Fig. 77 shows that 80 gallons water per minute are required.

Fig. 78 shows that 140 square feet of cooling coil surface are required when working at the rate of 50 B.t.u. per hour per square foot per degree difference.

Fig. 79 shows 64 lineal feet trough required.

Also shows 8 troughs and coils wide and space required as follows:

6 in. coil centers require space 54 in. wide
8 in. coil centers require space 68 in. wide
10 in. coil centers require space 82 in. wide
12 in. coil centers require space 96 in. wide

From Figs. 78 and 79 it was found that 140 sq. ft. of surface and 64 lineal feet of troughs were required. Fig. 80 shows the following:

Pipe diameter	1½ in.	1¼ in.	1 in.
Lineal Feet	225	283	404
Pipes High	5	6	7

Pipes High have been increased to eliminate fractions and in designing a unit the lineal feet of coil required would have to be increased in proportion. Allowance must be made for dirty coils, uneven water distribution, quick control of temperatures and other factors, all of which might double the coil surface shown mathematically by the charts.

The heat transfer which may be obtained in the upper chamber and the maximum rise in the water temperature, and therefore the use of Fig. 77, will vary with each change in nozzle, pump pressure, time element, pounds of water used per pound of air, water to air temperature differences, and other such factors as might be expected, but once the volume of water and the temperature through which it must be cooled are determined, the design of that part of the apparatus using refrigeration will be a comparatively simple problem to those familiar with such work.

CHAPTER XX

DESIGN AND CONSTRUCTION OF AIR DUCTS

By F. R. STILL, Member

THE successful operation of a mechanical or plenum heating installation, an exhaust system or a dust collecting plant is largely dependent upon the correct design of the duct system. Materials, proportions, friction, location and innumerable other items are factors in the correct operation of a duct system.

In the design of ducts and flues for the mechanical circulation of air, or by gravity, losses due to friction are the basis for figuring and these losses must be kept within the available pressure difference. This pressure difference in mechanical ventilation is that derived from the fan while in gravity ventilation it is the asperating effect due to the temperature and height of the column of heated air.

When attempting the design of a duct system the general rules to remember are:

1. The air should be conveyed as directly as possible at reasonable velocities to obtain the result desired with greatest economy of power, material and space.
2. Sharp elbows and bends are to be avoided.
3. All ducts or flues shall have sides as nearly equal in size as possible. (In no case shall the ratio between long and short sides be greater than 10 to 1.)

The piping systems for various operations must be of different design as the principal consideration for industrial work is for heating while in public buildings the air required for ventilation greatly exceeds the volume needed for heating. For instance, the ducts for a school, theatre or other public buildings, where freedom from noise and elimination of drafts is essential and where branch ducts serve individual rooms, is a much different problem in design than that involved in proportioning ducts intended for heating a factory, where a main duct of decreasing dimensions extends lengthwise of the building and gives a uniform distribution of air. For public buildings air velocities must, therefore, be kept low between 900 and 1200 ft. per minute while in industrial buildings they can range from 1500 to 2000 ft. per minute or even more with no other disadvantage than expensive operation.

Standard velocities of air in public buildings are as follows:

1. Through the outside air intakes 1,000 ft. per min.
2. Through connections to and from heater 1,000 to 1,200 ft. per min.
3. Through the main discharge duct from 900 to 1,200 ft. per min.
4. In branch ducts 700 to 900 and vertical flues 400 to 600 ft. per min.
5. In registers or grilles 200 to 400 ft. per min. depending upon the size and location.
6. If diffusers of proper design are used, 25 per cent higher air velocities may be permitted.