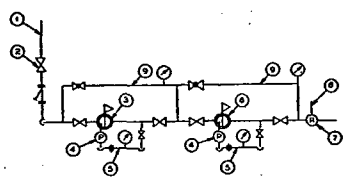
where the steam must be shut off tight to prevent build-up of pressure on the low-pressure side at time of no load, and the other where the low-pressure lines will condense enough steam to prevent build-up of pressure due to normal leakage through the valve. In the first case single-seated valves, either direct-operated or pilot-controlled, should be used and in the latter case double-seated valves, either direct-operated or pilot-controlled, may be used. Valves available are direct-operated, spring, weight, air-loaded, or pilot-controlled, using either the flowing steam or auxiliary air or water as the operating medium. The direct-operated, double-seated valve is less affected by varying inlet steam pressure than the direct-operated, single-seated valve. Pilot-controlled valves, either single- or double-seated, tend to eliminate the effect of variable inlet pressures.



1. Service pipe from district steam main
2. Service valve
3. Pressure-reducing valve
4. Pilot
5. Balance line
6. Pressure-regulating valve
7. Safety relief valve
8. Relief valve discharge to outside
9. Bypass, one size smaller than pressure-reducing valve

Note: All fittings should be American Standard Class 250 cast iron and/or 300 lb steel.

(Used Where High-Pressure Steam is Supplied for Low-Pressure Requirements)

Fig. 28 .... Two-Stage Pressure-Reducing and Pressure-Regulating Equipment

Valves that shut off all steam are called *dead end* type. They are single-seated, and some of them have pilot operation or constant air loaders that provide close control of the reduced pressure. If a thermostatically controlled valve is installed after, and near, a reducing valve in such a manner as to cut off the passage of steam, the dead end type of reducing valve should be used and a suitable trap should be installed to provide for drainage of condensate formed between the reducing valve and the control valve. If a one-stage reduction is desired, it is necessary to use either a pilot-controlled or an air-loaded direct-operated pressure-reducing valve where low pressures are to be maintained closely.

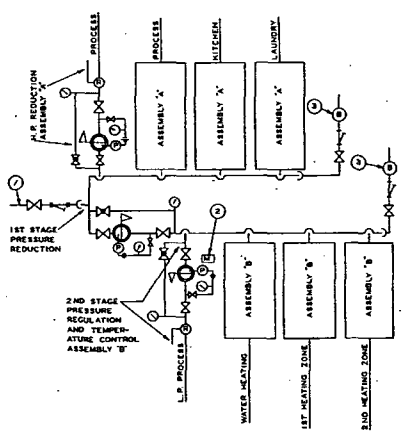
Installation

The installation of pressure-reducing valves in pipe lines requires detailed planning. They should be installed to give ease of access for inspection and repair. There should be a bypass around each reducing valve of area equal to the area of the reducing-valve seat ring. The globe valve in a bypass line should be of a good type of construction, and must shut off absolutely tight. A steam pressure gage, graduated up to the initial pressure, should be installed on the low-pressure side. This should be ahead of the shut-off valve because the reducing valve can be more accurately and conveniently adjusted with the shut-off valve closed. A similar gage should be installed downstream from the shut-off valve for use during manual operation.

Strainers should be installed on the inlet of the primary pressure-reducing valve and are also desirable before the second-stage reduction if there is considerable piping between the two stages. If a two-stage reduction is made, it is well to install a pressure gage immediately before the reducing valve of the second-stage reduction for use in setting and checking the operation of the first valve. In all cases it is advisable to install a drip trap between the two reducing valves.

Safety valves located on the low-pressure side should be set at least 5 psi higher than the reduced pressure where the reduced pressure is under 35 psig and at least 10 psi higher than the reduced pressure if the reduced pressure is above 35 psig or is the first-stage reduction of a double reduction. A safety valve or valves, installed on the low-pressure side of a reducing valve or valves, should be of sufficient capacity and should be set to relieve the entire output of the reducing valves in the event pressure on the equipment exceeds the low-pressure setting by the values indicated above. The outlet from relief valves should be piped to a location where the discharge to atmosphere cannot jeopardize persons or property.[8] (See Figs. 28 and 29.)

Typical service connections are shown in Fig. 30 for low-



1. Service pipe from district steam main
2. Motorized pilot on pressure-regulating valve
3. Bucket trap on header drip line

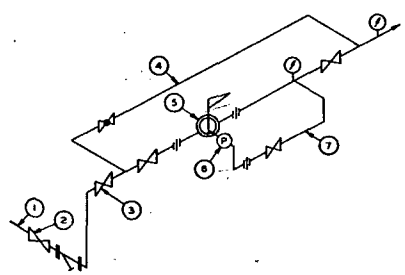
Note: Where process equipment is individually controlled, temperature control on header may be omitted. All fittings should be American Standard Class 250 cast iron or 300 lb steel in both reduction and regulation assemblies.

Fig. 29 .... Steam Supply Installation with Header for Process and Zone Connections

pressure service and Fig. 31 for high-pressure service. The district heating industry refers to valves according to their functional use. The pressure-reducing valve reduces pressure to a safe point, and the pressure-regulating valve regulates pressure to that required by equipment served. Fig. 31 illustrates the use of a pressure-regulating valve with a bypass. This bypass permits the operation of the system in case of failure in the pressure-regulating valve. In the smaller sizes, the bypass is sometimes omitted. When servicing is required, the pressure-regulating valve can be removed, a filler installed, and the inlet stop valves used for manual regulation of the pressure until repairs are made. Fig. 29 shows a typical service installation with a separate line to the various heating zones and process equipment. If the initial pressure is below 50 psig the first stage pressure-reducing valve may be omitted. In Assembly *A*, Fig. 29, the single-stage pressure-reducing valve is also the pressure-regulating valve.

If the radiation served is of cast iron and the inlet pressure exceeds 50 psig, the ASME Code[9] requires the installation of pressure-relief valves where the inlet pressure exceeds the safe working pressure of the steam-using equipment, except where two reducing valves are installed in series and *both* are set at or below the safe working pressure of the equipment serviced. This, however, is not two-stage reduction. See Fig. 31.

Two reducing valves, installed in series and both set at or below the safe working of the equipment serviced, introduce a source of safety while taking advantage of the more stable and satisfactory control provided by a single-step reduction. As can be seen from Fig. 31, the second valve which is set for a slightly higher reduced pressure is normally wide open and only comes into play to throttle the flow of high-pressure steam resulting from any failure of the primary valve. The increase of the system pressure to the higher pressure of the second valve is a signal that the primary valve requires maintenance. With bypasses as illustrated,



1. Service pipe from district steam main
2. Service valve
3. Operating valve
4. Manual bypass
5. Pressure-regulating valve
6. Pilot
7. Balance or impulse line. Follow manufacturer's recommendation.

Fig. 30 .... Pressure-Regulating Valve with Bypass for Low Pressure Service

the primary valve can be serviced without shutting down the system. Since the valves are not both operating at the same time the distance between the valves is not critical.

When making a two-stage reduction, e.g., 150 to 50 psig and then 50 to 2 psig, allowance for expansion of steam on the low-pressure side of each reducing valve should be made by increasing the pipe area to approximately double the area of a pipe of the size of the reducing valve. This also allows steam flow to be at a more nearly uniform velocity. Separating the valves by a distance of at least 20 ft is recommended to reduce excessive hunting action of the first valve.

Fig. 28 shows a typical double-reduction installation where the pressure in the district steam main is higher than can safely be applied to building heating systems. The first or

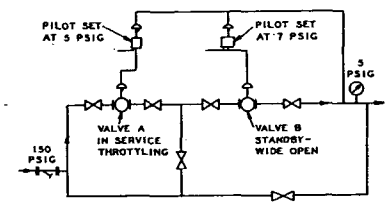


Fig. 31 .... Single-Stage Pressure Reduction—Series Installation

pressure-reducing valve effects the initial pressure reduction. The pressure-regulating valve regulates the steam to the desired final pressure.

Pilot-controlled or air-loaded direct-operated reducing valves may be used without limitation for all reduced pressure settings for all heating, process, laundry, hot water, etc. services. Spring-loaded direct-operated valves may be used for reduced pressures up to 50 psig providing they can pass the required steam flow without excessive deviation in reduced pressure.

Weight-loaded valves are used for reduced pressures below 15 psig and for moderate steam flows.

Pressure-equalizing or impulse lines must be properly connected to serve the type of valve selected. For direct-operated diaphragm valves with rubber-like diaphragms, the impulse line should be connected into the bottom of the reduced-pressure steam line to allow maximum condensate to exist on the diaphragm and in the impulse or equalizing line or, if connected to the top of the steam line, a condensate accumulator should be used to reduce variations in the head of condensate on the diaphragm. Equalizing or impulse lines for pilot-controlled and direct-operated reducing valves employing metal diaphragms should be connected into the expanded outlet piping approximately 2 to 4 ft from the reducing valve and pitched away from the reducing valve to prevent accumulation of condensate. Pressure impulse lines for externally pilot-controlled reducing valves employing compressed air or fresh water should be installed in accordance with manufacturer's recommendations.

Selection of Valve Size

Pressure-regulating valves should be sized to supply adequately the maximum steam requirements of the heating