This invention relates to boilers and superheaters, and more particularly to a means for supporting the tubes of superheaters located in comparatively high temperature zones.

The tubes are usually comparatively small in diameter, so that they are relatively weak with respect to transverse bending loads. Consequently there is a tendency for the tubes to sag from their own weight, particularly in the case of long tubes extending in substantially horizontal directions. Furthermore, the tubes expand and contract considerably in a longitudinal direction as a result of the excessive temperature changes to which they are subjected, and this often causes buckling of the tubes.

It is accordingly one object of the invention to provide a simple and inexpensive means to support the tubes of a superheater, and particularly to provide a construction which will prevent sagging or buckling of the tubes.

It is a further object of the invention to provide a superheater tube support which may be located in very high temperature zones, and which is so constructed that it will satisfactorily withstand the high temperatures and the action of the hot furnace gases.

With these and other objects in view, as will become apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

Referring to the drawing illustrating one embodiment of the invention, and in which like reference numerals indicate like parts,

Fig. 1 is a longitudinal sectional elevation through a boiler and superheater;

Fig. 2 is an enlarged view of the supporting means for the superheater tubes, shown in section on the line 2—2 of Fig. 4;

Fig. 3 is a top plan view of the supporting means; and

Fig. 4 is a section on the line 4—4 of Fig. 2.

The embodiment illustrated comprises a furnace chamber 10 having a front wall 11, a rear wall 12, and side walls 14. The furnace 10 may be fired with any suitable fuel.

Associated with the furnace is a steam boiler of the well-known Badenhausen type comprising a rear water drum 15 mounted above the rear wall 12, a front water drum 16 mounted above the front wall 11, and a steam and water drum 18 mounted above the rear drum 15. These drums are all arranged transversely of the furnace chamber 10, and they are connected by three banks of water tubes to form a complete circulating system. As illustrated, tube bank 19 slopes upwardly and forwardly between drums 15 and 16, tube bank 20 slopes upwardly and rearwardly between drums 16 and 18, and tube bank 22 extends substantially vertically between drums 18 and 15. A steam drum 23 is mounted above the front water drum 16, and a row of tubes 24 leads from the steam and water drum 18 to the steam drum. These tubes 24 support refractory material 26 which forms a roof for the steam generator. A vertical plate 27 is located in the rear of the vertical tube bank 22, and a gas outlet duct 28 is connected at the lower end of this tube bank. Baffles 30 are arranged to direct the hot gases from the furnace chamber 10 successively over the tube banks 19, 20 and 22 to the outlet 28. This generates steam which is delivered to the steam and water drum 18 and then flows through the tubes 24 to the steam drum 23. The steam is dried and slightly superheated as it passes through the tubes 24 which are exposed to contact with the hot gases.

The lower tube bank 19 is bent upwardly intermediate its length to provide a space therebelow for a convection superheater 32 formed of comparatively small diameter tubes bent into zigzag loops in vertical planes. The inlet ends of the superheater tubes 32 are connected to the steam drum 23. A row of water tubes 33 is located beneath the superheater tubes and extends between the drums 15 and 16. These tubes 33 reduce the temperature of the gases slightly before they reach the superheater, and also protect the superheater to an appreciable extent from the direct radiant heat of the furnace.

The steam as it leaves the superheater 32 is delivered to a second superheater 34 which is located in a zone of comparatively high temperature beneath the water tubes 33. In the construction illustrated the superheater tubes 34 are parallel but staggered with respect to the water tubes 33, and the tubes 34 extend from a horizontal header 36 in the rear of the wall 12 to a horizontal header 37 in front of the wall 11. The outlet ends of the convection superheater tubes 32 are connected to the header 36, which may be conveniently supported from the drum 15 by means of angles 38. The header 37 is fastened to a suitable supporting structure 39.

The superheater tubes 34 are small in diameter as compared with the water tubes 33, and tend to sag because of their own weight and the long space between the headers 36 and 37. Furthermore, these superheater tubes are exposed to in-
tense radiant heat as well as contact with the hot gases which flow upwardly from the furnace 10, and there is consequently a considerable longitudinal expansion of the tubes which tends to result in buckling and distortion. There may also be some relative movement between the headers 36 and 37.

In order to overcome these difficulties I provide means for supporting the superheater tubes 34 intermediate their lengths from the water tubes 33, the construction preferably being such as to allow full freedom for longitudinal expansion of the superheater tubes. In the illustrated embodiment each superheater tube 34 is formed with an expansion bend or loop 41 intermediate its length, each loop 41 being shaped as an inverted U extending upwardly from the tube. An upwardly projecting lug or plate 42 is welded or otherwise secured to each superheater tube at the top of the loop 41 therein, and each lug 42 is supported from a tile 43 which rests upon a pair of adjacent water tubes 33. The tiles 43 are preferably formed of a suitable refractory material capable of withstanding high temperatures. Each tile 43 is provided with an opening or slot 45 extending vertically therethrough to receive the lug 42, and the lug is formed with a transverse aperture 46 through which a pin 47 is inserted at assembly. This pin, which is preferably square in cross-section, rests upon the upper surface of the tile and thus supports the tile 43. The tile may be recessed at 49 to receive the pin 47, and this recess may be filled with plastic refractory 50 (Fig. 2) to protect the pin 47 and the upper part of the lug 42 from exposure to the hot gases. Each tile 43 is shaped to fit closely against the adjacent water tubes and to extend downwardly between the tubes and close to the top of the loop 41, so that the lug 42 is almost entirely enclosed.

The operation of the invention will now be apparent from the above disclosure. Hot gases from the furnace 10 flow past the tube row 33 and the tube banks 19, 20 and 22 to the gas outlet 28. Steam which is generated in the water tubes separates from the water in drum 18 and flows through the tubes 24 to drum 23 and thence into the superheater tubes 32. After passing through these tubes and being superheated, the steam enters the rear header 26 and the high temperature superheater tubes 34, where it is raised to the desired final temperature and then delivered to the front header 37, which may be connected to any apparatus requiring superheated steam, such as a steam turbine (not shown).

Since the superheater tubes 34 are spaced a substantial distance below the water tubes 33, there is no opportunity for molten ash particles or slag carried by the furnace gases to bridge across between the tubes and block the gas passage. The construction provides an effective slag screen. The loop 41 in each superheater tube provides sufficient flexibility to take care of any expansion or contraction caused by temperature changes in the tubes or relative movements between the headers 36 and 37, thus preventing any possibility of the tubes buckling, or pulling out of the headers. At the same time each tube is firmly supported adjacent to the loop by means of the tile and associated parts, so that sagging of the tubes is prevented. Any heat absorbed by the lugs 42 will be transmitted directly to the superheater tubes, because of the welded connection, and overheating of the lugs will be prevented. Furthermore, these lugs are well protected from the hot gases by reason of the surrounding refractory tiles 43. These tiles are fully capable of withstanding high temperatures without danger, and they are in any event cooled considerably by reason of their extensive contact with the water tubes 33. The construction is simple and inexpensive to manufacture and install.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A combined boiler and superheater comprising a furnace chamber, a row of spaced parallel inclined water tubes extending above the furnace chamber, a row of spaced parallel superheater tubes located a substantial distance below the water tubes and directly exposed to the radiant heat from the furnace chamber, said superheater tubes being parallel to and staggered with respect to the water tubes, each superheater tube being formed with a loop intermediate the length thereof shaped as an inverted U projecting upwardly from the tube, and supporting means connecting the water tubes with the loops.

2. A combined boiler and superheater comprising a row of spaced parallel inclined water tubes, a row of spaced parallel superheater tubes located below the water tubes and staggered with respect to the water tubes, each superheater tube being formed with a loop intermediate the length thereof shaped as an inverted U projecting upwardly from the tube, a lug welded to each loop and extending upwardly therefrom, refractory tiles bridging across between the water tubes, each tile having an opening therethrough to receive one of the lugs, the lugs having transverse apertures through their upper portions and the tiles having recesses in their upper surfaces, a pin located in each aperture and resting upon the upper surface of the adjacent tile and within the recess therein, and plastic refractory material in each recess to protect the pins and upper portions of the lugs.

3. A combined boiler and superheater comprising a row of spaced parallel inclined water tubes, a row of spaced parallel superheater tubes located below the water tubes and staggered with respect to the water tubes, each superheater tube being formed with a loop intermediate the length thereof shaped as an inverted U projecting upwardly from the tube, a lug welded to each loop and extending upwardly therefrom, and refractory tiles bridging across between the water tubes and arranged to support the lugs, each tile having an opening therethrough to receive one of the lugs and thus protect the lug from exposure to hot gases, the tiles being shaped to contact with a substantial area of the water tubes.

4. A combined boiler and superheater comprising a furnace chamber, a row of spaced parallel inclined water tubes extending above the furnace chamber, a row of spaced parallel superheater tubes located a substantial distance below the water tubes and directly exposed to the radiant heat from the furnace chamber, said superheater tubes being staggered with respect to the water tubes, a lug projecting upwardly from each superheater tube intermediate the length thereof, and refractory tiles bridging across between the water tubes adjacent to the lugs and serving to support the lugs, the tiles being shaped to extend throughout substantially their entire length and protect them from the heat.

5. A combined boiler and superheater comprising a furnace chamber, a row of spaced parallel inclined water tubes extending above the furnace chamber, a row of spaced parallel superheater
tubes located a substantial distance below the water tubes and directly exposed to the radiant heat of the furnace chamber, each superheater tube being formed with a loop intermediate the length thereof shaped as an inverted U projecting upwardly from the tube, and supporting means connecting the water tubes with the loops.

6. A combined boiler and superheater comprising a furnace chamber, a row of spaced parallel inclined water tubes extending above the furnace chamber, a row of spaced parallel superheater tubes located a substantial distance below the water tubes and directly exposed to the radiant heat of the furnace chamber, said superheater tubes being staggered with respect to the water tubes, each superheater tube being formed with a loop intermediate the length thereof shaped as an inverted U projecting upwardly from the tube, a lug welded to each loop and projecting upwardly therefrom, and refractory tiles bridging across between the water tubes adjacent to the lugs and arranged to support the lugs.

MAX H. KUHNER.