

# FOR THOSE WHO TRAVEL THE WATERS OF THE WORLD...



## **DURAMAX** PROPELLER SHAFT SEAL SYSTEM

*The clean, low maintenance alternative  
to messy stuffing boxes*



## **DURAMAX® MARINE**LLC

17990 Great Lakes Parkway  
Hiram, OH 44234

**PHONE** 440.834.5400

**FAX** 800.497.9283 USA & Canada  
or 440.834.4950

**E-MAIL** [info@duramaxmarine.com](mailto:info@duramaxmarine.com)  
**WEB** [www.duramax-marine.com](http://www.duramax-marine.com)

# **MEMO:**

FROM: DURAMAX® MARINE LLC

TO: ALL PLEASURE AND COMMERCIAL BOAT AND  
SHIP OWNERS, DEALERS, DESIGNERS AND  
MANUFACTURERS

YOU'VE REQUESTED MORE INFORMATION ABOUT THE  
REVOLUTIONARY DURAMAX PROPELLER SHAFT SEAL  
SYSTEM. AND HERE IT IS!

WHETHER YOU TAKE YOUR FAMILY FOR AN OUTING  
ON A NEARBY LAKE...OR DESIGNING A FLEET OF  
COMMERCIAL FISHING BOATS ON THE OPEN SEA,  
WE'VE GOT A DURAMAX SHAFT SEAL SYSTEM THAT'S  
JUST RIGHT FOR YOUR INBOARD PROPULSION VES-  
SEL. EASY TO INSTALL RETROFIT...OR O.E.M.

READ ON FOR ALL YOU NEED TO KNOW TO ORDER  
YOUR ENVIRONMENTALLY-FRIENDLY DURAMAX SHAFT  
SEAL SYSTEM.

# **DURAMAX<sup>®</sup>** **PROPELLER SHAFT SEAL SYSTEM**

Over the years, we have tested many different seal designs to find a clean, quiet, maintenance-free, environmentally-friendly alternative to stuffing boxes and other types of shaft seals. This booklet provides you with information about shaft seals and how they work. It will help you make an informed decision when selecting a shaft seal system for your propeller shaft.



*AT DURAMAX MARINE, OUR GOAL IS KEEPING BOATS ON THE WATER...*

# THE HISTORY OF STUFFING BOXES AND HOW THEY WORK

## STUFFING BOXES

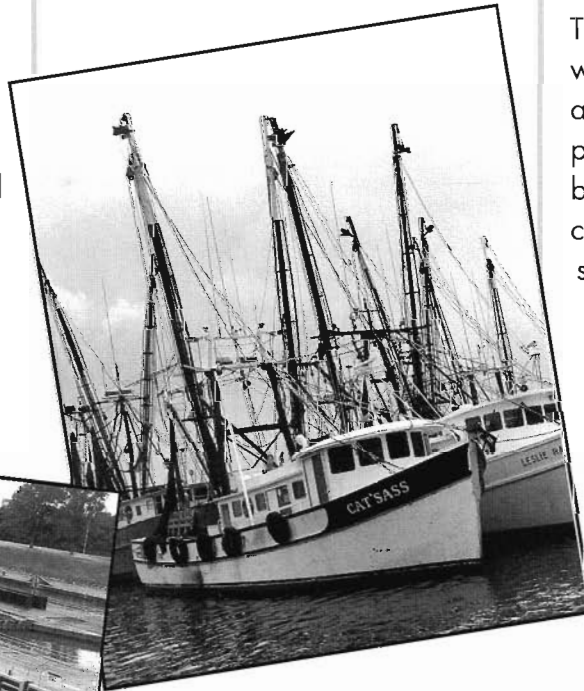
Many of the traditions of going to sea are still alive today. An old tradition that remains in use is the stuffing box or packing gland that is used to seal the propeller shaft where it enters your vessel. This 16th Century design was originally developed in Holland for use in pumps operated by windmills. The windmills pumped salt water from wetlands being reclaimed from the sea. Packing glands made of balsa wood that were wrapped around hardwood shafting sealed out most of the water but allowed just enough to leak through to lubricate the shaft and allow it to turn freely. This same technology is still being used today on ships equipped with stuffing boxes.

Although the stuffing box is an inexpensive and simple approach to sealing the propeller shaft, it is ineffective in keeping water out of your bilge. The stuffing box uses water to lubricate the packing and to minimize the frictional heat generated by the propeller shaft as it rotates inside the packing. It must leak to adequately lubricate and cool the propeller shaft and packing.



When the propeller shaft is at rest, the stuffing box continues to leak. This allows enough water into the vessel that a pump is required to flush the water overboard. One drip per minute equals about 50 gallons of water per week. Most stuffing boxes leak 5 to 10 drops per minute, which equals approximately 250 to 500 gallons per week.

The only line of defense for this water leakage is the bilge pump and the electrical system that powers it. You are relying on the bilge pump, pump switch, wire connections, battery and/or shore power to keep your vessel afloat. Many boats that sink do so at the moorings. Typically, they do not sink to the bottom...just deep enough for someone to notice. However, that is deep enough to cause significant damage to the inside of the vessel including the engine.



As you use your propulsion system, the packing inside your stuffing box is wearing. Constant readjustment of the gland pressure on the packing is required to compensate for this wear and to control the amount of water leakage and frictional heat build-up. This continuous wear eventually requires you to repack your stuffing box. Stuffing boxes require constant maintenance, and many vessels are designed without considering this maintenance requirement.



Consequently, they are built without allowing sufficient room to access the stuffing box, which makes it difficult to do the required maintenance.

In addition to packing wear inside the stuffing box, the packing also wears the propeller shaft. The amount of propeller shaft wear depends on the type of packing, gland pressure, frictional heat build-up, the type and quantity of lubricant, the amount of contaminants that become imbedded in the packing and the frequency of maintenance. Eventually, the wear becomes so severe that the shaft needs to be repaired or replaced.

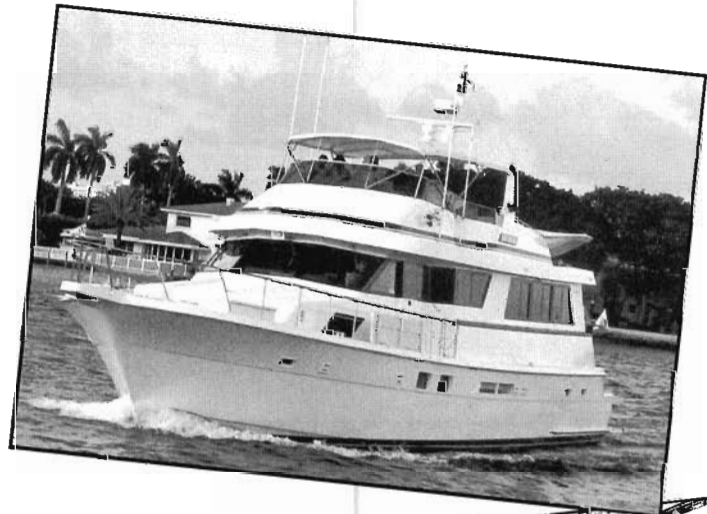
Packing and shaft wear are such a serious problem with stuffing boxes that manufacturers have developed packing that is impregnated with oil and other lubricants to help reduce wear. Also, many stuffing boxes are equipped with grease fittings that allow you to inject grease to help lubricate the packing.

These solutions create another problem. The water that enters the bilge through the stuffing box mixes with oil and grease and becomes severely contaminated. When your bilge pump comes on, it pumps this contaminated water overboard. This can be very expensive! The Federal Water Pollution Control Act

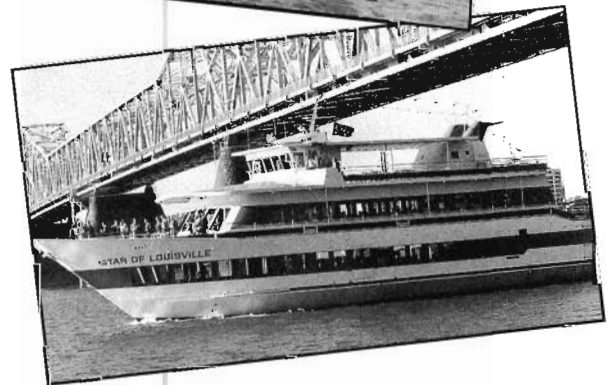
## THE DURAMAX SHAFT SEAL SYSTEM SAVES YOU MONEY

causes a sludge or emulsion beneath the surface of the water." Oily discharges from your boat can lead to federal water pollution fines of up to \$25,000.

Ships should be dry on the inside and the water should remain on the outside. With today's technology, dripless shaft seals are making this possible. Known as mechanical seals, the "face seal" and the "lip seal" are the most common.



prohibits the "discharge of oil or oily waste into or upon the navigable water of the United States or the waters of the contiguous zone if such discharge causes a film or sheen upon or a discoloration of the surface of the water or



## THE DURAMAX SHAFT SEAL SYSTEM IS A LEADER IN SHAFT SEAL DESIGN

### MECHANICAL FACE SEALS

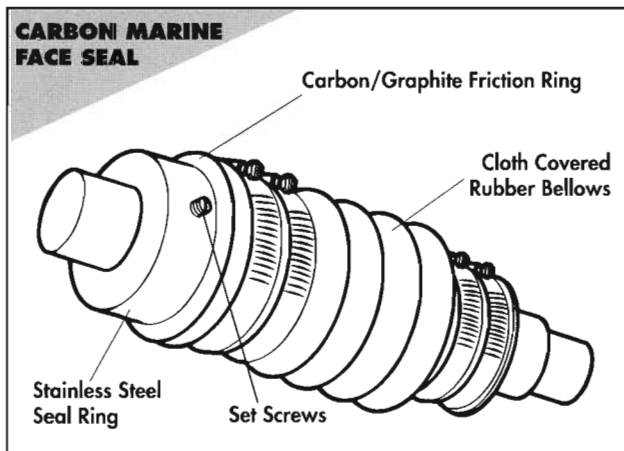
The most popular mechanical seal used on rotating propeller shafting is the face seal. Two finely-machined surfaces or faces are located perpendicular to the shaft and are pressed together to form a seal. One face surface—the seal ring—is attached to and turns with the propeller shaft. The other face surface—the friction ring—is part of the seal body. It remains stationary and does not turn with the shaft. The seal ring and the friction ring are arranged so that they are always in contact with each other. The seal body is normally a compressed rubber bellows or spring-loaded bellows that forces the stationary friction ring against the rotating seal ring. This creates a very effective and leak-proof seal.

The friction ring and the seal body have an inside diameter larger than the propeller shaft diameter. This prevents the propeller shaft from hitting the seal body and causing leakage through the seal faces. This also allows for shaft misalignment, excessive dimensional runout and vibration in the propulsion system.

Since face seals do not use the propeller shaft as a sealing surface, you do not have shaft wear caused by the packing in stuffing boxes or the rubber lips found in lip seals. Also, the shaft is allowed to rotate with less resistance, which increases fuel economy and helps provide better propulsion system performance.

Due to the simplicity of the face seal design, most marine face seals available on the market today are excellent dripless shaft seals. The difference among them are the method of installation and removal, type of materials used and design features.





( figure 1 )

### CARBON FACE SEALS

Carbon face seals (fig. 1) are one of the earliest examples of a face seal adapted to the marine environment. They work but have several design features that can cause problems.

The seal face consists of carbon graphite, which is brittle and subject to chipping, scratching or pitting. This can result in leakage and seal failure. Carbon graphite used in salt water can create galvanic corrosion of the stainless steel shafting materials. Stainless steel shafting manufacturers advise against the use of carbon graphite with stainless steel shafting.

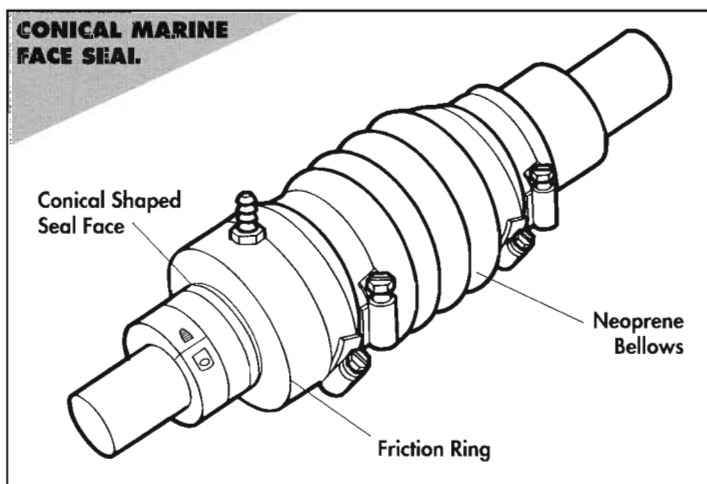
The seal ring design of the carbon face seal makes it very difficult to install or remove. Embedded in the inside diameter of the seal ring are two O-rings that keep water from leaking past the seal ring into the vessel. The seal ring inside diameter is only slightly larger than the diameter of the propeller shaft. This close tolerance between the shaft and

seal ring requires careful installation or you could damage these O-rings by cutting them on the key-way slots. If you damage the O-rings, there will be leakage through the inside diameter of the seal ring. Also, if there is galling or marking on the shaft, the seal ring cannot be installed without first polishing the shaft.

The seal ring is secured to the propeller shaft with setscrews. These setscrews are tightened into and can damage the surface of the propeller shaft. The set screws also electrically connect the seal ring to the propeller shaft and can lead to galling and/or electrolysis. If the seal ring galls to the shaft, it must be cut into pieces to remove it.

### CONICAL FACE SEALS

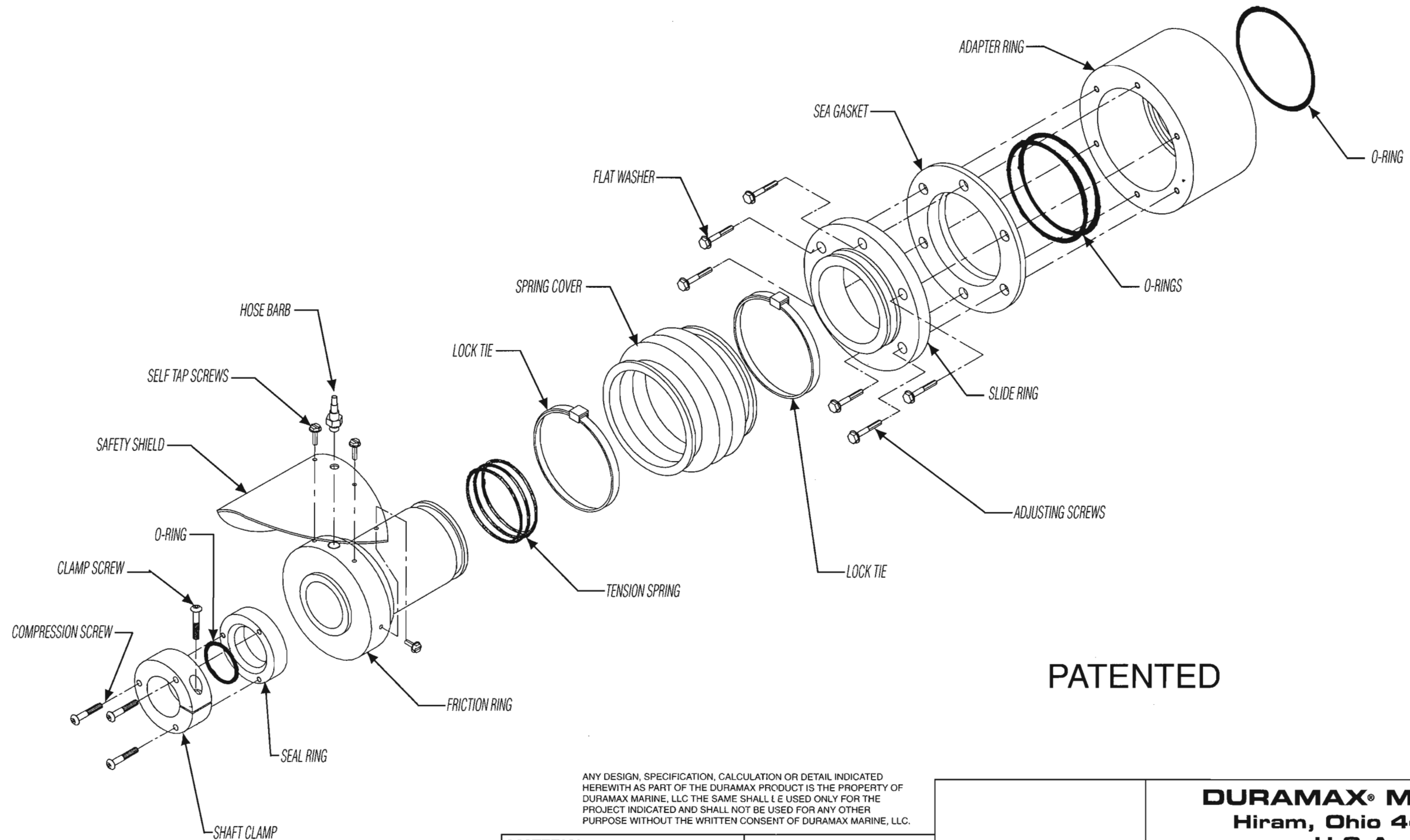
Conical marine face seals (fig. 2) are also available for marine applications. These face seals have a seal ring with a beveled face and a mating friction ring with a counter bevel. Any vibration or misalignment will cause the conical face to wear into an oval or elliptical shape. This prevents the seal from seating correctly, causing it to leak. These seals work in low RPM applications, but for most marine applications, the propeller shaft RPM is too high and there is too much propulsion system movement for this type of face seal to operate properly.



( figure 2 )

REVISIONS

REV	DESCRIPTION	DATE	APPROVED



PATENTED

ANY DESIGN, SPECIFICATION, CALCULATION OR DETAIL INDICATED HEREWITH AS PART OF THE DURAMAX PRODUCT IS THE PROPERTY OF DURAMAX MARINE, LLC THE SAME SHALL NOT BE USED FOR ANY OTHER PROJECT INDICATED AND SHALL NOT BE USED FOR ANY OTHER PURPOSE WITHOUT THE WRITTEN CONSENT OF DURAMAX MARINE, LLC.

<b>MATERIAL</b>	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONS ± ANGLES ± 3 PLACE DIMENSIONS ± 2 PLACE DIMENSIONS ±
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<b>DURAMAX® MARINE</b> Hiram, Ohio 44234 U.S.A.			
DURAMAX SHAFT SEAL EXPLODED VIEW			
PREPARED	EKP	SIZE	CODE SL-18
CHECKED	JSL	B	41000000
APPROVED		DWG. NO.	841000000
		SCALE	NONE
		DATE	9-09-94
		SHEET	
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# THE DURAMAX SHAFT SEAL SYSTEM IS THE ONLY CHOICE

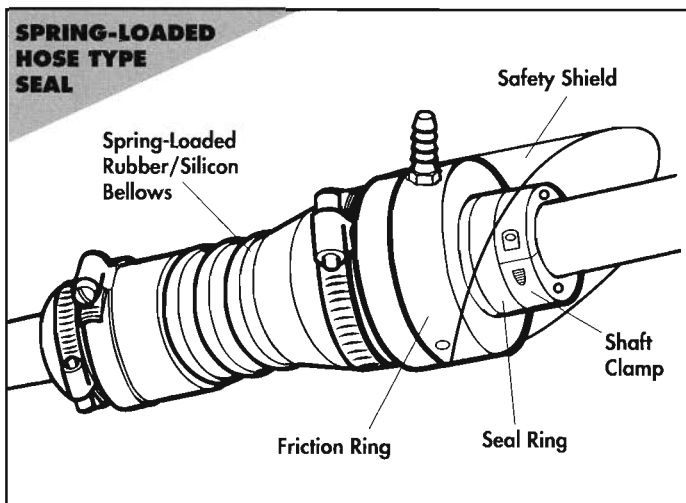
## BELLOWS TYPE FACE SEALS

Both the Carbon Face Seal (fig. 1) and the Conical Face Seal (fig. 2) use a convoluted rubber bellows as the seal body and to maintain the required pressure on the seal faces. When a rubber bellows is used as a spring, the seal depends on the compressibility and durometer (hardness) of the rubber to maintain pressure at the faces to create the seal.

The physical properties of rubber, regardless of type, are affected by temperature, environment and age. As the aging rubber loses its physical properties, the amount of pressure on the seal face decreases. This can result in seal leakage and requires you to adjust the face pressure by adding additional compression to the rubber bellows or eventually replacing the rubber bellows. In addition, as rubber ages, it becomes less compliant and brittle to the point where it will deteriorate, crack and leak.

Several face seal manufacturers have recognized this problem and have incorporated fabric reinforcement in an attempt to assist with structural strength. Also, several manufacturers have molded a spring into their rubber bellows (Fig 3). This is an improvement over the convoluted rubber bellows because the spring maintains a constant pressure on the seal faces for the life of the seal. However, it does not eliminate the aging process of the rubber itself.

Another problem with bellows-type face seals is that the flexibility of the bellows can allow the seal faces to be accidentally knocked off their seat or sealing surfaces which will allow a major leakage of water into the vessel. Also, any bellows-type seal uses the bellows as the only barrier between you and the sea. If the bellows should fail or be damaged, a serious leakage situation will occur.



( figure 3 )

## LIP SEALS

Another common type of mechanical seal used on rotating propeller shafting is the lip seal (fig. 4). Lip seals are similar to stuffing boxes in that they utilize the propeller shaft as a sealing surface. A rubber ring with a lip on the inside diameter fits over the propeller shaft. The tight interference fit between the rubber lip and the propeller shaft ensures continuous contact and creates a seal.

In order for the lip seal to operate properly, the propeller shaft must be very smooth. If the shaft is pitted or marred, it will damage the lip seal or will not allow a proper fit of the lip seal to the shaft. This will result in leakage through the lip seal.

The rubber lip seal is not a very effective solution for sealing marine propeller shafts. As the propeller shaft turns, frictional heat is created which causes the rubber lip seal and propeller shaft to wear... leading to eventual leakage through the lip seal.

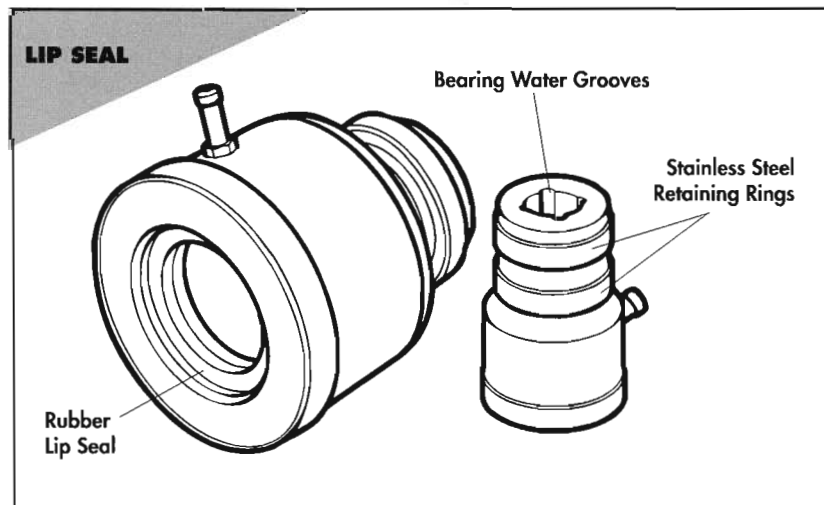
Shaft wear can be severe when using a lip seal with stainless steel shafting material. Stainless steel has great tensile strength but due to its high nickel content, it has low resistance to abrasion. Another problem when using a rubber lip seal with stainless steel shafting is crevice corrosion. The tight interference fit of the rubber lip to the stainless steel shaft results in oxygen deprivation of the stainless steel and the shaft cannot oxidize to protect itself. This results in a groove being etched into the shaft...causing the lip seal to leak.

Propeller shaft misalignment and shaft line vibration will cause lip seals to leak. One lip seal manufacturer has tried to solve this problem by incorporating into his design a propeller shaft bearing to assist with reducing the shaft line vibration that causes seal leakage.

*THE DURAMAX SHAFT SEAL SYSTEM  
KEEPS YOUR BOAT DRY*

Several types of lip seals are available for sealing marine propeller shafts. They vary in the number of rubber lips used per seal assembly and the type of lubricant used. One type uses a single lip with water lubrication. Another type uses a double lip seal lubricated with transmission fluid. This seal has a reservoir of more than 16 ounces of transmission fluid. As the seal wears, transmission fluid can leak out into the seawater which could result in federal water pollution fines.

( figure 4 )



# THE DURAMAX SHAFT SEAL SYSTEM IS BETTER BY DESIGN

## THE DURAMAX SHAFT SEAL SYSTEM

The design evolution of the Duramax Shaft Seal System (fig 5) has taken into account the numerous problems associated with other types of shaft seals used in marine environments. Its engineered design provides solutions to these problems. Please read this section and learn why we feel the Duramax Shaft Seal System is a better design and the best choice for your shaft seal requirements.

## THE FRICTION RING

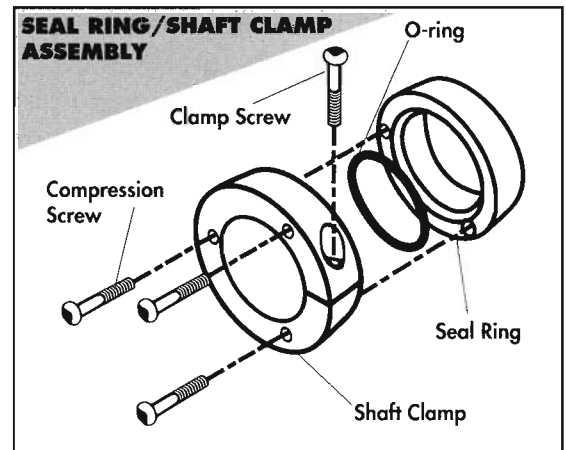
The Duramax friction ring is the stationary part of the seal face. It is made of impact-resistant, high

temperature, oil-impregnated nylon that is impervious to shock or blows. It can withstand high temperatures up to 350 degrees Fahrenheit. This material eliminates the galvanic corrosion and brittleness problems associated with carbon graphite materials.

## THE SEAL RING/SHAFT CLAMP ASSEMBLY

The Duramax Seal Ring/Shaft Clamp Assembly is a unique two-piece design that allows easy installation, removal and electrically isolates the seal ring from the propeller shaft.

A non-conductive Delrin\*\* shaft clamp is utilized to attach the assembly to the propeller shaft. It is a true split clamp design that does not gall or mark the shaft when it is clamped in place.



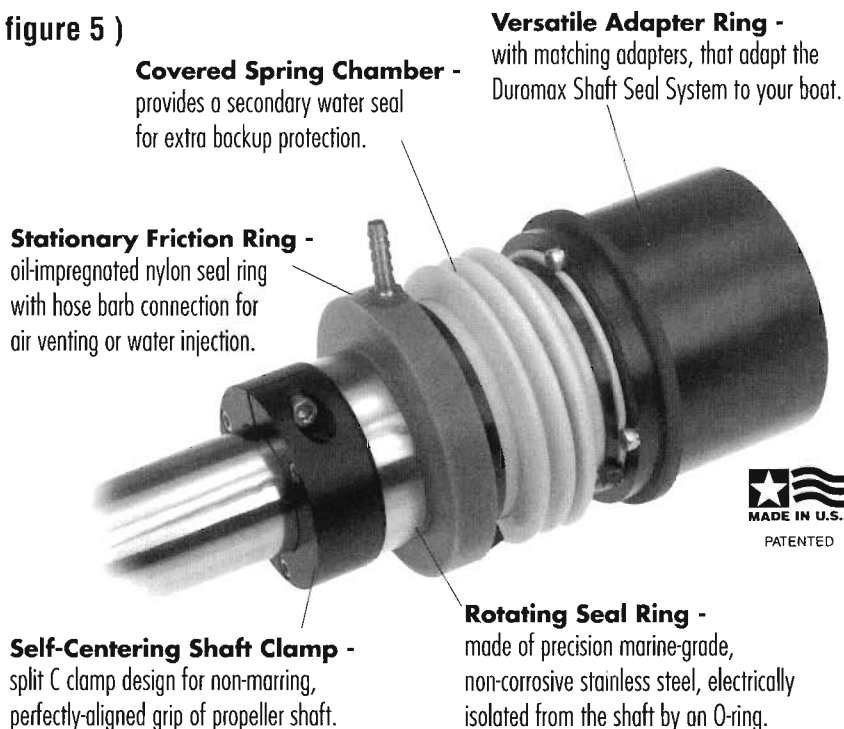
( figure 6 )

Plus, it opens large enough to slide over the propeller shaft even if it is galled or pitted! The 316 stainless steel seal ring is designed with the inside diameter machined 0.015 inches (0.38mm) larger than the propeller shaft. It has a 45-degree bevel machined in the inside diameter which allows an O-ring to be compressed into the slope when the seal ring is attached to the shaft clamp. (Fig.6).

The Duramax Shaft Clamp/Seal Ring design electrically isolates the stainless steel seal ring from the propeller shaft and eliminates the galling of the seal ring to the propeller shaft. Also eliminated is the damage caused by attaching the seal ring to the propeller shaft with setscrews.

\*\*Delrin is a registered trademark of E.I. DuPont De Nemours & Co. (Inc), Wilmington, Delaware

( figure 5 )



## MAIN BODY SEAL

Most mechanical seals use a rubber bellows or spring-loaded rubber/silicone hose to connect the seal to your boat. This type of connection works; however, it is the weakest point of the seal assembly. If the bellows or hose is punctured or if the material weakens or fails, large amounts of water will enter the vessel. Also, severe leakage will occur if someone steps on the seal body or accidentally displaces the seal off center.

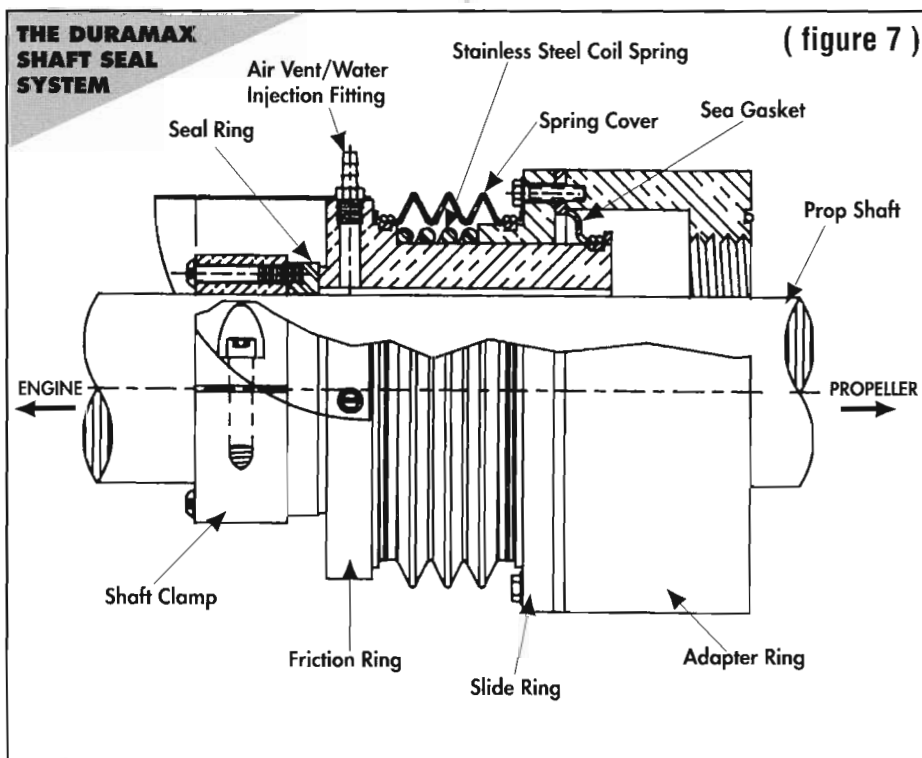
chamber (fig. 7). This special design feature provides a secondary seal to the main body seal and would prevent the entry of seawater into the vessel.

## TENSION SPRING

In order for a mechanical face seal to work properly, face tension or pressure must be placed on the rotating seal ring and the stationary friction ring. This tension creates the seal between the two faces. Mechanical face

## ONLY THE DURAMAX SHAFT SEAL SYSTEM HAS BACK UP PROTECTION

associated with rubber bellows by utilizing an engineered 316 stainless steel coil spring. The spring diameter and number of coils have been designed and tested to provide the proper face pressure that creates a reliable seal and ensures a long wear life of the seal faces.



The Duramax Main Seal Body has been designed to eliminate the use of a rubber bellows or spring-loaded hose. It employs a rigid, spring-loaded, composite body that cannot be knocked off the seal face. The main seal body is attached to an adapter ring by a neoprene sea gasket. If this sea gasket were to fail, the sea water would enter the sealed spring

seal manufacturers who utilize a rubber bellows rely on the compressibility and durometer of the rubber to maintain the face tension. As the rubber ages and loses its physical properties, the amount of face pressure decreases, which affects the reliability of the seal.

The Duramax Shaft Seal System eliminates the problems

## AIR VENT/WATER INJECTION FITTING

In order for a mechanical face seal to work correctly, a thin film of water is required between the two seal faces. This water film acts as a lubricant, carries away frictional heat and maintains the proper seal face temperature. Every Duramax Shaft Seal System has an air vent/water injection fitting. This design feature ensures an adequate supply of water lubrication at the seal face.

For a displacement hull (sailboat, trawler, etc.), the fitting is used to vent or bleed off any air trapped at the seal face, which could prevent water from reaching the seal faces.

For high-speed hulls (approximately above 12 knots), as the vessel reaches higher speeds, a vacuum can occur on the stern tube which draws the lubricating seawater outboard and starves the seal faces. In these types of installations, the fitting is used to inject water to the seal faces.

## CHOOSING THE RIGHT DURAMAX SHAFT SEAL SYSTEM

### DURAMAX ADAPTS THE SEAL TO YOUR BOAT

The Duramax Shaft Seal System is manufactured in the U.S.A. and is available for shafts from 3/4 to 6 3/4 inches diameter. They are easy to install for the O.E.M. or retrofit installations.

Duramax has designed and developed a series of mounting adapters for flanged, hose connection, stern tube and thru hull installations. These adapters allow us to adapt the Duramax Shaft Seal System to your ship rather than you adapting your ship to our seal. This reduces installation time and saves you money.

For production boat builders, Duramax has additional design options not shown in this booklet. Contact us for more information on these options.

Choosing the right Duramax Shaft Seal System for your vessel is easy. You will find product specification data sheets in the back pocket of this information booklet.

Locate the data sheet coded "DXU" and look in the left-hand column for your shaft diameter. Right next to the shaft diameter listing is the part number for the Duramax Shaft Seal Assembly.

Now, select the proper adapter for your stern tube or deadwood attachment by looking at the adapter data sheets. You will need to know the outside diameter size of your stern tube and the space available from the aft end of your shaft coupling to the forward end of the stern tube.

### THE DURAMAX SHAFT SEAL ADVANTAGE

The marine industry is becoming aware of face seals for sealing propeller shafts. Every other industry that once used packing glands now uses face seals. You find them in pool pumps, automobile water pump, air conditioners and jet engines, etc. Nobody wants a spinning shaft to leak. That is why the maintenance-free Duramax Shaft Seal System is becoming more and more prevalent throughout the marine industry.

With the Duramax Shaft Seal System, say "goodbye" to the costly maintenance of your stuffing box and repairs of worn propeller shafts. You can stop worrying about expensive water pollution fines because the Duramax Shaft Seal System keeps your bilge dry and the water around your boat clean!

Find out for yourself! When you replace your old, leaking stuffing box with a Duramax Shaft Seal System, the water in your bilge and seal maintenance will be history. We know—we designed it that way!

Our sales engineers are ready to answer your questions and provide assistance with selecting the Duramax Shaft Seal System. Please call us at 440-834-5400 or FAX us at 440-834-4950, or visit our website, [www.duramax-marine.com](http://www.duramax-marine.com).



## **DURAMAX® MARINE BEARINGS**

Johnson Cutless® Sleeve Bearings  
Johnson Cutless® Flanged Bearings  
Johnson Cutless® Demountable Rubber Stave Bearings  
Romor® I Bearing Staves  
Romor® Segmental Housings  
Duramax® "490" Rudder Bushings  
Duramax® Industrial Bearings



## **DURAMAX® MARINE HEAT EXCHANGE SYSTEMS**

Johnson Demountable Keel Coolers  
DuraCooler® Keel Coolers  
Box Coolers



## **DURAMAX® MARINE FENDERING SYSTEMS**

Johnson Commercial Dock Bumpers  
Johnson Tow Knees  
LINERITE®\* II composite batterboard systems  
Johnson Weatherstrip Door Gaskets,  
Window Channel and Hatch Cover Gaskets

\*LINERITE® is a registered trademark of the BF Goodrich Company



## **DURAMAX® MARINE SEALING SYSTEMS**

Duramax® Shaft Seal System  
Johnson Stuffing Boxes  
Duramax® "Strong Boy" Stern Castings and Stuffing Boxes

17990 Great Lakes Parkway  
Hiram, Ohio 44234 U.S.A.

PHONE 440.834.5400

FAX 800.497.9283 USA & Canada  
or 440.834.4950

E-MAIL [info@duramaxmarine.com](mailto:info@duramaxmarine.com)

WEB [www.duramax-marine.com](http://www.duramax-marine.com)

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