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-11. 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

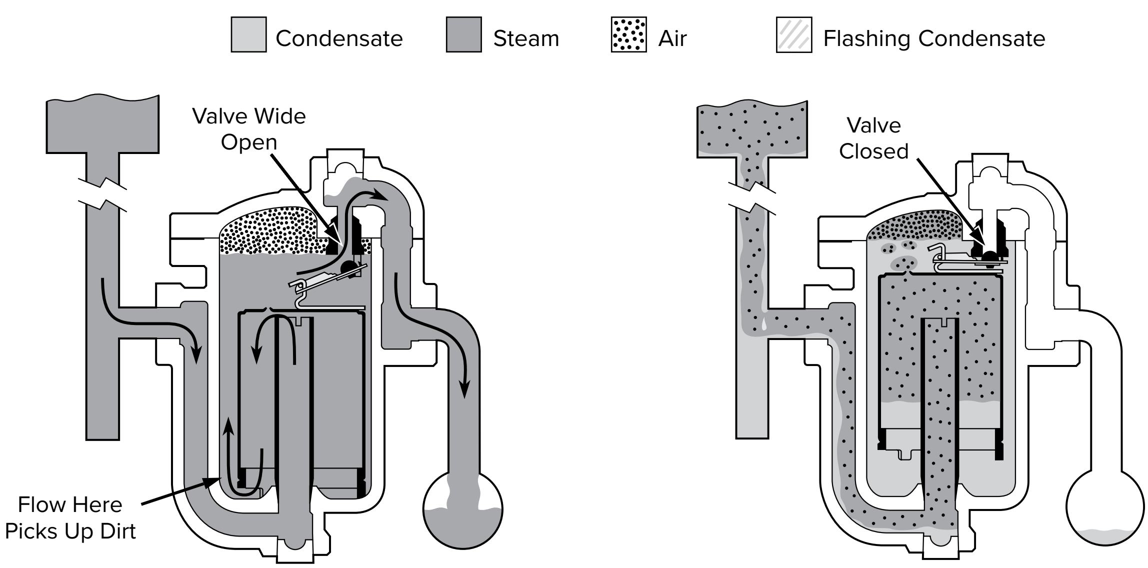
The valve and seat of Armstrong inverted bucket traps are high chrome stainless steel, ground and lapped. All other working parts are wear- and corrosion-resistant stainless steel.

Operation Against 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.

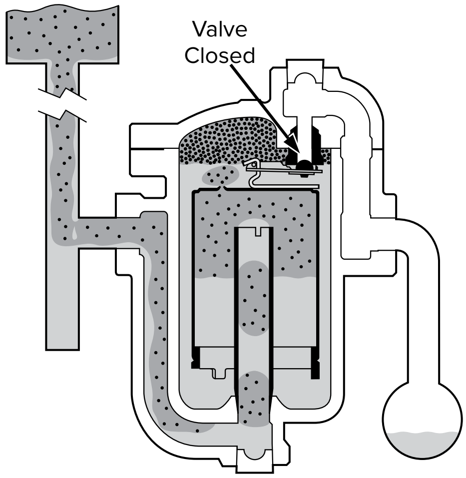
Back pressure has no adverse effect on inverted bucket trap operation other than capacity reduction caused by the low differential. There is simply less force required by the bucket to pull the valve open, cycling the trap.

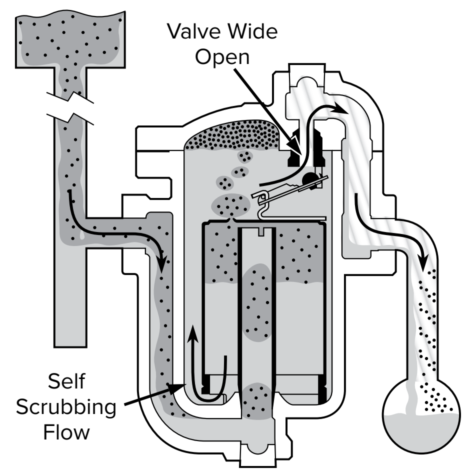
Figure CG-11. Operation of the Inverted Bucket Steam Trap (at pressures close to maximum)



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.





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.

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-4.

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 650 psig and temperatures to 800°F.
2. **Cast Iron Traps.** Standard inverted bucket traps for general service at pressures to 250 psig and temperatures to 450°F. 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 2,700 psig at 1,050°F.
4. **Cast Stainless Steel Traps.** Standard inverted bucket traps for high capacity, corrosive service. Repairable. For pressures to 700 psig and temperatures to 506°F.

Table CG-4. Typical Design Parameters for Inverted Bucket Traps

Body and Cap Materials	**Cast Iron**	**Stainless Steel**	**Forged Steel**	**Cast Steel**	**Cast Stainless Steel**
Connections	1/2" thru 2-1/2"	3/8" thru 1"	1/2" thru 2"	1/2" thru 1"	1/2" thru 2"
Type Connections	Screwed	Screwed, Socketweld	Screwed, Socketweld or Flanged	Screwed, Socketweld or Flanged	Screwed, Socketweld or Flanged
Operating Pressure (psig)	0 thru 250	0 thru 650	0 thru 2,700	0 thru 600	0 thru 700
Capacity (lbs/hr)	To 20,000	To 4,400	To 20,000	To 4,400	To 20,000

The Float and Thermostatic Steam Trap

The float and thermostatic trap is a mechanical trap that operates on both density and temperature principles. The float valve operates on the density principle: A lever connects the ball float to the valve and seat. Once condensate reaches a certain level in the trap the float rises, opening the orifice and draining condensate. A water seal formed by the condensate prevents live steam loss.

Since the discharge valve is under water, it is not capable of venting air and non-condensables. When the accumulation of air and non-condensable gases causes a significant temperature drop, a thermostatic air vent in the top of the trap discharges it. The thermostatic vent opens at a temperature a few degrees below saturation so it's able to handle a large volume of air—through an entirely separate orifice—but at a slightly reduced temperature.

Armstrong F&T traps provide high air-venting capacity, respond immediately to condensate and are suitable for both industrial and HVAC applications.

Reliable Operation on Modulating Steam Pressure

Modulating steam pressure means that the pressure in the heat exchange unit being drained can vary anywhere from the maximum steam supply pressure down to vacuum under certain conditions. Thus, under conditions of zero pressure, only the force of gravity is available to push condensate through a steam trap. Substantial amounts of air may also be liberated under these conditions of low steam pressure. The efficient operation of the F&T trap meets all of these specialized requirements.

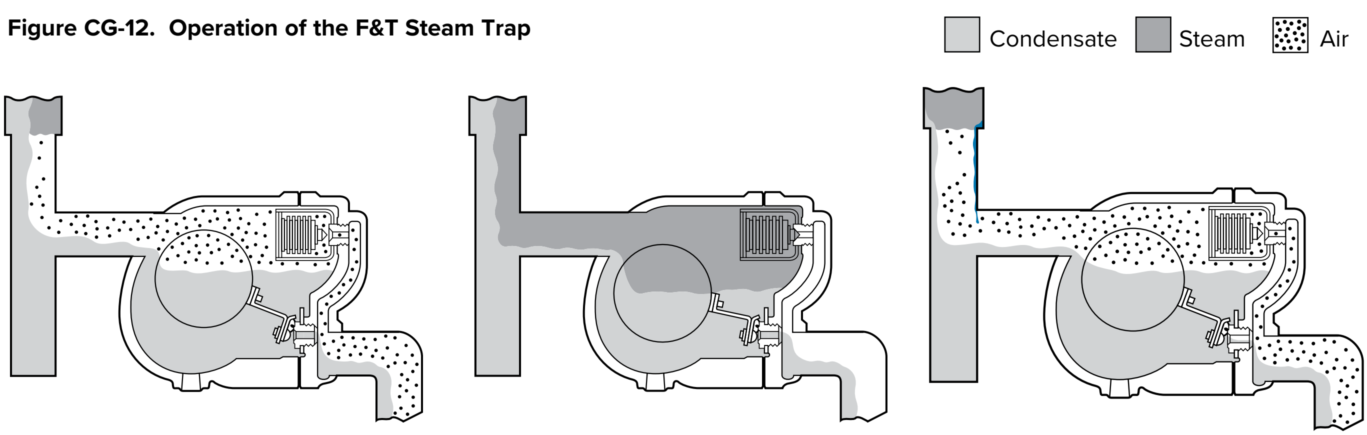
High Back Pressure Operation

Back pressure has no adverse effect on float and thermostatic trap operation other than capacity reduction due to low differential. The trap will not fail to close and will not blow steam due to the high back pressure.

Table CG-5. Typical Design Parameters for Float and Thermostatic Traps

Body and Cap Materials	Cast Iron	Cast Steel
Connections	1/2" thru 3"	1/2" thru 3"
Type Connections	Screwed or Flanged	Screwed, Socketweld or Flanged
Operating Pressure (psig)	0 thru 250	0 thru 465
Capacity (lbs/hr)	To 208 000	To 280 000

Figure CG-12. Operation of the F&T Steam Trap



1. On start-up, low system pressure forces air out through the thermostatic air vent. A high condensate load normally follows air venting and lifts the float, which opens the main valve. The remaining air continues to discharge through the open vent.

2. When steam reaches the trap, the thermostatic air vent closes in response to higher temperature. Condensate continues to flow through the main valve, which is positioned by the float to discharge condensate at the same rate that it flows to the trap.

3. As air accumulates in the trap, the temperature drops below that of saturated steam. The balanced pressure thermostatic air vent opens and discharges air.

NOTE: These operational schematics of the F&T trap do not represent actual trap configuration.

The Controlled Disc Steam Trap

The controlled disc steam trap is a time-delayed device that operates on the velocity principle. It contains only one moving part, the disc itself. Because it is very lightweight and compact, the CD trap meets the needs of many applications where space is limited. In addition to the disc trap's simplicity and small size, it also offers advantages such as resistance to hydraulic shock, the complete discharge of all condensate when open and intermittent operation for a steady purging action.

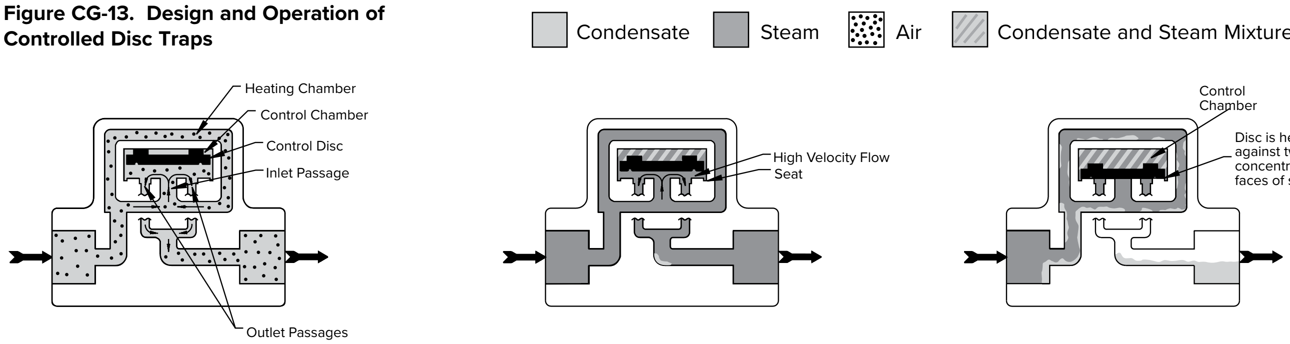
Operation of controlled disc traps depends on the changes in pressures in the chamber where the disc operates. The Armstrong CD trap will be open as long as cold condensate is flowing. When steam or flash steam reaches the inlet orifice, velocity of flow increases, pulling the disc toward the seat. Increasing pressure in the control chamber snaps the disc closed. The subsequent pressure reduction, necessary for the trap to open, is controlled by the heating chamber in the cap and a finite machined bleed groove in the disc. Once the system is up to temperature, the bleed groove controls the trap cycle rate.

Unique Heating Chamber

The unique heating chamber in Armstrong's controlled disc traps surrounds the disc body and control chamber. A controlled bleed from the chamber to the trap outlet controls the cycle rate. That means that the trap design—not ambient conditions—controls the cycle rate. Without this controlling feature, rain, snow and cold ambient conditions would upset the cycle rate of the trap.

Table CG-6. Typical Design Parameters for Controlled Disc Traps	
Body and Cap Materials	Steel
Connections	3/8" thru 1"
Type Connections	Screwed, Socketweld or Flanged
Operating Pressure (psig)	10 thru 600
Capacity (lbs/hr)	To 2 850

Figure CG-13. Design and Operation of Controlled Disc Traps



1. On start-up, condensate and air entering the trap pass through the heating chamber, around the control chamber and through the inlet orifice. This flow lifts the disc off the inlet orifice, and the condensate flows through to the outlet passages.

2. Steam enters through the inlet passage and flows under the control disc. The flow velocity across the face of the control disc increases, creating a low pressure that pulls the disc toward the seat.

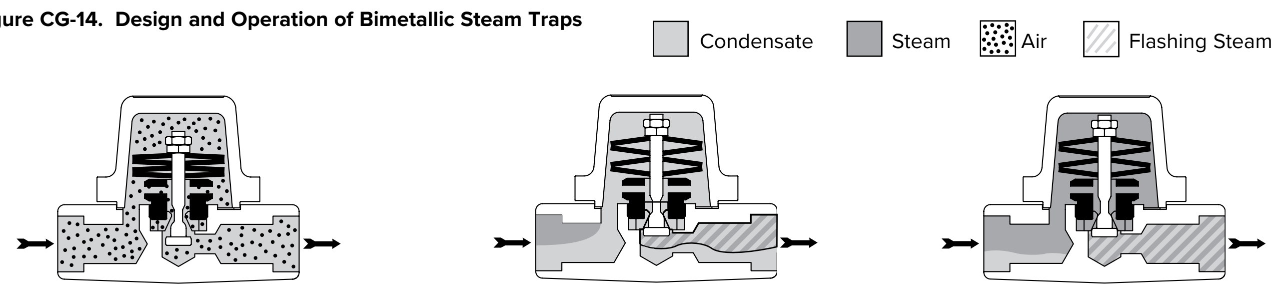
3. The disc closes against two concentric faces of the seat, closing off the inlet passage and also trapping steam and condensate above the disc. There is a controlled bleeding of steam from the control chamber; flashing condensate helps maintain the pressure in the control chamber. When the pressure above the disc is reduced, the incoming pressure lifts the disc off the seat. If condensate is present, it will be discharged, and the cycle repeats.

The Bimetallic Steam Trap

Bimetallic steam traps have the ability to handle large start-up loads. As the trap increases in temperature, its stacked nickel-chrome bimetallic elements start to expand, allowing for tight shutoff as steam reaches the trap, thus preventing steam loss. In addition to its light weight and compact size, it offers resistance to water hammer. Titanium valve and seat on high-pressure bimetallic traps ensure extremely long service life in the harsh environment of superheated steam systems.

Table CG-7. Typical Design Parameters for Bimetallic Traps		
Body and Cap Materials	Carbon Steel	Stainless Steel
Connection Sizes	1/2", 3/4", 1"	
Type Connections	Screwed, Socketweld, Flanged	Screwed, NPT, BSPT, Socketweld, Buttweld, Flanged
Operating (psig)	0 - 250	200 - 900
Cold Water Capacity lb/hr	up to 11 000	

Figure CG-14. Design and Operation of Bimetallic Steam Traps



1. On start-up, the trap is cold, so the elements are flat and the valve is wide open, which results in air and condensate being easily removed from the system by working pressure.

2. With increasing temperature of the condensate, the bimetallic elements will start to expand and flex.

3. When set temperature is reached, the force of the elements is high enough to close the valve completely against the system pressure working on the valve.

The Thermostatic Steam Trap

Armstrong thermostatic steam traps are available with balanced pressure bellows or wafer-type elements and are constructed in a wide variety of materials, including stainless steel, carbon steel and bronze. These traps are used on applications with very light condensate loads.

Thermostatic Operation

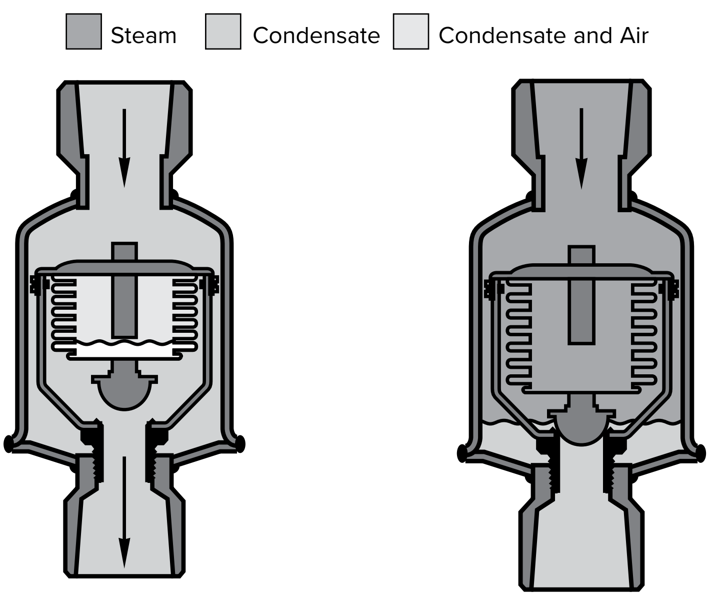
Thermostatic steam traps operate on the difference in temperature between steam and cooled condensate and air. Steam increases the pressure inside the thermostatic element, causing the trap to close. As condensate and non-condensable gases back up in the cooling leg, the temperature begins to drop, and the thermostatic element contracts and opens the valve. The amount of condensate backed up ahead of the trap depends on the load conditions, steam pressure and size of the piping. It is important to note that an accumulation of non-condensable gases can occur behind the condensate backup.

Table CG-8. Design Parameters for Thermostatic Traps

	Balanced Pressure Bellows		Balanced Pressure Wafer		
Body and Cap Materials	Stainless Steel	Bronze	Stainless Steel	Carbon Steel	Bronze
Connections	1/2", 3/4"	1/2", 3/4"	1/4" thru 1"	1/2", 3/4"	1/2", 3/4", 1"
Type Connections	Screwed, Socketweld	NPT Straight, Angle	Screwed, Socketweld	Screwed, Socketweld	NPT Straight, Angle
Operating Pressure (psig)	0 - 300	0 - 50	0 - 400	0 - 600	0 - 65
Capacity (lbs/hr)	To 3 450	To 1 600	To 70	To 85	To 960

NOTE: Thermostatic traps can also be used for venting air from a steam system. When air collects, the temperature drops and the thermostatic air vent automatically discharges the air at slightly below steam temperature throughout the entire operating pressure range.

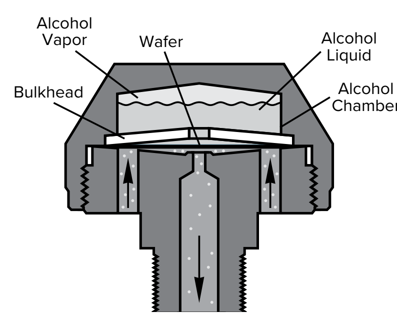
Figure CG-15. Operation of the Thermostatic Steam Trap



1. On start-up, condensate and air are pushed ahead of the steam directly through the trap. The thermostatic bellows element is fully contracted, and the valve remains wide open until steam approaches the trap.

2. As the temperature inside the trap increases, it quickly heats the charged bellows element, increasing the vapor pressure inside. When pressure inside the element becomes balanced with system pressure in the trap body, the spring effect of the bellows causes the element to expand, closing the valve. When temperature in the trap drops a few degrees below saturated steam temperature, imbalanced pressure contracts the bellows, opening the valve.

Figure CG-16.
Operation of Thermostatic Wafer



Balanced Pressure Thermostatic Wafer operation is very similar to balanced pressure bellows described in Fig. CG-15. The wafer is partially filled with a liquid. As the temperature inside the trap increases, it heats the charged wafer, increasing the vapor pressure inside. When the pressure inside the wafer exceeds the surrounding steam pressure, the wafer membrane is forced down on the valve seat, and the trap is closed. A temperature drop caused by condensate or non-condensable gases cools and reduces the pressure inside the wafer, allowing the wafer to uncover the seat.

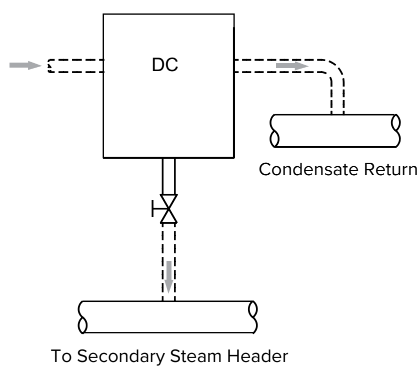
Armstrong automatic differential condensate controllers (DC) are designed to function on applications where condensate must be lifted from a drain point or in gravity drainage applications where increased velocity will aid in drainage.

Lifting condensate from the drain point—often referred to as syphon drainage—reduces the pressure of condensate, causing a portion of it to flash into steam. Since ordinary steam traps are unable to distinguish flash steam and live steam, they close and impede drainage.

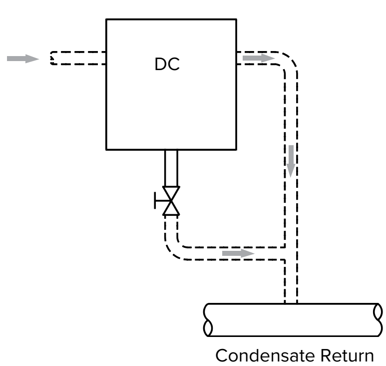
Increased velocity with gravity drainage will aid in drawing the condensate and air to the DC. An internal steam by-pass controlled by a manual metering valve causes this increased velocity. Therefore, the condensate controller automatically vents the by-pass or secondary steam. This is then collected for use in other heat exchangers or discharged to the condensate return line.

Capacity considerations for draining equipment vary greatly according to the application. However, a single condensate controller provides sufficient capacity for most applications.

Figure CG-17.



For the most efficient use of steam energy, Armstrong recommends this piping arrangement when secondary steam is collected and reused in heat transfer equipment.



Piping arrangement when flash steam and non-condensables are to be removed and discharged directly to the condensate return line.

Condensate Controller Operation

Condensate, air and steam (live and flash) enter through the controller inlet. At this point flash steam and air are automatically separated from the condensate. Then they divert into the integral by-pass at a controlled rate, forming secondary steam (See Fig. CG-18).

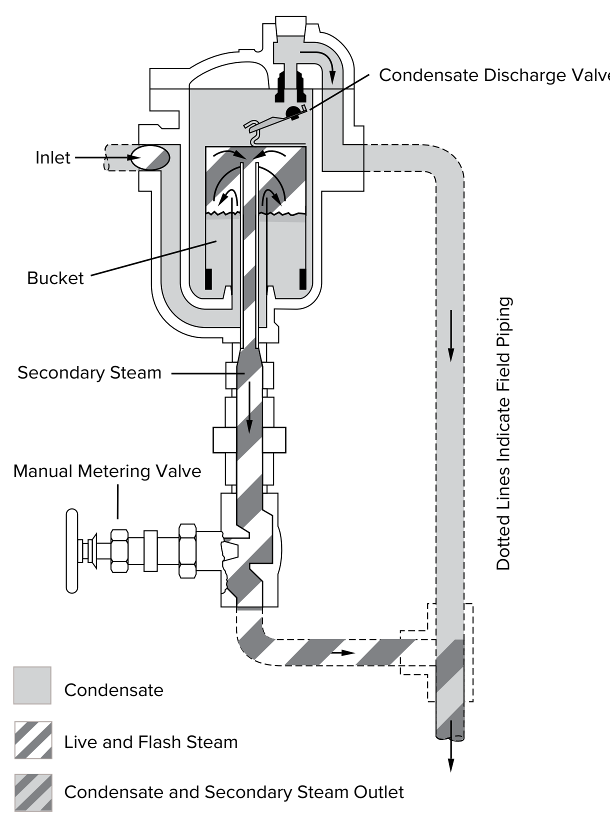
The valve is adjustable so it matches the amount of flash present under full capacity operation or to meet the velocity requirements of the system. The condensate discharges through a separate orifice controlled by the inverted bucket.

Because of the dual orifice design, there is a preset controlled pressure differential for the secondary steam system, while maximum pressure differential is available to discharge the condensate.

Table CG-9. Typical Design Parameters for the Automatic Differential Condensate Controller

Body and Cap Materials	**Cast Iron**	**Steel**
Connections	1/2" thru 2"	1" thru 2"
Type Connections	Screwed	Screwed
Operating Pressure (psig)	0 thru 250	0 thru 650
Capacity (lbs/hr)	To 20 000	To 20 000

Figure CG-18. Condensate Controller Operation



Steam Trap Selection

To obtain the full benefits from the traps described in the preceding section, it is essential to select traps of the correct size and pressure for a given job and to install and maintain them properly. One of the purposes of this section is to supply the information to make that possible. Actual installation and operation of steam trapping equipment should be performed only by experienced personnel. Selection or installation should always be accompanied by competent technical assistance or advice. This section should never be used as a substitute for such technical advice or assistance. We encourage you to contact Armstrong or its local representative for further details.

Basic Considerations

Unit trapping is the use of a separate steam trap on each steam-condensing unit including, whenever possible, each separate chest or coil of a single machine. The discussion under the Short Circuiting heading explains the "why" of unit trapping versus group trapping.

Rely on experience. Select traps with the aid of experience–either yours, the know-how of your Armstrong Representative or what others have learned in trapping similar equipment.

Do-it-yourself sizing. Do-it-yourself sizing is simple with the aid of Steam-A-ware™, Armstrong's sizing and selection software program, which can be downloaded at: **armstrong**international.com.

Even without this computer program, you can easily size steam traps when you know or can calculate:

1. Condensate loads in lbs/hr
2. The safety factor to use
3. Pressure differential
4. Maximum allowable pressure

1. **Condensate load.** Each "How To" portion of this section contains formulas and useful information on steam condensing rates and proper sizing procedures.
2. **Safety factor or experience factor to use.** Users have found that they must generally use a safety factor in sizing steam traps. For example, a coil condensing 500 lbs/hr might require a trap that could handle up to 1 500 lbs/hr for best overall performance. This 3:1 safety factor takes care of varying condensate rates, occasional drops in pressure differential and system design factors.

Safety factors will vary from a low of 1.5:1 to a high of 10:1. The safety factors in this book are based on years of user experience.

Configuration affects safety factor. More important than ordinary load and pressure changes is the design of the steam-heated unit itself. Refer to Figs. CG-21, CG-22 and CG-23 showing three condensing units each producing 500 pounds of condensate per hour, but with safety factors of 2:1, 3:1 and 8:1.

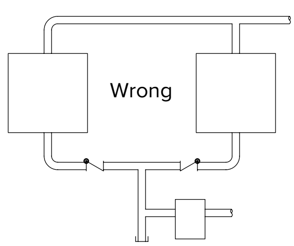


Figure CG-19. Two steam-consuming units drained by a single trap, referred to as group trapping, may result in short circuiting.

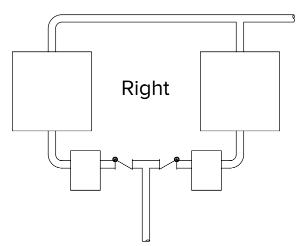


Figure CG-20. Short circuiting is impossible when each unit is drained by its own trap. Higher efficiency is assured.

Short Circuiting

If a single trap connects more than one drain point, condensate and air from one or more of the units may fail to reach the trap. Any difference in condensing rates will result in a difference in the steam pressure drop. A pressure drop difference too small to register on a pressure gauge is enough to let steam from the higher pressure unit block the flow of air or condensate from the lower pressure unit. The net result is reduced heating, output and fuel waste (see Figs. CG-19 and CG-20).

Identical Condensing Rates, Identical Pressures With Differing Safety Factors

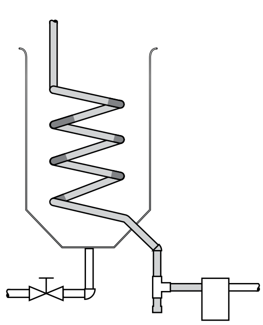


Figure CG-21. Continuous coil, constant pressure gravity flow to trap. 500 lbs/hr of condensate from a single copper coil at 30 psig. Gravity drainage to trap. Volume of steam space very small. 2:1 safety factor.

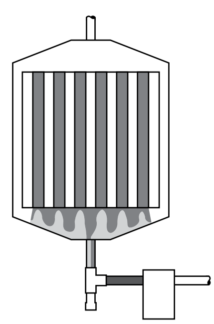


Figure CG-22. Multiple pipes, modulated pressure gravity flow to trap. 500 lbs/hr of condensate from unit heater at 80 psig. Multiple tubes create minor short-circuiting hazard. Use 3:1 safety factor at 40 psig.

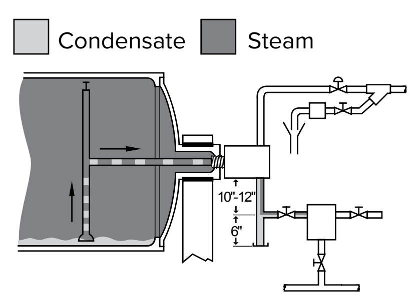


Figure CG-23. Large cylinder, syphon drained. 500 lbs/hr from a 4' diameter, 10' long cylinder dryer with 115 cu ft of space at 30 psig. The safety factor is 3:1 with a DC and 8:1 with an IB.

Economical steam trap/orifice selection. While an adequate safety factor is needed for best performance, too large a factor causes problems. In addition to higher costs for the trap and its installation, a needlessly oversized trap wears out more quickly. And in the event of a trap failure, an oversized trap loses more steam, which can cause water hammer and high back pressure in the return system.

3. **Pressure differential.** Maximum differential is the difference between boiler or steam main pressure or the downstream pressure of a PRV and return line pressure. See Fig. CG-24. The trap must be able to open against this pressure differential.

NOTE: Because of flashing condensate in the return lines, don't assume a decrease in pressure differential due to static head when elevating.

Operating differential. When the plant is operating at capacity, the steam pressure at the trap inlet may be lower than steam main pressure. And the pressure in the condensate return header may go above atmospheric.

If the operating differential is at least 80% of the maximum differential, it is safe to use maximum differential in selecting traps.

Modulated control of the steam supply causes wide changes in pressure differential. The pressure in the unit drained may fall to atmospheric or even lower (vacuum). This does not prevent condensate drainage if the installation practices in this handbook are followed.

IMPORTANT: Be sure to read the discussion to the right, which deals with less common but important reductions in pressure differential.

4. **Maximum allowable pressure.** The trap must be able to withstand the maximum allowable pressure of the system or design pressure. It may not have to operate at this pressure, but it must be able to contain it. As an example, the maximum inlet pressure is 350 psig and the return line pressure is 150 psig. This results in a differential pressure of 200 psi; however, the trap must be able to withstand 350 psig maximum allowable pressure. See Fig. CG-24.

Factors Affecting Pressure Differential

Except for failures of pressure control valves, differential pressure usually varies on the low side of the normal or design value. Variations in either the inlet or discharge pressure can cause this.

Inlet pressure can be reduced below its normal value by:

1. A modulating control valve or temperature regulator.
2. "Syphon drainage." Every 2' of lift between the drainage point and the trap reduces the inlet pressure (and the differential) by one psi. See Fig. CG-25.

Discharge pressure can be increased above its normal value by:

1. Pipe friction.
2. Other traps discharging into a return system of limited capacity.
3. Elevating condensate. Every 2' of lift increases the discharge pressure (and the differential) by one psi when the discharge is only condensate. However, with flash present, the extra back pressure could be reduced to zero. See Fig. CG-26, noting the external check valve.

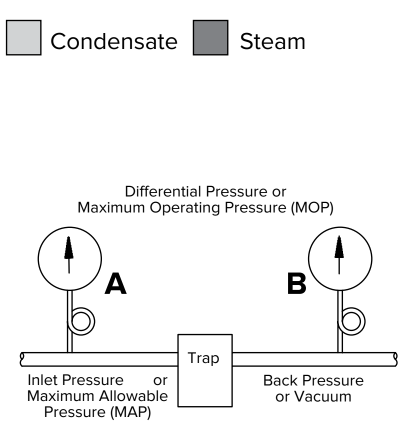


Figure CG-24. "A" minus "B" is Pressure Differential: If "B" is back pressure, subtract it from "A". If "B" is vacuum, add it to "A".

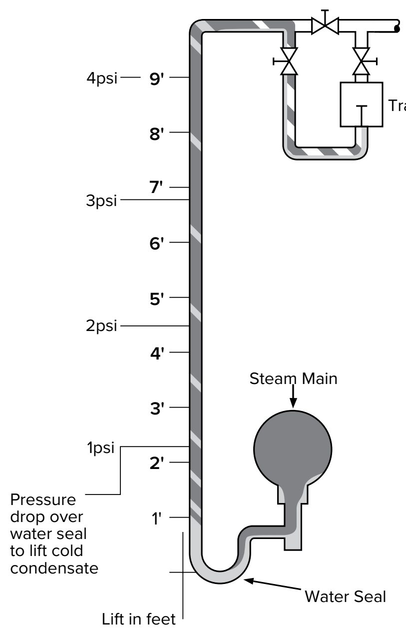


Figure CG-25. Condensate from gravity drain point is lifted to trap by a syphon. Every 2' of lift reduces pressure differential by 1 psi. Note seal at low point and the trap's internal check valve to prevent backflow.

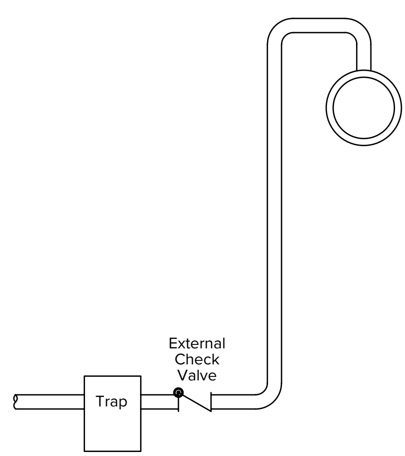


Figure CG-26. When trap valve opens, steam pressure will elevate condensate. Every 2' of lift reduces pressure differential by 1 psi.

This table provides recommendations for traps likely to be most effective in various applications. The recommended safety factors ensure proper operation under varying conditions. For more specific information on recommended traps and safety factors, contact your Armstrong Representative.

Table CG-27.

Application	1st Choice	2nd Choice	Safety Factor
Boiler Header	IBLV	F&T	1.5:1
(Superheat)	IBCV	Wafer	Start-Up Load
Steam Mains & Branch Lines (Non-Freezing)	IB (CV if pressure varies)	F&T	2:1, 3:1 if @ end of main, ahead of valve, or on branch
(Freezing)	IB	Thermostatic or Disc	Same as above
Steam Separator	IBLV	DC	3:1
Steam quality 90% or less	DC	—	
Tracer Lines	IB	Thermostatic or Disc	2:1
Unit Heaters and Air Handlers (Constant Pressure)	IBLV	F&T	3:1
(0-15 Variable Pressure)	F&T	IBLV	2:1 @ 1/2 psig Differential
(16-30 Variable Pressure)			2:1 @ 2 psig Differential
(>30 Variable Pressure)			3:1 @ 1/2 Max. Pressure Differential
Finned Radiation & Pipe Coils (Constant Pressure)	IB	Thermostatic	3:1 for quick heating 2:1 normally
(Variable Pressure)	F&T	IB	
Process Air Heaters (Constant Pressure)	IB	F&T	2:1
(Variable Pressure)	F&T	IBLV	3:1 @ 1/2 Max. Pressure Differential
Steam Absorption Machine (Chiller)	F&T	IB Ext. Air Vent	2:1 @ 1/2 psig Differential
Shell & Tube Heat Exchangers, Pipe & Embossed Coils (Constant Pressure)	IB	DC or F&T	2:1
(Variable Pressure)	F&T	DC or IBT (If >30 psig IBLV)	<15 psig 2:1 @ 1/2 psig 16-30 psig 2:1 @ 2 psig >30 psig 3:1 @ 1/2 Max. Pressure Differential
Evaporator Single Effect & Multiple Effect	DC	IBLV or F&T	2:1, If load 50 000 lbs/hr use 3:1
Jacketed Kettles (Gravity Drain)	IBLV	F&T or Thermostatic	3:1
(Syphon Drain)	DC	IBLV	
Rotating Dryers	DC	IBLV	3:1 for DC, 8:1 for IB variable pressure, 10:1 for IB variable pressure
Flash Tanks	IBLV	DC or F&T	3:1

IBLV = Inverted Bucket Large Vent
IBCV = Inverted Bucket Internal Check Valve
IBT = Inverted Bucket Thermic Vent
F&T = Float & Thermostatic
DC = Differential Condensate Controller

Use an IB with external air vent above the F&T pressure limitations or if the steam is dirty. All safety factors are at the operating pressure differential unless otherwise noted.

Installation and Testing of Armstrong Steam Traps

Before Installing

Run pipe to trap. Before installing the trap, clean the line by blowing down with steam or compressed air. (Clean any strainer screens after this blowdown.)

Trap Location ABCs

Accessible for inspection and repair.

Below drip point whenever possible.

Close to drip point.

Trap Hookups. For typical hookups, see Figs. CG-60 (below) through CG-71, pages CG-47 through CG-50.

Shutoff Valves ahead of traps are needed when traps drain steam mains, large water heaters, etc., where system cannot be shut down for trap maintenance. They are not needed for small steam-heated machines—a laundry press, for example. Shutoff valve in steam supply to machine is usually sufficient.

Shutoff Valves in trap discharge line are needed when trap has a by-pass. It is a good idea when there is high pressure in discharge header. See also Check Valves.

By-passes (Figs. CG-64 and CG-65) are discouraged, for if left open, they will defeat the function of the trap. If continuous service is absolutely required, use two traps in parallel, one as a primary, one as a standby.

Unions. If only one is used, it should be on discharge side of trap. With two unions, avoid horizontal or vertical in-line installations. The best practice is to install at right angles as in Figs. CG-60 and CG-64, or parallel as in Fig. CG-65.

Standard Connections. Servicing is simplified by keeping lengths of inlet and outlet nipples identical for traps of a given size and type. A spare trap with identical fittings and half unions can be kept in storeroom. In the event a trap needs repair, it is a simple matter to break the two unions, remove the trap, put in the spare and tighten the unions. Repairs can then be made in the shop and the repaired trap, with fittings and half unions, put back in stock.

Test Valves (Fig. CG-60) provide an excellent means of checking trap operation. Use a small plug valve. Provide a check valve or shutoff valve in the discharge line to isolate trap while testing.

Figure CG-60.
Typical IB Hookup

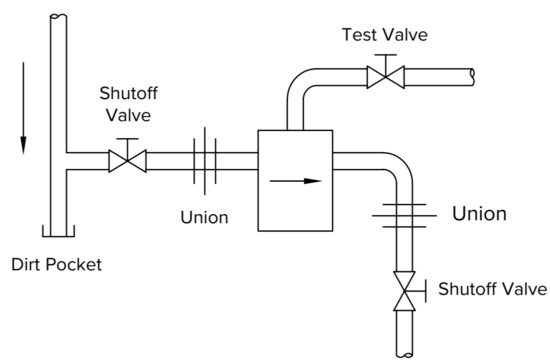


Figure CG-61.
Typical IB Bottom Inlet—Top Outlet Hookup

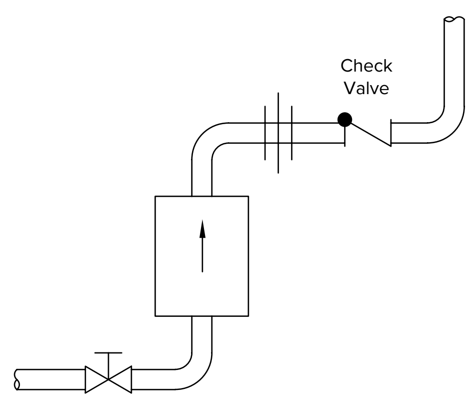


Figure CG-62.
Typical IB Bottom Inlet—Side Outlet Hookup

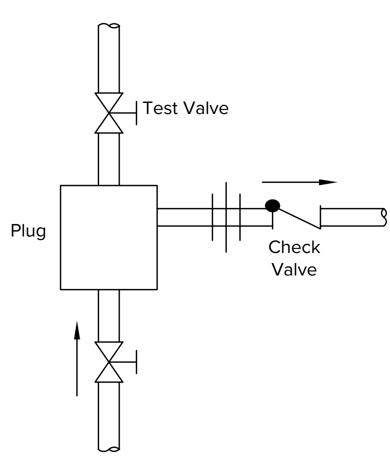
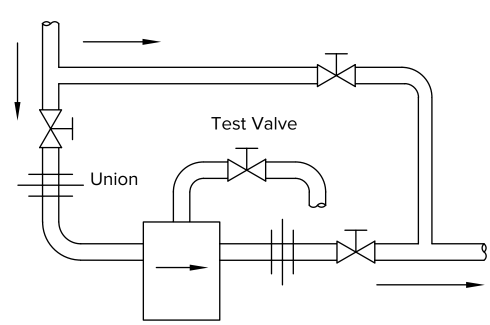


Figure CG-63.
Typical IB By-pass Hookup



Strainers. Install strainers ahead of traps if specified or when dirt conditions warrant their use. Some types of traps are more susceptible to dirt problems than others—see Recommendation Chart on page CG-4.

Some traps have built-in strainers. When a strainer blowdown valve is used, shut off steam supply valve before opening strainer blowdown valve. Condensate in trap body will flash back through strainer screen for thorough cleaning. Open steam valve slowly.

Dirt Pockets are excellent for stopping scale and core sand, and eliminating erosion that can occur in elbows when dirt pockets are not provided. Clean periodically.

Syphon Installations require a water seal and, with the exception of the DC, a check valve in or before the trap. Syphon pipe should be one size smaller than nominal size of trap used but not less than 1/2" pipe size.

Elevating Condensate. Do not oversize the vertical riser. In fact, one pipe size smaller than normal for the job will give excellent results.

Check Valves are frequently needed. They are a must if no discharge line shutoff valve is used. Fig. CG-63 shows three possible locations for external check valves—Armstrong inverted bucket traps are available with internal check valves, while disc traps act as their own check valve. Recommended locations are given in Fig. CG-63.

Discharge Line Check Valves prevent backflow and isolate trap when test valve is opened. Normally installed at location B, Fig. CG-63. When return line is elevated and trap is exposed to freezing conditions, install check valve at location A.

Inlet Line Check Valves prevent loss of seal if pressure should drop suddenly or if trap is above drip point in IB traps. Armstrong Stainless Steel Check Valve in trap body, location D, Fig. CG-63, is recommended. If swing check is used, install at location C.

Figure CG-64.
Possible Check Valve Locations

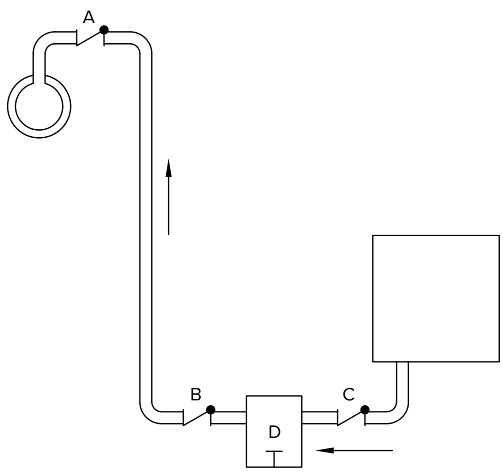


Figure CG-65.
Typical IB By-pass Hookup, Bottom Inlet—Top Outlet

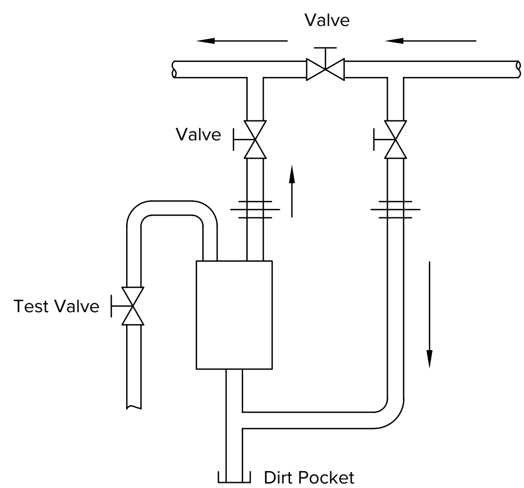
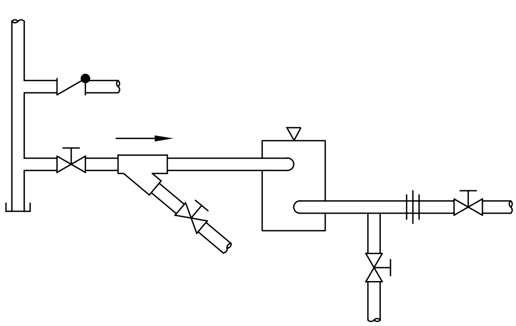


Figure CG-66.
Typical F&T Hookup



Protection Against Heat Exchanger Stall

Stall occurs when the inlet pressure will fall below the outlet pressure of a steam trap. In these situations, a condensate pump should be used to covercome the back pressure, return the condnesate adequately, and avoid stalling the heat exchanger. When a condensate pump is not practical, a **Safety Drain Trap** should be used whenever there is a likelihood that the inlet pressure will fall below the outlet pressure of a primary steam trap, especially in the presence of freezing air. One such application would be on a modulated pressure heating coil that must be drained with an elevated return line. In the event of insufficient drainage from the primary trap, condensate rises into the safety drain and is discharged before it can enter the heat exchanger. An F&T trap makes a good safety drain because of its ability to handle large amounts of air and its simplicity of operation. Safety drain trap should be same size (capacity) as primary trap.

The proper application of a safety drain is shown in Fig. CG-66. The inlet to the safety drain must be located on the heat exchanger drip leg, above the inlet to the primary trap. It must discharge to an open sewer. The drain plug of the safety drain is piped to the inlet of the primary trap. This prevents the discharge of condensate formed in the safety drain by body radiation when the primary trap is active. The safety drain has an integral vacuum breaker to maintain operation when pressure in the heat exchanger falls below atmospheric. The inlet of the vacuum breaker should be fitted with a gooseneck to prevent dirt from being sucked in when it operates. The vacuum breaker inlet should be provided with a riser equal in elevation to the bottom of the heat exchanger to prevent water leakage when the vacuum breaker is operating, but the drip leg and trap body are flooded.

Protection Against Freezing

A properly selected and installed trap will not freeze as long as steam is coming to the trap. If the steam supply should be shut off, the steam condenses, forming a vacuum in the heat exchanger or tracer line. This prevents free drainage of the condensate from the system before freezing can occur. Therefore, install a vacuum breaker between the equipment being drained and the trap. If there is not gravity drainage through the trap to the return line, the trap and discharge line should be drained manually or automatically by means of a freeze protection drain. Also, when multiple traps are installed in a trap station, insulating the traps can provide freeze protection.

Anti-Freeze Precautions.

1. Do not oversize trap.
2. Keep trap discharge lines very short.
3. Pitch trap discharge lines down for fast gravity discharge.
4. Insulate trap discharge lines and condensate return lines.
5. Where condensate return lines are exposed to ambient weather conditions, tracer lines should be considered.
6. If the return line is overhead, run vertical discharge line adjacent to drain line to top of return header and insulate drain line and trap discharge line together. See Fig. CG-67.

NOTE: A long horizontal discharge line invites trouble. Ice can form at the far end, eventually sealing off the pipe. This prevents the trap from operating. No more steam can enter the trap, and the water in the trap body freezes.

Figure CG-67. Typical Safety Drain Trap Hookup.

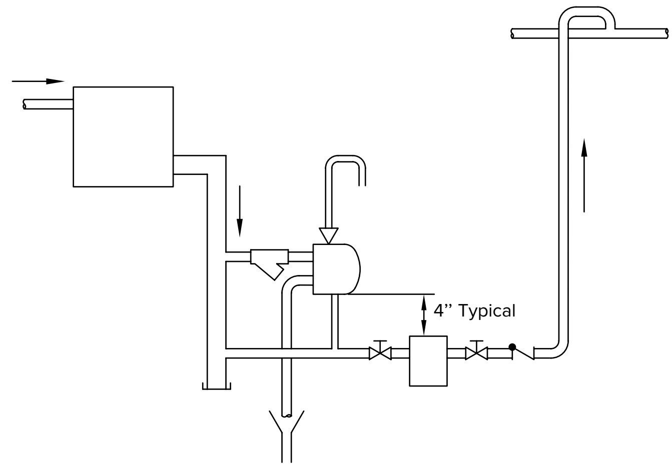


Figure CG-68.
Typical Condensate Pump Hookup.

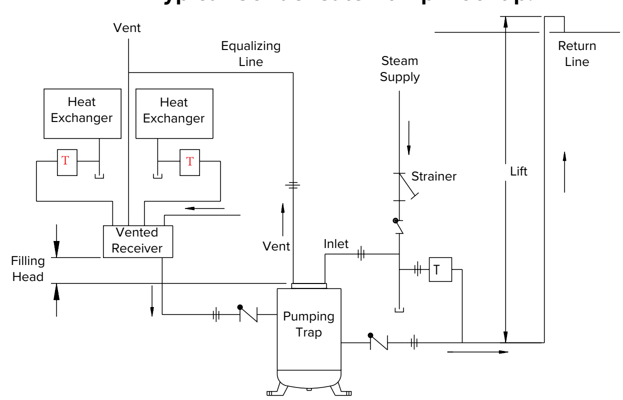
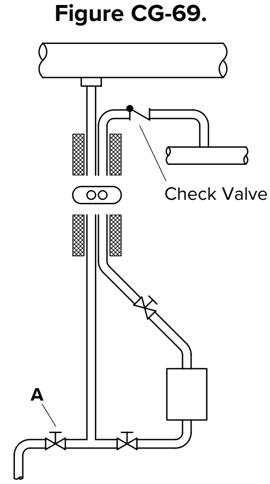


Figure CG-69.



Outdoor installation to permit ground level trap testing and maintenance when steam supply and return lines are high overhead. Drain line and trap discharge line are insulated together to prevent freezing. Note location of check valve in discharge line and blowdown valve **A** that drains the steam main when trap is opened for cleaning or repair.

Testing Armstrong Steam Traps

Testing Schedule.
For maximum trap life and steam economy, a regular schedule should be set up for trap testing and preventive maintenance. Trap size, operating pressure and importance determine how frequently traps should be checked.

Table CG-28. Suggested Yearly Trap Testing Frequency

Operating Pressure (psig)	Application			
	Drip	Tracer	Coil	Process
0-100	1	1	2	3
101-250	2	2	2	3
251-450	2	2	3	4
451 and above	3	3	4	12

How to Test

The test valve method is best. Fig. CG-60 (page CG-47) shows correct hookup, with shutoff valve in return line to isolate trap from return header. Here is what to look for when test valve is opened:

1. **Condensate Discharge**—Inverted bucket and disc traps should have an intermittent condensate discharge. F&T traps should have a continuous condensate discharge, while thermostatic traps can be either continuous or intermittent, depending on the load. When an IB trap has an extremely small load it will have a continuous condensate discharge which causes a dribbling effect. This mode of operation is normal under this condition.
2. **Flash Steam**—Do not mistake this for a steam leak through the trap valve. Condensate under pressure holds more heat units-Btu-per pound than condensate at atmospheric pressure. When condensate is discharged, these extra heat units re-evaporate some of the condensate. See description of flash steam on page CG-6.
How to Identify Flash: Trap users sometimes confuse flash steam with leaking steam. Here's how to tell the difference: If steam blows out continuously, in a "blue" stream, it's leaking steam. If steam "floats" out intermittently (each time the trap discharges) in a whitish cloud, it's flash steam.
3. **Continuous Steam Blow**—Trouble. Refer to page CG-51.
4. **No Flow**—Possible trouble. Refer to page CG-51.

Listening Device Test. Use a listening device or hold one end of a steel rod against the trap cap and the other end against your ear. You should be able to hear the difference between the intermittent discharge of some traps and the continuous discharge of others. This correct operating condition can be distinguished from the higher velocity sound of a trap blowing through. Considerable experience is required for this method of testing, as other noises are telegraphed along the pipe lines.

Pyrometer Method of Testing. This method may not give accurate results, depending on the return line design and the diameter of the trap orifice. Also, when discharging into a common return, another trap may be blowing through, causing a high temperature at the outlet of the trap being tested. Better results can be obtained with a listening device. Request Armstrong Bulletin 310.

Figure CG-69.
Typical DC Hookup

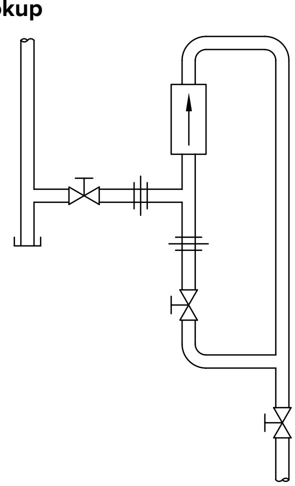


Figure CG-70.
Typical Disc Trap Hookup

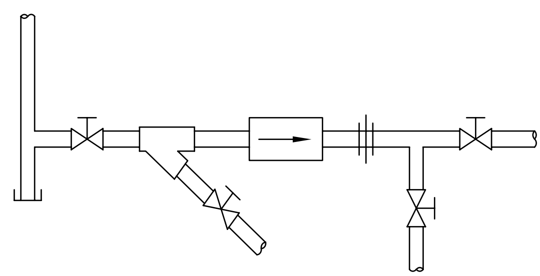
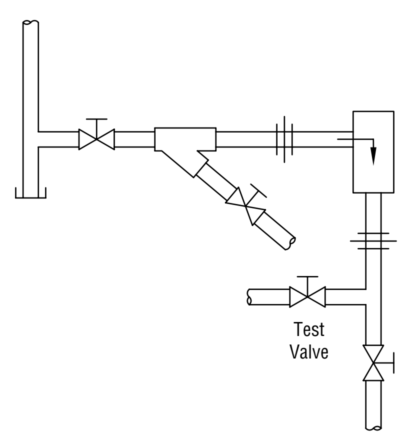


Figure CG-71.
Typical Thermostatic Hookup



Troubleshooting Armstrong Steam Traps

The following summary will prove helpful in locating and correcting nearly all steam trap troubles. Many of these are actually system problems rather than trap troubles.

More detailed troubleshooting literature is available for specific products and applications—consult factory.

Whenever a trap fails to operate and the reason is not readily apparent, the discharge from the trap should be observed. If the trap is installed with a test outlet, this will be a simple matter—otherwise, it will be necessary to break the discharge connection.

Cold Trap—No Discharge

If the trap fails to discharge condensate, then:

A. Pressure may be too high.
1. Wrong pressure originally specified.
2. Pressure raised without installing smaller orifice.
3. PRV out of order.
4. Pressure gauge in boiler reads low.
5. Orifice enlarged by normal wear.
6. High vacuum in return line increases pressure differential beyond which trap may operate.

B. No condensate or steam coming to trap.
1. Stopped by plugged strainer ahead of trap.
2. Broken valve in line to trap.
3. Pipe line or elbows plugged.

C. Worn or defective mechanism. Repair or replace as required.

D. Trap body filled with dirt. Install strainer or remove dirt at source.

E. For IB, bucket vent filled with dirt. Prevent by:
1. Installing strainer.
2. Enlarging vent slightly.
3. Using bucket vent scrubbing wire.

F. For F&T traps, if air vent is not functioning properly, trap will likely air bind.

G. For thermostatic traps, the bellows element may rupture from hydraulic shock, causing the trap to fail closed.

H. For disc traps, trap may be installed backward.

Hot Trap—No Discharge

A. No condensate coming to trap.
1. Trap installed above leaky by-pass valve.
2. Broken or damaged syphon pipe in syphon drained cylinder.
3. Vacuum in water heater coils may prevent drainage. Install a vacuum breaker between the heat exchanger and the trap.

Steam Loss

If the trap blows live steam, the trouble may be due to any of the following causes:

A. Valve may fail to seat.
1. Piece of scale lodged in orifice.
2. Worn parts.

B. IB trap may lose its prime.
1. If the trap is blowing live steam, close the inlet valve for a few minutes. Then gradually open. If the trap catches its prime, chances are the trap is all right.
2. Prime loss is usually due to sudden or frequent drops in steam pressure. On such jobs, the installation of a check valve is called for—location D or C in Fig. CG-63 (page CG-48). If possible, locate trap well below drip point.

C. For F&T and thermostatic traps, thermostatic elements may fail to close.

Continuous Flow

If an IB or disc trap discharges continuously, or an F&T or thermostatic trap discharges at full capacity, check the following:

A. Trap too small.
1. A larger trap, or additional traps, should be installed in parallel.
2. High pressure traps may have been used for a low pressure job. Install right size of internal mechanism.

B. Abnormal water conditions. Boiler may foam or prime, throwing large quantities of water into steam lines. A separator should be installed or else the feed water conditions should be remedied.

Sluggish Heating

When trap operates satisfactorily, but unit fails to heat properly:

A. One or more units may be short-circuiting. The remedy is to install a trap on each unit. See page CG-17.

B. Traps may be too small for job even though they may appear to be handling the condensate efficiently. Try next larger size trap.

C. Trap may have insufficient air-handling capacity, or the air may not be reaching trap. In either case, use auxiliary air vents.

Mysterious Trouble

If trap operates satisfactorily when discharging to atmosphere, but trouble is encountered when connected with return line, check the following:

A. Back pressure may reduce capacity of trap.
1. Return line too small—trap hot.
2. Other traps may be blowing steam—trap hot.
3. Atmospheric vent in condensate receiver may be plugged—trap hot or cold.
4. Obstruction in return line—trap hot.
5. Excess vacuum in return line—trap cold.

Imaginary Troubles

If it appears that steam escapes every time trap discharges, remember: Hot condensate forms flash steam when released to lower pressure, but it usually condenses quickly in the return line. See Chart CG-4 on page CG-6.