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INVERTED BUCKET TRAPS

Bucket traps are so named because the float or bucket which operates the mechanism to open and close the discharge port is of open construction. The primary purpose of this Engineering News is to discuss Inverted Bucket Traps such as Hoffman Series 600 and 600A. It should be pointed out that there are two types of bucket traps, namely (1) Inverted Bucket Traps (2) Open or Upright Bucket Traps. Inasmuch as these two types are entirely different in construction and operating principle, the following explanations are necessary to have a proper understanding of these differences.

OPEN OR UPRIGHT BUCKET TRAPS

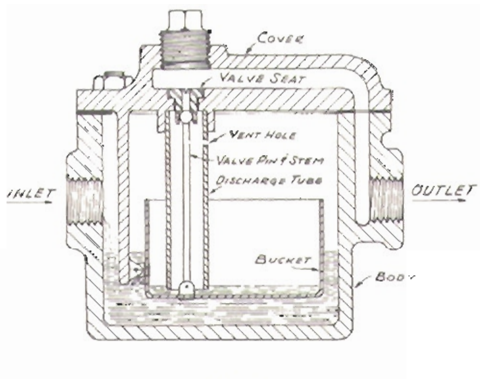

Fig. 1

The Open or Upright Bucket Trap is shown diagrammatically in Fig. 1. It operates on the principle of condensate entering the trap body to float the upright bucket, to close the valve pin and the valve seat. As condensate continues to flow into the trap body it rises to fill the space between the bucket and trap body until it overflows into the open bucket and increases its weight, and causes the bucket to sink thereby opening the discharge port. Steam pressure then discharges the condensate up through the discharge tube, valve seat and trap outlet. The valve pin and stem are fastened directly to the bucket and open and close the discharge port with each rise and fall of the bucket. The open bucket is hinged to a support which is part of the cover. This trap is recommended for service on equipment which is subjected to wide pressure fluctuations or pulsations. The construction of Open Bucket Traps is not as simple as that of the Inverted Bucket Traps, and is usually more expensive.

INVERTED BUCKET TRAPS

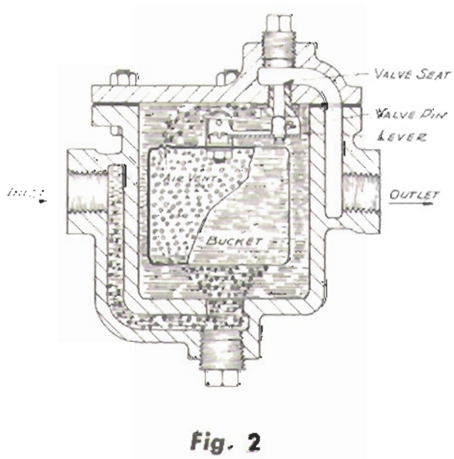

Fig. 2

Fig. 2 shows the construction of an Inverted Bucket Trap. As can be seen, the inverted bucket is entirely submerged in the condensate. The bucket is fastened to the end of a lever, and the valve pin is fastened to the same lever, but near the fulcrum. Fig. 3A, 3B, 3C, and 3D show the sequence of operation for an Inverted Bucket Trap.

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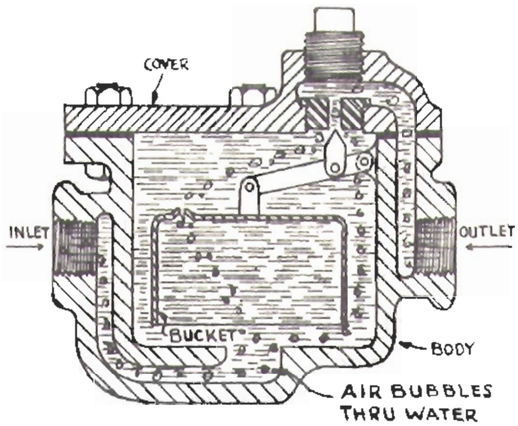


Fig. 3A

Figure 3A shows the position of the bucket when steam is turned on. Excess condensate and air flow through the valve seat.

Figure 3B shows the position of the bucket when condensate ceases to flow and steam enters the trap, and accumulates in the bucket. The steam pressure will push out more condensate until enough water has been displaced by steam in the bucket and it floats, holding the valve seat closed.

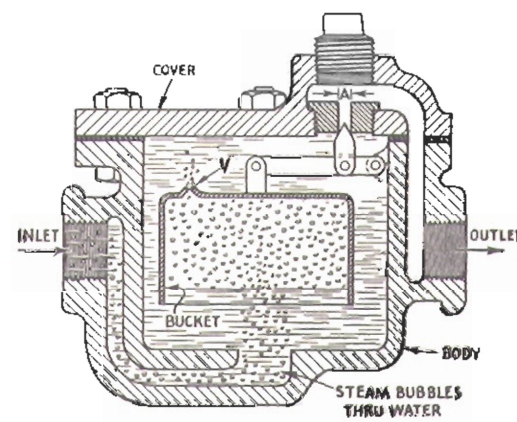


Fig. 3B

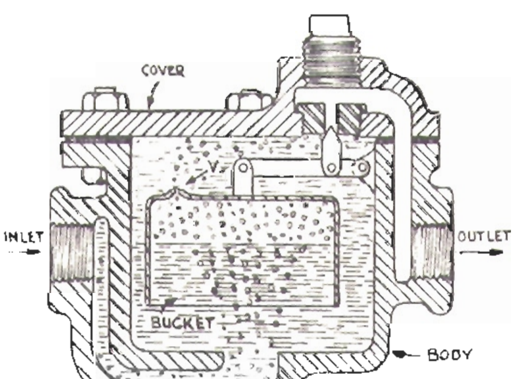


Fig. 3C

Figure 3C. Steam slowly condenses inside the bucket and entrained air gradually escapes through the vent in the bucket (V), rising to the top of the trap. When steam condenses the water level rises inside the bucket causing the bucket to lose buoyancy.

Figure 3D. When the weight of the bucket times the lever arm ratio equals the pressure on the seat port, the bucket drops. Condensate and air are forced from the trap by steam pressure until sufficient steam has displaced the water in the bucket causing the bucket to become buoyant.

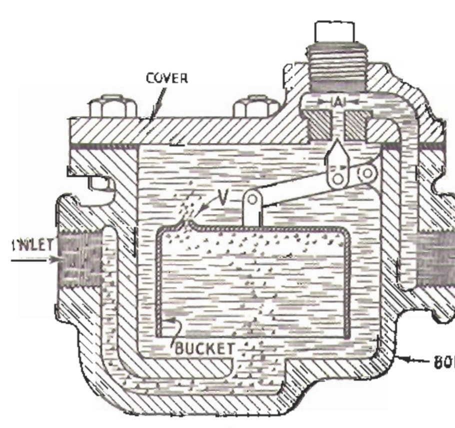


Fig. 3D

Simple Internal Construction. Conventional Inverted Bucket Traps are simple in construction as can be seen in Fig. 2. The basic internal mechanical parts are composed of the following: (1) Bucket; (2) Bucket Lever; (3) Valve Pin; (4) Valve seat; (5) Seat Yoke; (6) Fulcrum Pin.

An Inverted Bucket Trap is easy to open and inspect for wear or other trouble. It is also easy to discover the trouble and to make necessary repairs.

Large Capacity. The capacity of an Inverted Bucket Trap is relatively large when compared to traps having the same valve seat diameters but which operate with continuous flow in a throttled position. Because of its design an Inverted Bucket Trap discharges or dumps intermittently under load condition. This intermittent operation causes the valve seat to be open wide to give maximum area of the discharge port.

Another reason the capacity is large is that condensate temperature has no effect on the operation of the trap.

Capacity Flexibility. The capacity of Inverted Bucket Traps is very flexible because of the availability of various valve seat diameters for operation over a wide pressure range. This is a definite advantage because it makes for easy changing of valve seats and valve pins for various uses and service applications. It also reduces trap inventories for jobbers' stocks.

Wide Pressure Range. The maximum differential pressure at which an Inverted Bucket Trap will operate depends upon three things: (1) Lever arm ratio; (2) Bucket Weight; (3) Valve seat diameter.

Inverted Bucket Traps have an advantage of being applicable to systems operating at pressures found in low pressure heating service to high pressure industrial uses. They are reliable over this wide pressure range because there are no float balls to collapse, nor are they limited to a narrow pressure range by the use of thermal elements.

Condensate Temperature. Because the operation of Inverted Bucket Traps does not depend upon condensate temperature, cooling legs are not required. This means the trap can be installed close to the equipment it serves and with minimum cost for piping and fittings. Condensate at steam temperature is easily handled and for this reason eqnipment and apparatus operate at maximum efficiency when drained by Inverted Bucket Traps.

Air Discharge. A conventional Inverted Bucket Trap does not have a separate air by-pass port which is necessary with Float and Thermostatic Traps. Both air and condensate are discharged through the same valve seat. Air passage through the trap is made possible by a simple hole in the inverted bucket. Air accumulations entering the trap are vented through this vent hole into the space above the bucket. When the trap discharges, air passes through the valve seat ahead of the condensate.

The size of the vent hole in the inverted bucket is very important because:

(1) If too large, buoyancy of bucket is adversely affected.

(2) If too small, condensate discharge capacity is reduced.

(3) If vent hole becomes clogged with any foreign substance, the trap will close and remain closed until the trouble is corrected. Air is always present in steam and if it can not be properly discharged because trap can not open the operation of the equipment will be seriously affected.

(4) Occasionally, Inverted Bucket Traps are equipped with buckets having thermostatic elements to take care of unusual quantities of air. When starting up

cold equipment, the thermostatic element is open. This causes the bucket to lose buoyancy and drop. The valve port then remains in a wide open position until all the air has been discharged. Steam then enters the trap and closes the thermostatic element, after which it operates in a conventional manner.

Inverted Bucket Traps can not air bind when used under usual conditions.

Body Construction. Hoffman Inverted Bucket Traps are made with a bolted flanged cover for pressures up to 200 psi. The body inlet and outlet tappings are in the same plane. This permits easy straight through piping connection without the use of extra pipe fittings.

Wear of Moving Parts. Inverted Bucket Traps have more moving parts to cause wear than Thermostatic Traps. However, when compared to Float and Thermostatic Traps, more wear can be permitted without seriously affecting operation. Float and Thermostatic Traps must be made more accurately and working parts held to closer dimensional tolerances.

Wire Drawing. Wire drawing of valve pins and valve seats is less common in Inverted Bucket Traps than in traps which operate in throttled position. The reason for this is that the valve seat opens wide with each intermittent operation and throttling action is reduced to a minimum.

Oversizing. Inverted Bucket Traps operate most effectively on continuous load applications and near rated capacity. If trap is sized on the basis of protecting against unusually large loads occurring infrequently, good performance cannot always be expected when the load is small. This practice often results in the trap losing its water seal or prime. When this happens, the bucket drops which opens the discharge port and steam will blow through until the water seal is restored. If the trap is allowed to operate under this condition for a long length of time, excessive wear of internal parts can be expected. The parts usually affected by this excessive wear are: valve seat, valve pin, hinge pins, bucket lever holes, and damage to the bottom edge of the inverted bucket.

The above problem often can be solved by using small valve seats which normally are used for higher pressure service.

Inverted Bucket Traps should never be selected by pipe size. Frequently, this results in over sizing. Selection should be made on the following basis:

(1) Actual condensate capacity of the equipment.
(2) Differential pressure across the trap.
(3) Service pressure - Service pressure is best defined as the actual pressure existing at the trap, or point of service, rather than at the boiler. In considering boiler pressure, allowance should be made for pressure drop through the service line at maximum load conditions.

Load Variation. Inverted Bucket Traps should not be selected if there is a great variation in load. This precaution is taken because when there is a light load condition existing, which is insufficient to cause the trap to discharge intermittently, the trap is in its normally closed position. However, bucket vibrations are set up by steam condensing inside the bucket which cause the valve pin to chatter in the valve seat. This action often permits water to be discharged at a greater rate than can be made up by condensate entering the trap. Finally, the bucket loses its buoyancy and drops, and in so doing the trap loses its water seal or prime.

This difficulty may also be encountered if there is a wide variation of pressure occurring at the time of light load. Pressure variations do not affect trap operation if load is adequate.

It is always desirable to be able to recognize troubles which are caused by extreme load variations. The symptoms can be best explained by the following sketches.

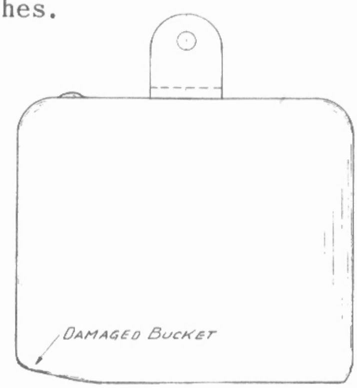


Fig. 4A

Damage to bottom edge of bucket caused by pounding against inside wall of trap body.

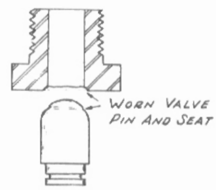


Fig. 4B

Excessive wear of valve seat and valve pin caused by impact.

Fig. 4C

Excessive wear of hinge holes due to impact.

Fig. 4D

Excessive wear of hinge pin cotter due to impact.

Priming. The basic operating principle of an Inverted Bucket Trap requires the inverted bucket to be submerged in water. It is important, therefore, for new installation, that the trap be primed. This can be done easily by one of the following methods.

(1) Fill the trap body by pouring water through the pipe tapping above the valve seat.

(2) Close a valve on the discharge side of the equipment until sufficient condensate has collected to fill the trap body.

Priming is always advisable when only a small amount of condensate is expected when the trap is in service.

Rust and Scale Effects. In service where rust, scale and other abrasive materials are present, Inverted Bucket Traps should give less valve pin and valve seat trouble than may be expected from other types of traps. The principal reason is that due to the intermittent operation of the trap such foreign matter suspended in the condensate is carried out of the trap before it has a chance to accumulate.

The use of dirt strainers is always advisable ahead of all traps to protect them from damage of abrasive material. Cost consideration will not always permit the installation of dirt strainers, and when such is the case an Inverted Bucket Trap will probably give less trouble than any other type of trap.

Pressure and Vacuum Service. Inverted Bucket Traps are suitable for vacuum as well as pressure service. The important thing to remember is that the trap must discharge from a higher to a lower pressure. In other words, there must be a differential pressure across the trap for it to function properly.

Trap Selection. It has already been pointed out that Inverted Bucket Traps should always be selected on the basis of load and pressure differential and not on pipe size. The capacities of Hoffman Series 600 and 600A Traps are given in the catalog as shown by the following table.

CAPACITIES — SERIES 600 INVERTED BUCKET TRAP

Trap No.	Conn. Size	PRESSURE DIFFERENTIALS—LBS. PER SQ. IN.															Shipping Wts. lbs. each
		30 lb. Seat				75 lb. Seat			125 lb. Seat			150 lb. Seat		200 lb. Seat			
		5	10	20	30	30	50	75	75	100	125	125	150	150	200		
		CAPACITIES IN POUNDS WATER PER HOUR															
600A	½" & ¾"	600	740	1020	1150	590	710	825	720	800	860	NOT AVAILABLE					5½
600	½" & ¾"	900	1100	1620	1950	1000	1180	1350	1000	1100	1200	1000	1050	880	975		7½
600	1"	2900	3400	4100	5200	3750	4150	4400	3100	3270	3700	3100	3300	2600	2900		22
600	1¼" & 1½"	4350	5600	8600	11000	6840	9000	10500	6400	7800	9000	5600	6600	6000	5400		40

Remember the pressures given in the table are Differential Pressures and not operating pressures.

(1) Back Pressure: When selecting a trap where there is a back pressure in the return the Differential Pressure will be as shown in the following example:

Steam Supply Pressure	=	50 psi
Return Back Pressure	=	20 psi
Differential Pressure	=	30 psi

The trap is, therefore, selected for a capacity at 30 psi Differential Pressure and not on the basis of 50 psi.

(2) Vacuum Return: When selecting a trap discharging into a vacuum return, the pressure in the return must be added to the supply pressure to obtain the proper Differential Pressure, as shown in the following example.

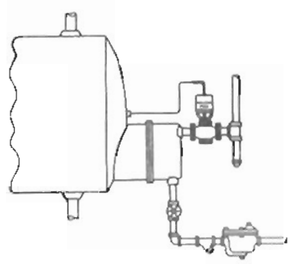
Steam Supply Pressure	=	6 psi
Pressure in Vacuum Return is 8'' Hg. (mercury) since 2.04'' Hg. = 1 psi therefore, 8'' Hg. = 4 psi (approx.)	=	4 psi
Differential Pressure	=	10 psi

(3) Lift to Overhead Return: Inverted Bucket Traps are often selected to discharge the condensate into overhead return mains. The height the condensate can be lifted depends upon the supply pressure and the back pressure. Although one (1) psi is equal to 2.3 feet of water pressure, it is common practice to use two feet of water pressure for each pound per square inch steam pressure. This amount allows for friction in the piping. The following example illustrates how to calculate maximum lift of condensate.

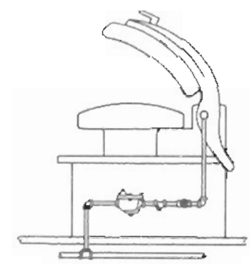
Supply Pressure	=	50 psi
Back Pressure	=	20 psi
Differential Pressure	=	30 psi
Therefore, the maximum lift will be 30 x 2	=	60 feet

(4) Noise: Very often Inverted Bucket Traps are not as quiet in operation as other types of traps. It is advisable to consider this noise problem when selecting traps for some installations. Often it is not desirable to install bucket traps in school class rooms, occupied offices, hospital rooms, or other locations where noise is objectionable or undesirable.

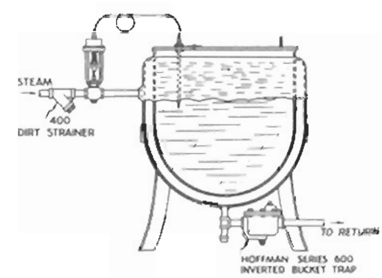
Application. The following diagrams suggest a few of the more common uses of Inverted Bucket Traps.



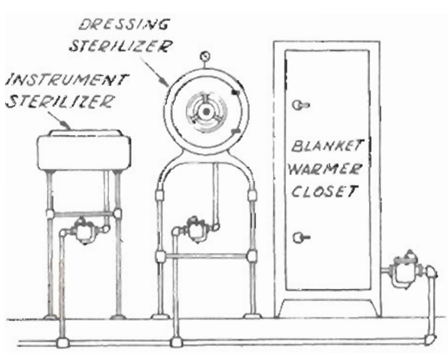
DRAINING STORAGE WATER HEATER



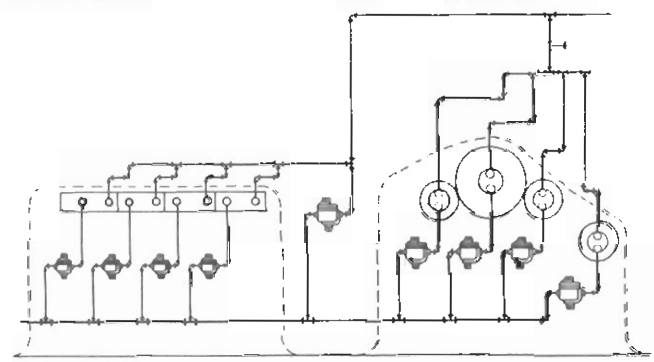
DRAINING CLOTHES PRESSER



DRAINING COOKING KETTLE

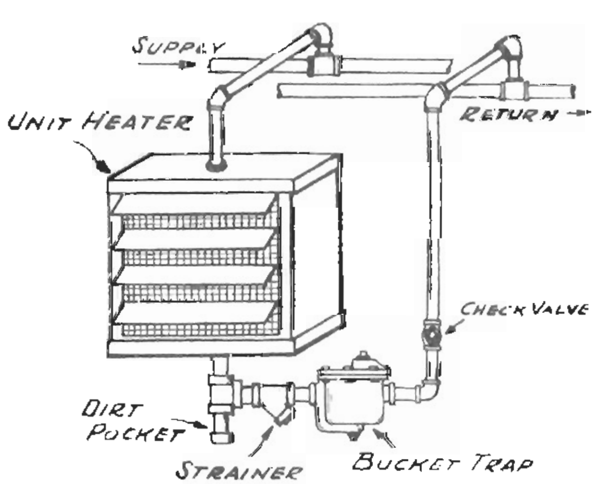


DRAINING HOSPITAL EQUIPMENT



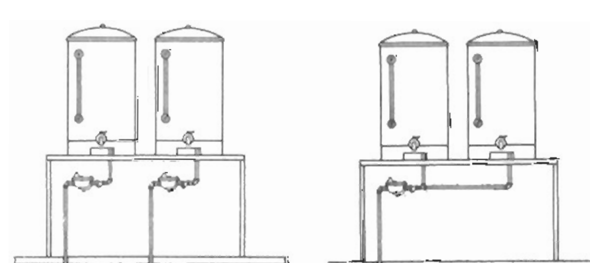
DRAINING CORRUGATED PAPER MAKING MACHINE

Installation. The following sketches show examples of proper and improper installations of Inverted Bucket Traps on equipment.



Proper method of discharging condensate to overhead return main with check valve on discharge side of trap.

Right Wrong



DRAINING COFFEE URNS

Use separate traps for each piece of equipment to prevent short circuiting or back flow.

Maintenance of Inverted Bucket Traps.

(1) Cleaning and Inspection: Periodic inspection of Inverted Bucket Trap parts is an excellent practice to insure maximum performance of equipment on which they are installed. Once the trap is open, clean the parts and examine for wear.

a. Check valve seat and valve pin for wear, grooving or wire drawing. A tight seating valve pin is usually indicated by a complete bright ring around the valve pin at the seat line.

b. Check the air vent hole in the bucket for stoppage.

c. Inspect the bucket levers and hinge pins. Replace if they show excessive wear.

(2) Steam Pressure: Check steam pressure periodically to insure that equipment is operating at its correct pressure. If pressure is too low the trap may not be discharging at its required rate. If too high, the trap may close and remain closed because of the lever ratio and port diameter.

(3) By-Pass Valve: If traps are installed with by-pass valves, the valves should be checked to insure that they are not leaking or have been turned on and left in open position.

(4) Gaskets: Inspect all cover and seat gaskets to insure tight seals. Leaking gaskets cause great waste of steam.

(5) Dirt Strainers: If dirt strainers are installed ahead of traps, be sure they are cleaned periodically. Dirt will seriously cut down the capacity of the trap.

(6) Trap Testing: If traps are removed from lines or equipment to be tested on maintenance test bench, be sure trap is primed before turning on the steam. (Always prime traps before replacing covers if removed for any reason.)

CAUTION: Do not mistake flash steam for live steam. Flash steam is re-evaporated condensate and has a white, puffy appearance. Live steam is often called "blue steam" and usually it can be detected by its direction of movement when passing through a leaking trap seat.

(7) Lapping. Extreme caution should be used if worn valve seats are lapped to obtain tight seating of valve pin. Too much lapping may increase seating diameter of valve pin and cause the trap to remain closed if pressure increases to too high a value.

(8) Replacing Valve Pins and Seats: Often it is impossible to tell if the valve pin or the valve seat is at fault when making repairs. It is good practice to replace both of them to insure best results.

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