THE DEVELOPMENT OF STEAM HEATING

STEAM heating has been called the younger brother of the steam engine. The production of steam for power set men thinking about its use for heating also. In 1745 Sir William Cook suggested that it should be possible to heat buildings with steam but not until James Watt developed the

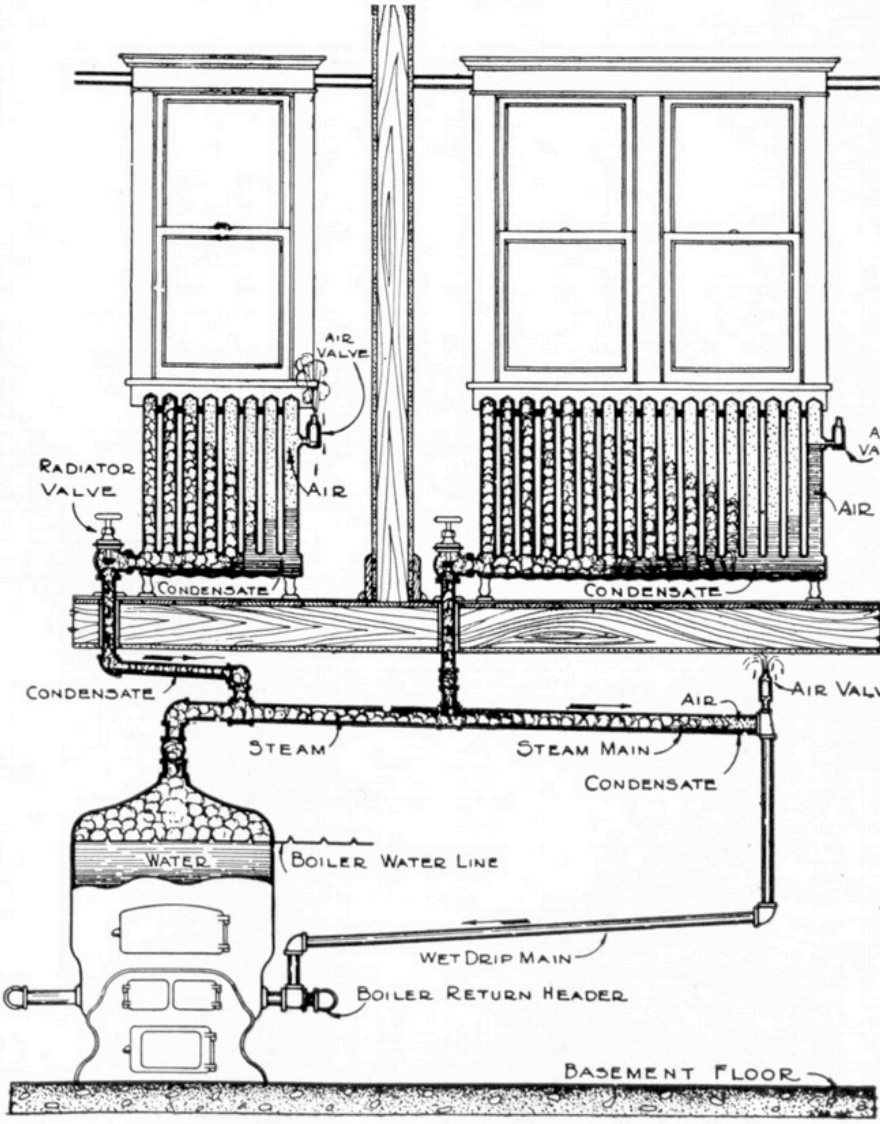

Fig. 905—The one-pipe heating system

steam engine for power purposes between 1768 and 1790 was much practical work done on steam heating.

An early example of this work was the power plant designed by Watt and Boulton for a cotton mill. Steam was produced at a boiler pressure of 2½ pounds for the steam engine and the exhaust steam was used to heat the mill. Flat-sided, tinned iron boxes were used for radiators and lead, copper or tin for piping.

The One-Pipe System

The one-pipe steam heating system, while not the first type to be experimented with, was one of the earliest to come into general use. Steam was supplied either from boilers or engines and was carried through a single system of piping to iron radiators. See Fig. 905 on preceding page.

The radiators were equipped with an inlet valve and with an air valve to permit venting of air from the radiators and its displacement by steam. Water of condensation drained out of the radiators through the same pipe which supplied steam. This design had one basic defect. Steam and water were expected to flow in opposite directions in the same pipe. They did so only under protest. Under certain conditions so much water would be held up in the radiators that it would begin to spurt into rooms from the air valves. Fluctuating boiler water line was a resultant problem. Water hammer and slow heating-up were almost universal characteristics.

The Two-Pipe, Two-Valve System

The two-pipe steam heating system with a valve at the inlet and outlet of each radiator was developed in an effort to provide separate routes for steam and water traffic. Steam was supposed to flow into radiators from the supply piping and water of condensation to flow out of the radiators into the return piping and back to the boiler. Air was vented from the radiators by air valves as in the one-pipe system. This early type of system also disclosed basic design weakness. In the heating-up period, steam would fill radiators nearest the boiler and would frequently flow on through the radiator into the return piping and thence into more distant radiators from the outlet end. Steam would also flow into these radiators from the supply end and air would be trapped between two walls of steam in the mid-section of the radiators where it could not reach an air vent. Heat output from the radiators would thus be seriously diminished by air binding.

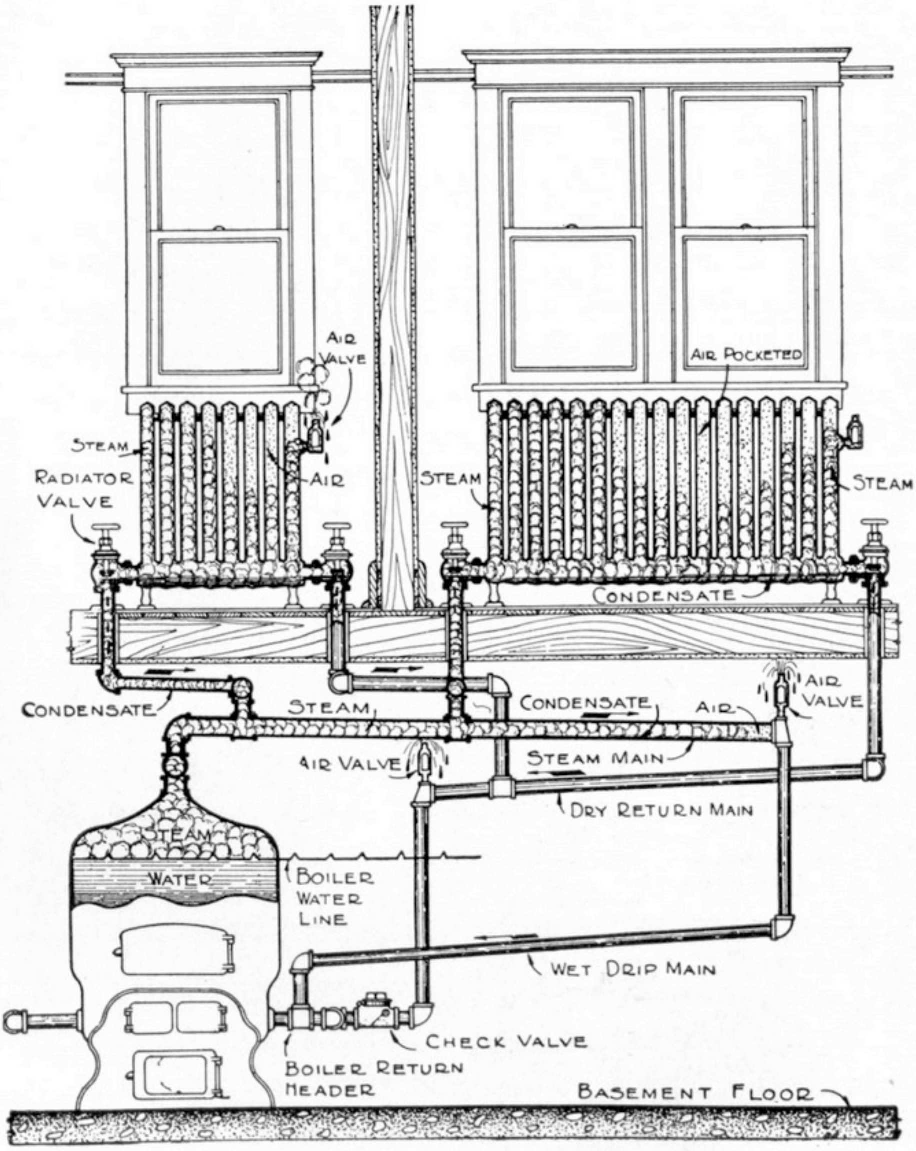

Fig. 906—The two-pipe, two-valve heating system

The Thermostatic Radiator Trap

The introduction in 1903 of the fluid-operated thermostatic trap by C. A. Dunham proved to be the solution of circulation problems in steam systems. This type of trap, now almost universally used in two-pipe, low-pressure and sub-atmospheric steam heating, permitted air and water to flow out of radiators continuously while preventing passage of steam into the return piping. It eliminated the whistle, spray and smell of the air valve, the inevitable hammer and holding up of water of the one-pipe system and the short-circuiting of steam and loss of heating surface of the two-pipe, two-valve system.

The Two-Pipe Gravity System with Thermostatic Traps

During the period from 1903 until 1926, the use of two-pipe steam systems with thermostatic traps at the outlet of each radiator and at drip points in the steam piping became general. In smaller buildings gravity systems were commonly installed. Steam would flow from the boilers through the supply pipes into the radiators displacing air by its own pressure. The displaced air and water of condensation would flow

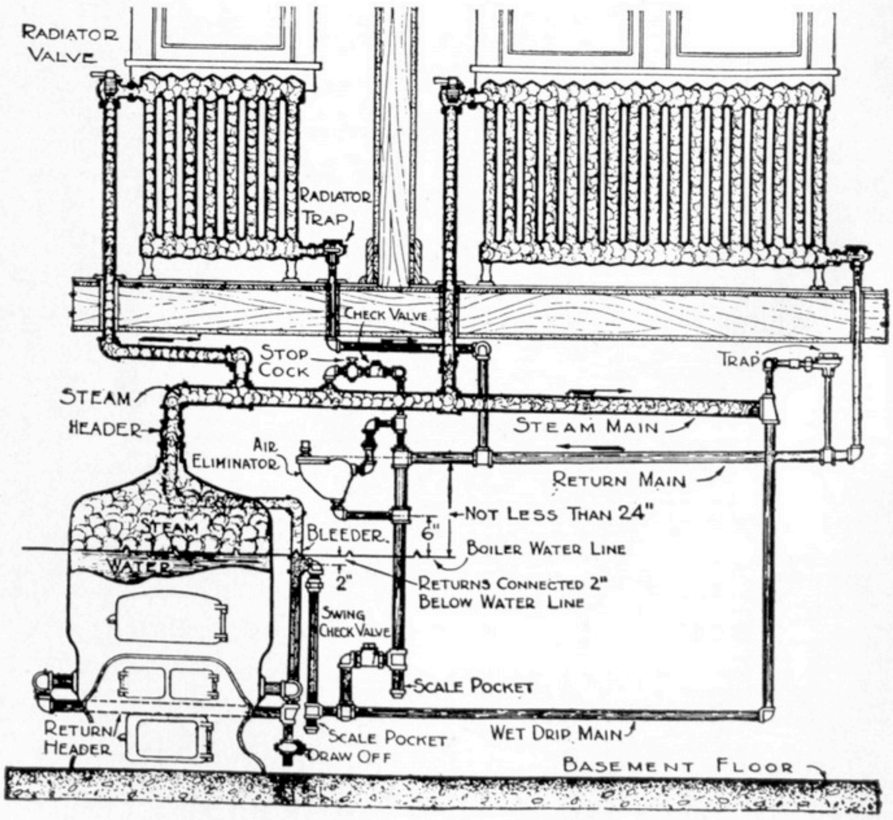

Fig. 907E—The two-pipe gravity system with thermostatic traps back through the return piping to the boiler room where the air would be automatically vented to the atmosphere and the condensation returned to the boiler by gravity. Such systems could be designed to function satisfactorily with a boiler operating at no greater than one-half pound pressure. These systems were known as vapor heating systems in the trade.

The Two-Pipe Gravity System with Boiler Return Trap

On installations in which the boiler pressure might be carried as high as 15 pounds, automatic return traps were used.

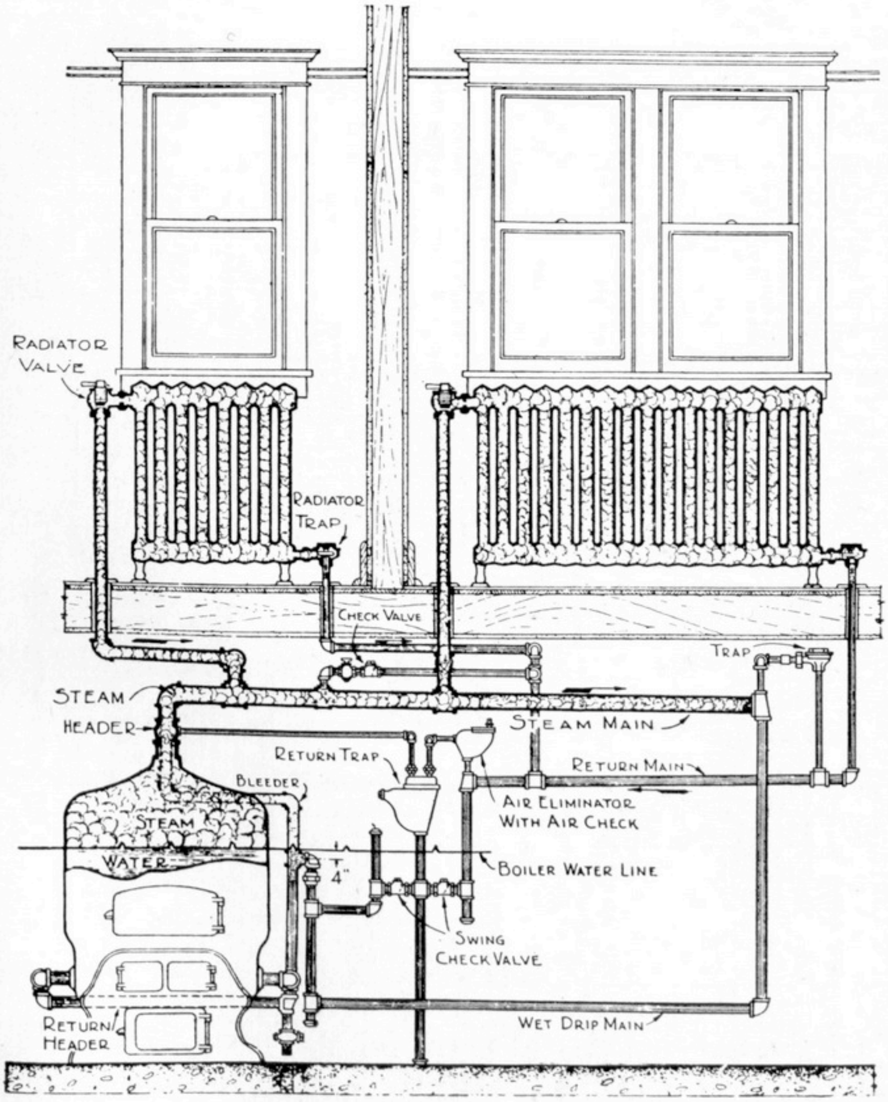

Fig. 1661—Two-pipe gravity system with boiler return trap

The reason for the return trap was that at such boiler pressures, return of condensate by gravity would result in the backing up of water into the system.

The Two-Pipe Gravity System with Condensation Pump

On installations in which boilers were to be operated at greater than 15 pounds pressure, to produce steam for other services as well as heating, pressure reducing valves were installed in the heating mains to reduce the pressure to a steady, desirable low pressure for heating. Condensation pumps were

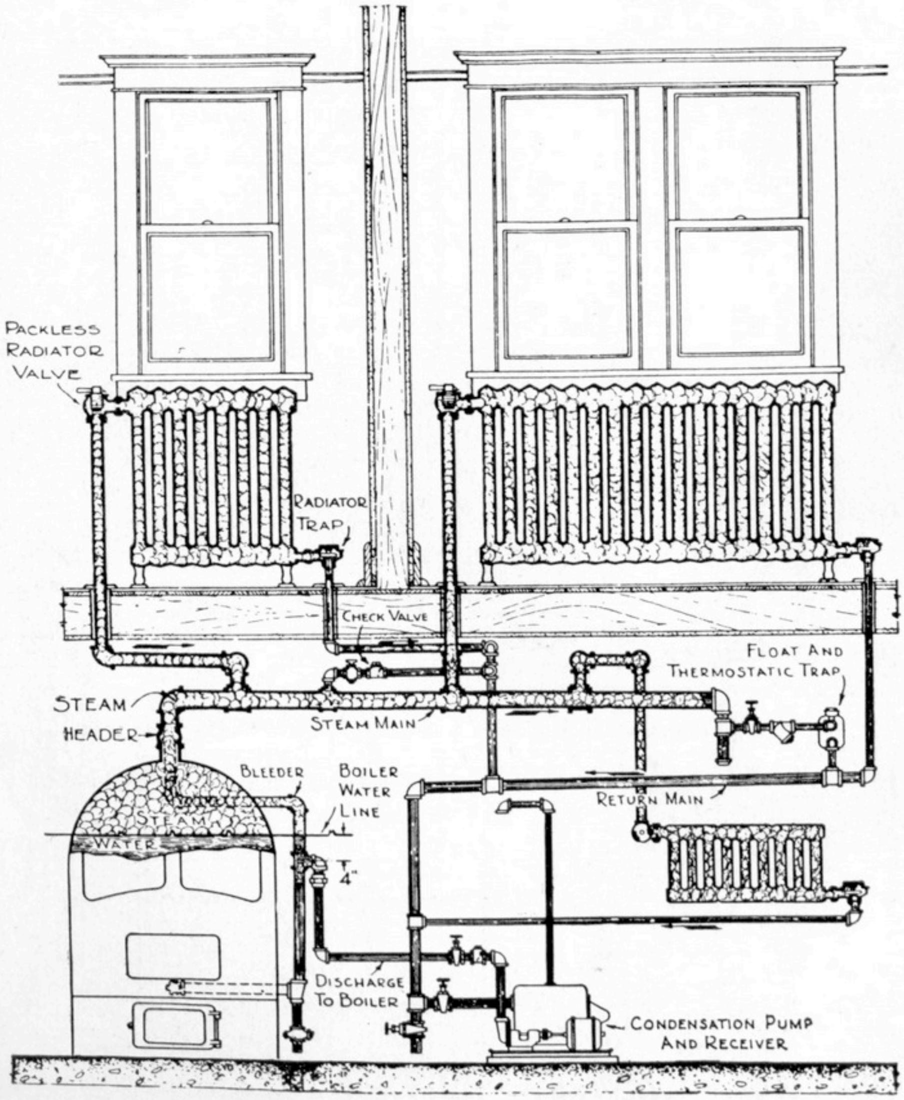

Fig. 1664—Two-pipe gravity system with condensation pump

used to return condensate to the boilers. This type of pump was and is also used where design necessitates return mains coming back to the boiler room at too low a level for the use of a boiler return trap.

The Vacuum Return Line Heating System

One other type of steam heating system significant in the progress of the industry is the vacuum return line system. As its name implies, it is characterized by the carrying of partial vacuums in the return system of piping. In design, except for

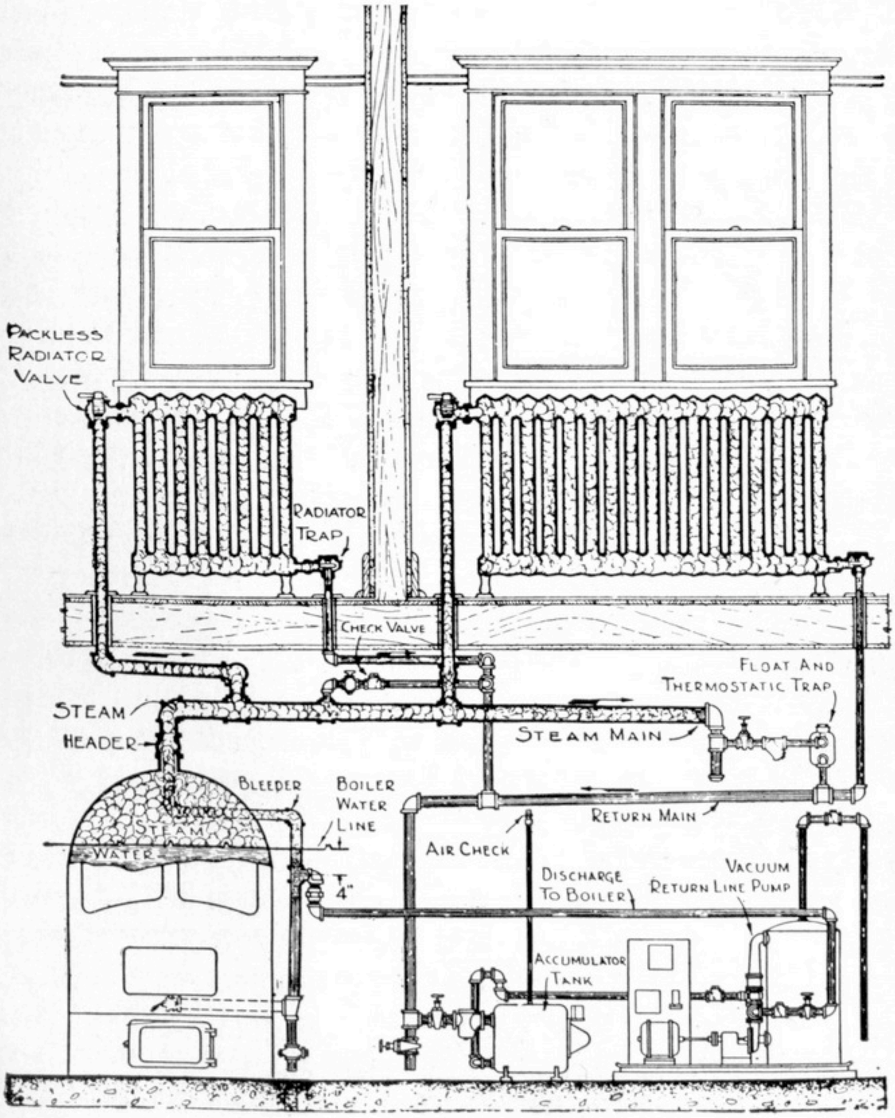

Fig. 1662—Vacuum return line heating system

one major difference, it is not unlike the simplest gravity two-pipe system with traps. Steam at low pressure flows into the radiators from a system of supply pipes. At the outlet end of each radiator its progress is halted by a trap which passes air and water only into the return piping. The return piping, however, does not lead directly back to the boiler but to a vacuum pump which exhausts and vents air from the return piping and returns condensate under pressure back to the boiler.

The installation of a vacuum pump on the return end of the heating system came into use to facilitate steam circulation at low pressures. Prior to its application, steam pressures up to 10 and 15 pounds had to be carried in larger buildings to force steam into the radiation while displacing air and overcoming pipe friction. Noise, excessive strain and wear on equipment and the difficulty of filling distant as well as near radiators led to successful experiments with pumps.

The modern vacuum return line system usually requires a maximum steam pressure of no greater than 2 pounds for rapid circulation. The pump is automatically governed to maintain a partial vacuum in the return piping from approximately 3 to 8 inches of mercury. Therefore, as long as the steam supply pressure is maintained at atmospheric pressure or slightly higher, steam circulation will be positive due to the pressure differential between the supply and return sides.

By 1926 the vacuum return line system was regarded as the most satisfactory and economical type of steam heating system for large and moderate-sized buildings or groups of buildings heated from a central plant. It solved the problem of rapid steam circulation through extensive piping systems without recourse to high pressures. It distributed heat quickly and noiselessly but it lacked one essential—adequate control of the rate of supply to meet variations in the rate of requirements as imposed by weather conditions. The discomfort and waste inherent in the system by reason of this lack of control were early recognized and, while generally accepted as a necessary evil, stimulated research on the problem of control.

The importance of the vacuum return line heating system as a step toward the present day circulation of steam at variable sub-atmospheric pressures will be dealt with in the following section.

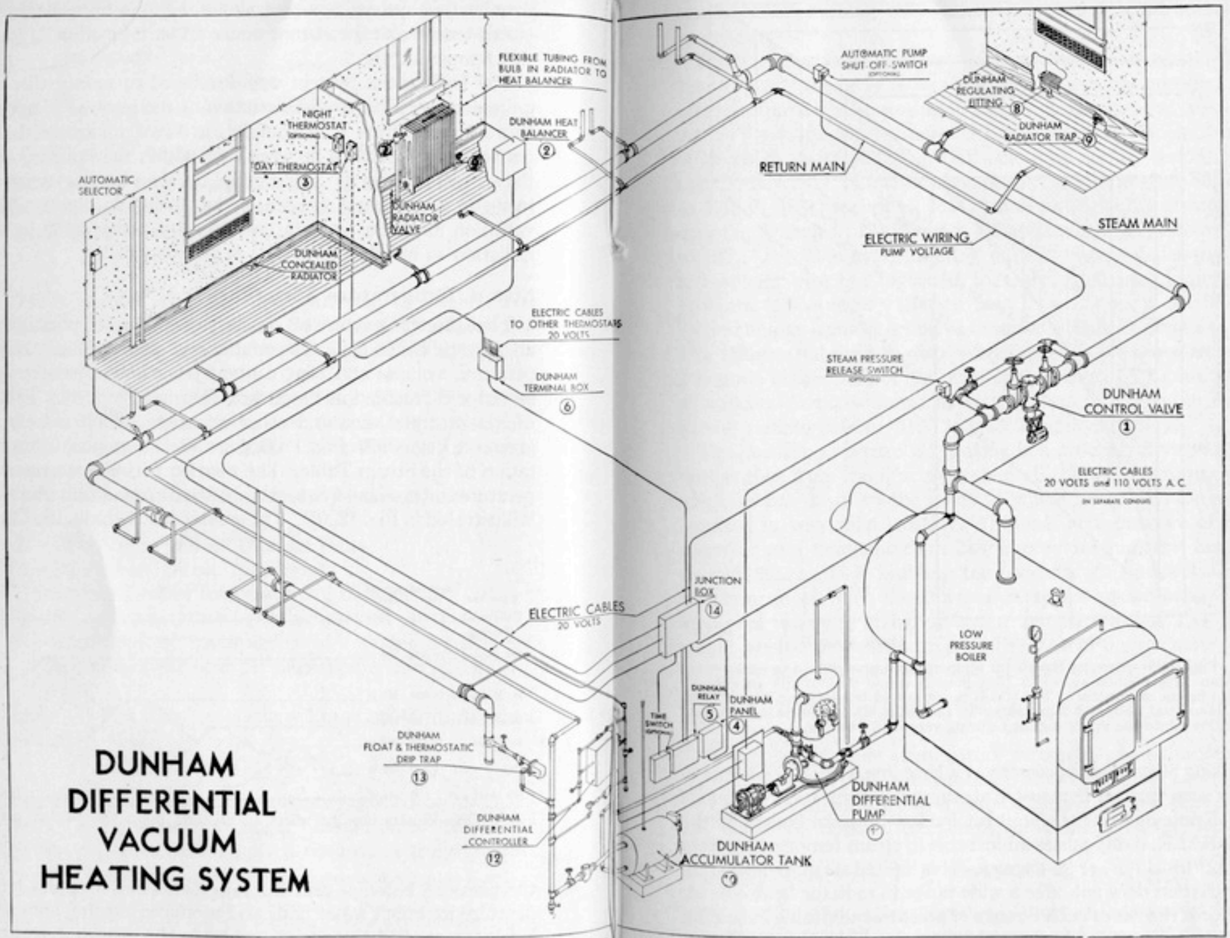

Fig. 1634B—Schematic diagram of a typical installation of the Dunham Differential Vacuum Heating System.