meet modern engineering requirements for such service. The complete system for which the plans were made need not be installed during the first season. The plans, however, should always be made for the ultimate installation capacity. Otherwise, the system would become inefficient as the load increases.

Theoretically, the central heating plant should be located at or close to the centre of the area over which heat is to be distributed. But this location is often out of question in an actual case owing to high costs of real estate, poor facilities for handling coal and ashes, lack of suitable water supply, and the location elsewhere of existing plants whose facilities will be utilized. A high first cost of real estate for the plant places an initial heavy overhead charge on the service, though this may sometimes be offset by other economies to be gained by a central location. Neighboring property owners frequently object to the location of such a station adjacent to their buildings on the plea that the attendant noise, dirt and smoke will tend to lessen the value of their holdings. The New York Edison Company has had to defend several suits for damages due to alleged injury to surrounding property from soot and cinders which were discharged by the smokestacks during periods of heavy loads. The Murphy Heating Company, of Detroit, on the other hand, have located their central station near the heart of the business district instead of on the river front. In general, however, it is not advisable to buy an expensive site even in a centralized location unless there are special considerations that make such a site more desirable than any other one available.

The cost of handling coal and ashes at the central station must be a minimum if low operating costs are to be obtained. This is more nearly possible when the plant is located beside a railroad or a dock so that coal cars may be switched to or unloaded into the station itself. When coal has to be trucked a considerable item is necessarily added to the costs of operation, and thus to the heat sold to customers. The saving of such charges will very frequently greatly offset the extra losses in pipe lines reaching to the distributing centre from a less central location.

A central heating plant, especially one using a low-pressure steam distribution system where the condensed steam is wasted to the sewers, uses a large quantity of water daily. It is desirable that such a plant should have access to a water supply independent of the city mains, either by means of a small pumping plant on a nearby lake or stream or by artesian wells. When the plant contains electric generating equipment which is run condensing during the summer season, large amounts of water must be at hand for cooling purposes. Such possible water demands should receive careful consideration in connection with the location of the plant.

In a later part of this series, it will be shown that the losses in distribution systems vary with the length and size of the pipe lines. Hence a central location is the most desirable from a distributing standpoint, for then the heating load can be secured by comparatively short pipe lines throughout the district it is proposed to serve and these lines can radiate in all directions from the plant. This would result in minimum heat losses and would also provide a more uniform pressure over the whole system provided the pipe lines were properly designed.

Systems for Distributing Heat.—Heat may be distributed from a central station either by means of hot water or by low pressure steam. At the present time there is a considerable difference of opinion regarding the relative advantages of these two systems. It is not intended in this thesis to advocate either system but rather to discuss the application of both in central heating practice.

Flow and return pipes must be provided in the hot water system. The return water enters the plant at a lowered temperature, passes through some type of re-heater and is then forced out through the system again by pumps. Several types of re-heaters utilizing the exhaust steam from engines are in use. Hot water systems are spoken of as "closed" or "open." On the former system closed heaters are used and the pump forces the return water through the heater and out into the flow pipe. By attaching a condenser with an air pump in series with these heaters, it is possible to carry any degree of vacuum desired. Live steam heaters in series with the exhaust heaters are also in common use for meeting peak loads. Sometimes it is desirable to place these above the level of the boilers so that the condensed steam flows back by gravity. The amount of heating to be supplied by this heater is adjusted by throttling the steam supply. Frequently a number of the boilers in the plant are so piped up that they can serve as water heaters.

The "open" system of hot water heating operates with open heaters or with a type of barometric condenser called "co-minglers." In the latter the exhaust steam and return water mix together and are drawn off by the circulating pump connected to the tail pipe which discharges the mixture into the heating system. The condensed steam goes to make up the losses in the system from leakage, while the excess is used as boiler feed. With the closed system the condensed steam from the re-heaters is pumped back into the boilers. The open system requires more power to circulate the water than the closed system as the return static pressure is necessarily lost in the vacuum of the co-mingler or in the open heater. The selection of the open or closed system depends largely on local conditions. When engines are used, and it is desired to carry a vacuum, the co-mingler would be the logical choice though other systems are also used for the same purpose.

Vacuum and pressure systems are both in use for distributing steam heat. In the vacuum system two pipe lines are installed—a large pipe to carry the low pressure steam to customers' installations, while a smaller one under vacuum acts as a return for the condensed steam to the plant. It is possible at times to operate this system with a partial vacuum at the engine exhaust, thus increasing the power and economy of the engine. The condensed steam is all returned to the plant and can be used again for boiler feed water. In some localities this item is of considerable importance.

The pressure system consists of a single pipe line with a steam pressure between 3 and 10 pounds about atmosphere. The condensed steam is usually metered at the customer's premises and wasted to the sewer. Exhaust steam from engines is generally used on this system, augmented when necessary by live steam passed through reducing valves. This is the simplest system of all.

It seems generally agreed with regard to the first cost of plants that both the station and distribution equipment of the steam pressure system can be installed for less money than the vacuum or either hot water system. On the other hand, the piping must be better insulated to prevent excessive line losses as the steam temperature is higher than if hot water or vacuum systems were used.