

ployed it would be better supplied by four separate flow and return mains from the heater than by a single main, and while it is true that when the radiation is located in one direction from the heater it is often possible and practical to supply it with a single main, there is a limit in size or diameter beyond which it is not safe or wise to go, and after reaching this limit it is an advantage to use two or more mains rather than to increase the size of a single main. While larger mains have been used and recommended, I have always found it best to place the limit at from eight to ten inches in diameter, depending on conditions, my objection to a larger main being the large body of water it contains, the difference in temperature between the top and bottom of the main causing unequal expansion, and the possibility of an internal circulation interfering with the general or desired circulation.

I have in mind a large building that was heated by hot water some years ago; in one section of it, about 60 by 40 feet, the main was carried from the heaters to the outside wall and continuously around it back to within 20 feet of the heaters, making this single main about 180 feet long. The circulation in this main has never been uniform, and with a low temperature of water the far end of it for about 80 or 90 feet is almost cold, whereas if two mains of a smaller size had been used each of them would have been 90 feet long and they would have given an apparently uniform circulation. While it is claimed that it is impossible to hold cold water above hot water in a hot water system, it is impossible in this case and in any case where, on account of large main, and a free circulation through the radiators and risers near the heater, the water is allowed to enter the return main near the heater at, say, five to ten degrees lower than the temperature of the flow main; the natural tendency of this heated water in the return main is to travel towards the upper end of the main instead of returning to the heater, and under these conditions, as soon as a sufficient number of radiators and connections are circulated to relieve the heater at the temperature at which it may be operated, the two columns of water at about the same temperature travelling or attempting to travel in the same direction hold the bal-

ance of the system in check and keep it cold. As it is often necessary to arrange mains in this way and sometimes impossible to arrange them in any other way, it is very desirable that there should be a remedy for this trouble, and I have found that the best and surest preventive was to take the connections for the near radiators, or for all the radiators and connections, from the side instead of from the top of the flow and return mains, thus retarding the flow through the near connections, assisting the flow to the extreme end, and making a uniform circulation through the entire main and system.

I designed an apparatus in this way some time ago where the main was over 300 feet long, and with the water at the heater at 130 degrees F., the temperature of the water at the extreme end was 120 degrees, while with a higher temperature of water at the heater the difference was less, until at 180 degrees the difference was only five degrees. I mention this to show that with a proper arrangement of branch connections and a suitable size of main it is possible to circulate water through a continuously rising horizontal main for long distances at a comparatively uniform temperature.

Where this system of mains is used and it is found desirable or necessary to supply indirect radiation or to locate radiation in the basement I have found it to be an advantage to use a separate main, either arranged with a siphon extending to the ceiling of the first floor or by increasing it in area, doing away with the siphon and dropping from a high point above the heater to the radiation and returning at or below the floor line, in either case carrying an air pipe from the highest point to the expansion pipe or expansion tank.

The overhead system, where practical or permissible, has some advantages, doing away with separate return risers and permitting the use of a smaller area of main for a given amount of radiation, and while the temperature of the water on the lower floors with this system is lower than on those above, radiation can be figured uniformly on any floor with a certainty of a uniform temperature and a positive knowledge as to results.

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