termination of the *design rate of flow* in any particular section of piping. The next general step is to determine the *size* of piping.

As water flows through a pipe, the pressure continually decreases along the pipe, due to loss of energy from friction. The problem is then one of ascertaining the minimum pressure in the street main, and the minimum pressure required for the operation of the topmost fixture. (A pressure of 15 psig may be ample for most flush valves, but reference should be made to the manufacturers' requirements. Some fixtures, especially wall-hung closets, require a pressure up to 25 psig. A minimum of 8 psig should be allowed for other fixtures.) The pressure differential thus obtained will be available for overcoming pressure losses in the distributing system, and in overcoming the difference in elevation between the water main and the highest fixture.

The pressure loss, in pounds per square inch, caused by the difference in elevation between the street main and the highest fixture, may be obtained by multiplying the difference in elevation in feet by the conversion factor 0.434.

When water flows through a pipe, friction occurs as the result of the sliding of water particles past one another. If the pipe wall is rough, the roughness projections cause additional friction, owing to the development of increased turbulence in the flowing water. As the water flows along a uniform pipe, the pressure decreases as a result of a dissipation of energy arising from the internal friction set up by viscosity of the water. This loss in energy is shown by the loss of pressure. The pressure loss is proportional to the length of straight uniform pipes, and varies greatly with flow velocity, pipe diameter, and roughness of pipe. Temperature has only a minor effect, within the working range, and usually is not considered.

Table 2 .... Demand Weights of Fixtures in Fixture Units[a]

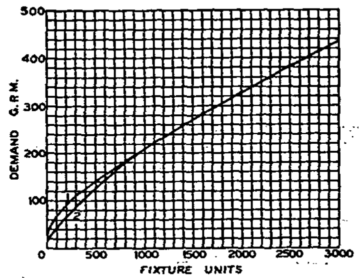
Fixture or Group[b]	Occupancy	Type of Supply Control	Weight in Fixture Units[c]
Water closet	Public	Flush valve	10
Water closet	Public	Flush tank	5
Pedestal urinal	Public	Flush valve	10
Stall or wall urinal	Public	Flush valve	5
Stall or wall urinal	Public	Flush tank	3
Lavatory	Public	Faucet	2
Bathtub	Public	Faucet	4
Shower head	Public	Mixing valve	4
Service sink	Office, etc.	Faucet	3
Kitchen sink	Hotel or restaurant	Faucet	4
Water closet	Private	Flush valve	6
Water closet	Private	Flush tank	3
Lavatory	Private	Faucet	1
Bathtub	Private	Faucet	2
Shower head	Private	Mixing valve	2
Bathroom group	Private	Flush valve for closet	8
Bathroom group	Private	Flush tank for closet	6
Separate shower	Private	Mixing valve	2
Kitchen sink	Private	Faucet	2
Laundry trays (1–3)	Private	Faucet	3
Combination fixture	Private	Faucet	3

From NBS Report BMS79 *Water-Distributing Systems for Buildings.*

[a] For supply outlets likely to impose continuous demands, estimate continuous supply separately and add to total demand for fixtures.

[b] For fixtures not listed, weights may be assumed by comparing the fixture to a listed one using water in similar quantities and at similar rates.

[c] The given weights are for total demand. For fixtures with both hot and cold water supplies, the weights for maximum separate demands may be taken as ¾ the listed demand for the supply.



No. 1 for system predominantly for flush valves.
No. 2 for system predominantly for flush tanks.

Fig. 1 .... Estimate Curves for Demand Load

On the basis of inside surface conditions, pipes may be classified as smooth, fairly rough, and rough, as follows:

Smooth. The pipe surface shows no perceptible roughness. Pipes made of copper, brass, or lead may usually be classified as smooth.

Fairly Rough. All ordinary pipes, such as wrought iron, galvanized iron, steel, and cast iron, after a few years of usage, may be called fairly rough.

Rough. Pipes that have deteriorated fairly rapidly for some 10 or 15 years after being laid, are classified as rough.

Figs. 3, 4, and 5 give the pipe friction losses corresponding to these three types of pipes for various nominal diameters for a water temperature of 50 F.[1] *Example 1* will illustrate the use of the charts.

Example 1: A 2½-in. fairly rough pipe supplies 100 gpm of water. Find the friction loss in head if the pipe length is 200 ft.

Solution: Enter Fig. 4 at 100 gpm, and move along this line until it intersects the 2½-in. diameter line. From this intersection point, move vertically down and read 4.5 psi friction loss per 100 ft of pipe length. Then the total friction loss will be $2 \times 4.5 = 9$ psi.

The pressure losses in the distributing system will consist of the pressure losses in the piping itself, plus the pressure losses in the pipe fittings, valves, and the water meter, if any. Approximate design pressure losses for disc-type meters for various rates of flow are given in Fig. 6. Flow limits for disc-type meters, which may be regarded as the limits of recom-

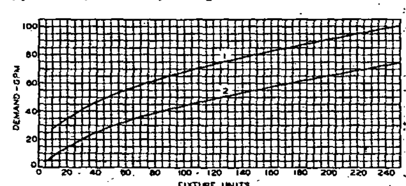
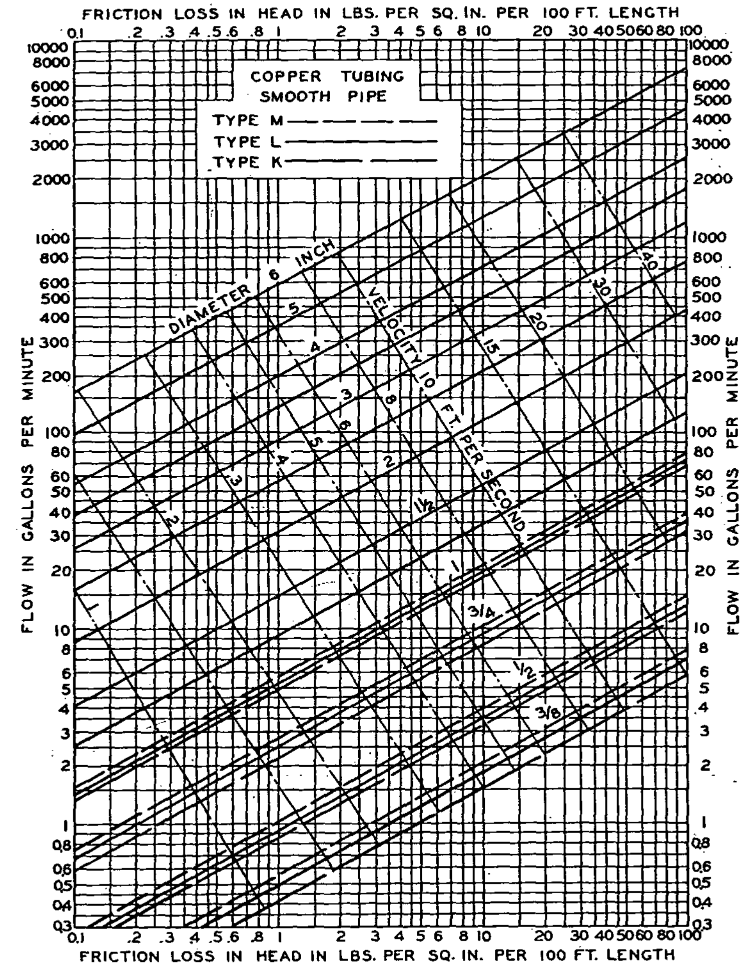


Fig. 2 .... Section of Fig. 1 on Enlarged Scale



[a] Another type of copper tubing, known as Type TP, now is being used extensively. Type TP tubing has the same outside diameter as standard brass pipe sizes. It can be interchanged with brass pipe or connected to brass pipe, using silver solder. Type B tubing, made to US Navy specifications, may be similarly used. For friction loss in Type TP or Type B tubing, the designer should adjust values of Fig. 13 for the actual inside diameter of the tubing.

Fig. 3 .... Flow Chart for Copper Tube[1,a]