or periodic service. For the latter, by means of several intermittent settings, steam will be supplied, during each period, in increments of a certain number of minutes for each successive setting of the switch, steam being shut off during the balance of the period. These settings afford from 15 to 80 per cent of that maximum heating effect, required on days of zero temperature.

A night switch with a variety of settings, may be adjusted so as to maintain throughout the night the intermittent supply called for by the day switch setting, or may be set to interrupt the operation of the day switch and entirely cut off the supply of steam to the radiation at night during certain hours which are selected by the operating engineer.

A morning service switch may operate independently of the day and night switches to supply full steam service to the radiation during the early morning hours (6.00 A.M. to 9.00 A.M.) or afford an excess heat supply when desired by the operator.

Still another form of control regulates the pressure in the mains leaving the boiler plants to correspond with the changes in local factors.

In general practice, the size of a pipe line is fixed so that steam can be delivered to the system at full rated boiler pressure. With a maximum load, the pressure drop in the line will be such that a fixed pressure can be held at a distant point due to definite requirements of the customer. This maximum load is generally fixed by future requirements that may not be reached for years, also the daily and hourly load may vary materially, or the pressure requirements fixing the design may vary at certain periods. Rather than carry full boiler pressure on the system with its corresponding line loss under varying loads, considerable saving can be made by installing one or more pressure-reducing valves in the boiler plant for holding the pressure at a point to correspond with the actual load requirements. In institutional heating these pressure-reducing valves make it possible to reduce the night pressure materially, thereby making a decided saving in coal. Where the load requirements vary considerably, a bank of reducing valves is often installed in multiple, so that the valve in use will be working very close to its rating.

At the present time, the tendency is to distribute at as high a steam pressure as possible, without unduly increasing the cost of the line construction. With standard weight pipe and welded joints, there is no reason why the line should not carry at least 200 lb. pressure at maximum load. With these higher pressures the lines can be kept small, decreasing the investment cost and corresponding line losses.

The reduction in pressure at the boiler plant, together with a considerable drop in the line, will produce a superheating of the steam so that the superheating will balance the line loss and this will make very little, if any, trap drip discharge, thereby eliminating water hammer. Too strong emphasis cannot be placed on the idea of having the distributing lines the right size rather than excessive.

The pipe line can be designed for any grade, but all low points should be drained through traps, discharging to the sewer or to return lines.

The practice of designing a line based on velocity of steam is becoming obsolete in favor of designing for pressure drop.

PIPE LINE EXPANSION

In laying out a pipe line the expansion should be actually determined for each run, and adequate provision should be made for it.

Two methods are in use for taking care of expansion, (1) by some form of expansion joint, and (2) some form of offset or bend.

Table 1 shows the expansion in 100 ft. of pipe at various temperatures. The expansion of any length of pipe is determined by taking the difference

TABLE 1. EXPANSION OF PIPE IN INCHES PER 100 FT.

TEMPERATURE DEG. FAHR.	WROUGHT IRON OR STEEL	CAST IRON	COPPER AND BRASS
0	0.00	0.00	0.00
10	0.08	0.05	0.13
20	0.15	0.10	0.25
30	0.23	0.15	0.35
40	0.30	0.25	0.45
50	0.38	0.36	0.57
100	0.76	0.72	1.14
150	1.15	1.10	1.75
200	1.57	1.50	2.38
250	1.99	1.90	3.02
300	2.47	2.35	3.74
350	2.94	2.80	4.45
400	3.46	3.30	5.24

TABLE 2. FOR LENGTH OF EXPANSION OFFSETS AND BENDS FOR PROPER EXPANSION OF PIPE

TOTAL EXPANSION IN INCHES*	FEET OF PIPE AND OFFSET OR U-BEND FOR DIFFERENT DIAMETERS OF PIPE									
	2″	3″	4″	5″	6″	8″	10″	12″	14″	16″
1	11	13	15	17	19	21	23	25	27	30
2	15	18	21	23	26	29	32	35	38	42
3	18	22	26	29	32	36	40	43	48	52
4	21	26	30	34	37	42	47	50	56	58
5	24	30	34	38	41	47	53	57	63	65
6	27	33	37	41	45	52	58	63	69	71
7	30	36	40	44	48	56	62	68	74	....
8	32	39	43	47	52	60	66	72	....	....

*This column shows the total expansion the offset will take care of without a cold strain. In general these amounts can be increased 40 per cent which increase can be taken up in cold strain of the pipe on being made up.

The length of pipe in the expansion piece should be the same whether in the form of a single right-angle offset or double offset or U-Bend.

The lengths of arms figured for 12,000 lb. per square inch tension for wrought iron pipe. If steel pipe is used this is good for 16,000 lb. per inch so that the arm will take care of ⅓ more expansion.

in expansion at minimum and maximum temperatures and dividing by 100 to arrive at the expansion per foot, then multiplying by the number of feet of pipe for which expansion is to be figured.

In the installation of transmission lines it is frequently the practice to figure on an installation temperature of 70 deg. fahr. and to compensate for about 40 per cent of the total expansion by means of a cold