its total equivalent length by the actual friction loss per foot at design flow. The circuit friction pressure drop is the summation of individual section pressure drops.

Calculation of Actual Friction Loss for *Example 1*

Section	Flow MBH GPM	Friction Loss FT/100 FT MI/FT (Fig. 3)	Pipe Size In. (Fig. 3)	Fittings Type	Fittings Equiv FT**	Pipe Length FT	Total Equiv Length of Pipe FT	Friction Loss Calculation	Friction Loss MI	Friction Loss FT
BC	43.5	1.5	1	1 ell	2.4	14	16	0.16 × 1.5		0.24
	4.35	180						16 × 180	2880	
CD	36.0	1.0	1	—	—	15	15	0.15 × 1.0		0.15
	3.6	120						15 × 120	1800	
DE	30.0	2.5	¾	1 ell	1.9	8	10	0.10 × 2.5		0.25
	3.0	300						10 × 300	3000	
EF	25.0	1.8	¾	—	—	10	10	0.10 × 1.8		0.18
	2.5	210						10 × 210	2100	
FG	18.0	1.0	¾	—	—	14	14	0.14 × 1.0		0.14
	1.8	120						14 × 120	1680	
GN	9.8	1.2	½	3 ells	3.6	8	23	0.23 × 1.2		0.26
	0.98	150		1 ¾ tee	3.4			23 × 150	3500	
				1 1 in. tee	4.8					
				1 Rad. V	3.6					
NO	41.8	1.4	1	1 ell	2.5	31	34	0.34 × 1.4		0.48
	4.18	170						34 × 170	5780	
OB	50.0	1.9	1	3 ells	7.5	38	116	1.16 × 1.9		2.20
	5.00	230		2 tees	10.0			116 × 230	26700	
				2 Gate Valve	2.5					
				1 Flow Valve	50.0					
				1 Boiler	7.5					
Convector friction loss*...									1200	0.10
Total Friction Loss..........									48590	4.02

* Data obtained from manufacturers' catalogs.
** See also Tables 2 and 3 and Fig. 7.
MI = milinches

If the total friction loss as determined does not agree with the pump head, some pipe size changes will be necessary to obtain closer agreement. The slight difference in head calculated by milinches and by feet of head is due to use of only 2 significant figures for the latter. This is well within the accuracy required.

As would be expected the calculated head of 4.02 ft is different from the 4.7 ft estimated. This is due to two factors: (1) the difference between the actual and estimated number of fittings and (2) the differences between actual and estimated losses in the different sections as the friction losses were generally below the average friction loss assumed.

The 1-in. pump initially selected would be entirely satisfactory for the installation and would produce a flow slightly in excess of 5 gpm. A procedure to determine the actual flow and head capacity of the pump and system is discussed under Circulating Pumps.

One-Pipe System, Description and Design

The one-pipe system, Fig. 10, has a single main for both supply and return. Special fittings installed at the connections to radiation risers or runouts generate the head necessary to produce flow through the heating unit. In this system the main or circuit loop does not change size from the first to the last radiation unit. The amount of water flowing in the main is constant, except at points where some of it is by-passed through radiation. Since the water temperature in the main drops progressively, some designers consider it necessary to increase the size of heat-transmitting surface accordingly by using a progressively lower design water temperature in sizing the heating units. Most one-pipe heating systems are designed, however, on the basis of a single design water temperature. Generally, the theoretical increase in heat-transmitting surface is needed only when the system is operating at full design output. A water temperature drop in the main of 20 deg or less minimizes the capacity reduction effect.

In comparison with a two-pipe system, the one-pipe system:

1. Permits simpler piping due to the use of one main of uniform size.
2. May be more acceptable when pipe is exposed in occupied spaces.
3. Is very adaptable to small systems or to individual loops in large systems,

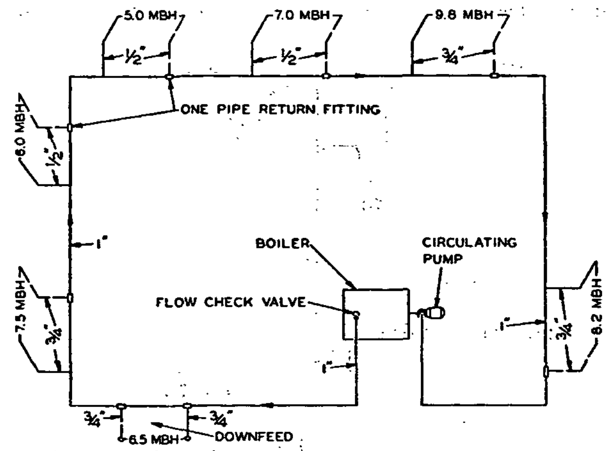

Fig. 10. A One-Pipe System

either horizontal or vertical, as a part of a two-pipe system, or to obtain zone control in large combination systems.

4. May be lower in installation cost.
5. Has a simpler problem in regard to water flow adjustment.

Continuing the comparison with two-pipe systems some disadvantages of one-pipe systems are:

1. The amount of water which can be by-passed by a one-pipe fitting or fittings is limited by the economics of design and the head applied. The fittings are not generally used to provide the water flow necessary for large air-handling units having a high pressure drop.
2. The pump head required is slightly higher than that required for a two-pipe reversed-return system of similar flow requirements.
3. If the progressive increase of radiation size as temperature drops is taken into account, a design complication and additional cost factor are encountered.
4. The main flow design temperature drop should not exceed 20 deg.

Design of a One-Pipe System

The basic design premise of a one-pipe system is that the pressure drop of the one-pipe fitting, or fittings, at the required main flow, be equal to or greater than the radiation circuit pressure drop at its required flow. The system may be divided into two or more loops for smaller main pipe sizes and pumps. Main and radiation circuit temperature drops may be dif-