No. 731,513. PATENTED JUNE 23, 1903.

D. L. SHAFFER.

FIRE FLUE BOILER.

APPLICATION FILED APR. 28, 1902.

NO MODEL.

Fig. 1.

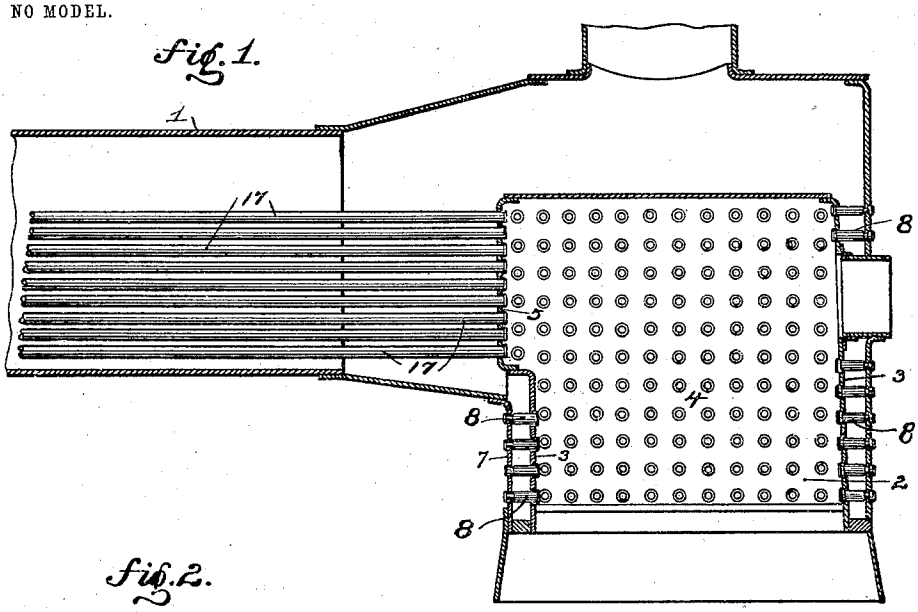



Fig. 2.

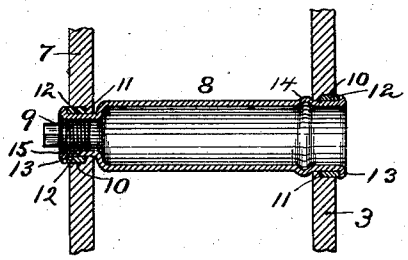



Fig. 4.

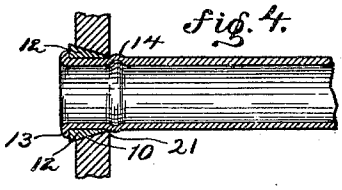



Fig. 3.

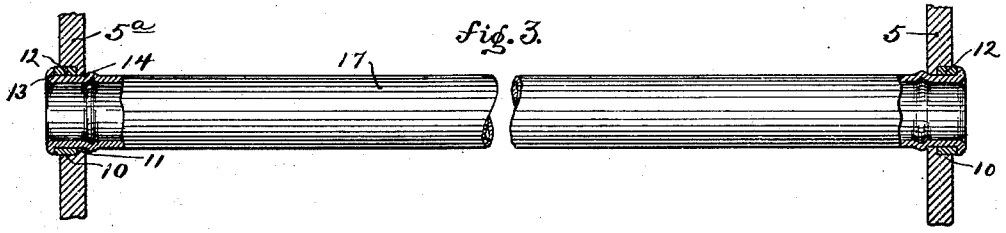
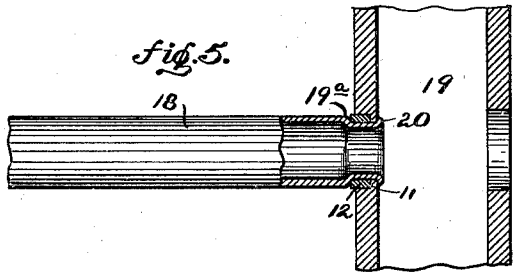



Fig. 5.




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No. 731,513. Patented June 23, 1903.

# UNITED STATES PATENT OFFICE.

DAVID L. SHAFFER, OF PITTSBURG, PENNSYLVANIA.

## FIRE-FLUE BOILER.

SPECIFICATION forming part of Letters Patent No. 731,513, dated June 23, 1903.

Application filed April 28, 1902. Serial No. 105,008. (No model.)

*To all whom it may concern:*

Be it known that I, DAVID L. SHAFFER, a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Fire-Flue Boilers; and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to fire-flue boilers, although portions thereof are adapted to water-tube boilers and to other apparatus.

One of the objects of my invention is to improve fire-flue boilers so as to provide additional heating-surface.

A further object of my invention is to provide a non-leaking joint for the tubular stay-bolts of my fire-flue boiler, the fire-flues of any fire-flue boiler, or for steam or similar pipes of any character.

In many fire-flue boilers, such as locomotives and the like, as well as in some water-tube boilers, the fire-box is surrounded by a water-jacket which is composed of inner and outer sheets forming the vessel for the water and which sheets are connected by stay-bolts. The fire-flues are connected to the front fire-box sheet and extend longitudinally of the boiler nearly to the stack and project through a similar flue-sheet.

One of the objects of my invention is to improve boilers of this type so as to provide an increased heating-surface.

To this end it consists in forming the stay-bolts from tubes having their inner ends open to the fire-box, so that the flame and heat can enter the same, and having their outer ends closed, so as to prevent the heat and flame from escaping.

Another object of my invention is to provide a non-leaking joint for these tubular stay-bolts and for the fire flues and tubes ordinarily used.

To this end it consists in forming an annular recess on one side of the flue-sheet around the tube or tubular stay-bolt and forcing into said recess a ring or collar of soft, compressible metal, such as copper or the like, and then expanding or beading out the end of the tube, so as to bear against this collar or ring.

In the accompanying drawings, Figure 1 is a sectional view of a locomotive-boiler, showing my invention applied thereto. Fig. 2 is an enlarged sectional view of the tubular stay-bolt. Fig. 3 is a sectional view of the fire-flue. Fig. 4 is a sectional detail view showing a modified form of joint, and Fig. 5 shows the joint applied to a water-tube boiler.

I have shown my invention applied to an ordinary locomotive-boiler; but it is to be understood that it is not limited thereto and that this has been selected for purposes of illustration only. In the drawings the shell of the boiler is shown at 1 and the fire-box at 2. The walls of this fire-box are formed of the end sheets 3, side sheets 4, and flue-sheet 5. The fire-flues project through the sheet 5 and extend to the opposite end of the boiler, where they project through a similar flue-sheet. The shell of the boiler is extended downwardly on each side and behind the fire-box, as at 7, so as to leave a considerable space between the same and the walls of the fire-box, thus forming the water-jacket for said box. The walls 7 of the boiler and the walls of the fire-box usually are connected by stay-bolts. According to the first part of my improvement I connect the same by means of hollow or tubular stays 8, one of which is shown in section in Fig. 2. These stays have their inner ends open and communicating with the fire-box, while their outer ends are closed in any suitable manner, as by means of the plug 9, so as to prevent the flame and heat from escaping. The flame and heat from the fire-box enter these tubular stays, thus heating the walls thereof and communicating heat to the water in the water-jacket. As a consequence the heating-surface of the boiler is increased to a very considerable extent and its steam-generating power is correspondingly increased. Furthermore, the side walls of the fire-box can be made much thicker and stronger than ordinarily without decreasing the steam-generating power, as the additional surface given by the hollow stays will compensate for the decreased heat-conducting property of the thicker fire-box walls. This part of my improvement can be applied to any construction of boiler having a water-jacket surrounding the fire-box and is not limited to the specific form of boiler shown. These tubular stays may of course be secured to the sheets in any suitable manner; but I

prefer to connect them thereto by means of the improved joint which forms the second part of my invention. This joint is formed by providing the sheets with a countersunk recess 10 surrounding the hole through which the tube projects. This recess may be formed either straight, as shown in Fig. 2, or may be beveled, as shown in Fig. 4. In either event, however, the recess does not extend entirely through the sheet, but leaves a portion of the walls of the sheet abutting against the tube and fitting closely thereagainst, thus, in fact, providing a shoulder 11. A bushing, ring, or collar 12 of soft compressible metal, such as brass or the like, is firmly driven or calked into this recess and around the end of the tube, and then the end of the tube is beaded or expanded outward to form a shoulder 13, which laps over the end of the collar or bushing, as shown. The end of the tube preferably will be straight—that is, untapered, as shown—and the soft-metal bushing when driven into the recess and against the shoulder 11 will be compressed firmly against the walls of the tube and against the walls of the recess, so that the joint can be calked up perfectly tight. The tube just inside of the flue-sheet will preferably be beaded outwardly, as shown at 14, so that when the packing-ring is driven into the recess the sheet cannot spring inwardly. The outer end of these tubular stays is reduced to form the neck 15; but this is merely for appearance sake, so as to obviate the necessity of cutting very large holes in the outer sheets; otherwise the outer joint is precisely the same as the inner. The pressure of the steam in the water-jacket tends to force the sheets 3 and 7 outward, and with the ordinary construction of tube-joints leakage is liable to result. With my tube-joint, however, such outward pressure will only more firmly compress the rings 12 between the shoulders 11 and beads 13, thus increasing rather than decreasing the tightness of the joint. The greater the pressure the greater the resistance of the joint against leakage. In Fig. 3 I have shown this joint applied to the ordinary fire-flues 17, the ends of which project through the flue-sheets 5 and $5^a$. The joint, however, is exactly the same as that above described with reference to the tubular stays 8. In both of these cases the steam-pressure is such as to force the flue-sheets apart, and consequently the recesses are formed on the outer faces of the sheets and the ends of the tubes are expanded out over the compressible bushing, so that when the pressure comes on the sheets the expanded ends 13 of the pipe will draw the compressible bushings the tighter in the seat. In case, however, the pressure is in the opposite direction the recesses for the packing-rings will be formed on the inner faces of the sheets. For instance, in Fig. 5 I have shown the joint applied to an ordinary water-tube boiler, the tube being shown at 18 and the header at 19. As is well known in boilers of this kind the tubes expand in length, so that the natural effect is to force them farther into the header. In applying my joint thereto the recess for the packing-ring 12 is formed on the outer face of the header-wall, and the tube will be provided with a shoulder $19^a$, which bears against the packing-ring, so that when said tube expands it will force the packing-ring tighter into the recess. The end of the water-tube will preferably be expanded, as shown at 20, merely to hold it in place.

So far I have mentioned only a recess 10 having straight walls. This, however, is not necessary, as the walls may be beveled, as shown, for instance, in Fig. 4. The inner portion of the flue-sheet, however, will bear against the pipe, as at 21, and the packing-ring will preferably be beveled, as shown, and forcibly calked into the recess. In all forms of my invention the depth of the recess 10 and of the bushing 12 is not essential, as a mere countersunk groove and a small ring or collar will be equally effective. The construction is such that the packing-ring will be driven in against a shoulder or its equivalent on the flue-sheet and cannot be driven through the flue-sheet. Consequently it will be calked very firmly around the tube and in the seat in the sheet, while the expanded outer end of the tube bearing against said bushing will compress it the tighter the greater the pressure or expansion. With fire-flue boilers and the like the ends of the tube and of the bushing 12 will preferably be permitted to project slightly beyond the face of the sheet—as shown, for instance, in Figs. 2, 3, and 4—so that when the bead on the end of the tube is destroyed, as it is by reason of the cinder striking against it and cutting it out, the bushing can be driven in farther and still leave a projecting end of the tube which can again be expanded outwardly to form a bead overlapping the bushing.

The tubular stays described can be applied to any boiler provided with a water-jacket around its fire-box or heating-chamber and irrespective of the particular type of boiler, whether it is a fire-flue boiler or water-tube boiler. The improved joint described can be used not only in connection with such tubular stays, but also in connection with the fire-flues or with water-tubes of a water-tube boiler or for any steam, water, or air tubes in steam, hot-water, or air regenerators or heating systems or tubes in refrigerating apparatus, or, in fact, in all apparatus or devices in which tubes are secured in sheets or plates.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In a steam-boiler, the combination with the sheets inclosing the fire-chamber, of other sheets surrounding the same and leaving a space to form a water-jacket, tubular stays connecting said sheets, said stays having their outer ends closed and their inner ends open and communicating with the fire-

chamber, annular recesses formed in the outer face of said sheets around said stays, said recesses ending in shoulders, and rings or collars of soft metal in said recesses and abutting against said shoulders, both ends of said stays being provided with beads which overlap and bear against said rings.

2. A tube connection comprising a sheet provided with a tube-seat, said seat being enlarged on one side to form an annular recess ending in a shoulder, a packing ring or collar of soft metal in said recess and abutting against said shoulder, and a tube having a straight or untapered end extending through the sheet and ring and being provided with a bead on its outer end which overlaps and bears against said packing-ring.

3. A tube connection comprising a sheet provided with a tube-seat, said seat being made to fit closely around the tube for a portion of the thickness of the sheet and being enlarged on one side to form an annular recess ending in a shoulder, a ring or collar of soft metal in said recess and abutting against the shoulder, a tube having a straight or untapered portion extending through the sheet and ring and being provided with a bead bearing against the sheet and having its outer end provided with a bead or shoulder overlapping the packing-ring.

In testimony whereof I, the said DAVID L. SHAFFER, have hereunto set my hand.

DAVID L. SHAFFER.

Witnesses:

F. W. WINTER,

ROBERT C. TOTTEN.