this excess pressure would not be so great as the case might be in a one-stage reduction.

In making a two-stage reduction, 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 up to 20 ft is recommended to reduce excessive hunting action of the first valve.

When the reduced pressure is approximately 15 psig or lower, the weight and lever type diaphragm valve is frequently used for moderate steam flows. Above 15 psig, up to 50 psig, spring loaded, direct operated diaphragm valves may be used providing they can pass the required steam flow without an excessive deviation in reduced pressure. Pilot-controlled reducing valves may be used without limitation for all reduced pressure settings for all heating, process, laundry, hot water, etc. services. Pressure-equalizing lines must be connected to properly serve the type of valve selected. For direct-operated diaphragm valves, they should be connected into the bottom of the reduced pressure steam main to allow maximum condensate to exist in the equalizing lines or the connection can be made into the top of the main if a water accumulator is used to reduce the variation of the head of water on the diaphragm. Equalizing lines for pilot-controlled 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 the accumulation of condensate. Pressure impulse lines for external-pilot-controlled reducing valves employing compressed air or fresh water should be installed in accordance with the manufacturer's recommendations.

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 bring about wire-drawing of valve and seat, due to small lift of the valve seat.

On installations where the steam requirements are relatively large and variable in mild weather or reduced demand periods, wire-drawing may occur. 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 50,000 lb of steam per hour are required, the size of one valve is on the basis of $0.7 \times 50{,}000$ lb, or 35,000 lb, and the other on the basis of $0.3 \times 50{,}000$ lb, or 15,000 lb. During the mild or reduced demand periods, steam will flow through the smaller valve only. During the remainder of the season, the larger valve is set to control at whatever low pressure is desired, and the smaller one at a somewhat lower pressure. Thus, when steam flow is not at its maximum, the smaller valve is closed, but it opens automatically when the maximum steam demand occurs, because this maximum demand creates a slight pressure drop in the service line.

The installation of reducing valves in pipe lines requires detailed planning. They should be installed to give ease of access for inspection and repair, and wherever possible, with diaphragm downward, except in cases of pilot operated valves.

There should be a by-pass around each reducing valve of area equal to

one-half the area of reducing valve. The globe valve in a by-pass 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.

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. They should be of sufficient capacity and set to relieve the entire output of the reducing valve if the pressure on the equipment should exceed the low pressure setting by 10 percent or more.

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

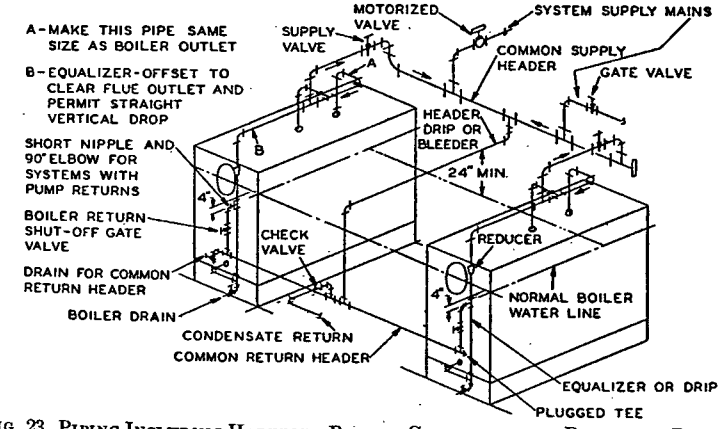

FIG. 23. PIPING INCLUDING HARTFORD RETURN CONNECTION FOR BOILERS IN BATTERY

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.

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. 23.

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