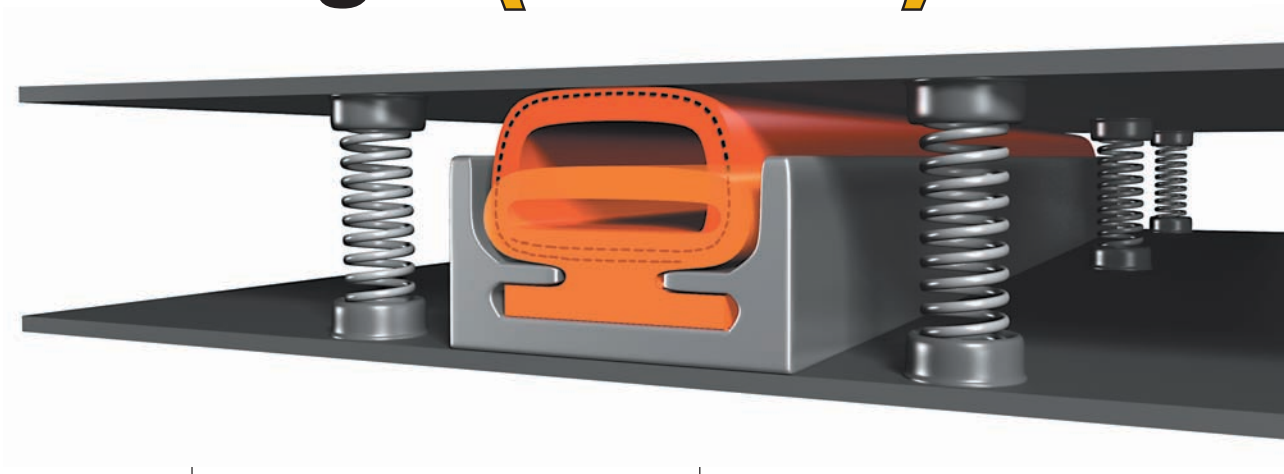
MACHINE DESIGN

Getting a (GENTLE) GRIP



Inflatable grippers can help solve tough clamping problems

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Rigid mechanical and magnetic clamps are fine for most industrial gripping and positioning. But what if the piece is too fragile or irregular for point-source gripping, or the factory environment is too corrosive or hostile? Or perhaps you want to cut costs and parts from the clamp or just make it better for a small added cost?

Maybe you should be thinking of a bladder clamp, which is essentially a rubber pillow that inflates and deflates on command. Bladder clamps reduce breakage in ice-cream cone bakeries, lug 500-lb engine blocks around foundries, and manipulate brittle graphite electrodes for blast furnaces. They're also beating corrosion in paper-making and handling machines and accurately positioning aerospace parts during adhesive bonding and riveting. And in many observatories, bladder clamps handle the delicate job of shuttling giant — not to mention brittle and priceless — telescope mirrors in and out of place for periodic cleaning. Breaking a mirror there goes way beyond seven years of bad luck.

Edited by Stephen Mraz

This footed bladder clamp holds pieces together for bonding or machining. Inflating the bladder lifts the clamping plate while springs ensure proper opening.

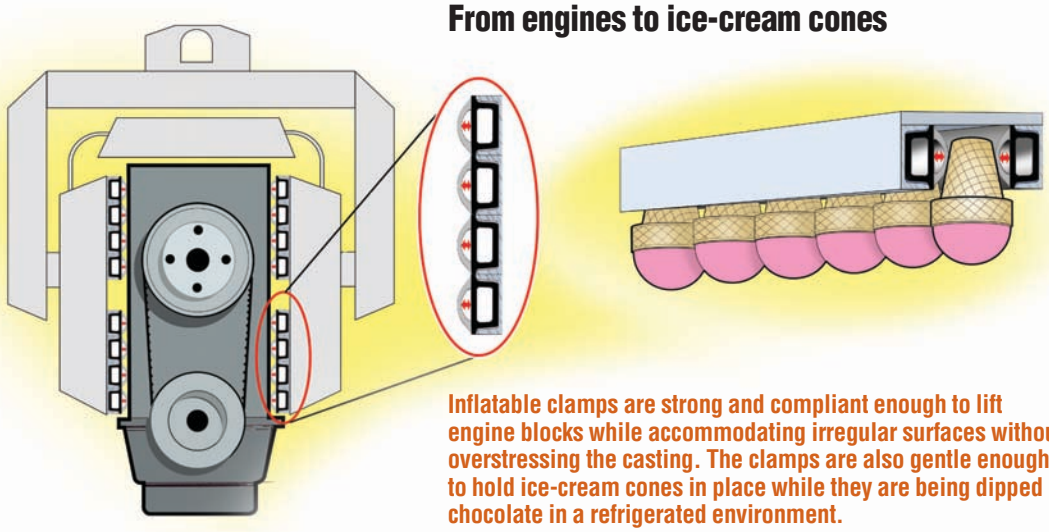
Unlike most other clamps and grippers, bladder clamps distribute force evenly over the entire contact area and conform to mildly irregular surfaces. This latter feature is often the main reason they are used. By nature, bladder clamps also damp out vibrations. And being nonmetallic, they introduce no contaminating lubricants or sources of sparking and electrical shorts. This is why they're often found in munitions and fuel handling and other "clean" operations.

Bladder clamps are inexpensive compared with automated mechanical, pneumatic, and magnetic clamps. They also fit more easily into cramped spaces.

FOUR BASIC PROFILES

Once you settle on a bladder clamp in principle, it will pay to begin with a standard profile if at all possible. Here are the four most popular profiles for bladder clamps:

Footed clamps simplify mounting and



Inflatable clamps are strong and compliant enough to lift engine blocks while accommodating irregular surfaces without overstressing the casting. The clamps are also gentle enough to hold ice-cream cones in place while they are being dipped in chocolate in a refrigerated environment.

the bulb portion inflates and moves outward. This is the profile used in most conveyor stops and part positioners. The top surface can have a gripping surface that ensures contact despite grit.

Low-profile clamps are usually used in hoop-type clamps, where they snap-fit into a retention groove.

Convoluted cross clamps offer greater stroke and higher forces than the other types. They can be found in load locks in processing equipment and tray positioners in hospital sterilizers.

Channel-style clamps fit into standard aluminum channel stock. They provide large contact areas, which translate into higher forces.

Heavy-duty clamps deliver higher forces but shorter strokes. The sides elongate during inflation while the flat top surface remains unchanged. The actuator is usually installed in a rigid channel, which holds it in place and ensures all internal pressure is converted to upward force.

The most popular materials used for bladder clamps are elastomers. But for flammable, explosive, or chip-handling applications, specify a conductive elastomer to avoid sparking or static. And for heavy loads, high clamping forces, or large-scale clamping, like structural plastic layups or airframe assembly, specify reinforced elastomers.

The maximum motion for a bladder clamp using standard profiles and materials is about 2.5 in. And because the clamps are made of rubber, which will cycle, the upper service temperature limit is 400°F. Sharp edges, corners, and rough surfaces should not touch the bladder clamp. And bladder clamps are not recommended for precise positioning unless the workpiece is going to be pushed against a rigid stop,

Most bladder clamps are specified as assemblies with the bladder installed in a rigid retainer. If you decide to make the retainer yourself, be sure all areas that touch the bladder are machined to 63 μin. or better with an axial lay. This will protect against piercing the bladder during assembly or use.

IS IT A FIT?

Is a bladder clamp right for your application? Here are some indicators:

Fragile part or surface that can't be marred. Bladder clamps give a gentle, even grip. Examples: handling green ceramic ware, kiln loading of grinding wheels.

COMPARING BLADDER MATERIALS

Common name/ Base polymer	EDPM or EP rubber	Neoprene	Nitrile or Buna-N	Natural rubber	Silicone
Chemical name	Ethylene propylene	Chloroprene	Acrylonitrile butadiene	Natural isoprene	Silicone
ASTM designation (ASTM D1418)	EP	CR	NBR	NR	VMQ
Tensile strength (psi)	>2,000	>2,000	>2,000	>2,000	>1,200
Tear resistance	3	3	2	3	2
Abrasion resistance	3 to 5	4	3	5	1
Compression set	3	3	3	5	4
Resilience (cold)	3	3	3	3	5
Resilience (hot)	4	4	3	2	5
Acid resistance (mild)	5	5	2 to 3	1 to 2	5
Acid resistance (strong)	3	3	2 to 3	1	2
Solvent resistance (aliphatic)	1	2 to 3	5	1	1
Solvent resistance (aromatic)	1	1	1	1	1
Solvent resistance (oxygenated)	3	1	1	1	1
Resists swelling in lube oil	1	3	4	1	1
Resists oil and gasoline	1	3	5	1	2
Resists oxidation	5	4	3	2 to 3	5
Resists ozone	?	4	3	2 to 3	5
Resists sunlight	?	4	2	1 to 2	5
Resists heat	4	3	3	2 to 3	?
Resists cold	4	3	2 to 3	3	?
Resists flame	1	3	1	1	2
Resists chlorinated hydrocarbons	1	1	2	1	1 to 2

Rated on a scale of 1 to 5, with 5 being the best.

Parts too irregular for rigid clamps. Conformal clamping surfaces distribute forces evenly for heavy lifts. Example: moving engine-block castings

Uniform pressure required over large area. Examples: vacuum forming large plastic structures, airframe assembly.

Explosive or flammable service. Rubber bladder clamps eliminate conductive metals and sparks, and can be made intrinsically safe. Examples: munitions and rocket fuel fabrication.

Contamination not tolerable. Rubber parts don't corrode or contaminate, and require no lubricants or coatings. Examples: food and pharmaceutical processing and packaging, clean-room part handling, semiconductor-foundry equipment.

Tight fit, tight budget. Bladder clamps fit into tighter physical and budget envelopes than mechanical, magnetic, or pneumatic clamps. All you need to operate is a hose leading to a standard compressed-air source.

Too many manualclamps. A single, quick-acting bladder clamp saves time compared with an array of mechanical clamps individually dogged down. Example: doors and hatches in isolation chambers.

If you think a bladder clamp may meet your need, collect a few facts about the requirements and involve an experienced vendor early on. They probably have solved dozens of problems much like the ones that seem so new to you.

Here's the information to have on hand for that first inquiry:

- Part dimensions and weight
- Available envelope for the gripper
- Surface areas available for clamping
- Desired force and stroke
- Ambient service conditions (temperature, corrosion)
- Duty cycle, expected life
- Specs on compressed air supply. **MD**