The design, operation and flexibility of the inverted bucket steam trap has made it the dominant trap in the marketplace. Since it was introduced by Armstrong in 1911, the inverted bucket trap has saved millions of dollars in industrial fuel bills because of its ability to respond to the characteristics of such a wide variety of heat-exchange applications.

The free floating linkage, hemispherical valve, and square-edged orifice provide line contact in any position. The valve is free to close in many positions because the lever is secured by a linkage which employs no fixed pivot points or valve guides to wear out. Long life is further ensured by using a seat material slightly softer than that of the valve. This difference in hardness allows the combination to be self-lapping, guaranteeing a tight seal over a long period of time without any adjustment.

As an Armstrong inverted bucket trap wears, its tight seal actually improves! The Armstrong inverted bucket trap must seal only one orifice. The ball valve and seat of the Armstrong trap provide essentially line contact—resulting in a tighter seal because the entire closing force is concentrated on one narrow sealing ring.
OPERATION AT PRESSURES CLOSE TO MAXIMUM

KEY
- Steam
- Condensate
- Air
- flashing Condensate

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

On start-up, condensate fills the trap body and the weight of the bucket holds the valve fully open, providing full-capacity drainage of large start-up loads.

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 by the pressure differential. Air and carbon dioxide continually pass through bucket vent and collect at top of trap. Any steam passing through the vent is condensed, and discharged as a liquid. Non-condensibles are vented promptly at steam temperature.

Steam flow through the bucket vent is limited by the vent size and low differential pressure created between the height of the steam beneath the bucket, and the level of the water seal above it. All steam passing through the vent is condensed, and discharged as a liquid. This prevents live steam loss and the single-phase flow lengthens the service life of the discharge orifice.
When entering condensate brings the condensate level slightly above the neutral line the bucket exerts a slight pull on the lever. The valve does not open, however, until the condensate level rises to the opening line for the existing pressure differential between the steam and the condensate return header.

Condensate, at steam temperature, enters the trap continuously, even when the valve is closed. This continuous drainage keeps the lines and system ahead of the trap free of condensate, eliminating the hazards of water hammer, freezing and corrosion, and the loss of heat exchange efficiency which can result from flooded lines and heat exchange surfaces.

When the condensate level reaches opening line, the weight of the bucket, times leverage, exceeds the pressure holding valve to its seat. Bucket then sinks and opens trap valve. Any accumulated air is discharged first followed by condensate. Discharge continues until more steam floats bucket at which time cycle begins to repeat.

With the orifice located at the top, dirt, scale and other matter settling to the bottom of the trap will not plug the discharge port. The intermittent discharge of an IB trap creates a self-scrubbing effect at the bottom of the trap. Dirt particles, smaller than the orifice diameter are flushed from the system. All of these advantages combine to allow usage of the IB without a strainer in relatively clean systems.

Because pressure inside the bucket equals pressure outside the bucket, sudden pressure changes and water hammer...which tend to crush ball floats & thermo-bellows devices...will not damage Armstrong's open float, inverted bucket design.
Low Pressure Continuously Modulating Mode of Operation

Today's energy consciousness suggests the use of inverted bucket traps in all applications to take advantage of their unique combination of energy efficiency and long life. In order to minimize the number of different trap and orifice size combinations used in plants with multiple pressure levels in steam main drain and steam tracing applications, the orifice size for the highest pressure is applied to all pressure ranges. When orifices suited for high pressures are used at low pressures, the "normal" mode of operation will not be an intermittent discharge. The discharge will appear to be continuous.

A 5/64" orifice in an 1811 suitable for operation at a maximum pressure differential of 400 psi will require a force of 30.4 oz. to open the valve. A high level of water under the bucket is required to provide sufficient force. The same orifice used at 80 psig requires only 6.08 oz. to open the valve. Only 1/5 as much force is required so only 1/5 as much bucket length must be filled with water. A much lower water level is adequate to provide the necessary force.

The weight of the bucket times the lever arm ratio supplies the valve opening force. At 80 psi differential, an 0.32 oz. pull by the bucket is required to open the valve. This amount of water must be removed from under the bucket with each discharge for intermittent operation. If 200#/hr. or 0.9 oz/sec of condensate load is present, the cycle rate of the trap must be 3cps. Obviously, a 3.29 oz. bucket submerged in water cannot move this rapidly so the bucket merely positions the valve to provide the continuously modulating flow.
Low Load Continuously Modulating Mode of Operation

The same operating mode is exhibited in inverted bucket traps which are used in extremely low condensate load applications even if the orifice is closely matched to the pressure differential.

When the valve in an inverted bucket trap is closed the bucket weight, $F_B$, is low and the forces attempting to hold the valve closed exceed those trying to open it. As the condensate level under the bucket rises, the net buoyancy of the bucket decreases until the opening forces balance and begin to exceed the closing forces. At this point the valve begins to crack open, a small flow of condensate starts through the cracked valve and water flows from under the bucket.

If the condensate flow into the trap is large enough relative to the instantaneous flow rate out through the cracked open valve, the water level under the bucket rises fast enough to reduce bucket buoyancy sufficiently so that the opening force grows to overcome the closing force permitting the valve to be pulled fully open.

If the condensate flow into the trap is small enough relative to the instantaneous flow rate out through the cracked open valve, water level under the bucket does not increase rapidly enough to reduce bucket buoyancy sufficiently and the closing force snaps the valve closed. This partially opening-instantly closing mode of operation then continues at a relatively rapid cycle rate which gives the appearance of continuous flow.

Regardless of the mode, it is the ever-present water seal, rather than the valve, which prevents live steam loss.

\[
P_1 A_0 L_2 > P_2 A_0 L_2 + F_B L_1 = \text{CLOSED}
\]

\[
P_1 A_1 L_2 = P_2 A_0 L_2 + F_B L_1 = \text{BALANCED}
\]

\[
P_1 A_0 L_2 > P_2 A_0 L_2 + F_B L_1 = \text{OPEN}
\]
Once the condensate level in the trap seals the bottom of the bucket when it is in the up position, the inverted-bucket is “primed” and cannot pass live steam to the valve. The water level outside the bucket rises until it forms a water seal above the bucket. The inverted bucket trap will retain its prime throughout the operating cycle unless subjected to a pressure drop so sudden and severe as to let the prime re-evaporate. Since this boiling-away takes several minutes, determined by the amount of pressure change, the reduced pressure must go unaltered for an extended period of time. Loss of prime can be identified by a violent rattling of the bucket inside the trap. Regaining prime can be accomplished, even on light loads, simply by closing a valve ahead of the trap, permitting the accumulation of condensate, then slowly opening the valve, allowing the condensate to enter the trap.

It must be stressed that all traps, regardless of type, use a small amount of steam through heat radiation from the body surface. For every 1000 B.T.U.’s radiated, approximately one pound of steam is condensed. This is not to be confused with live steam loss.

\[
\text{Heat Loss} = (f) A_s \times \Delta t = (f) A_s \times (T_1 - T_2)
\]

- \(A_s\) = Surface Area of trap
- \(T_1\) = Temperature of condensate
- \(T_2\) = Ambient Temperature
ARMSTRONG CAST IRON INVERTED BUCKET TRAPS FOR GENERAL SERVICE

for pressures to 250 psig . . . capacities to 20,000 lbs/hr

No 800

Side inlet, side outlet traps. Cap and mechanism can be removed without disturbing pipe connections.

No 814

No 880

No 883

Side inlet, side outlet traps with integral strainers. This type costs less than standard trap plus standard strainer. Saves fittings.

No.211 No.216

No.880

No.883

Bottom inlet, top outlet traps. Cap and mechanism can be removed without taking body from the line.

FORGED STEEL TRAPS FOR HIGH PRESSURE SERVICE

Armstrong offers the inverted bucket steam trap in a wide selection of materials, pressure ranges, connection sizes and piping configurations to ensure the right trap is available for each application.

This allows combinations to be chosen to give lowest steam use, lowest maintenance, and longest life, while minimizing purchase and installation costs.
SERIES TEN-TEN STAINLESS STEEL TRAPS
for pressures to 450 psig ... and capacities to 4400 lbs/hr

SERIES EIGHTEEN TEN STAINLESS STEEL TRAPS
for pressures to 400 psig ... and capacities to 1000 lbs/hr

The stainless steel inverted buckets are low cost, all-welded traps which require no maintenance during their long service life. The thin-wall construction can expand to withstand freezing and they are so lightweight that, generally, the piping can support the weight of the trap. Horizontal and vertical piping can be accomodated with side-inlet/opposite side-outlet connections, bottom in/top out, and top in/bottom out. The 2011, Armstrong's newest I.B. trap can be piped in any configuration, and can be renewed in-line.

Series 1910 For pressures to 400 psig and capacities to 900 lbs/hr.
Inverted bucket traps are available to suit almost any process or space heating application, and the fact that they can operate on any differential pressure below maximum is of special interest for drip and tracer and modulated pressure applications. A single orifice size can be used over a wide pressure range. This lowers inventory costs and lessens the likelihood that the wrong trap will be installed.

Armstrong has long believed that energy conservation is best served through education.

A portion of Armstrong’s one-and-one-half day Energy Management Seminar is devoted to the theoretical construction of the ideal steam trap. Engineers, pipefitters, maintenance supervisors, energy coordinators and others from around the country have volunteered their criteria for a perfect steam trap. While the list often grows quite long, and includes such requests as “a trap that will last forever”, the following are some of the more common demands:

- No live steam loss
- Fast drainage
- Long life
- Withstands freeze-up
- Not affected by dirt
- Continuous air venting
- Low maintenance
- Won’t promote corrosion
- Won’t promote water hammer
- Operates over wide pressure ranges
- Adaptable to piping configuration

No single trap is ideally suited to all applications. However, for over seventy years, the inverted bucket steam trap has successfully met severe challenges in countless installations throughout the world. Its versatility, efficiency, and long life have placed the inverted bucket at the forefront of Armstrong’s energy conservation campaign.