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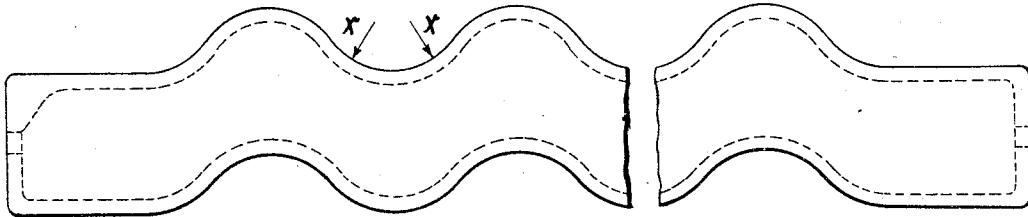
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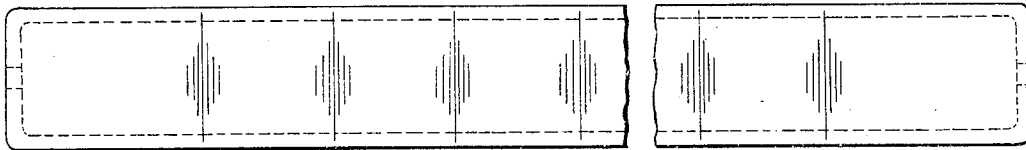
QUADRANGULAR TUBE

Filed June 19, 1931

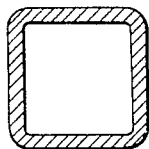
*Fig. 1.*



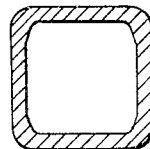
*Fig. 2.*



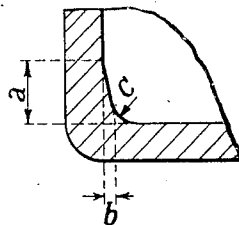
*Fig. 3.*



*Fig. 4.*



*Fig. 5.*



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# UNITED STATES PATENT OFFICE

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## QUADRANGULAR TUBE

Application filed June 13, 1931, Serial No. 345,801, and in Germany July 16, 1930.

This invention relates to a new or improved quadrangular tube adapted for the manufacture of corrugated headers for water tube boilers.

5 The corrugated headers hitherto manufactured for water tube boilers possessed the defect that the square tube utilized lost its cross-section during the pressing of the corrugations in that at the points pressed during corrugating, the radius of the rounded off inner corners became considerably reduced, which caused wrinkles and defects at the points in question. The invention has for its object a quadrangular tube in the bending of which this drawback does not occur.

According to this invention, a quadrangular tube adapted for the manufacture of corrugated headers for water tube boilers has rounded corners on the outside as usual and an increased wall thickness in the neighborhood of the corners. Preferably the cross-section of each thickened part lies asymmetrical with respect to the corresponding diagonal and in such manner that all sides of the tube are symmetrical relatively to their median lines. In an embodiment of the invention each thickened part has the form of a right-angled triangle, the sides of which coincide with the inner sides of the tube cross-section and one side of which ( $a$ ) is about as long as twice the wall thickness of the tube, and the length of the other side of which ( $b$ ) is about one-third of the wall thickness of the tube. The corner, where the inner side of the tube cross-section, with which the said shorter side coincides and the hypotenuse of the said triangle meet, is rounded off with a radius which is about equal to the wall thickness of the tube. In this embodiment the sides of the finished corrugated header, which are determined by the longer sides of the said triangle, lie parallel to the bending plane of the header.

The invention is shown by way of example in the accompanying drawing, in which:—

Fig. 1 shows a finished corrugated header in plan view on the bending plane;

Fig. 2 a side elevation corresponding to Fig. 1;

Fig. 3 a cross-section through a quadrangular tube of customary shape prior to bending;

Fig. 4 a cross-section through a quadrangular tube of the shape proposed according to this invention, also prior to bending; and

Fig. 5 is a part of Fig. 4 on a larger scale and also illustrates a portion of the sectional view of Fig. 1.

Referring to the drawing, whilst the tube shown in Fig. 3, which is the customary shape, has the usual wall thickness, even in the neighborhood of the rounded edges, the wall thickness in the case of the tube according to Fig. 4, which is the shape according to the present invention, is increased adjacent the corners. The thickened parts lie asymmetrical relatively to the corresponding diagonals and in such a manner that all sides of the tube are symmetrical relatively to their median lines. Each thickened part has the shape of a right-angled triangle, the sides of which coincide with the inner sides of the tube cross-section and one side  $a$  of which (Fig. 5) is about as long as twice the wall-thickness of the tube and the length of the other side  $b$  of which is about one-third of the wall thickness of the tube, whilst the corner, where the inner side of the tube cross-section, with which the shorter side coincides, and the hypotenuse of the said triangle meet, is rounded off with a radius  $c$ , which is about equal to the wall thickness of the tube.

When the tube is bent into a header after being filled with an incompressible material, the sides of the tube which are determined by the longer sides  $a$  of the triangle increasing the thickness, are laid parallel to the bending plane of the header.

By means of the embodiment described, the threatened inner bend is displaced out of the compression range of the wall to be bent and the threatened corner is protected by the thickening against excessive compression stresses. Tests have shown that a header produced in this way possesses at the pressed points and particularly at the points which were hitherto exposed to the greater danger

(which are indicated with arrow  $\alpha$  in Fig. 1), an inner bend the radius of which corresponded at least to that prescribed, i. e. about one-third to one-half of the wall thickness of the tube. In addition these points were free from defects and wrinkles.

What I claim and desire to secure by Letters Patent is:—

1. As a new article of manufacture a quadrangular tube adapted for the manufacture of corrugated headers for water tube boilers and having rounded outer corners, the wall thickness in the neighborhood of the corners being greater than elsewhere.

2. As a new article of manufacture a quadrangular tube adapted for the manufacture of corrugated headers for water tube boilers and having rounded outer corners, the wall thickness in the neighborhood of the corners being greater than elsewhere, each thickened part lying asymmetrical with respect to the corresponding diagonal and in such a manner that all sides of the tube are symmetrical relatively to their median lines.

3. As a new article of manufacture a quadrangular tube adapted for the manufacture of corrugated headers for water tube boilers and having rounded outer corners, the wall thickness in the neighborhood of the corners being greater than elsewhere, each thickened part having the form of a right-angled triangle the sides of which coincide with the inner sides of the tube cross-section and one side of which is about as long as twice the wall thickness of the tube and the length of the other side of which is about one third of the wall thickness of the tube, whilst the corner where the inner side of the tube cross section with which said second-named side coincides and the hypotenuse of the triangle meet, is rounded off with a radius about equal to the wall thickness of the tube.

4. As a new article of manufacture a quadrangular tube adapted for the manufacture of corrugated headers for water tube boilers and having rounded outer corners, the wall thickness in the neighborhood of the corners being greater than elsewhere, the cross section of the thickened portion at said corners being bounded by a straight inwardly facing edge which is rounded off where it meets the inner walls of the tube.

5. A corrugated tubular header for water tube boilers having rounded outer corners, the wall thickness in the neighborhood of the corners being greater than elsewhere, each thickened part having the form of a right-angled triangle the sides of which coincide with the inner sides of the header cross section and one side of which is about as long as twice the wall thickness of the header, and the length of the other side of which is about one third of the wall thickness of the header, while the corner where the inner side of the header cross section with which said second-

named side coincides and the hypotenuse of the triangle meet is rounded off with a radius about equal to the wall thickness of the tube, and the sides of the header which include the longer sides of the strengthening triangles lie parallel to the longitudinal bending plane of the header.

The foregoing specification signed at Cologne, Germany, this 8 day of June, 1931.

MATTHIAS INGENKAMP.

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