

From Fig. 1, the probable usage for 57 gpm maximum flow in a mixed system is 100 per cent. Therefore, Section A should be sized for 57 gpm.

Section B, which supplies two apartments will have a maximum flow of  $2 \times 57$  gpm = 114 gpm. From Fig. 1, the probable usage for 114 gpm is approximately 75 per cent and the probable flow in Section B =  $114 \times 0.75 = 86$  gpm.

Similarly, the probable flow in Section C is found to be 98 gpm. Since all risers in this particular example are supplying the same number of fixtures, the probable flow in risers 1 and 2 is the same as determined for riser 3.

To determine the probable flow in Section E, add the maximum flow in risers 2 and 3, and multiply the sum by the probable usage for the sum, thus:  $(171 + 171) \times 0.35 = 120$  gpm probable flow in E. Similarly, the probable flow in Section F is determined.

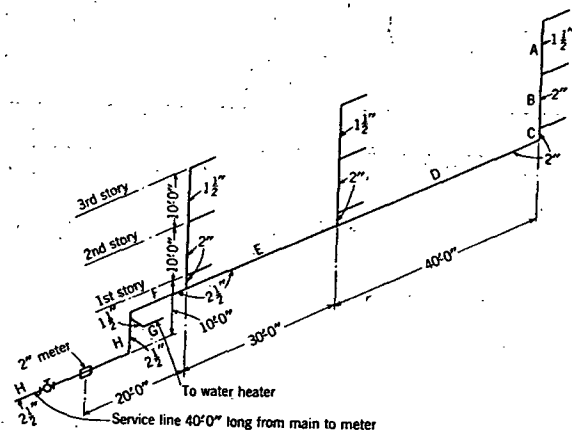


FIG. 3. UP-FEED COLD WATER SYSTEM WITH FLUSH VALVES

It should be noted that the probable flow in E cannot be determined by adding the probable flow in risers 2 and 3.

To determine the maximum flow in line G to the water heater, the total hot water requirements are determined as follows:

|                     |                       |
|---------------------|-----------------------|
| 9 laboratories..... | $9 \times 3 = 27$ gpm |
| 9 tubs.....         | $9 \times 5 = 45$ gpm |
| 9 sinks.....        | $9 \times 4 = 36$ gpm |
| Maximum flow.....   | = 108 gpm             |

The probable flow in all sections of the system are determined as described previously, and tabulated in Table 4.

The next step in the solution is the determination of the allowable pressure drop:

|                                                      |                         |
|------------------------------------------------------|-------------------------|
| Loss in a 2 in. meter for 149 gpm, from Table 2..... | = 22 lb per square inch |
| Hydrostatic head = 30 ft ( $30 \times 0.43$ ).....   | = 13 lb per square inch |
| Pressure at top fixture.....                         | = 15 lb per square inch |
| Total.....                                           | 50 lb per square inch   |
| Allowable pressure loss = $70 - 50$ lb.....          | = 20 lb per square inch |

To determine the allowable pressure loss per 100 ft of pipe, the longest run to the highest fixture must be used. In Fig. 3 this would be the length to the top fixtures on riser No. 3. The developed length from the meter to the top of riser 3 is 120 ft, and the

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equivalent length, allowing 50 per cent for fittings is 180 ft. The service line is 40 ft long, making a total equivalent length of 220 ft from the main to the farthest fixture. Since the service line is usually straight, no allowance has been made for fittings.

The total allowable loss is 20 lb per square inch, and the developed length of piping is 220 ft. Therefore, the allowable loss per 100 ft of pipe is  $\frac{20 \times 100}{220} = 9.1$  lb.

Knowing the probable flow in all lines and the allowable loss per 100 ft of pipe, it is possible to determine the pipe sizes from Fig. 2 by reading the pipe size indicated at the intersection of the two known factors. Pipe sizes for all parts of the system are given in Table 4.

Ordinarily the size above the intersection, on the chart is selected. However, it is permissible to select a pipe slightly undersize if the next section of the line is oversize. This is illustrated in the sizing of sections A and B. The pipe size of  $1\frac{1}{2}$  in. is slightly small for A, but 2 in. is enough oversize for B, so that the average loss in the two is less than 9.1 lb per 100 ft.

In this example, all risers have been sized for the same loss per 100 ft of pipe. Where the main is long it is frequently possible to increase the pressure drop per 100 ft of pipe in the risers near the meter, and thus reduce their size. For example, the total friction

TABLE 4. SUMMARY OF RESULTS FOR EXAMPLE 3

| SECTION | MAXIMUM FLOW GPM | PROBABLE USAGE PER CENT | PROBABLE FLOW GPM | ALLOWABLE LOSS LB PER 100 FT | PIPE SIZE IN.  |
|---------|------------------|-------------------------|-------------------|------------------------------|----------------|
| A       | 57               | 100                     | 57                | 9.1                          | $1\frac{1}{2}$ |
| B       | 114              | 75                      | 86                | 9.1                          | 2              |
| C-D     | 171              | 57                      | 98                | 9.1                          | 2              |
| E       | 342              | 36                      | 123               | 9.1                          | $2\frac{1}{2}$ |
| F       | 513              | 28                      | 144               | 9.1                          | $2\frac{1}{2}$ |
| G       | 108              | 43 <sup>a</sup>         | 46                | 9.1                          | $1\frac{1}{2}$ |
| H       | 621              | 24                      | 149               | 9.1                          | $2\frac{1}{2}$ |

<sup>a</sup>From curve for fixtures having no flush valves.

loss from the meter to the top of riser 1 in Fig. 3, could be as great as the total loss from the meter to the top of riser 3. However, all parts of the main must always be sized to assure sufficient pressure at the last riser. In a small system, such as shown in Fig. 3, no appreciable reduction in pipe sizes can be made by taking advantage of the possibility just described.

## PIPE SIZES FOR DOWN-FEED COLD WATER SYSTEM

The risers for down-feed systems may be reduced considerably in size compared with those for up-feed systems because of the 0.43 lb per foot gain in pressure due to increasing hydrostatic head as the lowest story is approached. It has proved practicable to select down-feed riser sizes on the basis of a pressure drop of 30 lb per 100 ft. The 13 lb difference between 43 lb per 100 ft and 30 lb per 100 ft will usually take care of the friction in the fittings.

The overhead mains, however, must be selected conservatively, as the pressure at the top will be low and the pressure drop available for friction will necessarily be small. In nearly all tall buildings the pressure is limited to that due to the hydrostatic head between the house tank and the main, though sometimes this is increased by the use of a pneumatic house tank.

Where flush valves are used on top story closets the minimum practi-