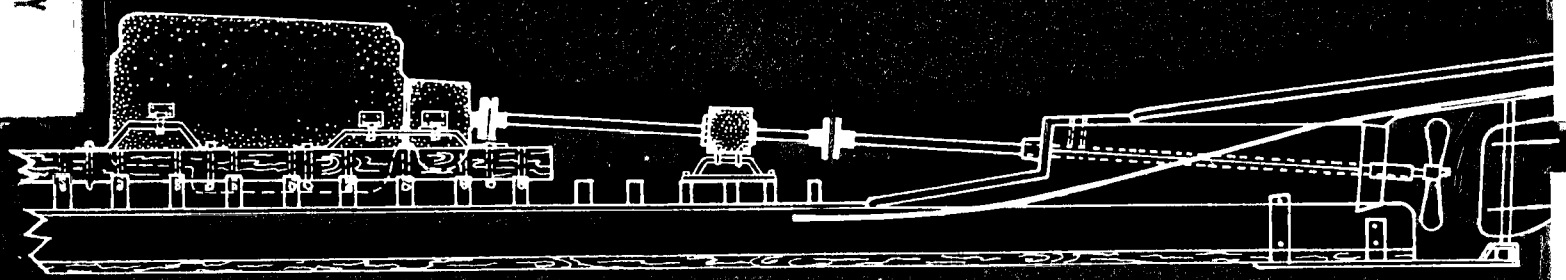
BOAT MAINTENANCE: ENGINE REALIGNMENT



BY DAN COLSON

Issued by the Georgia Sea Grant College Program • The University of Georgia, Athens, Georgia
Marine Extension Bulletin No. 11, July 1988

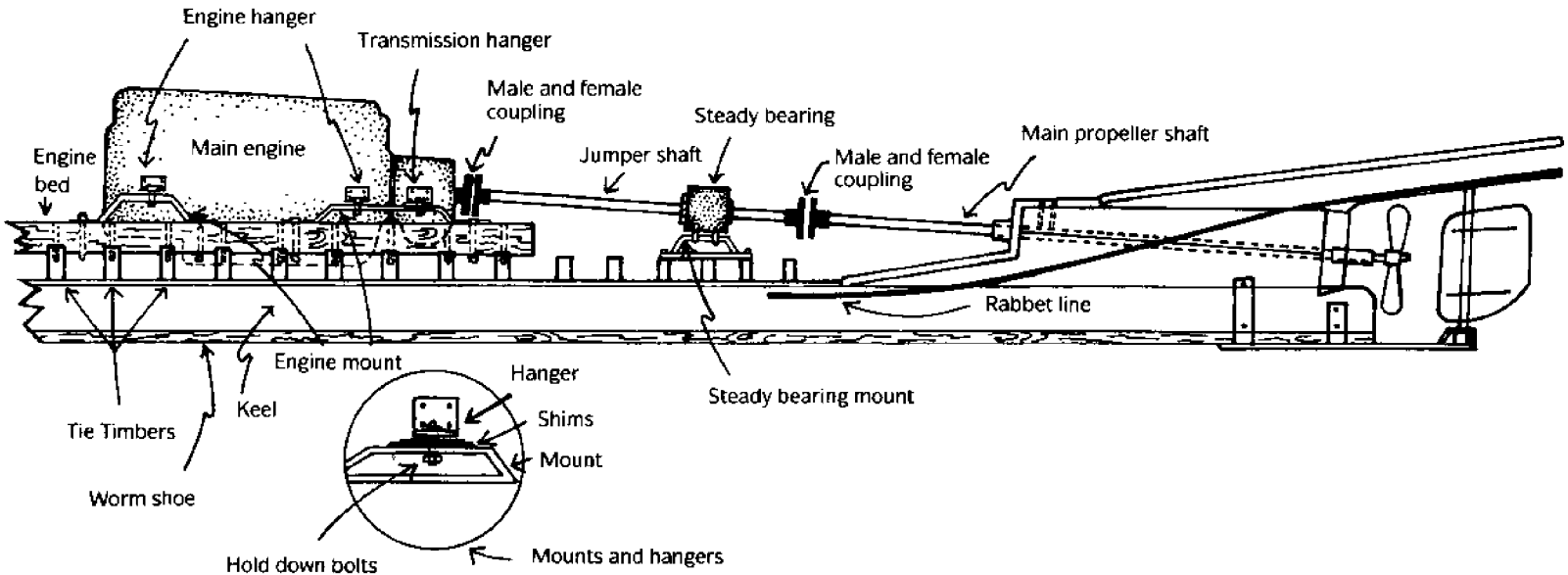


Figure 1. Propeller shaft side view

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The University of Georgia
Marine Extension Service
P.O. Box Z, Brunswick, Georgia 31523

Published 1988

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Any number of problems can cause a boat to vibrate, and any of them, if left unattended, can cause serious damage to a vessel. A bent wheel, shaft, rudder, or rudder shoe can cause vibration, but these problems are fairly easy to spot and correct. A process of elimination may lead to the conclusion that the misalignment of the main engine with the propeller shaft is causing the vibration. If this problem is not corrected, serious damage to the clutch can result.

Realignment of the engine is not overly complicated, but it is time-consuming and does require a great deal of patience. This publication is designed to assist those who are willing to tackle the problem themselves. The procedures described here are applicable to large commercial craft only.

The first step in the engine realignment process is to repack the stuffing box.

Repacking The Stuffing Box

Repacking the stuffing box should be done while the vessel is in dry dock to prevent water entering the boat through the shaft log when the old packing is removed. Choices of packing include flax, teflon, and graphite. Flax is considered the best

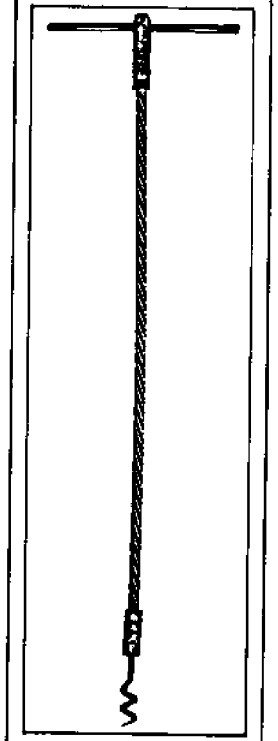

Figure 2. Packing puller

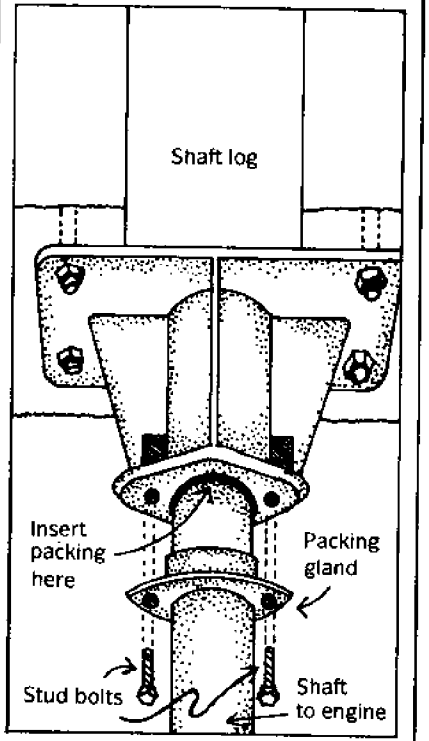

Figure 3. Repacking stuffing box

packing material for marine use. Teflon packing is widely used with high-speed stainless steel shafts, but is acceptable for marine use.

To determine the correct size of packing to use, remove the stud bolts (or locking nut in the case of screw-on packing gland) from the packing gland, and slide the gland up the shaft. Measure the thickness of the part of the gland that was inserted into the stuffing box. This thickness represents the size packing you will need.

Before removing the old packing, place blocks under the propeller shaft to relieve the weight of the shaft on the packing and use a packing puller to remove the old packing. (A packing puller may be purchased at a pump and pipe supply house.) To determine the correct length of packing, wrap the packing once around the propeller shaft and cut the ends off square leaving a 1/8- to 1/ 4 -inch space between the two ends. After cutting the first piece, make sure it will go into the stuffing box evenly. If it will not go in evenly, go back and check to make sure the propeller shaft is centered in the stuffing box. Once the correct length of packing has been determined, use it as a pattern and cut several additional pieces. The exact number of pieces will differ according to the size of the stuffing box. Apply

a liberal amount of good multi-purpose grease to each piece of packing before inserting it into the box. It is important that each piece of packing be tamped firmly and evenly into place. This can be facilitated by making a "split pipe tool." Using a piece of pvc or rigid pipe with approximately the same inside diameter as the outside diameter of the propeller shaft, cut a length 6 to 8 inches longer than the stuffing box and split the pipe lengthwise into two equal parts using either a bandsaw or cutting torch, depending on the type of pipe used. Place the two split pieces of pipe around the propeller shaft and use them to slide the first piece of packing into the box as far as it will go. Tamp it firmly into place. Insert the remainder of the packing in the same way, but be sure to stagger the butting ends of each successive piece 90° from the previous one. This prevents water from passing through the gaps in the packing and into the boat. Add packing until there is 1/2 to 1 inch of space at the front of the box to accomodate the packing gland, then replace the packing gland and tighten it evenly until it is firmly resting against the packing. Secure the gland with a locking nut or stud bolts, but, remember, if stud bolts are used, be sure they are wired firmly into place. Note: If flax packing is used, a small amount of wax or grease may seep from the stuffing box. This is not unusual and it will stop after a few hours of running time.

Steady Bearing

Note: The steady bearing and engine should never be realigned while the boat is in dry dock. Realignment should be done only after the boat has been in the water long enough to settle into its natural shape (fiberglass and steel hulls - 24 hours; wooden hull - 72 hours).

Larger commercial boats have long propeller shafts which are composed of two separate shafts, the main propeller shaft and the jumper shaft. The stern end of the main shaft goes through the stuffing box with the opposite end coupled to the jumper shaft. The forward end of the jumper shaft couples to the gearbox. The steady bearing, or intermediate bearing, serves to support the jumper shaft and main shaft and may be located on either the main or jumper shaft (see diagram). The steady bearing must be inspected before realigning the engine to the shafting.

There are two common types of steady bearing, the babbitt and the roller bearing. Both types are

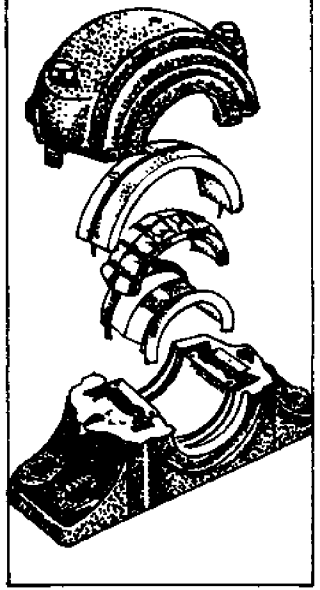

Figure 4a. Split roller bearing

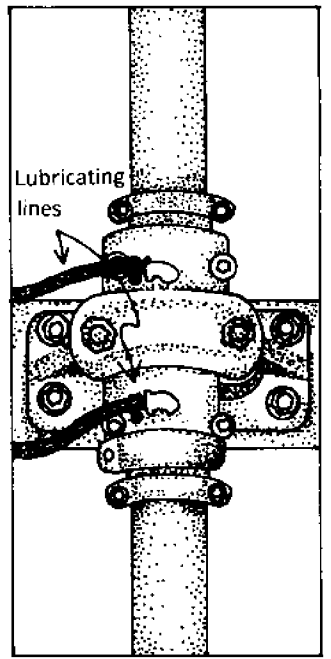

Figure 4b. Roller bearing lubricating lines

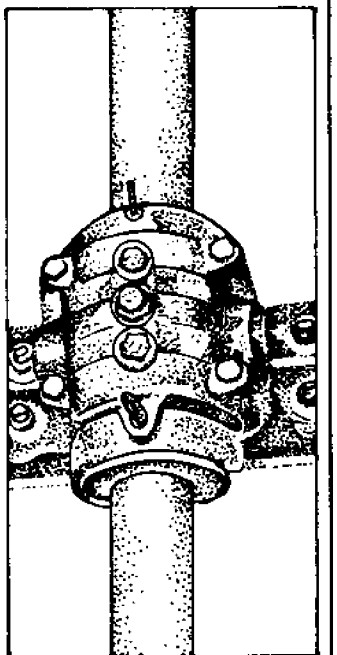

Figure 5a. Split babbitt bearing (sleevoil)

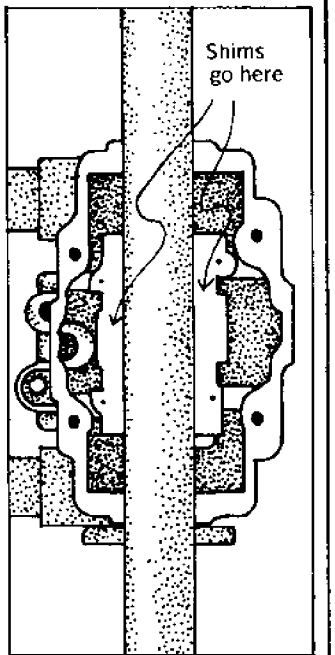

Figure 5b. Open split babbitt bearing (sleevoil)

two-part (split) bearings which contain an insert that may be replaced easily. To determine whether a bearing needs to be repaired or replaced, start by trying to pry the propeller shaft up or down in the bearing housing. If any movement is felt, the bearing should be opened for inspection.

First, remove the cap from the bearing to make sure what type of bearing it is. If it is a roller bearing, a replacement bearing must be installed. If a babbitt bearing is used, chances are that the spacer shims can be replaced between the two bearing parts instead of replacing the entire bearing. If only a single shim is left in the bearing, remove it and replace it with thinner shims so that the bearing fits snugly around the propeller shaft.

The second thing to check when inspecting the steady bearing is proper lubrication. A roller bearing is lubricated by grease and has two lubricating lines leading to it; a babbitt bearing is lubricated by oil and has a single lubrication line. First, check the grease fitting or oil reservoir to ensure that they are properly filled. Both are usually located on the aft bulkhead of the engine room. Once this has been done, inspect the lines for cracks or breaks. Notice particularly where the line (or lines) connects to the bearing. Lubrication lines usually are made of cop-

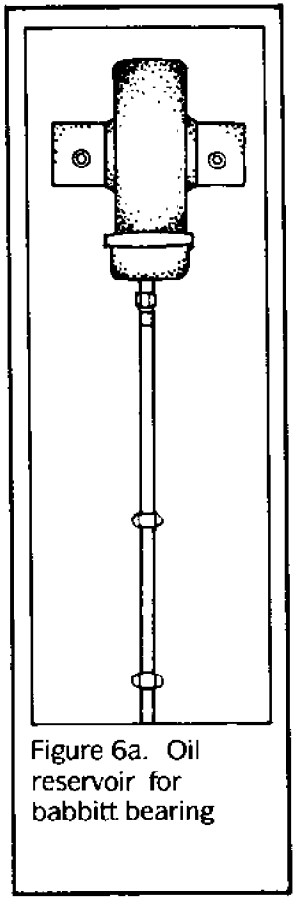

Figure 6a. Oil reservoir for babbitt bearing

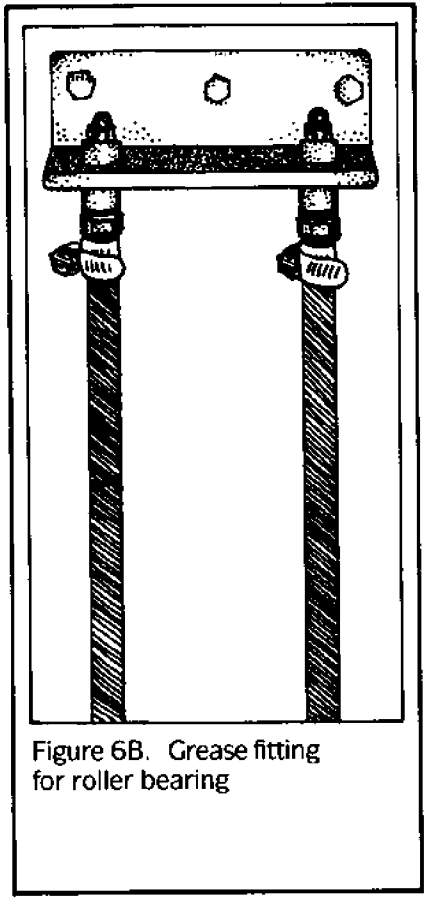

Figure 6B. Grease fitting for roller bearing

per tubing, or, less frequently, of reinforced nylon. If copper tubing is used, make sure it is connected to the bearing with a flexible line (approximately one foot long), which can absorb vibration. Without a flexible line, the rigid copper tubing will break at the fitting on the steady bearing block. If the break goes unnoticed, the bearing will recieve insufficient lubrication which will cause serious damage to both the bearing and the propeller shaft.

Once the steady bearing has been inspected and either replaced or repaired, check to make sure it is properly aligned with the propeller shaft. The alignment check should be made at the flanged coupling that connects the main shaft to the jumper shaft. Start by loosening the bolts which hold the jumper shaft coupling to the gearbox. Do not remove these bolts, as the shaft must be held loosely in place. Then place blocks under the shaft to prevent it from falling or bending should the coupling be completely separated accidentally. Now, remove the bolts holding the coupling between the propeller shaft and jumper shaft. Use a pipe wrench to turn the propeller shaft slowly. This will cause the coupling flanges to separate. Allow the flanges to separate just enough to place a feeler gauge (approximately .015 inch) between the flanges. Take

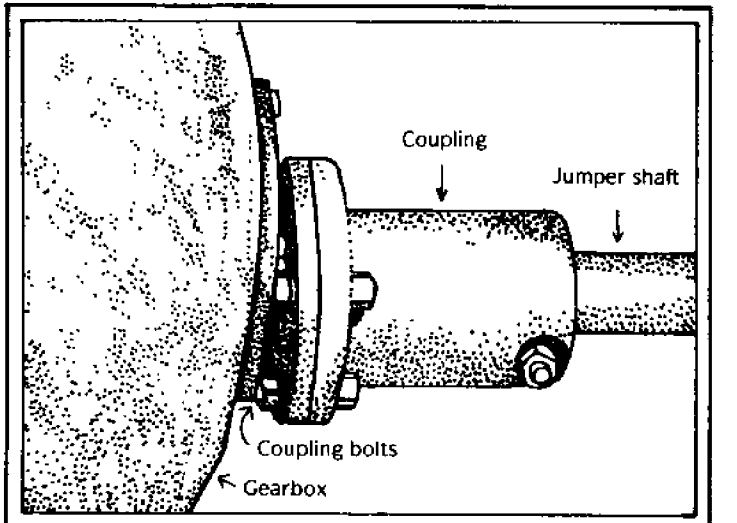

Figure 7. Side view of gearbox, coupling bolts, coupling, and jumper shaft

feeler gauge readings all around the coupling flanges. If the readings are in excess of .001 inch for every inch of coupling diameter, it will be necessary to realign the steady bearing with the propeller shaft (e.g., an 8-inch coupling = .008 inch). If your readings are within tolerance, go on to the realignment of the main engine.

MAIN ENGINE REALIGNMENT

After repacking the stuffing box and carefully checking the steady bearing, the final step is the realignment of the main engine with the propeller shaft. It takes at least two people, and preferably three, to realign the main engine. Be sure adequate help is on hand before proceeding. First, slacken the roller chain or belts driving the main winch or hydraulic pump. It is difficult to determine exactly how much slack is needed until the alignment process begins, so use your better judgement and remember it is better to have too much slack than too little. Slack is also needed in the exhaust pipes leading from the engine manifolds to the mufflers. If the flex pipe in the exhaust line is relatively new, it should allow some movement during the realignment of the engine. Also loosen the water lines at the rubber hose or flex pipe where they connect to the main engine. Next, place blocks under the propeller shaft. This will prevent the shaft from being damaged by sagging or by being stepped on accidentally. The blocks should be placed about 2 feet aft of the gearbox coupling to allow for ample working room. Using a pipe wrench, rotate the shaft and check for marks on the flanges of the coupling. These marks will have been made with a center punch or chisel. If no marks can be found, mark the coupling on both flanges before separating it, so ensuring that the coupling can be aligned properly when it is put back together.

Next, remove the bolts that hold the coupling together, and use a pipe wrench to rotate the propeller shaft. As this is done, the coupling will separate. Continue rotating the shaft until the coupling has separated completely with the flanges approximately 2 inches apart. If the coupling does not separate easily, do not attempt to spread the coupling apart with a steel wedge, as this will damage the face of the coupling. Instead, pull back gently on the pipe wrench as the shaft is rotated. Once the coupling has been separated, clean the faces of both flanges thoroughly with solvent and steel wool until all grease, rust, and nicks are removed and the flanges are clean and smooth to the touch.

Before realignment, remember that the engine aligns to the shaft - not the shaft to the engine. With this in mind, the next step is to find the approximate midpoint of the propeller shaft. First, rotate the shaft with forward pressure on the pipe wrench until the coupling flanges are about 1/4 inch apart. Remove about 2 inches of blocking from under the shaft. Raise the shaft by hand until strong resistance is felt, then

lower the shaft until all resistance is relieved. Keep doing this until you get a feel for the midpoint. Place blocks under the shaft to hold this position.
Remove about 2 inches of blocking from under the shaft. Raise the shaft by hand until strong resistance is felt, then lower the shaft until all resistance is relieved. Keep doing this until you get a feel for the mid-point. Place blocks under the shaft to hold this position.

Rotate the shaft again using the pipe wrench and forward pressure until the coupling goes together. If it doesn't, it is because the male and female connections are not matching up. In this case, the engine will have to be moved to allow the connections to fit properly. To do this, begin by loosening the hold-down bolts on the engine mounts. Do not remove them altogether, however. It is possible that the engine has jacking bolts built into the mounts. If so, use them to raise or lower the engine. However, if the engine does not have jacking bolts, a hydraulic jack can be used. By jacking or prying sideways, adding or removing shims, the engine can be moved, allowing the coupling to go back together.

After making sure the male and female coupling connections match, use two C-clamps or coupling

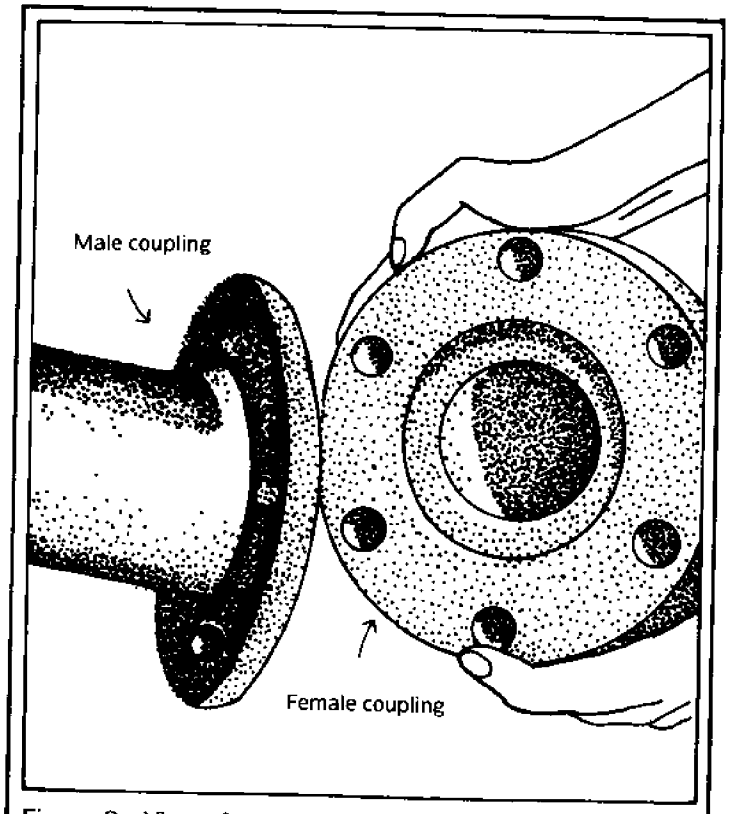

Figure 8. View of male and female couplings

bolts to pull the coupling to within .015 to .020 inch. Using a feeler guage, take a reading at the closest point between the two flanges. Note: If coupling bolts were used to pull the coupling together, remove them at this point so readings can be taken all the way around the coupling. Once the closest point has been found, make a note of it and then find the widest point and take a reading there. The difference between these two readings shows how far the engine is out of alignment. To correct the alignment, add shims (ranging in thickness from .010 to .020 inch) under the appropriate motor mounts or remove them as necessary until the difference between the two readings has been accounted for. This is a trial-and-error process, and work can't be accurately checked until the hold-down bolts have been securely tightened and a true coupling alignment reading can be made. The shim arrangements may have to change several times in order to reach a tolerance of .001 inch for every inch of coupling diameter. Once tolerance (or less) is reached, bolt the coupling together with SAE fine thread, case-hardened machine bolts and new lock washers.

Engine realignment involves a sequence of steps, each of which must be carefully completed before continuing to the next. It is important to realize that the steps are interrelated and failure to correctly carry out any of the steps in the sequence will compromise the entire alignment procedure. Just remember to be very precise and very patient.

Please refer any questions to:

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NOTE: The descriptions and illustrations contained in this brochure are the best judgements of the University of Georgia Marine Extension Service on effective and appropriate techniques for power train realignment. However, there is no express or implied certification that such descriptions and illustrations assure proper and safe power train realignment.

UPD 9752/7-88