.

Refer to the section on LUBRICATION for recommendations on types of oil or grease and frequency of changes or re-lubrication.

A field check on vibration can be made without instruments because a vibration level of 1 to 3 mils (.001” to .003”) will allow a new nickel to stand on edge on top of the bearing housing for a few seconds. When a vibration is in the range of 3 to 5 mils (.003” to .005”) at an operating speed less than 1800 RPM it is possible to stand a new nickel on edge on top of the bearing housing for 2 or 3 seconds. A vibration level more severe than this should be investigated and corrective measures taken to control the cause. This check is valid only for shredders operating without material being fed, with all the hammers free to pivot on their bolts or pins.

SECTION IIA. LUBRICATION OF BEARINGS

The importance of proper lubrication cannot be overstated in the operation of a shredder because the bearing life depends upon it. Shredder duty is among the most difficult applications for anti-friction bearings so the lubricant selection is vital to its performance. The higher speed large shredders require a circulating oil lubrication system to insure an adequate supply of oil for both cooling and lubricating the bearing.

The bearing housing is designed to provide a sump through which the rolling elements of the bearing will pass. The oil level should be no higher than the center point of the lowest rolling element which can be gauged by the center of the sight glass on the side of the bearing housing.

OILS

Oil used for shredder bearing lubrication should be a highly refined mineral oil of medium body (SAE 30 to 40) that is non-oxidizing with good de-foaming properties and contain extreme pressure (EP) additives. The viscosity of the oil should be between 105^{o}F and 150^{o}F SSU at the anticipated operating temperature range of 160^{o}F to 180^{o}F or between 500 and 750 SSU at the standard base temperature of 100^{o}F. The oil should yield a minimum TIMKEN OK load of 45 pounds.

Oils that conform to the above specifications have been found to provide satisfactory service over the past several years in many large shredder installations. However, it is always preferable to consult a competent lubrication engineer for more specific recommendations, particularly if the conditions at the installation site are unusual.

CIRCULATING OIL SYSTEMS

When circulating oil systems are used the entry or feed is made through the center hole in the top of the housing, the drain should be made from both sides of the bottom of the housing through drain lines having inserts to maintain the proper oil level in the bearing. Lines to bearing housings should have flexible connections. Shredder bearings are given a coating of a basic lubricant at the factory to protect them from corrosion in transit and storage.

The bearing housings **MUST BE FLUSHED** before operating and filled with the correct lubricant for the installation.

High-speed shredder installations may require the oil level be lowered below center of oil sight glass to avoid heat build up due to churning. The oil level can be controlled by adjustment of the flow control valves on the lubrication circulation system or simply draining the sump on static system.

Abnormal bearing temperature may indicate faulty lubrication. Normal temperature may range from cool or warm to the touch, up to a point too hot to touch for more than a few seconds, depending on bearing size, speed and surrounding conditions. If the bearing is too hot to touch for more than a few seconds it is prudent to check the temperature by applying a thermometer at the top of the bearing housing. The bearing housing temperature is usually 10°F lower than the bearing temperature. If the bearing housing temperature is 180°F or higher, immediate steps should be taken to determine the cause and make corrections.

If the shredder is equipped with a water-cooled heat exchanger on the lubrication circulation system, make certain that clean cooling water is flowing to oil cooler. Verify the cooling water passages in the heat exchanger are not obstructed preventing proper cooling of the circulating oil.

PERIODIC LUBRICATION INSPECTION AND CHANGES

Frequency of oil changes in a static system with a bearing lubricated solely by the oil in the housing will depend on several local operating conditions.

Deterioration of oil is caused by heat, oxidation, catalytic reactions, and dirt or water contamination. Therefore, periodic oil changes must be made. The most desirable approach to the question of when to replace the oil is a continuous program of oil sampling and laboratory analysis.

After the initial two weeks of operation, the oil in the bearing housings should be changed on installations without oil circulation systems.

FLUSHING BEARING HOUSING

It is recommended that the bearing housing be thoroughly flushed out after the original oil has been drained. Fill the bearing housing to the center of the sight glass with SAE 10 straight mineral flushing oil, which should not contain additives. The shredder should be brought up to operating speed (without load) and immediately shut down. Drain off flushing oil and refill with recommended operating lubricant to proper level.

After the break-in procedure outlined above it is recommended that the oil be changed and the bearing housing flushed once a month to establish a basis for normal operating conditions. Then, depending on the condition of the oil drained from the bearing housing, the change period may be extended, but never more than every three months of operation.

In a shredder installation with an oil circulating system, test the lubricant at least every six months. If a change in the appearance is noted, check the oil immediately.

Change filters when indicating devices denote plugging of the element or when fluid analysis reveals a change is needed.

COLD WEATHER OPERATION

The heater in the circulating lubrication system reservoir is to be connected so it will operate even when the rest of the system is shut down to maintain a uniform 80°F to 90°F in the reservoir. Shredders installed in area where the ambient temperature drops below 20°F when they are shut down should have the oil circulation system operate continuously to maintain a uniform temperature on the bearings. It may be necessary to heat trace the drain lines from some outside installations to insure proper flow back to the reservoir.

SECTION IIB. GREASE LUBRICATION

The pillow block bearings on Williams' equipment designed for grease lubrication are normally equipped with zerk type fittings unless otherwise specified.

Normal procedure when re-greasing bearing housings is to remove the drain plug and clean away any hardened grease from the opening so the old grease can be purged and any excess new grease can flow out.

The many types of grease available are of different qualities and compositions so it is necessary to select the grease carefully to insure dependable bearing service.

Bearings on Williams' equipment designed for grease have been lubricated at the factory with a LITHIUM based grease that has a No. 2 consistency, which is suitable for normal operating conditions. For best results, re-lubricate with lithium base grease or a grease that is compatible with the original lubricant. Mixing of different greases is not recommended. If necessary to change to a different grade, make, or type of lubricant, flush bearings thoroughly before changing.

GREASE SPECIFICATIONS

A good bearing grease must have the following properties:

1. Freedom from chemical or mechanical active ingredients such as free lime, iron oxide, and similar minerals or solid substances.

2. It must not separate or change in consistency, harden, or form acid.

3. A melting point (dropping point) considerably higher than the operating temperatures.

A grease conforming to the following specification will provide proper lubrications for most Williams pillow block bearing applications designed for grease:

1. **Lithium Soap Base**
2. **NLGI No. 2**
3. **Worked Penetration Range at 77°F 265/295**
4. **ASTM Dropping Point °F 380**
5. **Mineral Oil Viscosity SUS at 100°F 750**
6. **Contain Non-Corrosive, Extreme Pressure Lubricity Additives, & be Water Resistant**

The lubricants listed below are typical products ONLY and should not be considered as exclusive recommendations:

Normal Ambient Operating Temperature Range 0ºF to 150ºF
NLGI Grade No. 2 (with EP additives)

METHODS OF RE-LUBRICATION

Before applying grease, the fitting on the bearing housing should be wiped clean, and the lever mechanism of the grease gun should be worked several times until trapped air is expelled and grease begins to come out of the nozzle. The drain plugs at the bottom of the cap and housing should be removed. Any dried or caked grease should be cleared from the drain area.

Grease should be applied while the machine is running. Add approximately 40 – 50 strokes of the lever from the hand-operated grease gun once a month to the grease zerk fitting on the top of the bearing housing. On some of the newer model bearing housings and housing caps there are grease zerk fittings on the sides. These zerk fittings are for lubricating the seals. Whenever the bearings are lubricated, a couple strokes of grease should be added to the seals.
(Reference Drawing # 61J-C-1955 on Page 13)

To avoid over-packing, the drain should be left open, after the gun has been disconnected, until no more grease is expelled from the drain. This is done to make sure the volume of grease has adjusted itself to the space in the housing, and to avoid overpacking. This may require anywhere from five to thirty minutes depending on the temperature and the size of the drain. Excess grease in the housing cavity will cause overheating. If grease is not expelled from the housing it may be necessary to disassemble the housing and clean the old grease out manually.

GREASING NEW BEARINGS

The bearing and housing grease reservoir should be packed with one of the greases listed above or an equivalent. Hand packing at time of assembly is generally preferable to greasing through a fitting because it is quicker and assures the proper amount of grease will be worked into all cavities of the bearing.

When hand packing, complete greasing of bearing is assured if grease is worked in at one side of the bearing until grease appears on the opposite side.

Housing reservoirs should be packed with grease to a level approximately level with the bottom of the shaft before it is pushed on the bearing. Then the bearing cap reservoir should be packed with grease

to the bottom of the shaft as it is slid into position. For a 5” bearing assembly it will take approximately two pounds (approx. 907g) of grease to hand pack the bearing, housing and cap reservoirs.

The drain plug should be left out when the new bearings are started up so any excess grease can be expelled as the surplus grease is flung off the raceways to avoid over-filling the housing.

BREAK-IN PERIOD

During the initial start-up period, after installing a new bearing, or the initial start-up of a new machine, there may be a break-in period during which the bearings will operate with above normal (160ºF-180ºF) temperatures. The outer race of the taper bore spherical roller bearing is common to two sets of rollers. During the assembly process, the outer race is rarely centered evenly between the two sets of rollers. When the outer race is off-center, the diametrical clearance on one side will be too tight. The reduction of the diametrical clearances on one side of the bearing will cause the bearing to heat up. This heat buildup is normal and necessary. The temperature increase of the bearing will force the outer race to move in an axial direction until it reseats itself, or the diametrical clearances are equal between the two sets of rollers.

During the break-in period, the bearing temperatures should be monitored and closely watched. If the bearing housing temperature increases above 200ºF, the machine should be shut down and the bearing allowed to cool down to ambient temperature. Once the bearing has cooled off, the machine can be restarted. It is not uncommon for this process to be repeated a couple of times before the outer race has taken seat.

Once the bearing has reseated itself, the temperature will usually drop to normal operating ranges (160ºF-180ºF) or below.

The normal stress of shipping and handling is usually enough to cause the outer race to shift in an axial direction. As a result of this movement, abnormally high temperatures during the initial start-up of new machines are to be expected, until the outer race has re-seated itself.

SECTION IIIA. ROLLER BEARING MAINTENANCE & SERVICE

Service on all taper bore Model “O” roller bearings used in Williams’ equipment from 5” through 12” is essentially the same. The main difference is the shaft for the 5” size is not gun drilled for hydraulic connections to assist in removing and replacing the bearing.

The bearings can be removed and replaced with the rotor in the shredder frame, provided sufficient clearance is available at the ends of the shaft to remove the flywheel and coupling half (see section on FLYWHEEL MOUNTING) before loosening the bearing hold down bolts.

CAUTION – DO NOT REMOVE NEW BEARING FROM ITS WRAPPING UNTIL IT IS ACTUALLY READY TO MOUNT.

BEARING HOUSING REMOVAL

Bearing housing for 5” bearings are doweled to the support pedestal with two #7 taper pins that must be removed before the housing can be moved.

Bearings 8” and larger have stop blocks with tapered keys that lock the bearing housing to the pedestal that must be removed before the housing can be moved. Unbolt the keepers that retain the tapered keys so they can be forced out of their slots by use of a hydraulic jack between their ends and the sides of the shredder frame. As the keys are removed, identify them with their slots using a marking device or paint so they will not get mixed up during reassembly.

When the ends of the bearing housings are clear and clean, scribe a match mark at each end of the bearing housing with a mating match mark on the sole plate of the pedestal. This will ensure the bearing housing is properly relocated and aligned with the rotor in the correct position when the bearing housing is reassembled.

If the bearings are to be replaced while the rotor is in the shredder, the shaft will have to be supported on blocking or suspended by a cable sling when the bearing housing is removed. (See section on ROTOR REMOVAL.)

On shredders with circulating lubrication systems, the hydraulic connections and drain lines will have to be disconnected and capped before the bearing housing can be removed. Be sure to provide a container to catch the oil from the bearing housing when the drain lines are removed. Depending on size of bearing there will be anywhere from a pint to several quarts of oil in the bearing housing.

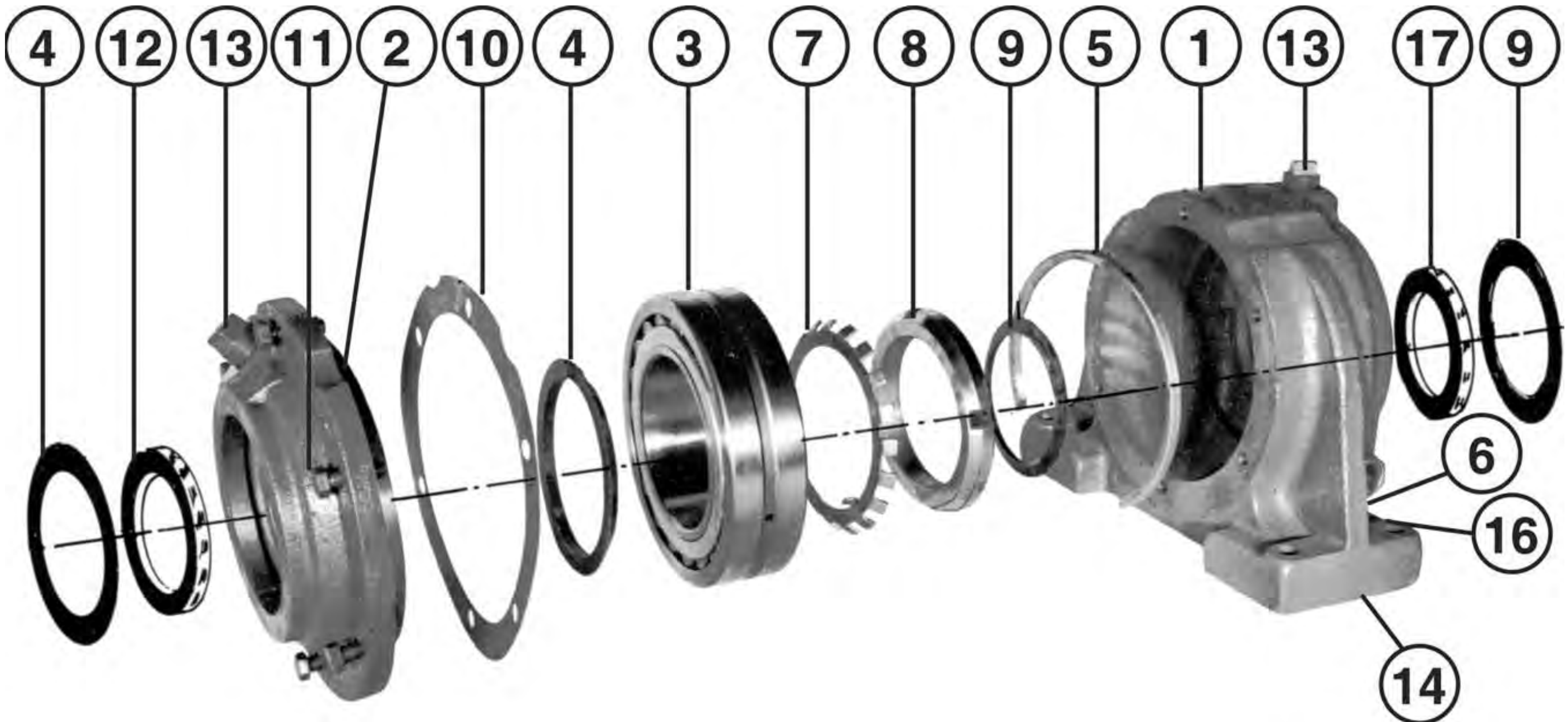
The bearing housing hold down bolts for 8” and 11” bearings have been torqued using a slugging wrench so the same procedure will be required for their removal. The hold down bolts for 12” bearing housings are 3.5” in diameter and have been tensioned while they were heated by electrical Cal-Rod units, which will have to be reconnected to heat the bolts to 350ºF for removal of the nuts.
(See 144-B-3906)

When the anchor bolt nuts have been loosened several turns, or about a quarter of an inch, the rotor can be raised and blocked so the bottom of the bearing housing is about an eighth of an inch above the support pedestal or sole plate, if the rotor is not to be removed from the housing for the bearing change.

ITEM NUMBER	**When Ordering Repairs, Give:** Part Wanted, Quantity, This Drawing Number, and Your Mill Number	PATTERN NUMBER	QUANTITY IN MACHINE
1	Pillow Block Housing	BC-286	1
2	Pillow Block Cap	BC-287	1
3	Roller Bearing		1
4	Oil Slinger, Large Bore (Should lightly rub Pillow Block Cap)		2
5	Stabilizing Ring (Used on Drive Side Only)		1
6	Oil Sight Gauge		1
7	Bearing Locknut Washer		1
8	Bearing Locknut		1
9	Oil Slinger, Small Bore (Should lightly rub Pillow Block Housing)		2
10	Gasket		1
11	Capscrews		6
12	Oil Seal, Large Bore		1
13	Inspection Port Pipe Plug		2
14	Oil Drain Plug		2
15	Oil Line Connection		1
17	Oil Seal, Small Bore		1
16	Not shown is a Thermocouple connection located opposite to the oil sight gauge (6) in bearing housing (1)		

PARTS LIST FOR MODEL "O"
5" TAPER BORE BEARING
WITH STATIC OR CONTINUOUS OIL LUBRICATION
DRAWING NUMBER 61J-B-3051

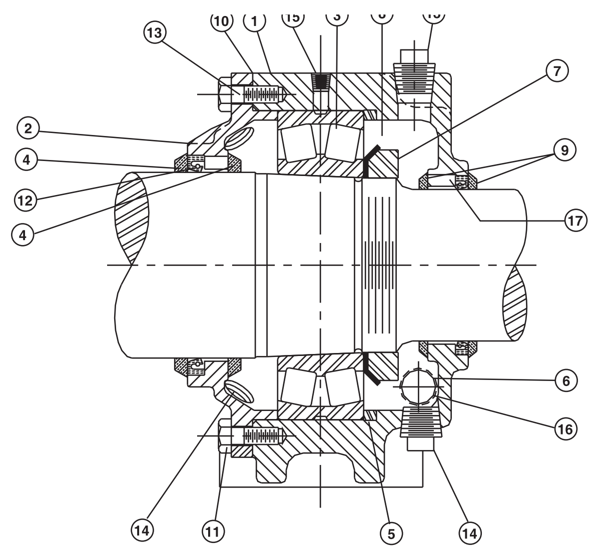
WILLIAMS
PATENT CRUSHER and PULVERIZER Co., Inc.



NOTE: SHOULD ROTOR OR BEARINGS BE REMOVED, WHEN REASSEMBLING, ALWAYS REMOVE INSPECTION PORTS (13) AND CHECK TO SEE IF OIL SLINGERS (9) ARE CORRECTLY POSITIONED AGAINST THEIR MATING SURFACES. IF NOT, PRY INTO POSITION

WHEN REMOUNTING BEARING -- MEASURE INTERNAL RADIAL CLEARANCE OF BEARING WITH A SHIM GAUGE -- FORCE BEARING ON SHAFT IN EASY STAGES UNTIL THE ABOVE NOTED RADIAL CLEARANCE IS REDUCED **.0025 IN.** TO **.0035 IN**.

SEE CHART ON PAGE 21.



WILLIAMS PATENT CRUSHER and PULVERIZER Co., Inc.

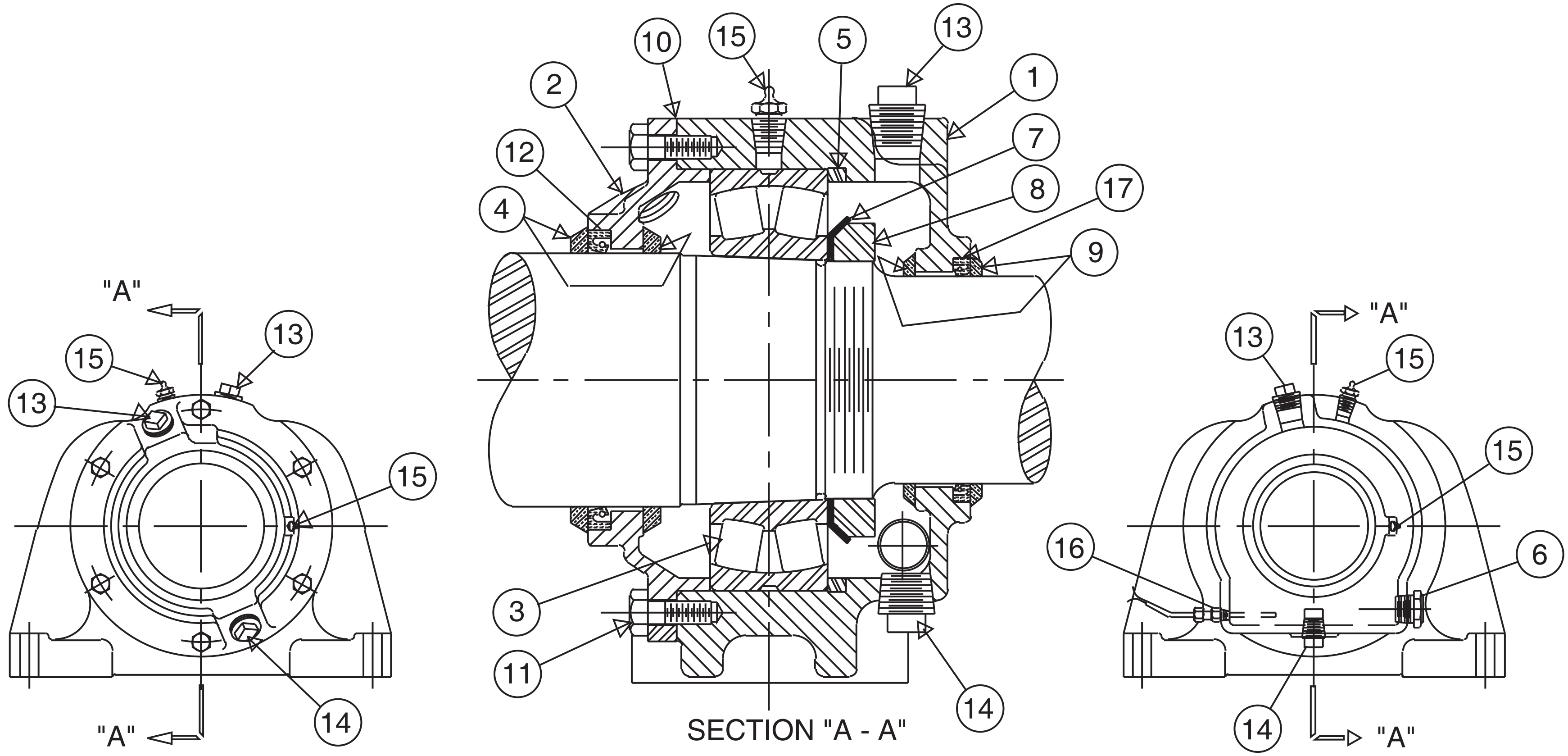
PARTS LIST FOR MODEL "O" 5" TAPER BORE PILLOW BLOCK WITH CONT. OIL LUBRICATION
DRAWING NUMBER 61J-B-3051

ITEM NUMBER	**When Ordering Repairs, Give:** Part Wanted, Quantity, This Drawing Number, and Your Mill Number	PATTERN NUMBER	QUANTITY IN MACHINE
1	Open Pillow Block Housing		1
2	Pillow Block Cap		1
3	Roller Bearing		1
4	Oil Slinger, Large Bore (Should lightly rub Pillow Block Cap)		2
5	Stabilizing Ring (Used on Drive Side Only)		
6	Oil Sight Gauge		1
7	Bearing Locknut Washer		1
8	Bearing Locknut		1
9	Oil Slinger, Small Bore (Should lightly rub Pillow Block Housing)		2
10	Gasket		1
11	Capscrews		6
12	Oil Seal, Large Bore		1
13	Inspection Port Pipe Plug		2
14	Oil Drain Plug		2
15	Grease Zerk		3
16	Thermocouple (Optional)		
17	Oil Seal, Small Bore		1

PARTS LIST FOR MODEL "O"
5" TAPER BORE BEARING
WITH GREASE LUBRICATION

DRAWING NUMBER 61J-C-1955

WILLIAMS
PATENT CRUSHER and PULVERIZER Co., Inc.



WILLIAMS PATENT CRUSHER and PULVERIZER Co, Inc.

NOTE: SHOULD ROTOR OR BEARINGS BE REMOVED, WHEN REASSEMBLING, ALWAYS REMOVE INSPECTION PLUG (13) AND CHECK TO SEE IF OIL SLINGERS (4) ARE CORRECTLY POSITIONED AGAINST THEIR MATING SURFACES. IF NOT, PRY INTO CORRECT POSITION

WHEN REMOUNTING BEARING -- MEASURE INTERNAL RADIAL CLEARANCE OF BEARING WITH A SHIM GAUGE -- FORCE BEARING ON SHAFT IN EASY STAGES UNTIL THE ABOVE NOTED RADIAL CLEARANCE IS REDUCED **.0025 IN.**

SEE CHART ON PAGE 21.

PARTS LIST FOR MODEL "O" 5" TAPER BORE, OPEN HOUSING BEARING WITH GREASE LUBRICATION

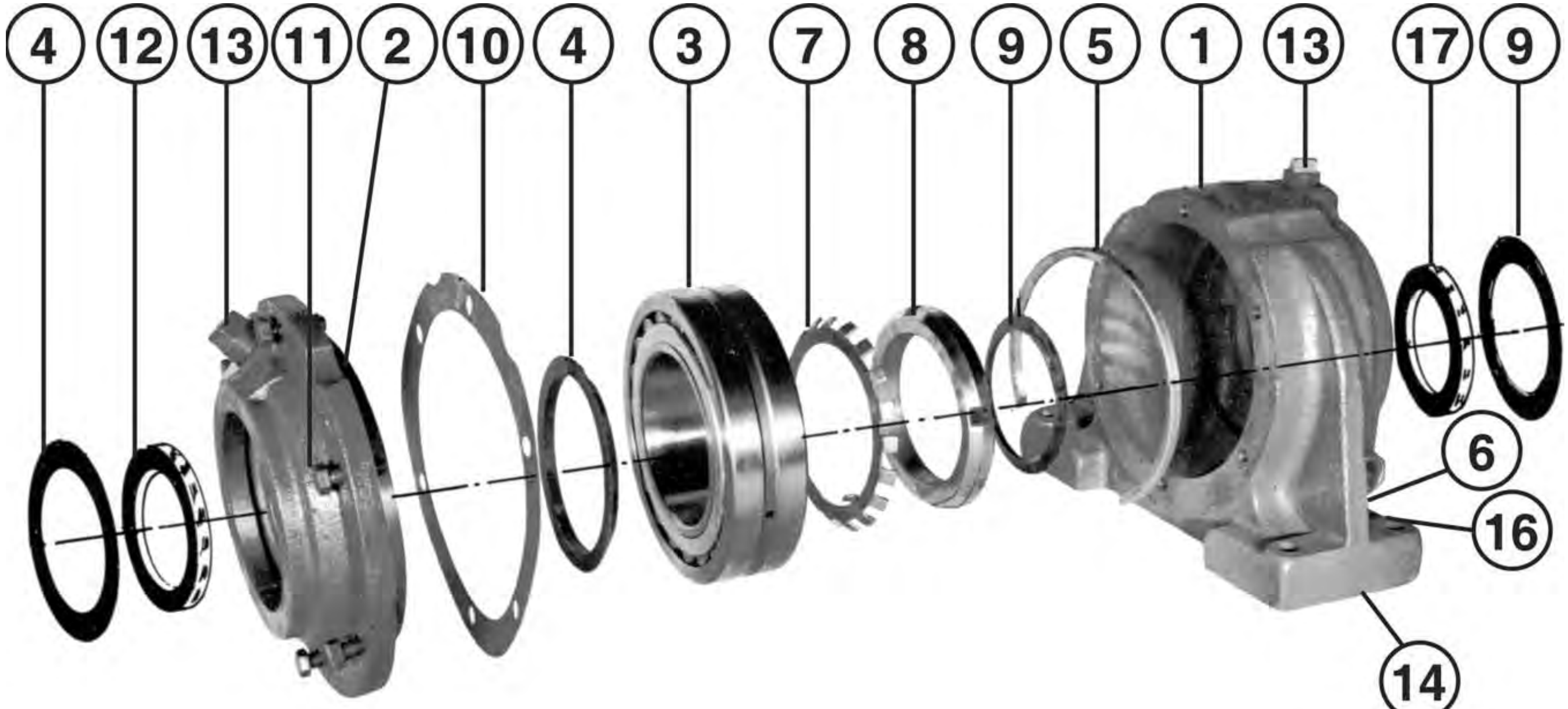
DRAWING NUMBER 61J-C-1955

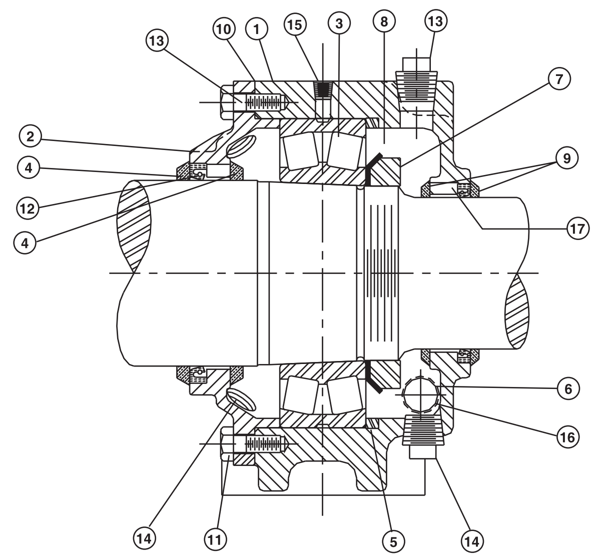
ITEM NUMBER	**When Ordering Repairs, Give:** Part Wanted, Quantity, This Drawing Number, and Your Mill Number	PATTERN NUMBER	QUANTITY IN MACHINE
1	Pillow Block Housing	SS-550	1
2	Pillow Block Cap	SS-551	1
3	Roller Bearing		1
4	Oil Slinger, Large Bore (Should lightly rub Pillow Block Cap)		2
5	Stabilizing Ring (Used on Drive Side Only)		1
6	Oil Sight Gauge		1
7	Bearing Locknut Washer		1
8	Bearing Locknut		1
9	Oil Slinger, Small Bore (Should lightly rub Pillow Block Housing)		2
10	Gasket		1
11	Capscrews		6
12	Oil Seal, Large Bore		1
13	Inspection Port Pipe Plug		2
14	Oil Drain Plug		2
15	Oil Line Connection		1
17	Oil Seal, Small Bore		1
16	Not shown is a Thermocouple connection located opposite to the oil sight gauge (6) in bearing housing (1)		

PARTS LIST FOR MODEL "O"
8" TAPER BORE BEARING
WITH STATIC OR CONTINUOUS OIL LUBRICATION

DRAWING NUMBER 61J-B-3052

WILLIAMS
PATENT CRUSHER and PULVERIZER CO., Inc.





NOTE: SHOULD ROTOR OR BEARINGS BE REMOVED, WHEN REASSEMBLING, ALWAYS REMOVE INSPECTION PORTS (13) AND CHECK TO SEE IF OIL SLINGERS (9) AND (4) ARE CORRECTLY POSITIONED AGAINST THEIR MATING SURFACES. IF NOT, PRY INTO POSITION

WHEN REMOUNTING BEARING -- MEASURE INTERNAL RADIAL CLEARANCE OF BEARING WITH A SHIM GAUGE -- FORCE BEARING ON SHAFT IN EASY STAGES UNTIL THE ABOVE NOTED RADIAL CLEARANCE IS REDUCED **.0035 IN.** TO **.0050 IN**.

SEE CHART ON PAGE 21.

WILLIAMS PATENT CRUSHER and PULVERIZER Co., Inc.

PARTS LIST FOR MODEL "O"
8" TAPER BORE PILLOW BLOCK
WITH CONT. OIL LUBRICATION

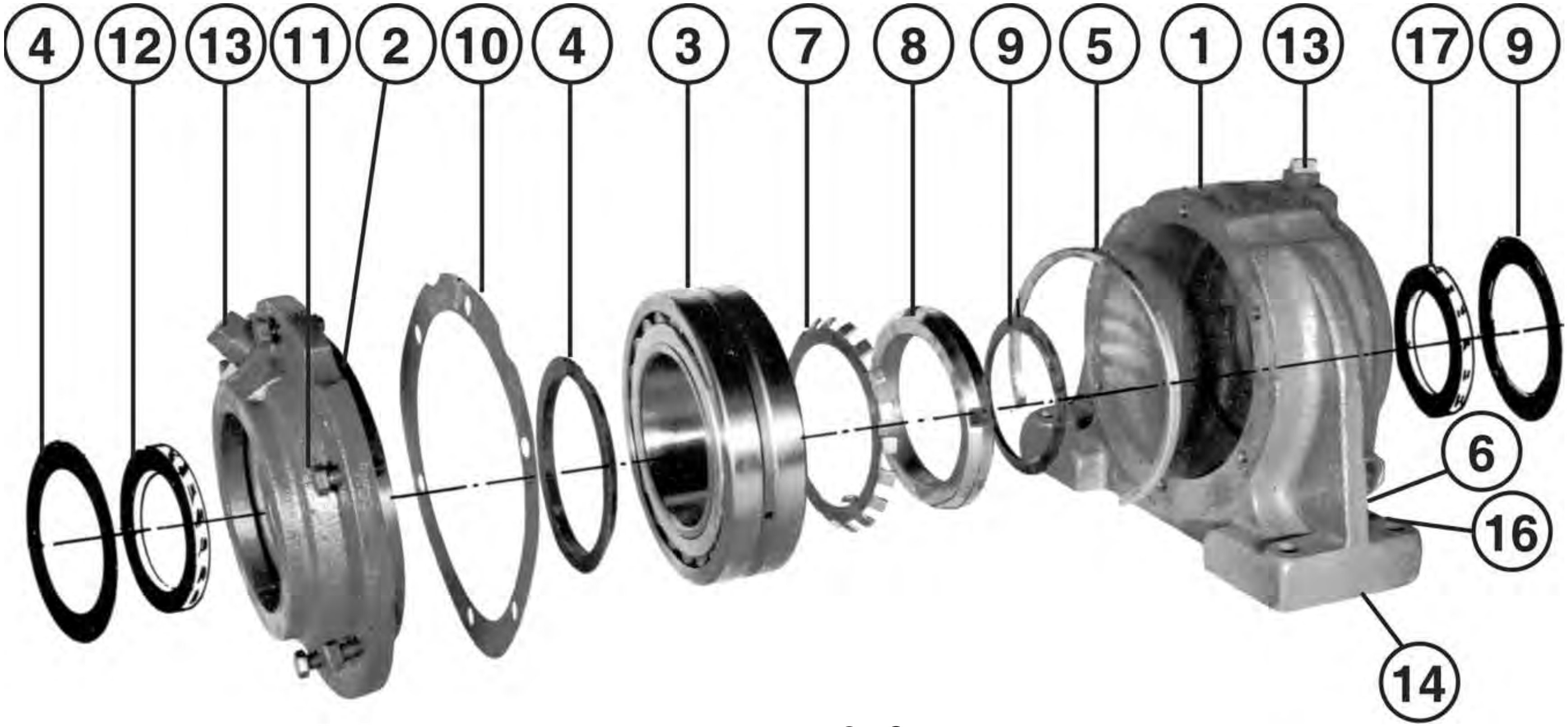
DRAWING NUMBER 61J-B-3052

ITEM NUMBER	**When Ordering Repairs, Give:** Part Wanted, Quantity, This Drawing Number, and Your Mill Number	PATTERN NUMBER	QUANTITY IN MACHINE
1	Pillow Block Housing		1
2	Pillow Block Cap		1
3	Roller Bearing		1
4	Oil Slinger, Large Bore (Should lightly rub Pillow Block Cap)		2
5	Stabilizing Ring (Used on Drive Side Only)		1
6	Oil Sight Gauge		1
7	Bearing Lockplate, Capscrews & Safety Wire		1
8	Bearing Locknut		1
9	Oil Slinger, Small Bore (Should lightly rub Pillow Block Housing)		2
10	Gasket		1
11	Capscrews		6
12	Oil Seal, Large Bore		1
13	Inspection Port Pipe Plug		2
14	Oil Drain Plug		2
15	Oil Line Connection		1
17	Oil Seal, Small Bore		1
16	Not shown is an Air Breather located on the face of the bearing housing (1)		

PARTS LIST FOR MODEL "O"
11" and 12" TAPER BORE BEARING
WITH CONTINUOUS OIL LUBRICATION
(Note: These bearings are available only with continuous oil lubrication)

DRAWING NUMBER 61J-B-3919

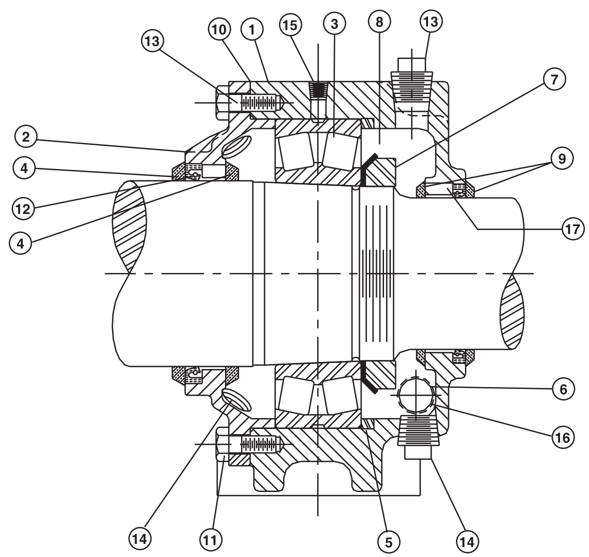
WILLIAMS
PATENT CRUSHER and PULVERIZER Co., Inc.



NOTE: SHOULD ROTOR OR BEARINGS BE REMOVED, WHEN REASSEMBLING, ALWAYS REMOVE INSPECTION PORTS (13) AND CHECK TO SEE IF OIL SLINGERS (9) AND (4) ARE CORRECTLY POSITIONED AGAINST THEIR MATING SURFACES. IF NOT, PRY INTO POSITION

WHEN REMOUNTING BEARING -- MEASURE INTERNAL RADIAL CLEARANCE OF BEARING WITH A SHIM GAUGE -- FORCE BEARING ON SHAFT IN EASY STAGES UNTIL THE ABOVE NOTED RADIAL CLEARANCE IS REDUCED **.0045 IN. TO .0065 IN. (11"),** and **.0050 IN. TO .0070 IN. (12")**.

SEE CHART ON PAGE 21.



WILLIAMS PATENT CRUSHER and PULVERIZER Co., Inc.

PARTS LIST FOR MODEL "O" 11" & 12" TAPER BORE PILLOW BLOCK WITH CONTINUOUS OIL LUBRICATION

DRAWING NUMBER 61J-B-3919

Install a lifting eye in the tapped hole provided in the top of the bearing housing and connect it to a lifting device that will permit the housing to be moved along the shaft and clear the end without binding or interference. **CAUTION:** This eye is to lift the bearing housing only and never to lift the rotor assembly.

Complete the removal of the bearing housing hold down bolts.

Listed below are the parts drawings for the different size bearings that use similar index numbers for the assembly items that are referred to in this discussion.

PILLOW BLOCK BEARING HOUSINGS						
BEARING SIZE IN.	PARTS DRAWING	BEARING WEIGHT LBS.	HOUSING PATTERN	WEIGHT	CAP PATTERN	WEIGHT
5	61J-B-3051	22	BC286	110	BC287	22
8	61J-B-3052	122	SS550	630	SS551	90
11	61J-B-3919	265	SS646	965	SS636	160
12	61J-B-3919	408	SS825	2255	SS717	335

BEARING HOUSING DISASSEMBLY

Before proceeding with the disassembly, clean the shaft on both sides of the bearing housing of all corrosion, debris and scale until bright metal shows, then give it a coat of light oil. This will allow the slingers and oil seals to slide along the shaft without their being damaged or broken. The slingers and oil seals are molded from a compressed synthetic rubber compound that is ideal for the application, but can be damaged or broken by mishandling, such as forcing or prying with improper tools. Carefully work the larger slinger (Item 4) away from the bearing housing cap toward the rotor about four inches along the cleaned and lubricated shaft. Remove the cap screws (Item 11) holding the housing cap (Item 2) to the bearing housing, and carefully pry the cap away from the housing.

OIL SEAL REMOVAL

It should not be necessary to remove the oil seal (Item 12) from the housing cap for the cap to slide along the shaft if the shaft is smooth and clean. If the oil seal (Item 12) is to be removed for inspection or replacement, use the proper tools to pull it out of its groove in the cap or housing. A cotter key puller is an ideal tool to pry into the oil seal butt joint. Pull one end out of the groove until the fingers can grasp it. When about a fourth of the seal is clear of the groove, grasp the spring with the hooked tool and pull it from the slot in the seal to relieve the pressure on the seal lip, which should allow the seal to come out the rest of the way without too much strain. Unhook the ends of the spring and remove it from the shaft. Separate the ends of the seal sideways and it can be slipped off the shaft. Inspect the oil seals for hardness and wear which would prevent them from doing their job of retaining the lubricant and keeping foreign material and moisture out of the bearing housing. If the seal appears free of defects or grooves, set it aside for re-installation. However, it is good practice to replace the oil seals when changing a bearing.

BEARING HOUSING CAP POSITION

Slide the housing cap along the shaft until it contacts the slinger (Item 4) that had been moved previously. The larger size bearing housing caps will have to be held upright on the shaft to keep them out of the way while changing the bearing. This can be done easily by wiring the cap to the side of the shredder housing or to the sling supporting the shaft.

The inside large diameter slinger (Item 4) can remain in place if it is in good condition while the bearing is being replaced.

REMOVING HOUSING FROM BEARING

Slide the small diameter slinger (Item 9) away from the face of the bearing housing and off the end of the shaft using a lubricant to ease its travel along the shaft. Remove and inspect the oil seal (Item 17) from the end of the bearing housing using the procedure described previously.

It will be necessary to support the larger bearing housing so it can be moved axially without binding or interference and allow it to clear the end of the shaft for removal.

The inside of the bearing housing has been honed and lapped to a snug fit on the outer ring of the bearing so a pulling device or effort will be required to slide the housing off the bearing. Set the bearing housing aside where the finished machined surfaces will be protected and rest it on blocking so the bottom mounting pads will not be damaged.

Flush out any oil remaining inside the housing with solvent and make certain that the sight glass (Item 6) is cleaned, then dried thoroughly. Spray or wipe the machined surfaces of the housing with a light machine oil to protect them from rust while the bearing is being replaced.

The drive side bearing housing has a stabilizing ring (Item 5), which should also be cleaned and replaced in the housing.

The inside small diameter slinger (Item 9) is next removed from the shaft to be cleaned and inspected. If found to be in good condition, set it aside for reassembly.

BEARING REMOVAL

Straighten up the tabs of the lockwasher (Item 7) on 5” and 8” bearings, or unbolt and remove the lockplate (Item 7) on 11” and 12” bearings so the locknut (Item 8) can be loosened. Use a spanner wrench that fits the locknut to loosen it on the shaft. If a spanner wrench is not available, use a blunted bar ground to fit the locknut slots for turning the locknut. Back the locknut off a few turns until it is 1/8” to 1/4” away from the bearing face. This will keep the bearing from shooting off the end of the shaft when it is freed from the tapered mounting seat on the shaft, by the hydraulic pressure or puller.

A conventional bearing puller that contacts the inner ring will be required to remove 5” bearings from the tapered mounting seat of the shaft.

CAUTION: Do not attempt to drive the bearing off the tapered mounting because of possible damage to the critical finish of the tapered mounting surface.

HYDRAULIC REMOVAL METHOD

To remove 8” and larger bearings, connect a hydraulic pump capable of delivering 10,000 psi to the 3/8” NPT tapped hole in the end of the shaft from which the bearing is to be removed.

Slowly apply pressure with the hydraulic pump until the bearing pops free, which will sound like an explosion, but the locknut acting as a safety measure will keep it on the shaft.

Remove the locknut and slide the bearing off the shaft using a fabric sling for the larger size bearings.

Clean the tapered mounting seat and examine it for nicks and burrs or other signs of fatigue and wear. If the tapered mounting is acceptable, the shaft is ready for installing the replacement bearing.

If the large diameter slingers (Item 4) have been found satisfactory, leave them in place along with the bearing housing cap; otherwise they should be replaced at this point. Should the slingers require replacing, carefully tap them onto the shaft with a soft-faced hammer and move them up the shaft several inches so they will be out of the way.

Be sure to slide the bearing housing cap onto the shaft before mounting the inside slinger (Item 4) on the shaft.

MOUNTING TAPERED BORE SPHERICAL ROLLER BEARINGS

Cleanliness during this operation is a must, and every effort should be made to provide a moisture and dust free environment. The installer should keep hands, tools and working area clean, because the bearing is a precision unit and any foreign material will be detrimental to its operation.

Unwrap the new bearing when all the necessary preceding operations have been completed and the proper tools are on hand to complete the mounting without delay to avoid contaminating the bearing with dirt or metal particles.

Do not remove the coating of “slush” – rust preventative oil applied at the factory for protection against corrosion. This preservative is compatible with grease and oil and does not need to be removed unless a synthetic lubricant is to be used.

The distance the bearing is forced onto the tapered seat determines the fit of tapered bore spherical roller bearings. This results in a reduction of diametrical clearance (DC) in the bearing through expansion of the inner ring. It is necessary to determine the initial DC before mounting, and to check the DC reduction during mounting until the specified DC is established.

To properly determine the initial DC, the following procedure is recommended. A feeler gauge with at least 3” long blades with a smallest blade thickness of .0015” will be required.

The following table of diametrical clearances before installation and recommended reduction of clearance is provided by the bearing manufacturer.

TABLE OF DIAMETRICAL CLEARANCES

BEARING SIZE		DIAMETRICAL CLEARANCE BEFORE INSTALLATION (inches)		REDUCTION OF DIAMETRICAL CLEARANCE (inches)		MINIMUM DIAMETRICAL CLEARANCE (inches)
inch	mm	min.	max.	min.	max.	After Mounting
5	130	.0063	.0081	.0025	.0035	.0030
8	200	.0088	.0114	.0035	.0050	.0040
11	280	.0118	.0156	.0045	.0065	.0055
12	300	.0130	.0169	.0050	.0075	.0060

CHECK DIAMETRICAL CLEARANCE

Lubricate the tapered mounting seat with a light machine oil. Slide the bearing (Item 3) onto the shaft until it is resting firmly on the tapered mounting seat with the inner and outer ring faces parallel. Slide the lockwasher (Item 7) and the locknut (Item 8) onto the shaft and run them up against the face of the bearing just had tight to hold it in position. Inspect the tangs of the lockwasher removed in the disassembly for cracks or signs of fatigue and replace if necessary.

Press down firmly on the top of the outer ring and oscillate the outer ring two or three times. This "seats" the inner ring and rolling elements. Position the individual roller assemblies so that a roller is at the bottom of the inner ring – on both sides of the bearing.

Press the two bottom rollers inward and upward to assure their being in contact with the center guide flanges as well as the inner ring raceways. With the rollers in the correct position, insert a blade of the feeler gauge (see chart for size range) between two of the bottom rollers. Move it carefully under the bottom roller between the roller and outer ring raceway. **NOTE: DO NOT ROTATE BEARING WHEN PASSING FEELER BETWEEN ROLLER AND OUTER RING!** Repeat this procedure using progressively thicker feeler gauge blades until one is found that will not go through. The blade thickness that preceded the "no-go" blade is the measure of diametrical clearance (DC) before installation.

Example: A 5" (130mm) bearing is to be mounted on a tapered shaft.

a. **By measurement with a feeler gauge, the initial DC is .0075"**

b. **Reference to table indicates a proper fit is obtained when DC is reduced by .0025" to .0035" or approximately .0030".**

Initial Clearance . . . . .0075"

Reduction of DC . . . . .0030"

Clearance after mounting . . . . . .0045"

c. **The locknut is tightened until the DC reaches .0045"**

NOTE: Tapered bore bearings must have the proper amount of diametrical clearance before installation to provide for the required mounting reduction of DC and to compensate for any further internal reduction from abnormal temperature conditions.

MOUNTING THE BEARING

Manual Method: When the required DC reduction has been determined, tighten the locknut (Item 8) with a spanner wrench until snug. If a spanner wrench is not available, use a blunted bar ground to fit locknut slots for tightening.

Lay a soft steel or brass bar along the shaft, in contact with the locknut and strike the bar several sharp blows with a hammer at several positions around the locknut. These blows drive the inner ring of bearing further up on the tapered shaft and release the pressure on the locknut threads, allowing the nut to be tightened easier. Continue to tighten the locknut (Item 8) while periodically measuring the DC at the unloaded roller, making sure it is firmly seated against the inner race and against the guide flange. When the proper amount of DC reduction is obtained the final clearance measurement on both faces of the bearing should be recorded for future comparison or reference.

Hydraulic Mounting Method: The larger size tapered bore bearings, 8” and up, can be eased onto the tapered mounting using the hydraulic method. Connect the hydraulic pump to the end of the shaft by the 3/8” NPT fitting. Tighten the locknut (Item 8) with the lockwasher (Item 7) on 8” bearings until it is firmly against inner ring of bearing. On 11” and 12” bearings, the locknut (Item 8) should be positioned with bolt holes outward and bearing directly against the face of the bearing inner ring. Introduce 2000-3000 psi oil pressure while tightening the locknut until proper DC is obtained.

SECURING LOCKWASHER

When the recommended reduction of DC has been attained, the bearing is in its proper position on the shaft. Find a lockwasher (Item 7) tang that is nearest a slot in the locknut on 5” and 8” bearings. If slot is slightly past tang don’t loosen nut, but further tighten so that the next nut slot clockwise meets a washer tang. Bend tang into the slot. The locknut (Item 8) on 11” and 12” bearings is secured by the tang of the lockplate (Item 7) inserted in a notch in the shaft, then bolted and wired to the face of the locknut. Do not loosen nut, but further tighten if necessary to allow tang to fit into notch on shaft.

ASSEMBLY OF BEARING HOUSING

Slide the small diameter inside oil slinger (Item 9) on the shaft until it is within a couple of inches of the locknut (Item 8) so it will contact the inside of the bearing housing.

Wipe the inside machined surfaces of the thoroughly cleaned bearing housing with a light machine oil. If this is the DRIVE SIDE bearing housing, it will have the stabilizing ring (Item 5) against the shoulder inside the housing.

NOTE: Only the DRIVE SIDE bearing housing has a stabilizing ring. Wipe the outside of the bearing with a light coat of machine oil to help it slide into the bearing housing.

Check to see that the housing gasket is in place on the housing cap before proceeding.

Hoist the bearing housing (Item 1) and slide it on the end of the shaft until it contacts the outer race of the bearing. Square the bearing outer race with the bore of the bearing housing so they are concentric. The bore of the bearing housing is honed to fit snug on the bearing so it will require some force to move it onto the bearing. Several light blows on the reinforcement gussets on both sides of the bearing housing will help move the housing onto the bearing without damage.

LOCATION OF HOUSING ON BEARING

The bearing housing is in the proper position on the drive side bearing when the inside shoulder with the stabilizing ring is flush against the bearing. This can be checked by removing the lubrication connection plug (Item 15) from the top of the housing to see if the lubrication groove of the bearing outer ring is centered in the hole. The outboard or “floating bearing” housing is in the correct position when the bearing is centered in the axial travel limits of the housing. This can be checked by observing through the lubrication connection hole (Item 15) if the inboard edge of the lubrication groove is centered in the opening.

NOTE: For Impact Dryer Mills or Hot Hogs where the rotors are subjected to heat, the outboard bearing may be positioned for maximum outward expansion. Maintain 1/8” minimum clearance between the bearing and the cap.

Slide the bearing cap (Item 2) into position, making certain it contacts the inner slinger (Item 4), and draw it against the bearing housing by tightening the cap screws (Item 11) equally around the cap.

Lower the rotor until the bearing housing contacts the pedestal supports or sole plate after checking to be sure the match marks on the ends of the bearing housing line up with marks on the support pedestal that were scribed prior to disassembly.

INSTALL BEARING HOUSING OIL SEALS

The RUP pattern oil seal (Item 12 & 17) is installed in the grooves in the end of the bearing housing and cap with the lip facing inward and butt joint at the top.

CAUTION: **All split seals are presized for the proper bearing housing at the factory. DO NOT ATTEMPT TO ALTER THE AS-RECEIVED SIZE ON JOB SITE.**

1. Separate seal ends sideways and slide it over the shaft with the lip pointing toward the mounting groove. Lubrication on the seal, shaft and mounting groove will facilitate installation. Position the butt joint at the top.

2. Lubricate the spring and install it around the shaft with hooked end connection 90^o away from butt joint. Insert the spring in the lip groove of the seal, which may require a small hooked tool to handle the spring and guide it completely into the lip groove.

3. Align seal ends and start the butt joint into the groove of housing by finger pressure, then slide the fingers around the seal simultaneously in both directions with a wrapping motion to start the inner edge of seal into the groove around its entire circumference before forcing any part fully into the groove. Then gently tap (only on the outer edge of seal) until it is seated in the housing groove, with the outer edge flush with the housing face.

Slide the outside slingers (Item 4 & 9) into position on both sides of the housing until they are contacting the machined face. Open the inspection port plugs (Item 13) to see that the inside slingers are flush against the inside of the housing. If the fingers were positioned properly on the shaft, they were snug against inside of bearing housing and cap when drawn into position. If they are not flush, they can best be moved when the shaft is rotating by using a round end rod inserted through the inspection hole (Item 13) and riding against the slinger edge until it moves flush against the inside of the housing. Use care to prevent any debris entering the bearing housing when the inspection plugs are removed, and replace them promptly.

A slight leak past the oil seals when the machine is running is to be expected, and will actually be helpful in lubricating the seal lip to prevent heat and wear. If leakage is severe, check to see the seal is seated properly, or else it could have been damaged during installation. Sometimes additional lip pressure by shortening the seal spring will correct leakage.

COMPLETE MOUNTING THE BEARING HOUSING

The bearing housing hold down bolts and lubrication lines are connected along with miscellaneous other items installed in the reverse order of their removal. See section on ASSEMBLY AND INSTALLATION.

The correct procedure for installation of bearing housing hold down bolts for 12” bearings is covered in Form 895A.

SECTION IIIB. INSTALLATION, LUBRICATION & OPERATION OF STRAIGHT BORE BEARINGS

Cylinder, or straight bore bearings are mounted on their shaft with a slight interference fit. Mounting is simplified by heating the bearing in an oil bath for 20 to 30 minutes at 200^o to 250^{o}F until it has expanded sufficiently to slide easily on the shaft.

See Drawing 61J-B-2668 for exploded view of bearing assembly and the index number of the items referred to in this text. All areas inside bearing housing (Item 1) and cap (Item 2) that are not machined are thoroughly cleaned and coated with GE red Glyptol or equivalent varnish.

The large felt seal (Item 8) is inserted in the groove of the housing cap (Item 2) before the cap is slid on the shaft along with the gasket (Item 9). Make certain that the drain plug (Item 12) is installed in the housing gap.

The oil bath to heat the bearing should not be allowed to go above 250^{o}F and the tank should have support blocks and a screen to keep the bearing away from the heat source while in the oil bath that may cause localized high temperature and reduce race hardness.

The heated bearing (Item 3) is slid on the bearing seat squarely against the shoulder. The lockwasher (Item 5) and the locknut (Item 6) are then installed to keep the bearing against the shoulder. As the bearing cools, the locknut should be tightened holding the bearing against the shoulder.

The oil bath leaves a thin film of oil on the bearing, which will prevent rust until it cools. But as soon as possible the bearing should be packed with the proper grease.

When the bearing has cooled and the locknut is fully tightened, bend a tang of the lockwasher (Item 5) into a slot of the locknut (Item 6). If slot is past the tang do not loosen the nut, but further tighten so that the next slot clockwise meets a washer tang.

The small diameter seal (Item 7) is inserted in the groove in the outside face of the bearing housing (Item 2). To minimize fretting corrosion during operation and to ease the installation on the bearing, coat the inside of the housing with a light machine oil. The drive side bearing has the stabilizing ring (Item 4) inserted in the bearing housing before it is slid on the bearing.

Make certain the outer ring of the bearing is square with the housing bore before attempting to slide it in place. If the outer ring becomes misaligned and stuck, do not force it further into the housing. Use a brass or soft steel bar and tap the outer ring until it becomes free and is realigned.

Check to see that the bearing housing is approximately one third to half full of grease when the housing cap (Item 2) is slid into place. Tighten the cap screws (Item 10) with the gasket (Item 9) in place to hold the housing cap firmly in place. The assembly is complete when the lubrication plug (Item 11) is in place on the bearing housing.

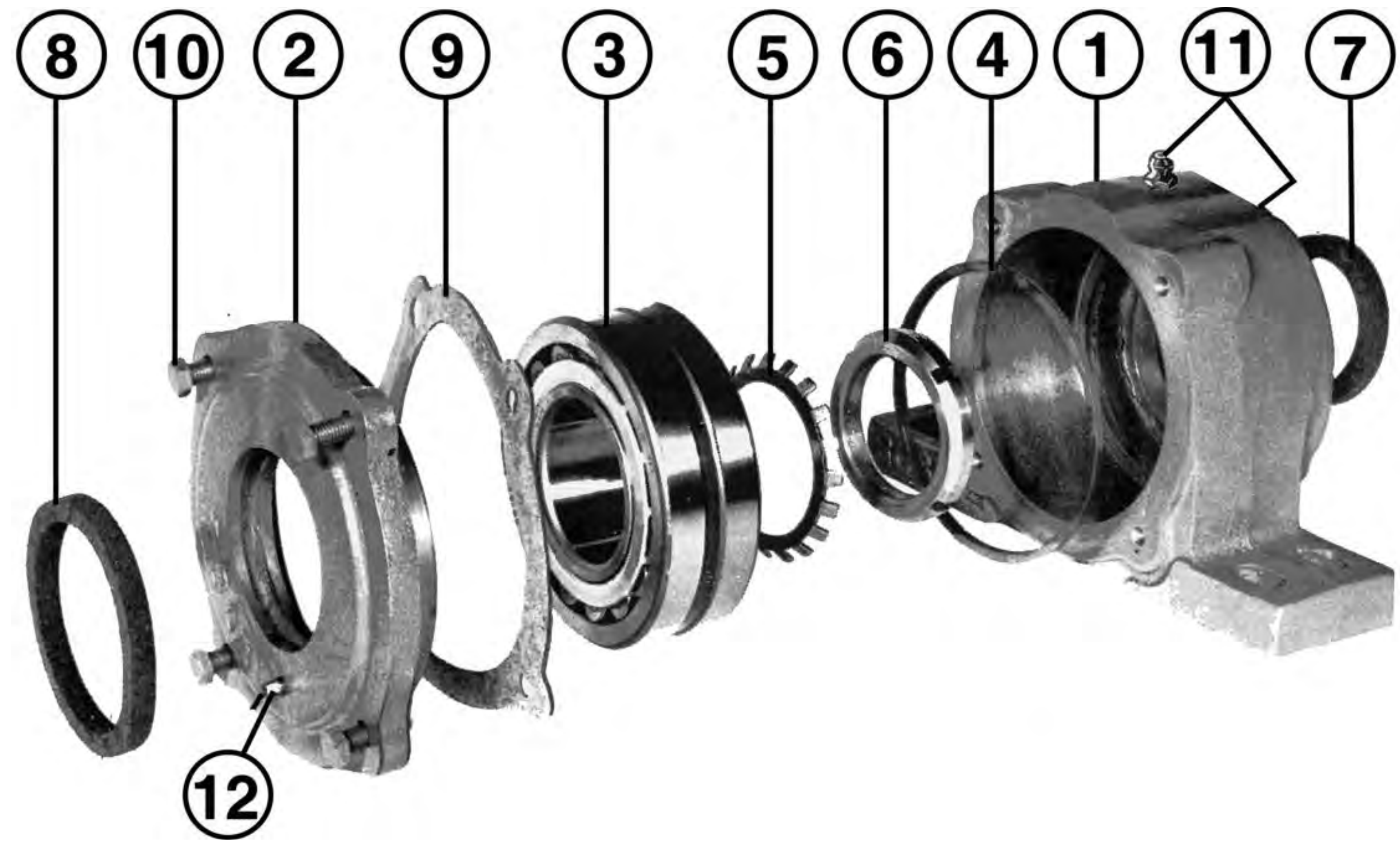
The flywheel side or outboard bearing is assembled in the same manner as above except the stabilizing ring (Item 4) is not used.

ITEM NUMBER	**When Ordering Repairs, Give:** Part Wanted, Quantity, This Drawing Number, and Your Mill Number	PATTERN NUMBER	QUANTITY IN MACHINE
1	Pillow Block Housing		1
2	Pillow Block Cap		1
3	Bearing -- Ball or Roller		1
4	Stabilizing Ring (Used on Drive Side Only)		
5	Bearing Locknut Washer		1
6	Bearing Locknut		1
7	Outside Dust Seal Ring		1
8	Inside Dust Seal Ring		1
9	Gasket		1
10	Cap Screws		
11	Lubrication Fitting (For Location, see below)		1
12	Lubrication Drain Plug		1

PARTS LIST FOR TYPE "O"
ROLLER & BALL BEARING
PILLOW BLOCKS

DRAWING NUMBER 61J-B-2668

WILLIAMS
PATENT CRUSHER and PULVERIZER CO., Inc.



OPERATIONS FOR MOUNTING BEARING ASSEMBLY

A. Slip bearing cap (2) over shaft.
B. Slip bearing housing gasket (9) in place on cap.
C. Press bearing (3) on shaft. Apply pressure to inner race only.
D. Mount & tighten lock washer (5) and lock nut (6).
E. Slip stabilizing ring (4) in housing for drive side only.
F. Slip housing (1) over bearing & fasten cap (2) to housing.
G. Bolt down housing to bearing pedestal.

FOR DISMANTLING - REVERSE PROCEDURE.

WILLIAMS PATENT CRUSHER and PULVERIZER Co., Inc.

PARTS LIST FOR TYPE “O” ROLLER & BALL BEARING PILLOW BLOCKS
DRAWING NUMBER 61J-B-2668

DISASSEMBLY

The removal of a bearing is the reverse of the preceding steps except a hydraulic or mechanical split ring puller is used to push the inner ring of the bearing off the shaft.

INSTALLATION

The rotor with the bearing assemblies is installed in the frame so the end disc is centered in the opening when the drive side or fixed bearing is securely bolted to its pedestal. The outboard, or flywheel side bearing housing is slid along the shaft as far as it can move in both directions and the limits of its travel is marked on the shaft. The bearing housing is then centered between these marks so the bearing can “float” in the housing when the shaft expands or contracts.

LUBRICATION

Straight bore bearing housings are designed for grease lubrication of the bearing unless specified otherwise.

The grade and type of grease used for the bearing depends on the application and temperature as well as the daily hours of operation.

An anti-friction bearing requires a comparatively small amount of lubricant, and over-lubrication will only cause trouble.

An important rule to remember is DO NOT OVER-LUBRICATE anti-friction bearings; however, lubrication must always be present in the bearing to avoid damage.

In the higher speed ranges, too much grease will cause churning and overheating that results in separation of the grease components and breakdown in lubricating values.

Normal operating temperatures are in the range of 150^{o} to 170^{o} F with a slight showing of grease at the seals to indicate the bearing is properly lubricated.

Many factors such as bearing size and speed and the environment determine how often the bearing should be relubricated. It is not possible to predetermine when new grease must be added because of the gradual way the lubricating value is reduced over a period of time. In establishing a greasing schedule, previous experience with similar equipment operating under comparable conditions is the best guide. Bear in mind that it is better to add small amount of grease at frequent intervals than a large amount infrequently.

The bearing size (bore diameter) and speed compared with the operating hours serve as a good estimate of the lubrication frequency or period.

The following chart lists various size mills and the suggested maximum greasing period:

MILL SIZE	MAXIMUM OPERATING SPEED	MAXIMUM GREASING INTERVAL HOURS
GP106	3600	2000
GP1512-18	3600	1200
ROCKET 10-30	3600	1200
METEOR 6-18	1800	1200
111 IMPACTOR	3600	1200
"C" SERIES	1800	300
200 IMPACTOR	1800	300
METEOR 20-24	1800	300
240 IMPACTOR	1800	150

When applying grease to the bearing housing through the fitting, make certain the fitting is wiped clean before connecting the grease gun, and the drain plug is removed from the housing cap to allow purging of the old grease. Sufficient grease should be added at each greasing to fill the bearing housing cavity from one-third to one-half full. If fill cannot be determined visually, make an estimate of the size of the cavity and measure the amount of grease expelled by a stroke of the gun.

SECTION IV. TROUBLESHOOTING

TROUBLE	OBSERVED CHARACTERISTICS	PROBABLE CAUSE	CORRECTIVE ACTION
TEMPERATURE	High bearing temperature after first start	Grease redistribution	Allow machine to cool, then restart
	Continuously high during operation	Churning of lubricant	Use lower oil level or less grease, or stiffer grade of grease.
		No lubricant	Add lubricant, check seals
		Excessive axial load	Check outer ring location in housing of "floating" bearing to allow thermal expansion.
	Hottest at center of bearing housing	Bearing misaligned	Bearing outer ring should be square in housing and housing perpendicular to shaft in both directions.
		Bearing housing pinching bearing ring	Debris under bearing housing causes distortion of housing when holding bolts are drawn down, that pinches outer ring of bearing. Clean and true bearing pedestal.
		Excessive radial load	Use correct fit of inner ring on shaft for straight bore bearings. Use bearings with greater internal diametrical clearance. For preloaded paired bearings, use lighter preloads. Balance rotor.
		Raceways pitted	Pitting usually result of electrical current flow due to improper ground when welding on rotor. Replace bearing.
	Hottest at faces of bearing housing	Slingers dragging against seal	Ease slinger away from face of seal a slight amount for clearance of 1/32" or less.

TROUBLE	OBSERVED CHARACTERISTICS	PROBABLE CAUSE	CORRECTIVE ACTION
EXCESSIVE VIBRATION	During acceleration or de-acceleration periods	Critical speed of machine components or feed chute	Isolate feed chute from mill, stiffen or support ducts or other components to change their criticals.
	During operation at a fixed speed	Foundation critical	May require change in operating speed of mill to avoid critical.
		Unbalanced rotating parts	Dynamically balance rotating parts. Determine if rotor or hammers are the cause of the unbalance by running rotor without hammers.
		Running at higher than rated speed	Refer to instruction manual for correct speed.
		Misalignment	Align to tolerances called for in instruction manual
		Bearing brinelled	Replace bearing, avoid excessive loading at mill or operating with unbalanced rotor.
		Machine loose on foundation	Retighten hold down bolts, but do not distort frame, which will increase vibration.
	During operation at fixed speed, but at a changing amplitude	Hammers held out of position by feed material	Reduce feed of oversize material into the mill or increase hammer size.
		Structural critical	Dynamically de-couple mill from forcing frequence by stiffening frame or isolating components that are responding to vibration from mill operation. May require changing mill speed if isolation is not practical. Condition can be positively identified by vibration analysis.
		Cover or components loose	Tighten all bolts holding accessories and covers on regular schedule.

TROUBLE	OBSERVED CHARACTERISTICS	PROBABLE CAUSE	CORRECTIVE ACTION
NOISE	High pitch, steady tone	Excessive axial load	Correct outer ring location in housing of "floating" bearing to allow thermal expansion.
		Excessive radial load	Check internal clearance on preloaded roller bearings and increase clearance to allowable maximum
		Misalignment of bearings	Correct alignment so that bearings are square with shaft in all directions
		Lack of lubricant	Regrease or add oil as necessary. Determine cause.
		Bearing exposed to vibration while machine is idle	Carefully examine bearing for wear spots separated by distance equal to ball or roller spacing. Replace bearing. Condition known as false brinelling.
		Wrong type of grease or oil causing breakdwon of lubricant	Refer to lubrication instructions for proper type of grease or oil for bearing.
		Replacement bearing selected with inadequate internal clearance for operating conditions where heat is conducted through shaft and expanding the inner ring.	Replacement bearings should have identical markings as original factory equipment.

TROUBLE	OBSERVED CHARACTERISTICS	PROBABLE CAUSE	CORRECTIVE ACTION
NOISE	Intermittent rumbles, rattles, clicks, etc.	Too much clearance in bearing.	Adjust preload on bearing.
		Excessive wear in raceways	Replace bearing.
		Loose machine parts or bearing hold down bolts	Tighten all hold down bolts, closures and other machine components.
	Low pitched clicking	Foreign material in bearing	Flush bearing, replace oil and check seals for wear, or use better practice in handling relubrication of bearing.
	Intermittent high pitched noise or squeal	Rollers or balls skidding	Use thinner grease or oil. Possible preload of bearing not adequate. Check clearance.
	Low pitched, continuous or intermittent noise or rumble.	Rotor or shaft rubbing housing	Correct machine parts or position of cover
		Too much clearance in bearing	Check for correct preload on bearing.
		Raceways pitted	Clean all parts and replace bearing and seals. Pitting is usually result of electric current going through bearing when welding on rotor without proper ground.
		Bearing brinelled	Replace bearing and avoid overloading.
		Resonant vibration of machine or hopper	Isolate hopper from mill, stiffen or sound-deaden thin panels and large flat surfaces. Tighten all hold down bolts on mill and support structure.

WILLIAMS

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LARGE CRUSHER CAGE AND HAMMER REPLACEMENT

WILLIAMS PATENT CRUSHER & PULVERIZER CO., INC.

2701 North Broadway • St. Louis, Missouri 63102, U.S.A.

FORM 843

LARGE CRUSHER
CAGE AND HAMMER REPLACEMENT

Introduction

The procedure and equipment to maintain or service large crushing equipment will vary from installation to installation, but the same general principles will apply for all large crushers.

On the job safety is the most important consideration in every portion of the maintenance or service of Williams crushing equipment including the use of proper safety equipment by the workmen.

Lock out the drive motor controls or circuit breaker before opening the crusher cover or when personnel are working near the rotor.

When the crusher cover is open, provisions should be made to keep it from moving by blocking it open or locking out the hydraulic operating system circuit breaker.

Hammer Replacement

The most frequent service operation is hammer replacement, which will vary with the amount and nature of the material crushed so no definite time schedule can be established. A hammer profile template will be the best way to gauge when a crusher hammer has worn beyond its efficient operating size.

Before undertaking this service operation, it would be advisable to assemble all the necessary materials and tools.

Work Platform

The most necessary item fabricated on the job is the work platform that will fit inside the crusher frame when the cover is open for the workmen to stand on when handling the hammers. The work platform should be constructed from sound dimension lumber to support the weight of the workmen and hammers, and be held firmly in position so it will not move while workmen are positioning the hammers on the rotor.

For non-reversible crushers, the work platform can rest directly on the horizontal cover flanges of the frame when the cover is open, and extend from the rear flange to the center discs of the rotor to allow the hammers to slide easily from the rotor onto the platform without having to hoist them manually.

Reversible crushers will have the work platform raised above the base cover flanges until the top is flush with the bottom of the hammer tip in the stationary rotor.

The large crusher rotor will always stop in and about the same position, with the hammer bolt 45 degrees above horizontal in the cover opening, so it is easy to position the work platform at the same place each time. The work platform should be made in two or more sections so it will be easy to move and have 12 inches of the side adjacent to the rotor separate, to allow the rotor to turn to present the next row of hammers for service without having to move the entire platform.

Locking Rotor

When the work platform is in position, the rotor is held rigid by a clamp or clip welded to the side of the rotor end disc, that will bear against the crusher frame to prevent the rotor from turning when a row of hammers is removed. The rotor will always turn towards the breaker plate, opposite the open cover, when a row of hammers has been removed unless it is restrained by a clamp. The clamp need only be welded to one side of the rotor and does not need to be welded to the crusher frame. Be certain to attach the ground to the rotor whenever welding is done on the rotor to protect the bearings.

Hammer Bolt Locking Device

The hammer bolt locking cap in the side of the end disc opposite the drive side is removed by cutting the welds that keep it in its holder. If need be, cut the locking cap to remove it from its holder because a new cap can be cut from mild steel plate easier than carefully removing the old lock cap to save it.

It should be possible to remove the cap by twisting it 90 degrees in its holder once the welds are cut away.

Clean away all debris from end of hammer bolt and the hole tapped in the end of the hammer bolt - then apply a coating of a light lubricant to the threads to facilitate insertion and removal of the hammer bolt pulling connector.

Hammer Bolt Size

The table below lists the hammer bolt sizes for each size of crusher and the dimension of the tapped hole in the end of the hammer bolt for the puller connection.

Crusher Series	Hammer Bolt Diameter	Hole Size	Wt of Hammer Bolt Lb Per Foot
700	4.50	2-1/2 - 4 NC x 3"	54.08
600	4.00	2 - 4-1/2 NC x 3"	42.73
500	3.437	1-1/2 - 6 NC x 3"	27.13
400	2.937	1-1/2 - 6 NC x 3"	23.04

The hammer bolt pulling connector rod is screwed into the end of the hammer bolt for a depth equal to the hole diameter, after coating the threads with a lubricant to facilitate its insertion and removal.

It is advantageous to lubricate the hammer bolt to ease its withdrawal by pouring kerosene or 10W motor oil alongside each of the center discs.

Hammer Bolt Pulling

Several methods can be used to remove the hammer bolt from a large crusher rotor depending on the size of the hammer bolt and the length of time it has been in service. It will always be necessary to support the hammer bolt as it is withdrawn from the rotor or else it will tend to bind in the disc openings. Usually a simple jib boom mounted on the side of the crusher hopper will be sufficient to support the hammer bolt and the pulling device which will have a maximum combined weight of about 1,000 pounds for even the largest size crusher.

The length of the jib boom or support track for the puller should be the length of the pulling device to allow the hammer bolt to be fully withdrawn from the rotor. The jib boom or track should be equipped with an easily moved trolley and manual lifting device to carry the hammer bolt and the pulling device. Smaller size hammer bolts that do not become "frozen" in the discs by the product the crusher grinds, can often be pulled using an eye bolt with a mechanical device attached to a substantial wall or other support opposite the end of the rotor. Some of the larger size hammer bolts can also be handled this way once they are partially withdrawn from the rotor by a hydraulic puller. Using a manually-operated mechanical puller is a lot faster than most hydraulic pulling equipment when a large pulling force is not required. From the above table, select the size of threaded eye bolt to use when use of a mechanical pulling device is practical.

Hydraulic Hammer Bolt Puller Operation

When a large pulling force is required to remove the hammer bolt, the Williams Model E Hydraulic Puller will handle the largest hammer bolts with ease. It will require an overhead track to support the hydraulic puller that will allow it to move parallel with the shaft as the hammer bolt is withdrawn.

When the above preparatory steps have been completed: –

1. Connect the hydraulic hoses to the electrical power unit and to the hydraulic pulling ram. The electrical powered pump unit is rated at 1-1/2 HP so be sure to connect it to a properly fused circuit for the nameplate voltage.

2. Thread the connecting rod with the proper size adaptor into the end of the hammer bolt until the adaptor nut is contacting the end of the hammer bolt.

3. Slide the 30 inch long spacer tube on the connecting rod until it bears against the side of the end disc.

4. Slide the pulling ram onto the connecting rod with the bottom of the ram against the spacer so the moving cylinder is facing the threaded portion of the connecting rod, while the pulling ram is suspended by its hoist.

5. Turn the jam nut onto the connecting rod until it is firmly against the pulling ram, and holding the spacer snug against the side of the end disc.

6. Start the hydraulic pump unit and slide the control valve handle either up or down depending on how the hoses are connected, until the pulling ram cylinder starts to extend. Continue holding the valve handle to move the ram cylinder until it has extended its full six inch stroke.

7. Reverse the valve on the pump unit until the ram cylinder is retracted, but be careful not to allow the cylinder to bottom out or else the hydraulic fluid will squirt out of the pressure relief valve on the side of the ram. Turn the jam nut on the end of the connecting rod until it is snug against the retracted cylinder of the pulling ram.

8. Repeat steps 6 and 7 until the jam nut reaches the end of the thread on the connecting rod.

9. Back off the jam nut about 18 inches so a slotted spacer can be inserted between the end of the solid spacer and the pulling ram so steps 6 and 7 can be repeated again. Continue to add spacers as the hammer bolt is withdrawn until all the hammers are removed from the row.

   As the hammer bolt is withdrawn, the hammers can be slid out of the rotor openings onto the work platform without having to lift them, provided the platform is positioned properly. Assemble a group of several used hammers on the work platform, then run a sling through the hammer eyes, and hoist them off the platform onto the staging area for rebuilding or salvage.

Hammer Weight Balance

The complete set of replacement hammers are accurately weighed to the closest pound and assembled into the rows in which they will be installed in the rotor. As each hammer is weighed, it should be marked so it can be arranged in a row where the hammer in the row opposite it is the same weight.

The following table is a guide for arranging hammers with the suggested maximum weight difference in ounces for hammers opposite each other and the maximum total difference in ounces between opposing rows.

HAMMER SIZE BY WEIGHT	ALLOWABLE WEIGHT DIFFERENCE IN OUNCES					
	Rotor Speed					
	1800 RPM		1200 RPM		900 RPM	
	Per Hammer	Per Row	Per Hammer	Per Row	Per Hammer	Per Row
Up to 50 lb. hammers	4	8	6	14		
50 to 100 lb. hammers			6	20	8	32
100 to 150 lb. hammers			8	26	16	36
150 to 200 lb. hammers					16	40
200 to 400 lb. hammers					32	48
Above 400 lb. hammers					32	60

It is important to keep the weight difference between opposing hammers as low as possible to maintain satisfactory dynamic balance and keep the operating vibration to a minimum to insure long service life of the rotor bearings.

Hammer Bolt Replacement

It is much easier and considerably safer to pull or push the hammer bolt back into the rotor rather than driving it with a hammer. Very little force is required to move the hammer bolt into the rotor provided it is supported to prevent it from sagging and binding in the disc openings. An effective arrangement for pulling the hammer bolt into place is to attach an eye to the side of the end disc above the hammer bolt hole so a 1-ton capacity come-along can be connected to pull the hammer bolt into the rotor.

If the hydraulic puller was used to withdraw the hammer bolt from the rotor, which was suspended from the jib boom to support the hammer bolt and puller, secure a second line from the jib boom to support the hammer bolt, while the hydraulic pulling ram is removed from the connecting rod. Then remove the split spacers from the connecting rod leaving only the solid 30 inch long spacer on the extended hammer bolt.

Attach a come-along to the end of the connecting rod, while its other end is hooked to the side of the end disc so the hammer bolt can be pulled into the rotor.

Select the first hammer in the row arranged from the match weighed replacement hammers for the row being replaced and hoist it onto the work platform. The hammer is slid into the rotor opening next to the end of the hammer bolt with the eye aligned with the hammer bolt. It may require raising the hammer slightly in the opening by a pinch bar bearing against the work platform and the tip of the hammer to get it to align properly with the hammer bolt, while the hammer bolt is pulled into the rotor and through the hammer eye. Repeat this process until the end of the connecting rod, which is attached to the come-along, is flush with the long spacer. Remove the support line from the jib boom and the come-along from the connecting rod so the long spacer can be removed from the hammer bolt - then reconnect the come-along to the end of the connecting rod. Install the remaining hammers in the row, and push the end of the hammer bolt into end disc until it is behind the locking ring. Remove the connecting rod and tack weld the lock plate into the lock ring with a low hydrogen rod making certain to ground the welding lead to the rotor.

Remove the rotor holding clip from the end disc and disconnect the come-along used to pull the hammer bolt into the rotor.

The section of the work platform adjacent to the rotor is raised so the rotor can be turned, which usually can be managed by flipping up the row of hammers manually to cause the rotor balance to change and rotate toward the breaker plate until the next row of hammers is in position for service.

Repeat the above process with each row of hammers until they are all replaced, being careful to get the proper weight matched hammer in each disc opening to maintain satisfactory operating balance of the rotor.

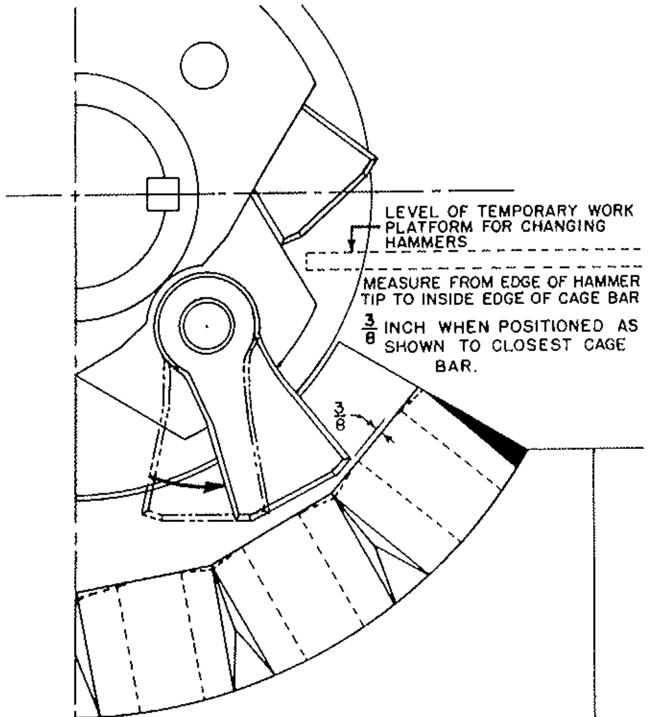
Cage Bar Service

The second most frequent service on a large crusher is the re-positioning or replacement of cage bars. Cage bars should be inspected regularly for distortion and wear so a new cutting edge can be positioned to maintain grinding efficiency in the crusher. Most large crushers use reversible box type cage bars which have two cutting edges on both faces that can be re-positioned when one set of cutting edges have worn or become rounded. Reversible crushers should use both edges of one face equally by alternate direction grinding before reversing the cage bars. Non-reversible crushers use the same pattern cage bars, but the second cutting edge on each face is positioned by switching the cage bars, end for end, before they are reversed to present the opposite cutting face for a total of four cutting edges on each bar.

Measuring Cage Bar Wear

There is no template to check cage bar wear, but a visual inspection of the cage bar will show that when a half inch or more of surface has been worn away across the face of the cage bar, it is due for replacement or re-positioning. Because of the slight dimensional variation in the cage bar castings, it is impossible to list an exact dimension from the hammer tip to the face of the cage bar to measure when determining wear or whether the cage bar is bent.

Use a straight edge along the length of the cage bar to determine if it has bowed while it was in service. A cage bar that has a bend or bow of more than one inch when measured from a straight line between both ends of the cage bar should not be reversed until it can be straightened. The design clearance between the tip of a new hammer and the closest face of a new cage bar in a large crusher is three-eighths inch when the hammer is projected radially from the rotor. If the clearance between a new or replacement hammer tip and the old cage is more than 3/4 inch, examine the cage bar for wear, or else it may have become distorted from heavy use, which will reduce the grinding efficiency of the crusher. See sketch on page 7 for the location where the clearance between the cage and hammer is measured.



TYPICAL POSITION OF ROTOR AT REST WITH COVER OPEN

Cage Bar Opening Size and Arrangement

Depending on the product size desired from a large crusher, quite often more than one size of cage bar opening is used in a set of cage bars to provide a variety of opening sizes in a predetermined pattern. Unless the product size graduation is to be changed, the cage bars should be replaced in the same order to present the same size cage openings in the grinding chamber as the original cage set.

The size of the cage bar opening governs the length of arc segment the individual bar will occupy in the complete cage ring, which will vary in length depending on crusher style. Because of slight variations in casting sizes or the combination of the cage bar arc segments in the cage ring, it is sometimes necessary to use a filler piece in the cage assembly to fill out the cage ring. If the cage bars are being removed to be reversed and reinstalled, note the location of the filler piece if one is used. When new cage bars are to be installed and a filler was used in the old cage ring, it may not be necessary to reinstall it with the new cage bars or else its size may need to be altered to properly fill out the cage ring. The replacement cage should not extend above the cage support ring or else it will not be possible to completely close the crusher cover. The usual procedure is to select a set or a combination of cage bars, which have individual arc lengths, that will exactly total the arc length of the cage support ring for the particular model crusher being serviced.

Cage Bar Removal

The cage bars in large crushers are held in place on the cage support ring by a locking wedge at either end of each cage bar, which bear against a lock ring welded to the side of the crusher frame, and held in place by a segmented clamp ring bolted through the lock ring to the side of the crusher frame.

To remove the cage bars, unbolt the clamp rings, which are held in place by two bolts in each segment through the side of the crusher frame. When the bolts are removed, the clamp segments can be slid around the cage ring and hoisted out of the crusher. The largest clamp segment from a 700 Series crusher will weigh about 250 pounds which will require a mechanical hoist to handle it safely when removing it from a crusher.

With the clamp rings out of the way, the locking wedges are exposed so they can be pried out of their slot beneath the lock ring and the top of the cage bar. When the wedges are removed from each end of a cage bar, it is free to move. Be careful to note which lock wedges were used with a particular cage bar because each size cage bar has a properly sized locking wedge to keep it securely in place in the cage ring and must be used again when the cage bar is replaced.

Attach the lifting equipment, or sling, to both ends of the cage bar so both ends will move equally as the cage bar is hoisted out of the crusher to prevent it from wedging against the side of the frame, if one end is moved ahead of the other. The largest size cage bar will weigh about 2,000 pounds so it is possible to lift the cage bars with a pair of come-alongs supported from the cover flange above the cage opening. When the cage bar is out of the support ring, it can be picked up with the mobile hoisting equipment and lifted through the cover opening or slid out to the side between the cover opening cylinder and the cover, whichever provides the easiest access. The cage bars in the portion of the cage opposite the cover opening will require special care when the locking wedges are removed to keep them from sliding down the cage support ring when personnel are in the way.

Continue the above procedure until all the cage bars have been removed from the cage support ring. Examine the cage support ring for any defects or unusual wear before replacing the cage bars, and make necessary repairs.

Replacing Cage Bars

Installing new cage bars or turning worn cage bars is essentially the reverse of the above procedure. Because of the slight variation in the cage bar castings, it may be necessary to provide filler pieces or shims between the locking wedge and the lock ring so the wedge will project out of its slot enough to be contacted by the clamp ring, which holds it tightly against the cage bars. It may also be necessary to use filler pieces to fill out the cage frame opening to insure the cage remains tight when the cover is closed.

To pull the cage bars into position on the upper end of the support ring opposite the cover opening, it will be necessary to attach a pair of come-alongs to the back of the breaker plate or the frame above the cage support ring. As each cage bar is moved into position, lock it in place with the proper wedges to keep the cage bars tight against each other in the support ring.

Replace the clamp rings and check to see that all the wedges are contacted as the holding bolts are drawn tight to pull the clamp ring segment against the side of the crusher frame. Draw the clamp ring holding bolts as tight as possible while pounding the clamp ring with a sledge hammer to prevent the bolts from loosening while in service. Check to make certain that all the clamp ring setments are properly seated so the rotating hammers will not contact them when the crusher operates.

Maintenance

It will be necessary to periodically check the clamp ring holding bolts with a wrench to insure they do not loosen as the cage bars seat themselves in the cage ring. A daily check should be made for the first two weeks of operation after the cage bars have been changed.

Include these bolts in the weekly maintenance check list on the crusher operating condition.

Never operate a crusher with badly worn or deformed cage bars because of the hazard of their breaking and jamming the rotor or causing more serious damage.

Periodically examine the cage bars for unusual wear so corrective action may be taken before all the wear surfaces of the cage bar have been used.