HEATING GREENHOUSES.

1. Q. What modern methods are employed for warming greenhouses and conservatories?

A. Steam and hot water systems are both used; steam at low pressure or hot water, both open tank and pressure systems.

2. Q. Which system is more generally employed?

A. Hot water. There are doubtless four or five hot water systems used to one of steam.

3. Q. What reason can be assigned for this favoring of hot water?

A. Several conditions contribute to this. Thousands of the smaller greenhouses and conservatories are maintained for the propagation of choice flowers for private use and these are invariably heated with hot water. Steam is used more particularly in commercial houses of large acreage in which hothouse vegetables, fruits or flowers are grown for market sale. Houses of this character have firemen who attend the heating apparatus day and night; on the contrary the heating plant in a smaller or private conservatory seldom has night attendance and for this reason hot water heat is preferred, as should the fire for any reason get low the water continues to circulate and give off heat for hours.

4. Q. Which type of apparatus is considered to be the best for the propagation of fruit, vegetables, or flowers?

A. Hot water. The heat from hot water in circulation is mild and the atmosphere in a house heated by hot water is balmy and humid and well adapted to the strong and healthy growth of the plants.

5. Q. Which is the more economical system to use—steam or hot water?

A. Hot water is the more economical with regard to the fuel requirements, and a considerable saving in fuel is effected by using hot water in preference to steam. As the cost of heating is the largest single item of the florists' expenses, this fact no doubt has largely to do with their preference for hot water heat.

6. Q. In what shape are greenhouses usually built, and how are they constructed?

A. As a rule greenhouses are built long and narrow. Some houses have an aisle two and one-half or three feet wide in the

centre with beds from four to six feet wide on either side. Larger houses have a wide centre bed in addition to those on the sides and consequently have two aisles. The general construction of all commercial houses is similar. They are sided with boarding single or double to the height of the beds; the roof and ends above this line are glass. In low built houses the eaves of the roof begin slightly above the outer edge of the beds. In larger houses there is sometimes a belt of glass between the eaves of the roof and the beds. The pitch of the roof is about one-third to the ridge. Large private conservatories and those in parks and botanical gardens are built in a variety of shapes with all sorts of roof construction, making it necessary to adapt the heating system to the style of construction followed.

7. Q. **How is the radiation required for heating a greenhouse determined?**

A. The amount of glass surface is alone figured in estimating radiation as practically all of the cooling surface is glass.

8. Q. **How can the glass surface in the ordinary greenhouse be quickly determined?**

A. For an approximate estimate, when only the dimensions of the house are given, the glass surface may be considered as equal to the length of the building multiplied by the width plus one-third; the one-third allowance being equal to the ends and the pitch of the roof. Should the greenhouse have a belt of glass on the sides and ends, this additional glass surface should be added.

9. Q. **What temperature must be maintained inside of a greenhouse in zero weather?**

A. The temperature required depends upon the character of the plants or flowers grown. A night temperature is figured on the basis of zero outside and 45 to 55 degrees inside for carnations, 60 to 65 degrees for roses, 55 to 60 degrees for chrysanthemums, etc.

10. Q. **What kind of radiating surface is employed for greenhouse heating?**

A. Pipe coils are used almost exclusively on account of the large area of surface covered by a pipe coil and the more evenly distributed heat.

11. Q. **How is the amount of radiating surface required determined?**

A. For steam to obtain the square feet of heating surface divide glass surface by 7 to obtain a temperature of 50 degrees, 6½ for 55 degrees, 6 for 60 degrees, 5½ for 65 degrees or 5 for 70 degrees.

For hot water use as divisors: 4, 3¾, 3½, 3¼ and 3. This is for zero weather. For climates where there are protracted periods of temperature below zero add 1½ per cent to the radiating surface for each degree below zero. The following tables while not strictly in accordance with the above rules are considered sufficient for average requirements.

FOR STEAM.

Square Feet Glass Exposure.	Number Square Feet Radiation Required at				
	40 Deg.	45 Deg.	50 Deg.	60 Deg.	70 Deg.
100	11	13	14	17	20
200	23	25	30	33	40
300	34	38	43	50	60
400	45	50	57	67	80
500	56	63	72	83	100
1,000	112	125	143	167	200
2,000	223	250	286	333	400
3,000	334	375	429	500	600
4,000	445	500	571	667	800
5,000	556	625	714	833	1,000
10,000	1,112	1,250	1,429	1,667	2,000
20,000	2,223	2,500	2,857	3,333	4,000
30,000	3,334	3,750	4,286	5,000	6,000
40,000	4,445	5,000	5,714	6,667	8,000
50,000	5,556	6,250	7,143	8,333	10,000

FOR WATER.

Square Feet Glass Exposure.	Number Square Feet Radiation Required at				
	40 Deg.	45 Deg.	50 Deg.	60 Deg.	70 Deg.
100	17	20	25	29	33
200	33	40	50	57	67
300	50	60	75	86	100
400	67	80	100	114	133
500	83	100	125	143	167
1,000	167	200	250	286	333
2,000	333	400	500	572	667
3,000	500	600	750	857	1,000
4,000	667	800	1,000	1,143	1,333
5,000	833	1,000	1,250	1,429	1,667
10,000	1,667	2,000	2,500	2,857	3,333
20,000	3,333	4,000	5,000	5,714	6,667
30,000	5,000	6,000	7,500	8,572	10,000
40,000	6,667	8,000	10,000	11,429	13,333
50,000	8,333	10,000	12,500	14,286	16,666

Radiation called for by above table is for tight, well-built houses. For poorly constructed houses add at least 10 per cent.

12. Q. **What boiler capacity is required for this class of heating, and how is the proper size determined?**

A. Greenhouses offer very little resistance to the cold, and therefore require strong boiler power in order to provide quickly for additional warmth to meet the demands of a sudden drop in temperature; therefore ample capacity should be figured. In determining boiler capacity consider 100 square feet of greenhouse coils as equivalent to 125 square feet of cast iron radiation.

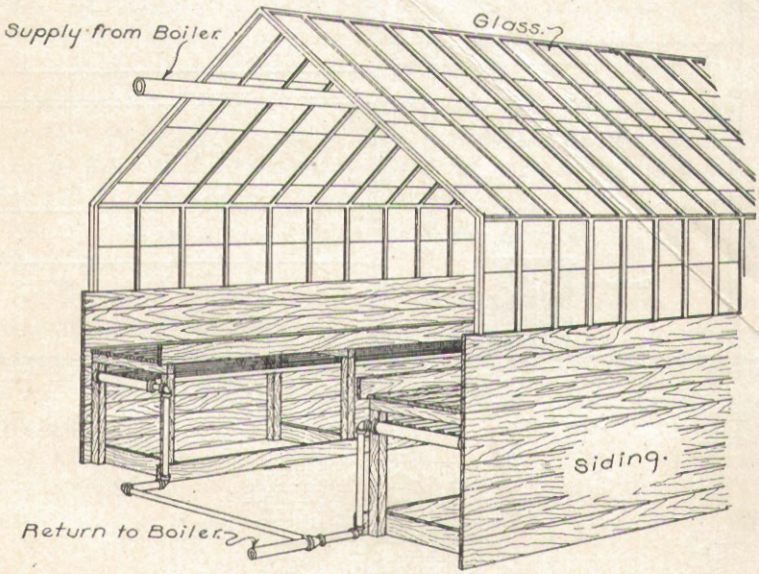

Fig. 156.—Method of Piping a Greenhouse.

Reserve equal to 50 per cent. of the total actual requirements should be provided.

13. Q. **What method of piping is employed in installing a heating apparatus for a greenhouse?**

A. The system commonly called the "overfed system" is most frequently used owing to the benefit derived from a more even distribution of the heating surface.

14. Q. **Describe the overfed system and method of piping.**

A. It is usual for the flow main (or mains—there may be more than one) to enter the house at the end nearest the boiler and to run overhead to the far end of the house, the pipe being hung on

the centre posts supporting the roof. At the far end this pipe is divided, the branches dropping to supply coils usually run under the beds. The flow pitches downward to the far end of the house and the coils pitch downward toward the boiler end; thus there is perfect drainage provided which insures a good circulation. At the boiler end of the house the returns from coils are usually con-

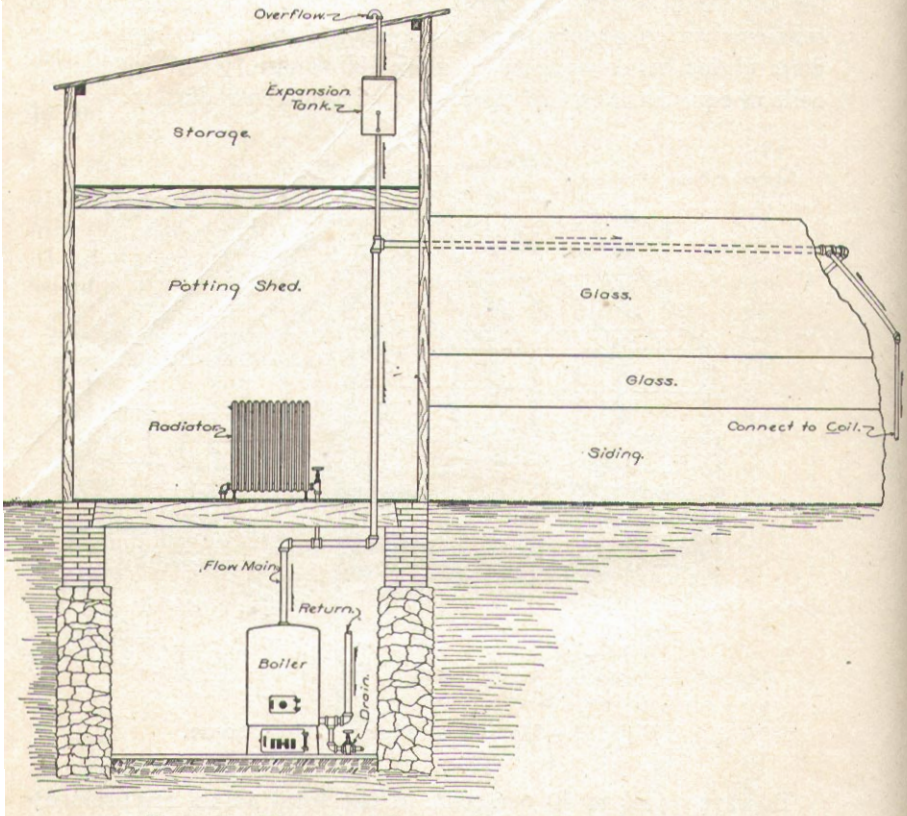

Fig. 157.—Elevation of Greenhouse Piping System.

nected together into a single pipe which leads to the return of the boiler. Fig. 156 illustrates this method.

15. Q. **Is there a difference in the method of piping for hot water or steam heating?**

A. The general arrangement of the flow and also of the return coils is similar for both systems. If hot water is used the air is exhausted from the system from the high point of the piping through the expansion tank connection at this point.

16. Q. Where is the expansion tank located, and how should it be connected?

A. In building a greenhouse it is usual to erect a potting shed at one end. This portion of the building is usually excavated for a cellar or pit to accommodate the boiler and in many instances has a second floor for use as storage or for the use of the man who attends the heating apparatus. The tank is located in this building well above the high point of the piping and it is connected to the system in the same manner as for the regular overhead system of hot water heating. Fig. 157 shows an elevation of a small house and potting shed.

17. Q. How and where should valves be placed on a heating system for a greenhouse?

A. It is customary to divide the piping into two or more coils according to the size of the house, and each section or unit of radiation should be so valved that a part of the heating surface may be cut out in moderate weather when only a portion of it is required to maintain the desired temperature.

18. Q. Is an accelerated or pressure system adapted to this class of heating?

A. Pressure systems are very commonly employed, a safety valve being used on the outlet of the expansion tank. Accelerated systems may be readily adapted to this work and in the case of exceptionally large plants centrifugal pumps can be employed to advantage.