GS DUNHAM LLC
THE STEAM HEATING PROFESSIONALS

Manufacturers Representative For: MEPCO MARSHALL ENGINEERED PRODUCTS CO. Vent-Rite VARI-VAC® ELGE®

25-70 Ulmer St., College Point, NY 11354 • Phone 718-886-4232 • Fax 718-886-4301

PUMP APPLICATION MANUAL NO. 1495C

HOW TO SELECT AND APPLY HEATING PUMPS.

The purpose of this manual is to provide the "do's" and "don'ts" for selecting and applying Condensation, Centrifugal and Vacuum Pumps. It supplements MEPCO Product Catalog and is designed to serve as a handbook for those who specify, and sell Pumps.

HEATING PUMPS

There are two types of pumps that are designed for use on steam heating systems — the Condensation Pump which is used with a Two-pipe Gravity Heating System and the Vacuum Pump which is used with Return Line Vacuum and Variable Vacuum Heating Systems. Although the design and ultimate operation of these two types differ they have one fundamental feature common to both — the accumulation of the condensate (that forms boiler feed water) and its delivery to the boiler (this is frequently referred to as "boiler feeding"). The water condensed from the steam supplied the steam heating system is the source of condensate.

Wherever the condensate is not wasted to the sewer, the cycle through which the medium passes in steam heating systems comprises (1) vaporization into steam, (2) conveyance to the radiation, (3) condensation from steam to water, (4) conveying condensation to the pump, and (5) its return to the boiler. Where the condensate is lost from the system or wasted to the sewer the fourth and fifth phase of the cycle may include wasting condensate and supplying water from a source of "make-up."

NOTE: Heating Systems of Optimum design always provide for return of condensate to the boiler.

Pumps must be used for steam heating systems if any of the following conditions exist.

1. The pressure at the boiler is too great to permit condensate to return to the boiler by gravity or by a boiler return trap.
2. The "dry" return mains are below the boiler water line.
3. The size of the heating system in terms of condensing capacity is beyond the capacity of the largest return trap.

NOTE: Return traps are not used so extensively now since condensation pumps are now available in a wide range of capacities and are not so expensive as compared with traps.

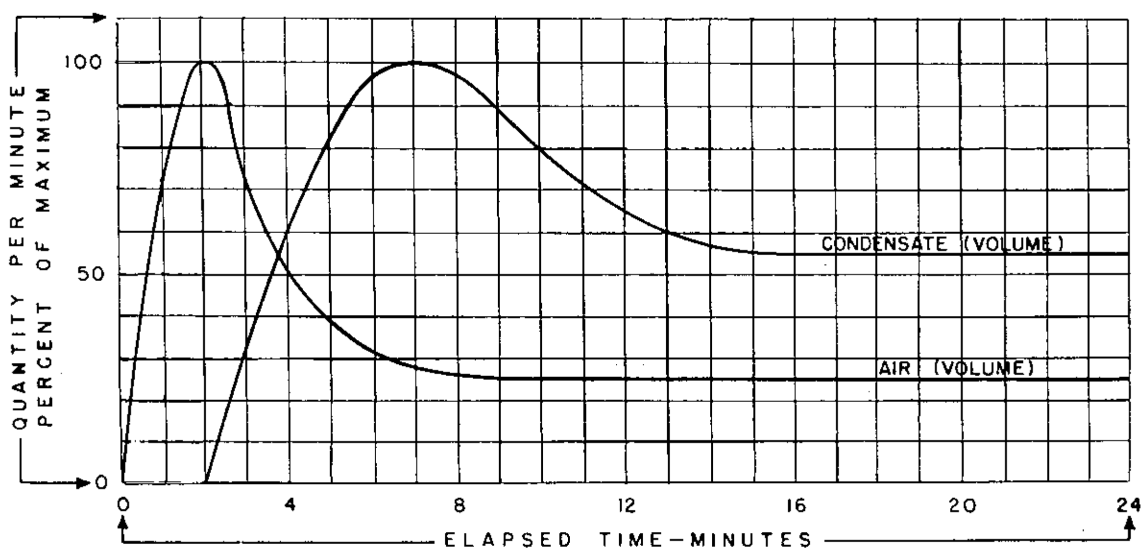
4. The condensate must be forced from a lower elevation over a "high point" or to the boiler room floor level. For example, where several buildings are fed from one boiler plant, and the condensate has to be raised from the basement of one building and forced through an underground

return to a higher level to reach the boiler room.

RELATION OF PUMPS TO STEAM HEATING SYSTEM CHARACTERISTICS

The peak loads on steam heating systems occur whenever initially started and the building is not up to temperature. The first demand on the pump, whether on a two-pipe gravity system or a vacuum type system, is the release of air from the piping and the radiation. In the case of the condensation pump the air is released from its vent and the venting is in consequence of the pressure exerted by the steam being supplied to the system. With the vacuum type systems the removal of air is speeded up by the pump.

Fig. 2039—Typical curves of air and condensate peak loads which occur at the pump when a vacuum return line heating system is started up.



NOTE: The test data indicates that the ASHRAE pump code provides air and water capacities that are more than adequate.

In the vacuum type systems the air removal quickly reaches and passes its maximum (peak) rate. This occurs many minutes ahead of the occurrence of the condensation return peak rate. Test data available reveals that the condensation return peak occurs from 5 to 18.5 minutes after the peak of air elimination has occurred. In two-pipe gravity systems the condensation return peak occurs or lags the air peak by 2.5 minutes to 25.5 minutes.

The same tests revealed that the maximum rate of condensation return on the vacuum system, ranged up to a maximum of 1.83 times the constant condensation rate, but the average rate was 1.43 times the condensation rate.

The peak rate of condensation return from the gravity system was 1.32 times the constant condensation rate. Pump capacities for the return of condensate provide three times the normal rated condensation rate.

A vacuum return line heating system is a two-pipe system (using traps at radiators and drip points) in which steam is circulated positively and rapidly and yet at low pressures as a result of the operation of a vacuum pump. The pump maintains a partial vacuum on the return lines by exhausting air from the system. It also returns condensate to the boiler or boiler feed apparatus.

MEPCO Vacuum Pumps are designed specially to perform these two major functions:

(1) To create and maintain a vacuum in the return piping of the heating system; (2) To return all condensate to boilers or boiler feed apparatus.

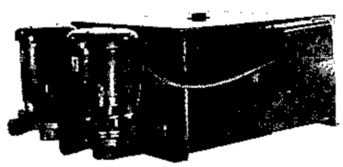
CONDENSATION PUMPS

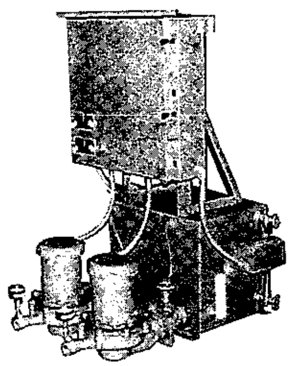
Condensation pumps are available as complete, compact assemblies ("packages") for returning water to low and medium pressure boilers from gravity heating systems, steam process equipment or combinations of both; or are available as components which may be "assembled" (installed) on the job to fit special conditions. On low pressure systems, they are also used where return mains are located at elevations which do not permit gravity flow of condensate to the boiler, thereby avoiding the expense of boiler pits.

Operated in response to a float switch, these pumps quickly elevate condensate from low to high return line; or automatically pump the condensate from auxiliary apparatus to storage tanks. Their use often permits the increase of usable heated space in a building, by allowing the radiation to be installed at a level lower than the boiler water level.

Where a return must terminate at a point which is distant from the boiler, condensation pumps save fuel by returning hot condensate to the boiler instead of wasting it to the sewer, thus reducing the amount of make-up water required and practically avoiding the difficulties from corrosion and encrustation.

These pumps are available as a "single" or a "duplex" unit. The duplex unit is comprised of two pumps with a receiver to which the suction of each pump connects. Duplex pumps usually employ an alternator which transfers the operation from one pump to the other in sequence, as the water level varies between the cut-in and cut-out points. In addition, it provides automatic standby service so that if one pump fails to start or handle the load, the second pump starts automatically.





Controlled by a tank mounted float switch, MEPCO Condensate Pumps are compact, complete assemblies which return water from atmospheric heating systems, boiler feed systems, low pressure steam process equipment or from any combination. These pumps lift condensate from extremely low to high return lines and can generate impressive fuel savings by returning hot condensate to the boiler or boiler feed pump instead of wasting it to the sewer. Further, by drastically reducing the amount of make-up water required, they conserve boiler chemicals and minimize difficulties from boiler encrustation.

The conditions demanding the use of a pump, as listed above, indicate the pump must return the condensate against the sum of the following which make up the total pressure the pump must work against.

1. The Boiler Pressure.

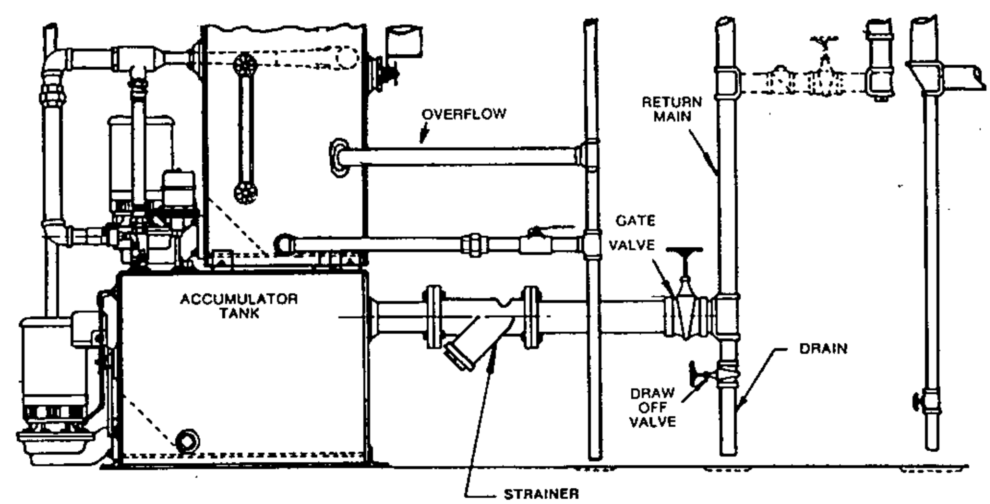
2. The static head due to the difference in elevation between pump discharge and the point to which it delivers the water (most frequently the boiler water line).

3. The friction head due to the piping, valves and fittings between the pump discharge and the boiler.

VACUUM PUMPS

In one of their functions, Vacuum Pumps are similar to Condensation Pumps. They receive system condensate and pump it to the boiler. However, the vacuum pump has an added function. It produces a vacuum by removing "air," vapor, and condensate from the system. This vacuum, thus created, causes circulation in the heating system before pressure has been raised on the boiler.

By rapidly exhausting "air" (non-condensable gases) and condensate from the system, the vacuum pump induces steam to circulate quickly, minimizes "warming-up time" and enables the heating system to function quietly. The tax on the capacity of the pump, caused by the air expulsion, comes earlier than and rather independent of the tax on the capacity caused by the condensate return in vacuum systems. The air peaks are generally quite sharp and the time interval to reach the peak and subside to the steady state is much less for the vacuum system than for the gravity system.



Vacuum Pumps are rated so that each standard unit will easily handle the requirements of any heating system up to the capacity of the pump without special allowance for covered piping.

By the flow of water through a single moving element—the pump impeller—a suction is created at all times, and positive pressure exerted for delivery of condensate direct to the boiler. Water and air are handled simultaneously whenever the unit is in operation.

Duplex units have the advantage over single pumps due to the provision of automatic stand-by service. Should one pump fail to start, or handle the load, the other pump is cut in and picks up the load since it is controlled by vacuum or float switches independent of the other pump.

SELECTION OF PUMPS

Whether a condensation pump or a vacuum pump is used depends, in most instances, upon whether lowest first cost or the best investment and optimum system performance is the major consideration.

The advantages of the vacuum pump over the condensation pump are as follows:

1. Rapid heating, when the system first starts up, is achieved by the addition of the vacuum pump. Air is evacuated from the system ahead of the steam, so that steam is distributed while pressures are still low. For example—by producing a slight vacuum, of four inches in the system and admitting steam at 1-lb. pressure (1 lb. above atmospheric pressure) the difference in pressure is 1 lb. positive, plus 2 lbs. negative—four-inch vacuum equals 2 lbs. negative—or 3 lbs. pressure difference. This permits steam to flow rapidly to all parts of the system which are unfilled, unimpeded by the need to force the air out. As each heating unit fills, the thermostatic trap closes so the circulation is equalized through other radiation which is still unfilled. After the system has filled, steam may be circulated continually at a pressure of 1 lb. or less. Circulation to all radiators is assured because a vacuum in the return line continually removes any air released by the thermostatic traps. This results in savings in fuel costs because boiler operates under vacuum in mild weather.

2. If returns are too low to reach the pump inlet by gravity, a separate accumulator tank may be placed at a lower level than the pump and the water is raised from it by the vacuum the pump produces. Thus, at times the need for a large pump pit may be eliminated. (Note: All pits should be drained, but pump pits must be drained.)

3. Advantage of variable temperature steam can be gained by the use of Vari-Vac Differential Heating System as ex-

plained in detail under another section. The economy and comfort of Variable Vacuum operation may be a very important consideration.

4. Pipe sizes may be reduced on systems of which vacuum pumps are components. This results in a substantial savings on costs. The cost of a vacuum pump is greater than that of a condensation pump, but the above advantages of the vacuum pump usually will offset this cost. On gravity systems, namely, those using condensation pumps, there is a noticeable delay of the heating of remote radiators behind the heating of radiators nearest the boiler. In mild weather the heating will be unbalanced and spotty. Whenever heat is needed, the steam pressure must be kept high enough to keep the radiation free of air.

SELECTION OF CONDENSATION PUMPS

The capacity tables are arranged for selection of the proper pump for the EDR (equivalent direct radiation) load and discharge pressure. If the boiler is at a higher level, or located some distance from the pump, care should be exercised to select a pump with sufficient discharge pressure to more than equal the following: the maximum boiler pressure, plus the difference in elevation reduced to pounds per square inch (2.31 feet of water equals 1 PSI) plus the friction in the discharge piping expressed in pounds.

Condensation pumps are rated in capacity for three times the normal condensation from the system. Note: Normal condensate is ¼ lb. of water per hour per square foot of radiation (or 1 GPM of condensate per 2,000 square feet EDR). A rating of three times this normal amount takes care of excess condensate when building temperature is low and initial heating begins.

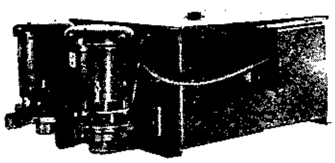
The "square feet of radiation" is the total equivalent of that contained in the radiators, unit heaters, and process equipment, if any, plus equivalent radiation in uncovered piping. Covered piping is usually neglected when determining pump size. Bare pipe is figured as 1¼ square feet EDR per square foot of actual pipe surface.

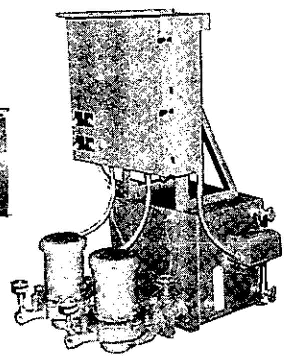
EXAMPLE: Assume a system has 10,000 square feet EDR. The normal condensate will be 5 gallons per minute. The pump is rated to handle three times this amount, or 15 GPM.

NOTE: If a duplex pump is used, each of its pumping units has the full rated capacity.

CONDENSATE PUMPS

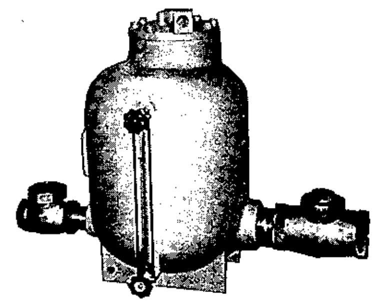
Controlled by a tank mounted float switch, MEPCO Condensate Pumps are compact, complete assemblies which return water from atmospheric heating systems, boiler feed systems, low pressure steam process equipment or from any combination. These pumps lift condensate from extremely low to high return lines and can generate impressive fuel savings by returning hot condensate to the boiler or boiler feed pump instead of wasting it to the sewer. Further, by drastically reducing the amount of make-up water required, they conserve boiler chemicals and minimize difficulties from boiler encrustation.





Model CRV

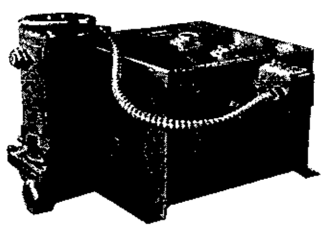
The MEPCO Model CRV Condensate Pump is offered in simplex and duplex configurations in capacities ranging from 1000 to 100,000 EDR (2-150 GPM) in pressures from 10 through 50 PSI at 1750 RPM and 10 through 70 PSI at 3450 RPM. Standard steel tanks are available in 10, 16, 24, 33 and 44 gallon sizes, with 70 and 100 gallon optional sizes available. Cast iron tanks are available in 15, 21, 35, 50, 75 and 110 gallon sizes. A wide variety of accessories from customized control panels to isolation valves are factory available with this model. **Refer to Form No. 1437 for the Model CRV.**



Model POTP®

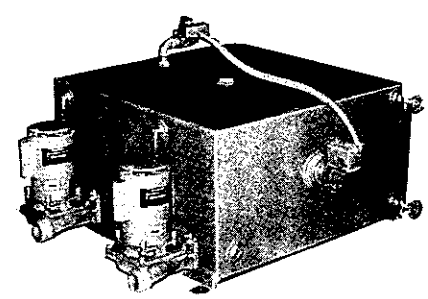
The Pressure Operated Transfer Pump, Model POTP® is designed to move condensate without the use of electricity and return condensate at temperatures above the 210°F limit of conventional centrifugal pumps. This saves energy by reducing flash steam and minimizes maintenance by eliminating electrical panels, starter and accessories. This pump is ideal for explosive atmospheres or submersible applications.
Refer to Form No. 1497.

Guardian® Model Pumps - Factory Stocked



Guardian® Condensate

The MEPCO Model GC (cast iron) and GS (steel) Guardian® Condensate Pump is furnished in simplex and duplex configurations for capacity of 12,000 EDR (18 GPM) and pressure of 20 PSI at 3450 RPM. Copper bearing steel tank sizes available are 10 and 16 gallons. Cast iron tank sizes available are 6, 15 and 21 gallons. This pump is factory stocked, and is especially designed to answer standardized needs. **Refer to Form No. 1438.**



Guardian® Boiler Feed

The MEPCO Model GSB (steel) Boiler Feed Pump is furnished in simplex and duplex configurations for capacity of 12,000 EDR (18 GPM) and pressure of 20 PSI at 3450 RPM. Copper bearing steel tanks available are 44, 70 and 100 gallons. This pump is factory stocked, and is especially designed to answer standardized needs. **Refer to Form No. 1438.**

- **REDUCES OPERATING COSTS** - These pumps are designed so that scale and rust usually found in heating system returns will not seriously affect the high efficiency and long life of the unit. A mechanical shaft seal rated at 225 degrees is used in these pumps, eliminating all stuffing box maintenance. Motors are mounted well above the floor level, affording increased protection from surface water and splash of floor cleaning operations.
- **OVERLOAD PROTECTION PROVIDED** - Magnetic starters, with overload protection, can be furnished on any pump mounted and wired or shipped loose. Single pumps and Duplex pumps with 1-1/2 HP motors and larger require magnetic starters. Smaller HP pumps are furnished as standard with motors wired to the float control. No wiring is furnished with pumps unless specified.

SPECIFICATIONS

Single and Duplex Configurations

Capacity Range	1,000 - 100,000 EDR (1/2 - 150 GPM)
Pressures (1750 RPM)	10 - 40 PSI
Pressures (3450 RPM)	10 - 70 PSI
Standard Steel Tank Sizes	10, 16, 24, 33, 44, 70 & 100 Gallon
Standard Cast Iron Tank Sizes	15, 21, 36, 50, 75 & 110 Gallon

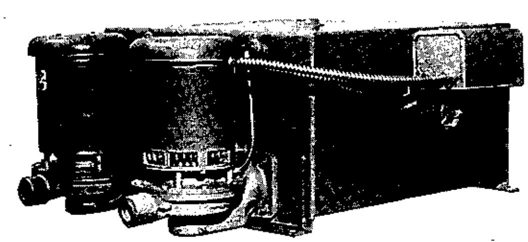
An unassembled condensation pump consists of a receiver tank with its control, saddles to support it and one or two motor driven centrifugal pumps as separate components.

The contractor provides proper foundations, also furnishes and installs the piping between the tank and the pumps and all wiring. Advantages of this type of installation are:

(1) Convenience in handling and installing.

(2) Increasing the suction head to prevent "cavitation" at the pump (see page 23) due to high water temperature

(3) Providing storage capacity for boiler water level control where condensate is slow in returning or is wasted.



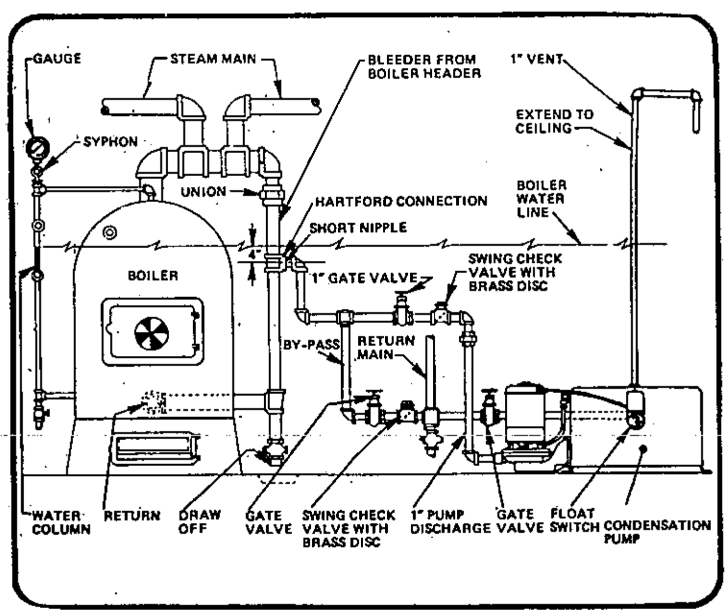
To prevent cavitation caused by the formation of steam in the pump impeller, the assembled pump is limited to water temperatures not exceeding 180 degrees. Where higher temperatures are expected.

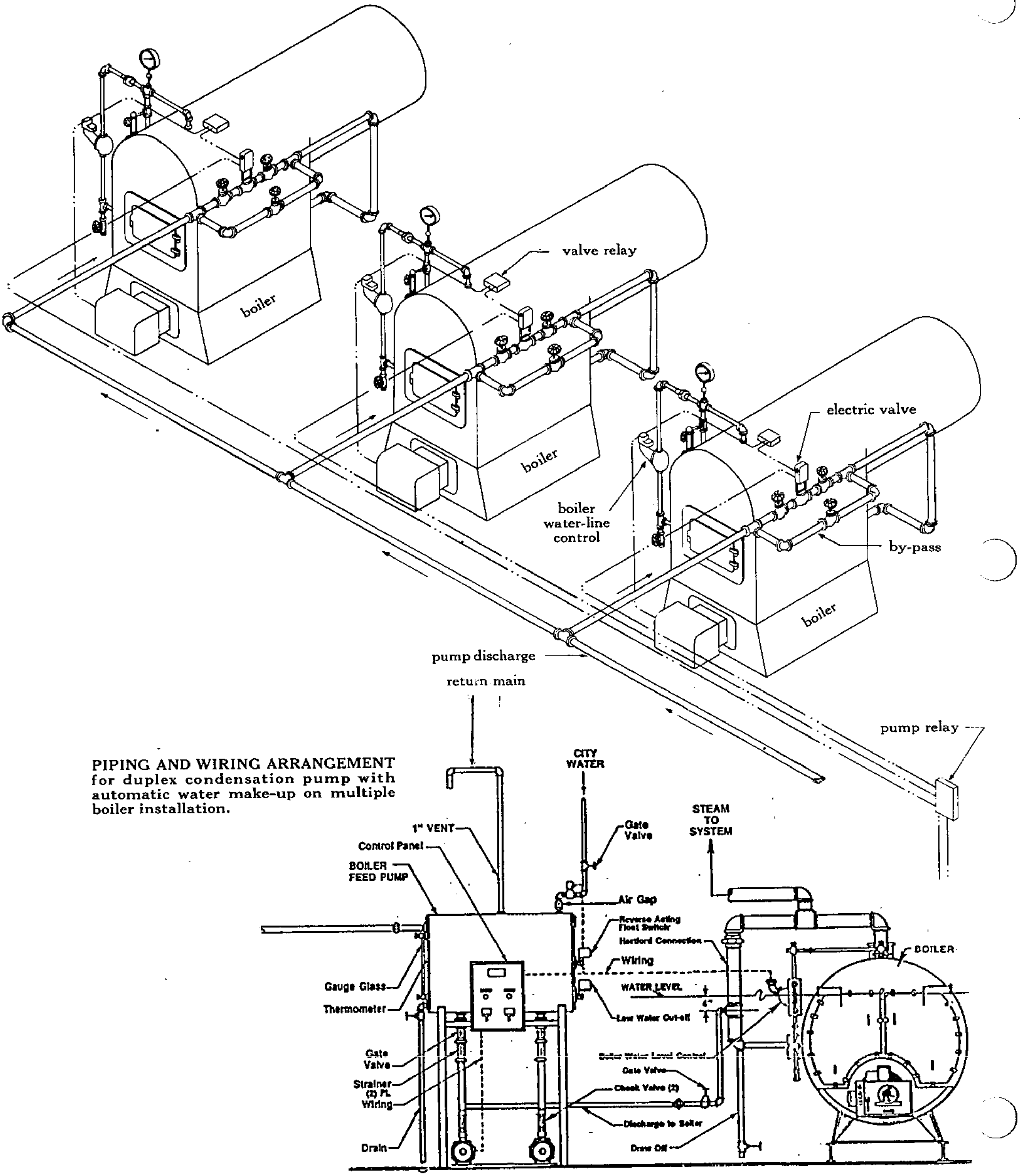
190 degrees — 3 feet
200 degrees — 6 feet
212 degrees — 9 feet

Where there is a lag in the return of the condensate, as is often the case in large spread-out jobs, especially when heating up, the boiler water level may drop so far that water must be added manually or by feeders. Later, as the condensate returns normally, there may be an excess of water in the boilers which must be drained off. To cure this, the tank of a pump may be made of the size necessary to contain sufficient surplus water in storage to maintain a proper boiler water level. This is done by omitting the usual float switch and installing water level controllers on the boilers to start and stop the pump. It is customary in this situation to equip the pump tank with a fresh water make-up valve operated by the float in the tank, so if the tank is in danger of going dry, new water will be added to the system. This takes the place of individual feeders on the boilers. As a precaution against flooding, the pump tank has an overflow tapping which may be piped to a convenient drain but there should be visual means to know whether water is overflowing so that continuous overflow due to a defective feeder may be detected.

With two or more boilers supplying a common header, or where the boilers are on different levels, it is best to have the pump (or pumps) deliver water to each boiler individually in keeping with the demand of each water level. One acceptable method is illustrated on page 12. Each boiler is provided with a water line controller which operates a valve in the feed line to that boiler and also the pump magnetic starter. When the boiler water line drops below the set point, the water line controller opens the valve and starts the pump. If there is insufficient water in the pump tank, the feeder on the tank will supply extra water.

PIPING AND WIRING ARRANGEMENT for controlling a single condensation pump to maintain a uniform water level in a single boiler.





PIPING AND WIRING ARRANGEMENT
for duplex condensation pump with automatic water make-up on multiple boiler installation.

SELECTION OF VACUUM PUMPS

Three factors must be considered when selecting a vacuum pump—water capacity, discharge pressure, and air capacity. Water capacity and discharge pressure are figured in the same way as explained for condensation pumps. Air capacity has been established and determined in accordance with the "Code for Testing and Rating Vacuum Heating Pumps" of the ASHRAE and the Heating Pump Manufacturers' Section of the Hydraulic Institute.

Saturated air capacity varies from approximately 0.5 cu. ft. per minute per 1,000 EDR of heating surface, in the small sizes, to 0.3 cu. ft. per minute in the large sizes. These variations are shown in the capacity tables in the Product Catalog. A return line vacuum pump with the standard vacuum control usually operates between 3 inches and 8 inches, or on the average of 5½ inches of vacuum. When the system is filled with steam at 2 psig, condensate temperatures may average up to 160 degrees. Return line vacuum pump ratings are based on vacuum and temperature.

In actual service, vacuum pumps are not required to operate for both maximum water and maximum air simultaneously. The air being expelled from the system under the evacuating action of the pump, quickly reaches a peak and rapidly reduces to the steady condition. The condensate peak follows or lags the air peak by a time interval which may vary from 5 to 18½ minutes. In many instances, condensate will not have started to return from the system at the time the "peak" rate of air expulsion is reached.

Typical curves of air and condensate peak loads which occur at the pump when a vacuum return line heating system is started up are illustrated by Fig. (2039 page 3). After the peaks are passed, both condensate and air return reduce to the steady return rate which is a fraction of the peak rate. The rate of steam supply and weather conditions influence the intervals between the peaks but not their sequence.

NOTE: The actual amount of air expelled (as measured) was a fraction of the capacities conforming to the requirements of the "Code for Testing and Rating Vacuum Heating Pumps."

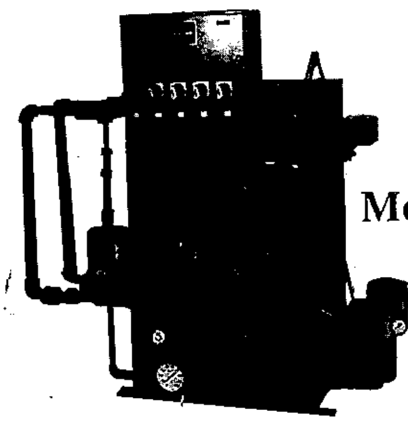
If more than 20 pounds discharge pressure is needed, select pumps with discharge pressures of 30 or 40 pounds as required. Larger pump motors are required for the increase in discharge pressure.

When high pressure steam is required for services other than space heating, still higher discharge pressures are needed. The condensate returning from these services should be piped to a Condensation Pump. The vacuum pump discharge can be connected to the Condensation Pump receiving tank (increased in size to provide adequate capacity for the additional load). The condensate pump may be selected for a sufficiently high discharge pressure to act as the boiler feed pump.

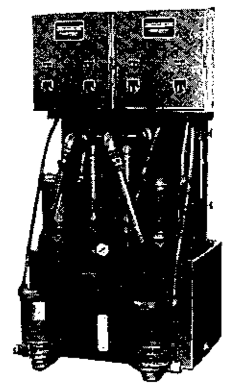
EXAMPLE: Assume a system has 20,000 sq. ft. of radiation. Under normal operation, the amount of water this system would condense is 10 gpm. However, to provide excess capacity during the heat-up period the pump is designed to handle 3 times this amount, or 30 gpm as indicated in the table. Note that the combined water and air capacity is based on the normal water rate of 10 gpm.

NOTE: Usually, one pump is sufficient for one building. Duplex pumps are usually selected to provide longer life and stand-by service in case of failure. However, there are many instances where more than one pump is required, or where a combination of Vacuum and Condensation Pumps is desirable.

For a low pressure boiler (15 lbs. or less) a pump discharge pressure of 20 lbs. is normally sufficient where the pump is in the boiler room, or near the boiler.



Model C5

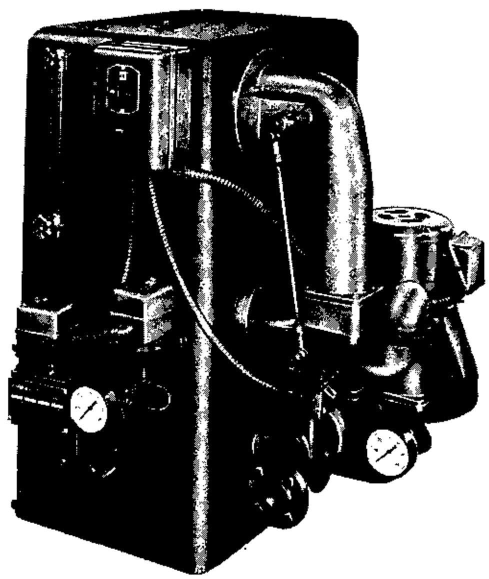


Model E2

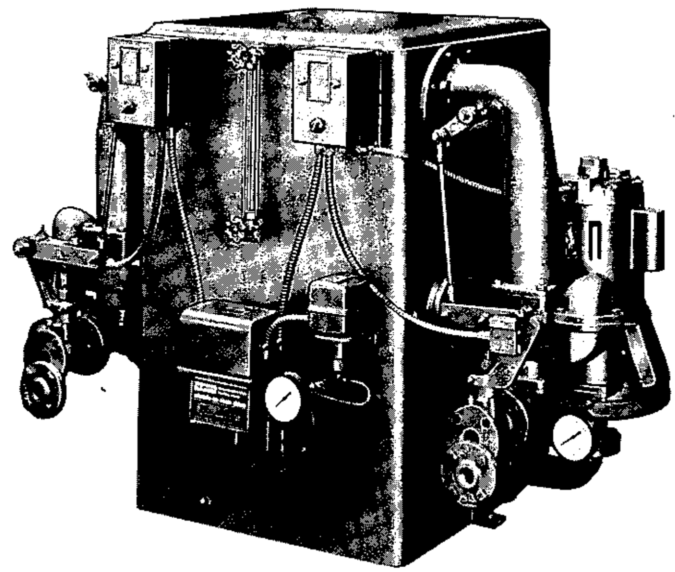
A MEPCO Model **E2** or **C5** Vacuum Pump is the heart of a steam heating system. For either new construction or retrofitting of older systems, the rapid removal of air from the system speeds warm up while reducing fuel consumption. Over 90 years of design background and production expertise, along with complete factory testing of each unit in all aspects including its ability to pull 25 inches of vacuum assure product quality and dependability. The **E2** and **C5** units feature MEPCO designed 3450 RPM centrifugal pumps, jet-type exhausters, heavy gauge copper bearing steel receivers with a ten year warranty, and come complete with electrical controls and essential accessories. The **E2** and **C5** units are manufactured in simplex or duplex configurations in capacities ranging from 5000 EDR (7.5 GPM) through 65,000 EDR (97.5 GPM). The Model **E2** does not espose system water to the atmosphere, but does require a make-up water connection to the hurling tank. The Model **C5** uses system water for the hurling tank and thus requires no make-up water connections.

Refer to Form No. 1407 for the Model E2.
Refer to Form No. 1498 for the Model C5

VACUUM PUMPS for small and medium-sized projects

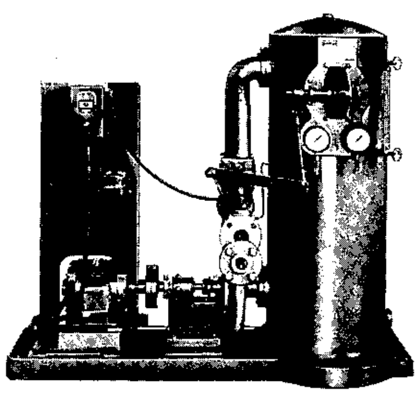


single pump

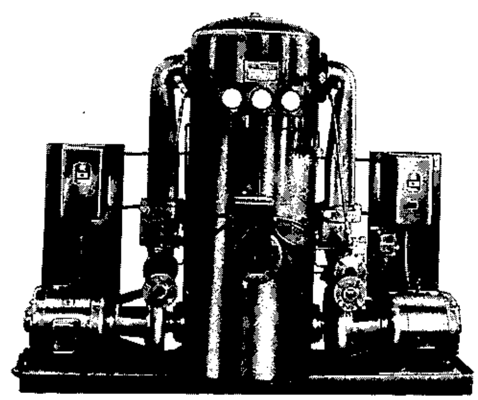


duplex pump

VACUUM PUMPS for larger projects*



single pump

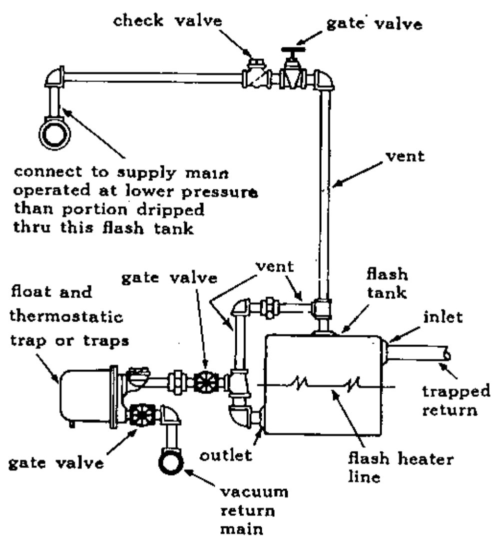


duplex pump

*Capacities to 65,000 EDR.

VACUUM PUMPS WITH HOT RETURNS

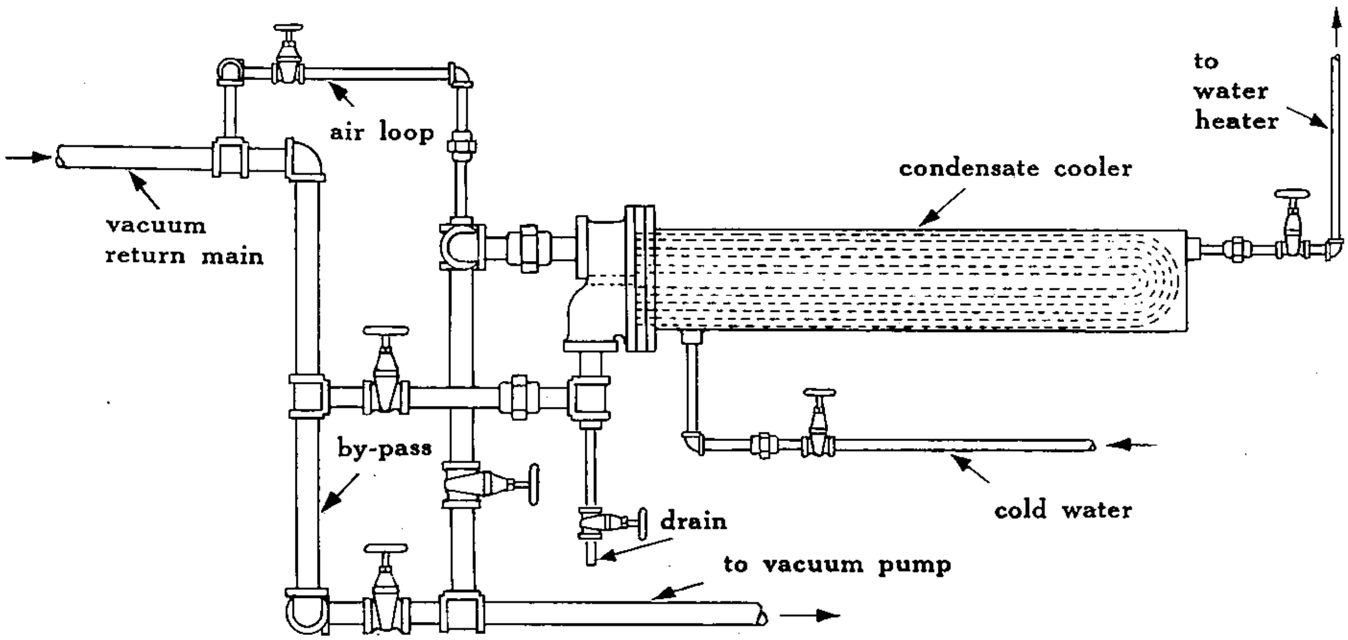
The return line from domestic water heaters may usually be taken to the Vacuum Pump without much harm to an ordinary vacuum system that is operated with low vacuum (not over 8 ins.) in the returns. Since water heaters do not run continuously, their periodic operation permits the Vacuum Pump to keep reasonably cool. However, it is better practice to pass condensate from a hot water generator and its domestic water supply thru a heat exchanger.



FLASH TANK AND PIPING DETAILS

If, however, the returns from kitchen equipment supplied at 10 lbs. are included, some means of cooling this hot condensate may be required. This may be done by bringing these returns back to the boiler room separately from the heating system returns. The hotter condensate is then made to pass thru a section of finned pipe, if the volume is small. Should the quantity of condensate be an appreciable amount, a water cooled condensate cooler consisting of a copper coil in a cast iron or steel shell should be used. The cold water line to the domestic water heater is connected to the shell, the coil is connected to the condensate return line. A common method is illustrated. This method permits free passage of air and provides maximum cooling effect.

The returns from medium or high pressure equipment, properly trapped, may be connected to a flash tank, as shown, so that the condensate has opportunity to lose considerable heat prior to passing into low pressure return line thru a trap.



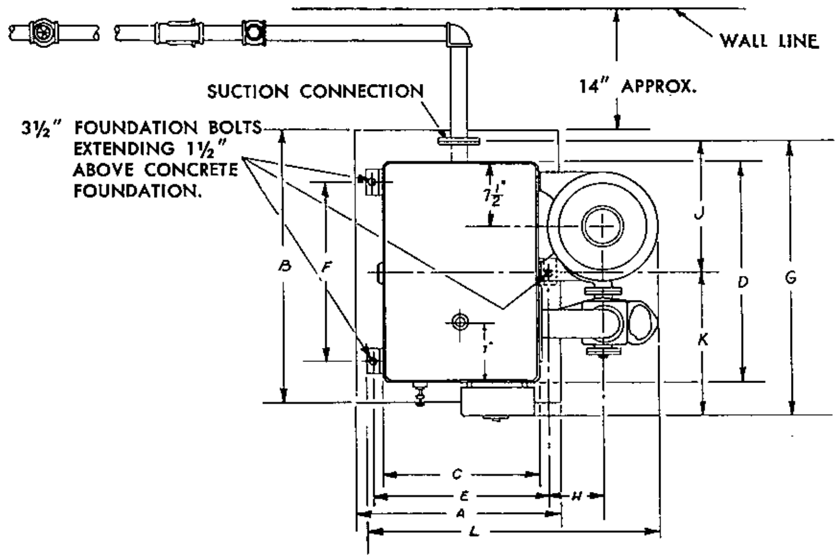
PIPING CONNECTIONS TO CONDENSATE COOLER

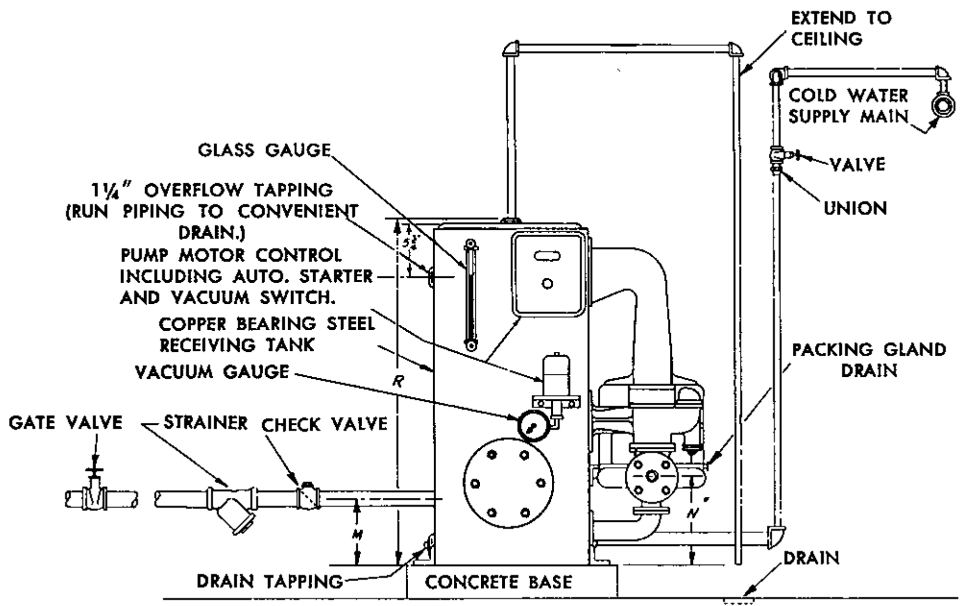
AIR LINE PUMPS

DESCRIPTION

Pumps of this type are used for handling air and vapor (but not condensate) from one-pipe air line heating systems. Pump consists of a motor, centrifugal pump, exhauster, air separating tank and electric controls. Good steam circulation is assured due to prompt removal of air from the system. Normally, these pumps operate automatically within a predetermined range in vacuum as governed by a vacuum switch. To remove the excess water that may accumulate, an overflow pipe from the air separating tank may be run to a sewer drain.

MODEL C3 — (Single)





MOTOR H. P.	PUMP DIMENSIONS IN INCHES														PUMP TAPPINGS		
	A	B	C	D	E	F	G	H	J	K	L	M	N	R	SUCT'N	OVER-FLOW	VENT
¾	24	27	18	25	20¼	20	32⅝	6⅜	14⅜	18¼	33⅝	9⅜	10⅜	36¾	¾"	1¼"	1"
¾	24	27	18	25	20¼	20	32⅝	6⅜	14⅜	18¼	33⅝	9⅜	10⅜	36¾	¾"	1¼"	1"
1	24	28	18	26	20¼	21	34	6⅜	15¼	18¾	34⅛	9⅜	10⅜	40¾	1"	1¼"	1"
1½	24	28	18	26	20¼	21	34	6⅜	15¼	18¾	34⅛	9⅜	10⅜	40¾	1"	1¼"	1"
1½	24	28	18	26	20¼	21	34	6⅜	15¼	18¾	34⅛	9⅜	10⅜	40¾	1¼"	1¼"	1"

SELECTION

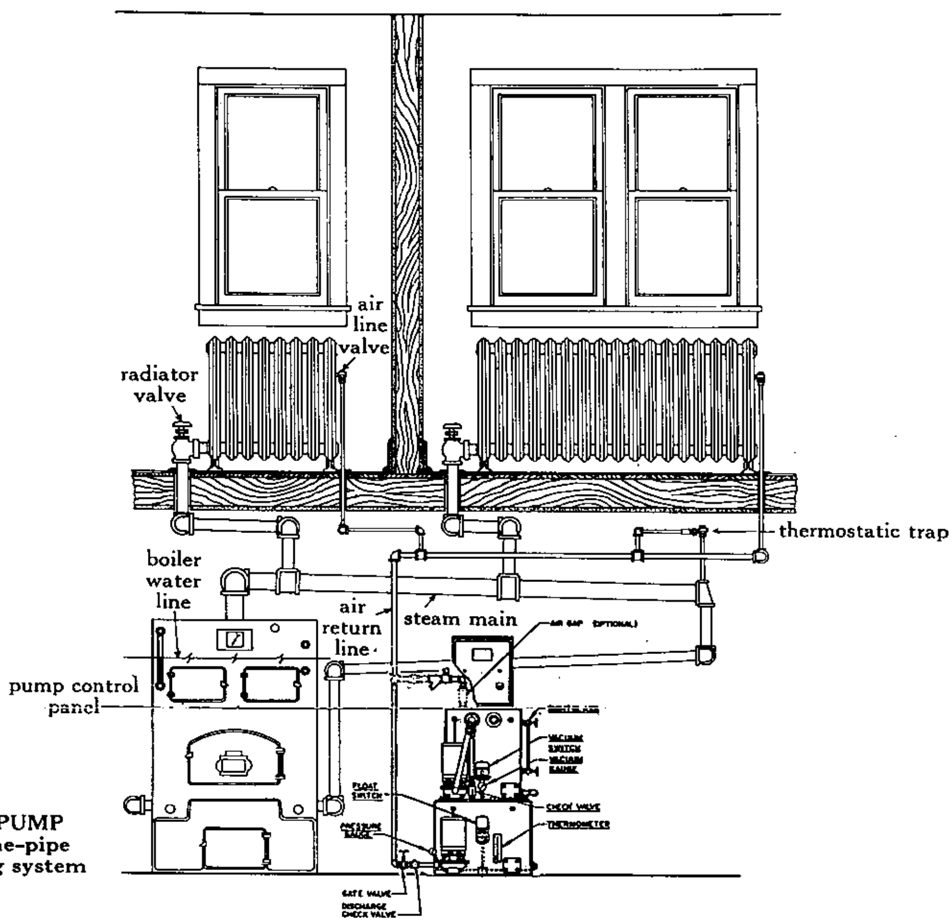
Air line pumps are rated solely on the basis of the EDR load. Consequently the selection of such a pump is determined by the total equivalent direct radiation on the air line system.

APPLICATION

The most common application for this type of pump is in converting an existing one-pipe gravity steam heating system (with air vents) to an "air-line" system. This conversion is accomplished by installing air line valves (thermostatic type air line vacuum valves) on each radiator in place of the air vent. Each air line valve is connected into a system of air return piping which is connected to the suction of the air line pump. This arrangement not only increases the operating efficiency of the system but also overcomes serious objections to air vents which are noisy and frequently discharge steam and water.

Air line pumps may also be used to prime the suction line and casing of large centrifugal pumps.

NOTE: These pumps are not suited for use as "dry" vacuum pumps on process applications where air only is to be handled.



AIR LINE PUMP
used on a one-pipe steam heating system

APPLICATION OF PUMPS

Many buildings use steam for purposes other than heating. An office building may use steam at 5 lbs. pressure for water heating. An apartment house may use steam at 10 PSI or more for kitchens and water heating. Hospitals may use steam at 75 PSI or more for a laundry, 40 to 50 PSI for sterilizers, 10 to 15 PSI for kitchens, 5 lbs. for water heating, and 2 lbs. for space heating. The condensate temperature, even from the relatively low pressure service of 5 PSI for water heaters, may be approximately 212 degrees. This equipment may be in the same room with the pumps, so there is little chance for the condensate to cool. Therefore, the water entering the pump may be heated to an extent that the pump will be unable to create the proper vacuum. This situation may be corrected by using a vacuum pump for the heating system returns, and a separate condensation pump for all other returns. The condensation pump motor will be relatively small and may be required to operate all year. This has the added advantage of saving power, as it will be the only pump used in the summertime.

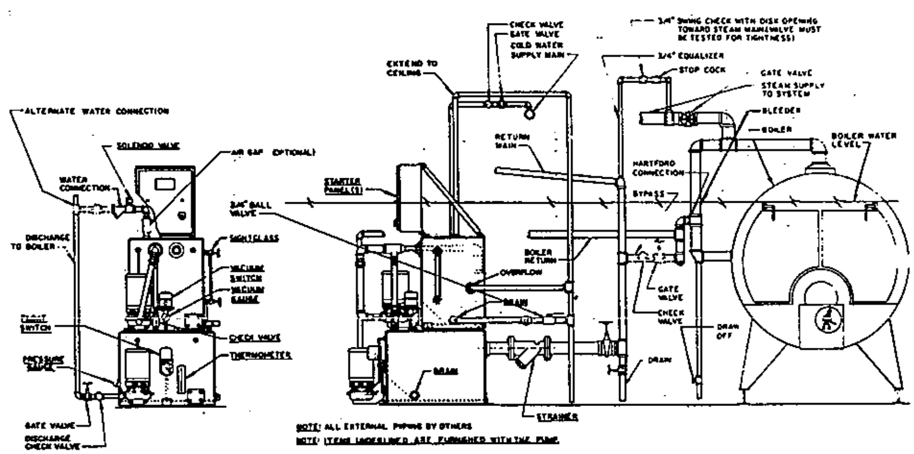
IMPORTANT: In a heating system circulating steam at high vacuum, it is essential to use separate pumps; otherwise the hot returns would seriously interfere with desirable operation at high vacuum because of the effect of the increased vapor pressure of the water.

PIPING CONNECTIONS

The following illustrations show the various piping connections for Condensation and Vacuum Pump installations.

NOTE: Pump dimensions and tapping sizes are found in Tables in the Condensation and Vacuum Pump Product Catalogs.

FIG. 1
TYPICAL PIPING OF SINGLE PUMP UNIT



¾" SWING CHECK VALVE WITH BRASS DISC OPENING TOWARD STEAM MAIN

FIG. 2
TYPICAL PIPING OF SINGLE PUMP UNIT WITH AUXILIARY ACCUMULATOR

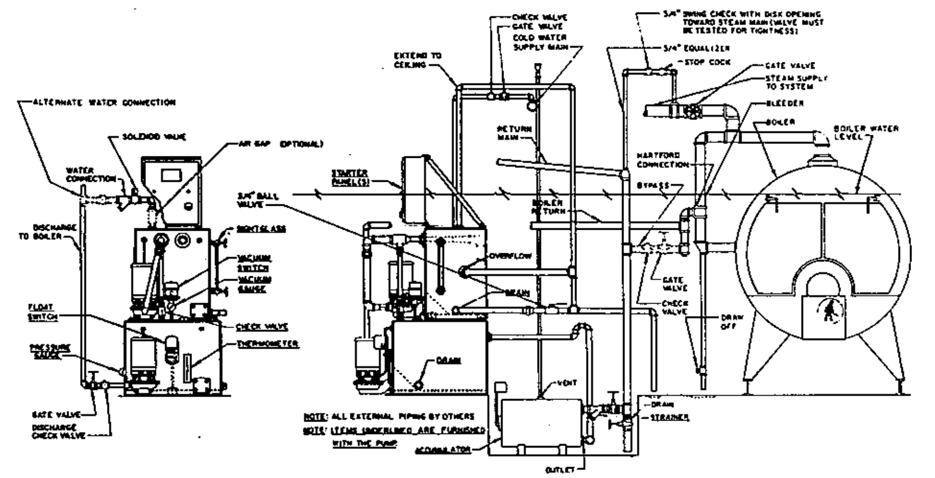


FIG. 3
TYPICAL PIPING OF DUPLEX UNIT

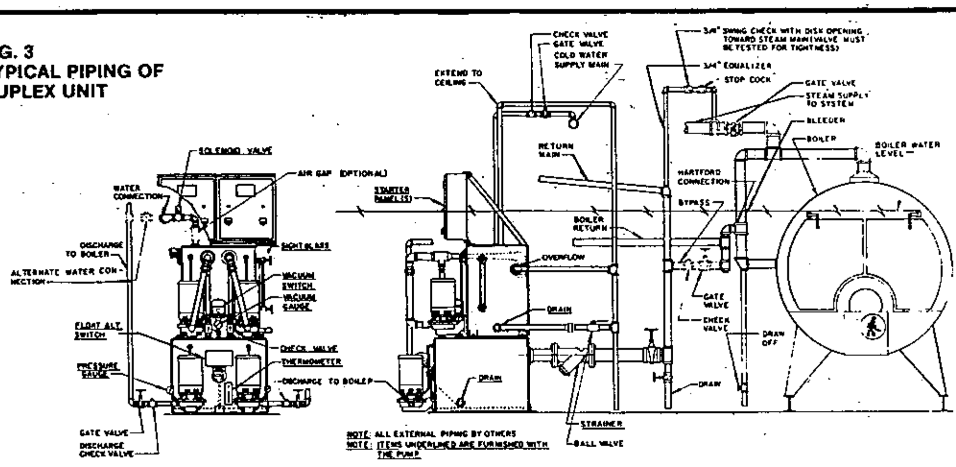
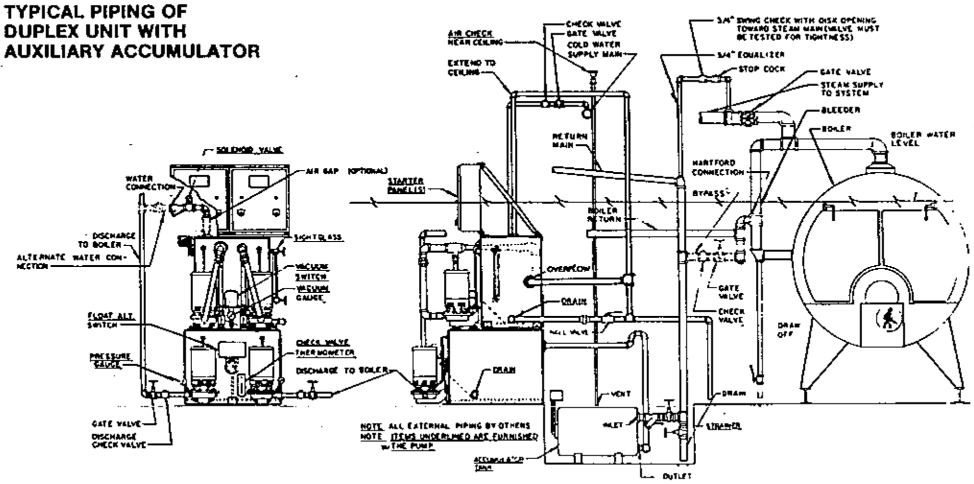
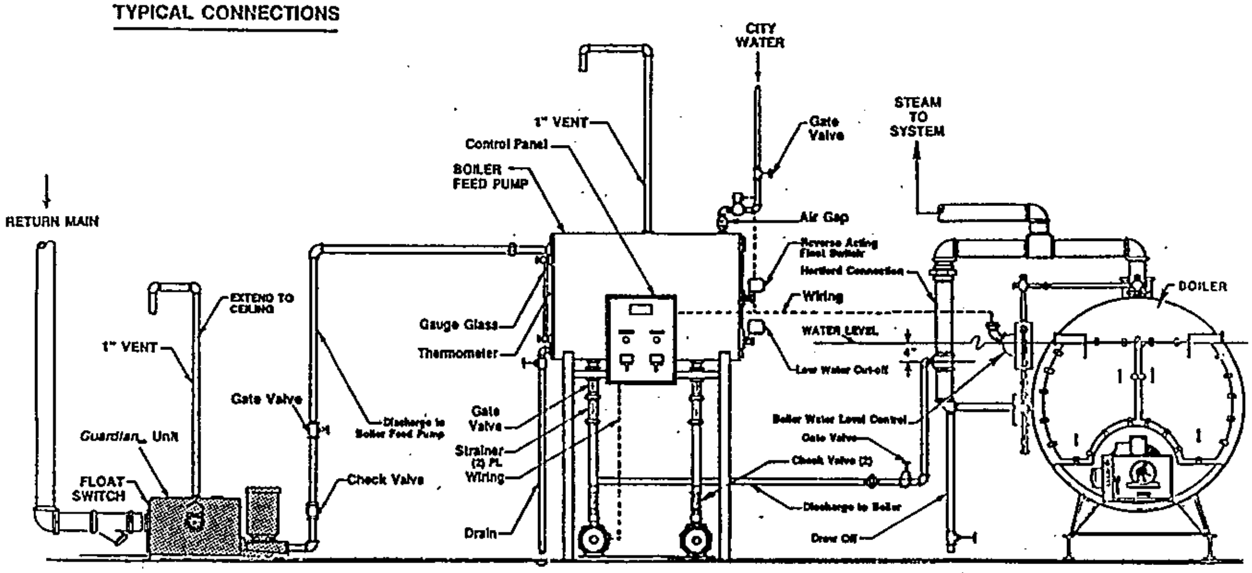


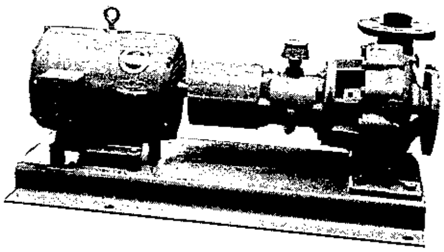
FIG. 4
TYPICAL PIPING OF DUPLEX UNIT WITH AUXILIARY ACCUMULATOR



TYPICAL CONNECTIONS



Note, external piping by others.

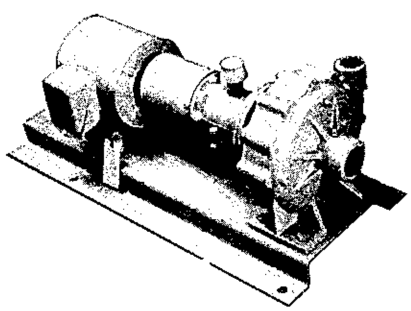


Model B9

The MEPCO Type B9 pump is of the volute type for horizontal mounting. Twenty-eight models are available in the B9 unit with ranges from 1 HP to 25 HP and capacities to 1,000 GPM, 40 PSI. **Refer to Form No. 1445.**

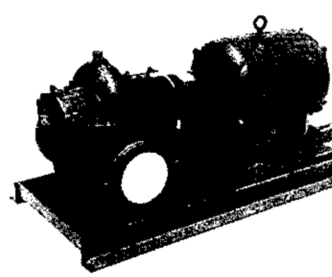
CENTRIFUGAL PUMPS

The primary purpose of a pump is to develop a difference in pressure between the liquid at its inlet or "suction" and the liquid at its discharge connection. When a pump provides such a differential, the liquid will flow through the pipe line to which it is connected. Pumps that depend upon centrifugal force to increase the pressure at its discharge above the pressure at its suction, are termed "centrifugal pumps." The liquid enters the impeller or rotating element of the pump at its center and as it turns the liquid is forced to revolve by the impeller vanes and is in turn discharged from the impeller to the scroll shaped case. The liquid enters the impeller at a low velocity and has a high velocity imparted to it. This velocity is converted into pressure within the case.



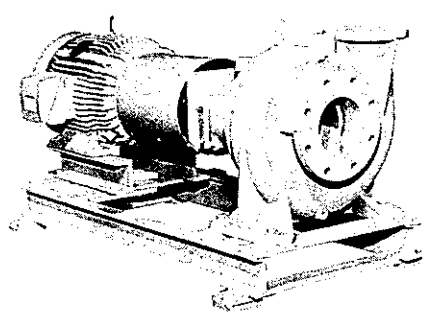
Model AB9

The MEPCO Type AB9 pump is of the volute type for horizontal mounting. Twenty-five models are available in the AB9 pump with ranges from 3/4 HP to 10 HP and capacities to 450 GPM, 40 PSI. **Refer to Form No. 1452.**



Model T

The MEPCO Type T pump is of the double suction horizontal split type. Fifty models are available in the T pump with ranges from 1 HP to 200 HP and capacities to 6000 GPM, 180 PSI. **Refer to Form No. 1607.**



Model E

The MEPCO type E pump is of double volute type for horizontal mounting. Thirty-two models are available in the E pump with ranges from 7-1/2 HP to 150 HP and capacities to 2600 GPM, 100 PSI. **Refer to Form No. 1451.**

A centrifugal pump cannot operate satisfactorily unless the suction pipe and the pump itself are completely filled (primed) with liquid. These pumps will discharge nothing if the "head" (pressure) against which they operate exceeds that for which the pump is designed.

THE TOTAL PUMP OPERATING HEAD

For a given volume of water supplied in a certain time the total operating head in the piping and pumping system is the algebraic sum of the "static heads," (variation in lift, both suction and discharge) all the friction losses at the operating capacity; the entrance and exit losses; the terminal pressure; and, the suction supply pressure. All these quantities are expressed in feet of the liquid. The static head is the pressure exerted on the bottom of the liquid column due to its weight.

PUMP SUCTION CONDITIONS

When the liquid pumped is hot the suction connections must be arranged so as to allow for the effect of the vapor pressure. Liquids have a vapor pressure which corresponds to each temperature. If the pressure of the liquid falls below the vapor pressure some of the liquid will vaporize. In any centrifugal pump, there is a definite loss in the friction and velocity head which occurs before the liquid enters the impeller vanes to an extent sufficient for it to receive energy from the pumping action of the impeller. Upon entering the suction of a centrifugal pump, a certain amount of pressure energy is converted into kinetic energy. The exact amount of this conversion depends upon various features of the suction passages and impeller inlet design. Therefore, when handling liquids in a pumping system, it is necessary that the pressure at any point in the piping system and in the impeller never be reduced to a value below the vapor pressure of the liquid at the temperature it is pumped. In order to prevent vaporization of the liquid at the impeller inlet (or "flashing") the energy at the pump suction must be in excess of the vapor pressure. If such condition is not provided, the static pressure at the impeller vanes will fall below the vapor pressure, and some of the liquid being pumped will change or "flash" into vapor. This "flashing" will form cavities within the liquid stream which are filled with vapor. The formation of vapor in this manner is called "cavitation."

The effect of cavitation is to prevent further increase in the quantity of liquid pumped, since the pumping space provided for the flow of liquid is partially filled by vapor. As the liquid enveloping the vapor bubbles pass on to regions in the impeller where additional energy becomes available, this energy causes condensation and collapse of the bubbles which is generally accompanied by considerable noise and vibration.

Centrifugal pumps are selected to deliver given quantities of water against a head (pressure) when operating at a given speed. If the head varies the quantity of liquid delivered will vary. The quantity delivered increases when the head reduces and decreases when the head increases, even though the speed of rotation remains the same.

Whether the head worked against is constant or varies must be considered in selecting centrifugal pumps to be certain the motors driving them are ample to supply the power requirements.

The data needed for selecting a centrifugal pump are: (1) Capacity of pump—gallons per min. (2) The total head, including that of the discharge and suction as well as pipe friction. (3) Variations in lift, both suction and discharge. (4) The liquid to be pumped. (5) Temperature of the liquid. (6) The nature of the service. (7) The motive power—if motor driven, the current available.

SIZING DISCHARGE PIPE

VACUUM PUMP suction connections and those of assembled condensation pumps, are incorporated in the assembly so are not altered by the conditions prevailing at the installation except for the effect of condensate temperature. The discharge connections may be such as to affect the discharge pressure required. Often altering the discharge pipe size may reduce the required head sufficiently to permit the use of a pump with lower discharge pressure.

Discharge piping is sized as follows:

STEP 1: determine pipe length

Measure the length of discharge pipe in feet. To this, add the equivalent length of each elbow, based on an assumed pipe size, as indicated in the following Table.

FRICTION OF WATER IN 90° ELBOWS

Size of Elbow, inches	½	¾	1	1¼	1½	2	2½	3	4	5	6
Friction Equiv. Feet Straight Pipe	5	6	6	8	8	8	11	15	16	18	18

STEP 2: calculate total friction loss

For assumed pipe size, calculate total friction loss from the next Table at full gpm capacity of pump. Add 30% to cover rough or poorly reamed pipe.

NOTE: If friction loss seems out of proportion to the boiler pressure, assume another pipe size and recalculate. Frequently, the use of a larger discharge line will reduce the friction head sufficiently to permit the selection of a pump having a lower discharge pressure. If friction loss is negligible, smaller pipe may be used.

FRICTION OF WATER IN PIPES

Velocity Heads† and Friction Heads†† for Flow of Water in Pipes

Gallons per Min. U. S.	½" Pipe		¾" Pipe		1" Pipe		1¼" Pipe		1½" Pipe		2" Pipe		2½" Pipe		3" Pipe		4" Pipe	
	Vel.† Head	Fric.†† Head	Vel. Head	Fric. Head	Vel. Head	Fric. Head	Vel. Head	Fric. Head	Vel. Head	Fric. Head	Vel. Head	Fric. Head	Vel. Head	Fric. Head	Vel. Head	Fric. Head	Vel. Head	Fric. Head
1	0.02	1.50	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
2	0.07	5.30	0.02	1.40	......	......	......	......	......	......	......	......	......	......	......	......	......	......
3	0.16	11.30	0.05	2 90	0.02	0.90	......	......	......	......	......	......	......	......	......	......	......	......
4	0.26	19.20	0.09	5.00	0.03	1.52	0.01	0.40	......	0.18	......	......	......	......	......	......	......	......
5	0.43	29.00	0.14	7.50	0.05	2.32	0.02	0.60	0.01	0.28	0.01	0.09	......	0.05	......	......	......	......
10	1.72	105.00	0.56	27.10	0.22	8.40	0.07	2.18	0.04	1.02	0.02	0.36	0.01	0.12	......	0.05	......	......
15	......	......	1.26	57.00	0.58	18.90	0.24	4.65	0.12	2.25	0.04	0.81	0.02	0.25	......	0.11	......	......
20	......	......	2.25	97.00	0.86	30.10	0.28	7.90	0.16	3.70	0.06	1.29	0.03	0.43	0.01	0.18	......	......
25	......	......	......	......	1.39	45.50	0.45	11.90	0.32	5.60	0.10	1.96	0.04	0.66	0.02	0.27	......	......
30	......	......	......	......	1.92	64.00	0.65	16.90	0.35	7.80	0.15	2.73	0.06	0.92	0.03	0.38	......	......
35	......	......	......	......	2.65	85.00	0.88	22.30	0.47	10.30	0.20	3.66	0.08	1.23	0.04	0.51	0.01	......
40	......	......	......	......	3.42	109.00	1.15	28.50	0.62	13.30	0.26	4.68	0.11	1.57	0.05	0.65	0.02	0.16
45	......	......	......	......	......	......	1.47	35.20	0.78	16.60	0.33	5.80	0.14	1.97	0.06	0.80	0.02	0.20
50	......	......	......	......	......	......	1.79	43.20	0.96	20.20	0.40	7.10	0.17	2.38	0.08	0.98	0.03	0.24
70	......	......	......	......	......	......	3.50	81.00	1.88	37.60	0.79	13.20	0.33	4.42	0.16	1.83	0.05	0.45
80	......	......	......	......	......	......	4.55	102.95	2.40	48.28	1.04	16.83	0.43	5.61	0.20	2.33	0.06	0.58
90	......	......	......	......	......	......	5.75	127.80	3.09	59.64	1.31	20.87	0.54	6.96	0.26	2.90	0.08	0.71
100	......	......	......	......	......	......	......	......	3.85	72.42	1.62	25.42	0.66	8.52	0.32	3.52	0.10	0.87
125	......	......	......	......	......	......	......	......	......	......	2.36	38.90	1.03	13.01	0.50	5.40	0.16	1.33
150	......	......	......	......	......	......	......	......	......	......	3.64	53.96	1.49	18.72	0.72	7.72	0.23	1.82

† Velocity heads given in feet. †† Friction head for 100 ft. of straight new wrought-iron pipe.

STEP 3: determine required pump pressure

Determine the required pump pressure by first adding the friction loss in feet to the static head, which is the difference in elevation between pump discharge connections and boiler water level. Multiply by 0.433 to convert this into pounds, and to this add the boiler pressure in pounds. The velocity head can be neglected in most cases.

EXAMPLE: To determine required discharge pressure for a pump to meet the following conditions:

Boiler pressure (safety valve blow-off pressure) 15 lbs.
Length of 1¼ in. pipe between pump and boiler 70 ft.
Number of 1¼ in. elbows (5 elbows, 1 gate valve,
1 check valve) 7 elbows.
Total radiation load 10,000 sq. ft. EDR

*Capacity of 10,000 sq. ft. pump in U.S. gpm 15 gals.
Boiler water line above pump 8 ft.

Boiler pressure	15.00 lbs.
Friction head in 70 ft. of 1¼ in. pipe $\frac{70}{100}$ x 4.65 x .433	1.40 lbs.
Friction head in 7 elbows (1¼ in.) $\frac{7 \times 8}{100}$ x 4.65 x .433	1.12 lbs.
Velocity head .24 x .433	.10 lbs.
**Static head 8 x .433	3.46 lbs.
Total pressure head	21.08 lbs.

The total head for the above condition exceeds 20 lbs. To use a pump having a 30 lb. discharge pressure would increase first cost and operating costs. The total pressure head can be reduced by using a larger discharge pipe as shown by the following calculation when using 1½ in. instead of 1¼ in. discharge pipe.

Boiler pressure	15.00 lbs.
Friction head in 70 ft. of 1½ in. pipe $\frac{70}{100}$ x 2.25 x .433	.69 lbs.
Friction head in 7 elbows (1½ in.) $\frac{7 \times 8}{100}$ x 2.25 x .433	.55 lbs.
Velocity head .12 x .433	.05 lbs.
**Static head 8 x .433	3.46 lbs.
Total pressure head	19.75 lbs.

A pump with 20 lbs. discharge pressure would be satisfactory.

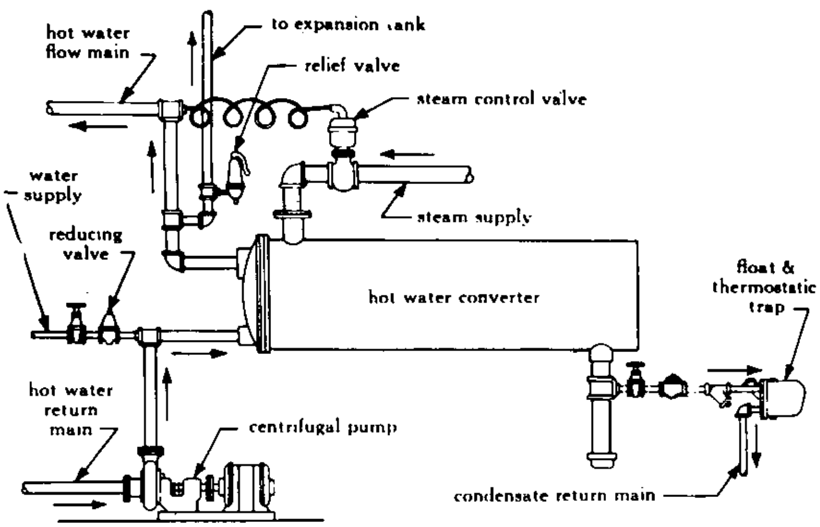
* *See Capacity Tables in Product Catalog.
**Head due to height of boiler water line.

The effect of the piping friction frequently dictates an increase in the size of the discharge line to keep this friction at a lower value and thus reduce the total head. Such a pipe size increase may permit the use of a pump (rated to operate) against a lower head. The larger pipe also keeps the velocities lower. Suction piping should be a size that provides low water velocities within it.

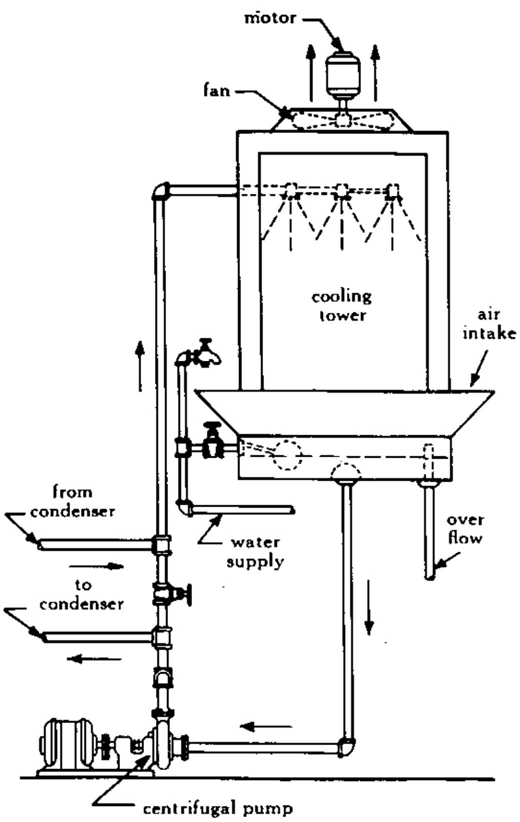
APPLICATION

Centrifugal pumps are widely used in forced circulation hot water heating and chilled water cooling systems where they can be installed in boiler rooms or locations where noise is not a factor. In dairies and ice cream plants they are employed for circulating water over cooling towers or spray ponds also for pumping brine through milk coolers or ice cream machines. In cold storage warehouses and in air conditioning systems they have similar uses.

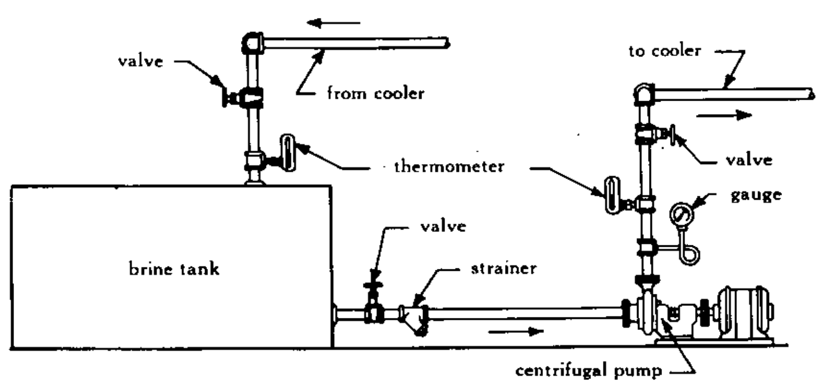
In industrial plants they are used for circulating oil in quenching and heat treating tanks, in food product plants for circulating hot liquids as a cooking medium or cold liquids as a cooling medium.



Centrifugal pump used on a forced-circulation hot water heating system



Centrifugal pump used for pumping water to a cooling tower in a dairy



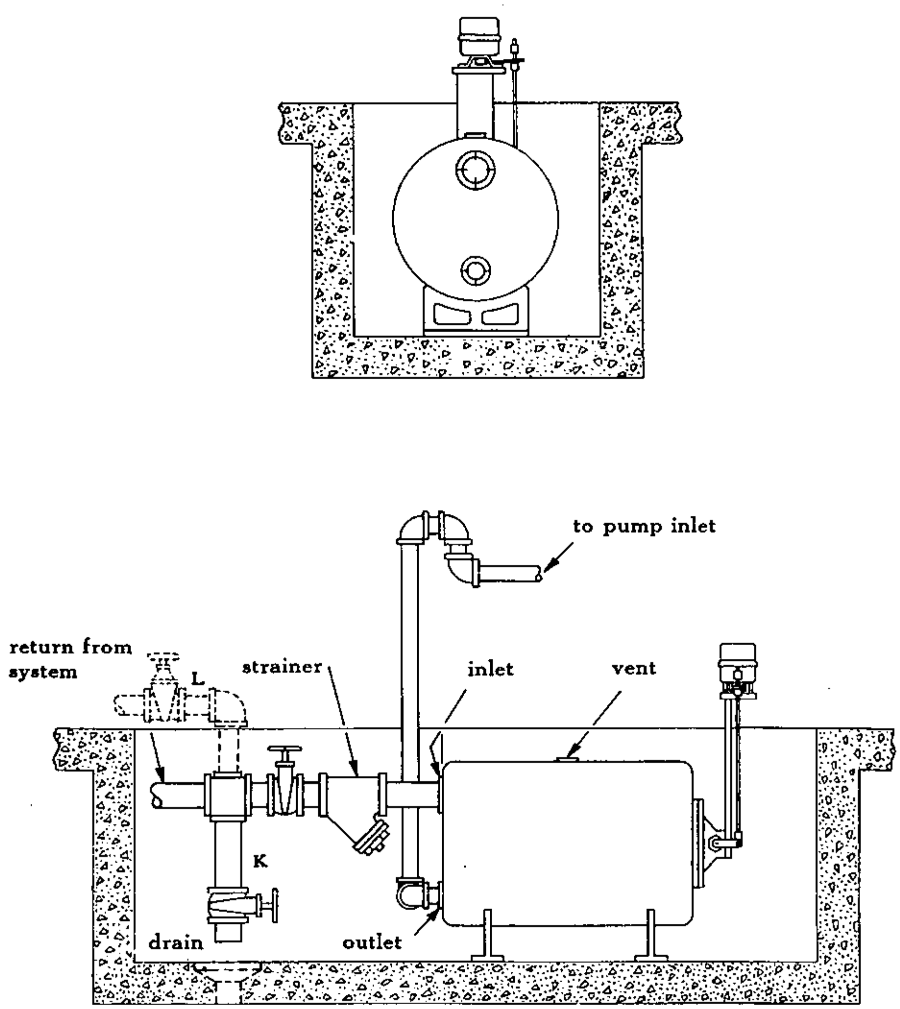
Centrifugal pump used for pumping brine to a milk cooler

SPECIAL APPLICATIONS

Low Returns: If Condensation Pumps are used where returns are too low for the condensate to return to pump inlet by gravity, the pump must be set in a pit. The pit must have drainage to a sewer, or a sump pump, to prevent damage by flooding.

If Vacuum Pumps are used, a separate accumulator tank may be set in a pit as illustrated. If the pit is provided with a drain, connection **K** should be installed so that the condensate can be passed into the drain if the pump is inoperative. If a drain cannot be installed, connection **L** is installed as shown, and connection **K** is omitted.

SEPARATE ACCUMULATOR TANK SET IN PIT

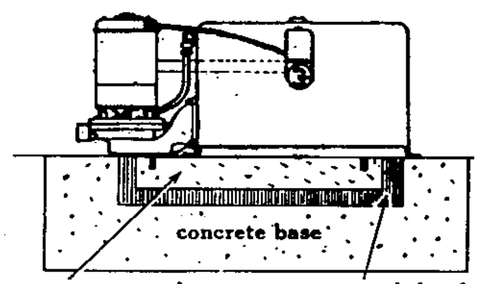


Pumps have mechanical, electrical and hydraulic noises. In a Vacuum Pump there is an exhauster noise.

Pumps located in boiler rooms are not apt to be heard above other noises. However, when located in separate rooms, pump noise may be heard, and vibrations transmitted through the piping to other rooms. This noise may not be apparent in office and industrial buildings, but may be objectionable in apartment houses, hospitals, theaters, and the like. Pumps can be installed so that noises are reduced by the following procedures:

Vibration-Proof Foundations: The best method is to use a two-base foundation. The lower base is concrete, cast on the floor, having a rectangular recess lined with cork or similar vibration-proof material as shown. The pump is mounted on its own concrete base which sets inside the cork lined recess. It is allowed, in effect, to "float" on the cork.

NOTE: It is advisable to consult manufacturers of vibration-proof materials to obtain recommendations on thickness, dimensions and types of materials.



VIBRATION-PROOF FOUNDATION

Piping Isolation: Usually, the biggest source of noise is in the discharge line, rather than in the return line. Immediately after leaving the pump, and before the first hanger, the discharge line should be fitted with a piece of flexible hose of suitable construction. If some noise is still transmitted to the pipe beyond the hose connection (usually caused by water velocity) the pipe should be hung with spring type hangers.

Miscellaneous Noise: Ball bearings may become worn, pumps may be out of line, flexible couplings may be out of line, or check valves and discharge valves may be worn, causing noise. Each job has its own specific problems, which may be solved on the job.

NOTE: In general, pumps should not be installed in the basements of residences with living quarters immediately overhead.

FLASH TANKS

DESCRIPTION

Where a heating system vacuum pump must also handle condensate from equipment operating at medium or high pressures, such as cooking equipment, sterilizers, hot water heaters, process equipment, etc., provision must be made to reduce the temperature of the condensate from the higher pressure equipment. There are two ways in which this can be accomplished. One, by the use of a flash tank; the other by a heat exchanger or condensate cooler.

A flash tank is a means of permitting the excess heat to re-vaporize a portion of the condensate for delivery to the steam piping of the vacuum return line system or to atmosphere, the remaining condensate being cooled to a value approximately the same as that coming from the heating system. Thus, vacuum pump operation is not handicapped by the high temperature condensate.

When condensate enters the flash tank, re-vaporization occurs. That is, a portion of the condensate "flashes" or forms steam. The steam or vapor thus formed is released from the tank to the low pressure heating main (see illustration next page).

If low pressure piping is not accessible, the steam may be released to atmosphere (also illustrated next page). The remaining condensate then passes through a trap into the vacuum return main.

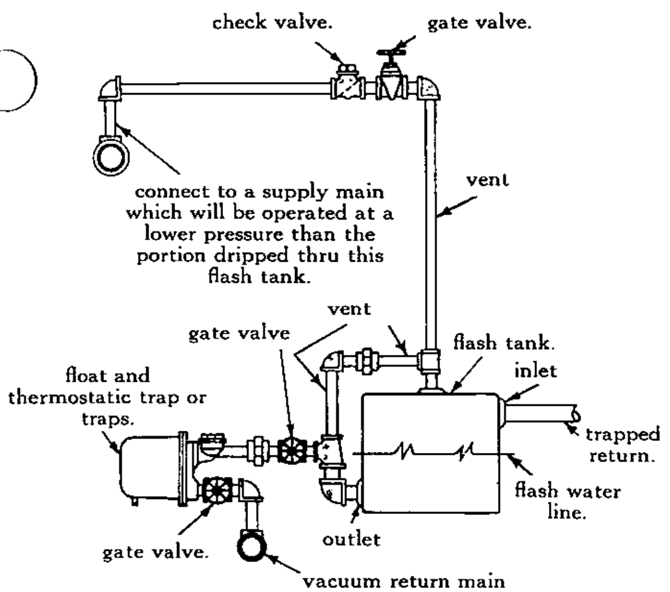
SELECTION

The size of the flash tank and the trap(s) to drain it are chosen on the basis of EDR load. See the Product Catalog.

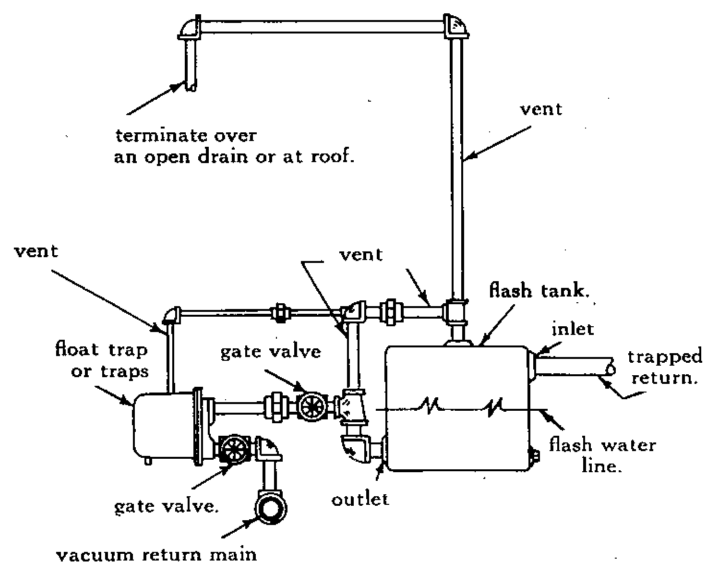
APPLICATION

A flash tank should always be installed so that condensate flows into it by gravity. The piping of the tank must be arranged so the tank is one-half full of water to provide maximum surface for re-vaporization.

NOTE: This type of installation wastes condensate and requires a corresponding amount of make-up water with its attendant problems. This is true only when released to atmosphere and arrangement should be avoided wherever possible.



FLASH TANK
with steam or vapor
released to main



FLASH TANK
with steam or vapor
released to atmosphere

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