In certain previous applications I have described the making of radiators, boilers, heaters and the like of very thin metal, preferably copper, because of its high conductive property. The present invention is directed to certain constructions by which such walls are stiffened against lateral pressures due to steam or vacuum within the tubes or chambers thereof. The accompanying drawings illustrate embodiments of the invention.

Fig. 1 is a horizontal section of a stiffened hollow or tubular structure.

Fig. 2 is a side elevation thereof.

Fig. 3 is a side elevation of a part of one of the stiffeners.

Figs. 4, 5 and 6 are horizontal sections illustrating modifications in detail.

Fig. 7 is a side elevation of part of one of the stiffeners of Fig. 5.

Figs. 8 and 9 are horizontal sections of other types of construction.

Referring to the embodiments of the invention illustrated, the water or steam wall or vessel is composed of sheets 1 of thin sheet metal spaced apart according to the required conditions of use. These two sheets are integrally united and extend continuously around comparatively stiff or heavily walled tubes 2, communicating by openings 3 with the space enclosed between the sheets 1. These sheets may be bowed outward as at 4, or may be flat as indicated at other points. They are braced at intervals by stiffeners located entirely within the sheets, so that the latter may remain imperforate so as to provide the maximum security against leaks. According to Fig. 1 the stiffeners consist of bars 5 of considerably greater width than the enclosed space and with flanges 6 or other enlargements on their edges. And the sheets 1 are bent outward as at 7 and around the enlargements 6 so as to embrace the latter and interlock the plates with the stiffeners, preventing or limiting outward movement of the plates under internal pressure and inward movement thereof in case of internal vacuum. The pipes 2 at the ends, surrounded by the plates 1 and held within a space between them, serve a similar stiffening function. For free circulation in the enclosed space, the stiffeners are provided with holes 8 at intervals in their length. See Fig. 3.

According to Fig. 4 each stiffener is made of two bars 9, overlapping at their inner edges and having registering holes. A longitudinal rod 10 passes through these holes in the several stiffeners so as to lock them against inward or outward movement.

According to Fig. 5 stiffeners 11 are used consisting of flat bars with holes 12 (Fig. 7) punched through their marginal portions. The sheets 1 are bent outward around the edges of these stiffening bars and are pressed inward as at 13 to partially enter the holes 12 and thus interlock the plates with the stiffeners. Holes 8 are provided for circulation through the centre.

According to Fig. 6, the same interlocking scheme is used, but the stiffener is made in two parts 14 overlapping at the centre and tied together by the rod 10 as in Fig. 4.

Fig. 8 shows the employment as a stiffener of an ordinary rolled I-beam 15 the flanges 16 of which are embraced and interlocked with the plates by portions 17 of the latter. The stiffeners shown are all ordinary commercial rolled bars or shapes. They may extend far beyond the plane of the side walls 1 as in Figs. 1 to 6, where a considerable stiffening is required, or to a less extent, as in Fig. 8, where there is less need for reinforcement.

Fig. 9 illustrates the arrangement where a joint is to be made in the walls of the vessel. In this case the plates 1 at each side of the vessel are welded together along the joint 18. Near the joint at each side there is a stiffener 19 comprising a bar with heads 20 about which portions 21 of the plate 22 are bent and interlocked. The joint at each side is reinforced by a second plate 22 located on the inner face of the first plate and extending to the stiffeners 19 at opposite sides of the joint, with flanges 23 bent outward and clamped between the stiffeners and the outwardly extended portions of the plates 1. Thus the plates 22 reinforce the joints against lateral strains and also against tensile strains.

The parts of the structure may be assembled in various ways. For example, the bends in the plates 1 may be made initially large enough to permit the easy insertion in their longitudinal direction of the stiffeners or the pipes 2 of Fig. 1 and the reinforcing plates 23 of Fig. 9. After which, the laterally extended parts of the plates may be pinched together into a close interlock with the stiffeners. The invention is particularly designed to facilitate the production of vessels for the uses described of very thin sheet
metal, particularly copper or cuprous alloys; and such thin sheets by their flexibility are best adapted for the bending operations involved.

Various modifications of the embodiments illustrated may be made by those skilled in the art without departing from the invention as defined in the following claims:

What I claim is:

1. A vessel of the character described having walls of thin flexible sheet metal and stiffeners extending across the enclosed space and having their opposite edges engaged by said walls, the stiffeners extending laterally beyond the normal plane of the walls and the wall extending around the outside of the stiffeners and interlocked therewith.

2. A vessel of the character described having walls of thin flexible sheet metal and stiffeners extending across the enclosed space and having their opposite edges engaged by said walls, the wall being formed of two plates welded together and the welded joint being reinforced by an inside plate extending across the joint and having its ends gripped between the stiffeners and portions of the plates.

In witness whereof, I have hereunto signed my name.

THOMAS E. MURRAY.