TECH NOTE: TYPES OF VIEWPORTS

There are three basic shapes for viewports: flat, conical, and spherical (domed). Of course, each has its advantages and disadvantages.

Flat Ports: These flat windows are easy to fabricate and install. They offer the least strength, so are used in shallow-water applications. Like windows on land, they are often made of glass, but are small in diameter and can be quite thick.

Conical Ports: These cone-shaped ports are widely used down to full ocean depth. The window is seated in the conical flange with an O-ring seal, an arrangement that allows more than 60 percent of the viewport to be supported against pressure by the flange, affording a large viewing area and minimizing the area subjected to direct sea pressure. Typically, sizes are 15–30 centimeters (approx. 6–12 in) in diameter on the outside face and 7–10 centimeters (approx. 3–4 in) on the inside face. August Piccard used conical viewports when designing *Trieste*.

Spherical (Dome) Ports: This type of viewport has the largest viewing area and best resistance to water pressure for its area. These ports can be as small as 5 centimeters (approx. 2 in) in diameter for underwater camera housings and as large as the huge 1.8-meter (approx. 6-ft) diameter domes in shallow-water tourist submarines. For submersibles diving to 330 meters (approx. 1,000 ft), the spherical ports are normally 60–90 centimeters (approx. 2–3 ft) in diameter.

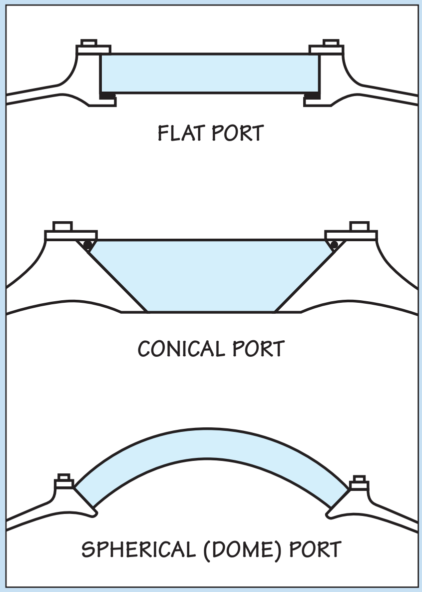

Figure 5.37: Types of Viewports

6.3. Pressure Can Access

Pressure canisters are usually designed to carry electrical and electronic components. Because these cans are smaller than pressure hulls—as small as 2.5 centimeters (approx. 1 in) in diameter and 5 centimeters (approx. 2 in) long—they can be made from lighter materials, such as PVC, Delrin, GRP, titanium, stainless steel, and aluminum. Their smaller size also makes them easy to fabricate in a small machine shop. Admittedly, there is no designated maximum size for a canister, so the distinction between canister and pressure hull can get somewhat blurry.

The dimensions of the pipe are determined by the components inside, and the thickness of the pipe wall is determined by the depth at which the can will operate. The endcap has to be equally robust, but it must also be easy to remove and reinstall for canister access and servicing.

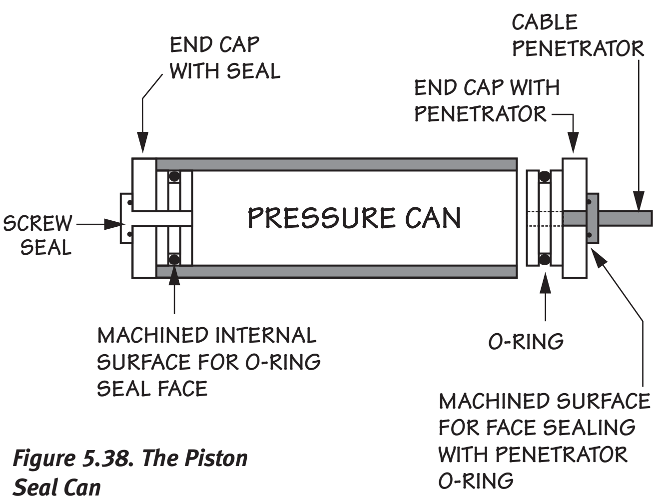

Figure 5.38. The Piston Seal Can

The three most common styles of pressure canisters, categorized by their method of sealing, are as follows:

6.3.1. Piston Seal

In a **piston seal** can, part of the endcap fits down inside the end of the cylindrical can, like a piston in a cylinder. An O-ring sandwiched between the "piston" and the inside of the can creates a waterproof seal. Piston seals work well because external water pressure compresses the diameter of the can slightly, squeezing the O-ring. As with other O-ring seals, the internal and piston seal surfaces must be machined to 1/1000th of an inch tolerance and must be smooth and free of sharp edges. Most O-ring failures occur because they are nicked on insertion and/or because dirt or hair gets caught in the O-ring groove.

6.3.2. Flange/Face

A **flange** or **face seal** can is relatively easy to fabricate without a lathe or other expensive tools and therefore makes an ideal choice for small-scale, low-budget projects. In this type of can, a flat flange is glued or welded to the end of the can. An O-ring or flat rubber gasket is then sandwiched between this flange and a flat plate serving as the endcap. Retaining bolts clamp the end plate to the flange, squeezing the O-ring or gasket. The retaining bolts and water pressure all function to squeeze the O-ring against the flange-sealing surface. Because the seal surface is easy to maintain and remove, it is the workhorse can for many ROVs. These cans can be 1 atm inside, but are also easily adapted for oil-filled or air-compensated use. (See Section 7.)

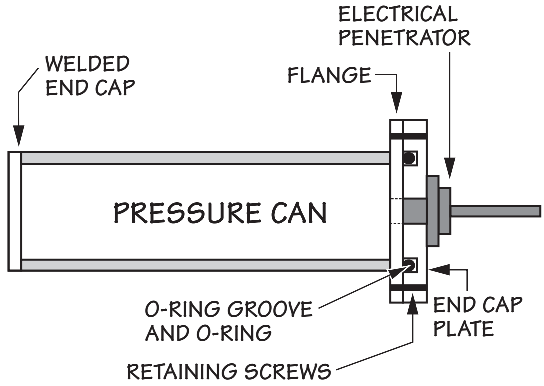

Figure 5.39. Flange or Face Seal Can

6.3.3. Jam Jar Variation

"Jam jar" refers to common glass jars used for home-canning, where such a jar is sealed by means of a gasket and a lid that screws down onto the mouth of the jar. In the underwater version, a threaded endcap is screwed down onto an O-ring located in a shallow hollow at the base of the threads on the can. The endcap has a groove that fits snugly around the O-ring when tightened. This effective shallow-water seal is commonly found on waterproof flashlights.

Upon surfacing, any internal pressure is relieved by slowly turning the endcap, so there is no need for a seal screw. (See *Safety Note: Seal Screws and Pressure Relief Valves.*) However, if the internal pressure increases enough, it can exert sufficient force so that the endcap seizes up, making it very difficult to unscrew. That's why an endcap should just be hand-tightened—never forced tight. See Figure 5.40 for a deep water variation that's a cross between a jam jar and piston seal can.

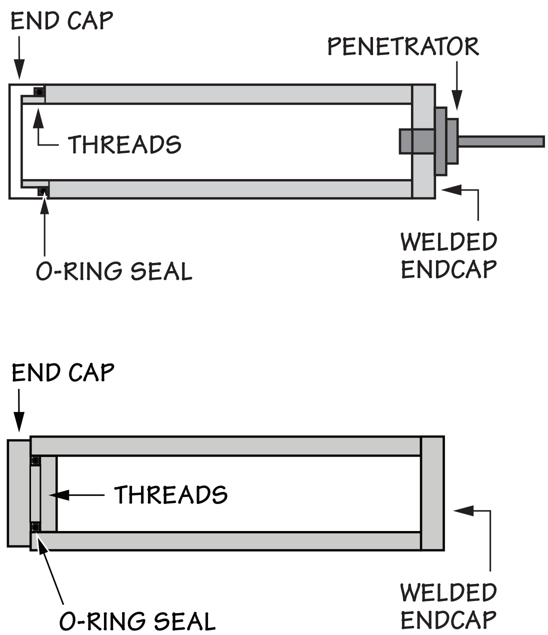

Figure 5.40: Jam Jar Variation

There are several different ways to create jam jar housings. Two popular variations are shown here. The upper one has a lid and O-ring arrangement common to underwater flashlights and other shallow use. The lower variation is better at resisting extremely high external pressures.

Image courtesy of Harry Bohm

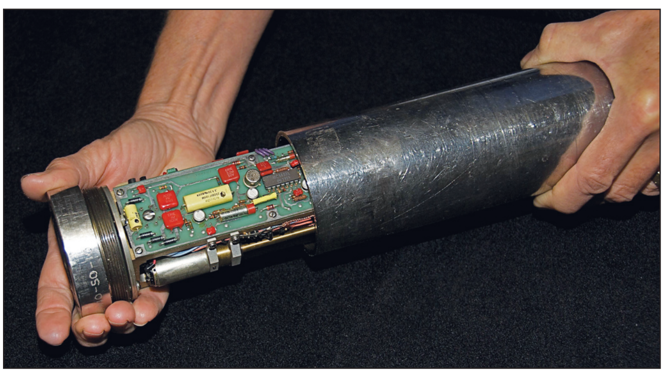

Figure 5.41: Camera with Jam Jar Endcap