THE ARMSTRONG
INVERTED BUCKET STEAM TRAP

CAP

AIR SPACE

ORIFICE

VALVE
LEVER
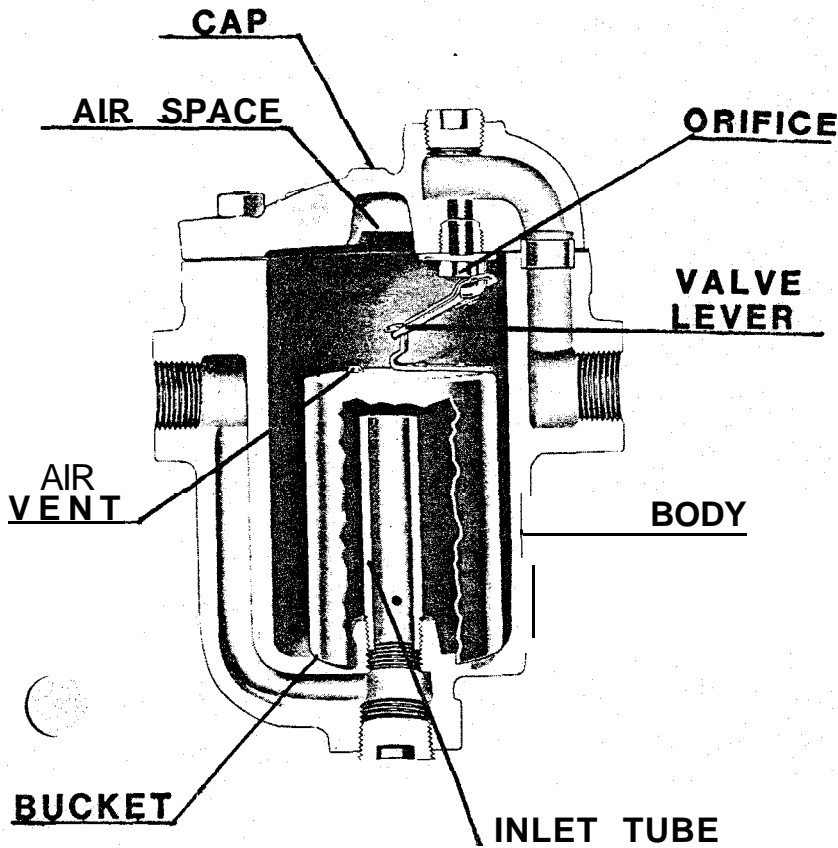
AIR
VENT

BODY

BUCKET

INLET TUBE

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.
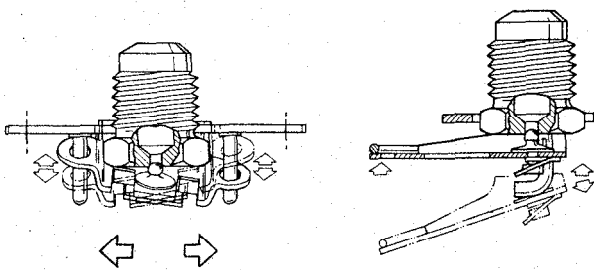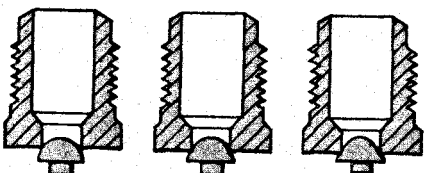
Armstrong IB Valve Seating/Ball Valve
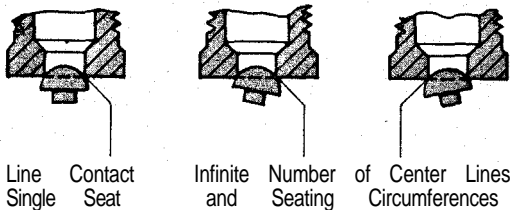
Line Contact   Infinite Number of Center Lines
Single Seat   and Seating Circumferences

IB Valve Wear Characteristics

Armstrong IB Ball Valve continues to seat itself deeper continuing to provide a tight seal,

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

VALVE
WIDE OPEN

FLOW
HERE
PICKS UP
DIRT
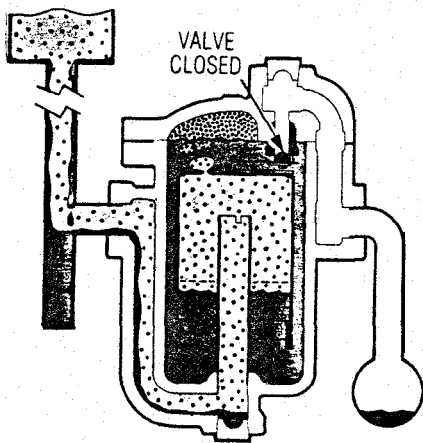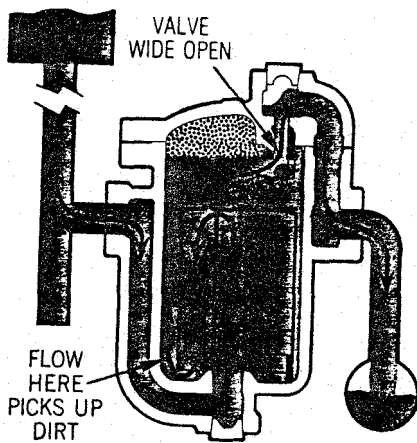
VALVE
CLOSED

START UP

Steam trap is installed in drain line be-
tween steam heated unit and condensate re-
turn 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, impart i ng buoyancy. Bucket then
rises and lifts valve toward its seat
until valve is snapped tightly shut by
the pressure differential. Air and
carbon dioxide cont inual ly pass through
bucket vent and collect at top of trap.
Any steam passing through vent is con-
densed by radiation from trap. Non-
condensibles are vented promptly at
steam   temperature.

Steam flow through the bucket vent is
limited by the vent size and low dif-
ferential 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.

VALVE
CLOSED

CLOSED
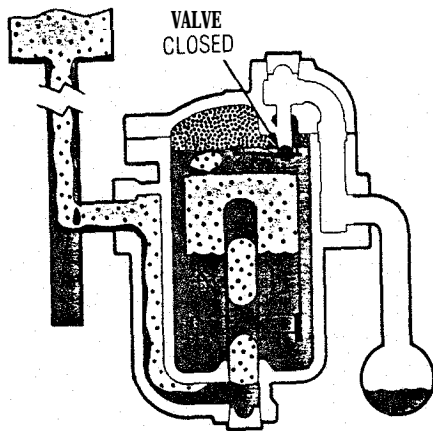
When entering condensate brings the condensate level slightly above the neutral line the bucket exerts a slight pull on the lever. The valve does not open, however, until the condensate level rises to the opening line for the existing pressure differential between the steam and the condensate return 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.

VALVE
WIDE OPEN

SELF
SCRUBBING
FLOW
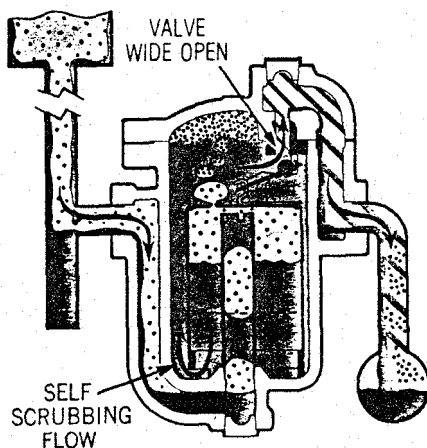
OPENING

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.

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**Force required
to open Valve.**

400 PSIG = 30.4 OZ
320 PSIG = 24.32 OZ
240 PSIG = 18.24 OZ
160 PSIG = 12.16 OZ
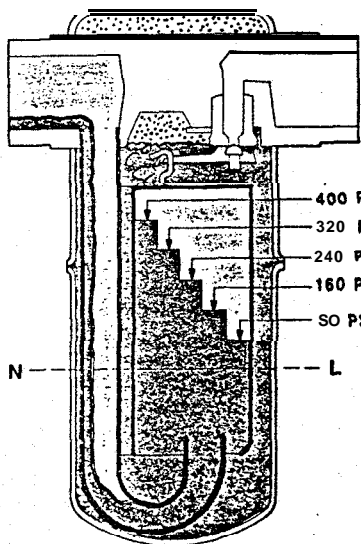SO PSIG = 6.08 OZ

N ----------- L

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 1 eve1 of water under the bucket is required to provide sufficient force. The same or if ice 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 different ial, 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.

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$$P_1 A_0 L_2 > P_2 A_0 L_2 + F_B L_1 \quad \text{---- CLOSED}$$

$$P_1 A, L_2 = P_2 A_0 L_2 + F_B L_1 \quad \text{---- BALANCED}$$

$$P_1 A_0 L_2 > P_2 A_0 L_2 + F_B L_1 \quad \text{-- OPEN}$$

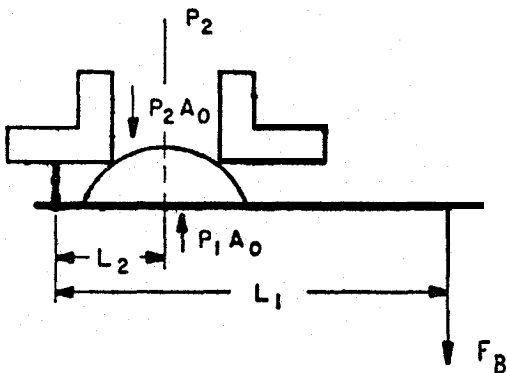## Low Load Continuously Modulating Mode of Operation

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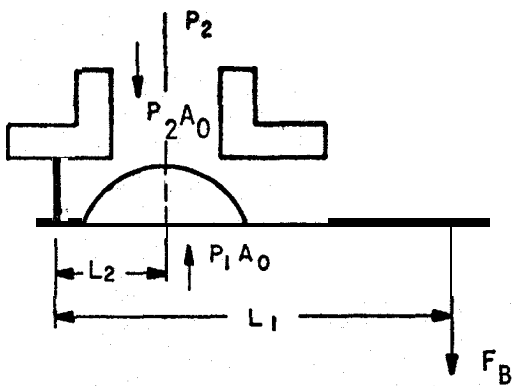
If the condensate flow into the trap is small enough relative to the instantaneous flow rate out through the cracked open valve, water level under the bucket does not increase rapidly enough to reduce bucket buoyancy sufficiently and the closing force snaps the valve closed. This partially opening-instantly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

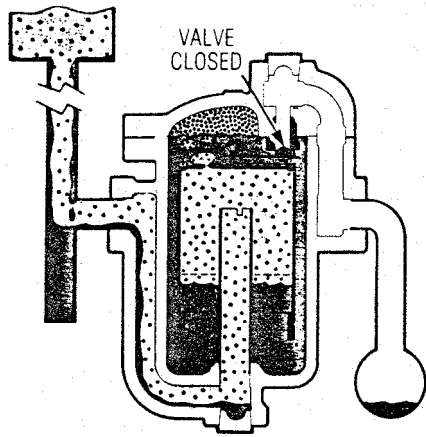Regardless of the mode, it is the ever-present water seal, rather than the valve, which prevents live steam loss.

PRIMING

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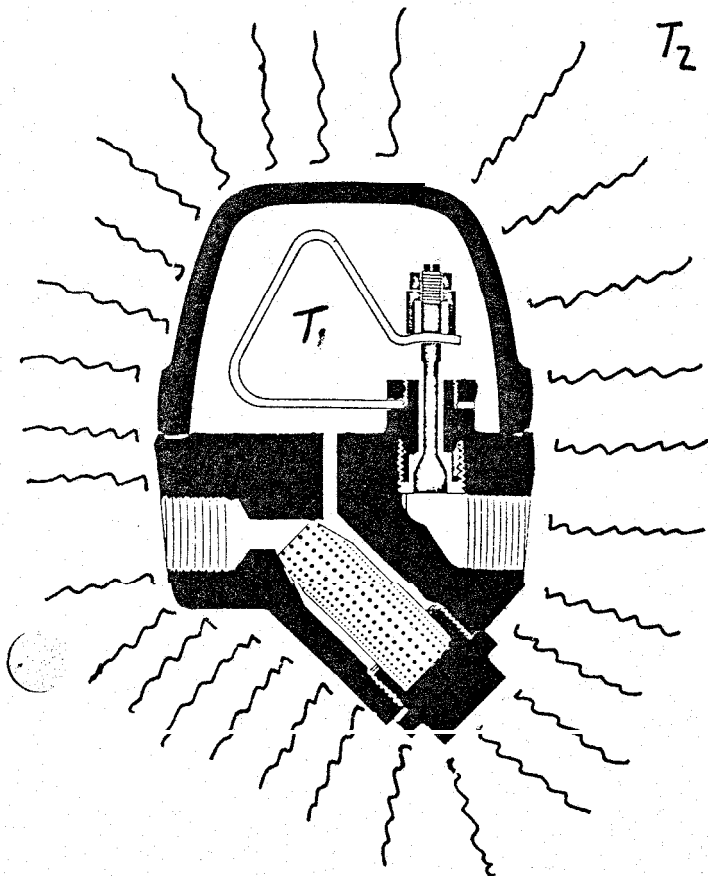
It must be stressed that all traps, regardless of type, use a small amount of steam through heat radiation from the body surface. For every 1000 B.T.U.'s radiated, approximately one pound of steam is condensed. This is not to be confused with live steam loss.

Heat Loss $=$ **(f)** A, x Δt
$\qquad\quad =$ **(f)** A, x $(T_1 - T_2)$
$A_s =$ 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   No 814   No.880   No 883
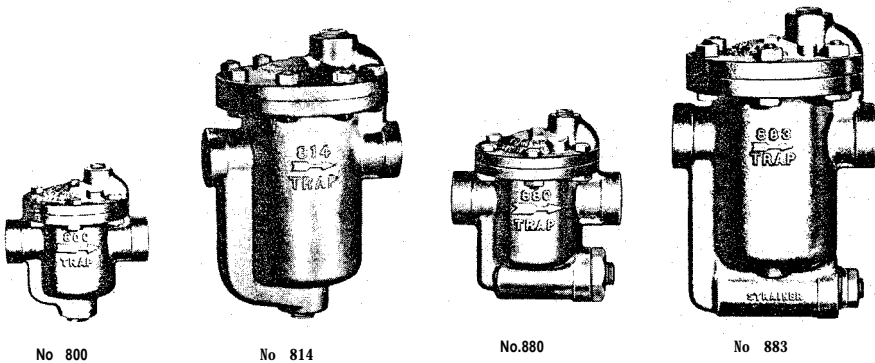
Side inlet, side outlet traps. Cap and mechanism can be removed without disturbing pipe connections.

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

No. 211   No. 216
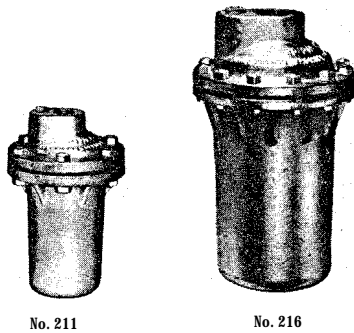
Bottom inlet, top outlet traps. Cap and mechanism can be removed without taking body from the line.

## FORGED STEEL TRAPS FOR HIGH PRESSURE SERVICE
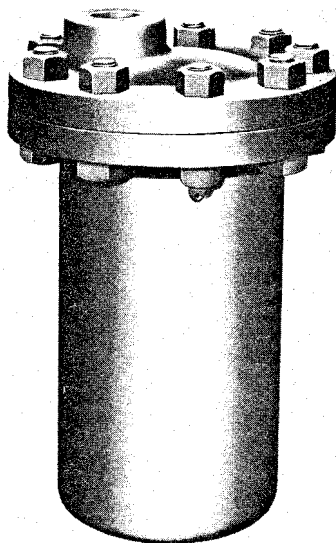

No. 312-416 forged steel traps.

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.

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SERIES TEN-TEN STAINLESS STEEL TRAPS
for pressures to 450 psig . . . and capacities to 4400 lbs/hr
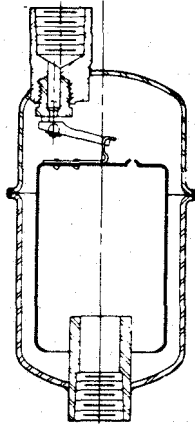

SERIES EIGHTEEN TEN STAINLESS STEEL TRAPS
for pressures to 400 psig . . . and capacities to 1000 lbs/hr
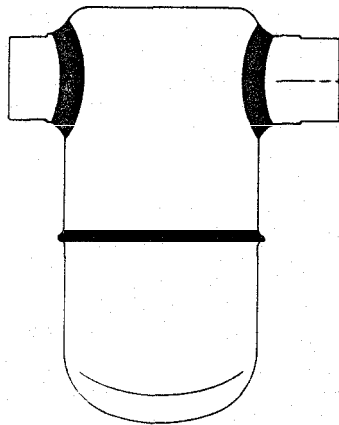
The stainless steel inverted buckets are low cost, all-welded traps which require no maintenance during their long service life. The thin-wall construction can expand to withstand freezing and they are so lightweight that, generally, the piping can support the weight of the trap. Horizontal and vertical 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.
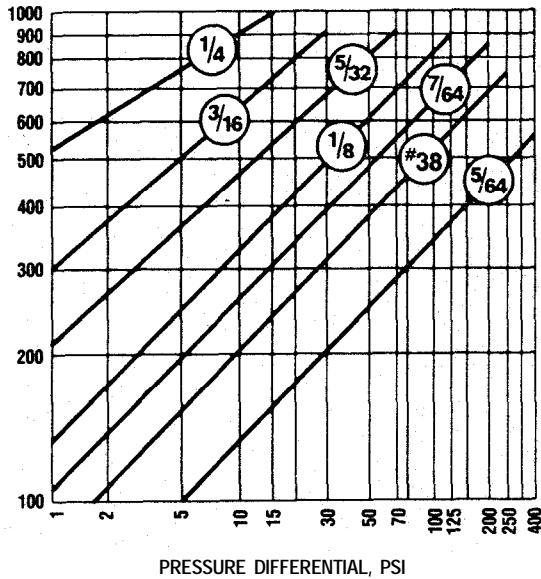
Series 1910
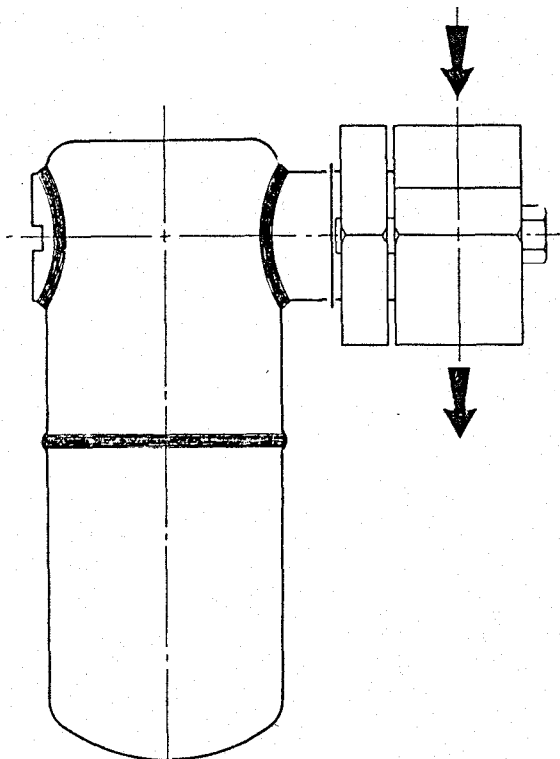**For pressures to 400 psig and capacities to 900 lbsJhr.**

8
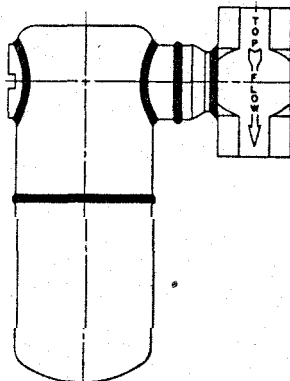
1811 TRAP CAPACITY

Continuous discharge capacities in pounds of hot condensate per hour at pressure differential indicated

PRESSURE DIFFERENTIAL, PSI

SERIES 2010

Stainless Steel Traps

Inverted bucket traps are available to suit almost any process or speace 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 Serminar 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 nands:

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 successfull 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' energy   conservation   campaign.