the counter flow of condensed water in the same pipe seriously interfere with each other. This use of the term critical velocity must not be confused with the term velocity as used in the various branches of engineering as meaning, the velocity at which stream line flow of any fluid, under given conditions, ceases and turbulent flow begins.

The critical velocity of steam and condensate mixtures has many applications in steam heating. In some cases where it is desired to carry the water along with the steam, it is desirable to so size the pipe that the velocity of the steam is above the critical point. Often, however, it is desired to have the water of condensation flow counter to the steam. In such cases it is necessary to so size the pipe that the velocity of the steam is below the critical point.

In connection with this investigation the following problems have thus far been studied, at the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS:

1. Critical velocity of risers—one and two-pipe systems;
2. Effect of rounded, reamed and unreamed entrances, to pipe upon the critical velocity;
3. Effect of entrances of pipe cut with single and three-wheel cutters upon the critical velocity;
4. Effect of unions and couplings upon the critical velocity.

CRITICAL VELOCITY IN ONE-PIPE RISERS

A series of tests were made on 10 ft. risers of the following nominal diameters: ¾ in., 1 in., 1¼ in. and 1½ in. In order that the data should apply to pipe as found on the market several pieces of each size, with a varying degree of internal smoothness were tested. Figs. 28 and 29 show the average results of such test. In Fig. 28, the total condensation in pounds per hour is plotted against header pressure in inches of water. The velocity of the steam in feet per second as computed from the total condensation and measured area of the pipe is plotted against header pressure in inches of water in Fig. 29.

On analyzing the data obtained from tests on these pipes including the data plotted in Fig. 28 and Fig. 29, the following points seem of significance:

1. The smaller the size of the pipe and thus the smaller the internal area of the pipe, the more pronounced is the wave portion. As the size of the pipe increases the wave becomes less pronounced. For the 1½-in. pipe it practically disappears. However, a distinct change in slope from the vertical towards the horizontal can still be found. If tests were run at very small increments of pressure change, 0.01 in. of water instead of 0.10 in., it may be that the wave portion would show much more clearly for larger size pipes.
2. The point of critical velocity for all tests ranging from a very rough to a very smooth pipe varies from 22.5 ft. per sec. to 29 ft. per sec. A very good average for the entire set of tests would be 25.0 ft. per sec. The maximum variation in capacity of the various sizes of pipes tested is given in Table 45.
3. The header pressure at which the critical velocity was found in all the tests on pipe ranging from rough to smooth varies from 0.30 in. of water to 0.40 in.
4. In view of 2 and 3 it may be said that for the sizes of pipe tested and within the limits of experimental error the critical velocity is independent of the size.

EFFECT OF ENTRANCE SHAPE UPON CRITICAL VELOCITY

A series of tests were made on 1-in. risers with various shaped entrances as shown in Fig. 30. The maximum capacities obtained in these tests are as follows:

		Per Cent Decrease
Reamed entrances	24.7 lb. per hr.	.0
Rounded entrances	23.9 lb. per hr.	3.2
Squared entrances	22.2 lb. per hr.	10.1
Three wheel cutter	19.2 lb. per hr.	22.2
Single wheel cutter	17.6 lb. per hr.	28.7

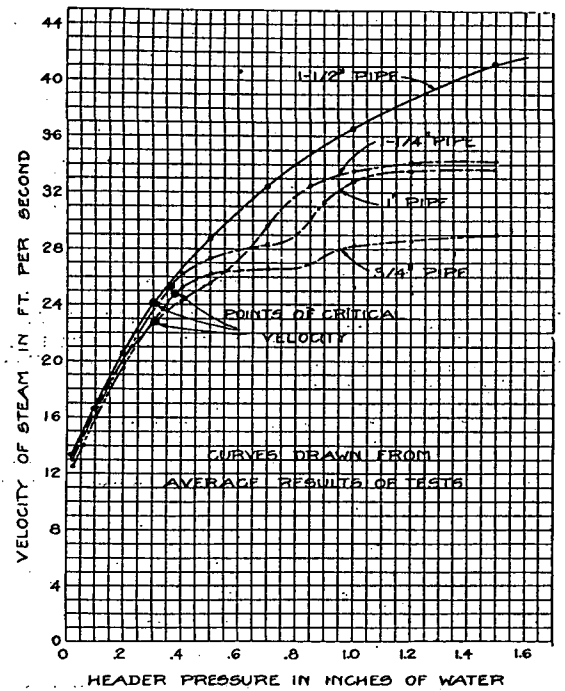

FIG. 29. CURVES SHOWING RELATION OF VELOCITY OF STEAM TO HEADER PRESSURE

As was expected, the results show a maximum capacity for the reamed pipe, slightly smaller for the rounded entrances and so on. While the results indicate a slight difference between the single and three-wheel cutter, due to the insufficiency of the data obtained, there is no attempt made here to designate the one cutter as giving a higher capacity than the other. It may be stated, however, that any cutting tool which leaves a burr in the entrance of the pipe may reduce the capacity of that pipe as much as 30 per cent. The amount of reduction depends upon the