From which we have

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

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 sq .in.)

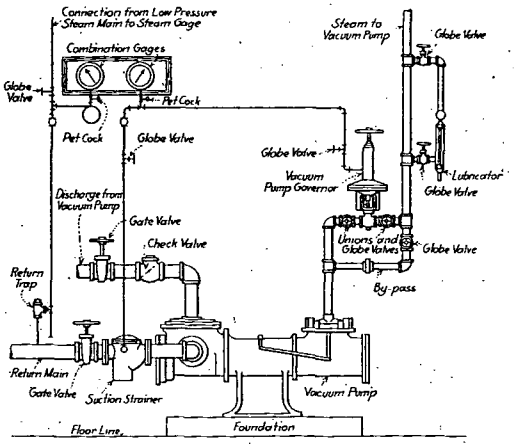

FIG. 46. METHOD OF MAKING CONNECTION TO STEAM-OPERATED VACUUM PUMP

In no case should the head against the discharge of reciprocating pumps exceed 15 lb. unless the pump stroke exceeds the bore and thus reduces the bad effect of clearance.

Where the pressure on the heater, boiler, etc., varies materially from time to time but in general is near the minimum, a substantial saving in energy may be obtained by using a hydro-pneumatic tank instead of a plain tank set at a higher elevation to overcome the peak pressure in the boiler or heater. The use of a plain tank keeps the pump operating against the maximum head, where the hydro-pneumatic tank set lower operates as a plain tank whenever the gravity head in the tank is sufficient to cause flow from its elevation, and employs the combination of air pressure and gravity head, with air vent closed, only at times of peak load. Only then is the air pressure load added to the pump discharge.

Where the head on the delivery side of steam driven pumps exceeds 15 lb. it is good practice to deliver the condensation to a vented receiver located close to the level of the vacuum pump outlet. This receiver should be connected to a separate steam or power driven water pump capable of delivering against the maximum head and controlled by a throttle valve, actuated by the water line in the receiving tank.

MOTOR DRIVEN RETURN LINE VACUUM PUMPS

Reciprocating Vacuum Pumps.—The displacement and piston speeds should be the same as for the water end of reciprocating steam driven return line vacuum heating pumps.

The type of drive between motor and pump may be chain, gear or belt.

Other than Reciprocating Pumps.—May be of the centrifugal or rotary type with receivers and generally of one of the following arrangements.

a. One pumping unit and motor for handling both air and condensate
b. One pumping unit and motor for handling air and a separate pumping unit and motor for handling condensate.
c. One pumping unit and motor for handling condensate with an air ejector operated by a recirculated portion of the condensate for handling the air
d. One pumping unit for handling condensate and another for handling the air, both operated by one motor.

The receiving tank capacity should be stated in gallons, and in case of automatically controlled units should be the capacity of the tank in gallons between the high and low water levels in this tank, as determined by the water-line control.

The receiving tank may be placed either on the suction side or on the discharge side of the pump. When placed on the suction side of the pump the capacity of the tank may be used to retain the condensation and to take care of the fluctuations between the rate of condensate returned and the rate of the pump delivery.

The suggested receiving tank capacities (as previously defined) for continuously operated and for automatically controlled units should be as follows:

TABLE 74. RECEIVER TANK CAPACITIES

SQ. FT. EQUIVALENT DIRECT CAST IRON RADIATION SURFACE	TOTAL RECEIVER TANK CAPACITY IN GALLONS	RECEIVER TANK CAPACITY BETWEEN HIGH AND LOW WATER LIMITS WHERE AUTOMATIC WATER LINE CONTROL IS USED.
8,000	28	20
16,000	33	24
26,000	40	29
40,000	49	35
65,000	63	47
100,000	80	63

The air capacities recommended, referred to cubic feet of air per 1000 sq. ft. of equivalent cast iron direct radiation, may be assumed on a decreasing ratio as the system increases in capacity of equivalent square feet of radiation, in accordance with the following Table 75. It should be noted that while water capacities of pumps to be added for fan blast