

TABLE 5. THERMAL EXPANSION OF PIPE IN INCHES PER 100 FT<sup>a</sup>  
(For superheated steam and other fluids refer to temperature column)

| SATURATED STEAM      |                                      |                                |  | ELONGATION IN INCHES PER 100 FT FROM -20 F UP |            |                   |             | SATURATED STEAM                      |                                |  |  | ELONGATION IN INCHES PER 100 FT FROM -20 F UP |            |                   |             |
|----------------------|--------------------------------------|--------------------------------|--|-----------------------------------------------|------------|-------------------|-------------|--------------------------------------|--------------------------------|--|--|-----------------------------------------------|------------|-------------------|-------------|
| Vacuum Inches of Hg. | Pressure Pounds per Square Inch Gage | Temperature Degrees Fahrenheit |  | Cast-Iron Pipe                                | Steel Pipe | Wrought-Iron Pipe | Copper Pipe | Pressure Pounds per Square Inch Gage | Temperature Degrees Fahrenheit |  |  | Cast-Iron Pipe                                | Steel Pipe | Wrought-Iron Pipe | Copper Pipe |
|                      |                                      | -20                            |  | 0                                             | 0          | 0                 | 0           | 664.3                                | 500                            |  |  | 3.847                                         | 4.296      | 4.477             | 6.110       |
|                      |                                      | 0                              |  | 0.127                                         | 0.145      | 0.152             | 0.204       | 795.3                                | 520                            |  |  | 4.020                                         | 4.487      | 4.677             | 6.352       |
|                      |                                      | 20                             |  | 0.255                                         | 0.293      | 0.306             | 0.442       | 945.3                                | 540                            |  |  | 4.190                                         | 4.670      | 4.866             | 6.614       |
|                      |                                      | 40                             |  | 0.390                                         | 0.430      | 0.465             | 0.655       | 1115.3                               | 560                            |  |  | 4.365                                         | 4.860      | 5.057             | 6.850       |
| 29.39                |                                      | 60                             |  | 0.518                                         | 0.593      | 0.620             | 0.888       | 1308.3                               | 580                            |  |  | 4.541                                         | 5.051      | 5.268             | 7.123       |
| 28.89                |                                      | 80                             |  | 0.649                                         | 0.725      | 0.780             | 1.100       | 1525.3                               | 600                            |  |  | 4.725                                         | 5.247      | 5.455             | 7.388       |
| 27.99                |                                      | 100                            |  | 0.787                                         | 0.898      | 0.939             | 1.338       | 1768.3                               | 620                            |  |  | 4.896                                         | 5.437      | 5.660             | 7.636       |
| 26.48                |                                      | 120                            |  | 0.926                                         | 1.055      | 1.110             | 1.570       | 2041.3                               | 640                            |  |  | 5.082                                         | 5.627      | 5.850             | 7.893       |
| 24.04                |                                      | 140                            |  | 1.051                                         | 1.209      | 1.265             | 1.794       | 2346.3                               | 660                            |  |  | 5.260                                         | 5.831      | 6.067             | 8.153       |
| 20.27                |                                      | 160                            |  | 1.200                                         | 1.368      | 1.427             | 2.008       | 2705                                 | 680                            |  |  | 5.442                                         | 6.020      | 6.260             | 8.400       |
| 14.63                |                                      | 180                            |  | 1.345                                         | 1.528      | 1.597             | 2.255       | 3080                                 | 700                            |  |  | 5.629                                         | 6.229      | 6.481             | 8.676       |
| 6.45                 |                                      | 200                            |  | 1.495                                         | 1.691      | 1.778             | 2.500       |                                      | 720                            |  |  | 5.808                                         | 6.425      | 6.673             | 8.912       |
|                      | 2.5                                  | 220                            |  | 1.634                                         | 1.852      | 1.936             | 2.720       |                                      | 740                            |  |  | 6.006                                         | 6.635      | 6.899             | 9.203       |
|                      | 10.3                                 | 240                            |  | 1.780                                         | 2.020      | 2.110             | 2.960       |                                      | 760                            |  |  | 6.200                                         | 6.833      | 7.100             | 9.460       |
|                      | 20.7                                 | 260                            |  | 1.931                                         | 2.183      | 2.279             | 3.189       |                                      | 780                            |  |  | 6.389                                         | 7.046      | 7.314             | 9.736       |
|                      | 34.5                                 | 280                            |  | 2.085                                         | 2.350      | 2.465             | 3.422       |                                      | 800                            |  |  | 6.587                                         | 7.250      | 7.508             | 9.992       |
|                      | 52.3                                 | 300                            |  | 2.233                                         | 2.519      | 2.630             | 3.665       |                                      | 820                            |  |  | 6.779                                         | 7.464      | 7.757             | 10.272      |
|                      | 74.9                                 | 320                            |  | 2.395                                         | 2.690      | 2.800             | 3.900       |                                      | 840                            |  |  | 6.970                                         | 7.662      | 7.952             | 10.512      |
|                      | 103.3                                | 340                            |  | 2.543                                         | 2.862      | 2.988             | 4.145       |                                      | 860                            |  |  | 7.176                                         | 7.888      | 8.195             | 10.814      |
|                      | 138.3                                | 360                            |  | 2.700                                         | 3.029      | 3.175             | 4.380       |                                      | 880                            |  |  | 7.375                                         | 8.098      | 8.400             | 11.175      |
|                      | 180.9                                | 380                            |  | 2.859                                         | 3.211      | 3.350             | 4.628       |                                      | 900                            |  |  | 7.579                                         | 8.313      | 8.639             | 11.360      |
|                      | 232.4                                | 400                            |  | 3.008                                         | 3.375      | 3.521             | 4.870       |                                      | 920                            |  |  | 7.795                                         | 8.545      | 8.867             | 11.625      |
|                      | 293.7                                | 420                            |  | 3.182                                         | 3.566      | 3.720             | 5.118       |                                      | 940                            |  |  | 7.989                                         | 8.755      | 9.089             | 11.911      |
|                      | 366.1                                | 440                            |  | 3.345                                         | 3.740      | 3.900             | 5.358       |                                      | 960                            |  |  | 8.200                                         | 8.975      | 9.300             | 12.180      |
|                      | 451.3                                | 460                            |  | 3.511                                         | 3.929      | 4.096             | 5.612       |                                      | 980                            |  |  | 8.406                                         | 9.196      | 9.547             | 12.473      |
|                      | 550.3                                | 480                            |  | 3.683                                         | 4.100      | 4.280             | 5.855       |                                      | 1000                           |  |  | 8.617                                         | 9.421      | 9.776             | 12.747      |

<sup>a</sup>From *Piping Handbook*, by Walker and Crocker. This table gives the expansion from -20 F to the temperature in question. To obtain the amount of expansion between any two temperatures take the difference between the figures in the table for those temperatures. For example, if a steel pipe is installed at a temperature of 60 F and is to operate at 300 F, the expansion would be 2.519 - 0.593 = 1.926 in.

has been found to give reasonably good results and is deemed to be sufficiently accurate for most heating work.

Fig. 1 shows several types of expansion bends commonly used for taking up thermal expansion. The amount of pipe,  $L$ , required in each of these bends may be computed from Equation 2.

$$L = 6.16 \sqrt{D \Delta} \quad (2)$$

where

$L$  = length of pipe, feet.

$D$  = outside diameter of the pipe used, inches.

$\Delta$  = the amount of expansion to be taken up, inches.

This formula, based on the use of mild-steel pipe with wall thicknesses not heavier than extra-strong, assumes a maximum safe value of fiber stress of 16,000 lb per square inch. When square type bends are used, the width of the bend should not exceed about two times the height. It is

further assumed that the corners are made with screwed or flanged elbows or with arcs of circles having radii five to six times the pipe diameter. Use of welding elbows with radii of  $1\frac{1}{2}$  times the pipe diameter will decrease the end thrusts somewhat but will raise the fiber stress correspondingly.

All risers must be anchored and safeguarded so that the difference in length when hot from the length when cold shall not disarrange the normal and orderly provisions for drainage of the branches.

Proper anchoring of piping is especially necessary with light-weight radiators, to allow for freedom of expansion in order that no pipe strain will distort the radiators. When expansion strains from the pipes are

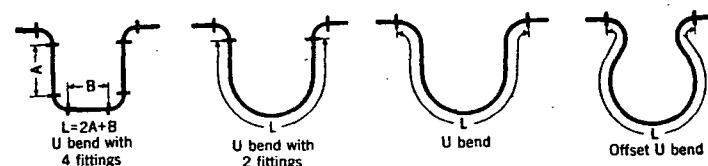


FIG. 1. MEASUREMENT OF  $L$  ON VARIOUS PIPE BENDS

permitted to reach these light metal heaters they usually emit sounds of distress which are exceedingly troublesome.

## PIPE THREADS

All threaded pipe for heating and ventilating installations uses the American Standard taper pipe thread which is made with a taper of 1 in 16 measured on the diameter of the pipe so as to secure a tight joint. Threads of fittings are tapered to the same taper. The number of threads per inch varies with the different pipe sizes. All threaded pipe should be made up with a thread paste suitable for the service under which the pipe is to be used.

## HANGERS AND SUPPORTS

Heating system piping requires careful and substantial support. Where changes in temperature of the line are not large, such simple methods of support may be utilized as hanging the line by means of rods or perforated strip from the building structure, or supporting it by brackets or on piers.

When fluids are conveyed at temperatures of 150 F or above, however, hangers or supporting equipment must be fabricated and assembled to permit free expansion or contraction of the piping. This can be accomplished by the use of long rod hangers, spring hangers, chains, hangers or supports fitted with rollers, machined blocks, elliptical or circular rings of larger diameter than the pipe giving contact only at the bottom, or trolley hangers. In all cases, allowance should be made for rod clearance to permit swinging without setting up severe bending action in the rods.

For pipes of small size, perforated metal strip is often used. For horizontal mains, the rod or strip usually is attached to the joists or steel work of the floor above. For long runs of vertical pipe subject to considerable thermal expansion, either the hangers should be designed to