(*a*) The degree of tightness of system; (*b*) the efficiency of the radiator traps; (*c*) the temperature of the condensate at the pump; (*d*) the probable cooling effect of the return piping; (*e*) the use of lift points in the return; (*f*) vacuum to be maintained at the pump; (*g*) introduction of large volumes of high temperature water into the return piping near the pump; (*h*) the use of long runs of piping from the source of steam supply to the farthest radiator.

High-pressure traps should not discharge directly into a vacuum return because of the vapor formed by the re-evaporation of a part of the hot condensation.

Fig. 2 shows one method which may be used for disposing of the greater part of the vapor of re-evaporation.

Steam-driven pumps can be economically used with steam pressures of 15 lb. or over and where the exhaust steam can be completely utilized.

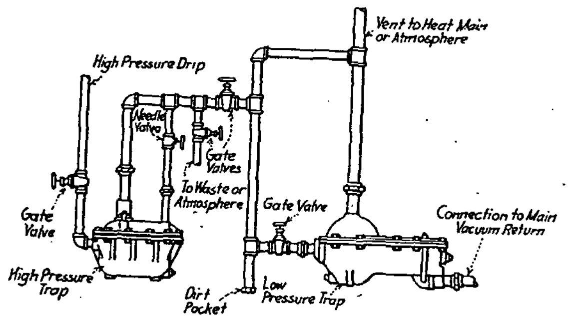

FIG. 2. METHOD OF DISCHARGING HIGH-PRESSURE APPARATUS INTO LOW-PRESSURE HEATING MAINS AND VACUUM RETURN MAINS THROUGH A LOW-PRESSURE TRAP

Where the supply of exhaust steam from engines or other sources is continuously in excess of that necessary to supply the heating system the electric-driven pump is generally the most efficient and is also preferable when the steam pressure is too low to operate a steam-driven pump.

Steam cylinder sizes of reciprocating vacuum pumps should include the effect of frictional resistance of the piping system, the pump resistance and the possible drop in steam pressure under unusual conditions. When this analysis is not feasible the following formula may be used:

$$A_s = A_w\, 3\left(\frac{\frac{V}{2} - P_d}{P_b}\right)$$

in which

A_s = area of steam piston in square inches.
A_w = area of water piston in square inches.
P_b = boiler pressure in pounds per square inch.
P_d = discharge pressure in pounds per square inch.
V = vacuum at pump expressed in inches of mercury.
$\frac{V}{2}$ = approximate vacuum in pounds per square inch (2 in. mercury = approximately 1 lb. per square inch).

Water cylinder sizes of steam-driven reciprocating vacuum heating pumps may be determined from Table 12.

The discharge from reciprocating vacuum heating pumps should be provided with means for releasing the entrained air. This may require water surface area in either a tank having a large horizontal cross-section or a stand pipe of sufficient sectional area to permit a low velocity of downward water flow while the entrained air is escaping to the surface against the water current. For removal of air in a separating tank 1 sq. ft. of horizontal cross-section for each 2,100 lb. of water per hour should be provided. When a stand pipe is used for air separation, one with a diameter equal to that of the pump cylinder is usually sufficient.

TABLE 12. CAPACITIES OF VARIOUS SIZES OF DIRECT DOUBLE ACTING STEAM-DRIVEN RECIPROCATING VACUUM PUMPS (FOR STEAM PRESSURE 50 LB. AND ABOVE)

SIZE, INCHES	SQUARE FEET OF DIRECT RADIATION
4 x 3 x 6	1,700
4 x 3⅝ x 6	2,500
4 x 4 x 6	3,000
4 x 4½ x 6	3,800
4 x 5 x 6	4,700
4 x 5 x 8	6,500
4½ x 6 x 8	10,000
5 x 6 x 10	11,000
5 x 6½ x 10	13,000
5 x 7¼ x 10	17,000
6 x 8 x 12	25,000
8 x 10 x 12	40,000
8 x 12 x 12	55,000
10 x 14 x 12	75,000
10 x 14 x 16	85,000
10 x 14 x 20	100,000
12 x 16 x 20	130,000
14 x 18 x 20	160,000
16 x 20 x 20	200,000
16 x 22 x 20	240,000

The freely vented air separating tank is preferable wherever a suitable location is available. The tank should be located at such a height that the pressure produced by the water column in its discharge pipe will be sufficient to overcome that in the low-pressure boiler feed-water heater or other point of disposal. Fig. 3 shows an arrangement which may be used for vacuum pump, air separating tank and feed-water heater. This arrangement provides means for the air to escape through a vent in the top of the tank and for the water to flow by gravity to the feed-water heater, through the loop seal attached to the discharge outlet of the tank. If the rate of flow of returns to the tank exceeds the rate of discharge from the tank the excess is permitted to overflow through an opening in the end of the tank, near the top.

The hydro-pneumatic type separating tank may be used whenever an open tank cannot be located at a height sufficient to provide gravity head to discharge the tank contents against the maximum pressure in