Table 11 .... Suggested Capacity of Pressure-Regulating Valves and Traps

Type of Control	*Pressure-Regulating Valve Capacity Lb/(Hr)(Sq Ft EDR[a])*
Continuous or modulating operation, intermittent with *on* periods over 3 hr in duration	⅓
Intermittent operation with *on* periods of ½ to 3 hr in duration	½
Intermittent operation with *on* periods of ½ hr or less	⅓[b]

[a] One square foot EDR = 240 Btu per hr.
[b] Except for 1-pipe systems or 2-pipe systems not orificed which should be 1 lb per sq ft EDR.

system or equipment. Consideration should be given to rangeability, speed of load changes, and accuracy of regulation required to properly handle system needs. This is especially important with temperature control systems using intermittent flow of steam to heat the building.

Certain types of pilot-operated pressure-regulating valves can be used as a temperature control valve in some temperature control applications, by actuating the pilot by means of a damper operator or small automatic control valve.[4]

Pressure-regulating valve capacities recommended for use with various types of temperature control are shown in Table 11.

Care should be exercised in selecting the size of a reducing valve. The safest method is to consult the manufacturer. It is essential that sizes of piping to and from the reducing valve be such that they will pass the desired amount of steam with the maximum velocity desired. A common error is to make the size of the reducing valve the same size as that of the service, or outlet pipe size. Generally, this will make the reducing valve oversized and cause wiredrawing of valve and seat due to the resultant small lift of the valve.

On installations where the steam requirements are relatively large and variable, wiredrawing and cycling control may occur in mild weather or during reduced-demand periods. To overcome this condition, two reducing valves are installed in parallel, with the sizes selected on a 70 and 30 percent proportion of maximum flow. For example, if 10,000 lb of steam per hour are required, the size of one valve is on the basis of 7000 lb, and the other on the basis of 3000 lb. During mild weather (spring and fall) the larger valve is set for slightly lower reduced pressure than the smaller one and hence remains closed as long as the smaller can supply the demand. During the remainder of the heating season the valve settings are reversed to keep the smaller one closed except when the larger is unable to supply the demand.

BOILER CONNECTIONS

Steam

Cast-iron, sectional heating boilers usually have several outlets in the top. Two or more outlets should be used whenever possible to reduce the velocity of the steam in the vertical uptakes from the boiler, and thus to prevent carrying of water into the steam main. Piping connections to the steam header are shown in Fig. 32.

Return

Cast-iron boilers are generally provided with return tappings on both sides, while steel boilers are generally equipped with only one return tapping. Where two tappings are provided, both should be used to effect proper circulation through the boiler. Recommended piping connections including the *Hartford return for a battery of steam boilers* having the *condensate returned by a pump*, are shown in Fig. 32. Connections for a single boiler are shown in Fig. 33. The 90-deg elbow, short horizontal nipple, and tee at the top of the Hartford connection may be replaced by an inverted Y fitting if the condensate flows to the boiler by *gravity*. The point at which the condensate enters the equalizer pipe should be 4 in. below the normal water line when a pump is used and usually 2 to 4 in. for gravity return.

The inverted Y fitting should not be used if condensate is *returned by a pump* because the fitting may direct the condensate upward into the equalizer pipe where it will cause noise due to rapid condensation of some steam. Proper selection of a pump capacity and discharge pressure is required in any case because a pump may deliver water at such a high rate that steam and cold condensate are brought into contact and cause noise.

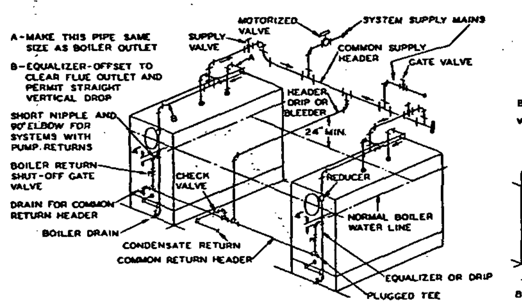

Fig. 32 .... Piping Including Hartford Return Connection for Boilers in Battery

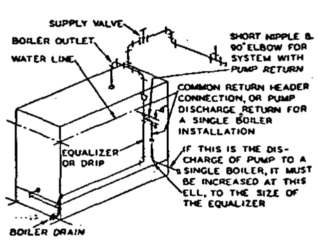

Fig. 33 .... Boiler Piping Including Hartford Return Connections

The size of equalizer recommended by the Hartford Steam Boiler Inspection and Insurance Co. is based upon grate area as follows: 1½, 2½, and 4 in. for grate areas of 4, 4 to 15, and over 15 sq ft respectively. It should not be less than the size of the main return piping from the system. The equalizer connection should be made as shown in Figs. 32 and 33 so that the steam flows toward it for best balance conditions. If the connection is such that the steam flows across the equalizer inlet, a lowered pressure will result at the inlet and tend to draw the condensate discharged by the pump into the steam thereby causing water hammer.

The condensate should enter the common return header of a battery of boilers midway between the end boilers. If the discharge line is more than 25 ft long, a check valve should be installed at the return header as shown in Fig. 32 in addition to the check valve at the outlet of the pump.

If the pump discharge is run at an elevation above the water line a spring-loaded check valve at the return header will keep the discharge line flooded and prevent water hammer which usually follows a system shutdown period.

Sizing Boiler Connections

Little information is available on the sizing of boiler runouts and steam headers. Although some engineers prefer an enlarged steam header to serve as additional steam storage space, there ordinarily is no sudden demand for steam in a steam heating system, except during the heating-up period, at which time a large steam header is a disadvantage rather than an advantage. The boiler header may be sized by first computing the maximum load that must be carried by any portion of the header under any conceivable method of operation, and then applying the same schedule of pipe *sizing to the header as is used on the steam mains* for the building. The horizontal runouts from the boiler, or boilers, may be sized by calculating the heaviest load that will be placed on the boiler at any time, and sizing the runouts on the same basis as the building mains. The difference in size between the vertical uptakes from the boiler, which should be of same size as the boiler outlet tapping, and the horizontal main or runout, is compensated for by the use of reducing ells.

Return connections to boilers in gravity systems are made *the same size as the return main itself. Where the return is* split and connected to two tappings on the same boiler, both connections are made the full size of the return line. Where two or more boilers are in use, the return to each may be sized to carry the full amount of return for the maximum load which that boiler will be required to carry. Where two boilers are used, one of them being a spare, the full size of the return main would be carried to each boiler, but if three boilers are installed, with one spare, the return line to each boiler would require only half of the capacity of the entire system, or, *if the boiler capacity were more than one-half* the entire system load, the return would be sized on the basis of the maximum boiler capacity. As the return piping around the boiler is usually small and short, it should not be sized to the minimum.

With returns pumped from a vacuum or receiver return pump, the size of the line may be calculated from the water rate on the pump discharge when it is operated, and the line sized for a very small pressure drop. The relative boiler loads should be considered, as in the case of gravity return connections. Boiler header and piping sizes should be based on the total load.

CONDENSATE RETURN PUMPS

Condensate return pumps are used for gravity systems when the local conditions do not permit the condensate to return to the boiler under the existing static head. The return of the condensate permits the water to pass repeatedly through the cycle of vaporization, with subsequent condensation and return to the boiler. During such repeated cycles any incrustants or other substances in solution are precipitated and the water de-activated to a considerable extent, so that corrosion of a serious nature is seldom ever encountered where the condensate is repeatedly used. Serious corrosion is more frequently found in systems in which the condensate is wasted, and fresh make-up water is continually being introduced.

A generally accepted condensate pump unit for low-pressure heating systems consists of a motor-driven centrifugal pump with receiver and automatic float control. Other types in use include rotary, screw, turbine and reciprocating pumps with steam turbine or motor drive, and direct-acting steam reciprocating pumps.

The receiver capacities of these automatic units should be sized so as not to cause too great a fluctuation of the boiler water line if fed directly to the boiler, and at the same time not so small as to cause too frequent operation of the unit. The usual unit provides storage capacity between stops in the receiver of approximately 1.5 times the amount of condensate returned per minute, and the pump generally has a delivery rate of 2 to 3 times the normal flow. This relation of receiver and pump size to heating system condensing capacity takes account of the peak condensation rate.

A typical installation of a motor-driven automatic condensate unit is illustrated in Fig. 10.

For installations where it is necessary to have the condensate pump available for operation at all times, the use of a duplex-type condensate pump fitted with a mechanical alternator is advantageous. Repair or replacement of one pump may then be made while the other remains in service.

VACUUM HEATING PUMPS

On vacuum systems, where the returns are under a vacuum, and subatmospheric systems, where the supply piping, radiation, and the returns are under a vacuum, it is necessary to use a vacuum pump to discharge the air and noncondensable gases to the atmosphere and to dispose of the condensate. Direct-acting steam-driven reciprocating vacuum pumps are sometimes used where high-pressure steam is available, or where the exhaust steam from the pump can be utilized. In general, however, these have been replaced by the automatic motor-driven return-line heating pump especially developed for this service. Steam-turbine drive is also frequently used where steam at suitable pressures is available, the steam being used afterward for building heating. The usual vacuum pump unit consists of a compact assembly of exhausting unit for withdrawing the air-vapor mixture and discharging the air to atmosphere, and a water removal unit which discharges the condensate to the boiler. They are furnished complete with receiver, separating tank, and automatic controls mounted as an integrated unit on one base. There are also special steam-turbine driven units which are operated by passing the steam to be used in heating the building through the turbine with only a 2 to 3 psi drop across the turbine required for