direction for better separation of the condensate. The steam piping should come off the top of the header pipe to assure that only dry steam leaves the boiler.

**THE HARTFORD LOOP**

Areas A, B, and C in Figure 5-5 represent what is known as a *Hartford loop*. This configuration was widely used when boilers were fired with coal. Its purpose is to insure that only very little water could be siphoned from the boiler in the event of a leak in the wet return piping. This would be the case if the wet return were piped into the bottom of the boiler. The Hartford loop also prevents excessive condensate from being pushed back through the return lines if the boiler pressure is higher than the return main. With a Hartford loop, the wet return enters the loop at a point 2 in. below the waterline. As a result, only 2 in. of the boiler’s contents can be lost if a leak or overpressure occurs.

In a Hartford loop, the system return piping connects into the boiler header with a close nipple. The reason for a close nipple is to minimize the size of the steam bubble that can form in this piping connection, thus minimizing any water hammer that could occur as the boiler waterline drops below the top of the close nipple.

Figure 5-6 is a schematic of a two-pipe system showing the Hartford loop with the entry of the wet return 2 in. below the boiler water level. It will be seen that the dry return is the distance A above the water level of the boiler. This dimension represents the pressure drop of the system. For example, if the system has a 1-lb pressure drop, a minimum height of 28 in. is required to assure good return flow of condensate.

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With the introduction of the *low water cut-off*, which de-energizes the heat source in modern oil-fired and gas-fired systems, and the *automatic water feeder*, the Hartford loop is no longer required as a safety device. When used, it serves only as a water conservation measure. It is also a means of keeping return line rust and sediment from entering the boiler if a flush valve is installed at the bottom of the return riser. Probably, the real reasons for continuing to use the Hartford loop in automatically fired installations is that it is easy and inexpensive to install.
Also, a good steam boiler installation requires an effective steam header. It must be capable of removing most of the entrained water droplets that migrate upward with the steam before they can move into the main steam piping. This water must be drained back into the boiler through the same type of equalizer pipe used with the loop. It is just as easy to tie the wet return into a higher point in the equalizer pipe as it is at the bottom of the boiler.

As a result, the Hartford loop tradition is carried along into modern boiler installations—even though there are more efficient means of boiler protection in automatic systems.

When there is about ¼-lb pressure drop in the steam supply main, water will seek a level in the wet return riser of about 7 in. However, after 3 or 4 in. of condensate have dripped, the return pipe resistance will be overcome. Once it is equalized, the condensate will flow freely into the boiler by gravity.
Figure 5-7 shows the return piping on systems using a boiler return trap. This system allowed condensate to return by gravity to the vented return trap until it reached a high water level. On a high level, the float closed a port to the vent and opened a port to allow boiler water to equalize with the return trap. Condensate in the return trap would then flow to the boiler due to its location above the boiler waterline. When the float lowered, the steam connection to the boiler would again close and the vent port would open.

Check valves are required at the inlet and outlet of boiler return traps. Figure 5-7 shows typical locations of the check valves for an automatic boiler return trap.

**THE IMPORTANCE OF PROPER PITCH OF PIPING**

An important element of good steam piping practice is proper pitch of the horizontal steam mains and branches. You should pitch steam mains 1 in. for every 20 ft, as shown in Figure 5-8.

Install a drip or condensate trap at the bottom of the riser where mains must rise vertically. You must pitch run-outs and branches ½ in. per foot. In steam lines, the steam flows in the top portion of the pipe, and any condensation must be
able to freely drain away through the bottom of the pipe or water hammer will develop. Figures 5-9 and 5-10 illustrate the pitch (slope) in the piping to allow condensate drainage.

**TWO-PIPE STEAM SYSTEM VARIATION**

Figure 5-11 shows the layout of return lines in a two-pipe system with a boiler feed pump. The discharge head of the pump forces the condensate water back into the boiler. The pump control on the boiler starts and stops the pump. A make-up water feeder is mounted on the boiler feed pump receiver to add
make-up water when the level is low in the receiver. In this system, the boiler feed pump receiver acts as the system storage instead of the boiler. Boiler feed pump receivers are normally sized to have 10 to 20 minutes of system storage capacity. In this case, the height of the return main above the boiler level is of no other significance than to feed water into the vented boiler feed pump tank.
ADDING BOILER TREATMENT

Do not add boiler water treatment ahead of the return pump. The solids in the chemical treatment will cause rapid wear of the mechanical seal faces. Add the treatment in a chemical injection receptacle, as shown in Figure 5-12 on