T. M. RENDCHEN.

STEAM SUPERHEATER FOR BOILERS.

APPLICATION FILED JAN. 30, 1912.

1,066,223. Patented July 1, 1913.

Fig. 1.

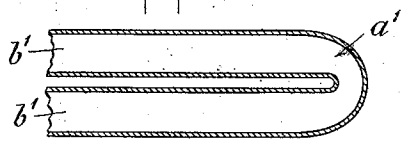


Fig. 2.

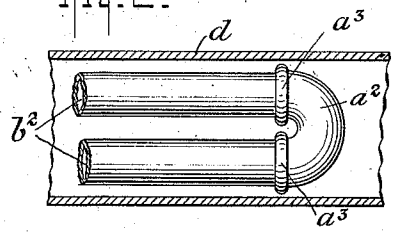


Fig. 3.

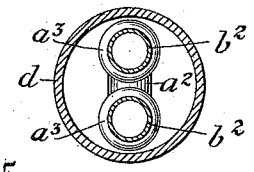


Fig. 4.

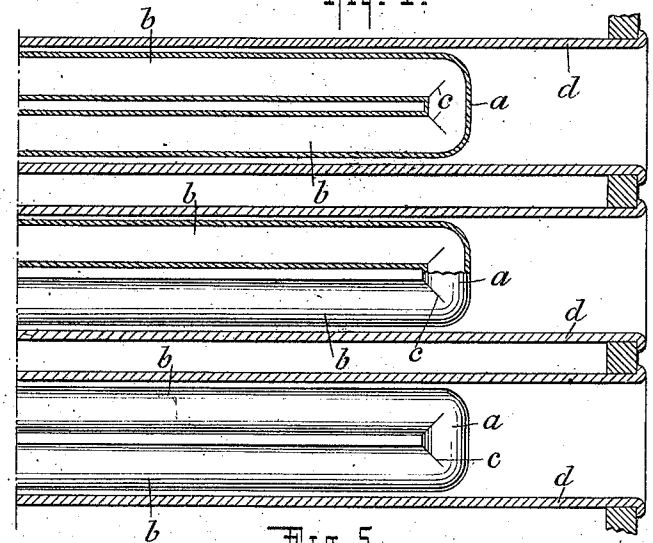


Fig. 5.

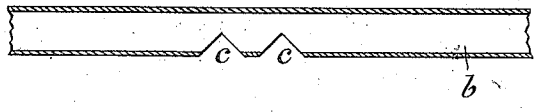
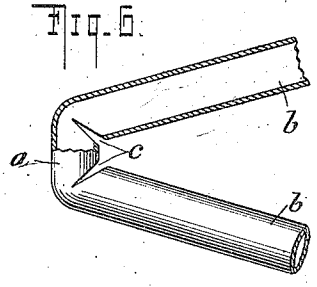


Fig. 6.



WITNESSES

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PHOTO-LITHO. by SACKETT & WILHELMS CORP. N.Y.

UNITED STATES PATENT OFFICE.

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STEAM-SUPERHEATER FOR BOILERS.

1,066,223. Specification of Letters Patent. Patented July 1, 1913.

Original application filed March 11, 1908, Serial No. 420,472. Divided and this application filed January 30, 1912. Serial No. 674,331.

To all whom it may concern:

Be it known that I, THEODOR MARTIN RENDCHEN, a subject of the German Emperor, and resident of Altona-Ottensen, in the German Empire, have invented certain new and useful Improvements in Steam-Superheaters for Boilers, of which the following is a specification.

This application is a division of my earlier application, Serial No. 420,472, filed March 11, 1908.

My invention relates especially to steam superheaters of the smoke tube type, *i. e.*, superheaters in which the steam to be superheated is passed through superheater tubes which are arranged in a plurality of the smoke or fire tubes of the boiler, the superheater tube in a given smoke tube returning upon itself and being provided with a return bend for the purpose of such return which bend usually lies wholly within the smoke tube between the two tube sheets of the boiler.

More especially my invention relates to the construction and character of this return bend by virtue of which I obtain certain marked advantages as will hereinafter appear.

The object of my invention is to produce a superheater of the type specified having superheater tubes provided with return bends which by their form and construction permit said superheater tubes to have a maximum cross sectional area without restricting said area at the bend, and with a minimum restriction of the cross sectional area of the smoke tubes in which said superheater tubes are inserted.

With this end in view my invention consists in certain novel features of construction and combinations of parts, as will be hereinafter fully described with reference to the accompanying sheet of drawings, and pointed out in the claims.

In the drawing, Figure 1 is a central longitudinal section of a superheater tube with return bend of well known construction, Fig. 2 is a longitudinal section, and Fig. 3 a cross section of a boiler smoke tube (unessential parts being broken away) containing a superheater tube of another well known construction; Fig. 4 is a longitudinal section (similarly broken away) through a plurality of boiler smoke tubes containing each a superheater tube arranged in accordance with and embodying my invention, and Figs. 5 and 6 are separate detailed views illustrating the preferred mode of construction of the superheater tube proper.

Similar letters of reference relate to like parts throughout the several views.

Steam superheaters, of the general type herein referred to, are known in which the superheater tubes connected with collectors suitably arranged in the boiler pass through the boiler smoke tubes in such a manner that each of the superheater tubes proceeding from one of the collectors is carried to and fro in each of one or more of said smoke tubes and is then connected with the other collector, the return bend of the superheater tube being located inside the boiler tube.

One of the most usual and obvious forms of paired superheater tubes, or superheater element with return bend, is that illustrated in Fig. 1 in which a single length of tube is bent back upon itself to provide the two legs b' b' united by the return bend a'. This bending even if done with the utmost care and in the most approved manner as *e. g.*, by suitably heating the tube where it is to be bent, and by packing the tube, at and near the part to be bent, with sand or other suitable medium, invariably results in a flattening of the tube at the bend and in a consequent diminution of cross section. When it is attempted to bend the tube so that the two legs b', b' shall lie very close together, as is necessary in order that they shall have a large cross section relatively to the cross section of the smoke tube in which the paired tubes are to be inserted, *i. e.*, in order not to require that a smoke tube of unduly great diameter be used, the relative flattening of the tube at the bend and conse-

quent relative diminution of cross section at that point becomes much greater. In bends made as above set forth the smallest permissible mean radius of bending which may be employed for superheater tubes to be used in superheaters of the type referred to without excessive restriction of cross section at the bend and consequent inefficiency of operation is the outer diameter of the tube to be bent *i. e.*, the legs of the tube of the bending may not be separated by a distance less than the diameter of the tube.

For a given distance between legs b', b' the relative flattening at the return bend will be less if a smaller diametered superheater tube be employed but this, of course, results in a less volume of steam passing through said tube, as well as in a greater loss of steam pressure, from one collector to the other.

In order to completely avoid any reduction in the cross section of the superheater tube at the return bend the construction illustrated in Figs. 2 and 3 is sometimes employed. Here the return bend consists of a special piece a^2, usually a casting and known as a "return bend", into which the two lengths, or legs, of tube b^2 are fitted. This bend a^2 must be made with walls of sufficient strength to withstand the, generally very high, pressure of the steam from which it results that the free cross section of the boiler tube is reduced especially by the enlarged socket portion a^3 of the bend into which the superheater tubes are fitted thereby impeding the free passage of the heating gases in a highly prejudicial manner. In this case also it is only possible to partially obviate this defect by the employment of superheater tubes having a prejudicially small relative diameter.

The connection of the two lengths of superheater tube arranged inside the boiler tube in accordance with either of the constructions just described, that is to say, by the return bend formed in the tube itself by bending a single length back upon itself or by a special separate bend presents grave disadvantages the chief of which is that in the first case the relative cross section of the superheater tube is reduced so that the steam is throttled, while in the latter case the relative cross section of the smoke tube is reduced whereby there results a smaller flow of the fire gases and hence a restriction of the heating power.

My present invention has for its object to avoid the difficulties and disadvantages above referred to and utilizes a superheater tube preferably formed by bending a tube length back upon itself so as to permit the two legs to be brought very close together without flattening the tube at the return bend and without in any way restricting the cross sectional area at such bend; this preferred way of bending the tube also enables a return bend to be provided which will lie substantially entirely between the opposite outer portions of the peripheries of the two legs, *i. e.*, which will neither bend nor be expanded outwardly beyond either leg in the plane of the two legs or laterally as to said plane. The superheater tubes thus formed, in combination with the smoke tubes in which they are inserted, comprise my invention, and provide an arrangement in which superheater tubes may be used which are of larger diameter than hitherto relative to said smoke tubes for an equal obstruction of fire gases, or else in which superheater tubes, of the same diameter as hitherto relative to the smoke tubes, may be used for a lessened obstruction of fire gases.

The essence of the preferred method of forming a superheater tube used by me resides in the fact that the bend a (Fig. 4) connecting the lengths of tube b is formed by bending the tube in such a manner that all pressing or upsetting of the material which might flatten the tube is avoided. With this object notches or recesses c (Figs. 4–6) are formed on the inner sides of the superheater tubes b at the places where the bends a are to be formed. The notches c are so formed and arranged that their edges meet after the two legs b have been bent parallel to one another, that is to say, when the curve or return bend has been completely formed. The abutting edges of the notches are then welded together and the bend or curved portion a, which is now finished, presents everywhere a cross section at least as great as that of the tube b itself (Fig. 4) and is also amply strong enough to withstand the steam pressure.

The desirable characteristics of the bend a in superheater tubes made as above described will remain exactly the same no matter how close together the two legs b, b may be brought. But in practice the distance between the legs should be sufficient to enable the welding of the notch edges to be thoroughly and conveniently done and this will ordinarily be not less than about $\frac{1}{8}''$. It is desirable also that there should be sufficient room between the legs to permit the fire gases to have free circulation over the entire surface of each leg.

Superheater tubes b comprising a return bend a formed and arranged in the manner described can be arranged inside the smoke tubes d of a boiler the internal diameter or cross sectional area of the smoke tubes being utilized to the best advantage while at the same time there is no unnecessary restriction of the cross sectional area of the boiler tubes.

The return bend a for the superheater tubes b formed and arranged in accordance

with the present invention therefore permits of the use of superheater tubes of the largest possible cross section without any restriction of area at the bend and with the smallest possible restriction of the cross section of the smoke tubes.

In the embodiment illustrated in the drawings I have shown the notches *c*, *c* as V shaped and cut to about the middle of the superheater tube *i. e.*, to a depth equal to about one-half the diameter of the tube and this type and depth of notch I prefer; but I find that notches of other types and depths will also enable me to produce superheater tubes capable of performing the purposes of my invention. Furthermore while, in the embodiment referred to, I have shown two notches for each return bend, the number of notches is not a necessary feature of my invention in its broader aspect.

While I have described my invention as embodied in a smoke tube superheater I may, without departing from the spirit of the invention, use it in other forms of heating apparatus, in which a pair of legs united by a return bend as one element is inserted in a tube as another element one of said elements carrying a heating medium and the other a medium to be heated.

Having described my invention, I now claim:—

1. In a heating apparatus, two tubes in combination, one of said tubes being located within the other and comprising two legs united by a return bend having an internal cross-section at least as great as that of the legs, said bend lying substantially entirely between the opposite outer portions of the peripheries of the two legs, one of said tubes being adapted for the passage of a heating medium and the other for the passage of a medium to be heated.

2. In a heating apparatus, two tubes in combination, one of said tubes being located within the other and comprising two legs distanced from one another by less than their own diameter and united by a return bend having an internal cross-section at least as great as that of the legs, said bend lying substantially entirely between the opposite outer portions of the peripheries of the two legs, one of said tubes being adapted for the passage of a heating medium and the other for the passage of a medium to be heated.

3. In a heating apparatus, two tubes in combination, one of said tubes being located within the other and comprising two legs substantially $\frac{1}{8}''$ apart and united by a return bend having an internal cross-section at least as great as that of the legs said bend lying substantially entirely between the opposite outer portions of the peripheries of the two legs, one of said tubes being adapted for the passage of a heating medium and the other for the passage of a medium to be heated.

4. In a heating apparatus, in combination, a straight tube and a tube located in said straight tube comprising two legs distanced from one another by less than their own diameter and integrally united by a return bend having an internal cross-section at least as great as that of the legs, said bend lying substantially entirely between the opposite outer portions of the peripheries of the two legs, one of said tubes being adapted for the passage of a heating medium and the other for the passage of a medium to be heated.

5. In a heating apparatus, two tubes in combination, one of said tubes being located within the other and having substantially uniform wall thickness throughout and further comprising two legs distanced from one another by less than their own diameter and united by a return bend having an internal cross-section at least as great as that of the legs, said bend lying substantially entirely between the opposite outer portions of the peripheries of the two legs, one of said tubes being adapted for the passage of a heating medium and the other for the passage of a medium to be heated.

6. In a superheater of the type described, in combination, a smoke tube, and a superheater tube within said smoke tube comprising two legs distanced from one another by less than their own diameter and united by a return bend having an internal cross-section at least as great as that of the legs said bend lying substantially entirely between the opposite outer portions of the peripheries of the two legs.

7. In a superheater of the type described, in combination, a smoke tube and a superheater tube within said smoke tube having substantially uniform wall thickness and further comprising two legs distanced from one another by less than their own diameter and united by a return bend having an internal cross-section at least as great as that of the legs, said bend lying substantially entirely between the opposite outer portions of the peripheries of the two legs.

8. In a superheater of the type described, in combination, a smoke tube and a superheater tube within said smoke tube, said superheater tube comprising a tube which has been notched upon one side, bent about said notches until the notch edges abut and then welded at the edges of said notch.

9. In a superheater of the type described, in combination, a smoke tube and a superheater tube of substantially uniform wall thickness within said smoke tube said superheater tube comprising two legs distanced from one another by less than their own

diameter and united by a return bend having an internal cross-section at least as great as that of the legs and having a weld extending from the inner surface of the bend radially outward said return bend lying, furthermore, substantially entirely between the opposite outer portions of the peripheries of the two legs.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

THEODOR MARTIN RENDCHEN.

Witnesses:
FRANZ KNEIFEL,
NORA WILKEN.