The steam requirements for water heating should be taken into account, but in most types of buildings this load will be relatively small compared with the heating load and will seldom occur at the time of the heating peak. Unusual features such as large heaters for swimming pools should not be overlooked.

The pressure at which the steam is to be distributed will depend, in part, upon whether or not it has been passed through electrical generating units. If it has, the pressure will be considerably lower than if live steam, direct from the boilers, is used. The advantages of low pressure distribution (2 to 30 lb per square inch) are (1) smaller heat loss from the pipes (2) less trouble with traps and valves and (3) simpler problems in pressure reduction at the buildings. With distribution pressures not exceeding 40 lb per square inch there is little danger even if the full distribution pressure should build up in the radiators through the faulty operation of a reducing valve; but with pressures higher than this a second reducing valve or some form of emergency relief is usually desirable to prevent excessive pressures in the radiators. The advantages of high pressure distribution are (1) smaller pipe sizes and (2) greater adaptability of the steam to various operations other than building heating.

The different kinds of apparatus which frequently must be served require various minimum pressures. Kitchen equipment requires from 5 to 15 lb per square inch, the higher pressures being necessary for apparatus in which water is boiled, such as stock kettles and coffee urns. An increased amount of heating surface, which is easily obtained in some kinds of apparatus, results in quicker and more satisfactory operation at low pressures. For laundry equipment, particularly the mangle, a pressure of 75 lb per square inch is usually demanded although 30 lb per square inch is sufficient if the mangle is equipped with a large number of rolls and if a slow rate of operation is permissible. Pressing machines and hospital sterilizers require about 50 lb per square inch.

SELECTION OF PIPE SIZES

The lengths of pipe, steam quantities and initial and terminal pressures having been chosen the pipe sizes can readily be calculated by means of the Unwin pressure drop formula. This formula, which gives pressure drops slightly larger than actual test results, is as follows:

$$P = \frac{0.0001306\ W^2 L \left(1 + \frac{3.6}{d}\right)}{y d^5} \qquad (1)$$

where

P = pressure drop, pounds per square inch.
W = weight of steam flowing, pounds per minute.
L = length of pipe, feet.
d = inside diameter of pipe, inches.
y = average density of steam, pounds per cubic foot.

This formula is similar to the Babcock formula given in Table 1, Chapter 9.

PROVISION FOR EXPANSION

The linear expansion of the pipe can be determined from Table 1. The elongation values in this table were computed from the following formula:

$$L_t = L_o \left[1 + a\left(\frac{t - 32}{1000}\right) + b\left(\frac{t - 32}{1000}\right)^2\right] \qquad (2)$$

where

L_t = length at temperature t deg F, feet.
L_o = length at 32 F, feet.
t = final temperature, degrees Fahrenheit.
a and b are constants as follows:

METAL	a	b
Cast-Iron	0.005441	0.001747
Steel	0.006212	0.001623
Wrought-Iron	0.006503	0.001622
Copper	0.009278	0.001244

In selecting expansion fittings it is well to allow a margin of 25 per cent between the computed expansion and the actual allowable travel of the expansion fitting to provide for inaccuracies in assembling, etc. Table 2 gives the dimensions of expansion offsets and bends required to take care of different amounts of expansion. For additional information on this subject, refer to Chapter 11.

CAPACITY OF RETURNS WITH VARIOUS GRADES

In general return lines when installed follow the contour of the land, and Table 3 gives sizes of return pipes for various grades. It is evident that at points where the grade is great, smaller pipes can be installed.

PIPE CONDUITS

Conduits for steam pipes buried underground should be reasonably water-proof, able to withstand earth loads and take care of the expansion and contraction of the piping without strain or stress on the couplings, also without affecting the installation or conduit. Expansion of the piping must be carefully controlled by means of anchors and expansion joints or bends so that the pipes can never come in contact with the conduit. Anchors can be anchor fittings or U-shaped steel straps which partially encircle the pipes and are firmly bolted to a short length of structural steel set in concrete.

In laying out conduits of this type the following points should be borne in mind:

1. An expansion joint offset or bend should be placed between each two anchors.

2. If the distance between buildings is 150 ft or less and the steam line contains high-pressure steam, it may be anchored in the basement of one building and allowed to expand into the basement of the second building. If the steam line contains low-