expansion joints being used where expansion may not be compensated otherwise.

The height of the heating coils above the boiler affects the design and proportion of the heating mains. In many greenhouses the coils are not more than 1 ft. 6 in. above the top of boiler and the arrangement of the greenhouse doors necessitates some of the coils being much shorter than others. In this case special care is necessary to avoid short circuiting or interference with the circulation of the water in the longer coils.

Table 1. Usual Temperatures Required in Greenhouses

Kind of Vegetation	Temperature Required, Deg. Fahr.
Violets, Camelias, Azaleas, Lettuce	40 to 45
Cool Palm Houses, Carnations	50 to 55
General Purposes, Roses, Mushrooms	55 to 60
Forcing Houses, Conservatories, Orchid Houses, Fern Houses	60 to 65
Peach House, Vinery, Early Tomatoes and Cucumbers, Tropical Palm House	65 to 70

Private greenhouses and medium size commercial greenhouses are mostly heated by hot water, and the large commercial houses by steam.

The radiation is made up of coils of pipe placed along the outside walls and under the benches.

Twenty or twenty-five years ago, it was customary to use 3 or 3½ in. pipe for the hot-water heating coils as the large water contents of this size pipe maintained a steady temperature in the houses where there was no night fireman and the gardener gave no attention to the fire during the night.

Now, most commercial houses where hot-water heat is used, the heating coils consist of 2 in. wrought iron or steel pipe. This smaller size holding much less water per square foot of radiation than the larger sizes, enables the fireman to raise the temperature of the house much quicker than when larger size pipe is used, and when the sun shines the house can be cooled off much quicker which is often desirable.

For small houses and long firing periods 3½ in. pipe is best.

To proportion the amount of hot-water radiation required for a green-

Table 2. Factors for Estimating Hot Water Radiation for Greenhouses

For 70 to 75 deg.	"	"	"	"	"	"	"	"	divide square feet of glass and equivalent by 2.00
65 " 70	"	"	"	"	"	"	"	"	" 2.28
60 " 65	"	"	"	"	"	"	"	"	" 2.62
55 " 60	"	"	"	"	"	"	"	"	" 3.00
50 " 55	"	"	"	"	"	"	"	"	" 3.46
45 " 50	"	"	"	"	"	"	"	"	" 4.00
40 " 45	"	"	"	"	"	"	"	"	" 4.67
35 " 40	"	"	"	"	"	"	"	"	" 5.50

house, it is almost impossible to figure the air leakage through the laps of the glass. This is not of any importance, however, for in cold weather these laps freeze and seal tight. Those that have had years of experience and specializing in greenhouse heating consider the exposed glass surface and its equivalent only and can guarantee a specified temperature by dividing the exposed glass and its equivalent by the factors in Table 2, which are based on the mean temperature of the water in the coils at 150 deg. and temperature outside at zero.

Greenhouses do *not* respond to figures in various ways: Two greenhouses covering the same amount of ground surface may be quite different in square feet of exposed glass surface. The workmanship, quality of glass, and exposure to prevailing cold winds must be taken into consideration. The humid atmosphere of greenhouses—and for some purposes the atmosphere is much more humid than for others, as for instance, for rose growing—at some temperatures causes the laps to seal with condensation, thus checking, or stopping the air loss through the laps. At lower temperatures, these laps are sealed with ice and at still lower temperatures, the inside surface of the glass is entirely frosted over so that its conductivity is changed. It may be much more difficult to heat a greenhouse at 15 to 25 deg. above zero with the wind blowing, than at zero or below, because the low temperature house may be sealed with ice, as stated.

Table 2 gives the factors for dividing the square feet of glass and equivalent in order to determine the square feet of hot-water radiation required in horizontal pipe coils. These are based on average water temperature of 150 deg. fahr., a temperature in flow mains of 180 deg. fahr. and outside temperature of 0 deg. fahr.

If the house is to be heated by 1¼ in. steam coils use the same divisors as given by Table 2, and the results will give lineal feet of 1¼ in. pipe coil required. (not square feet of radiation.)

Table 3. Factors to Multiply Figures Obtained from Table 2 to Determine Square Feet of Hot Water Radiation for other than 0 deg. Outside Temperatures

5	deg.	above	0	.....	0.92	5	deg.	below	0 ..... 1.06
10	"	"	0	.....	0.84	10	"	"	0 ..... 1.15
15	"	"	0	.....	0.75	15	"	"	0 ..... 1.24
20	"	"	0	.....	0.66	20	"	"	0 ..... 1.33
25	"	"	0	.....	0.58	25	"	"	0 ..... 1.42
30	"	"	0	.....	0.50	30	"	"	0 ..... 1.05
						35	"	"	0 ..... 1.58
						40	"	"	0 ..... 1.63