Approaches to Prevent Outboard Motors From Flipping Into Boats After Striking Floating or Submerged Objects

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PropellerSafety.com

Supplement #1

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This paper is for informational purposes only.
This paper is NOT professional advice for those considering modifying any boat(s) or marine drive(s) with any devices.

Forward

Welcome to the first supplement to the third edition of our inventory of ways to prevent outboard motors from breaking off and flipping into boats when striking submerged objects or in rough water. The list includes old school approaches, modern approaches, high-tech approaches, and a few futuristic approaches.

The third edition is available online at:

http://www.propellersafety.com/wordpress/wp-content/uploads/prevent-outboards-flipping-into-boats.pdf

The third edition was published in July 2018. This 2020 supplement lists methods we have encountered since then.

Much of this supplement refers to methods and technologies patented by major marine drive manufacturers (Brunswick/Mercury Marine, Yamaha, Suzui, Honda, Yanmar). Others come from well known electronics firms in the marine business (FLIR. Furno, Navico). Still others come from well know marine suppliers (Showa, Parker Hannifin). Some are improvements to existing products (The Leash). A group of technologies and methods with potential applications to this problem come from the All Terrain Vehicle (ATV) side of Polaris.

Notable events include:

1. Numerous systems for detecting floating or sunken objects, including shallow bottoms before impact
2. More outboard manufacturers patenting ways to monitoring marine drive impacts
3. Numerous systems to automatically react to such detections and prevent impacts
4. Multiple developments from The Leash (bass boat outboard motor tether)
5. A tether design by Suzuki was found in historical Japanese Patents
6. Honda patents monitoring quick turns as an indication of near miss impacts

Mechanics of This Document

Due to the shear size of the third edition, we elected to publish a supplement instead of creating a fourth edition.

This document will not go back and discuss the details of the problem, the process by which outboard motors break off and flip into boats, or previously published methods of preventing outboard motors from entering boats. It relies on the third edition to cover those issues and much more.

This supplement lists methods and approaches designed to mitigate or prevent outboard motors from breaking off and flipping into boats not listed in the third edition. It also identifies additional technologies potentially useful in preventing the problem. Some of these technologies previously existed, others have come into fruition since the third edition was published in July 2018.

This document uses the same headings and numbering system as the third edition. Only the sections for which additional material have been identified will be listed.

Table of Contents

Proposed Solutions to Prevent Outboards From Flipping Into Boats Supplement 1

Section numbers below are consistent with those used in the third edition for these particular categories. Section 2G is a new category.

Note: Figure numbers begin with S1 to signify they are in the first supplement

1A2. Tilt Cylinder Provides Two Stage Damping (at top or at bottom)

Another Mercury Marine Two Stage Cylinder

Our third edition contained early Mercury Marine patents for two stage cylinder designs that allow the drive to clear the object before maximum damping loads were applied by the tilt cylinder.

A 2017 presentation by Mercury Marine to the Western Dredging Association[1] revealed a two stage cylinder design we had not previously seen. Like some others, it uses a spring loaded washer on the rod end to cover or restrict fluid trying to enter the piston relief valves once the drive clears the object.

In this instance, it appears that once the piston contacts the washer the direct holes the fluid enters the top of the piston through are blocked. Now fluid is forced to exit the rod end via a more tortuous path through the side of the piston. It also appears they may not be using all the relief valves after the washer blocks flow through the top of the piston. If Mercury is doing this, it allows them to set two separate relief valve pressures. They could use a lower setting for the spring type relief valve for those that get blocked off, and higher setting for those still in use after the washer comes down.

Figure S1-1A showing Mercury's more recent two stroke tilt cylinder design comes from their 2017 presentation.

Showa

We identified another early Showa 2 stage cylinder patent, **Japanese Patent Application JPH01282088**, published 13 November 1989.

This patent has a very strong resemblance to the Brunswick device described above and shown in **Figure S1-1A**.

Showa uses a piston containing one check valve and multiple relief valves. It incorporates a traditional memory piston, plus an "ashtray" shaped spring loaded washer inside the cylinder on the rod end. Just as in the Brunswick design the washer is designed to cover all the relief valve inlets about the same time the drive clears the water. One relief valve inlet is still accessible via a tortuous path (causing the pressure to rise again making double hump pressure curve.

Sketches of Showa's Japanese Patent Application are shown in **Figure S1-1B**. Showa's patent application was rejected over a decade after it was filed.

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[1] Mercury Marine - Dredge Pipeline Hazards. Proceedings of the Dredging Summit & Expo 2017. June 26-29, 2017. Vancouver British Columbia, Canada. Published by the Western Dredging Association. 35 pages.

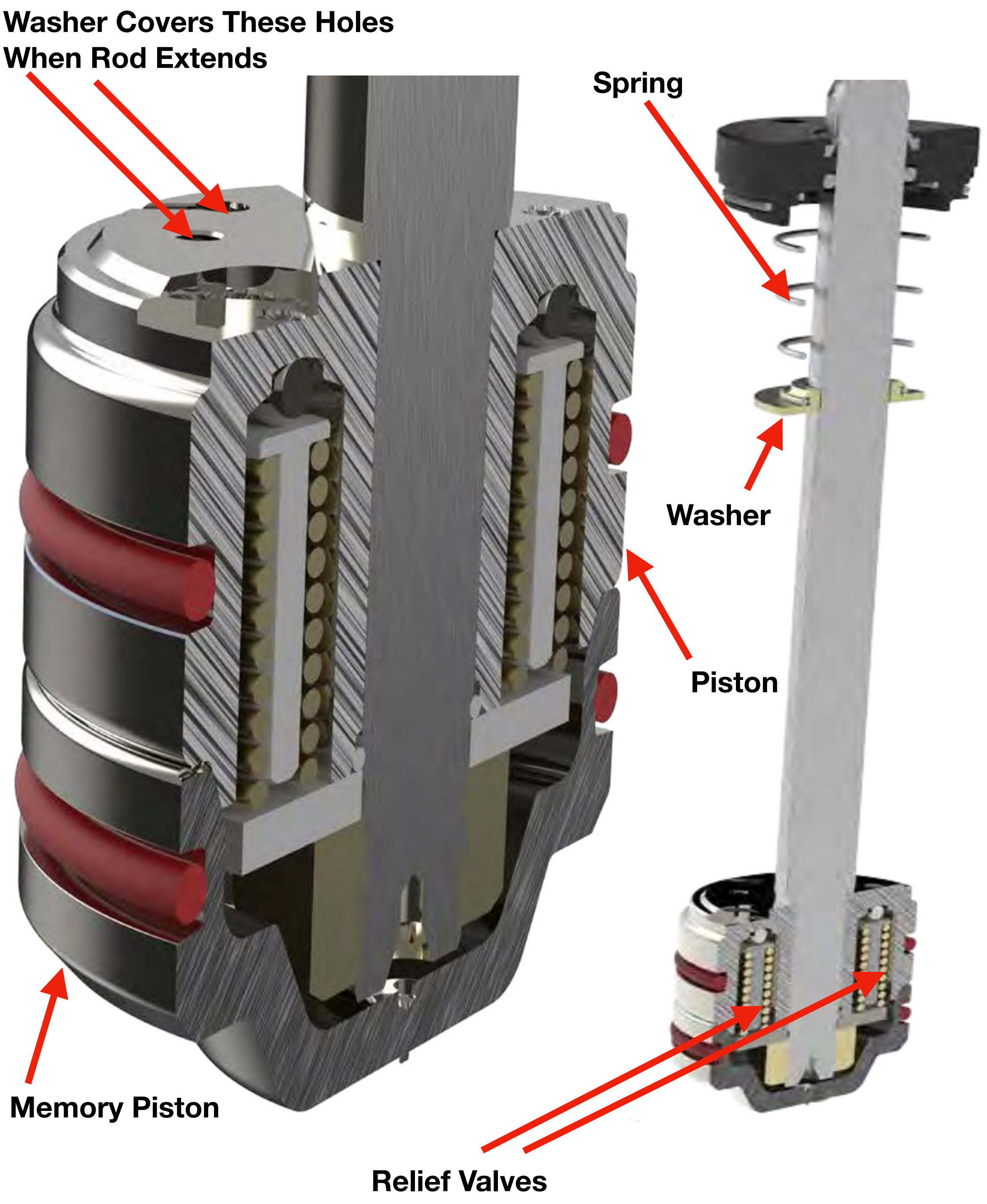


Figure S1-1A. Mercury Marine Two Stage Tilt Cylinder

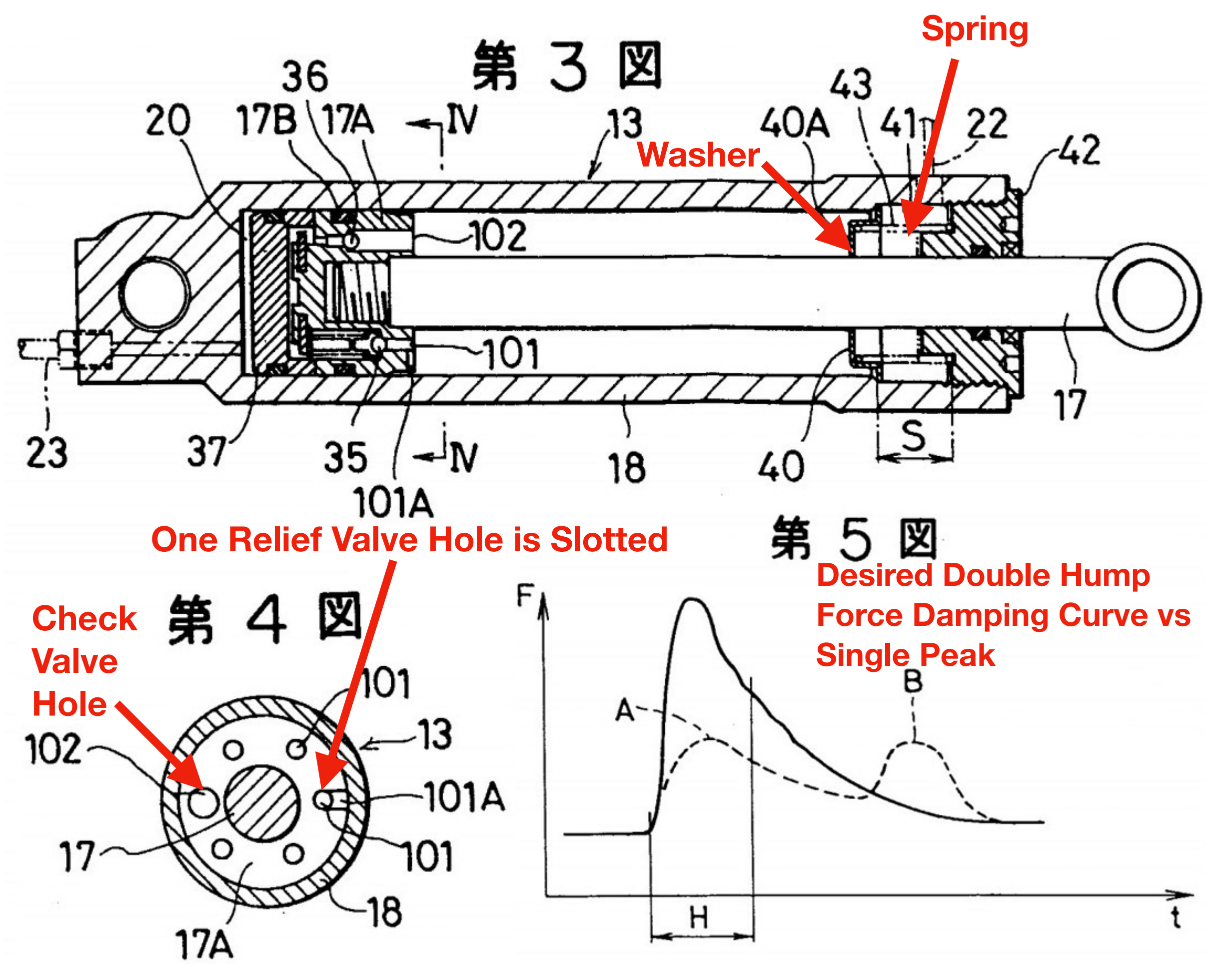


Figure S1-1B: Showa 2-stage Tilt Cylinder Patent Application
Japanese Patent Application JPH01282088

1A4. Active Control of Tilt Cylinder

This category was originally established for tilt cylinders dynamically controlled DURING a log strike to allow the drive to raise up and over the log, then apply a force profile that would protect the drive and those onboard through the rest of it's upward swing.

Meanwhile a number of systems that automatically trim / tilt the drive based on identified hazards (floating logs, submerged objects, submerged trees, stumps, rocks, shallow water, etc.) and/or a high probability of those hazards have come on the scene. Most have not yet made it to the marketplace. While these new systems do actively control the tilt cylinder, they do so before impact, not during impact. These new systems have been placed in **Section 6 Advance Detection of Imminent Impact**.

1A10. Reduce Maximum Boat Speed

For decades outboard motor manufacturers have built families of outboard motors by frame size. They use the same engine and major components to cover a range of horsepowers. This is accomplished by electronically controlling variables such as maximum engine speed, engine timing, quantity of fuel injected, and air intake. Drive manufacturers use Engine Control Units (ECUs) to control these and other variables. For example most manufacturer's 200 to 250 horsepower outboard motors of a certain technology (such as four strokes) are all of the same frame size.

OEM (Original Equipment Manufacturer) 200, 225, and 250 horsepower outboards have few differences other than the ECU chip and horsepower decals. ECU chips available on the aftermarket can increase the horsepower output of 200 or 225 horsepower outboards for a fraction of the OEM price difference to step up to a 250 horsepower outboard.

Outboard manufacturers oppose use of aftermarket ECU chips. Manufacturers say their own ECU chips sometimes limit exhaust gas and maximum speeds to meet regulations for certain destinations. We suspect profit from the steep markup for essentially the same product is another reason they do not like aftermarket ECU chips.

Suzuki

In response to the aftermarket ECU problem, Suzuki patented a method to prevent their use.

Suzuki **U.S. Patent 10,232,924 Engine Control Device and Engine Control Method**. Issued 19 March 2019.

The Suzuki patent above uses a "detecting unit" to detect the rotation of the intake side camshaft. The intake side camshaft has protrusions for discriminating between models . The arrangement or number of protrusions is different for each engine model.

Thus if an aftermarket ECU tries to change things, a sensor detects the specific protrusions to determine the actual engine model while another sensor reads the model information from ECU memory, a determining unit sees if the models match. If not a warning is generated.

This exact function is not relevant to outboard motors breaking off and flipping into boats, beyond the possibility of increasing the share of 225 and 250 horsepower outboards on bass boats. However it does illustrate capabilities of outboard motor ECUs and a means to mechanically code model information inside the outboard that is digitally readable.

More information about how these technologies might be applied are in **Section 1A10** of the third edition.

Polaris

While Polaris is well known for Personal Water Craft (PWC) and more recently for their entry into the pontoon boat market, this entry focuses on Polaris' presence in the All Terrain Vehicle (ATV) market.

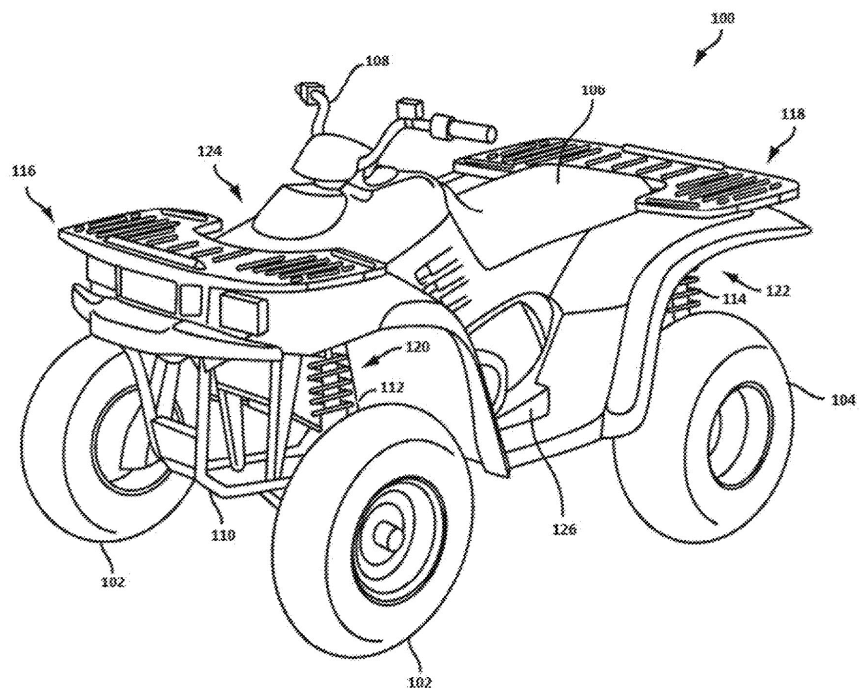


Figure S1-2: Polaris ATV patent image

In **U.S. Patent 10.086,698** Polaris teaches use an engine ECU in combination with sensors to modify vehicle performance based on sensor data. Among those sensors are seat belt sensors, safety net (cab net) sensors, throttle sensors, gear sensors, and a GPS. **Figure S1-2** comes from this patent.

Safety nets (cab nets) are basically doors made out of webbing. They are used on ATVs to prevent operators feet or legs from slipping past footrests and going outside the protected area. Safety net sensors detect presence or absence of safety nets.

The system can reduce maximum speeds if safety devices (seat belts and safety nets) are not in use, as well as based upon location (via GPS defined zones).

The system can also reduce maximum speeds based upon digital keys with transmitters. Keys can be provided with different maximum speeds. In addition maximum speed can be programmed by the user.

The system can also be used to control engine torque based on detection of the seat belt(s) being latched or not.

The system recognizes when the vehicle goes airborne based on acceleration rate of the vehicle. When the vehicle goes airborne the system reduces engine torque to reduce vehicle speed to its approximate speed before the ATV went airborne.

One unique feature is the ability to control the pitch or angle of the vehicle when airborne by speeding up the rotation of specific wheels.

Another feature of the ECU is modifying the actual position of the throttle plate with respect to position of the throttle based upon certain modes of operation. See **Figure S1-3**.

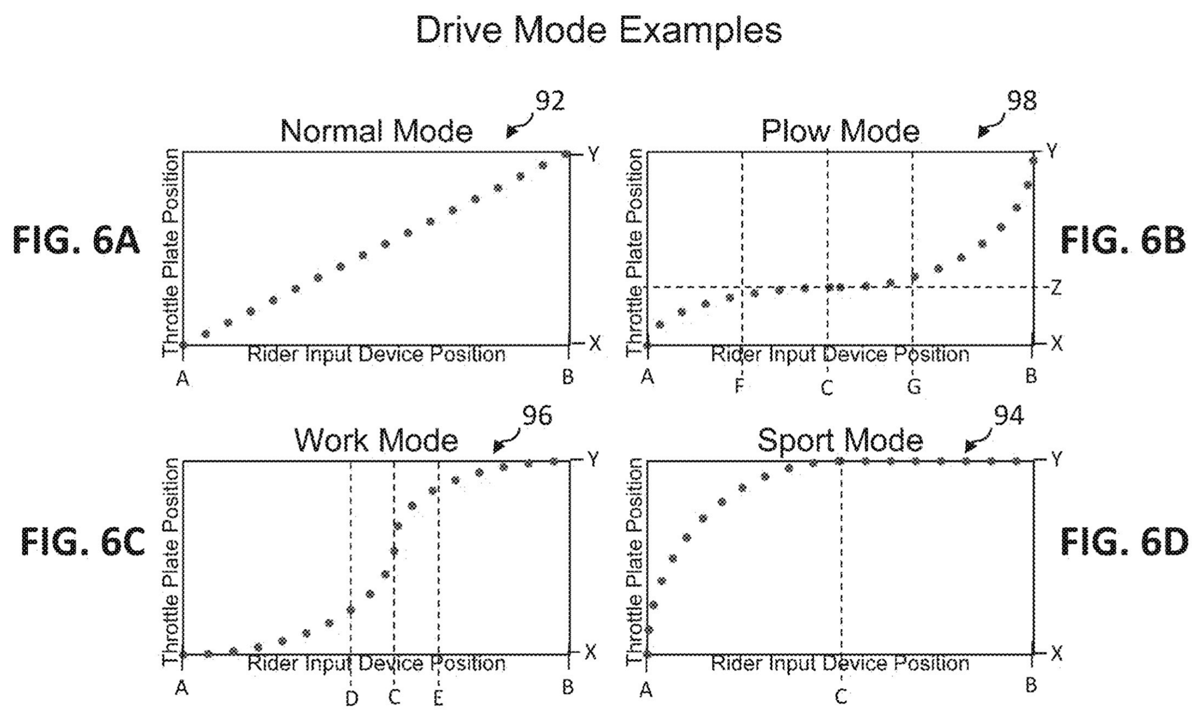


Figure S1-3: Polaris Throttle Modes

Polaris identifies these modes as Normal Mode (direct correlation between throttle position and throttle plate position), Plow Mode (flat response out in the mid range throttle positions), Work Mode (flatter response at low and high throttle positions), and Sport Mode (maximum throttle plate position is reached by midrange throttle position).

A 2019 Polaris patent application, **US2019/0389478** further develops some of the technologies discussed in Polaris' patent.

Several methods put forth by Polaris have direct application to preventing outboard motors from breaking off and flipping into boats.

For example:

1. Use of **Geofencing** to limit maximum speeds in specific areas known for debris or other hazards (dredge pipes, submerged hazards such as parts of bridges, submerged trees, areas of previous impacts, etc)

2. **The ECU requiring presence and use of certain safety devices** such as a tether, running with the rear pedestal seat in place (one designed to stop the outboard), certain breakaway components, and/or a GPS geofencing system to achieve maximum speeds.

3. **Detecting when the outboard motor has broken free and is airborne** based on its acceleration and killing the engine.

4. **Use of safety nets to catch the outboard** before it enters the boat.

5. **Use of a seat belt analogous product (The Leash)** to prevent the outboard from leaving the area it is designed to be used in.

6. **Combining Throttle Modes and limiting maximum speed**. For example something like the Sport Mode could be selected during tournament fishing for getting up on plane quickly. After a few minutes throttle response could be changed to **Normal Mode** and maximum speeds could then be limited.

Yamaha

We refer our readers to the second Yamaha patent, **U.S. Patent 8,277,266** Outboard Motor and Marine Vessel Including the Same issued 2 October 2012 discussed in **Section 5A** Kill Engine to Prevent Propeller From Rotating. We especially direct you to **Figure S1-22** in that section. Yamaha limits engine RPM, which basically limits boat velocity, based on trim angle and the force at which an impact would break something.

1B8. Use of Stronger Processes to Form the Parts

Outboard motors are often provided with different leg lengths. This is sometimes accomplished by using the same upper and lower parts with one or more driveshaft spacers between them in combination with a longer driveshaft. This allows the outboard to be mounted higher and still reach the water with its propeller.

Thin driveshaft spacers allow fine tuning the height of the propeller with respect to the water for optimum performance.

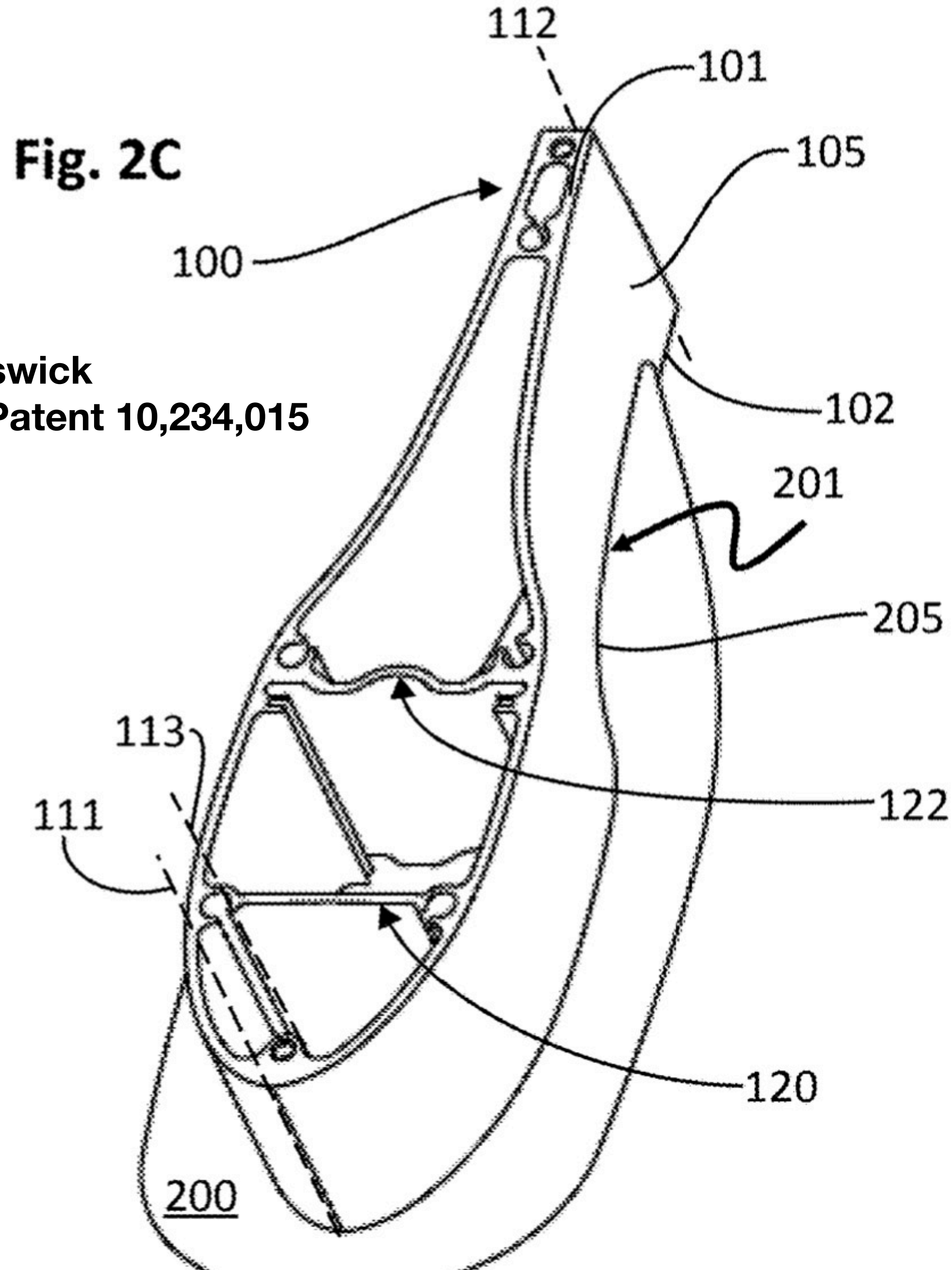
Outboard manufacturers typically cast driveshaft spacers.

Brunswick **U.S. Patent 10,234,015** Wrought Structural Component For a Marine Outboard Engine issued 19 March 2019 teaches the use of an extruded driveshaft spacer.

Brunswick says, “Cast components also generally have a limited ability to absorb impact energy. Even the best cast aluminum alloys have decreased tensile ductility compared to a wrought alloy. As a result, the components prepared by casting have a limited ability to absorb impact energy.”

Brunswick goes on to describe a particular alloy with low silicon and copper content that can be extruded to form driveshaft spacers with greater impact resistance.

Figure S1-4 shows Brunswick’s extruded driveshaft spacer welded to the spray plate along seam #201.



Brunswick
U.S. Patent 10,234,015

Figure S1-4 Brunswick Extruded Driveshaft Spacer Welded to Splash Plate. US Patent 10,234,015

1B9. Optimize Current Designs for Strength (CAE)

Outboard motor mount brackets, the heavy vertical brackets the outboard motor is attached to, must be extremely strong to survive both normal use plus drive impacts with stumps, rocks, or other objects.

Yamaha calls them clamping brackets in:

U.S. Patent 7,172,476 Outboard Motor With Bracket Assembly. Assigned to Yamaha. Issued 6 February 2007.

In the patent above, Yamaha explains "the need for a bracket assembly of an outboard motor that can be light and compact while having the necessary rigidity and strength."

To accomplish this task, Yamaha teaches the use of webbing on both sides of the motor mounting brackets as seen in **Figure S1-5**.

Webbing allows Yamaha to make the motor mounting bracket lighter and more compact while maintaining the same strength.

This creates an opportunity to increase the strength of non webbed motor brackets by increasing their overall thickness, then webbing them to reduce their weight to near that of the original non webbed brackets.

In addition to **U.S. Patent 7,172,476,** Yamaha has two design patents on webbed motor mount brackets, **U.S. D520,021** and **U.S. D520,022**,

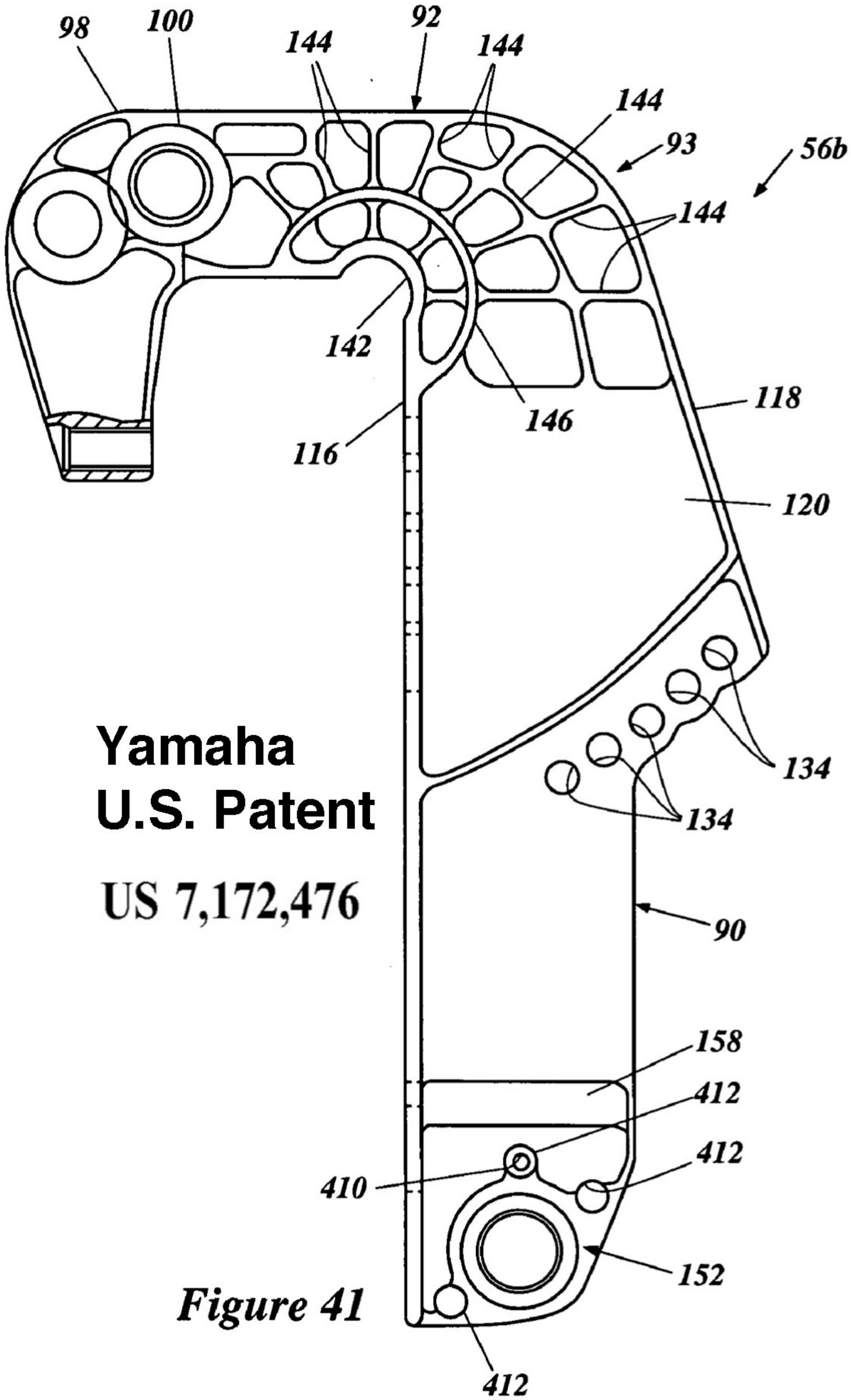


Figure S1-5: Yamaha Webbed Outboard Motor Bracket

1C1. Frangible / Breakaway Drives

Yanmar

In **JP2001001990A** published in 2001, Yanmar teaches "*When obstacles such as protrusions and drifting trees in shallow water collide with the outboard motor, the hydraulic lock is released.*" (the relief valve system begins to let the outboard raise up)

"*Problem to be Solved: To solve a problem of hydraulic lock, since the hydraulic operation is inevitably slightly delayed with respect to an impact at the time of a collision, improvements in responsiveness has been desired.*" (it takes a while for the tilt cylinder relief valve system to begin to allow the outboard to swing up).

Yanmar also states, "*improving the rigidity of the outboard motor itself so that the outboard motor is not destroyed increases the weight and makes high-speed navigation difficult. In the conventional outboard motor, a certain degree of rigidity is compromised to secure a desired ship speed.*"

Thus Yanmar proposes a frangible pin be used to connect the end of the tilt cylinder rod to the rod end. At sufficient impact the pin breaks saving the outboard and allowing the outboard to tilt up. A spare pin could be used to re-attach the rod end after the incident.

While the text of their patent uses "outboard" the images show a stern drive. However the same approach could be applied to an outboard motor.

Yanamar's approach is shown in **Figure S1-6**. Item #17 is the frangible pin.

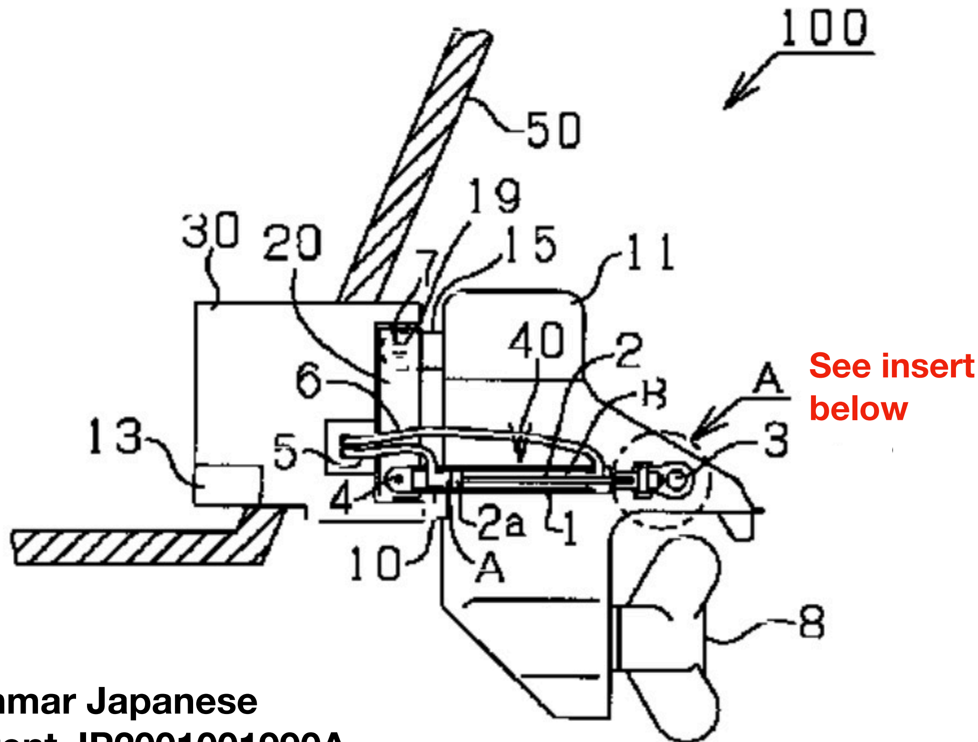
One unmentioned challenge to Yanmar's approach is the possibility of the undamped outboard motor swinging up with enough energy to break off and flip into the boat.

Blue Sky Marine

Blue Sky Marine designed a through hull drive of the nature of Brunswick's Zeus drive and Volvo Penta's IPS drive, Blue Sky Marine's drive was similarly designed to breakaway in severe impacts in a manner causing no risk to the vessel.

The basics of Blue Sky Marine's design can be seen in **U.S. Patent 9,266,593** issued 23 February 2016 as **U.S. Patent 9.809,289** issued 7 November 2017.

These two Blue Sky Marine patents also teach of using a tether to retrieve the drive if it breaks off.



Yanmar Japanese Patent JP2001001990A

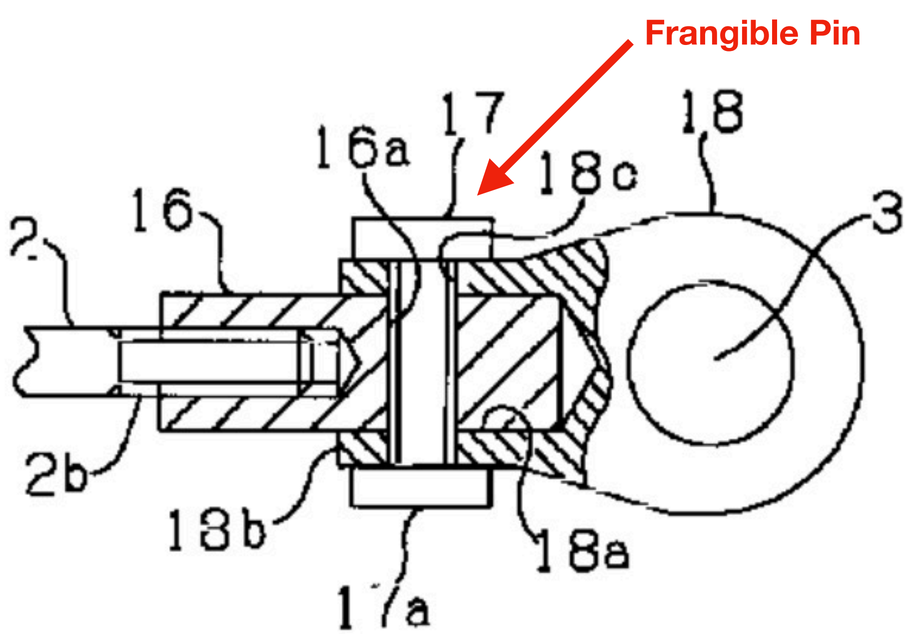


Figure S1-6: Yanmar Frangible Pin Japanese Patent

1C2 Breakaway Skeg

Suzuki introduced a breakaway skeg in their 2016 Japanese patent, **JP2016203803A**. Suzuki says among the problems to be solved is: "*To reduce damage to a lower casing* (the gear case to which a skeg extends downward from) *related to a collision with an underwater obstacle*."

Rather than make a separate skeg from an aluminum alloy, Suzuki chose to make their breakaway skeg out of a synthetic resin. This reduced weight of the skeg while improving rust resistance as paint is often scraped off aluminum skegs by contact with the seabed.

A dovetail fitting is used to attach the synthetic resin to the gear case.

Use of a separated skeg also makes it easier for Suzuki to produce the same gear case for counter rotation motors (When two outboards are used on a vessel they are often setup to rotate in opposite directions to cancel steering torque). Suzuki can just make one skeg for right hand rotation propellers and one skeg for left hand rotation propellers. The skegs differ in their convex cross sectional shape to generate negative pressure on one side to reduce steering torque.

Suzuki's breakaway skeg was designed to protect the gear case. However, it could also protect those on board bass boats by breaking away when the skeg strikes a significant submerges object. This would allow the outboard motor to clear the obstacle before the outboard breaks off.

Suzuki's breakaway skeg is shown in **Figure S1-7**.

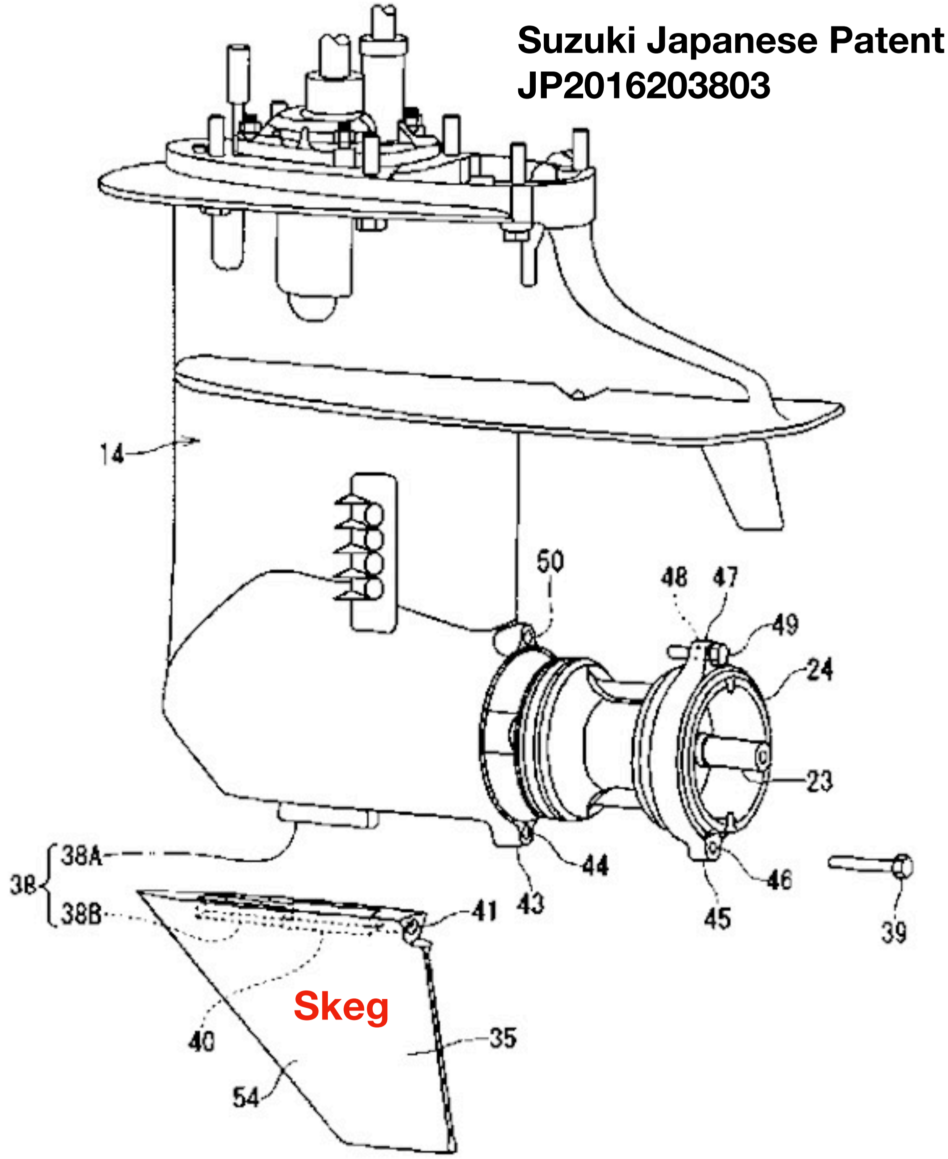


Figure S1-7: Suzuki Breakaway Skeg
Japanese Patent JP2016203803

2A. The Leash

Since out third edition, The Leash has been acquired by Precision Sonar. They have had some patent activity and introduced two new attachment methods. In addition we missed a few earlier developments as well.

The Leash **U.S. Patent 10,435,128** Marine Outboard Tether patent issued 8 October 2019.

The original leash patent, **U.S. Patent 9,771,136** previously covered in our third edition, only had three claims. It taught how to preventing a marine drive from violently flipping into the boat when a submerged object is struck.

Their more recent **U.S. Patent 10,435,128** has 19 claims and specifically teaches preventing the outboard from flipping into the passenger or drivers compartment of a marine vessel when the drive section strikes a submerged object.

The original The Leash installation went forward over the top of the back of the jack plate and then down to attach to the top motor mounting bolts. See **Figure S1-8** which is a copy of **Figure 42** from our third edition which shows this installation method.

Figure S1-8: The Leash original mounting method

As time progressed, some users started bolting The Leash's front spools directly to the side of their jackplate. Besides achieving a sleeker appearance, it also removed any possibility of The Leash weakening where it went over the top of the jackplate.

The Leash followed up with what they called Mini Brackets as seen in **Figure S1-9** to move the attachment point back to the motor mounting bolts. A The Leash video referred to this method as their Gen 2 Leash.[2]

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[2] The Leash Installation Guide. The Leash Fishing. YouTube. 4 May 2018. 4 minute 15 seconds in length. Viewed 14 October 2020.

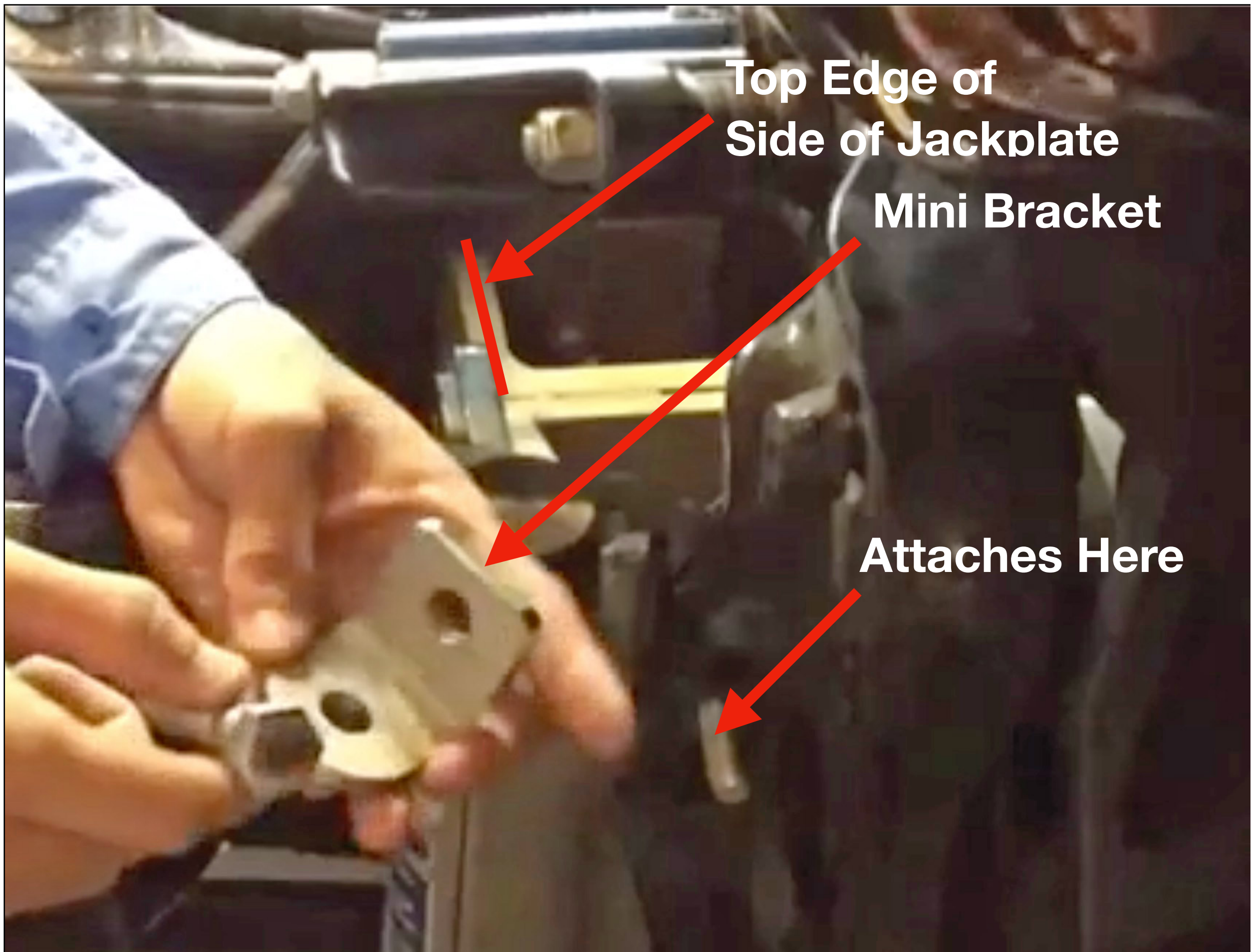

Figure S1-9: The Leash mini bracket
Bracket is attached to a top motor mounting bolt with the rounded side extending the same direction the mounting bolt extends, parallel to the side of the jackplate.

Figure S1-10 on the next page shows The Leash attached to the mini bracket.

We suggest there is an additional opportunity to make the mini brackets deformable under impact so they too would absorb a portion of the energy. They could be replaced after significant collisions as is The Leash. Basically, the mini bracket could be designed so the current 90 degree bend “pulls out” to be a much more rounded corner under extreme loads.

Figure S1-10: Installed Mini Bracket for The Leash

The Leash is still being sold with mini brackets. However a new option has come on the scene. The Leash now has a pair of Max Brackets that bolt on each vertical pair of engine mounting bolts. Precision Sonar's web site says Max Brackets do not currently fit the Evinrude G motor or Mercury Marine outboards built after 2012. However we see them installed on a fairly new large Mercury four stroke Pro XS outboard in **Figure S1-12**.

Figure S1-11: The Leash Max Brackets

The Leash recommends the use of Max Brackets on outboards of 150 or more horsepower. The Max Bracket ties the leash to all four motor mounting bolts vs one bolt on each side.

A pair of Max Brackets are shown in **Figure S1-11** above. Not seen in the image are several holes through the upper part of the vertical rib of each Max Bracket.

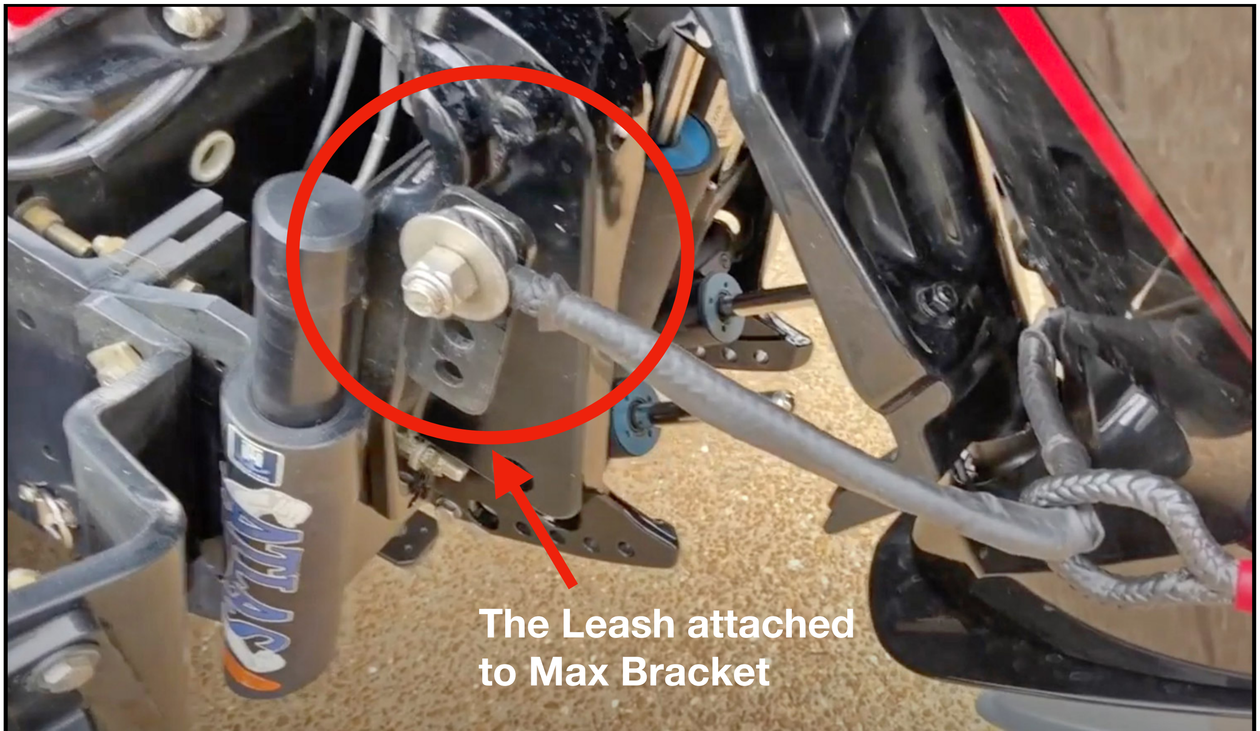

Figure S1-12: The Leash Installed to Max Bracket

The Leash is bolted to the side of Max Brackets as seen in **Figure S1-12**. which comes from a Big Jim Fishing video.[3]

The Leash still has at least one outstanding patent application, **US Patent Application 2019/0193826**. This application is for a version of the Max Bracket that also prevents outboard mounting bolts from loosening.

[3] The Leash for Outboard Motors. Big Jim Fishing. 27 May 2020. YouTube. 4 minutes 49 seconds. Viewed 14 October 2020.

2B. Use of a Strap, Chain, or Cable to Limit Maximum Tilt

U.S. Patent 3.416,759 invented by Donald Arnett and issued 17 December 1968 takes a very basic approach of strapping the outboard down as seen in **Figure S1-13.**

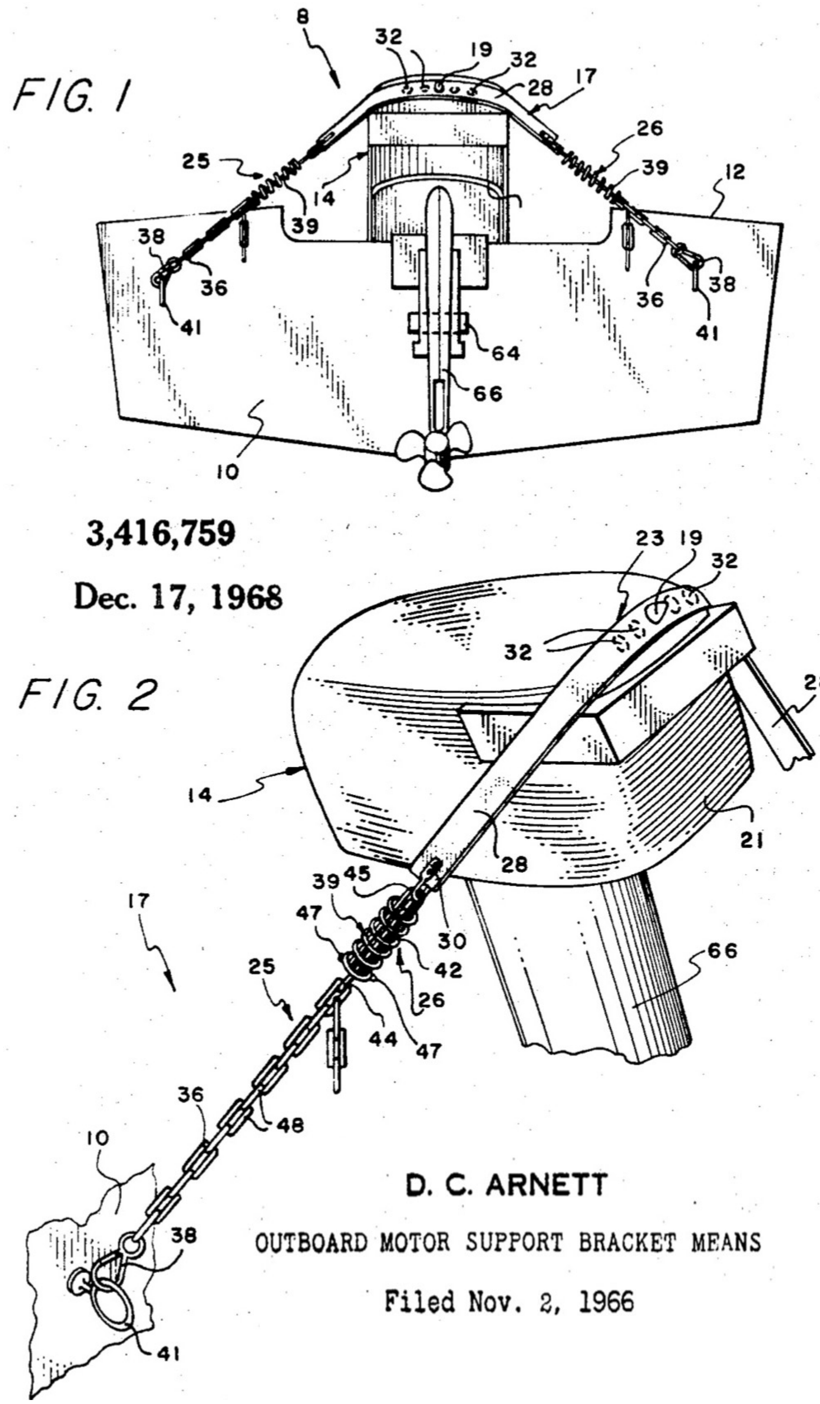

Figure S1-13: U.S. Patent 3,416,759
Outboard Motor Support Bracket Means

2C. Use of Existing Lines as Tethers

Brunswick's **U.S. Patent 10,017,136** Outboard Motor and Rigging System for Outboard Motor issued 10 July 2018. Brunswick's patent teaches of an outboard motor coupled to a transom via several lines extending from the engine through an aperture (opening) in the motor housing and on to the vessel. A protective tube attached to the engine surrounds the lines with its other end attached to the vessel. Each line is configured to be coupled to its mate on each end. **Figure S1-14** comes from this patent.

As written the primary elements of interest to preventing outboard motors from breaking off and flipping into occupied areas of boats in this patent are battery cables. In many instances battery cables remain attached after the outboard enters the boat. On some occasions the outboard motor itself is no where in sight, but later found because it was submerged and still attached to the boat via battery cables. **Figure 43** on **Page 116** of our third edition shows such an instance.

As mentioned on **Page 117** of our third edition, it may be possible to redesign some of these existing cables to act as a tether, especially the battery cables. If not, a secure attachment point on the motor could be identified or created. Then an additional cable, preferably with some stretchability similar to Vectran could be used, passed through the protective tube, and attached to a secure point on the vessel.

This cable could restrain the outboard from entering occupied areas of bass boats.

While a classic restraining cable is one example, as mentioned in our third edition, it may be possible to design an attachment tether purely to direct the outboard motor somewhere other than occupied areas of bass boats.

One product we have yet to see enlisted as an outboard motor tether is kinetic recovery ropes, also called snatch ropes and tanker ropes. They are used as tow straps to recover stuck vehicles. Kinetic ropes have a great deal of stretch. They allow the tow vehicle to run at the end of the rope which then stretches and yanks the stuck vehicle out of the mud. Some firms such as Bubba Off-Road Recovery Gear fuse military kinetic recovery rope technologies with civilian applications. Besides keeping the outboard out of passenger areas, kinetic recovery ropes might be able to redirect the outboard to somewhere else. Such a rope might be ran through a protective tube like Brunswick teaches in this patent.

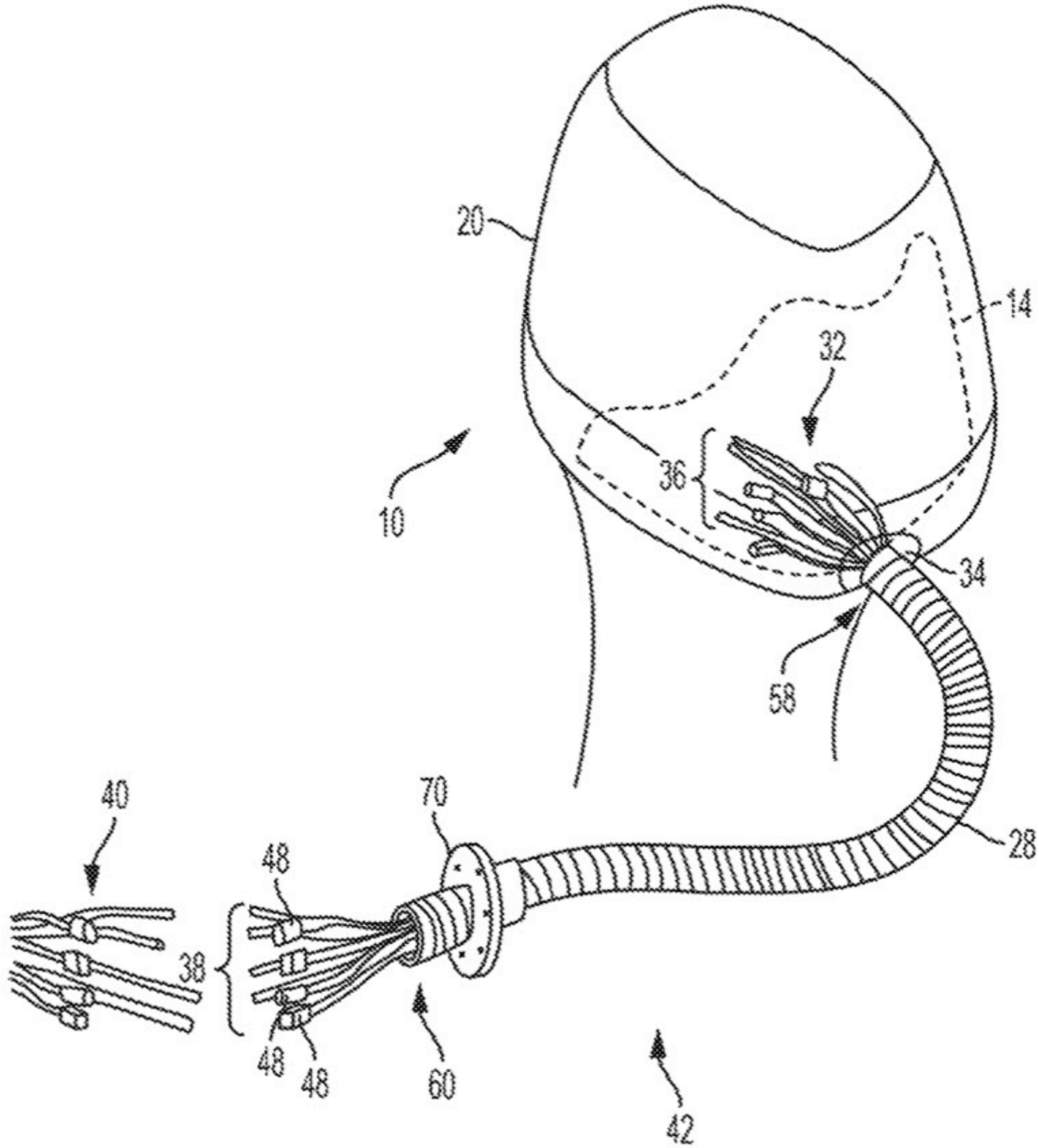

Figure S1-14: Brunswick Rigging Patent Sketch
U.S. Patent 10,017,136

2G. Cushioned Swivel Bracket *(this is a new category)*

Suzuki Elastic Bushing

Suzuki **Japanese Patent JPH04243689** Protecting Device for Outboard Motor issued 31 August 1992 reveals a cushioned swivel bracket. Note this was one of two Suzuki patents issued at the same time focusing on cushioning the swivel bracket.

As illustrated, this patent teaches the use of a swivel bracket with four separate arms through which the tilt tube passes. The outside two arms feature breakaway bolts allowing those two arms to fail under intense impacts. The two inside arms are lined with elastic bushings. When the two outside arms fail, the elastic bushings in the two inside arms allow the swivel bracket to move rearward as the elastic bushings are compressed.

Figure S1-15 covers the bibliography of the patent. **Figure S1-16** show the motor mounting brackets and the swivel bracket with the through tube and the elastic bushings.

Bibliographic data: JPH04243689 (A) — 1992-08-31

In my patents list Report data error Print

PROTECTING DEVICE FOR OUTBOARD MOTOR

Page bookmark	JPH04243689 (A) - PROTECTING DEVICE FOR OUTBOARD MOTOR	
Inventor(s):	MIYASHITA YASUSHI +	
Applicant(s):	SUZUKI MOTOR CO +	
Classification:	**- international:**	***B63H20/02; B63H20/08; F02B61/04; F16C11/04; F16F7/12;*** (IPC1-7): B63H21/26; F16C11/04; F16F7/12
	- cooperative:	**F02B61/045 (EP)**
Application number:	JP19910019102 19910121	
Priority number(s):	JP19910019102 19910121	

Abstract of JPH04243689 (A)

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Select language patenttranslate powered by EPO and Google

PURPOSE:To soften impact and suppress breakage when a load over a prescribed value is applied, by tightening a half divided bearing on both the outsides of the elastic bush of a swivel bracket by a bolt and supporting a supporting shaft, and allowing a bolt to be cut when a load over a prescribed value is applied, and permitting the swivel bracket to be moved. CONSTITUTION:A cylindrical elastic bush 9 is inserted into a shaft hole 8 at the front edge of a swivel bracket 2, and a supporting shaft 3 is inserted into the center hole 10 of the elastic bush 9. Further, a half divided bearing 11 is tightened by a bolt 12 at both the outsides of the elastic bush 9 at the front edge of the swivel bracket 2, and the supporting shaft 3 is supported. A groove 13 is formed at the neck part of the bolt 12, and the bolt is tightened on the swivel bracket 2 by a prescribed torque, and the bolt 12 can be broken when a load over a prescribed value is applied. When the bolt 12 is broken, the half divided bearing 11 is demounted, and the swivel bracket 2 moves within the elasticity range of the elastic bush 9, and the impact is softened, and breakage can be reduced.

Figure S1-15: Suzuki Japanese Patent JPH04243689

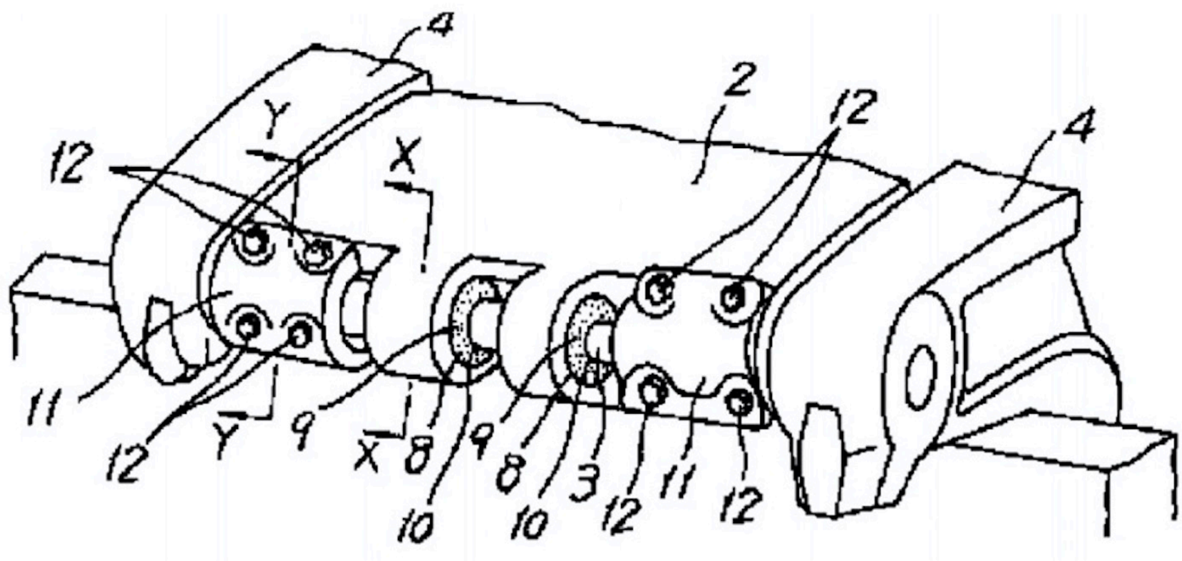

Figure S1-16: Motor Mounting Brackets (4), Swivel Bracket (2), Tilt Tube (3), Elastic Bushings (9), Breakaway Bolts (12), Collar Retaining Tilt Tube that breaks away (11)

Figure S1-17 labels the components in **Figure S1-16** above, and provides cross sectional views of the breakaway collars and elastic bushings.

While the elastic bushing is relatively small (probably allows less than 3/4 of an inch of compression) it allows the event to extend over more time which significantly reduces peak forces and stress levels.

The elastic bushings lengthen the time of impact, reducing peak stress levels. Depending on how much energy was absorbed by the breakaway bolts, hydraulic tilt cylinder, and other components, stresses in the remaining two swivel bracket arms could be decreased.

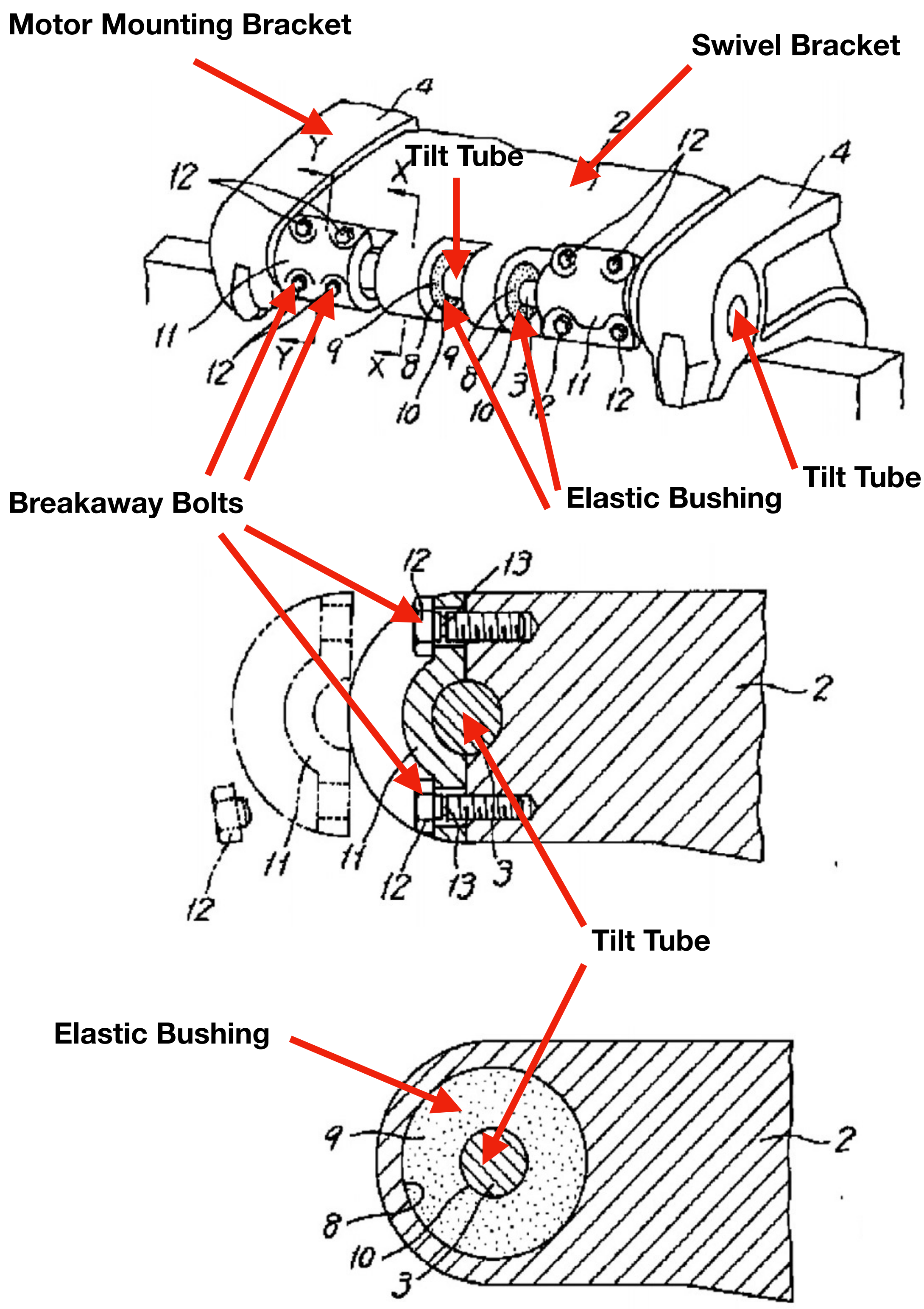

Figure S1-17: Suzuki Japanese Patent JPH04243689 drawings

Suzuki Tether

Suzuki received another Swivel Bracket Cushioning patent at the same time as the Elastic Bushing patent previously discussed. The two patents issued consecutively.

Japanese Patent JPH04243690 Protecting Device for Outboard Motor was issued 31 August 1992. It is interesting that Suzuki put the same title on both patents, each of which addressed the same problem, but did so in very different ways.

Figure S1-18 provides the bibliography information on **JPH04243690**

Figure S1-19 provides an overview of the assembly.

Suzuki does not identify specific materials or construction methods for the tether. They only refer to it as an "elastic band" (as translated from Japanese).

Bibliographic data: JPH04243690 (A) — 1992-08-31

In my patents list | Report data error | Print

PROTECTING DEVICE FOR OUTBOARD MOTOR

Page bookmark	JPH04243690 (A) - PROTECTING DEVICE FOR OUTBOARD MOTOR
Inventor(s):	MIYASHITA YASUSHI +
Applicant(s):	SUZUKI MOTOR CO +
Classification:	**- international:** ***B63H20/02; B63H20/10; F02B61/04; F16C11/04; F16F7/00;*** (IPC1-7): B63H21/26; F16C11/04; F16F7/00
	- cooperative: **F02B61/045 (EP)**
Application number:	JP19910019103 19910121
Priority number(s):	JP19910019103 19910121

Abstract of JPH04243690 (A)

Translate this text into

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PURPOSE:To absorb impact and minimize breakage by allowing a band consisting of an elastic body to extend to shift a swivel bracket to the rear side when the lower part of an outboard motor collides with an obstacle and is applied with an impact over a prescribed value. CONSTITUTION:The front edge of a swivel bracket 2 which holds an outboard motor is axially installed at the front edge of a clamping bracket 4 by a supporting shaft 3, and a hydraulic cylinder 5 is connected between the swivel bracket 2 and the clamping bracket 4, and the attitude of the outboard motor 1 is controlled by a hydraulic pressure. A shaft hole 9 is formed, in conformity with a half divided shaft hole 8, at the front edge of the swivel bracket 2, and a band 10 consisting of an elastic body such as high tensile fiber is wound on the outside of the half divided shaft hole 8. When the impact is too sharp to dispose of it for the release valve of the hydraulic cylinder, the band 10 consisting of the elastic body is extended, and the swivel bracket 2 shifts to the rear side, together with the outboard motor 1, and the band 10 serves as damper, and the impact is dumped.

Figure S1-18: Suzuki Japanese Patent JPH04243689

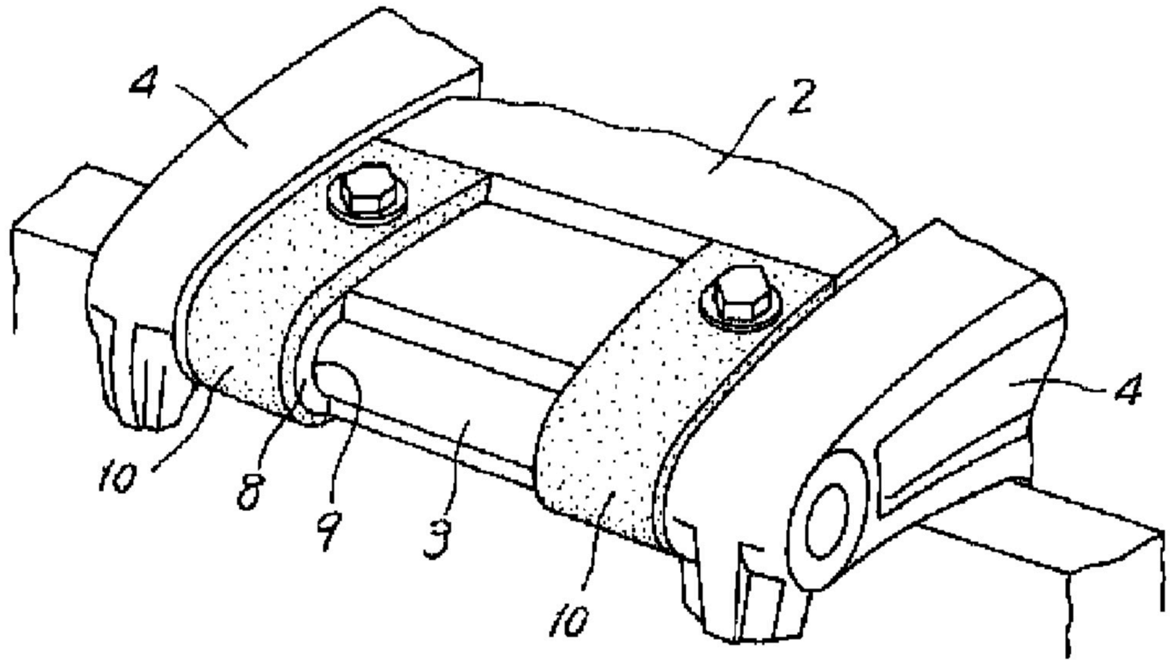

Figure S1-19: Motor Mounting Brackets (4), Swivel Bracket (2), Half Collar (8), Tethers (10)

Figure S1-20 includes two cutaways of the swivel bracket show in **Figure S1-19** to better illustrate its construction.

Somewhat similar to Suzuki's previous Cushioned Swivel Bracket patent, this patent has half collars in front (towards the bow) of the tilt tube. These half collars are retained by a wide strap (tether) that stretches during impact allowing the swivel bracket to move rearward, thus increasing the time of impact and reducing maximum impact forces and the resultant stresses.

Suzuki's patent notes: "*If the speed at which the lower portion of the outboard motor collides with an obstacle is high, the release valve (tilt cylinder relief valves) cannot operate completely (cannot open fast enough), and the hydraulic cylinder and the outboard motor cannot be operated. The gear case at the bottom of 1 (the outboard motor) may be damaged, and a high repair cost may be required.*"

Suzuki's goes on to state, "*Further, by selecting an elastic band having sufficient strength, it can be used for a long period of time, and it is effective even it if it is used for band without a hydraulic cylinder.*" Meaning you don't even need a tilt cylinder to protect the swivel bracket.

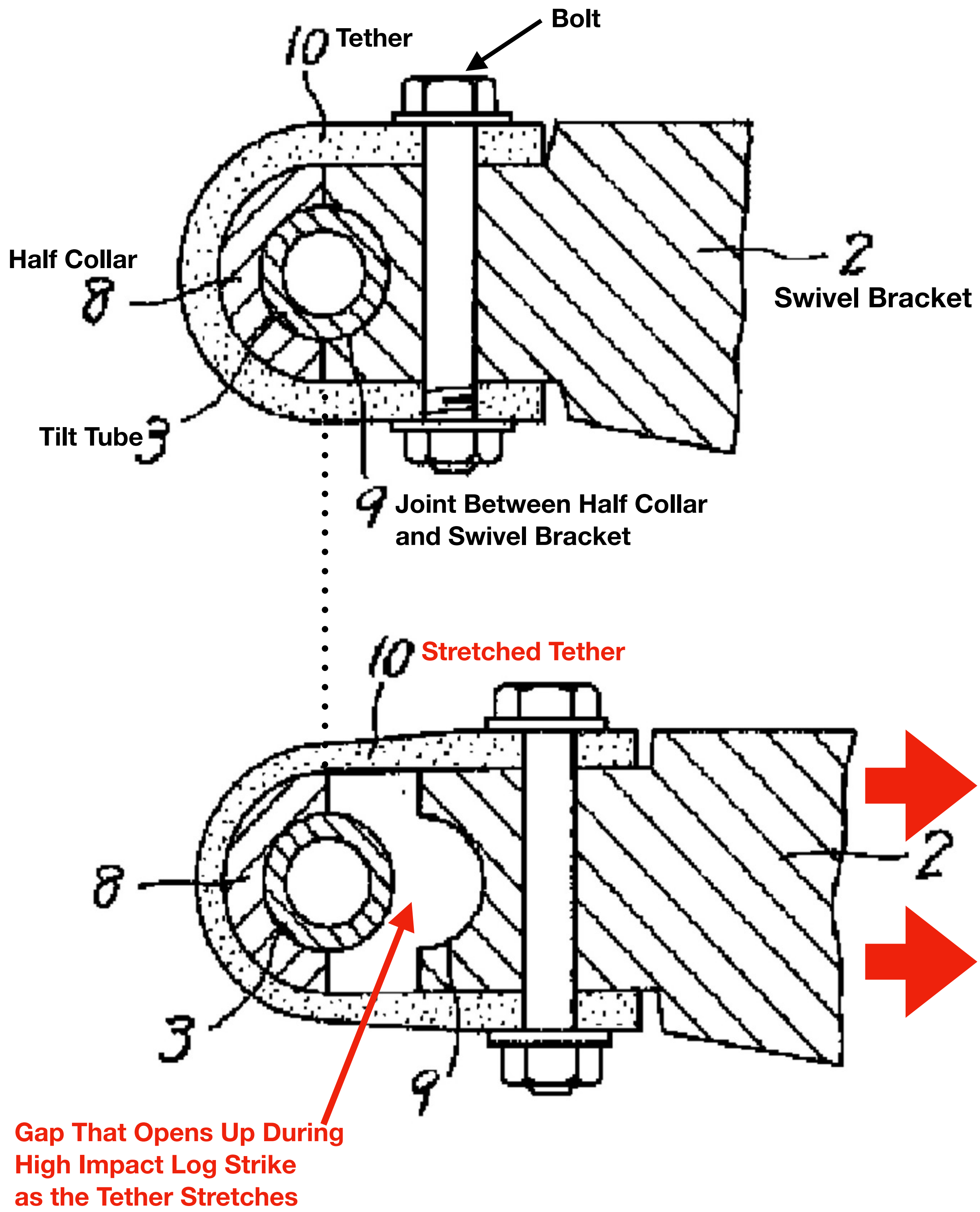

Figure S1-20: Suzuki Tether Cut Away Sketches

5A. Kill Engine to Stop Propeller From Rotating

This category includes approaches to slow or kill the engine before it enters the boat to mitigate the hazard of the rotating propeller. The propeller, itself a major hazard, also serves to “walk” the outboard around the boat as it bounces off the vessel, especially off the rear deck and gunnel.

Sanshin (Yamaha) & Yamaha

Two earlier Yamaha patents have since been identified. Both detect tilt angle and slow the engine based on certain conditions.

Sanshin **U.S. Patent 4,861,291** Marine Engine Protection Device, issued 29 August 1989. This patent focuses on maintaining cooling water to outboard and stern drive engines at higher trim/tilt angles and making sure stern drives are protected by their gimbal arms at higher trim/tilt angles.

The patent states:

“It is, therefore, a principle object of this invention to provide an arrangement for protecting a marine outboard drive from damage if it is tilted up more than a predetermined amount.

It is a further object of this invention to provide an arrangement for reducing the speed of the driving engine when the marine propulsion outboard drive is tilted up more than a predetermined amount.”

“The speed of the power means is reduced when the height of the propulsion means exceeds a predetermined volume.” We suspect they meant “height “instead of “volume.

The system consists of a Control Unit, Trim Indicator, Warning Light, and Warning Buzzer as seen in **Figure S1-21**.

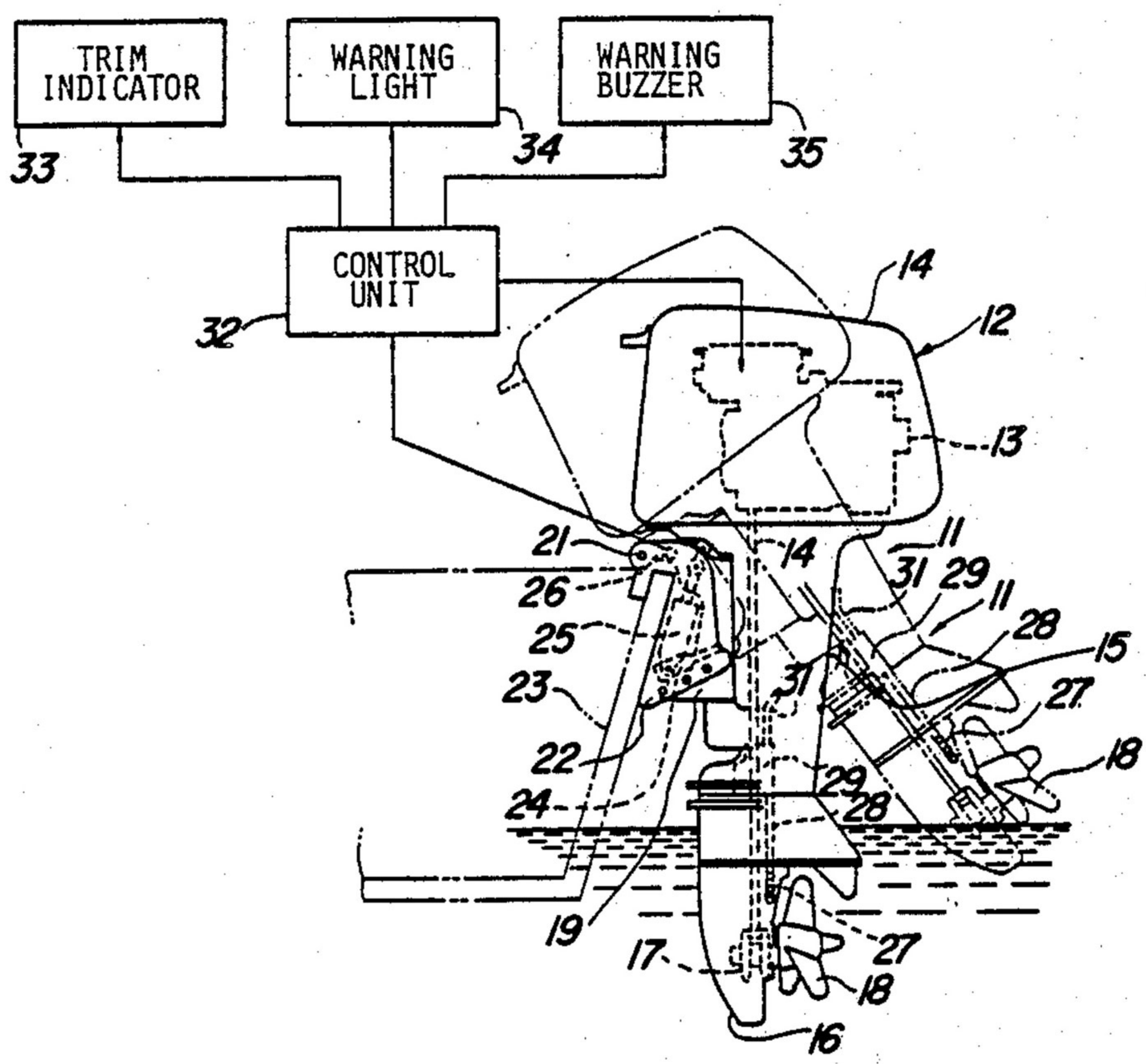

Figure S1-21: Yamaha U.S. Patent 4,861,291 sketch

Similar technologies to those used by Yamaha in U.S. Patent 4,861,291 could be used to kill the engine when it breaks off the vessel.

Yamaha **U.S. Patent 8,277,266** Outboard Motor and Marine Vessel Including the Same issued 2 October 2012.

Some statements from Yamaha's Summary of the invention:

"Specifically, for example, in order to prevent a lower end of the outboard motor main body from contacting a shallow bottom when a marine vessel travels through a shallow water region or in order to lift and bring a stem of the marine vessel above a water surface and onto land in bringing the marine vessel out of the water and onto land, the marine vessel is propelled forward with the outboard motor main body and the swivel bracket being tilted up. In this state, the propeller is close to the water surface and thus, for example, if the water surface is very wavy, the propeller enters and exits in and out of the water. When the propeller is in the air instead of in the water, a resistance of the water is not applied to the propeller. Thus, when the propeller is in the air instead of the water, a rotation speed of the propeller increases even if an opening degree of a throttle valve provided in the engine is fixed. When the propeller reenters the water in such a state, a large propulsive force that drives the hull forward is suddenly applied to the outboard motor main body and the swivel bracket. Also, even if the propeller is underwater, when the rotation of the propeller is rapidly accelerated by increasing the opening degree of the throttle valve, a large propulsive force that drives the hull forward is suddenly applied to the outboard motor main body and the swivel bracket."

"In the state in which the outboard motor main body and the swivel bracket are tilted up, the supporting of the outboard motor main body and the swivel bracket by the trim rod is released and these components are supported only by the tilt rod. When the outboard motor main body and the swivel bracket are supported by the tilt rod, the propulsive force generated by the outboard motor main body is transmitted to the tilt rod. Thus, in the state in which the outboard motor main body and the swivel bracket are tilted up, a large load is applied to the tilt rod. In a case in which the tilt cylinder is, for example, a hydraulic cylinder, a pressure inside the tilt cylinder increases when a large load is applied to the tilt rod. Hydraulic oil is thus discharged from inside the tilt cylinder via a relief valve, etc., connected to the tilt cylinder and a projection amount of the tilt rod decreases. The load applied to the tilt rod is thereby reduced. However, when a sudden load is applied to the tilt rod, pressure release by the relief valve lags behind and a large load is applied to the tilt rod because the load applied to the tilt rod is not adequately reduced."

Yamaha says their invention solves these problems by using a controller (the Engine Control Unit or ECU) that receives information on trim/tilt angle, power tilt & trim switch operation, shift status (Forward-Neutral-Reverse), and engine speed. The controller reduces engine speed when the trim/tilt is between one lower angle and one higher angle (prevents high RPM in the zone used to propeller the vessel in very shallow water) when in forward gear. They slow the engine by making one to three cylinders misfire.

Figure S1-22 shows the problem as defined by Yamaha and what they plan to do about it. A description of this chart follows.

Theta1 and Theta 2 define the tilt range Yamaha is concerned about which includes the upper part of the shallow water marine vessel running region. Yamaha labels their tilt region of concern as R1.

The curved line in the top right corner labeled as L3(Fixed Load) is a line obtained by measuring tilt angle and engine speed when a fixed load is applied to the Power Tilt & Trim system, and something breaks.

The “fixed load” referred to above is the minimum force at which at least one component of the support mechanism, Power Tilt & Trim system, or hull breaks.

Examples of breakage of the support mechanism include deformation of the motor clamp bracket, the swivel bracket, the tilt shaft.

Examples of breakage of the Power TIlt & Trim system include deformation of the tilt cylinder rod, or damage to the main body of the tilt cylinder.

Examples of damage to the hull include deformation or breakage of the transom.

We note the L3(Fixed Load) line resembles the yellow curve in **Figure 73** Log Strike Mode by Speed and Resistance to Impact on page 173 of our third edition. The basic difference is we converted engine RPM to velocity.

As in our chart, the hatched area in the top right corner of **Figure S1-22** “is a region in which the load applied to the tilt rod exceeds the fixed load.” In these instances the ECU brings engine RPM down to V1 or to the variable RPM described by curve V2. Either way it keeps the fixed load below the minimum force at which something breaks.

Yamaha explains maximum tilt angle is Theta2. When a fault (short circuit or disconnection) occurs, an abnormal detection value (Theta 3) is output from tilt angle detection module.

L2 is a speed reference line with which the engine speed varies according to tilt angle. Yamaha says the speed reference line L2 is a curve that varies similar to L3 at the lower limit of Theta1.

Theta 1 is the minimum angle at which the outboard is supported only by the tilt cylinder.

Theta 2 is maximum tilt.

Force on the tilt cylinder for a given force on the lower outboard increases with tilt angle.

Yamaha notes this patent corresponds to **Japanese Patent application 2010-111105** filed 13 May 2010.

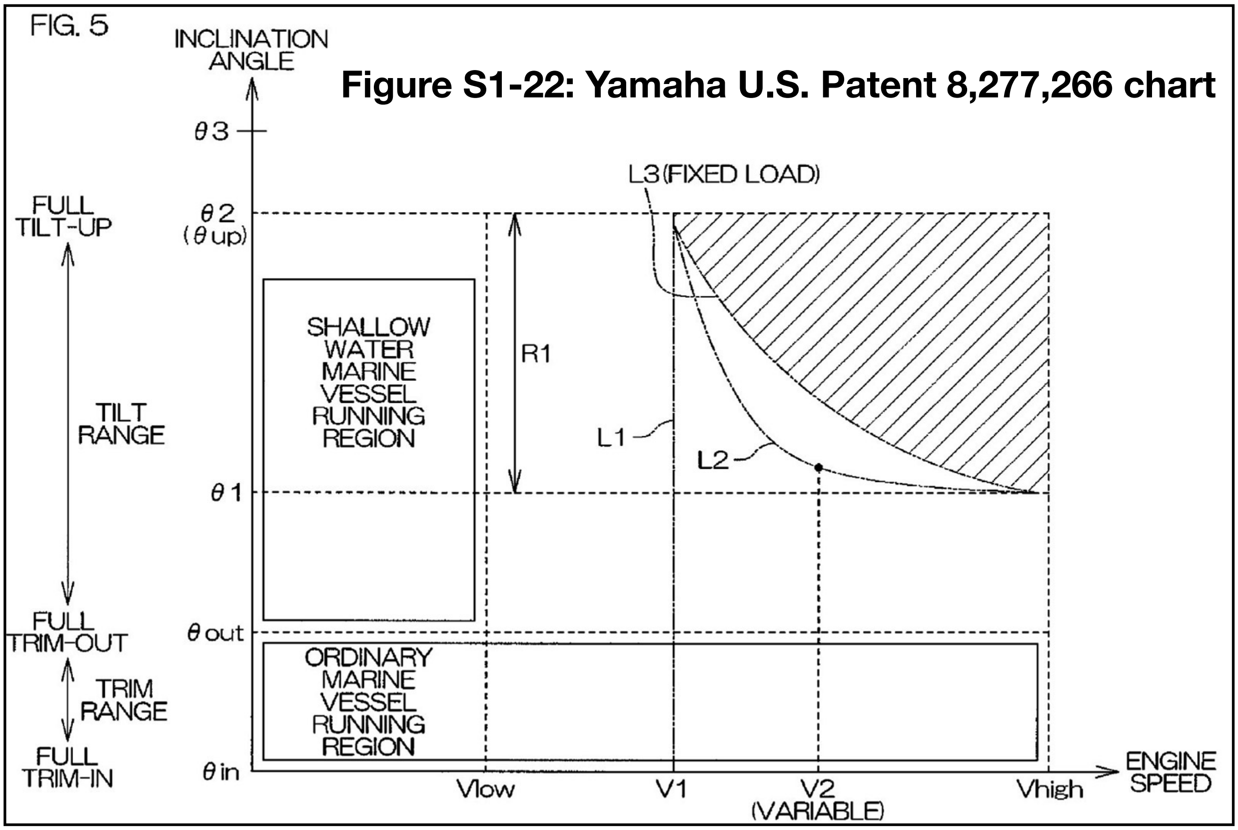

Figure S1-22: Yamaha U.S. Patent 8,277,266 chart

Similar techniques to those used by Yamaha lend themselves to slowing or killing the engine when the outboard breaks off.

Similar techniques could be used to limit maximum engine RPM in order to limit maximum boat velocity to a speed less than the minimum speed at which the outboard motor could break off if a submerged object were struck.

We note that several methods described in the next section, **Section 6A** Advance Detection of Imminent Impact, also slow or stop the engine during impact or anticipated impact.

6A. Advance Detection of Imminent Impact

Avoidance detection became a very active category after our third edition. Previous systems tended to focus on detecting floating or submerged hazards in the path of the vessel. Several recent patents integrate detection with an automatic response to avoid striking the object.

Brunswick / Mercury Marine

Brunswick **U.S. Patent 10,281,928** Systems and Methods for Raising and Lowering a Marine Device on a Marine Vessel issued 7 May 2019.

This patent teaches a control module, such as the Engine Control Unit (ECU) in communication with a GPS location sensor and a database of water depths corresponding to the vessels current and/or predicted location. The control unit signals one or more systems capable of raising the drive when the vessel approaches hazardously shallow water. Systems controlled include the outboard tilt and trim system, a hydraulic jackplate, and trim tabs. The control module can also issue a warning when impact is imminent. **Figure S1-23** and **Figure S1-24** illustrate the system.

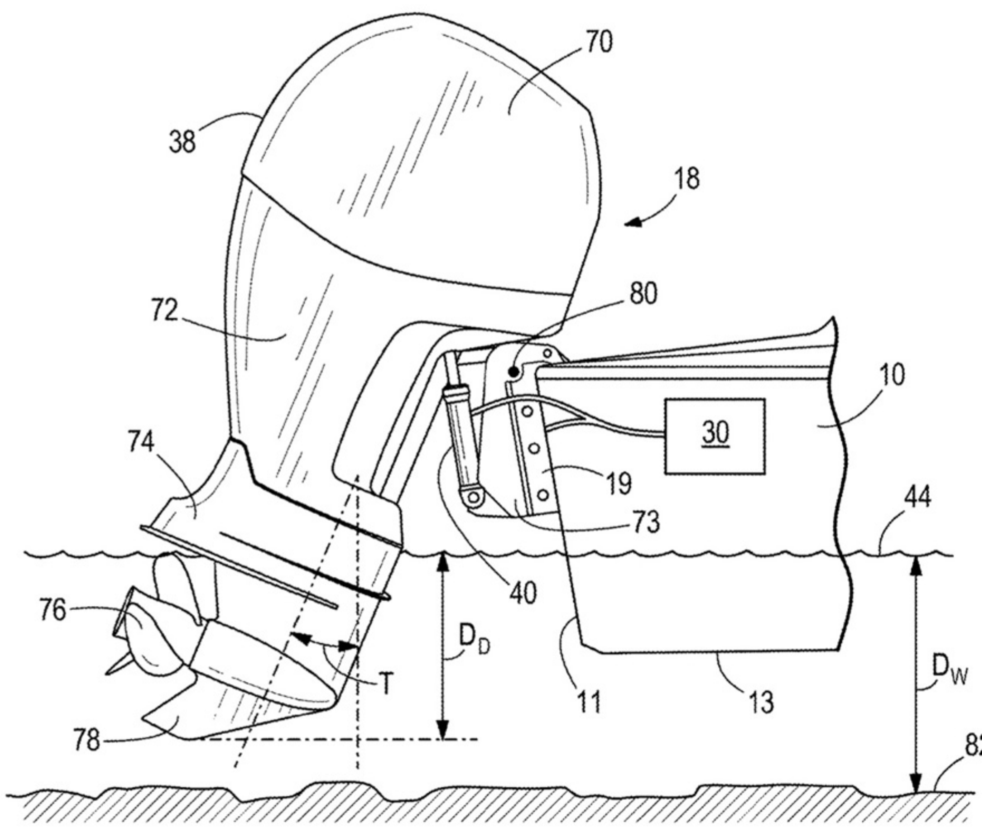

Figure S1-23: Brunswick Patent 10,281,928 sketch

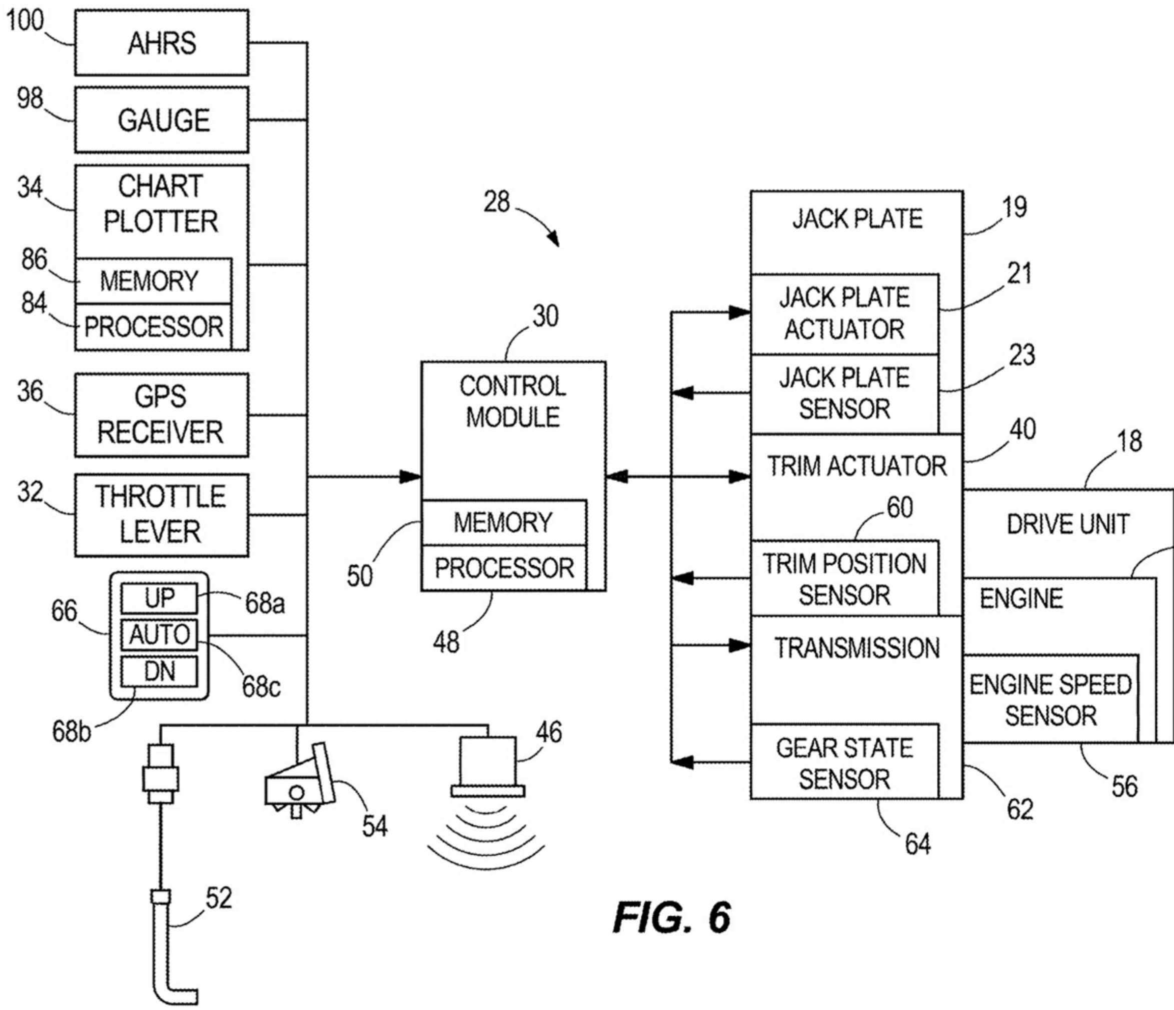

Figure S1-24: Brunswick Patent 10,281,928 Control System

Some outboard motor breaks off and flips into boat accidents result from striking a stump, submerged pipe, submerged bridge, even a trash dumpster in one instance. Brunswick's system as described could prevent some of these accidents or at least warn those on board that impact is imminent.

U.S. Patent Application 2020/0031448 Lanyard System and Method for a Marine Vessel. Assigned to Brunswick. Published 30 January 2020.

This patent application is part of a group of patent applications based on Fell Marine wireless lanyard technologies. As can be seen in **Figure S1-25** this patent teaches the ability to provide boat operator with a variable length/distance wireless lanyard based on vessel speed.

One patent claim covers the lanyard control module (Engine Control Unit / ECU) being configured to receive the GPS location of the vessel and "adjust a radius of the permitted zone based on the GPS location." The system can force the boat operator to be closer to the helm based on where the vessel is.

Similar technologies could limit maximum vessel speed based on risk of striking floating or submerged objects based on GPS location which is an application of geofencing.

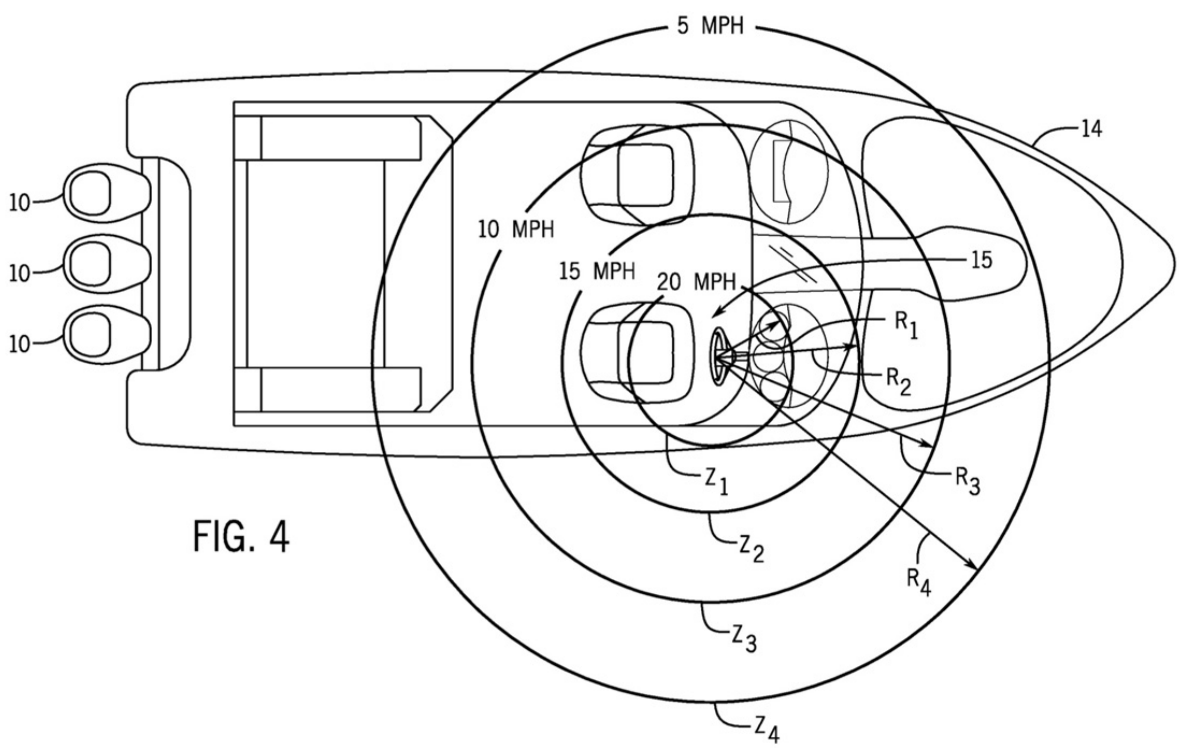

Figure S1-25 Brunswick U.S. Patent Application 2020/0031448 drawing

U.S. Patent Application 2020/0250992 Marine Propulsion Control System and Method. Assigned to Brunswick. Published 6 August 2020.

This patent application is one of several automatic docking patent documents assigned to Brunswick. Numerous Brunswick patent applications and patents describe complex methods that could be used to automatically dock a vessel along side a dock or in a slip. The control system is capable of steering multiple drives, thrusters, and other propulsion devices on a particular vessel to bring the vessel along side a dock or into a slip including in challenging wind and current condition. Some systems create virtual bumpers (they automatically stay a set distance from the dock.

Paragraph 30 states:

The propulsion control system 20 also includes one or more proximity sensors 72, 74, 76, and 78. Although one proximity sensor is shown on each of the bow, stern, port and starboard sides of the vessel 10, fewer or more sensors could be provided at each location and/or provided at other locations, such as on the hardtop of the vessel 10. The proximity sensors 72-78 are distance and directional sensors. For example, the sensors could be radars, sonars, cameras, lasers (e.g. lidars or Leddars), Doppler direction finders, or other devices individually capable of determining both the distance and direction (at least approximately), i.e. the relative position of an object O with respect to the vessel 10, such as a dock, a seawall, a slip, another vessel, a large rock or tree, etc.

If the system can calculate the relative position of the vessel with respect to seawall, large rock, or tree it could be useful in preventing collisions with such objects, thus preventing outboard motors from breaking off and flipping into boats.

FLIR

We previously wrote of FLIR's **U.S. Patent Application 2017/0158297** for Watercraft Protection System and Methods on **Page 152** of our third edition. The system used sensors to anticipate impacts with floating objects, submerged objects, or groundings and adjusted marine drive depth to prevent impact while displaying information about the event. Since then, FLIR was issued **U.S. Patent 10,717,503** on 21 July 2020 for this system. The system was designed to actively protect outboard motors, stern drives, and inboard drives by raising motors and adjusting trim tabs.

Since our third edition, FLIR has been awarded two additional patents and had one patent application published all focusing on detecting and displaying objects before impact. These three systems do not automatically take action, they purely identify the hazard, display it's heading, and warn the operator.

1. **U.S. Patent 10,431,099** Collision Avoidance Systems and Methods. Issued to FLIR 1 October 2019.

2. **U.S. Patent 10,488,503** Surface Mapping System and Methods Using Dynamic Thresholds. Issued to FLIR 26 November 2019.

3. **U.S. Patent Application 2019/0251,356** Augmented Reality Labels Systems and Methods assigned to FLIR published 15 August 2019.

The FLIR patent application focuses on integrating several sensor systems (some of which are capable of detecting floating or submerged objects or shoals),then displaying their findings in one "overlay" augmented reality system becoming a sensor fusion navigational system.

Irwin M. Kaplan

Mr. Kaplan was issued **U.S. Patent 4,290,043** Method of and System for Detecting Marine Obstacles on 15 September 1991.

The system uses an optical transmitter, an optical receiver, and an alarm. An obstacle in the path of incident, reflected, or refracted light is detected by reflecting light towards the receiver which sounds the alarm. While the Kaplan patent was mentioned in the third edition on **Page 150**, we included it here with the addition of **Figure S1-26** below.

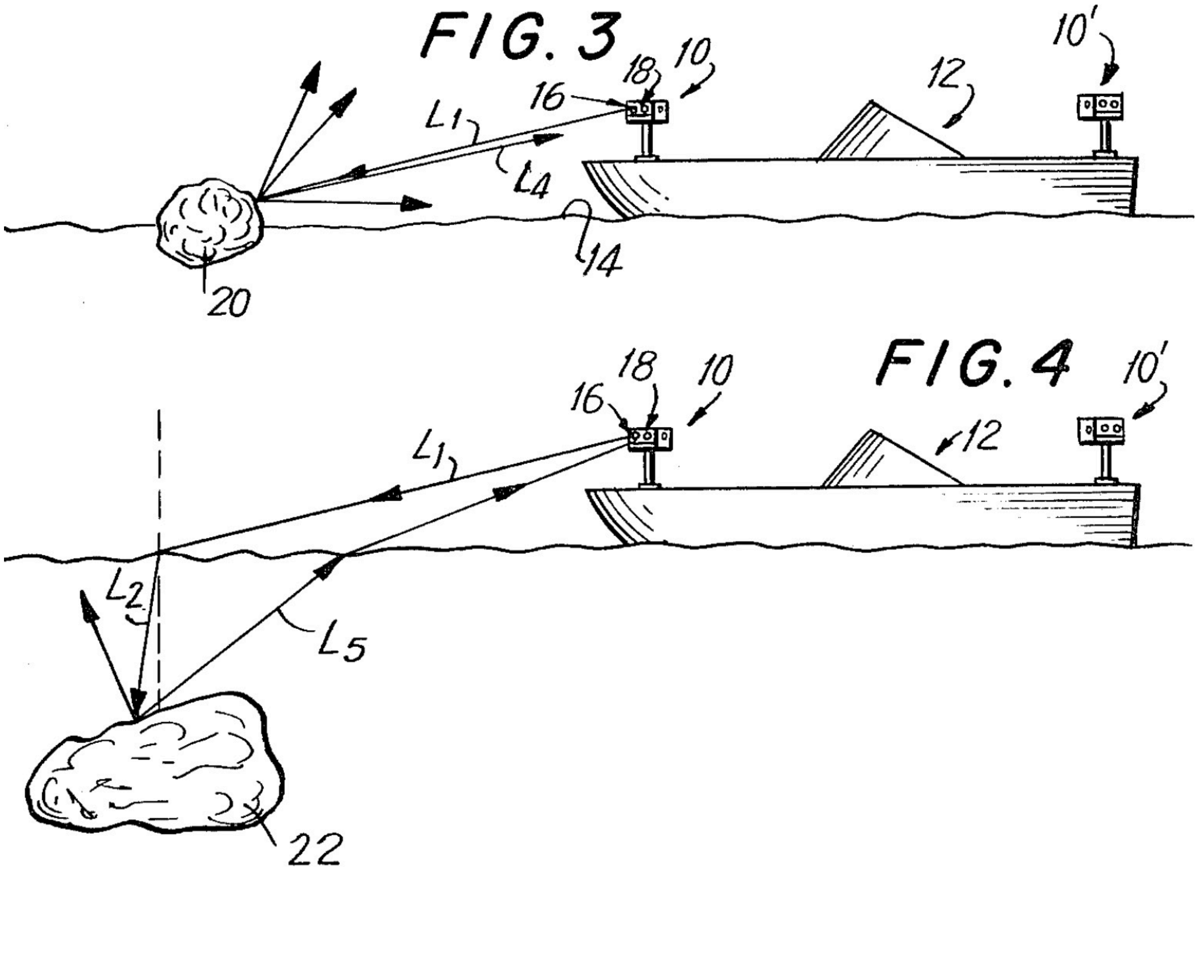

Figure S1-26: Kaplan Optical Detection Patent
U.S. Patent 4,290,043

Juha Tykkylainen of Finland

Mr. Tykkylainen of Finland received **International Publication Number WO 00/47465** which was published 17 August 2000 for "Safety Device for Motor Boat"'.

The device consists of an echo sounder mounted to the leading edge of an outboard motor. A control system tilts the outboard motor up when an obstacle is detected and slows the RPM of the propeller. See **Figure S1-27**.

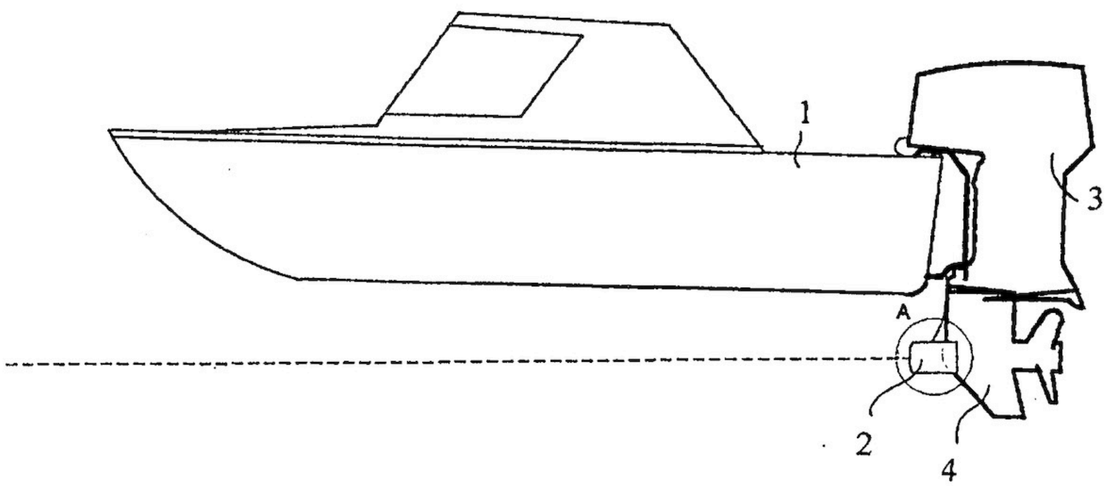

Figure S1-27: Tykkylainen Echo Sounder Patent drawing

ElJiEm Co., Ltd of Korea

ElJiEm Co., Ltd of Korea filed **Korea Patent Application 1020140116139** Colision (sic) Protect System of Outboard Motor on 2 September 2014.

The system uses a sensor such as an ultrasonic sensor to detect hazards in front of the outboard motor. When a hazard is detected, the system stops the propeller and tilts the outboard motor up.

Item 24 in their Figure 1 is the sensor. In this version, the system just kills the propeller. Item 224 in their Figure 2 is the sensor. In this version, the system kills the propeller and rotates the outboard up using the rotation apparatus item 230 (trim system).
See **Figure S1-28**.

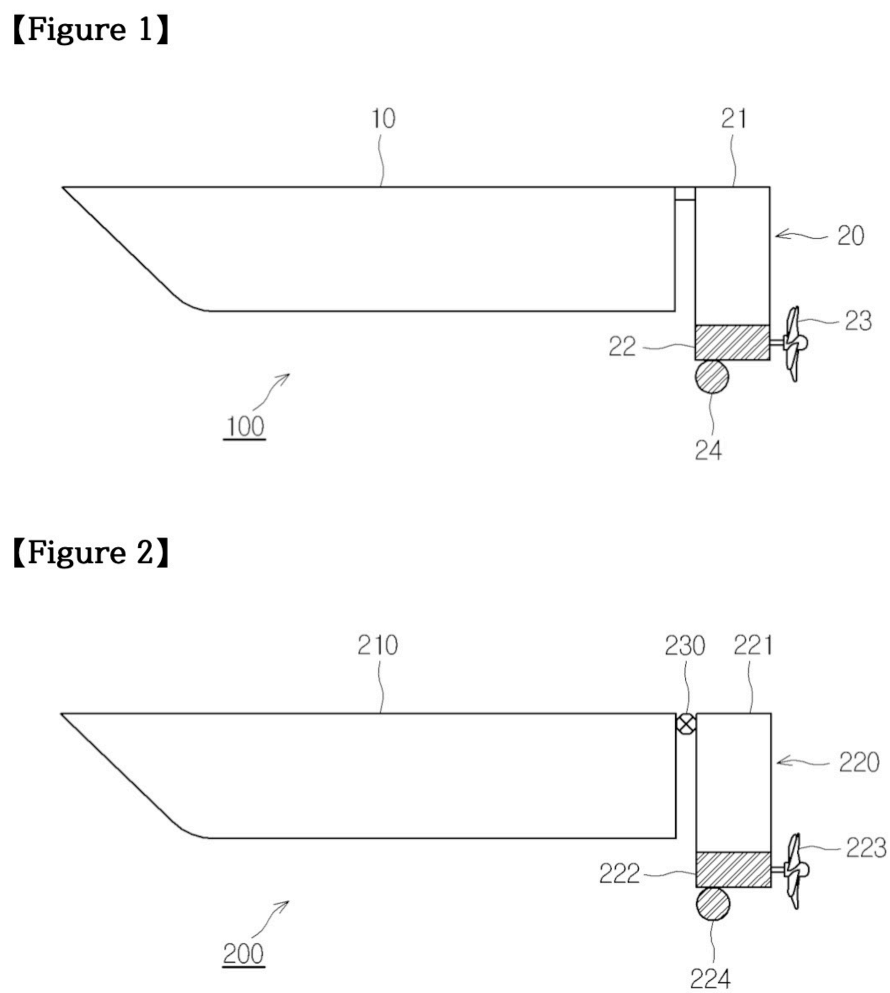

Figure S1-28: ElJiEm Co., Ltd of Korea patent application

Advance Detection - Ship based

We have seen several advance impact detection patents for ships. Some of these systems may be too large, expensive, require too much power, or require too much manpower for operation on recreational boats. However, they may provide some ideas to those working on the problem.

Some ship advance detection patents are listed below:

1. **U.S. Patent 7,483,33**6 Device for Avoiding Obstacles for High Speed Multi-Hulled Watercraft. Assigned to Thales in France.

2. **U.S. Patent 9,513,367** Image Gated Camera for Detecting Objects in a Marine Environment. Assigned to Elbit Systems Ltd.

3. **U.S. Patent Application 2003/0112171** Method Apparatus and Computer Program Products for Alerting Surface Vessels to Hazardous Conditions. Assigned to Honeywell.

4. **Japanese Patent JP6293960** Collision Avoidance Support System.

5. **Japanese Patent JPH0747992** Grounding Alarm Device. Assigned to Mitsubishi.

7D. Breakaway Mounts (Breakaway / Kick Up Jack Plates)

Mark Pelini received **U.S. Patent 10,220,926** Breakaway and Hydraulic Lift Jack Plate on 5 March 2019.

A breakable position locking pin, #42 in **Figure S1-29** allows the hydraulic jack plate to swing up.

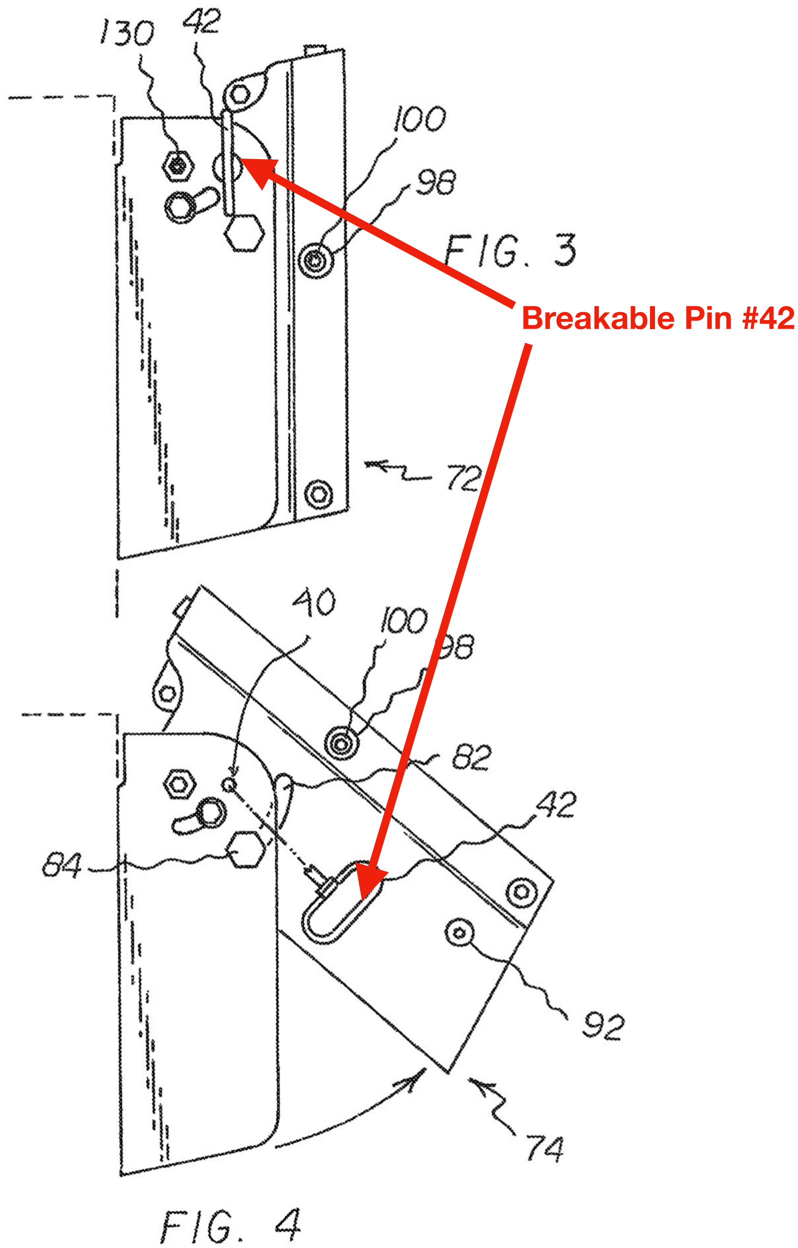

Figure S1-29: Pellini Breakaway Jack Plate U.S. Patent 10,220,926

A few months later, Mark Pelini was issued a related patent, **U.S. Patent 10,293,905** for a Breakaway Jack Plate on 21 May 2019. This version uses a breakaway pin #42 in conjunction with slots allowing the drive to swing up and then return back to its original position under gravity and force of the propeller. See **Figure S1-30**.

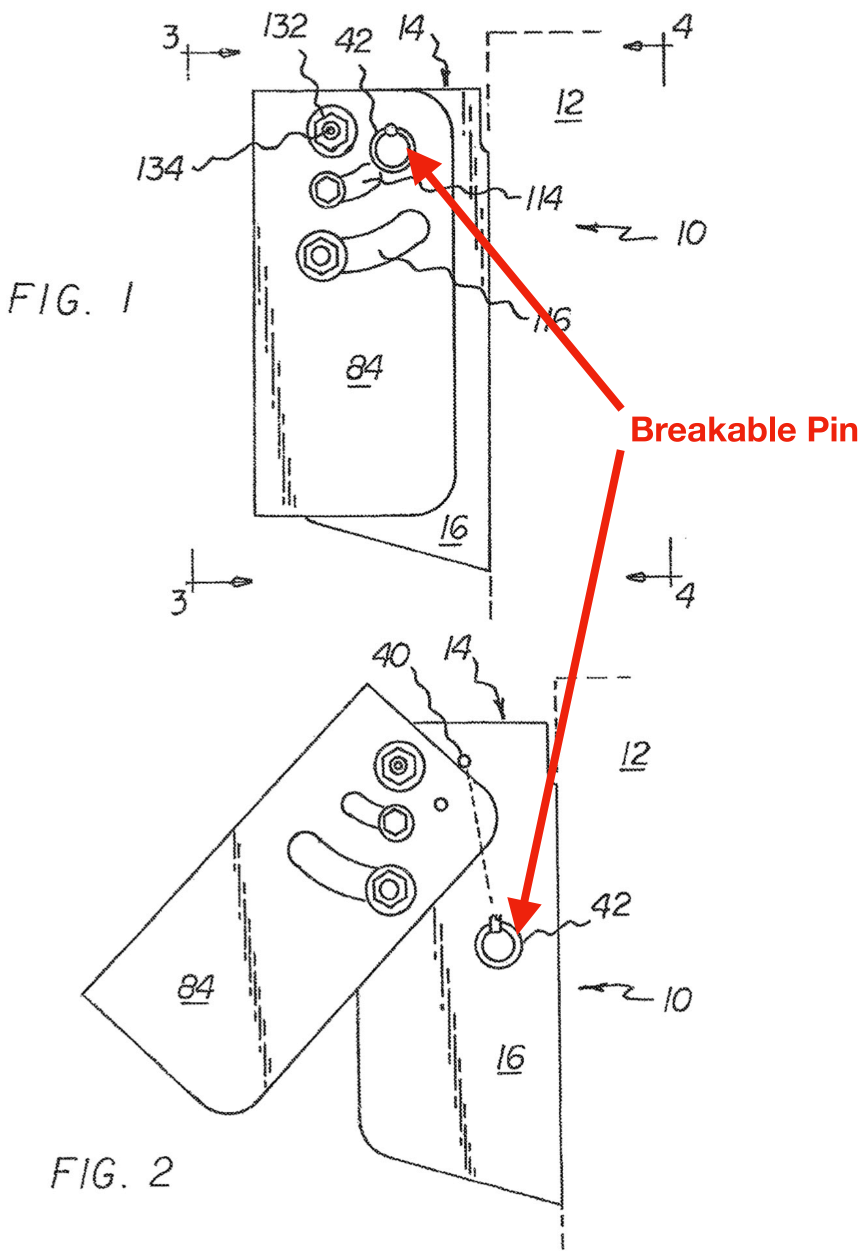

Figure S1-30: Pelini Breakaway Jack Plate
U.S. Patent 10,293,905

Daniel Vance, Jr. received **U.S. Patent 10,343,756** Outboard Engine Kick-up Jacking Plate on 9 July 2019. Tensioner assembly #140 is adjusted to let the drive swing up during severe impacts. The hydraulic jack plate can rotate up, but its rotation is limited by a limiting strap (chain #108) in **Figure S1-31**.

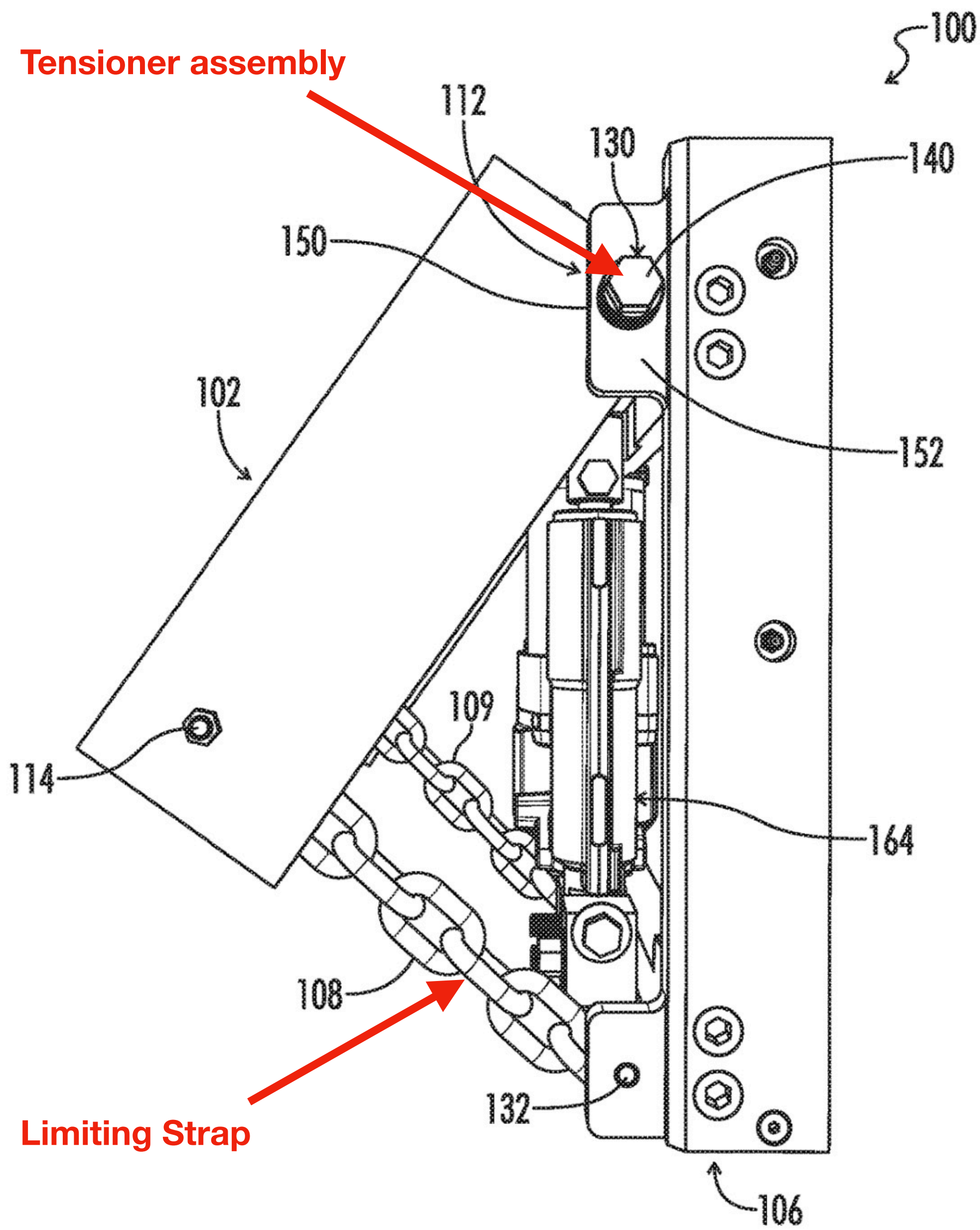

Figure S1-31: Vance Kick-up Jack Plate drawing U.S. Patent 10,343,756

11. Record Impact Data

CORRECTION - the only patent in this category in the third edition was incorrectly listed as belonging to Yamaha. It was a 2015 Suzuki patent on Page 167. We also noticed the Suzuki patent teaches automatically slowing or stopping the engine in severe impacts.

When we first created this category we anticipated these devices would purely record impacts. Now we recognize several systems both record impacts and take some action during severe impacts such as slowing or stopping the engine / propeller.

Brunswick / Mercury Marine

Brunswick received a pair of patents in this area in 2019 and 2020.

Sometimes those applying for patents try to patent both the device and what it does in the same patent. Sometimes patent attorneys or the patent office will encourage the inventor to split the patent into what they call a Method patent (how it works) and a System patent (the device itself).

Brunswick filed separate system and method patents for detecting and recording marine drive impacts including their severity. The unit then stores impacts and their severities, combines the current impact and severity with past impacts, determines the cumulative impact force, informs the operator of the need for maintenance or service, and estimates the remaining useful life of the marine drive. In some instances the system is designed to shut down the engine (stop the propeller) when an underwater impact occurs.

Both patents determine an underwater impact occurred and its severity by monitoring the rate of change of trim and comparing rate of change to a stored value.

The two Brunswick patents are:

1. **U.S. Patent 10,214,271** Systems and Methods for Monitoring Underwater Impacts to Marine Propulsion Devices. Issued 26 February 2019. This patent has the METHOD claims.

2. **U.S. Patent 10,577,068** Systems and Methods for Monitoring Underwater Impacts to Marine Propulsion Devices. Issued 3 March 2020. This patent has the SYSTEM claims.

Figures S1-32, S1-33, and **S1-34** come from Brunswick **U.S. Patent 10,214,271**.

(12) **United States Patent**
Gonring et al.

(10) **Patent No.: US 10,214,271 B1**
(45) **Date of Patent: Feb. 26, 2019**

(54) **SYSTEMS AND METHODS FOR MONITORING UNDERWATER IMPACTS TO MARINE PROPULSION DEVICES**

(71) Applicant: **Brunswick Corporation**, Lake Forest, IL (US)

(72) Inventors: **Steven J. Gonring**, Slinger, WI (US); **Mark D. Curtis**, West Bend, WI (US)

(73) Assignee: **Brunswick Corporation**, Mettawa, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/277,419**

(22) Filed: **Sep. 27, 2016**

(51) **Int. Cl.**

B63H 21/22	(2006.01)
B63H 23/00	(2006.01)
B63H 5/125	(2006.01)
B63H 20/08	(2006.01)
B63H 21/21	(2006.01)
B63H 20/10	(2006.01)
B63H 21/14	(2006.01)
B63J 99/00	(2009.01)

(52) **U.S. Cl.**
CPC ***B63H 21/21*** (2013.01); ***B63H 20/10*** (2013.01); ***B63H 21/14*** (2013.01); *B63H 2021/216* (2013.01); *B63J 2099/006* (2013.01)

(58) **Field of Classification Search**
CPC B63H 20/10; B63H 2020/10
USPC .... 440/1, 61 T
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,975,750 A *	3/1961	Smith	B63H 20/10 440/56
4,005,674 A	2/1977	Davis	
4,318,699 A	3/1982	Wenstadt et al.	
4,734,065 A *	3/1988	Nakahama	B63H 20/10 440/1
4,861,291 A *	8/1989	Koike	B63H 20/10 440/1
4,872,857 A	10/1989	Newman et al.	
4,931,025 A *	6/1990	Torigai	G05D 1/0875 440/1
4,955,831 A *	9/1990	Inoue	B63H 21/265 440/1
5,067,919 A *	11/1991	Okita	B63H 21/265 440/61 C
5,645,009 A *	7/1997	Lexau	B63H 21/265 114/274
6,109,986 A	8/2000	Gaynor et al.	
6,179,673 B1 *	1/2001	Leroux	B63H 20/106 440/65
6,200,177 B1	3/2001	Scott et al.	
6,273,771 B1	8/2001	Buckley et al.	

(Continued)

Primary Examiner — Daniel V Venne
(74) *Attorney, Agent, or Firm* — Andrus Intellectual Property Law, LLP

(57) **ABSTRACT**

Systems and methods are for monitoring underwater impacts to marine propulsion devices. The systems can comprise a marine propulsion device that is trimmable up and down about a trim axis; a trim sensor that senses at least one of a current trim position of the marine propulsion device relative to the trim axis and a rate at which the marine propulsion device is trimmed relative to the trim axis; and a controller that is configured to compare the rate at which the marine propulsion device is trimmed relative to the trim axis to a stored threshold value to thereby determine whether an underwater impact to the marine propulsion device has occurred.

13 Claims, 5 Drawing Sheets

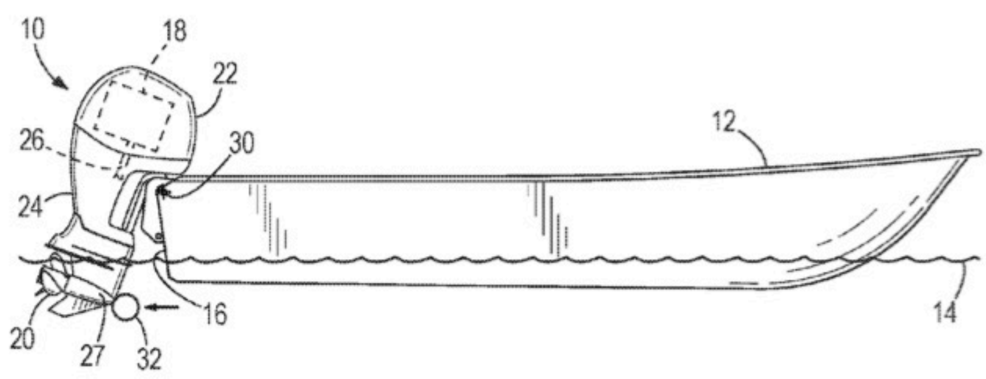

Figure S1-32: Brunswick Recording Patent drawing
U.S. Patent 10,214,271 - the method patent

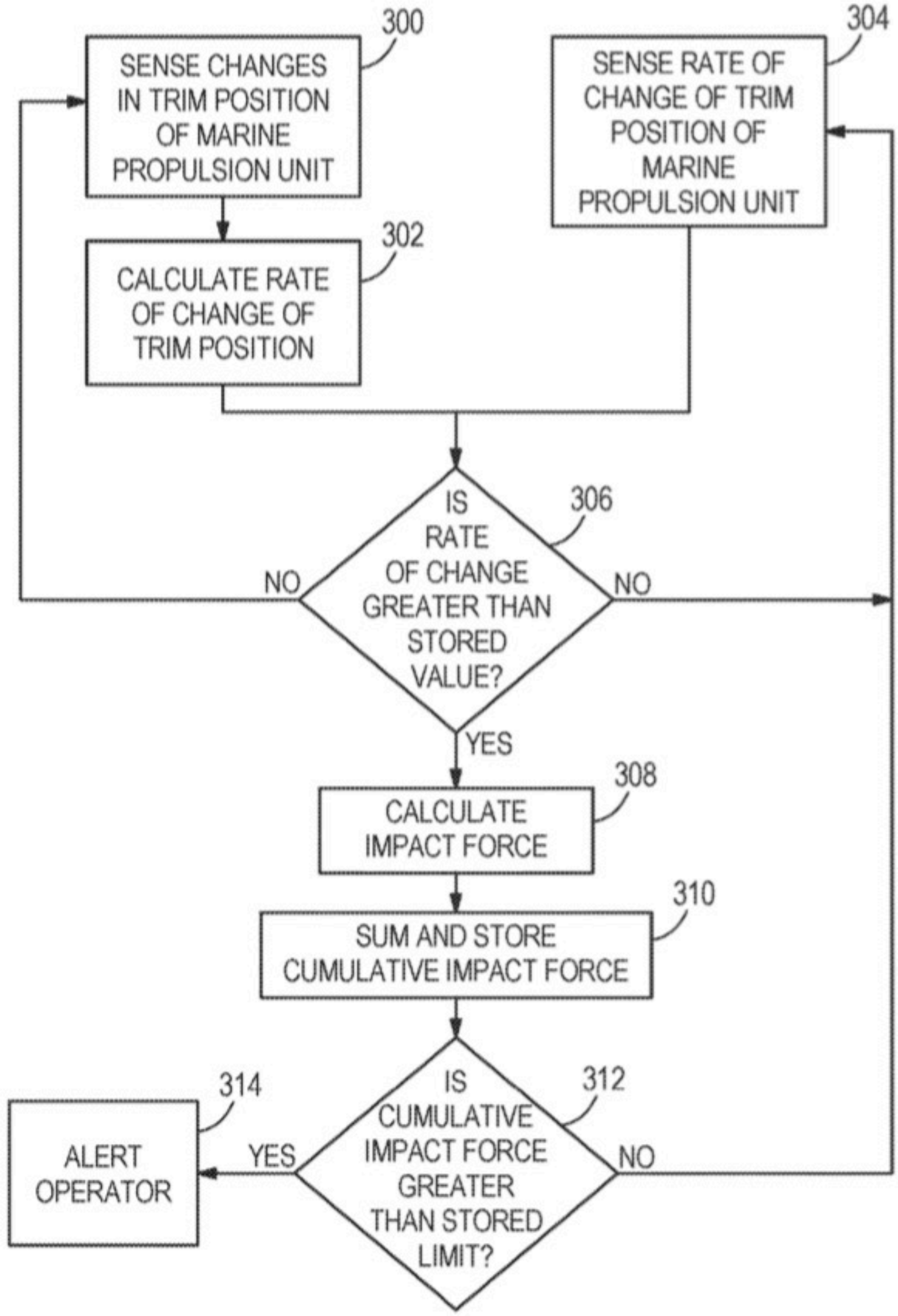

FIG. 7

Figure 33: Brunswick Recoding Patent Recording Logic
U.S. Patent 10,214,271 - the method patent

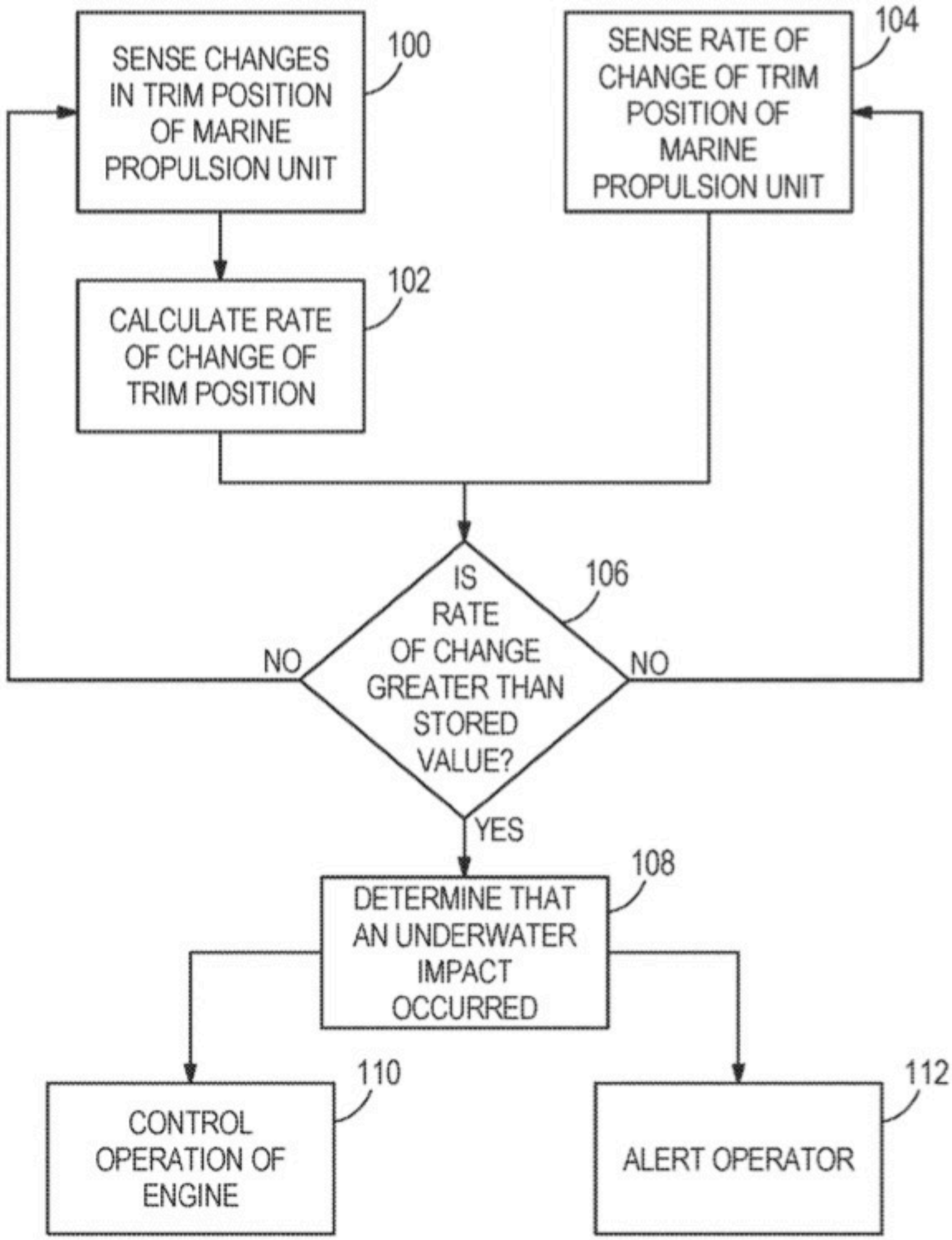

FIG. 5

Figure 34: Brunswick Recoding Patent Logic for Killing Engine U.S. Patent 10,214,271 - the method patent

Polson Enterprises / PropellerSafety.com

On 2 March 2019 we posted our “Log strike impact mapping / charting” invention. A quick description of the invention is below.

Quick Description - This invention proposes using technologies similar to those already patented by Suzuki and Brunswick to record log strikes, then share that data anonymously, and creates crowd sourced maps/ charts of the aggregated impacts. These crowd sourced maps could be printed paper maps as well as displayed on onboard navigational displays or other electronic devices. The maps portray relative risk of impact based on location.

We claimed the invention as published and placed all parts of it not previously patented in the public domain for all to use.

We would have followed this entry up here with some graphics and additional information, but just short of two months after we posted this invention, Honda was issued a U.S. Patent for a similar invention. Honda was granted yet another patent on this technology in 2020.

Honda obviously filed for their version of the invention before we published our version. We wish Honda well with their invention which is described on the next page.

Honda

Honda was issued two patents for a marine drive impact recording system:

1. **U.S. Patent 10,272,977** Boat Navigation Assist System, and Navigation Assist Apparatus and Server of the System. Issued 30 April 2019. **Later referred to as the '977 paten**t.

2. **U.S. Patent 10,746,552** Boat Navigation Assist System, and Navigation Assist Apparatus and Server of the System. Issued 18 August 2020. **Later referred to as the '552 patent.**

Earlier in this section it was noted that Brunswick elected to apply for both a Method and a Systems patent for their entry. By comparison, Honda has filed two patents, each of which covers the Apparatus (method) and System.

Their '977 patent teaches use of a trim position indicator possibly in combination with an accelerometer combined with a gps and other sensors to detect impacts and where they occurred.

Honda's '552 patent teaches quick turns at speed are indicative of objects in the water. Basically they sense quick turns at speed to predict near misses of water obstacles. When they predict a near miss, they log the location as a potential impact site. Honda's '552 patent teaches detecting quick turns in combination with a gps and other sensors including possibly an accelerometer to detect near misses and marine drive impacts and where they occurred.

Both systems alert the boat operator to impacts. The systems and their respective inputs to the control system (they call it the server) can be seen in **Figure S1-35** and **Figure S1-36** respectively.

Figure S1-37 from Honda's '997 patent shows how Honda can collect impact or near miss impact location data from many drives. With that data, Honda can then create grids on lake digital maps indicating relative risk of impact in individual grid cells and distribute those maps to others. Beyond color coding a digital map, different levels of alerts or warnings can be issued based on the level of risk in the cell the vessel is in or approaching. Earlier, as seen in the Polson Enterprises invention listed before this one, we taught a similar approach (except for including quick turns).

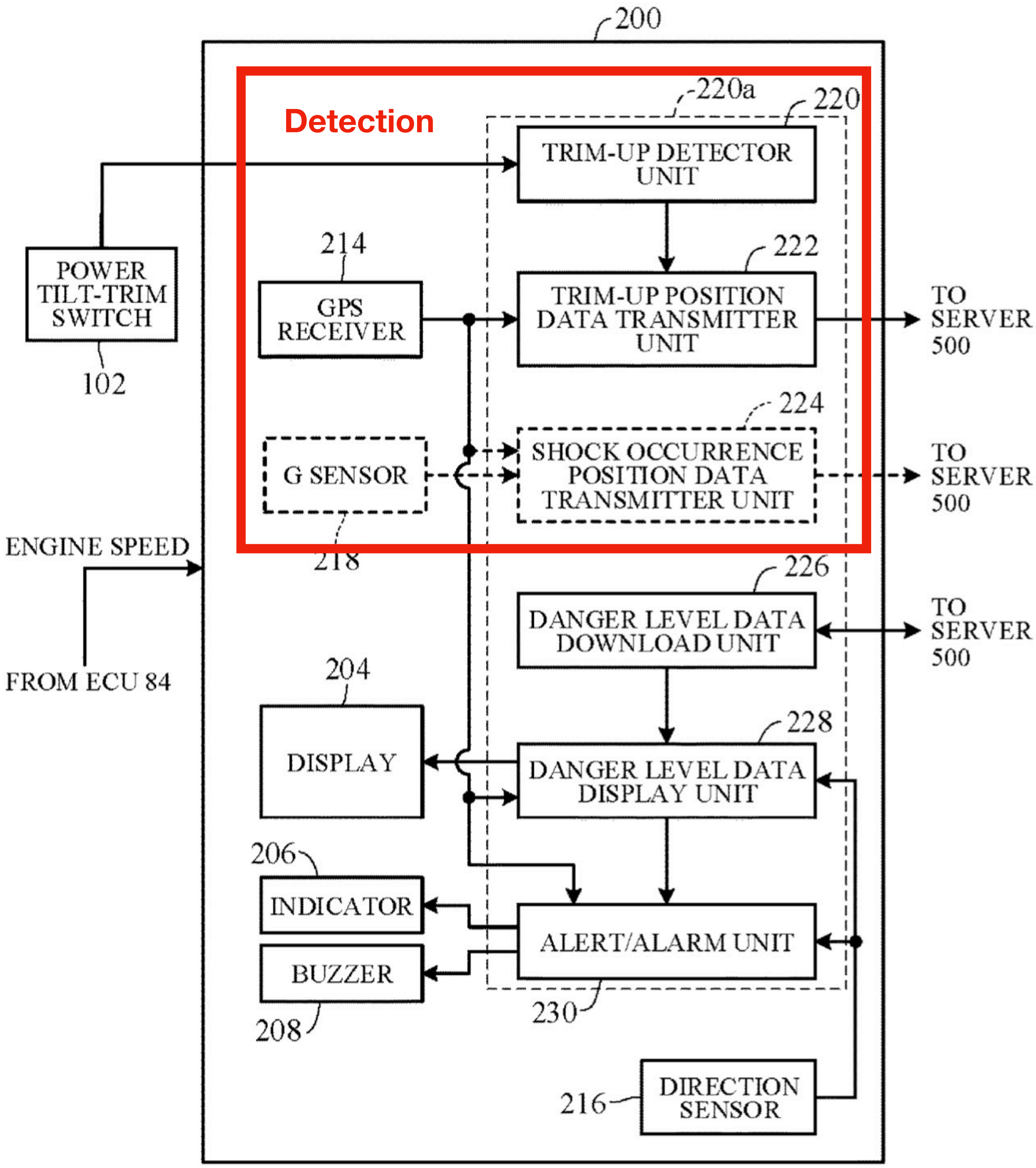

Figure S1-35: Honda U.S. Patent 10,272,977 sensor drawing
The Impact Recording Patent

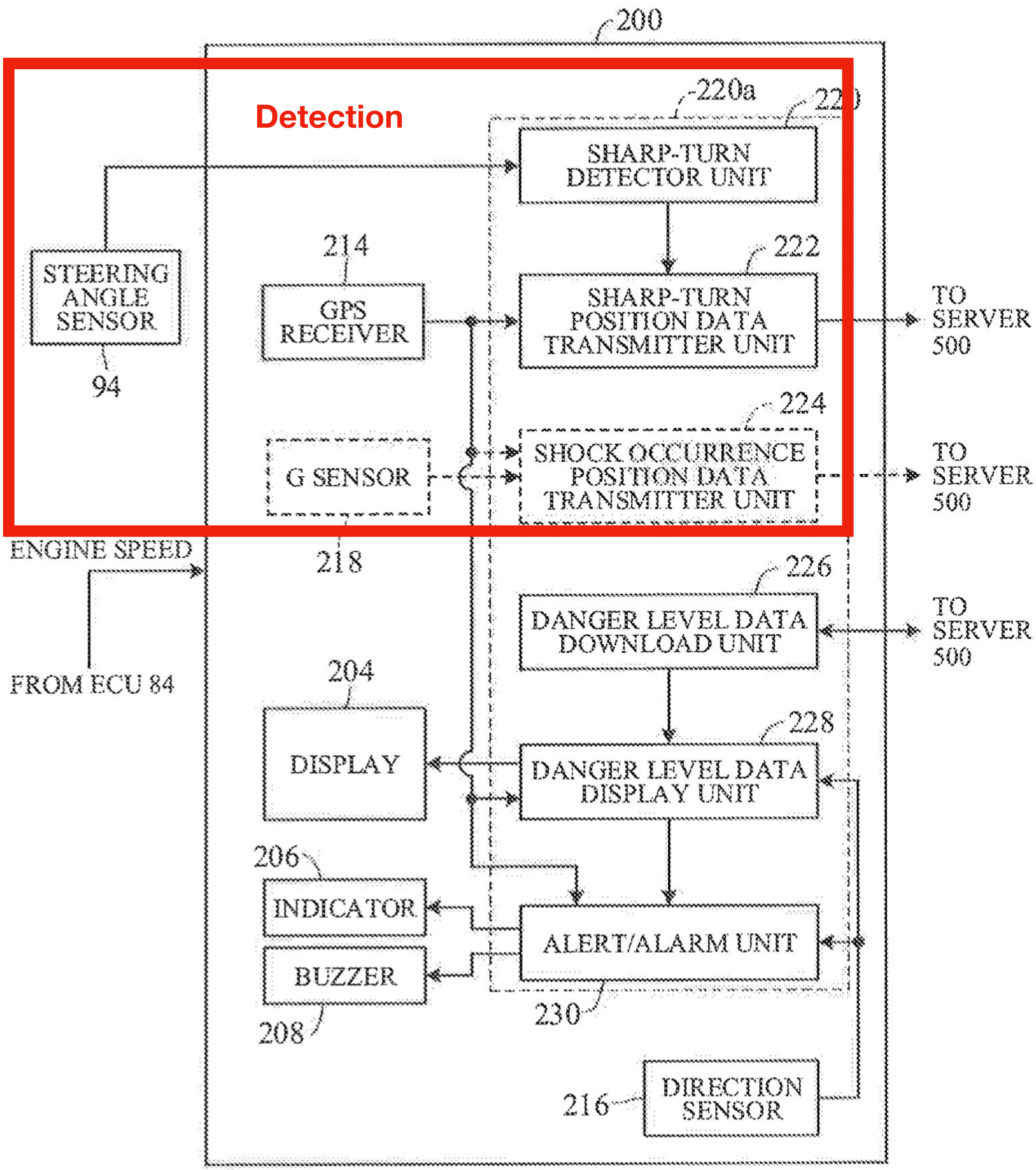

Figure S1-36: Honda U.S. Patent 10,746,552 sensor drawing
The Quick Turn & Impact Recording Patent

FIG. 8

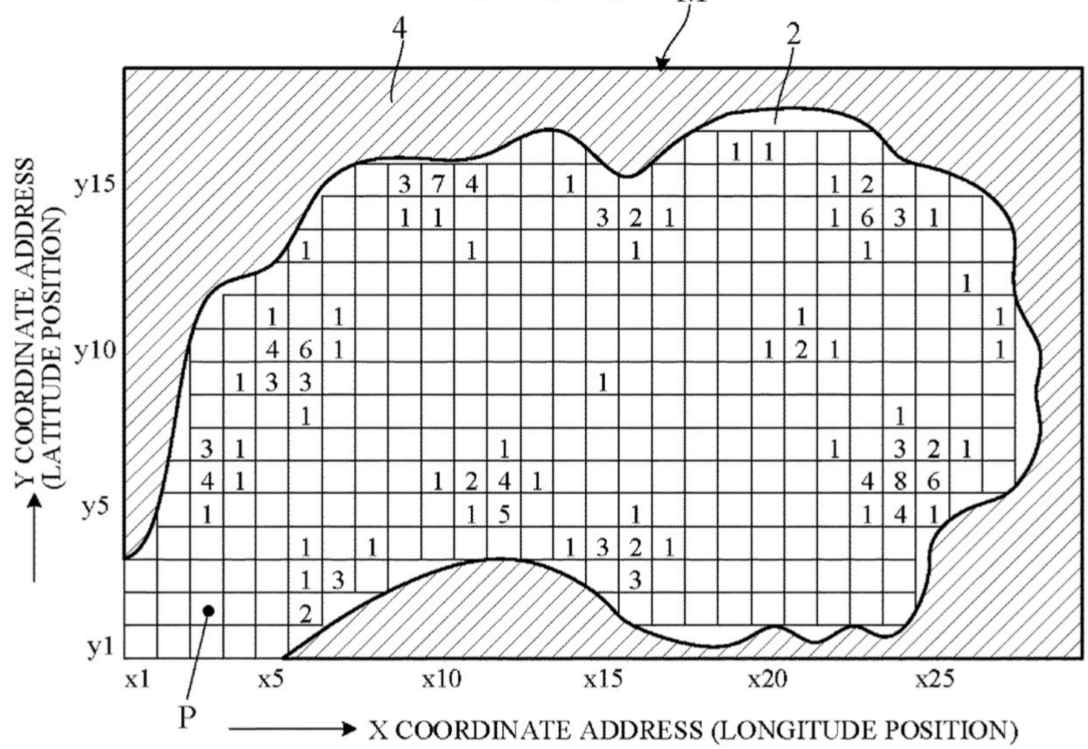

FIG. 9

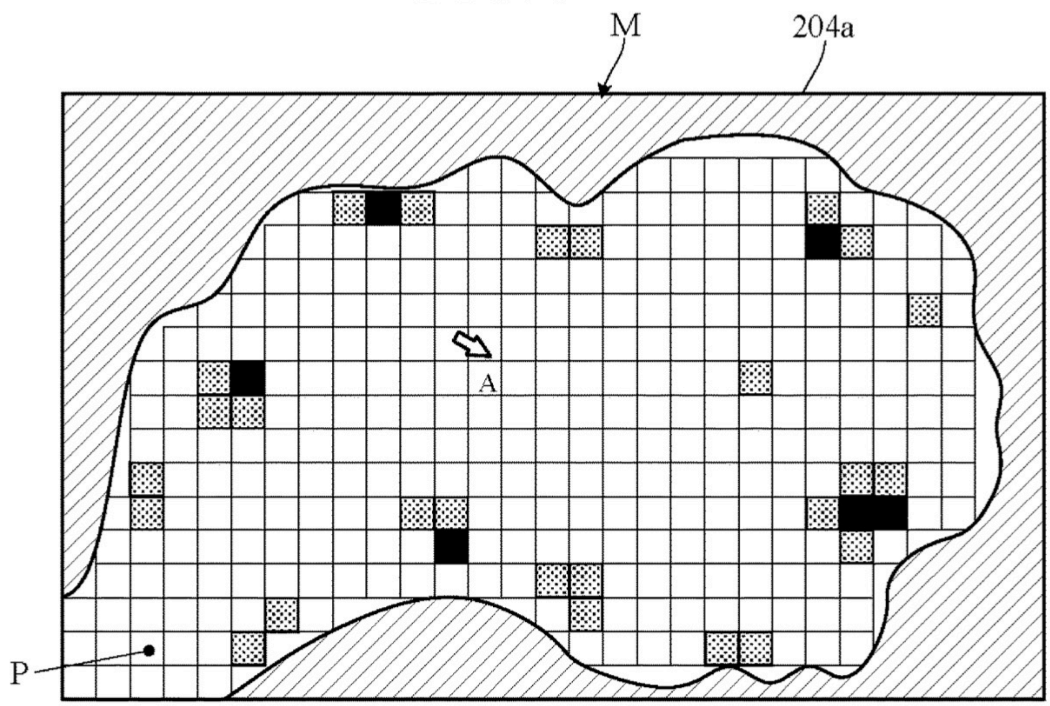

Figure S1-37: Honda Map Impact Grid Generated by Multiple Drives

Navico

Navico owns Lowrance and Simrad, which combine for a substantial piece of the recreational charting plotting and fish locating business.

Navico **U.S. Patent Application 2019/0353763** Impact Detection Devices and Methods was published 21 November 2019.

While the Navico patent applies to detecting impacts to recreational vessel sonar sensors and their housings, it is included here because it details how to detect impacts in the same environment as marine drives. It even includes detecting impacts to sonar units mounted on marine drives. See **Figure S1-38**.

Navico notes that impacts can damage the transducer or move it from its desired location affecting the quality or accuracy of its sonar returns. Some impacts may not be recognized by a boat operator when underway. Their system alerts the boat operator to sonar sensor or housing impacts via an alert, light, or buzzer and a second notification may be sent if the impact exceeds a predetermined threshold. The Navico patent teaches use of an accelerometer to detect impacts to their devices. A remote service may access the system, receive information from the system, and diagnose issues.

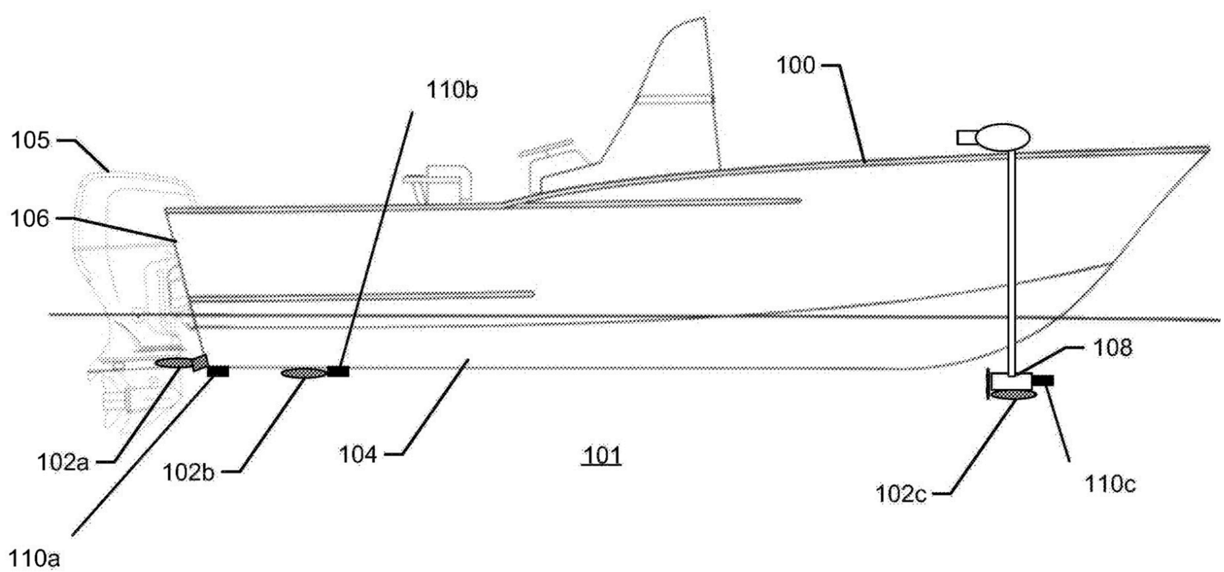

Figure S1-38: Navico patent showing potential locations of sonar devices and their exposure to underwater impacts

In Closing

We continue to encourage the boating industry to review all of these approaches plus any others they may be aware of and take action to prevent bass boat outboard motors from breaking off and flipping into boats.

If you are aware of any approaches or devices to prevent outboard motors from breaking off and flipping into bass boats striking floating or submerged obstacles not shown here or in our third edition, please call them to our attention using the contact us tab on PropellerSafety.com

The End