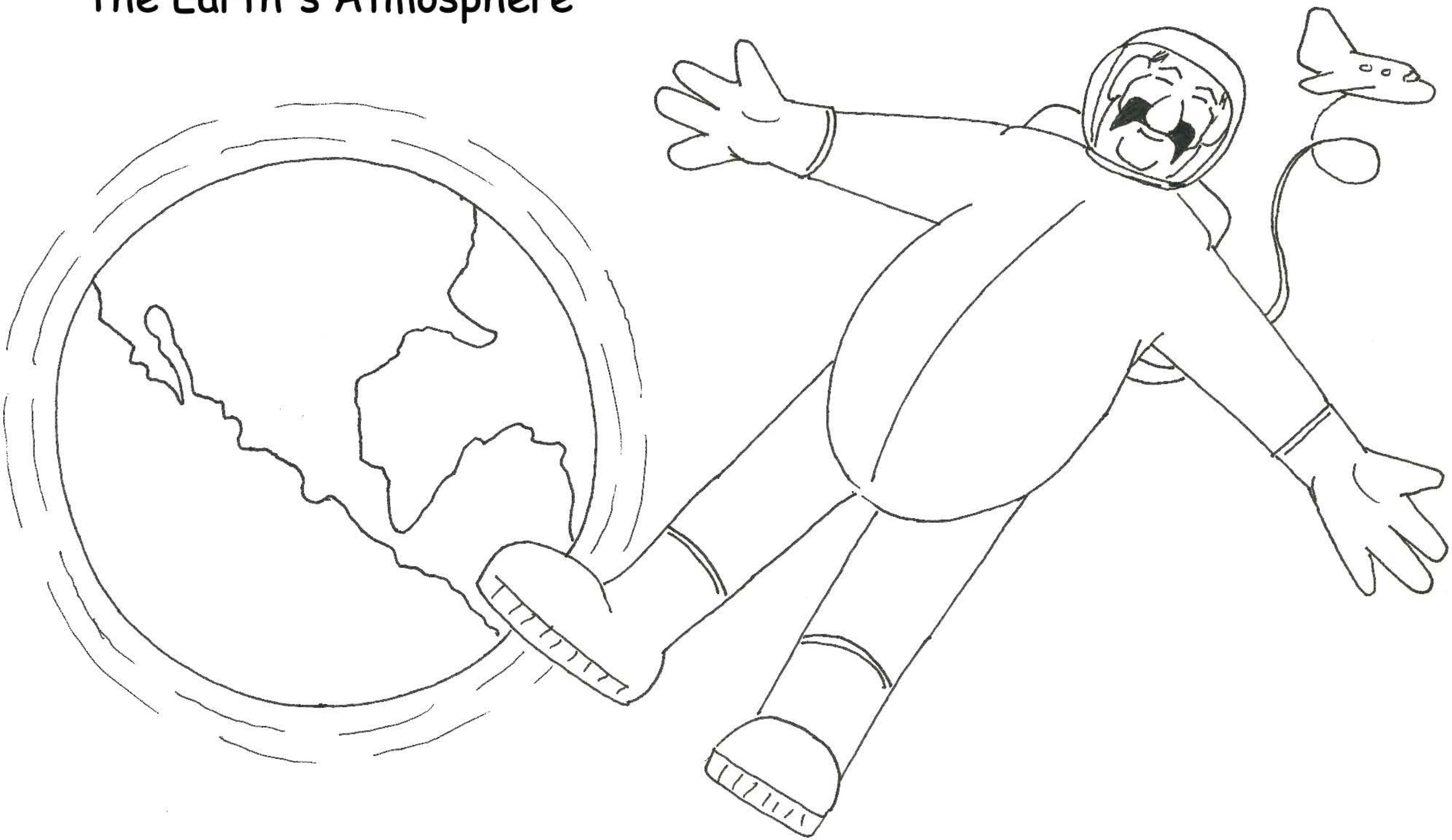
The Cavitation Coloring Book

Part 1: Understanding Atmospheric Pressure

The Earth's Atmosphere

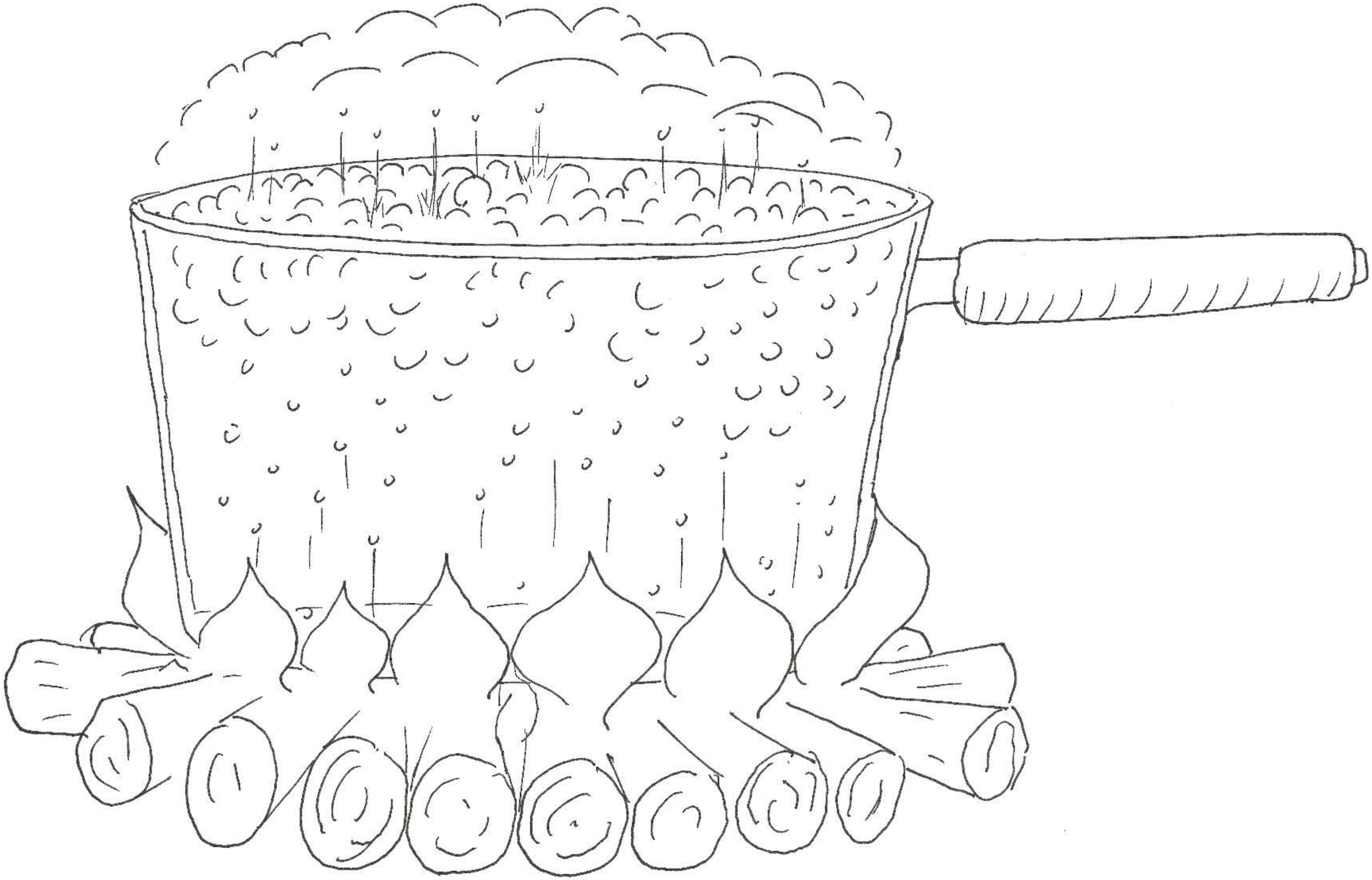


The layer of air surrounding Earth, the atmosphere, has weight. The atmosphere is thinner at higher altitudes and thicker at lower altitudes. The thicker it gets the more it weighs.

Think of the weight of Earth's atmosphere in terms of a swimming pool. As Spud, the pump mechanic, dives deeper in his pool he experiences increasing weight and pressure from the layers of water on top of him. The pressure and weight from our Earth's atmosphere works the same way.

At a depth of 8 feet in Spud's 10' wide x 10' long x 8' deep pool there are 49,944 lbs of water at 3.47 psi.

The same principle applies to boiling water. As water is heated molecules form vapor bubbles that rise toward the surface in the direction of an area with less pressure. At the same time pressure from the Earth's atmosphere pushes back against the surface of the boiling water.

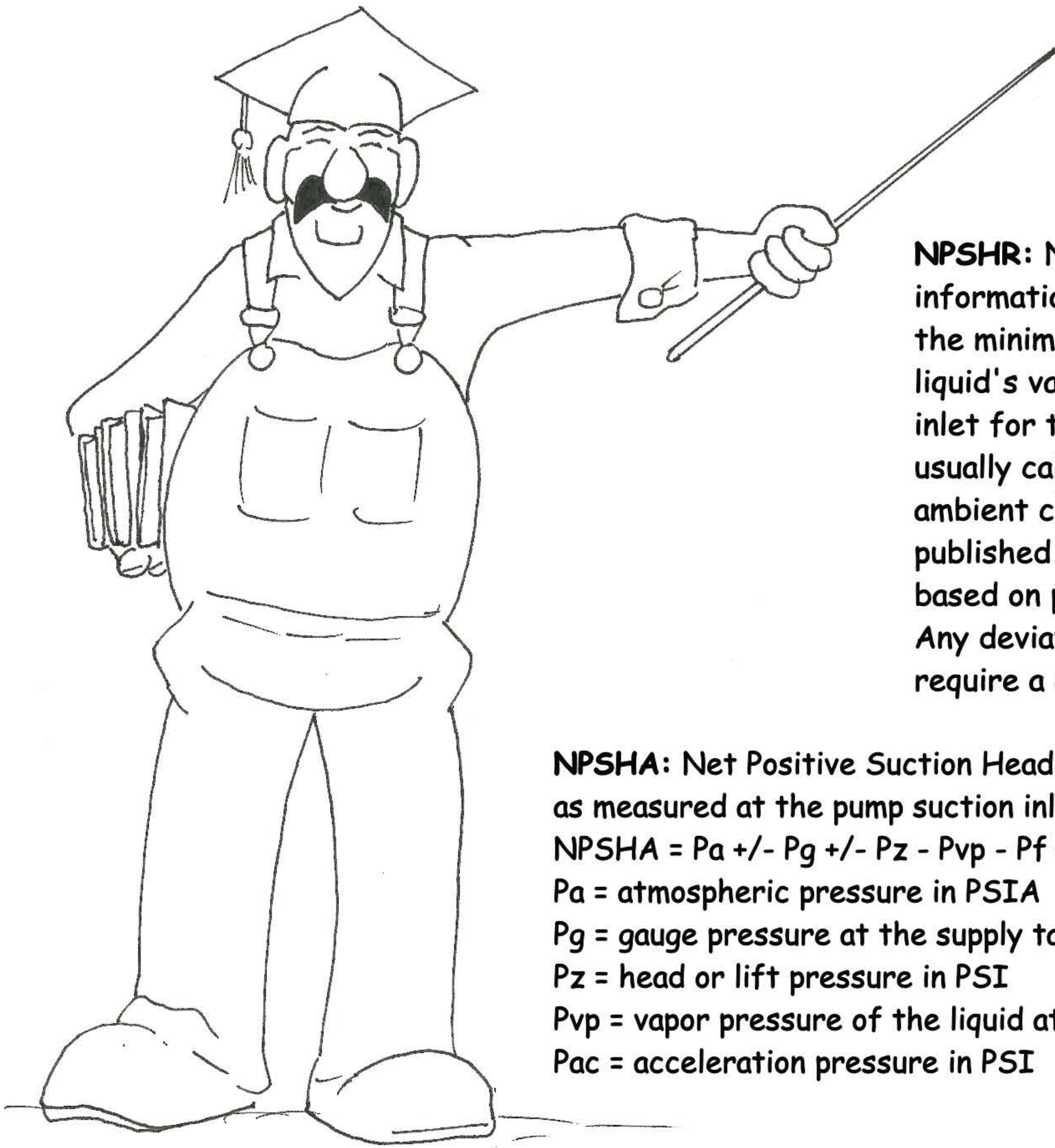


Steam forming above the pot is created from vapor bubbles escaping from the boiling water.

Vapor pressure can be defined as the pressure from vapor in a state of equilibrium with a liquid when measured in a closed container. A liquid's boiling point is the temperature at which vapor pressure at the surface is equal to the pressure exerted by its surroundings, in our case atmospheric pressure. Atmospheric pressure at sea level is 14.7 PSIA (Pounds per Square Inch Absolute). With the full weight of the atmosphere pressing down on the cooking pot at sea level, water will boil at 212° F.

Water's boiling point drops 1.8° F for every 1,000 ft. increase in altitude as the Earth's atmosphere thins. At an altitude of 10,000 ft. and an atmospheric pressure of 10.1 PSIA, Spud's water will boil at 194° F.

Pump Terminology Everyone Should Know



NPSH: Net Positive Suction Head; in other words suction pressure. NPSH is measured in pounds per square inch (PSI) at the pump suction inlet.

NPSHR: Net Positive Suction Head Required; normally information supplied by a pump's manufacturer. This is the minimum suction pressure, exceeding the pumped liquid's vapor pressure, required at the pump suction inlet for the pump to function correctly. NPSHR is usually calculated under the most ideal conditions using ambient clean water pumped at sea level. A table is published by the pump manufacturer detailing NPSHR based on plunger diameter and pump operating RPM. Any deviation from these very ideal conditions may require a change in NPSHR.

NPSHA: Net Positive Suction Head Available; actual PSI of liquid being pumped as measured at the pump suction inlet. A commonly used formula for NPSHA is:

NPSHA = Pa +/- Pg +/- Pz - Pvp - Pf - Pac where:

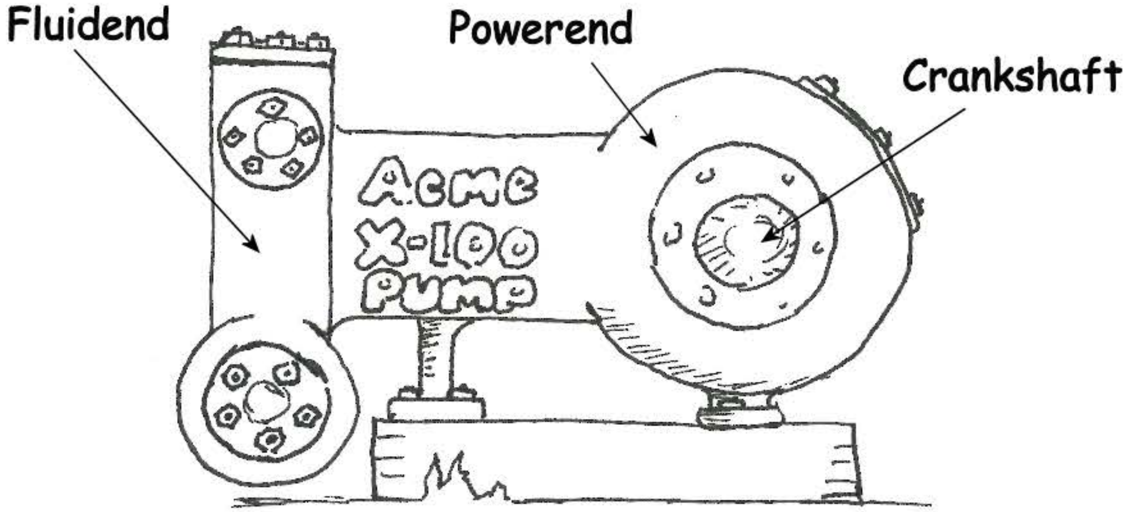
Pa = atmospheric pressure in PSIA

Pg = gauge pressure at the supply tank in PSIG

Pz = head or lift pressure in PSI

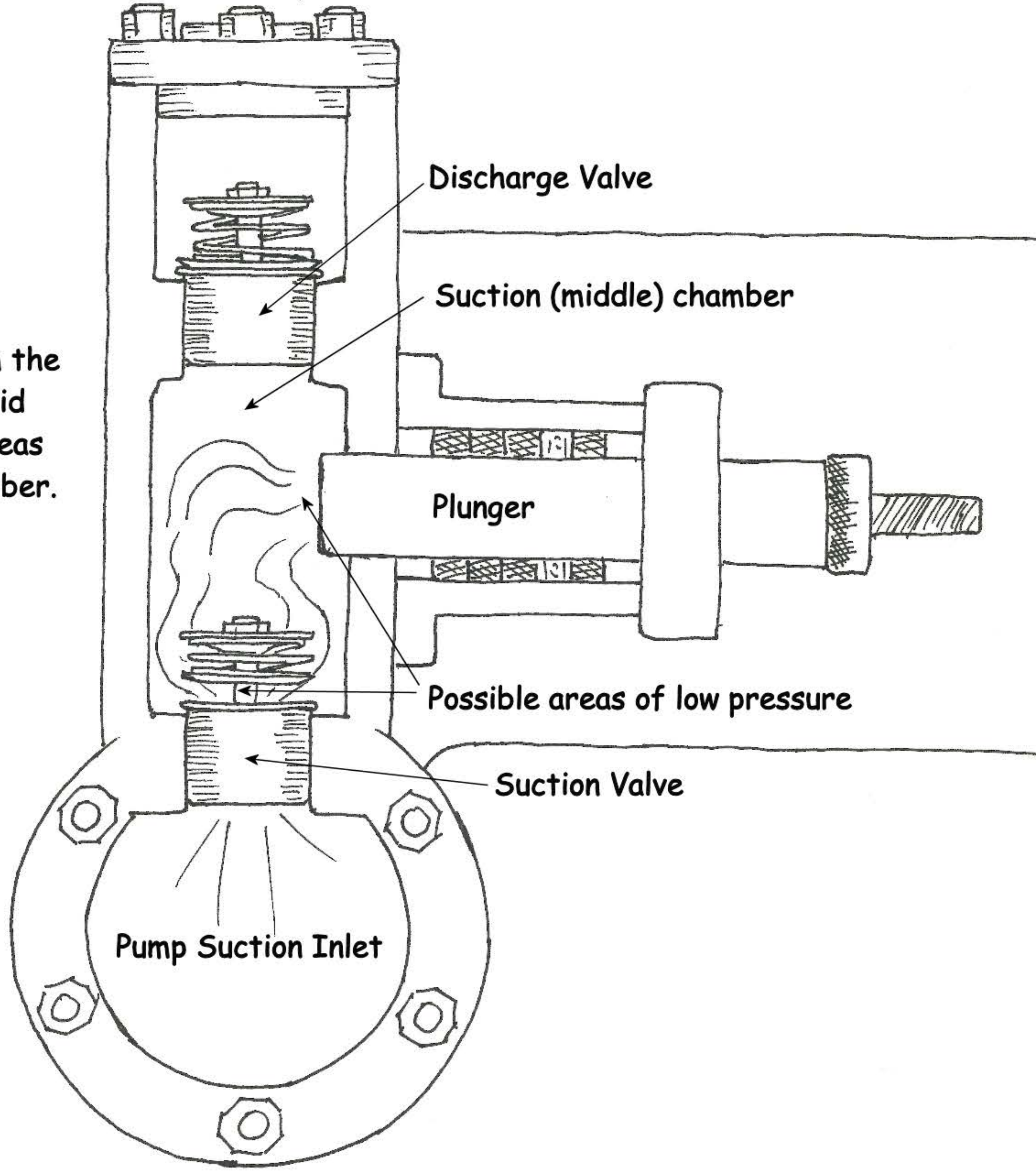
Pvp = vapor pressure of the liquid at its actual temperature in PSIA

Pac = acceleration pressure in PSI



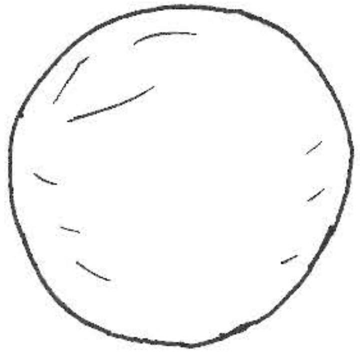
Reciprocal Plunger Pump

Fluidend Cutaway

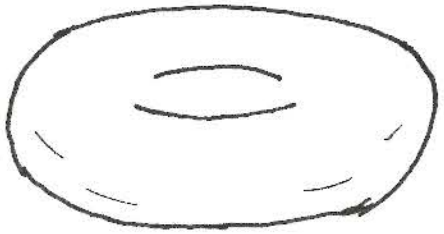


On the suction stroke, as the plunger recedes away from the suction chamber, the bottom suction valve opens and liquid is pulled into the middle chamber. Naturally occurring areas of high and low pressure develop within the suction chamber. If the suction side of the pump is starved and incoming fluid pressure (NPSHA) falls below the liquid's vapor pressure vapor bubbles will form. These vapor bubbles are called cavitation.

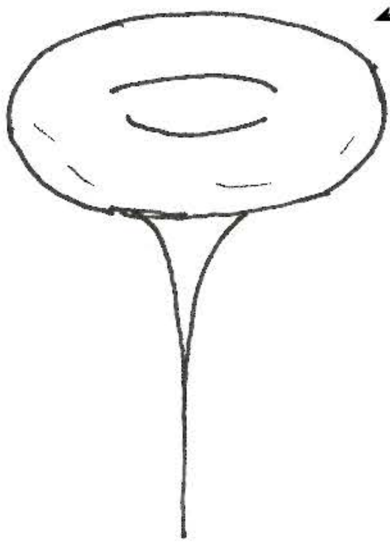
Common signs of severe cavitation include loud banging noises and vibration. Left unresolved cavitation will cause damage to metal surfaces in the fluidend and to fluidend components. Eventually heavy cavitation and mechanical stress resulting from cavitation will damage the pump's powerend. Pump life is shortened; overall pump production will be limited.



Inside the pump's fluidend when the suction side of the pump is starved and suction pressure falls below the liquid's vapor pressure, vapor bubbles are formed.

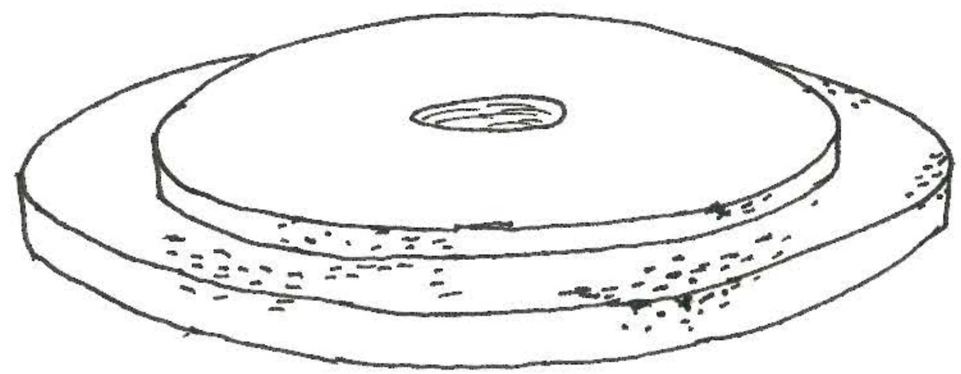


As the plunger moves back toward the fluidend, pressure within the suction chamber increases. Vapor bubbles are compressed and begin to flatten out into a shape similar to a donut.



As pressure increases vapor bubbles implode and produce a high pressure jet stream. The high pressure jet streams cut into metal; combined vapor bubble implosions produce loud banging noises and vibration.

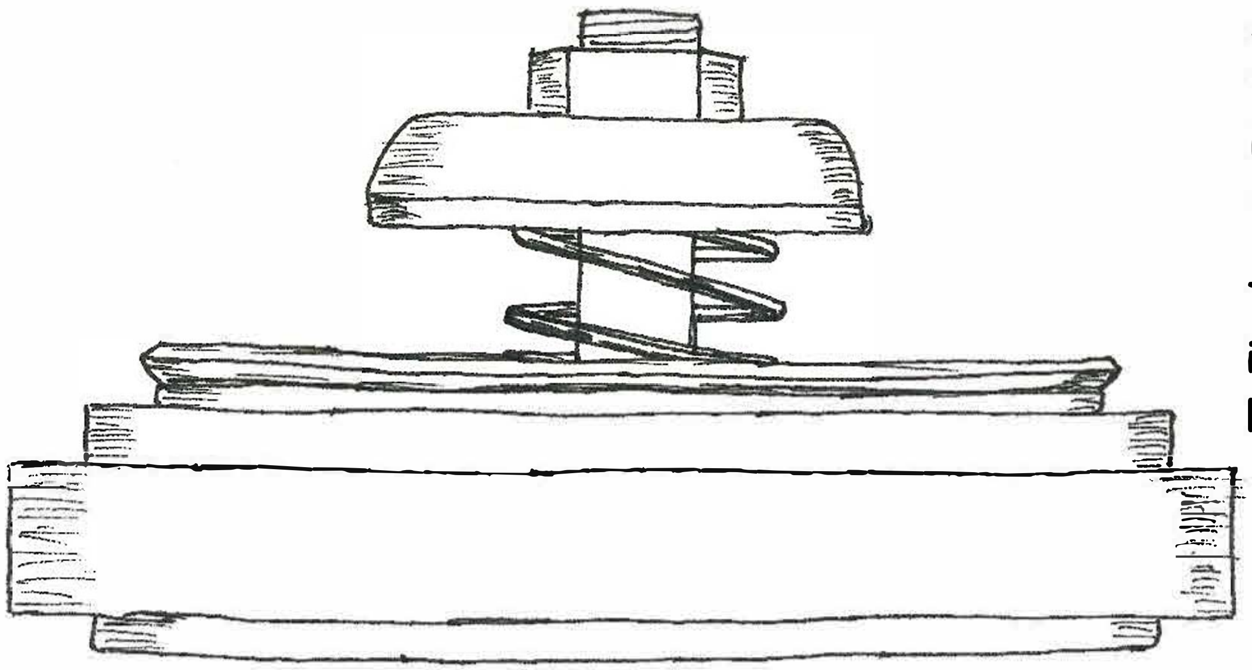
Cavitation Damaged Suction Valve Disc



Cavitation damage can be observed most often inside the fluidend around the end of the plunger and on the surface of the valve member or disc in the suction valve assembly. Damage appears as pits on metal surfaces. Severe implosions can break valve springs, break wedge shaped segments off valve discs and blow valve discs in half.

As we've seen, starving a pump (low NPSH) creates low pressure areas within the suction chamber which can cause cavitation. Low NPSH combined with a liquid's vapor pressure, temperature and the pump's altitude can produce severe cavitation. The Cavitation Coloring Book Part 2 will address the more common reasons for low NPSH. Watch for it on Triangle Pump Components Inc.'s website at www.triangle-pump.com.

Durabla Style V7H Low NPSH Pump Valve



Triangle Pump Components Inc. (TPCI) produces a full line of quality pump valves, ceramic and metal plungers, stuffing box brass, and plunger packing. A partial fix for low NPSH can be done by installing TPCI's Cavitation Package (CavPacK™), which includes a suction and discharge valve.

The suction valve design - V7H (light spring, low lift) - is the most effective valve for low net positive suction head applications in which plunger pumps are starved of incoming fluid on the suction side. The V7H allows in as much fluid as possible. The lightweight metal valve disc allows forexceptional service life, significantly outlasting other leading styles of pump valves. To help maintain its long life span, the low-sliding friction and inertia of the V7H's disc keeps power consumption to a minimum while in use.

Triangle Pump Components Inc. Sales and Manufacturing Locations:

Corporate Office and Valve Manufacturing: 3644 West Highway 67, Cleburne TX 76033, Tel: (817) 202-8530 Fax: (817) 202-8533

Plunger and Packing Manufacturing: 1600 S.E. 23rd, Oklahoma City, OK 73129, Tel: (405) 672-6900 Fax: (405) 672-8088

Canadian Stocking Warehouse: 6721 67th Ave., Bay #4, Red Deer, Alberta T4P 1K3, Tel: (403) 343-1969 Fax: (403) 342-1959