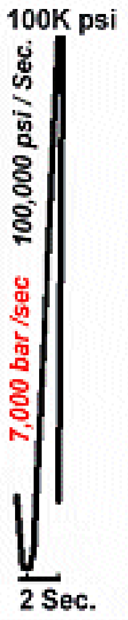
No Moving Parts Dampers Since 1965. **HOW THEY WORK** Why they are so huge and expensive.

Ball-Pack Diffusion. Spreading the time base, makes transient amplitudes shrink.

"No moving parts dampers since 1965"

The WaveGuard Ceramic

Part Nbrs. Wag/Cer



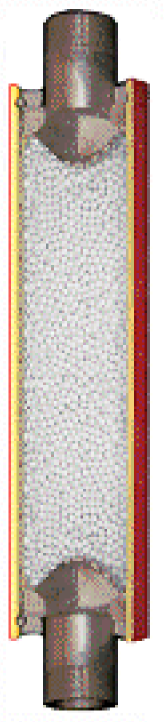
Pressure transients with rise rate in excess of 100,000 psi per second are very common. For example 50 psi and greater spikes at 1000 Hz. are a rise rate of at least 100K psi./sec.

Pressure travels in an average liquid at a mile a second, so it will take 1/1760 secs to pass through a 36" WaveGuard. However some of the transient will travel three times the distance around the balls, and some will go a hundered different distanced paths through them. The parts of the transient will arrive at the other end at different times.

This time lag, spreading of the base time, reduces the height of the transient to near nothing.
The volume of liquid between the balls, aprox 30% of the total cylinder volume, has a mass deadening effect and its compressibility also helps,

Three things have caused the disappearance of the high frequency transient disturbances, time lag has spread the base reducing the height, mass has deadened, and the modulus of compressibility has absorbed.

WAVEGUARDS WITH THE CERAMIC BALL PACK ARE FOR HIGH FREQUENCY ATTENUATION.



Ram-Jet How to get the pressure wave in there without reflection.

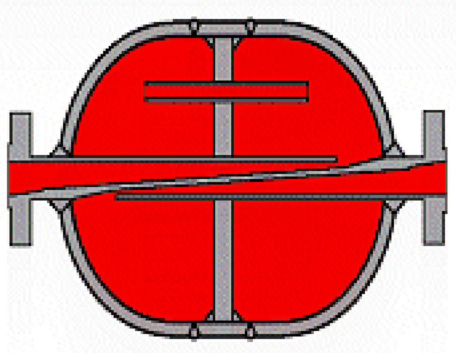
No moving parts dampers since 1965

The WaveGuard w/ Orifice

Part Nbrs. Wag/HO

Pressure, which transfers through a typical liquid at 1440 meters per second, or think say 5200 Kilometers per hour / well over 3,000 MPH bounces back from changes in cross sectional area. A concentric reducer for example is seen by a pressure wave as a "brick wall" the reflection simply produces an additional frequency.

Ram Jet



As our objective is to address pressure changes, we must first make them enter the damper. The smaller the hole through which they enter, relative to the size of the chamber into which they enter, the more efficiently they are dissipated.

The essential design parameter is therefore to go from a large pipe to a small hole without bouncing the pressure wave back up the system, (though there is some reflection from the open orifice end). This is achieved with a taper of include angle not wider than 7 degrees. This angle is as effective in not reflecting the pressure waves as a 5D bend . We now have the small orifice.

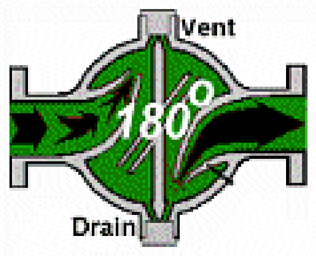
Tight space

The pulses and shocks have been intensified, and are EXPLODED into the damping chamber, and the mass transfer has had a local velocity increase with minimal increase in backpressure.

Pressure pulse transients die away by a cube law of distance from orifice to chamber wall, & the compressibility of the huge volume within the large diameter, smooths the flow fluctuations. These would otherwise result in low frequency acceleration head pulsation from system resistance to flow.

Be careful of plain "tanks" with a smaller entrance than the pipeline size. Such tanks simply produce higher frequencies in your system and force your piping to do the damping.

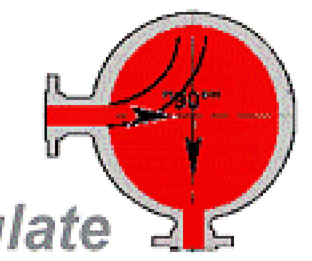
Orifices Helpful Δ P



The "e" number in the selection tables is the equivalent volume in3 of gas loaded damper. For example a damper with a volume of 50 liters may have an "e" of 25 in3, or be the equivalent of a 0.4Liter gas loaded damper to give only a 10% acceleration head pulsation.

WaveGuards are not "black box witchcraft", the ratio of inlet size to chamber diameter gives the "discharge coefficient" and orifice selection is by the Helmholtz calculations.

See Pg. 113
Slurry & Particulate



To apply efficient no moving parts dampers, you need to be able to tollerate a typical 2 bar pressure drop, have lots of space, and a large check book.

Bubble-Generation, making bubbles work for you, but keep away from suction.

No moving parts dampers since 1965

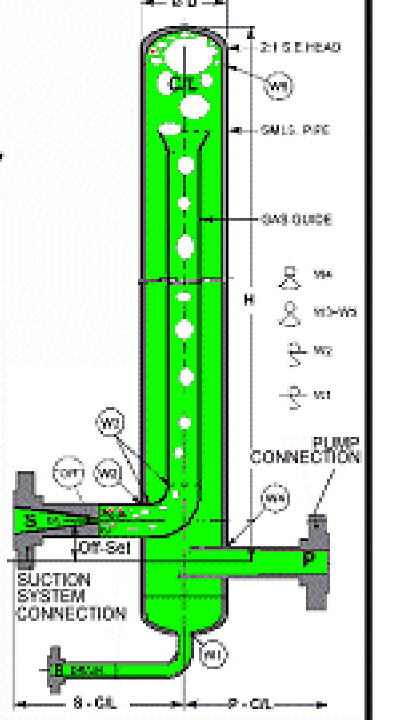
The CavGuard range

Part Nbrs Cag/

The CavGuard is the age old suction side "Stand Pipe" with a couple of differences. It is forced to replenish its bubble cap, but the bubbles, before they are re absorbed, are forced to rise away from tha pump suction intake. Like steam injection dampers.

The orifice is chosen to remove excess force from suction lines that are supplied by centrifugal pumps at a high pressure. The suction line is destabilizing suction check valves of positive displacement reciprocating pumps. Too much pressure force combined with a large driving mass from a long supply line is the worst enemy of efficient pumping, because it drives the suction side when the pump has been designed to be in control of filling itself.
Selecting a cavitation or suction hammer preventer may require suction system analysis. Hardware prices do not absorb analysis, please contact LDi.

PART Nbr.	System 150# S inch	to Pump 150# P inch	PRICE $ -or- €	D inch	H feet	S-CI inch	P-CI inch	B inch	OR inch	e Nbr.
CAGss1	0.75	1	**1443**	4.5	5'	4.75	5	0.5	0.5	75
CAGss2	1.0	1.5	**2210**	6.6	5'	7	7.5	0.5	0.75	175
CAGss3	1.5	2	**4248**	8.6	5'	9.5	10	0.5	1.0	310
CAGss4	2.0	2.5	**6654**	10.7	6'	12	12.5	0.75	1.25	575
CAGss5	2.5	3	**7362**	12.7	6'	14.5	15	0.75	1.5	825
CAGss6	3	4	**8222**	16	6'	19	20	0.75	2	1320
CAGss7	4	5	**14184**	20	10'	24	25	1.0	2.5	3490
CAGss8	5	6	**17847**	24	10'	26	30	1.0	3	5070



CONCLUSION:- *By understanding a little Liquid Dynamics , you can dispense with moving parts dampers, but it will take a lot of space and money.*