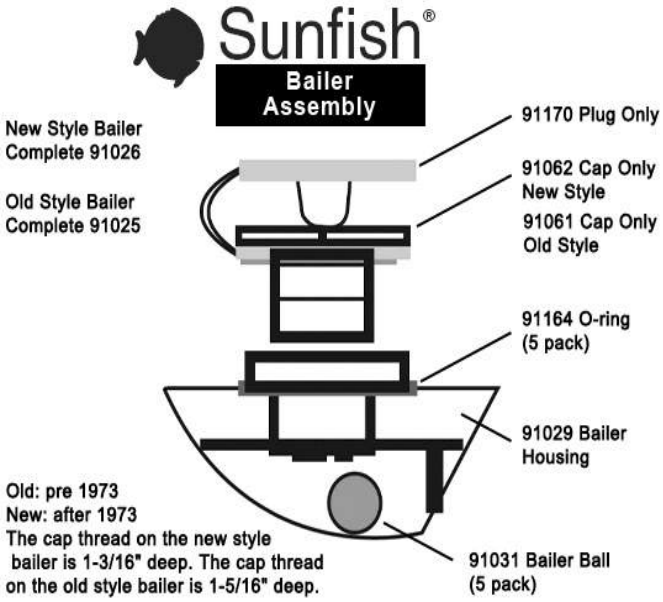
Part I: Rebuilding a Sunfish Plastic Bailer

The plastic Sunfish bailer replaced the metal DePersia bailer in 1971 (see the Appendix for information about the De Persia Patents). In general this was probably a good thing. The DePersia was expensive to manufacture and was prone to corrosion, with the vent cap sometimes (perhaps inevitably) fusing immovably to the bailer body. But there are issues with the plastic bailer as well. The main difficulty is that the plastic bailer is not as resistant to crush or grounding damage as the metal DePersia. The same plastic bailer was used on the AMF/Alcort Minifish (and the O'Day Javelin and Daysailer II & III, but with a longer screw-in cap). Because of the bailer location on the Minifish the chance of damage is even greater than with the Sunfish.



Bailer materials/details:
91029 Bailer Housing: *PVC plastic*
91061/**91062** Bailer Cap: *acetal? Nylon?*
91031 Bailer Ball: 5/8" *PMP/TPX?*
The specific gravity of PMP (polymethylpentene) is 0.83--a good choice for a floaty plastic ball

Note:
The bailer cap and housing are straight threaded 1" diameter x 16 TPI ("Threads Per Inch"). Commonly available 1" plumbing nipples, elbows, and adapters are *taper threaded* 14 TPI NPT ("National Pipe Taper"), and so plumbing adapters *will not fit* the threads of a stock Sunfish bailer.

An old plastic bailer to rebuild:

This bailer housing (complete with screw-in cap and plug) came with the 1983 Minifish I recently bought. As you can see, on the Minifish the bailer is located on the central keel molding just behind the centerboard slot (not the best placement as the bailer sits in the disturbed water flowing back from the centerboard). The bailer is actually the lowest part of the boat. As the old bailer shows, damage is almost certain in this location.

In 2017 a new Bailer Housing (part # 91029) only costs about $15, but I decided to try rebuilding a stronger version of the bailer for use on this boat.

Minifish bailer location

Materials:

The Sunfish bailer housing is made of polyvinyl chloride plastic (PVC). This plastic is inexpensive and widely available. PVC is relatively soft, is easy to cut and shape with hand tools, and can be solvent welded to itself. One of the handiest sources for PVC is white PVC plumbing pipe (and pipe fittings) from a nearby big box store. The plumbing department also sells the PVC cement to glue the pieces together.

Procedure:

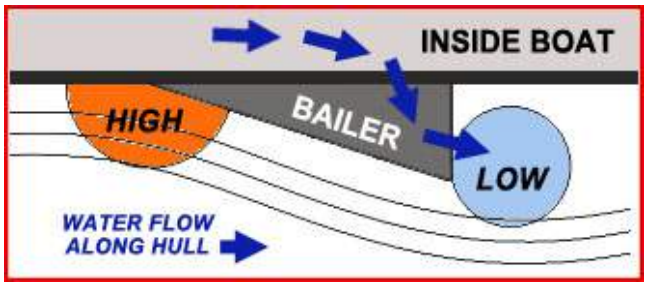
PVC is a thermoplastic: if heated to about 300° F. PVC will soften and become rubbery and flexible. If held to a new shape and allowed to cool the PVC will retain the new shape.

To rebuild the old damaged bailer I used 2″ Schedule 40 white PVC to make flat sheets. I glued the sheets together to build up the base of the bailer. I cut ~3″ long sections of pipe, then cut the sections lengthwise with a hacksaw. I stood a piece of pipe upright on a piece of flat 10 gauge steel from my scrap collection and heated the pipe inside and out with a heat gun, being careful to keep the gun moving (if the PVC is overheated or scorched it turns first yellow then brown). When the pipe was rubbery-soft I picked it up (wearing gloves) and flattened it out on the steel. I heated both sides again, then put another piece of steel on top of the flattened pipe, put the sandwich on the floor, and stood on it for a few minutes until the plastic was cool. If not nicely flat you can repeat the heating/sandwiching until you're happy with the result (you can check YouTube for videos under "flatten PVC"). A heat gun worked better for me than a toaster oven. Boiling PVC in water to soften it doesn't really get the plastic hot enough.

2″ Schedule 40 pipe yields flat pieces about 3/16″ thick. The pieces will be quite smooth on one side (the outside of the original pipe) and a little wavy on the other side (where the inside of the pipe was flow-molded in manufacturing). I block sanded the wavy sides of the pieces before gluing them into the thickness I needed. You can remove any printing on the pipe and clean the PVC before gluing by wiping the surfaces with acetone. I did not use PVC primer before gluing pieces together.

A flat PVC piece from 2" Schedule 40 pipe

How a self bailer works:



A self bailer works by disrupting the water flow under a hull--the bailer is just a streamlined bump on the hull with a hole inside leading from the hull out through the back of the bump. Water flow creates a high pressure area when it encounters the bump, and a turbulent, low pressure area as it swirls around behind the bump. The hole through the bump causes any water inside the hull (at atmospheric pressure) to flow toward the lower pressure area behind the bump, and so out of the boat. Self bailers work best on boats with shallow draft. Most begin to work as boat speed approaches about 4 mph, and work better as speed increases.

Rebuilding the old bailer's "bump":

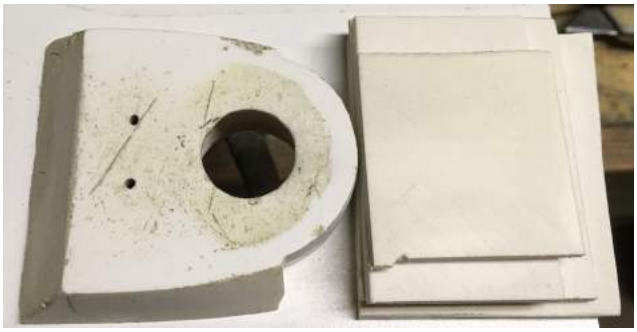
I needed to re-make the "bump" that was broken off the damaged bailer housing. I decided to use part of a 1-1/2" 90° PVC plumbing elbow:

Cutting the elbow on the band saw

Trying the elbow on the damaged bailer housing

Rebuilding the base of the housing:

I needed to clean up the damaged housing and make a new nose for the baseplate.



Cleaned-up housing with stack of PVC pieces

Glued PVC stack ready to glue to housing

Finishing the bailer rebuild:

Elbow ready for gluing to bailer housing

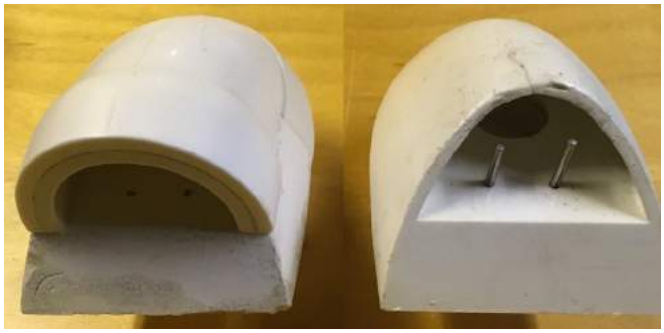
Bailer housing with a solid nose

Elbow flange somewhat faired

I left the original flange on the elbow piece so that I could glue a half-round strip of 1-1/2″ pipe into it to make the open end of the elbow double-thick (and thus hopefully stronger than the stock bailer). I faired the molded lip of the flange a bit, but this bailer will not be as hydrodynamically slippery as the stock bailer.

Ball retaining pins yet to be reinstalled

Rebuilt bailer Stock bailer



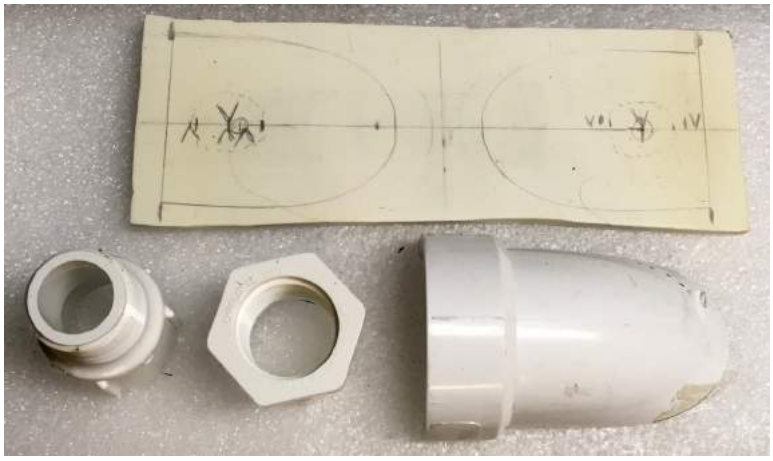
Rebuilt bailer Stock bailer

Part II: Building a Replacement PVC Bailer

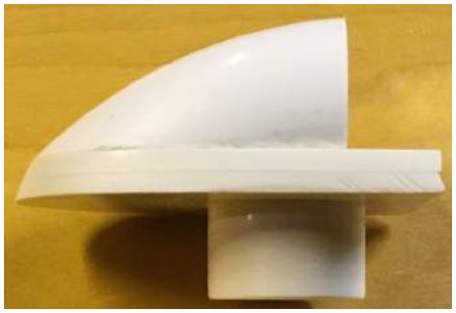
Having rebuilt a badly damaged Sunfish plastic bailer I thought I would try building a new PVC bailer in the approximate size and style of the factory bailer (if you plan to race, a bailer like this is obviously not Class legal). Using mostly scrap and on-hand materials the cost of this bailer was less than $5.

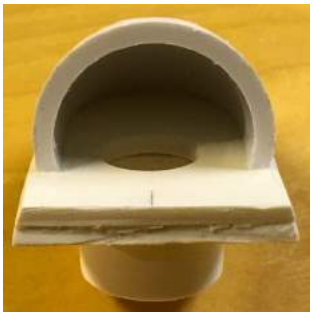
This bailer will seal to the hull with a thin flatiron-shaped EPDM gasket glued to the housing and a thick neoprene washer under the screw-in cap. The 3/4″ threaded male adapter used to make the cap has a bore of 11/16″ (a bit larger than the stock bailer bore of 9/16″).

If you make a bailer like this using PVC plumbing adapters you must factor in the thickness of the your hull. A problem using adapters is that the tapered NPT threads of the cap will bottom out in the housing in only about 1/4″--i.e., the cap of this bailer will only "take up" about 1/4″ (the straight-threaded 91062 stock bailer will tighten almost 1/2″). The hull of the Minifish is almost 3/4″ thick at the bailer hole, so I left the female adapter glued to the housing long enough to reach almost through the hull hole. The 1/4″ take up is enough to compress the EPDM and neoprene gaskets.



PVC sheet (from 2" Schedule 40 pipe); top of a 1-1/2" 90° PVC elbow; 3/4" NPT threaded PVC adapters





Housing glued up

Housing and cap finished; all pieces made of PVC

Three bailers compared:

Rebuilt bailer New bailer Stock bailer

Rebuilt bailer New bailer Stock bailer

Part III: Building a Scupper Bailer

The major advantages of the stock Sunfish bailer are that it is readily available, easy to replace, and Class legal for those who race.

The stock Sunfish bailer does have some shortcomings. It's relatively expensive to replace (about $45 in 2017) and is somewhat prone to damage. It's also not as efficient as it might be. The bore through the screw-in cap is only about 9/16" diameter, and the bailer balls (especially the newer balls with the rubber perimeter seals) partially obstruct the bore. Leaves, weed, or litter in the cockpit can obstruct or even clog the smallish drainage hole in the cap. If the bailer O-ring is new and the hull is in good condition around the through-hull hole the bailer seals well to the boat, but a tattered O-ring or chipped or gouged gelcoat/laminate around the hole can cause the bailer housing to leak or twist. Some people just use silicone or (even better) 3M 4200 adhesive to adhere the housing to the hull.

There are a number of dinghy bailers that *could* be adapted to a Sunfish (from Sea Sure, Elvstrom/Andersen, Super Shute, Topper, Allen/Delta, etc.), but this would usually mean cutting a rectangular hole in the hull and bonding or mechanically fastening the bailer in place. These bailers have issues of their own. Most cost 2-3 times (or more) as much as the plastic Sunfish bailer, and installing one can create a hard spot on the hull. Most metal through-hull bailers are not very feet-friendly either.

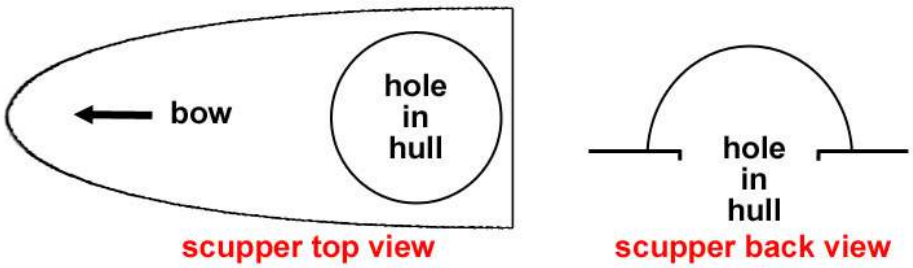
Surfski paddlers solved the bailer problem years ago by using simple scupper bailers. These bailers work well and are cheap and easy to build.

Molded
thermoplastic scupper bailer

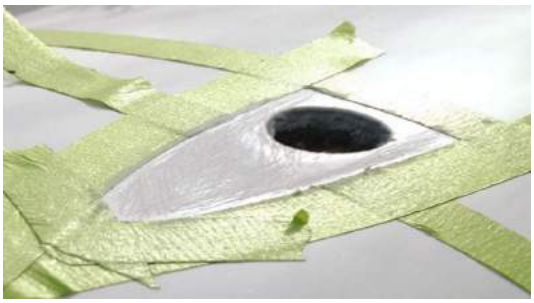
A scupper bailer is just a streamlined hood bonded over a hole in the hull. The rear open end of the hood creates the low pressure area that drains water from inside the moving boat.

Adding a scupper bailer:

A scupper bailer is easy to add to a Sunfish. The hole in the hull for a stock Sunfish bailer is usually about 1-1/16" diameter. This size hole will work, but the hole could be reduced a bit in size by filling and re-drilling. Most surfski bailers are installed over holes from about 1/2" to 3/4" in diameter. With any scupper, the hood should just cover the hole in the hull. If the hole is 1-1/16" in diameter, the rear, open end of the finished scupper would be a half circle about 1-3/8" to 1-5/8" in diameter.



Building a scupper bailer:



Draw the shape of the scupper footprint on the hull over the existing bailer hole, with the hole quite close to the open end of the scupper:

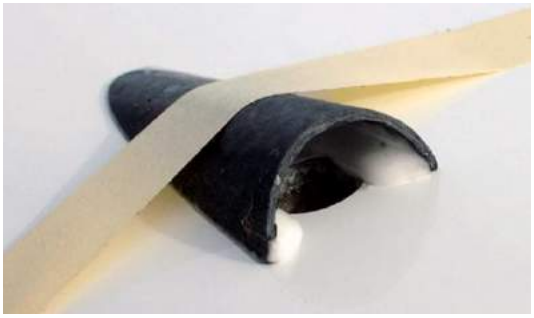
Sand the gelcoat/laminate around the outside of the scupper footprint drawn on the hull to provide a good bonding surface. Tape the hull outside of the bonding area to protect against resin drips. Create a male mold for the scupper from modeling clay, wax, or fine-grained insulation foam stuck to the hull over the scupper footprint. Fair the mold material to a nice teardrop/catenary shape.

Foam as a male mold

Lay up a strong laminate over the mold, extending the laminate 3/4" or more on to the sanded hull to bond the new scupper in place. If using rigid styrene-based insulation foam as a mold be aware that both polyester and vinylester resin will dissolve the foam (epoxy will not). If using polyester or vinylester a trick is to coat the foam with melted wax. Multiple layers are probably needed, but the wax will protect the foam from the resin and the wax can be gently scraped to a nice smoothness before laminating.

An alternate method of molding a scupper hood is to wrap a piece of 1-1/4" PVC pipe or 1-5/16" wooden closet rod with fiberglass (or carbon fiber, etc. etc.) to make a pipe-like lamination, and then to cut a slice from the lamination at an acute angle. The cut piece of the lamination forms the hood, and can be glued over the hull hole with epoxy paste.

Slice of fiberglass pipe



Carbon fiber hood

Carbon fiber scupper Installed

Layup schedule:

Remember that with composite laminates thickness = rigidity, and a high ratio of reinforcement-to-resin = strength. You want both. The finished scupper laminate should be stiff and gutsy, probably measuring at least 1/8″ thick. A laminate this thick will require a number of layers if made entirely with cloth. Commonly accepted layup rules-of-thumb suggest:

7.5 oz/yd^2 fiberglass plain weave cloth...	needs ~10 layers for 1/8″ thickness
10 oz/yd^2 fiberglass plain weave cloth...	needs ~7 layers for 1/8″ thickness
6 oz/yd^2 carbon fiber twill...	needs ~10 layers for 1/8″ thickness
5 oz/yd^2 Kevlar plain weave cloth...	needs ~10 layers for 1/8″ thickness
2 oz/yd^2 CSM (chopped strand mat)...	needs ~2 layers for 1/8″ thickness

(if using epoxy resin with CSM, be sure the CSM binder will dissolve in epoxy)

An all CSM layup would be a bad choice here (not enough reinforcement), but some mat could be sandwiched with layers of fabric to bulk up the laminate.

There are some tricks to working with fiberglass. One is to cut fiberglass fabric on the bias to help the cloth lay snugly against complex curves. Another is to lay plastic wrap over the wet laminate. The plastic wrap lets you work out bubbles, consolidate the layup, and smooth the surface so that less final finishing is needed.

If you molded directly to the hull, when the lamination has cured dig out the clay, wax, or foam that formed the male mold and sand smooth the scupper hood and the joint with the hull. If you sand into the fabric in the laminate don't leave it exposed--give it a final coat of resin. Trim the back open end of the hood to a crisp edge--the sharper the edge (within reason) the larger the low pressure area behind the scupper and the stronger the bailer suction. A good bailer gurgles as it works.

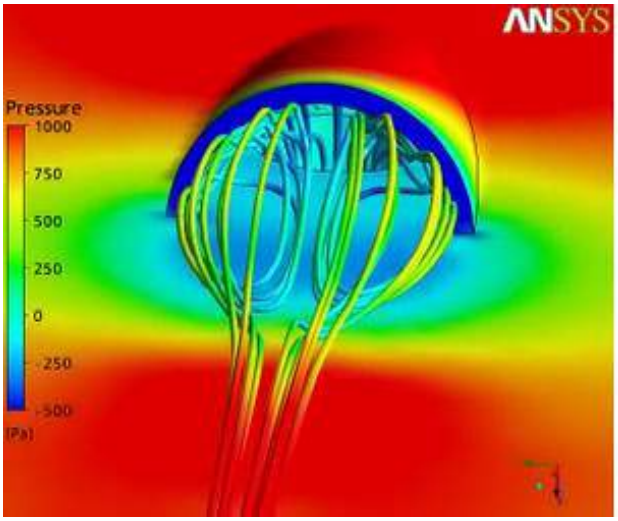
No float valve!

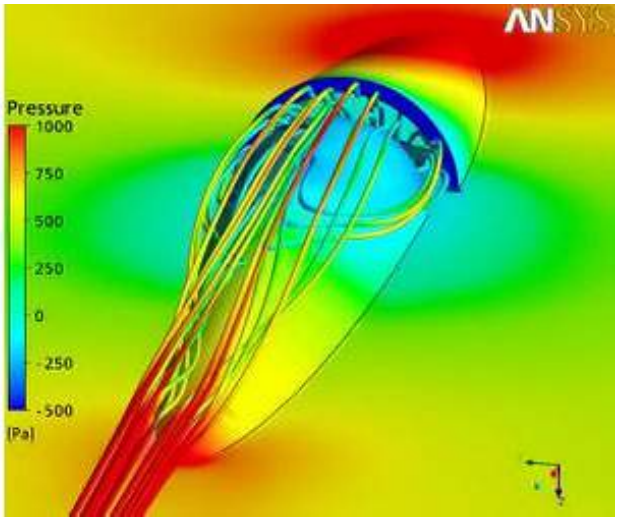
Simple scupper bailers don't use float valves. If the boat stops moving or moves too slowly the cockpit will take on water. Find a plug for the through-the-hull hole that opens into the scupper. Bailer holes in Sunfish and Minifish are usually about 1-1/16″ in diameter. The plug could be rubber or firm closed-cell foam--anything that's easy to stuff in the hole and gentle to your feet when you step on it. Think about a plug retaining cord glassed to the cockpit floor or tied to the hiking strap.

Scupper bailers with "bullets":

Many surfski paddlers use scupper bailers with "bullets." A bullet is a streamlined molding bonded to the hull just behind the scupper bailer. Tests show that bullets increase the low pressure area behind the scupper and thus the efficiency of the bailer.

Scupper bailers with bullets





Flow diagram simulations (from: ***http://tinyurl.com/zwljon6***)**:**

Left: a scupper bailer without a bullet. Water flow curls and recirculates in the low pressure area (in blue) behind the scupper.

Right: a scupper with a bullet close behind it. Water still recirculates behind the scupper, but flow soon straightens and streams away over the bullet, and the blue low pressure area is larger.

The simulation referenced above suggests that adding a bullet behind a scupper bailer is a good thing all around. Adding a bullet decreases the boat speed at which the bailer begins to work (by as much as 10%), increases bailer flow at increased boat speeds (by as much as 40% at 5.5 mph), and reduces bailer pressure drag (by as much as 60%).

Typical scupper/bullet dimensions:

scupper hood: 2-7/8″ long x 1-3/8″ wide (at the rear opening)

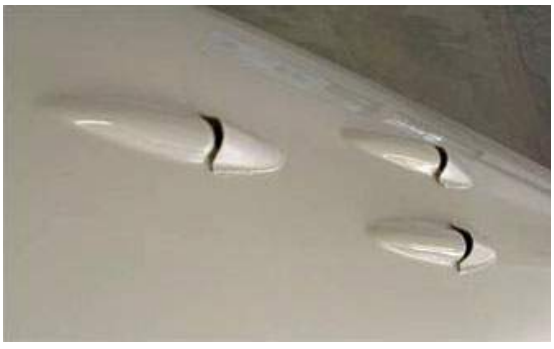
scupper bullet: 4-1/2″ long x 1-1/16″ wide
(The rear of the scupper should just cover the through-hull hole. The front of the bullet should nearly touch the through-hull hole.)

Other scupper bailers:

Scupper bailer and bullet made of PVC pipe

All-in-one 3-D printed combo scupper + bullet
5” long, 1-5/16” wide, 1/2” high
designed for 3/4” hole

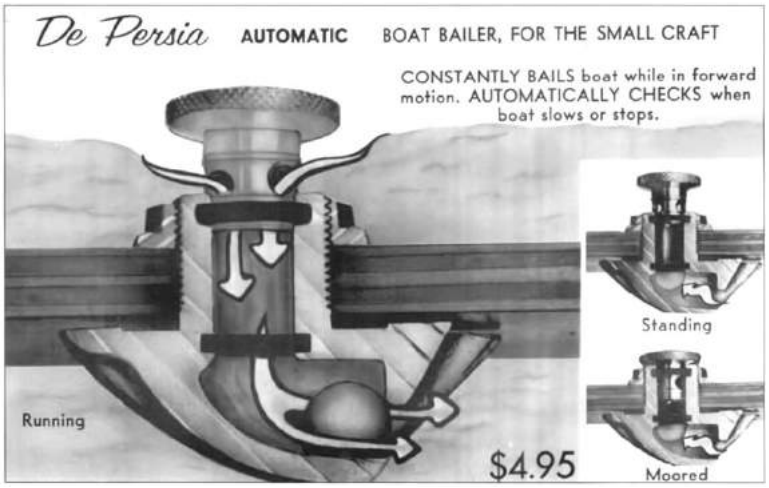
A different look



Too many scuppers (?)

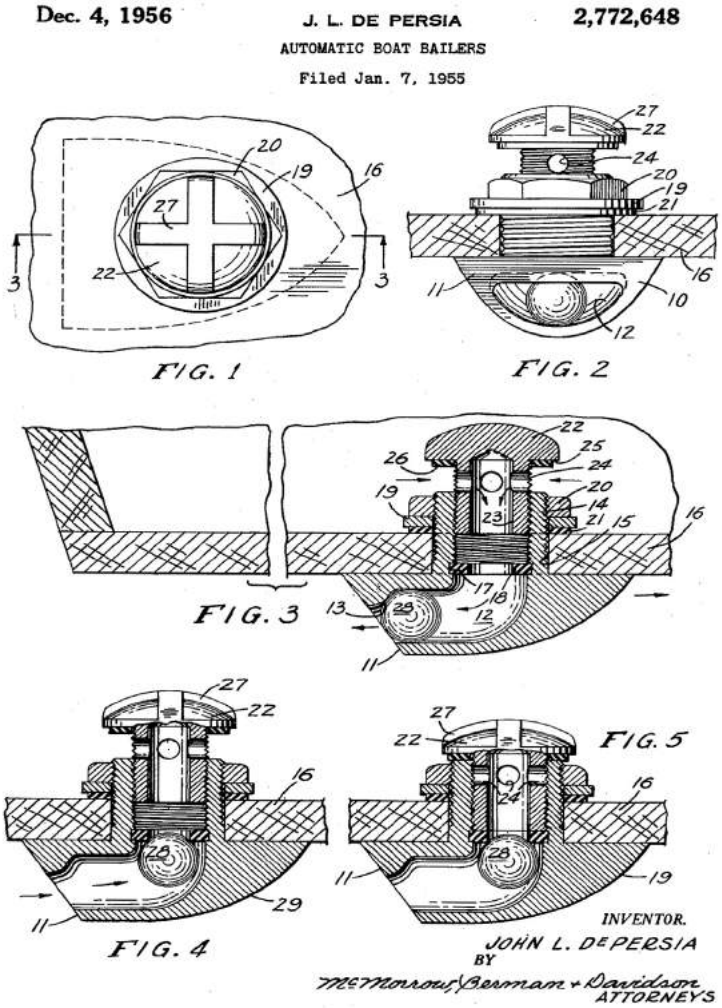
Appendix: De Persia Boat & Boat Bailer Patents

(John L. De Persia • 12/2/1909 - 4/25/1989)

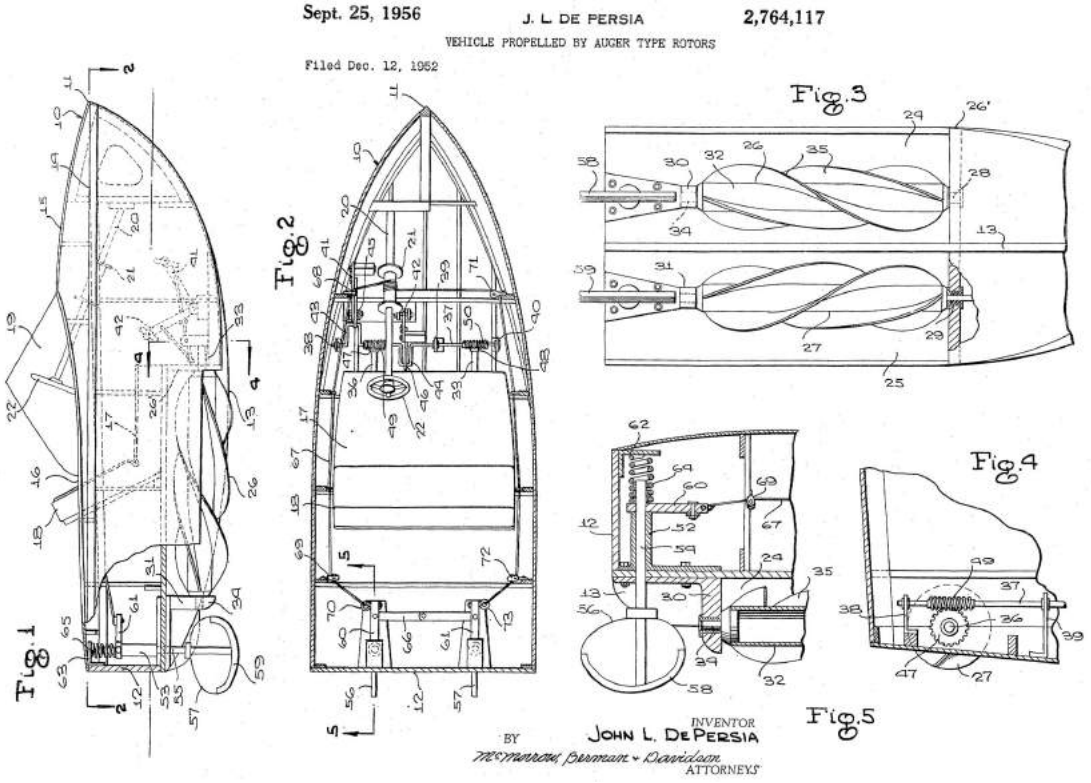


1965 advertising postcard for the De Persia bailer... only $4.95!

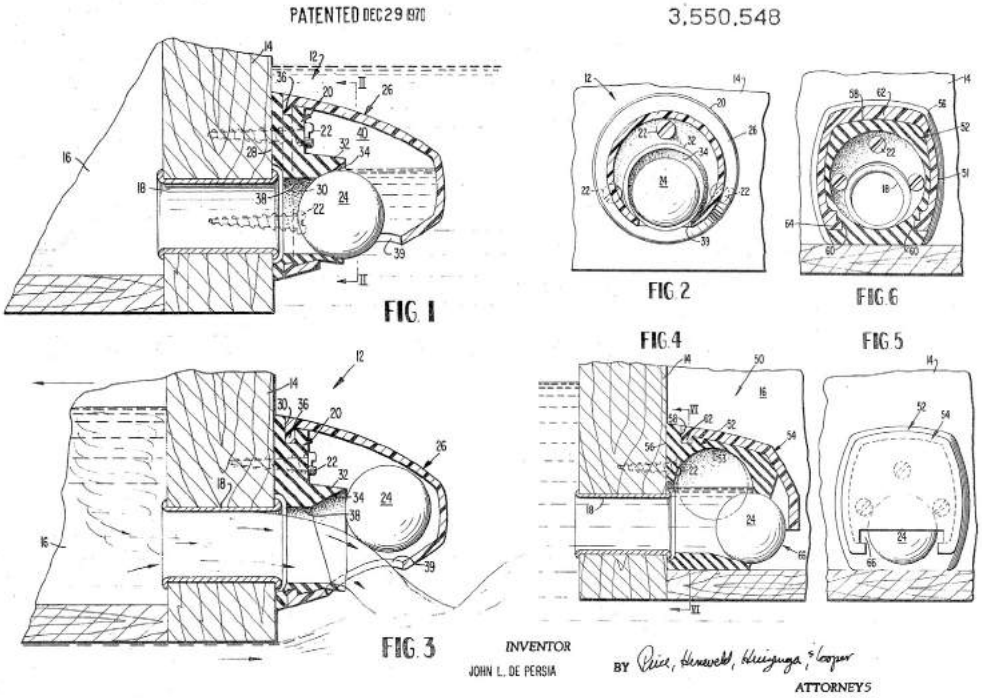
Patent 2,772,648 (1956) "The primary object of the present invention is to provide a boat bailer which will automatically suck water out of the boat bilge as the boat moves through the water, and one which can also be used to drain water from rowboats, canoes, or the like, when the latter are beached."

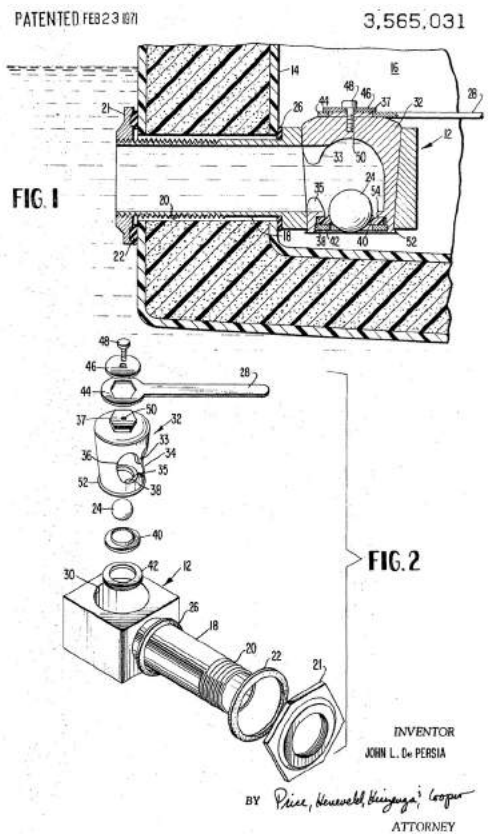


Patent 2,764,117 (1956) "This invention relates to a vehicle propelled by auger type rotors and more particularly to such a vehicle arranged to function as a boat in water or as a sled on ice."

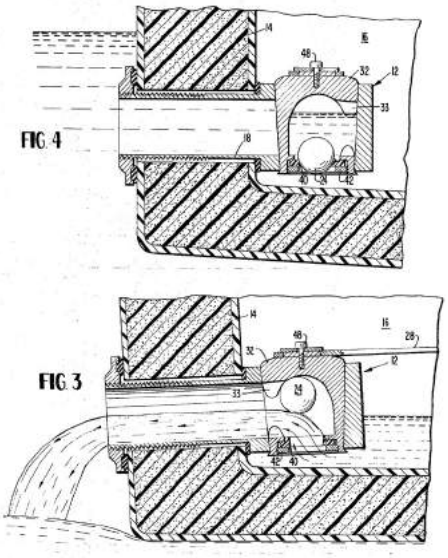


Patent 3,550,548 (1970) "l have now discovered a bailer which can be attached to the back wall of a boat by using a resilient seat member and a casing in snap-fit engagement with the seat member, and a check valve within a conduit through the seat member and the casing."

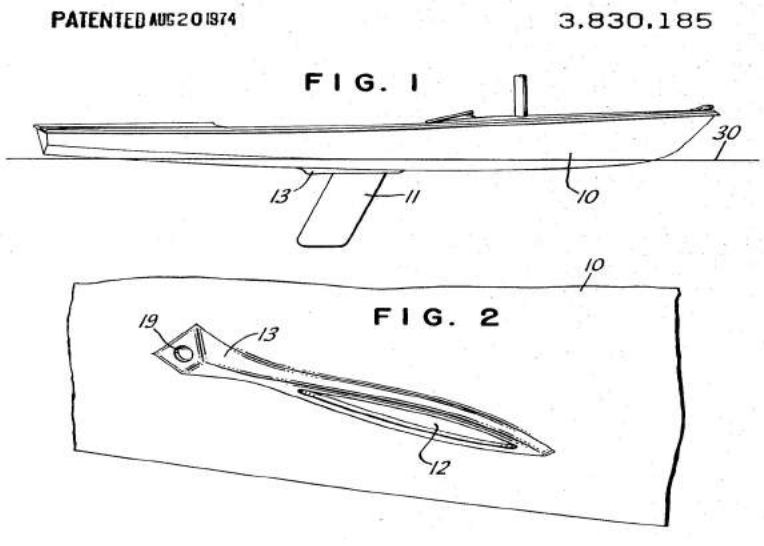


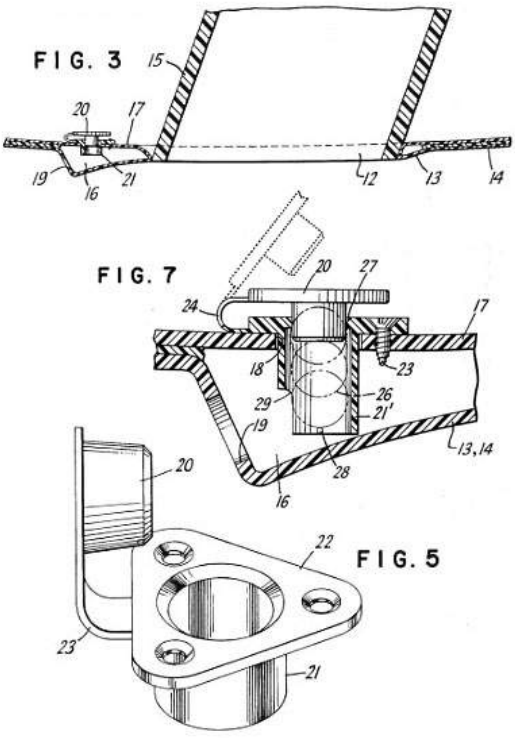


Patent 3,565,031 (1971) "This disclosure relates to a boat bailer adapted to be remotely controlled through an external handle so that the bailer can be positioned beneath the back seat of a boat or otherwise out of view."



Patent 3,830,185 (1974) "An integral fish shaped fairing blister is formed on the outside bottom surface of the boat about the daggerboard opening. The tail fin is hollow and has a rear facing exit opening. Another exit opening is formed in the inside bottom surface of the boat above the hollow tail fin. Either one of these exit openings is provided with a manually or automatically operable closure to bail the boat when under way".





This Patent was assigned to AMF. This is the bailer design used for the AMF/Alcort Force 5 sailboat. The setup is not very well regarded--the hull protrusion is subject to damage, and the bailer sits in the disturbed water flow right behind the centerboard.