The Inverted Bucket Steam Trap

The Armstrong inverted submerged bucket steam trap is a mechanical trap that operates on the difference in density between steam and water. See Fig. CG-16-1. Steam entering the inverted submerged bucket causes the bucket to float and close the discharge valve. Condensate entering the trap changes the bucket to a weight that sinks and opens the trap valve to discharge the condensate. Unlike other mechanical traps, the inverted bucket also vents air and carbon dioxide continuously at steam temperature.

This simple principle of condensate removal was introduced by Armstrong in 1911. Years of improvement in materials and manufacturing have made today's Armstrong inverted bucket traps virtually unmatched in operating efficiency, dependability and long life.

Long, Energy-Efficient Service Life

At the heart of the Armstrong inverted bucket trap is a unique leverage system that multiplies the force provided by the bucket to open the valve against pressure. There are no fixed pivots to wear or create friction. It is designed to open the discharge orifice for maximum capacity. Since the bucket is open at the bottom, it is resistant to damage from water hammer. Wearing points are heavily reinforced for long life.

An Armstrong inverted bucket trap can continue to conserve energy even in the presence of wear. Gradual wear slightly increases the diameter of the seat and alters the shape and diameter of the ball valve. But as this occurs, the ball merely seats itself deeper – preserving a tight seal.

Reliable Operation

The Armstrong inverted bucket trap owes much of its reliability to a design that makes it virtually free of dirt problems. Note that the valve and seat are at the top of the trap. The larger particles of dirt fall to the bottom, where they are pulverized under the up-and-down action of the bucket. Since the valve of an inverted bucket is either closed or fully open, there is free passage of dirt particles. In addition, the swift flow of condensate from under the bucket's edge creates a unique self-scrubbing action that sweeps dirt out of the trap. The inverted bucket has only two moving parts – the valve lever assembly and the bucket. That means no fixed points, no complicated linkages – nothing to stick, bind or clog.

Corrosion-Resistant Parts

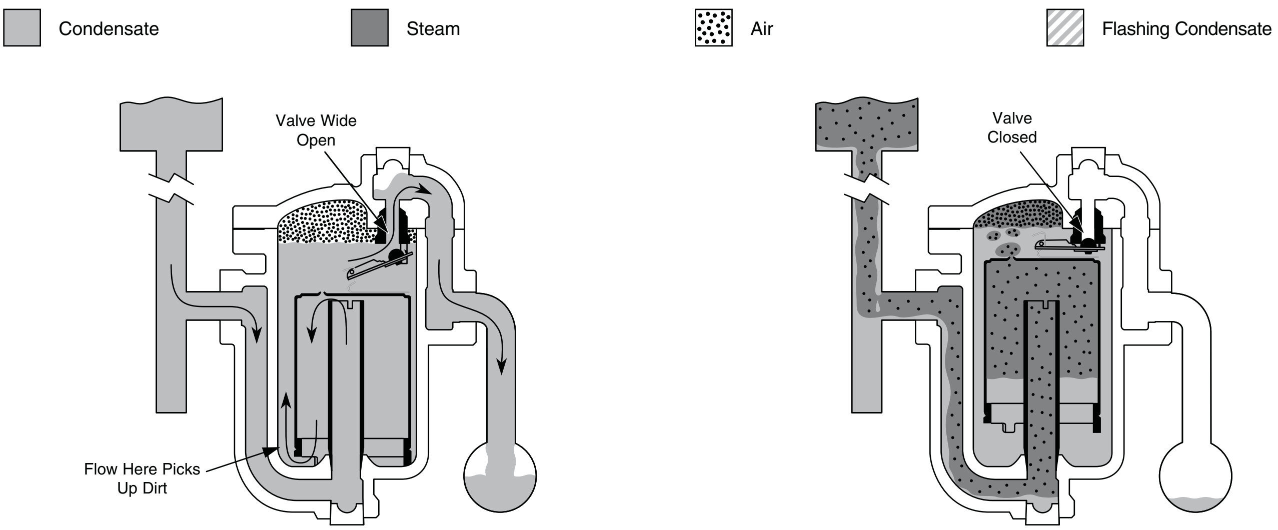
The valve and seat of Armstrong inverted bucket traps are high chrome stainless steel, ground and lapped. All other working parts are wear- and corrosion-resistant stainless steel.

Operation Against High Back Pressure

High pressure in the discharge line simply reduces the differential across the valve. As back pressure approaches that of inlet pressure, discharge becomes continuous just as it does on the very low pressure differentials.

Back pressure has no adverse effect on inverted bucket trap operation other than capacity reduction caused by the low differential. There is simply less force required by the bucket to pull the valve open, cycling the trap.

Figure CG-16-1. Operation of Inverted Bucket Steam Trap (at pressures close to maximum)



1. Steam trap is installed in drain line between steam-heated unit and condensate return header. On start-up, bucket is down and valve is wide open. As initial flood of condensate enters the trap and flows under bottom of bucket, it fills trap body and completely submerges bucket. Condensate then discharges through wide-open valve to return header.

2. Steam also enters trap under bottom of bucket, where it rises and collects at top, imparting buoyancy. Bucket then rises and lifts valve toward its seat until valve is snapped tightly shut. Air and carbon dioxide continually pass through bucket vent and collect at top of trap. Any steam passing through vent is condensed by radiation from trap.

Types of Armstrong Inverted Bucket Traps Available to Meet Specific Requirements

The availability of inverted bucket traps in different body materials, piping configurations and other variables permits flexibility in applying the right trap to meet specific needs. See Table CG-17-1.

1. **All-Stainless Steel Traps.** Sealed, tamper-proof stainless steel bodies enable these traps to withstand freeze-ups without damage. They may be installed on tracer lines, outdoor drips and other services subject to freezing. For pressures to 45 barg and temperatures to 427°C.

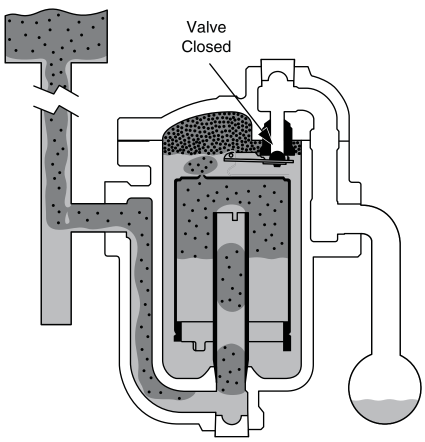
2. **Cast Iron Traps.** Standard inverted bucket traps for general service at pressures to 17 barg and temperatures to 232°C. Offered with side connections, side connections with integral strainers and bottom inlet – top outlet connections.

3. **Forged Steel Traps.** Standard inverted bucket traps for high pressure, high temperature services (including superheated steam) to 186 barg at 560°C.

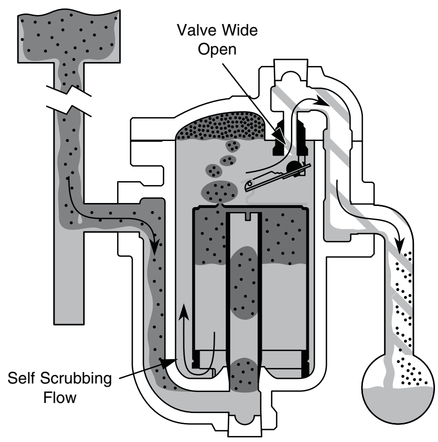
4. **Cast Stainless Steel Traps.** Standard inverted bucket traps for high capacity, corrosive service. Repairable. For pressures to 47 barg and temperatures to 263°C.

Table CG-17-1. Typical Design Parameters for Inverted Bucket traps

Body and Cap Materials	Cast Iron	Stainless Steel	Forged Steel	Cast Steel	Cast Stainless Steel
Connections (mm)	15 - 65	15 - 25	15 - 50	15 - 25	15 - 50
Type Connections	Screwed, Flanged	Screwed, Socketweld or Flanged	Screwed, Socketweld or Flanged	Screwed, Socketweld or Flanged	Screwed, Socketweld or Flanged
Operating Pressure (barg)	0 thru 17	0 thru 45	0 thru 180	0 thru 40	0 thru 47
Capacity (kg/h)	To 9 500	To 2 000	To 9 500	To 2 000	To 9 500



3. As the entering condensate starts to fill the bucket, the bucket begins to exert a pull on the lever. As the condensate continues to rise, more force is exerted until there is enough to open the valve against the differential pressure.



4. As the valve starts to open, the pressure force across the valve is reduced. The bucket then sinks rapidly and fully opens the valve. Accumulated air is discharged first, followed by condensate. The flow under the bottom of the bucket picks up dirt and sweeps it out of the trap. Discharge continues until more steam floats the bucket, and the cycle repeats.

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The Inverted Bucket Steam Trap

Energy Efficient Because It's So Reliable

The inverted bucket is the most reliable steam trap operating principle known. The heart of its simple design is a unique leverage system that multiplies the force provided by the bucket to open the valve against pressure. Since the bucket is open at the bottom, it resists damage from water hammer, and wear points are heavily reinforced for long life.

The inverted bucket has only two moving parts – the valve lever assembly and the bucket. That means no fixed points, no complicated linkages. Nothing to stick, bind or clog.

Wear and corrosion resistance

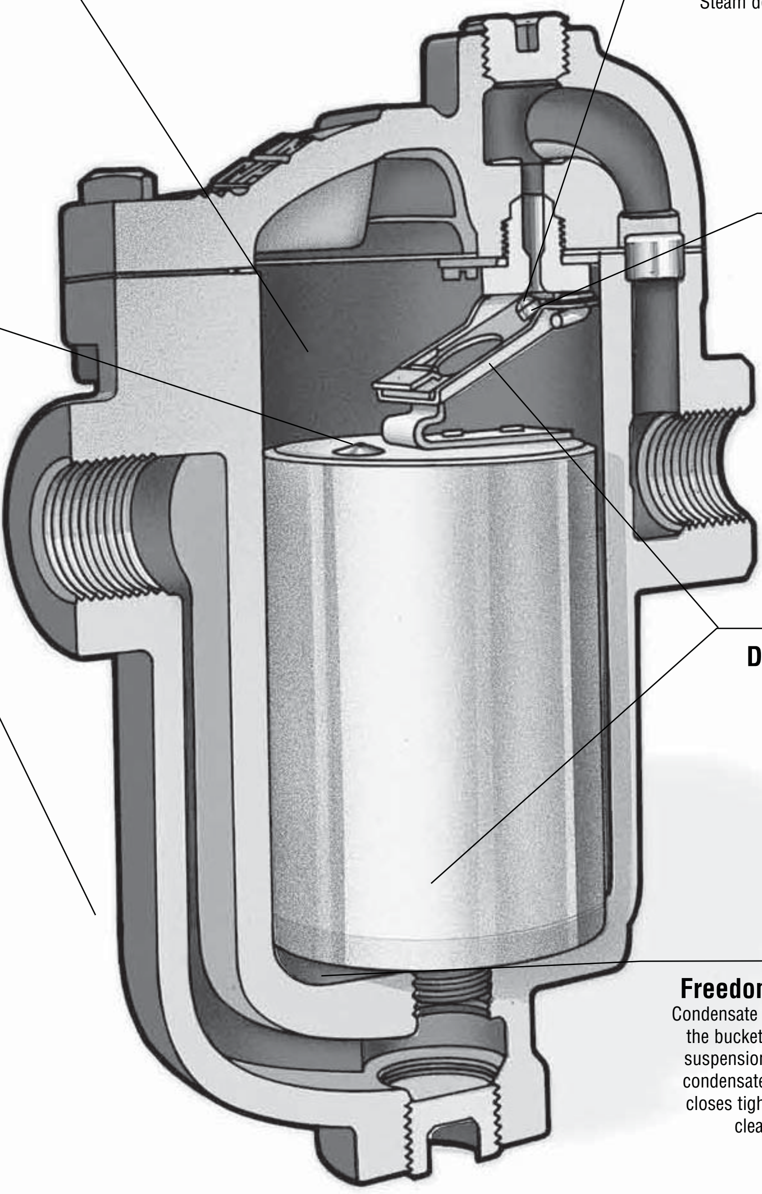
Free-floating guided lever valve mechanism is "frictionless," and all wear points are heavily reinforced. All working parts are stainless steel. Valve and seat are stainless steel, individually ground and lapped together in matched sets.

Continuous air and CO_2 venting

Vent in top of bucket provides continuous automatic air and CO_2 venting with no cooling lag or threat of air binding. Steam passing through vent is less than that required to compensate for radiation losses from the trap so it's not wasted.

Excellent operation against back pressure

Since trap operation is governed by the difference in density of steam and water, back pressure in the return line has no effect on the ability of the trap to open for condensate and close against steam.



Virtually no steam loss

Steam does not reach the water-sealed discharge valve.

Purging action

Snap opening of the valve creates a momentary pressure drop and turbulence in the unit drained. This breaks up films of condensate and air and speeds their flow to the trap.

Dependable operation

Simple, direct operation with nothing to stick, bind or clog. Only two moving parts – the valve lever and the bucket.

Freedom from dirt problems

Condensate flow under the bottom edge of the bucket keeps sediment and sludge in suspension until it is discharged with the condensate. Valve orifice opens wide and closes tightly. No buildup of dirt or close clearances to be affected by scale.

Resistance to damage from water hammer

Open bucket or float will not collapse as a result of water hammer.

Inverted Bucket Steam Trap

Conserves Energy Even in the Presence of Wear

Armstrong inverted bucket steam traps open and close based on the difference in density between condensate and steam – the inverted bucket principle. They open and close gently, minimizing wear. This simple fact means that inverted buckets are subject to less wear than some other types of traps.

In fact, as an Armstrong inverted bucket trap wears, its tight seal actually improves. The ball valve and seat of the Armstrong trap provide essentially line contact – resulting in a tight seal because the entire closing force is concentrated on one narrow seating ring.

An Armstrong inverted bucket trap continues to operate efficiently with use. Gradual wear slightly increases the diameter of the seat and alters the shape and diameter of the ball valve. But, as this occurs, a tight seal is still preserved – the ball merely seats itself deeper.

Corrosion-Resistant Parts

The stainless steel valve and seat of the Armstrong inverted bucket steam trap are individually ground and lapped together in matched sets. All other working parts are wear- and corrosion-resistant stainless steel.

Venting of Air and CO_2

The Armstrong inverted bucket provides continuous automatic air and CO_2 venting with no cooling lag or threat of air binding.

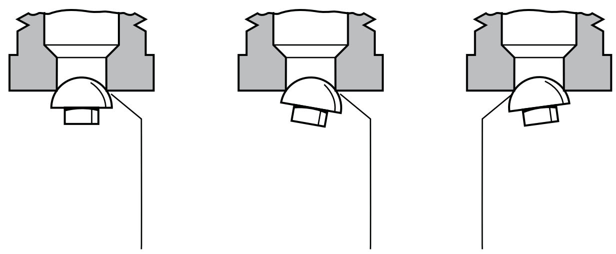
Operation Against Back Pressure

The Armstrong inverted bucket has excellent performance against back pressure. It has no adverse effect on inverted bucket operation other than to reduce its capacity by the low differential. The bucket simply requires less force to pull the valve open and cycle the trap.

Freedom From Dirt Problems

Armstrong designed its inverted bucket to be virtually free of dirt problems. The valve and seat are at the top of the trap, far away from the larger particles of dirt, which fall to the bottom. Here the up-and-down action of the bucket pulverizes them. Since the valve of an inverted bucket is either fully closed or open, dirt particles pass freely. And the swift flow of condensate from under the bucket's edge creates a unique self-scrubbing action that sweeps dirt out of the trap.

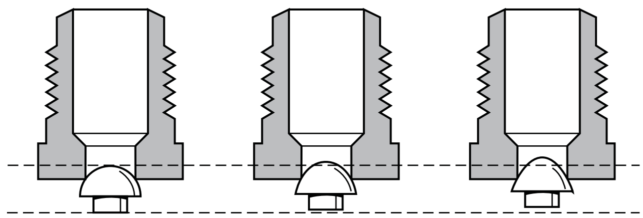
Armstrong IB Valve Seating/Ball Valve



Line Contact – Single Seat

Infinite Number of Center Lines and Seating Circumferences

IB Valve Wear Characteristics



Armstrong IB ball valve continues to seat itself deeper, providing a tight seal even in the presence of wear.

All dimensions and weights are approximate. Use certified print for exact dimensions. Design and materials are subject to change without notice.

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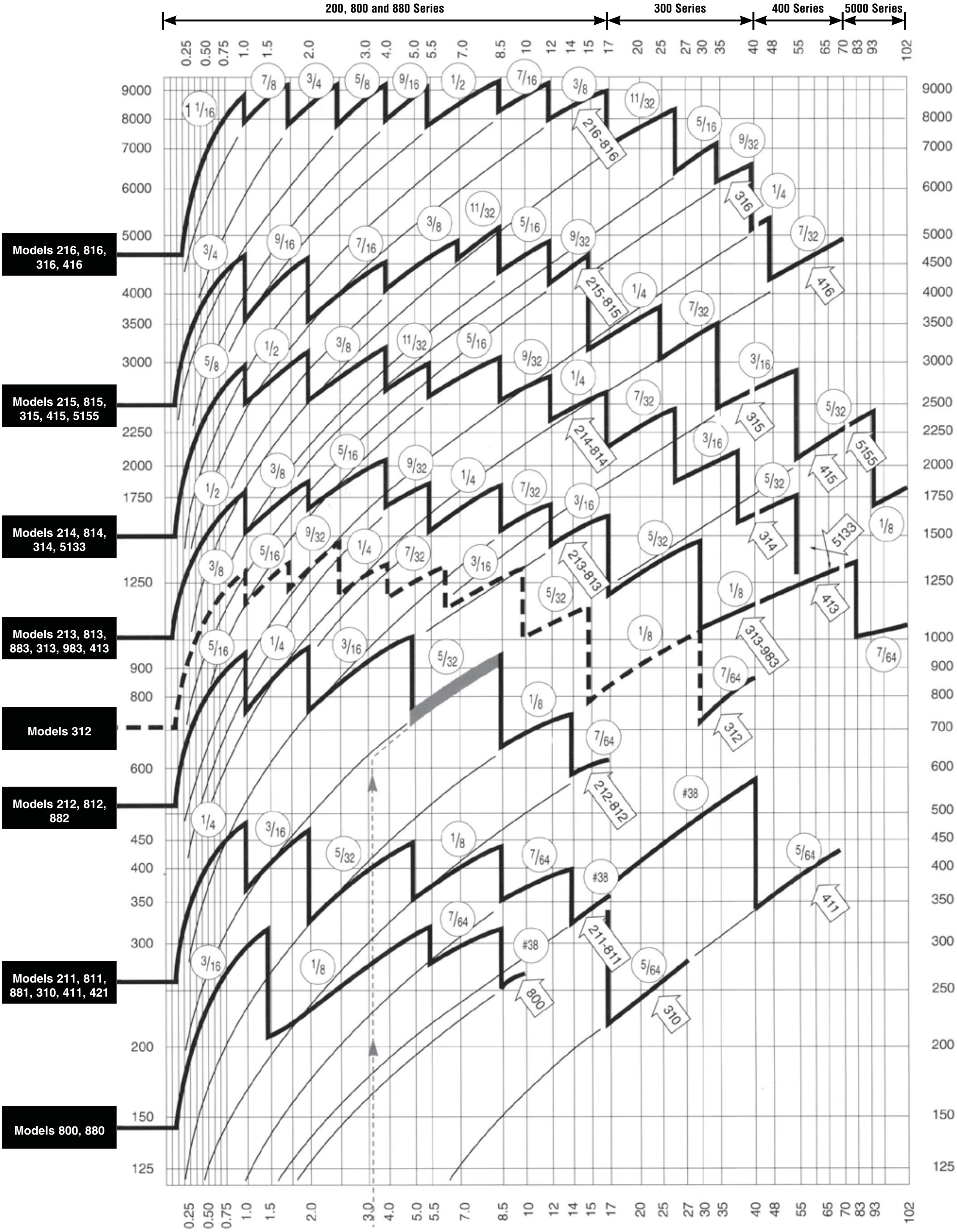
IB Steam Trap Summary Capacity Chart

Pressure difference in bar between steam line and return line with trap valve closed

Note: Above capacity chart does not include all models available. Refer to specific page of trap required for capacities not covered above.



Pressure difference in bar between steam line and return line with trap valve closed

Note: Above capacity chart does not include all models available. Refer to specific page of trap required for capacities not covered above.

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How to Use the IB Steam Trap Summary Capacity Chart

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How the Capacity Chart was made

The Armstrong capacity chart shows continuous discharge capacities of Armstrong traps under actual operating conditions as determined by literally hundreds of tests. In these tests condensate at the steam temperature corresponding to the test pressure was used. The choking effect of flash steam through the orifice, as well as the back pressure created by flash steam, were automatically taken into account. Actual installation hookups were used so that pipe friction in both inlet and discharge lines also were reflected in the results.

Trap capacity ratings based on cold water tests which produce no flash steam would be much too high. Orifice tests also are too high because they ignore pipe friction. Theoretical calculations of trap capacities have never been conservative. You can rely on Armstrong capacity ratings because they show actual capacities of hot condensate.

Heavy “sawtooth” curves

show capacities for traps using maximum possible diameter orifices for the pressures shown.

Thin line curves

extending down to the left of the heavy curves show the capacities of Armstrong traps at pressures below their maximum ratings. For example: a model 216 trap with 1/2" orifice good for a maximum working pressure of 8,5 bar will have a continuous discharge capacity of a little less than 6 000 kg/h at 2,8 bar.

How to use the inverted bucket trap capacity chart

To select an inverted bucket steam trap using the Armstrong capacity chart, you must know the condensate load, safety factor and pressure differential. Remember, the objective is always to select a trap that can 1) operate at the maximum differential pressure and 2) handle the capacity at the minimum differential pressure. Consider the following typical problems:

Example 1:
Constant Pressure and Condensing Rate
Given:

Maximum pressure differential:	5 bar
Operating differential:	4 bar
Condensate load:	133 kg/h
times 3:1 safety factor or:	400 kg/h

Enter chart at 4 bar and go up to 400 kg/h capacity. This is directly on the 5/32" orifice line as shown in Chart ST-77-1. The capacity of this 5/32" orifice at pressures less than 2 bar is indicated by the thin line. Follow the line to the right to the vertical drop at 5 bar. This means this orifice will operate to a maximum of 5 bar differential - the other requirement for this application. Follow the heavy line back to the left and note that it’s attached to the arrow indicating that the 211, 811 or 881 traps (1811 and 1011 are other possibilities) with the 5/32" orifice will yield this capacity. This is the trap to use.

Example 2:
Constant Pressure and Condensing Rate but with Possible High Back Pressure
Assume for example:

Maximum pressure differential:	6 bar
Operating differential minimum:	3 bar
Operating differential normally:	4 bar
Condensate load:	133 kg/h
times 3:1 safety factor or:	400 kg/h

To solve the problem, refer to the sawtooth chart, page ST-76. Enter at the minimum differential pressure (3 bar) and move up until you intersect a line that is above 400 kg/h capacity, which is the first thin line above the heavy “sawtooth” for the 211, 811 and 881 traps. Note that this is the continuation of the capacity line for the 5/32" orifice for the 212, 812 and 882 traps. Now follow the line to the right until the vertical drop at 8,5 bar differential. This is within our requirement of 6 bar. Therefore a 5/32" orifice can handle the 400 kg/h condensate load when fitted into a 212, 812 or 882 trap and that it will not lock shut at the 6 bar maximum differential. This is the trap to use since it will handle the load at both the minimum and maximum operating differentials, even though it has a maximum operating pressure differential of 8,5 bar.

Orifice sizes:

1 7/8"	= 47,0 mm	5/16"	= 7,9 mm
1 5/8"	= 41,0 mm	19/64"	= 7,5 mm
1 17/32"	= 39,0 mm	9/32"	= 7,1 mm
1 1/8"	= 28,0 mm	17/64"	= 6,7 mm
1 1/16"	= 27,0 mm	1/4"	= 6,4 mm
7/8"	= 22,2 mm	7/32"	= 5,6 mm
3/4"	= 19,0 mm	13/64"	= 5,1 mm
11/16"	= 17,5 mm	3/16"	= 4,8 mm
5/8"	= 15,9 mm	11/64"	= 4,4 mm
9/16"	= 14,3 mm	5/32"	= 4,0 mm
1/2"	= 12,7 mm	1/8"	= 3,2 mm
7/16"	= 11,2 mm	7/64"	= 2,8 mm
3/8"	= 9,5 mm	# 38	= 2,5 mm
11/32"	= 8,7 mm	5/64"	= 2,0 mm

Chart ST-77-1: Selection Curve Example 1