Aug. 9, 1966 C. D. JUCHTERN 3,265,044

HEAT EXCHANGER TUBE SUPPORT

Filed April 3, 1964 2 Sheets-Sheet 1

FIG_1

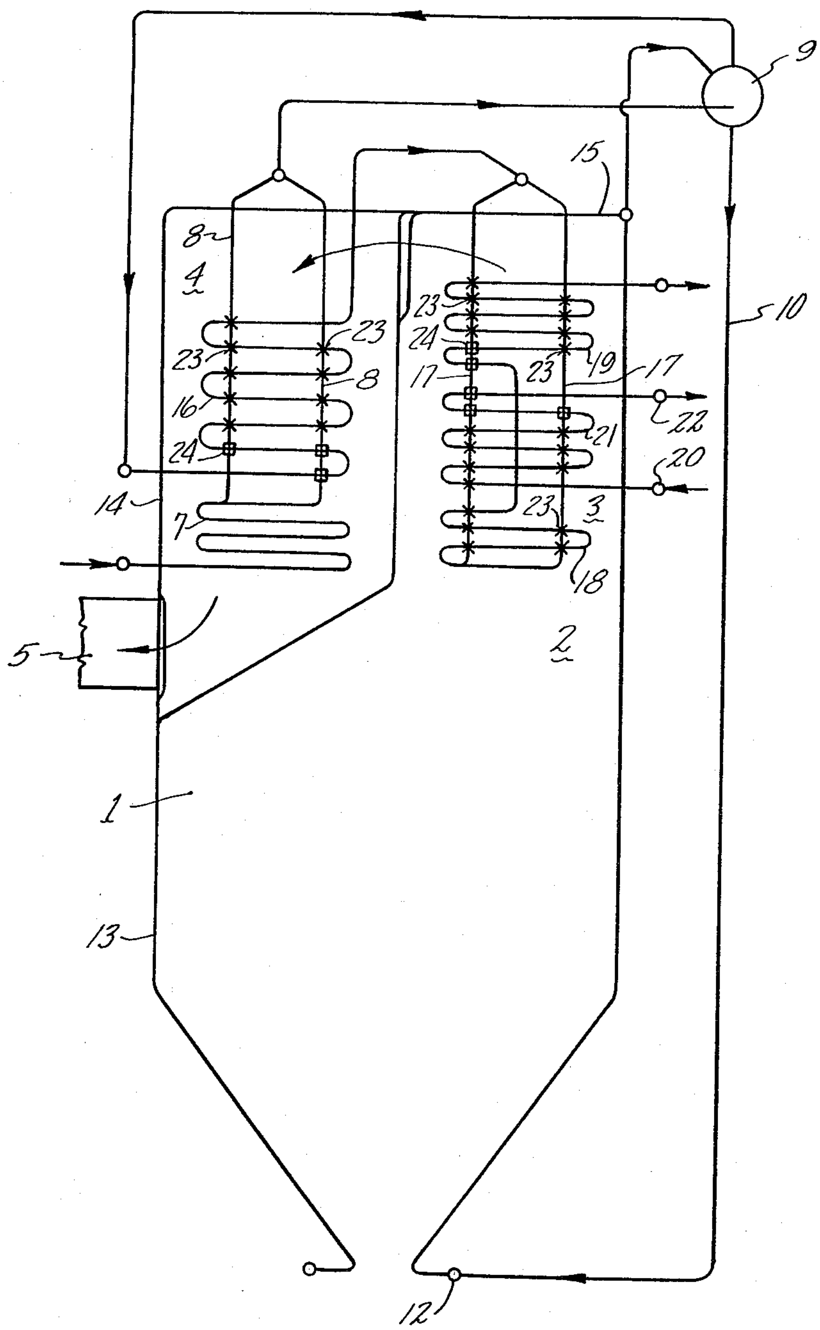

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FIG. 2

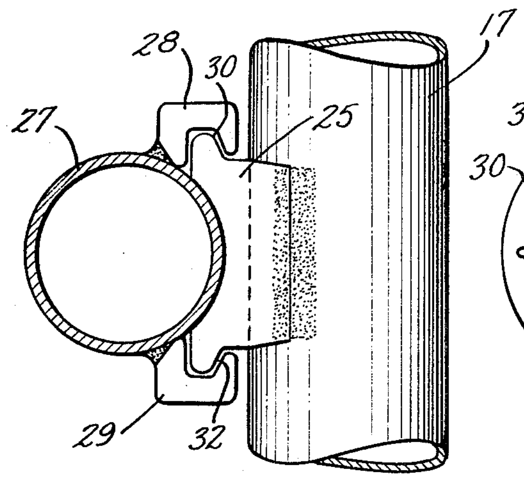


FIG. 5

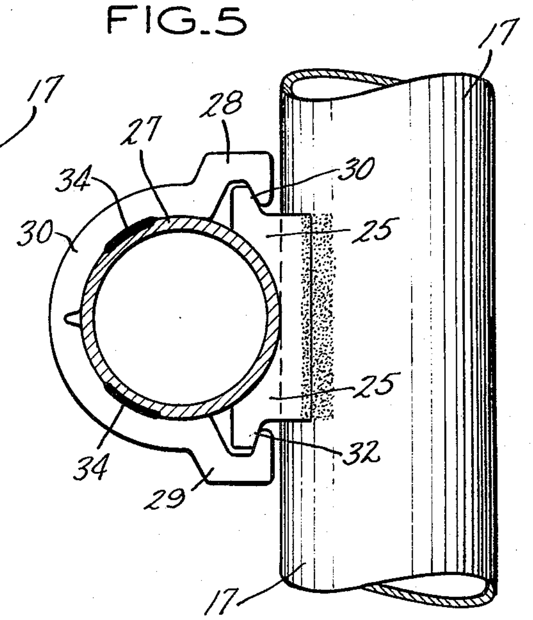


FIG. 3

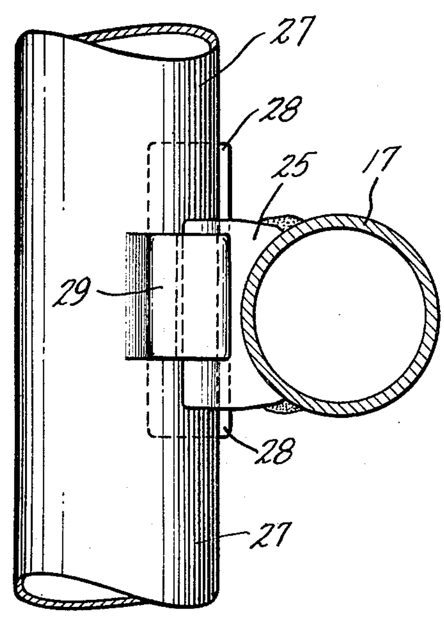
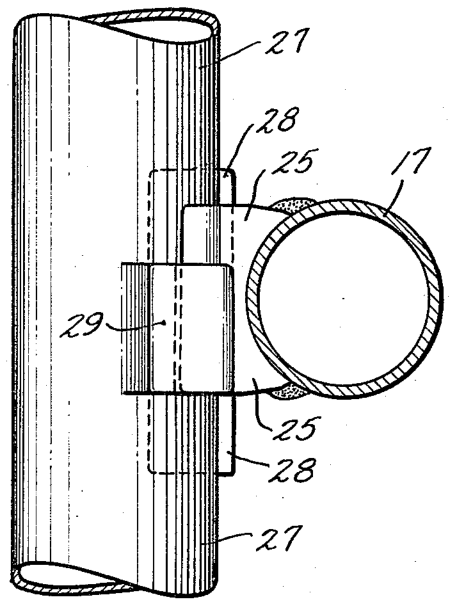


FIG. 4



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HEAT EXCHANGER TUBE SUPPORT

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This invention relates to heat exchangers and particularly to an apparatus for slidably supporting horizontal serpentine heating surface on a vertical tube in a vertical flue of such a heat exchanger.

In the design of vapor generators in particular, horizontal heating surface is normally disposed in a vertical flue as an effective and efficient means of transferring heat. This surface normally comprises serpentine tubular elements such that the flow of the vapor passing therethrough progresses upward or downward through the flue. Surface of this type is used in several sections for the superheating of the high pressure vapor, and also for the reheating of low pressure vapor.

Whereas end support of these elements is possible in smaller units, in the large vapor generators the supported span is excessive permitting too much deflection and stress in the elements. Therefore vertical support tubes are run through the flue on which the horizontal elements are supported. Where relative expansion between the various passes of the elements of the particular heating section and the relative expansion of the various sections is small, each pass of the elements may be directly welded to the support tube. Some of these elements expand more than other due to the difference in temperature of the fluids passing through the horizontal elements, either in one section as the steam progresses therethrough, or between adjacent sections. This is particularly true when the temperature level dictates the use of austenitic material which expands about 30 percent more than the ferritic material used elsewhere. When such differential expansion is encountered, with the elements directly welded to the support tubes, the horizontal elements must be spaced vertically at considerable distances, to prevent overstressing of the support tubes and permits them to flex sufficiently. Since this requires excessive vertical distances, the problem has been avoided by supporting the elements from the support tube so that they were free to move relative to one another.

This has been done in the past by bifurcating the support tube and running one leg of the bifurcate down each side of the horizontal elements. Between the pair of tubes were then welded bars, upon which each pass of the horizontal elements would rest. This is expensive due to the cost of fabricating bifurcates and due to the increased amount of tubing required. The use of the bifurcate decreases the flow in the two legs after the bifurcate to one-half of that in the main tube, decreasing the cooling effect of the steam flow, and thereby increasing the metal temperature of the support tube. There is also introduced the problem common in most bifurcating situations, in that there is no assurance that the flow will be divided evenly between the two tubes.

In my invention the horizontal elements are slidably supported from individual support tubes in a manner such that each is free to expand relative to the support tubes through a novel attachment which has a low propensity to jam due to ash binding.

It is an object of this invention to support horizontal elements in a vertical flue of a vapor generator so that each pass and each section is free to expand without overstressing the support tubes and without having to provide excessive length of the support tubes for flexibility.

It is a further object to provide a sliding joint to support the horizontal elements which is free from freezing due to ash accumulation.

Other and further objects of the invention will become apparent to those skilled in the art as the description proceeds.

With the aforementioned objects in view, the invention comprises an arrangement, construction and combination of the elements of the inventive organization in such a manner as to obtain the results desired, as hereinafter more particularly set forth in the following detailed description of an illustrative embodiment, said embodiment being shown by the accompanying drawings wherein:

FIGURE 1 is a sectional side elevation of a typical vapor generator showing a typical location of the support arrangement;

FIGURE 2 is a sectional side elevation of the support detail;

FIGURE 3 is a bottom view of FIGURE 2 in the cold, or as erected, positions;

FIGURE 4 is a bottom view of FIGURE 2 in the hot, or normal operating, position; and

FIGURE 5 is a sectional side elevation showing an alternate method of securing the jaws to the horizontal tube.

FIGURE 1 is a sectional side elevation of a vapor generator illustrating the use of the instant invention. Fossil fuel is bruned in furnace **1** with the combustion gases passing through the throat **2**, thence passing upwards through flue **3** and downwards through flue **4** exiting through duct **5**. Feedwater is supplied to the economizer **7** at about 420° F. wherein it is heated to approximately 500° F., thereafter passing through the support tubes **8** being collected and conveyed to the steam drum **9**. Downcomer **10** carries the boiler water downward to furnace wall supply headers **12** from which the steam generating surface is supplied. This steam generating surface operating at saturated temperature includes the frunace walls **13**, the walls of the flue **14** and the roof **15**.

Saturated steam is conveyed from the steam drum **9** to the horizontal superheater section **16** wherein the steam is heated before being conveyed through the support tubes **17** to the intermediate superheater section **18** and then to finishing superheater section **19**. The steam thus heated is conveyed to a steam turbine (not shown) and returned to the vapor generator passing through header **20**, reheated in reheating section **21**, to be returned again to a turbine through reheat outlet header **22**.

The horizontal heating surface in the flues **3** and **4** is supported from the support tubes **17** and **8** through directly welded supports **23** and through sliding supports **24**. It should be noted that many different tubing temperatures are encountered in this support arrangement. The walls **14** of the flue **4** are at saturation temperature which is approximately 650° F. whereas the temperature of the support tubes **8** is only 500° F. The steam entering section **16** is also 650° F., but the temperature leaving this section is in the order of 800° F. The walls of flue **3** are also at saturation temperature with the temperature entering reheater **21** being in the order of 450° F. while the temperature leaving this section is in the order of 1000° F. The support tubes **17** in this section are at about 800° F. with the temperature leaving superheating sections **18** and **19** at about 900° F. and 1000° F. respectively. In order to permit adequate flexing in the movement of all the pressure parts without overstressing any individual part, some of the passes of the horizontal assemblies are left partially unsupported, some are directly welded as indicated by directly welded supports **23**, while others are supported through sliding supports **24**.

These sliding supports **24** are shown in more detail in

FIGURE 2 wherein saddle **25** is welded to support tube **17**, which could equally well be support tube **8**. The tube **27** of one pass of a horizontal assembly is supported from the saddle **25** by means of an upper jaw **28** and lower jaw **29**. In order that tube **27** will be able to expand freely with relation to support tube **17**, it is important that the jaws **28** and **29** be parallel with the tube **27** as well as the upper lip **30** and the lower lip **32** of the saddle **25**. The saddle arrangement facilitates accurate alignment. It is recommended that the saddle be welded longitudinally to the tube **17** on both sides of the tube, to avoid the possibility of the saddle cocking and so binding in the jaws **28** and **29**.

Under normal loading the tube **27** exerts a downward force on the saddle **25**, the jaw **28** supporting all the load while the jaw **29** is relatively inoperative, but is required to prevent the tube **27** from warping or twisting off the saddle **25**. During erection of some units it is required that the support tubes **17** be cold sprung thereby reversing the forces such that when the unit is cold the tube **27** exerts an upward force on saddle **25**. At this time jaw **29** engaging lip **32** of the saddle **25** prevents the tube **27** from disengaging from its support on tube **17**.

My tube support has particular application in zones of very high gas temperature such as in supporting horizontal elements in the vertical flue **3**. Each portion of the tube support is in good heat transfer contact with the steam cooled tubing thereby facilitating the cooling of the support members. Furthermore, each support member is comprised only of short portions so that no extreme high metal temperature would be encountered in any portion of the tube support. It is this combination of small casting volume, short heat transfer lengths and adequate welding contact with both hanger tube and unit tube which provides good cooling of the support. This makes it possible to use these spacers in areas of high gas temperature without their burning up or wasting away because of corrosive elements in the products of combustion.

It has been found that sliding parts inside the gas pass of vapor generators often tend to fill with ash and slag subsequently binding the sliding elements. In order to avoid this difficulty the sliding clearances between jaw **28** and the saddle **25** as well as between the lower jaw **29** are limited to a maximum of about $\frac{1}{32}$ of an inch. With a small clearance of this magnitude the ash canot build up sufficient strength to freeze a sliding joint. The ash buildup on these joints may occur during normal full load operation or it may occur while the unit is shutting down. In many cases this ash will be deposited while still sticky, freezing to a solid mass upon cooling.

In my invention precautions have been taken to avoid substantial ash buildup at any place in the joint where binding may occur. The upper jaw **28** is extended to cover the entire saddle **25** not only in its hot position but also in the erected cold position. This can be best seen by reference to FIGURES 3 and 4 which are bottom views of FIGURE 2 in the cold and hot positions respectively. In these figures the extension of the upper jaw **28** beyond the saddle **25** in each position can be clearly seen.

In order to prevent the accumulation of ash in the concave upward opening of the lower jaw **29**, this lower jaw is fabricated to be shorter than the saddle and is placed to be in complete engagement with the saddle both in the cold position as illustrated in FIGURE 3 and in the hot position as illustrated in FIGURE 4. Inasmuch as the concave upward opening of the lower jaw **29** is always filled with the lower lip **32** of the saddle no ash buildup can occur beyond the amount of the clearance. This permits free operation of the slip joint during start-up and shutdown of the unit.

Although it is preferred that the element tube **27** be supported essentially tangent to the support tube **17** this is not always feasible because of the varying spacing of the assemblies in the various banks of horizontal elements. Inasmuch as the support tubes **17** must ideally be straight, variations in spacing between reheater section **21** and superheater sections **18** and **19** make it necessary to suport the horizontal tubes **27** in some cases a finite distance from the support tube **17**.

The determination of the particular joints which require a sliding joint must be made on the basis of the over-all design of the entire gas pass structure. In some cases it may be preferable to solidly weld all the joints on one of the support tubes with the other support tube carrying sliding joints. In some cases solid welded joints may be used on both support tubes at some elevations while sliding joints are desired for support at other elevations. In each design an analysis of the entire structure should be made to determine which joints can be welded without setting up excessive stresses in any tube, the remainder of these tubes requiring sliding joints. In the course of this analysis the amount of relative expansion and the direction of it will be determined, thereby establishing the relative lengths of the jaws **28** and **29** with respect to the saddle **25** as well as their disposition in the cold position to permit expansion in the proper direction, as the unit heats up.

If no particular precautions are taken when jaws **28** and **29** are welded to the element tube **27**, the weld on cooling will cause the jaws to rotate away from the saddle **25**, thereby producing a poor fit between the jaw and the saddle with excessive clearance and a possibility that the jaws may rotate off the saddle. These jaws should be securely clamped during welding to avoid this problem of excessive rotation.

The embodiment illustrated in FIGURE 5 demonstrates an alternate method of avoiding this problem of rotation. Saddle **25** is again welded to the support tube **17** as before, this figure illustrating the application to tangent tubes. The upper jaw **28** and the lower jaw **29** are incorporated as opposite ends of C-shaped member **30**. The C-shaped member is welded circumferentially at weld **34** thereby avoiding the problem of rotation of the jaws on the cooling of the weld metal.

While I have illustrated and described a preferred embodiment of my invention it is to be understood that such is merely illustrative and not restrictive and that variations and modifications may be made therein without departing from the spirit and scope of the invention. I therefore do not wish to be limited to the precise details set forth but desire to avail myself of such changes as fall within the purview of my invention.

What I claim is:

1. A heat exchanger having a furnace, means for burning an ash laden fuel therein, a vertical flue for the conduction of combustion gases from said furnace, horizontal serpentine tubular fluid heating elements disposed in said vertical flue, each of said serpentine elements comprising a plurality of horizontal tubes, vertical support tubes extending through said vertical flue adjacent the serpentine elements, means for supporting a horizontal tube of one of said heating elements from the vertical support tube comprising: a saddle welded to the vertical support tube, said saddle having an upper lip projecting vertically upward and extending parallel to said horizontal tube, and a lower lip projecting vertically downward and extending horizontally parallel to said horizontal tube; an upper jaw welded to said horizontal tube slidably engaging said upper lip; a lower jaw welded to said horizontal tube slidably engaging said lower lip; and said lower jaw extending longitudinally with the horizonal tube a lesser distance than the upper jaw, and located such that all portions of said lower jaw are vertically underneath some portion of said upper jaw.

2. A heat exchanger having a furnace, means for burning an ash laden fuel therein, a vertical flue for the conduction of combustion gases from said furnace, horizontal serpentine tubular fluid heating elements disposed in said vertical flue, each of said serpentine elements comprising a plurality of horizontal tubes, vertical support tubes extending through said vertical flue adjacent the serpentine elements, at least one horizontal tube of said serpentine elements moving a predetermined distance in relation to one of said support tubes, means for supporting a horizontal tube of the serpentine heating elements from said one vertical support tube comprising: a saddle welded to the vertical support tube, said saddle having an upper lip projecting vertically upward and extending parallel to said horizontal tube, and a lower lip projecting vertically downward and extending horizontally parallel to said horizontal tube; an upper jaw welded to said horizonal tube slidably engaging said upper lip; a lower jaw welded to said horizontal tube slidably engaging said lower lip; and said lower jaw extending a distance less than said lower lip extends, and located such that no portion of the lower jaw disengages said lower lip during the relative movement.

3. An apparatus as in claim **2** wherein the upper jaw is extended horizonally parallel to the horizontal tube a greater distance than the upper lip such that during a pre-

determined relative movement all portions of the lip are engaged with some portion of the upper jaw.

4. An apparatus as in claim **2** wherein the upper and lower jaws comprise opposite ends of a C-shaped member encircling said horizonal tube, said C-shaped member being welded circumferentially to the horizontal tube.

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