Feb. 13, 1968 W. A. HALE 3,368,547

FINNED-TUBE HEAT EXCHANGER

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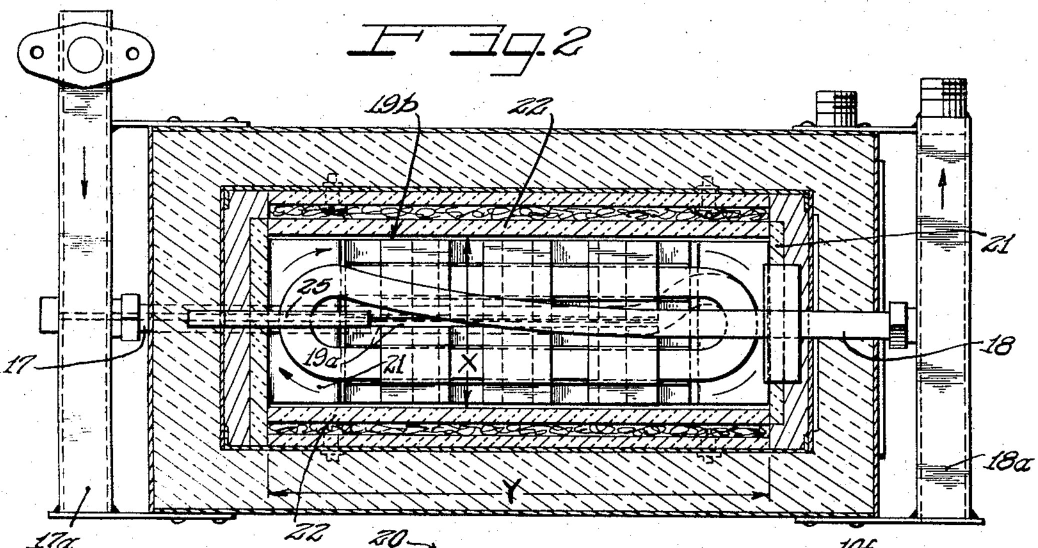
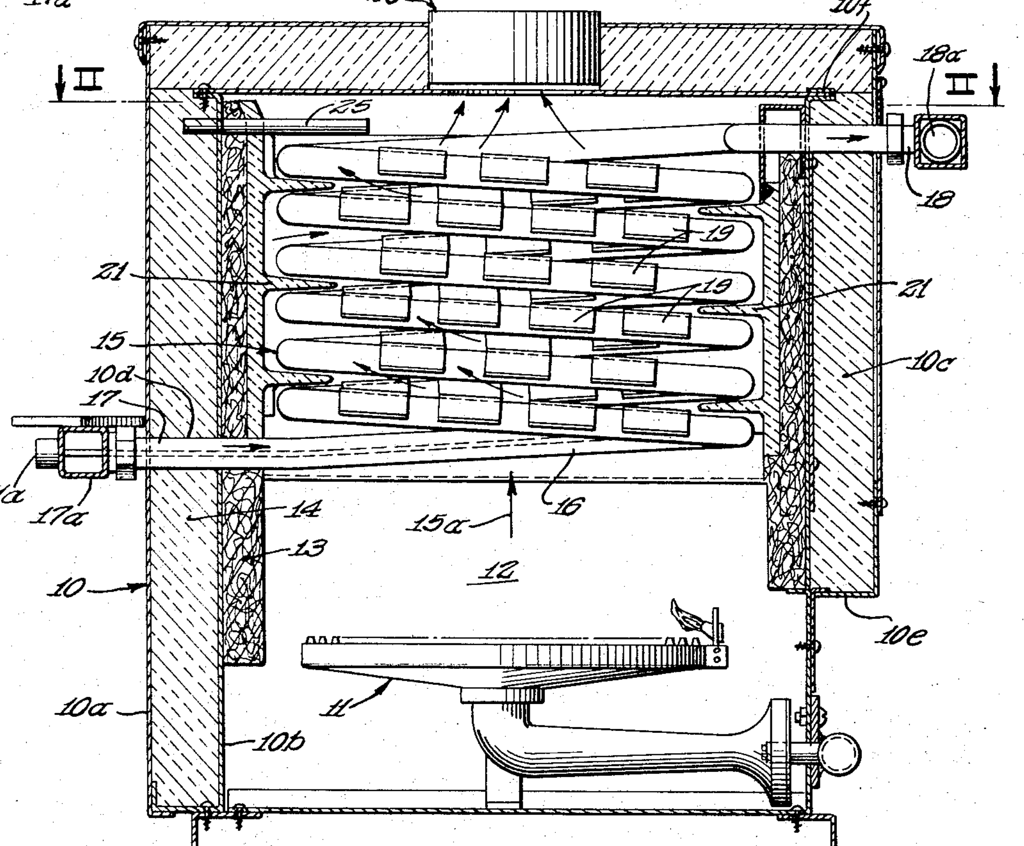
Fig. 2





INVENTOR.

William A. Hale

Fig. 1

BY Hill, Sherman, Meroni, Gross & Simpson ATTORNEYS

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FINNED-TUBE HEAT EXCHANGER

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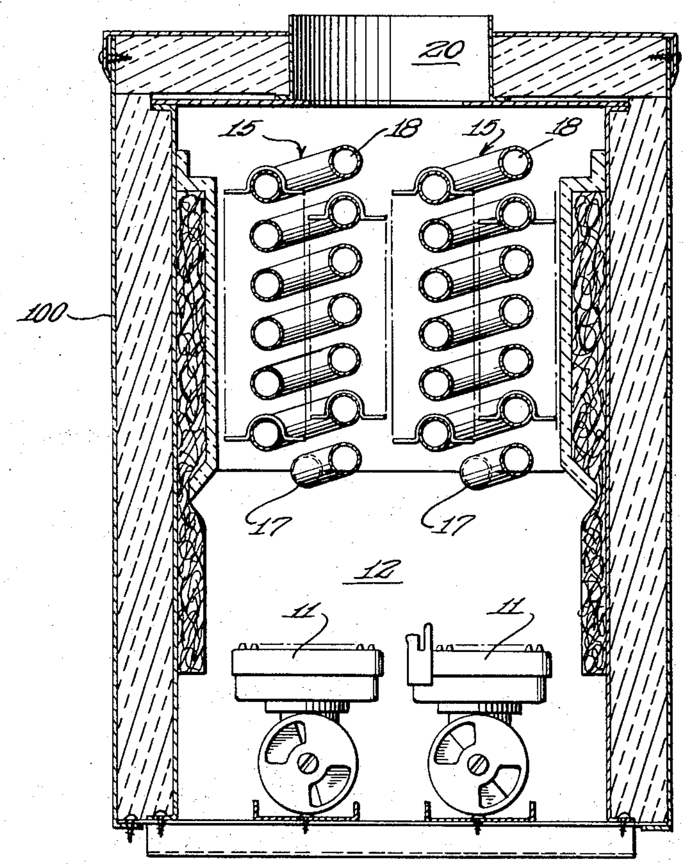
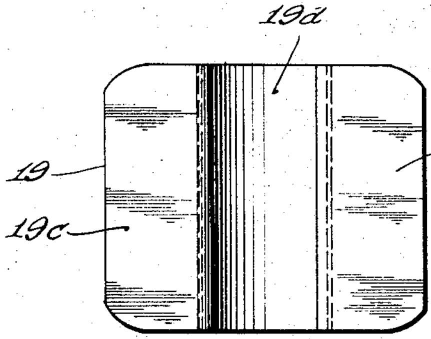


Fig. 3



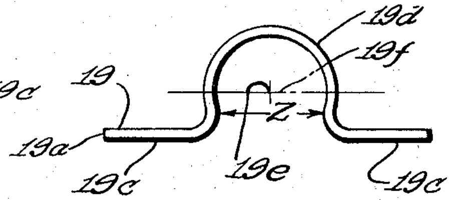


Fig. 6

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Fig. 5

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FINNED-TUBE HEAT EXCHANGER

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Fig. 4

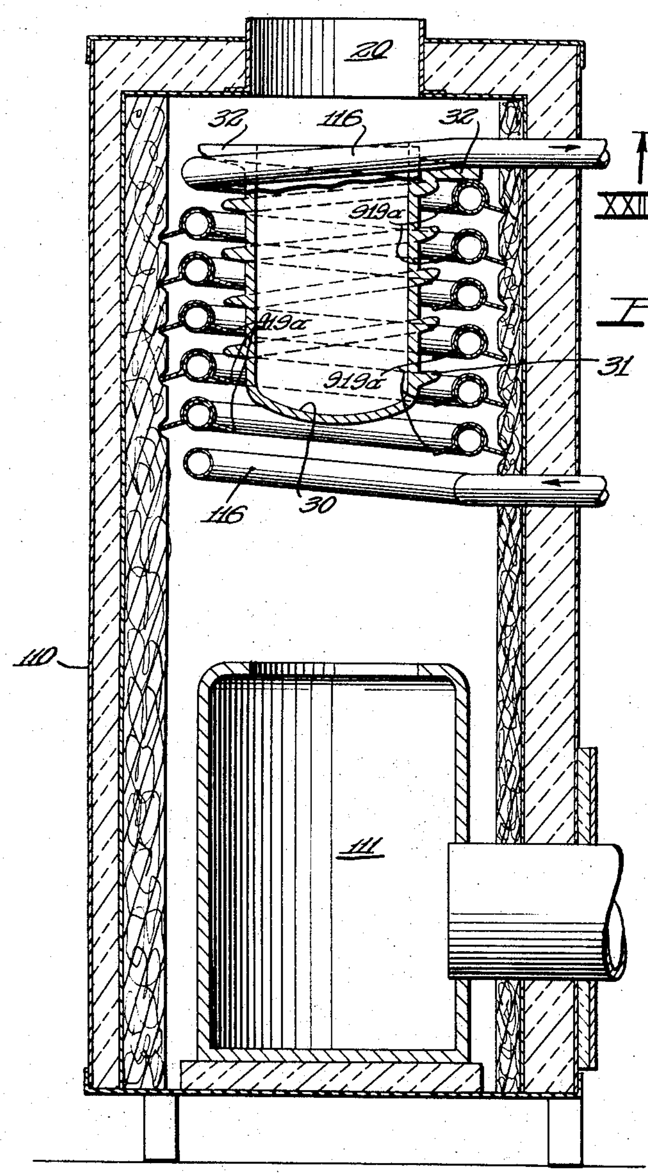

Fig. 22

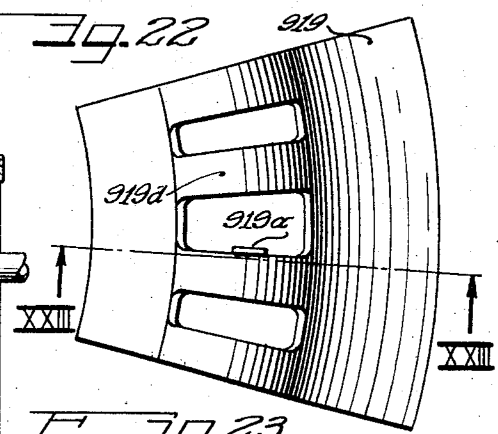

Fig. 23

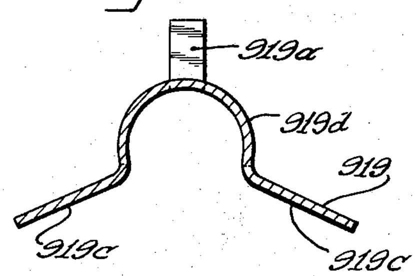

Fig. 24

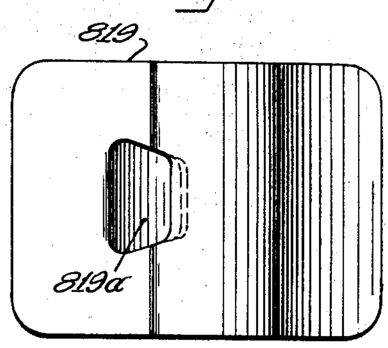

Fig. 25

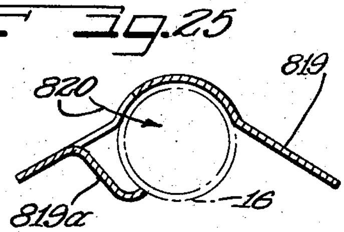

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Fig. 7

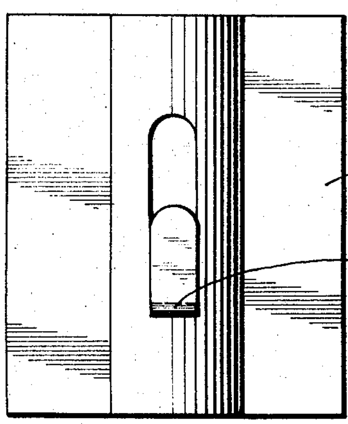


Fig. 8

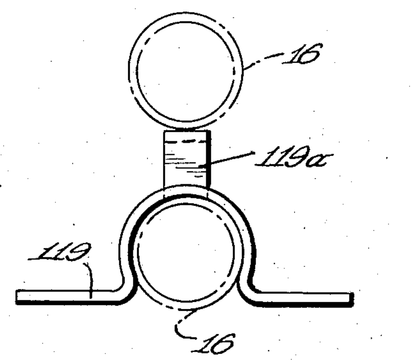


Fig. 10

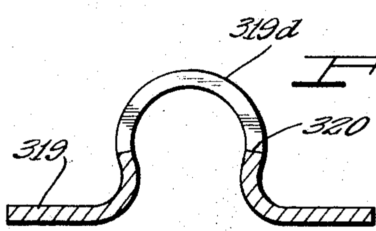


Fig. 12

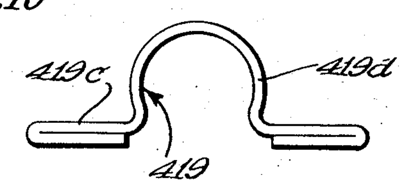
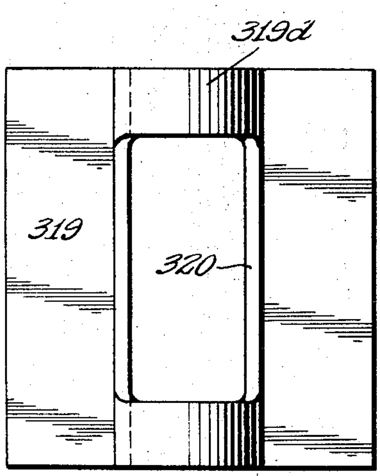


Fig. 9



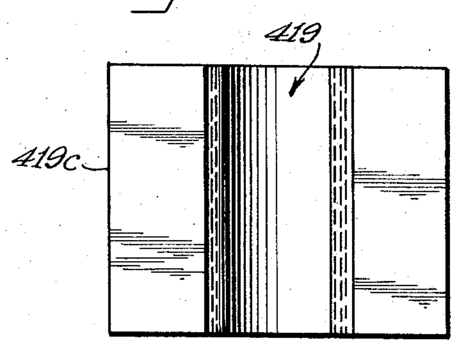
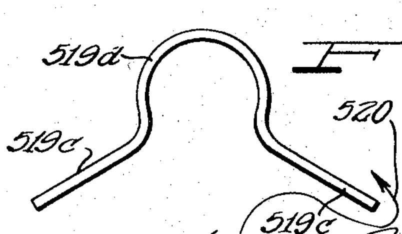


Fig. 11

Fig. 13



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FINNED-TUBE HEAT EXCHANGER

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Fig. 14

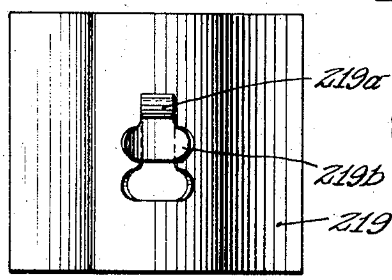


Fig. 15

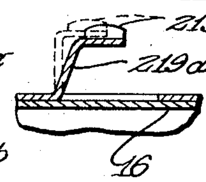


Fig. 16

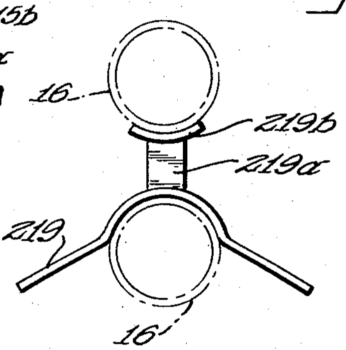


Fig. 17

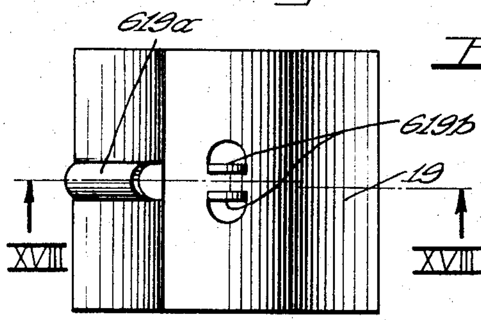


Fig. 19

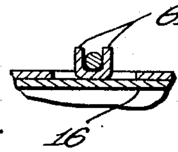


Fig. 18

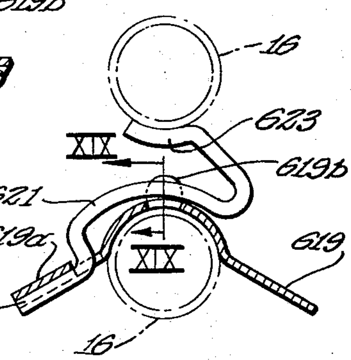


Fig. 20

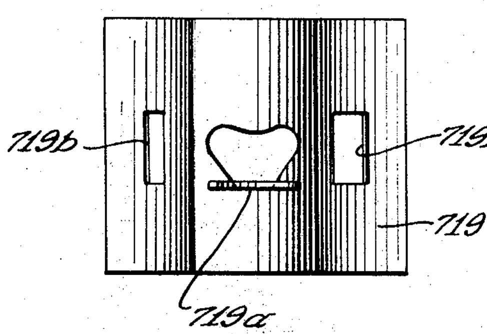
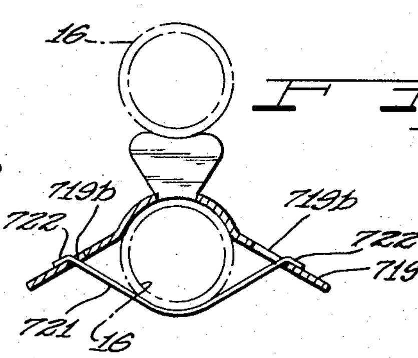


Fig. 21



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United States Patent Office

3,368,547

Patented Feb. 13, 1968

3,368,547

FINNED-TUBE HEAT EXCHANGER

William A. Hale, 4503 N. Knoxville Ave., Peoria, Ill. 61614

Filed Oct. 23, 1965, Ser. No. 503,323

8 Claims. (Cl. 126—350)

ABSTRACT OF THE DISCLOSURE

A water tube type heat exchanger is provided with sheet metal fins mechanically fixed in place thereon in appropriate position to improve transfer efficiency. The fins may be employed as spacing means, in addition to their heat transfer function, for positioning the adjacent coils of a multiple coil tube and, further, the fins may be provided with a configuration substantially controlling the flow of heat transfer medium, such as combustion gas, along and around the water tube coil. A number of specific embodiments of fin construction are disclosed.

The present invention relates to heat transfer devices and is, more particularly, concerned with the provision of a novel and substantially improved hot water boiler. As those skilled in the art of boiler construction are aware, increased efficiency in high speed water circulation systems, as well as improved materials have led to very substantial simplifications in modern heating systems. Increasing attention has, accordingly, been given to the continued improvement of such systems along the lines of efficiency. However, as new, more compact, and efficient hot water boilers have developed, improvements in the form of cost reduction have lagged behind.

By employing several novel techniques of manufacture and assembly, I have provided an extremely inexpensive and yet unusually highly efficient hot water boiler. As a result of the novel configuration of the boiler components of my invention, increased boiler capacity is achieved in an extremely simple manner. This simplicity has very substantially reduced the cost a manufacture of the boiler and has, at the same time, provided an improved over-all boiler efficiency throughout the range of normal sizes for home heating purposes.

In accordance with the principles of my invention, a copper coil is preformed into its final configuration in a bare, unfinned state. Utilizing this initial forming step permits the simple manipulation of the copper tubing. Following the forming step, a plurality of individual fins are mechanically clipped to the tubing along the length thereof. The mechanical attachment of the fins to the tubing is designed to provide close contact between the fin and the tube such that dipping of the tube with assembled fins clipped thereon will provide a very satisfactory metallic bond. This is particularly true when the tubing is copper and bonding agents such as tin or zinc are employed to provide a permanently tinned or galvanized, bonded connection between each of the fins and the tubing. By this arrangement, manipulation of the fins onto the tubing is readily accomplished while the final positioning of the fins is rendered permanent as a result of the bonding operation. Following the bonding operation, portions of the clips may be removed if desired but in the preferred embodiments of the invention the mechanical clipping portions acting to temporarily retain the fins in adjusted position from the tubing are retained as further heat transfer portions. As further set forth below, the specific configuration of the individual fins may be varied throughout a wide range while providing the benefits above enumerated.

In addition to the specific fin configuration, the boiler of my invention has a compact, unitized coil and fin assembly capable of simple installation and servicing. The

method of manufacture of the assembled unit is novel and has minimized cost of the boiler assembly.

It is, accordingly, an object of the present invention to provide a simplified hot water boiler of improved efficiency.

Another object of the present invention is to provide an improved finned coil for hot water boilers or the like.

Still a further object of the present invention is to provide an improved fin element adaptable for use in heat transfer equipment.

Still a further object of the present invention is to provide a novel and improved method of assembly and disassembly of a hot water boiler or the like.

A feature of the invention is the provision of a snap-on mechanically retained heat conducting fin.

Still another feature of the invention is the provision of a preformed coil with permanently bonded sheet metal heat conducting fins projecting therefrom.

Still other and further objects and features of the present invention will at once be understood from a consideration of the attached specification and drawings in which various embodiments of my invention are shown by way of illustration only, and wherein:

FIGURE 1 is a side-elevational view, in partial cross-section, of a hot-water boiler incorporating the principles of the present invention;

FIGURE 2 is a plan view, in partial cross-section, of the boiler illustrated in FIGURE 1;

FIGURE 3 is an end-elevational view of the boiler constructed in accordance with the principles of the present invention, in the same manner as FIGURE 1, but incorporating a pair of heat transfer coils and related burner equipment.

FIGURE 4 is a side-elevational view in partial cross-section, of a round boiler modification constructed in accordance with the principles of the present invention;

FIGURE 5 is a plan view of a first form of fin employed in accordance with the principles of the present invention;

FIGURE 6 is an end-elevational view of the clip shown in FIGURE 5;

FIGURE 7 is a plan view of a fin constructed similarly to the fin shown in FIGURE 5 but with a positioning tang struck up therefrom;

FIGURE 8 is an end-elevational view of the fin shown in FIGURE 7 in position in a boiler;

FIGURE 9 is a further embodiment of a fin constructed in accordance with the principles of the present invention shown in plan view;

FIGURE 10 is an end-elevational view of the fin shown in FIGURE 9;

FIGURE 11 is a plan view of a still further modified form of the fin of the present invention;

FIGURE 12 is an end-elevational view of the fin illustrated in FIGURE 11;

FIGURE 13 is an end-elevational view of a still further modified form of fin;

FIGURE 14 is a plan view of a still further form of fin;

FIGURE 15 is a partial side-elevational view of the fin shown in FIGURE 14;

FIGURE 16 is an end-elevational view of the fin shown in FIGURE 14 shown in position relative to a boiler coil;

FIGURE 17 is a plan view of a still further embodiment of the invention;

FIGURE 18 is a cross-sectional view, in part, taken along the line XVIII—XVIII in FIGURE 17;

FIGURE 19 is an end-elevational view of the fin shown in FIGURE 17 in its assembled relation;

FIGURE 20 is a further embodiment of a fin constructed in accordance with the principles of the present invention;

FIGURE 21 is an end-elevational view of the fin shown in FIGURE 20 in assembled relation with boiler components;

FIGURE 22 is a plan view of a still further modified form of fin design for use with a circular or round boiler;

FIGURE 23 is an end-elevational view of the fin illustrated in FIGURE 22;

FIGURE 24 is a still further modified form of fin; and

FIGURE 25 is an end-elevational view of the fin illustrated in FIGURE 24.

As shown on the drawings:

As has been above noted, boilers of the water tube type commonly employed in domestic heating systems have received close scrutiny from the point of view of cost and efficiency in recent years. Increasingly improved insulation, water circulating equipment, and automatic burner and circulation control have materially reduced the over-all size of individual boiler units. My own studies in the area of improving the efficiency and lowering the cost of gas-to-water heat transfer systems has proved that although the recent developments in these areas have been significant, extremely important improvements in both of these areas are possible through the method and apparatus of the present invention. In accordance with the principles of the present invention the gas flow outside of, and around, the water tube of the boiler has been directed into a more efficient heat transfer contact, and the technique of positioning and applying heat transfer fins directly to the water tubes has been improved. The improved over-all system is clearly shown in FIGURES 1 through 4, in several embodiments, and specific forms of heat transfer fins configuration are more fully illustrated in the remaining figures.

As may be seen from a consideration of FIGURES 1 and 2, a first form of improved heat exchanger is comprised of a housing **10** containing an oil or gas burner element **11** positioned at the base of a firebox or combustion chamber **12** above which a generally spiral shaped coil **15** is positioned. The coil **15** comprises a conduit **16** having an inlet connection **17**, an outlet connection **18**, and a plurality of heat-conducting fins **19**. Combustion gases leaving the chamber **12** circulate generally longitudinally of the conduit **16** and, at the same time, generally upwardly toward the flue **20**. As shown in FIGURES 1 and 2, the coil **15** is wound in a flattened spiral when viewed from above. This spiral is of a dimension permitting the fins **19** to project immediately adjacent one another in the central area, a fact which can readily be seen from FIGURE 2 where the edges **19*a*** of the fins **19** approach each other along the central isle. Similarly, the exterior edges **19*b*** of the individual fins extend substantially against the insulation **13**. In the embodiment illustrated the insulation **13** comprises a conventional fibrous insulation such as for example the material marketed under the trademark "Kaowool" comprising 2200° insulation material or similar product such as "Carborundum Fiber Frax" insulation material. This insulation material is positioned inside of an additional insulating layer **14** of conventional type, such as for example 2" thick 1200° U.S. Gypsum oven insulation positioned between the outermost housing wall **10*a*** and the inside housing wall **10*b***.

As a result of the close proximity of the outermost edges **19*b*** with the inside layer of insulation, and the close proximity between the centermost edges **19*a*** with corresponding edges **19*a*** of other fins, the circulation of the combustion gases is forced into a generally helical path with some longitudinal movement along the longitudinal axis **15*a***, permitted between adjacent fins. A tortuous path is thus provided which requires that the combustion gases pass in intimate contact with the fins in a wiping or scrubbing manner on their way to the flue **20**.

It will be clear that the conduit **16**, upon which the fins **19** are positioned, is extremely rugged. As shown, it has no internal seams or connections in the combustion chamber area. In addition, as will now be more fully discussed, the individual fins **19** are bonded in an efficient heat transfer relationship in a simple, inexpensive manner permitting simple manufacture or on-site repair of the boiler without in any way endangering the boiler from the introduction of seams, fittings, or the like.

I have found that as a result of the tortuous path provided in this manner, a single copper conduit **16**, formed in an output heat exchanger coil as shown in FIGURES 1 and 2, employing ⅞" O.D. copper tubing coiled as illustrated in a space having a width *x*, shown in FIGURE 2, of 5" and a length *y* of 13" with six coils will produce a gross output on the order of 50,000 B.t.u.'s per hour per unit, when firing the unit with gas. The unit may readily be fired with oil by lowering the burner unit, possibly necessitating a lengthening of the combustion chamber **12** in the vertical dimension, and in such installations I have found that the same tubing arrangement will provide a gross output on the order of 56,000 B.t.u.'s per hour. As will be recognized by those skilled in the art, such an output is extremely high for a coil configuration of such small size and compactness.

A major advantage of the system and technique employed in the present invention is that multiples of the system may readily be achieved merely by the addition of further coils and burners. This is readily observable from a consideration of FIGURE 3 where the combustion chamber **12** is shown to have a pair of identical burners **11** positioned beneath a pair of identical coils **15**. The flue **20** is, as in the case of a single coil embodiment of FIGURES 1 and 2, positioned centrally in the top of the housing **100**. Essentially all of the basic components are identical, except twice in number, in the embodiment shown in FIGURE 3. One difference in construction is, of course, that a header is desirable for connecting the coil inputs **17** to a single circulation input header **17*a***, and connecting the two outputs **18** to a joint output header. Such input and output headers may, of course, take conventional form and as shown, are preferably positioned externally of the housing **10** in the general position shown by the header connections **17*a*** and **18*a*** of FIGURE 1. It has been found that the utilization of two burners with two coils in the manner illustrated provides a gross output rating on the order of 95,000 B.t.u.'s per hour that similar utilization of three coils with three burners provides a rating of 145,000 B.t.u.'s per hour, four similar units a rating of 192,000 B.t.u.'s per hour and the combination of five similar units will provide a gross output rating of approximately 240,000 B.t.u.'s per hour, all when fired with gas. A single thermal switch **11*a*** senses the water temperature in the coil and shuts off the burner **11** upon a tube temperature of 300° F. indicating lack of water therein. With this system, it becomes extremely simple to construct an entire range of boiler units with an absolute minimum of different parts.

In the embodiment of the boiler shown in FIGURES 1 and 2, baffles are provided at the front and rear of the coil **15** in the form of ceramic separators **21**. Such a ceramic lining may encircle the coil **15** in the form of ceramic sides **22**, as well. A second embodiment of peripheral coil construction is found in the cylindrical boiler embodiment of FIGURE 4. As may readily be observed from FIGURE 4, the peripheral edges of the individual fins substantially contact the "Kaowool" insulation directly. In this form of the invention, which will be more fully described below, the individual fins completely encircle the coil providing a substantially continuous flow path without baffles. When such substantial contact between the individual fins and the "Kaowool" insulation is employed in the embodiments of the invention illustrated in FIGURES 1, 2 and 3, ceramic elements **21** and **22** are eliminated and fins **19** are snapped into position continuously around the ends of the coil. Under these circumstances, such individual fins **19** positioned at the ends of the coil may take the form of a one-piece continuous fin covering substantially the end of the coil as a generally segmental circular fin larger than that of the same circular conduit-gripping shape as illustrated in connection with the burner of FIGURE 4.

Contrary to conventional boiler construction, the fins of the present invention run generally longitudinally of the tube and transversely to the direction of intended gas flow relative to the axis **15***a* of the coil **15**. In conventional practice, fins are generally applied in some manner to the water tube such that the fins lie transverse to the longitudinal axis of the water tube and in a plane running substantially parallel to the axis of the coil. I have found that the provision of the fin generally longitudinally of the conduit and transversely positioned relative to the coil axis provides a much more tortuous path and greatly superior wiping action of the flue gases relative to the water coil. This in turn has provided a substantially improved over-all boiler efficiency without an increase in space requirements. Still further, as will now become apparent, the utilization of the longitudinally extending fin has permitted a greatly improved fin-to-conduit connection capable of simple manufacture and inexpensive assembly.

Preferably, the individual fins **19** are formed of stamped sheet metal snapped over a tubular form conduit into a stable, spring-retained condition on the conduit. Preferably, the retaining force for maintaining the individual fin firmly on the conduit is supplied by the fin itself. A primary form of fin is illustrated in FIGURES 5 and 6. As may there be seen, the fin **19** comprises a pair of laterally extending ears **19***c* joined by a segmental cylindrical portion **19***d* struck on a curve about a center **19***e*. As shown, the segmental cylindrical portion **19***d* extends over-center on opposite sides of a diametral line **19***f* so that the dimension Z forming a restricted neck portion is of smaller length than the diameter of curvature of the portion **19***d*. Accordingly, the fin **19** may be snapped over the conduit into a friction fit position.

In assembling a heat transfer coil, the coil is initially formed in a generally helical form with a continuous length of conduit. After taking the final generally helical form, the individual fins are snapped into place and pivoted into the position generally illustrated in FIGURES 1 and 2. After this assembly procedure the coil, comprising the conduit with the assembled fins, is preferably dipped into a tin or zinc bath or like metallurgical treatment to provide a bond between the individual fins and the conduit. This bond provides an extremely efficient heat transfer medium between the fins and the conduit. Following the metallurgical treatment, the assembled coil is inserted from the right-hand wall of the boiler as viewed in FIGURE 1, by removal of the front wall **10***c* of the housing **10**. In such assembly, the inlet conduit portion **17** may have a dowel, not shown, inserted therein and projecting substantially therebeyond for insertion into the hole **10***d* in the side wall of the boiler. This acts as a guide and permits extremely rapid insertion of the coil into the position shown in FIGURE 2. During such assembly the header **18***a* is not assembled with the outlet portion **18** of the conduit and following insertion of the coil into positions, the side wall portion **10***c* is slipped over the extension **18** into the position shown and rigidly retained in such position by assembly screws, not shown, and slip-on foot connections **10***e* and **10***f*. As a result of such a slip-on connection, the wall **10***c* may readily be removed by removal of the header **18***a*, for cleaning of the coil in position in the boiler. Alternatively, of course, the entire coil may readily be removed from the boiler for repair or cleaning by removal of the header **17***a* and movement of the coil and the wall **10***c* as a unit toward the right. If found desirable, a positioning guide pin **25** may be rigidly imbedded in the wall **10***b* for co-operation with ceramic locator **21** or, alternatively, with a bracket (not shown) welded or otherwise secured to conduit **16**.

Due to the fact that the coil **15** of the boiler of the present invention comprises a plurality of turns, the fins may be employed as a device for accurately spacing the coils. Such an arrangement is shown in the embodiment of FIGURE 7 where fin **119** is shown as having an upstruck tang **119***a*. The tang **119***a* co-operates with the next adjacent turn of the coil conduit **16** to space adjacent coils as shown in FIGURE 8. In constructions in which the turns of the coil **15** are accurately and fixedly spaced by external means, the fin need not comprise an arrangement having an over-center retaining action. Such an arrangement is shown, for example, in FIGURES 14, 15 and 16. There, the fin **219** is provided with an upstruck adjustably bendable tang **219***a* having an arcuate portion **219***b* which co-operates with the next adjacent turn of the coil conduit **16** in the manner illustrated in FIGURE 16. In view of the curved shape of the tang **219***b*, the turns of the coil will accurately locate and position the fins **219**. During the metallurgical bonding operation, the fins become integrated with the tubing and subsequent variation and separation between the turns of the coil **15** will not cause separation of the fins **219** from the conduit **16**.

A further modification of the fin **19** is illustrated in FIGURES 9 and 10 where fin **319** is illustrated. There, a very substantial pierced opening **320** is provided. The opening operates to substantially relieve the amount of material in the arcuate portion **319***d* thereby rendering the assembly of the device to the conduit simpler by increasing the flexibility of the fin. Under such circumstances the thickness of the fin material may be increased, if desired, without increasing the difficulty of manual assembly. Another technique of rendering the lateral portions of the fin more rigid is illustrated in FIGURES 11 and 12 where the laterally extending portions **419***c* of the fin **419** are bent backwardly upon themselves to provide a double thickness. This arrangement may be employed with a relatively thin arcuate portion **419***d* to, again, provide a relatively flexible arcuate portion with a substantial, relatively stiff, laterally extending fin portion.

In some installations it is desirable to increase the restriction of gas flow beyond that available with the arrangements above described. One technique of accomplishing this is to provide for a downward deflection of the lateral fin portions in the manner illustrated in FIGURE 13. As there shown, portions **519***c* deflect downwardly from the arcuate portions **519***d*. This downward deflection is in the upstream direction of gas flow and requires gas to pass backwardly upon itself and outwardly before it can proceed upstream, as illustrated by the arrow **520**. It will be clear that this downward positioning or deflection of the fins may be employed with any of the fin forms of the present invention.

A further embodiment of fin construction provides a particularly simple assembly procedure. For example, the arrangement shown in FIGURES 17 through 21 incorporate a separate spring element for maintaining the fins in position on the tube. This separate spring element permits utilization of a fin not having a snap-over feature and at the same time permits a very stable, assembled, relationship. In the embodiment shown in FIGURES 17 through 19, a wire spring **621** is employed with fin **619**. The wire spring **621** has an end projection **622** that co-operates with an upstruck tunnel **619***a* and locating guide tab **619***b*. The wire spring **621** is provided with an arcuate form extension **623** co-operating with the next adjacent conduit **16** and co-operates therewith to maintain the fin **619** pressed downwardly in its position against conduit **16**.

Similarly, in the embodiment shown in FIGURES 20 and 21, the fin **719** is provided with an upstruck portion **719***a* that acts in co-operation as a spacer with the next adjacent conduit **16**. The fin **719** is maintained resiliently in contact with the lower coil conduit portion **16** by means of a resilient spring **721** that is provided with hook portions **722** that project through apertures **719***d* for co-operation with fin **719**. In assembly, the spring **721** is passed beneath the lowermost conduit portion **16**, upwardly through the aperture **719***b* on one side of the fin to a point at which it projects substantially therebeyond. With the fin and spring thus positioned, the other end of the spring is pressed upwardly into axial alignment with the other aperture **719***b* and is slid relative to the conduit portion **16** through the other aperture **719***b* into the assembled position shown in FIGURE 21.

The relatively flexible form of spring employed in the embodiment of FIGURES 17 through 21 may be achieved by the use of a relatively flexible upstruck tang portion of the fin itself as shown in the embodiment of FIGURES 24 and 25. As there shown, the fin **819** is provided with an upstruck tang spring portion **819***a* which projects in cantilever fashion slightly beyond the center condition. As a result the fin may be snapped over the conduit **16** by movement in the direction of the arrow **820**. The fin construction permits simple assembly and an absolute minimum of parts. It will, of course, be apparent that if desired a still further tang may be upstruck for co-operation as a spacer with the next adjacent turn of the coil.

In the fin configurations above discussed, the fins have been provided with a generally straight segmental cylindrical portion for co-operation with a generally straight portion of the coil conduit. In constructions in which the boiler is generally circular as shown in the embodiment of FIGURE 4, or in which the fin is constructed for attachment to the ends, or arcuate portions of coils **15** such as illustrated in FIGURES 1 and 2, it is desired that the fin be curved to co-operate with the curved portion of the coil conduit.

An example of such a fin is found in FIGURES 22 and 23. As there shown, the fin **919** is provided with an arcuately configurated segmental cylindrical portion **919***d*. It will be apparent that fins of the curved type as shown in FIGURES 22 and 23 may readily take any of the forms in the remaining figures.

In the specific embodiment of the boiler incorporating a circular form, and illustrated in FIGURE 4, it is necessary to employ the form of fin described in FIGURES 22 and 23. In view of the fact that a relatively large diameter coil turn is employed, it is desirable that the central area of the coil be filled with a gas flow controller. This controller takes the form of a generally cylindrical plug **30**. Preferably the plug **30** has a helical flange **31** in the form of a thread projecting around its peripheral surface. The thread **31** cooperates with the inwardly facing edges **919***a* to provide a restriction to gas flow. The plug is preferably constructed of ceramic and is provided with ears **32** which act as stops against the uppermost turn of the coil **116** to position the plug accurately with respect to the individual coil turns. The burner **111** may, of course, be of any conventional form and forms no part of the present invention.

The improved boiler and fin configuration, as well as technique of boiler construction and assembly, described above are of great importance in providing an inexpensive highly efficient hot water boiler system. It will be apparent to those skilled in the art that the fins may be constructed of a wide variety of materials, for example, stainless or spring steel, which provide very strong snap-action retention. Alternatively, the fins may be constructed of such materials as copper, if desired. Copper is particularly satisfactory where separate springs are employed, such as for example in the embodiments shown in FIGURES 17 through 21. Similarly, although the fins have been described as metallurgically bonded to the coil turns by means of a molten dip of tin or zinc, other fastening means may be employed. For example, the fins may be spotwelded, brazed, soldered, or otherwise secured to the conduit if desired. Since many variations will be readily apparent to those skilled in the art from the numerous embodiments above described, it is my intent that the scope of the present invention be limited solely by that of the hereinafter appended claims.

I claim as my invention:

1. In combination in a heat exchanger, means providing a source of high temperature combustion gas, a gas outlet and means providing a gas flow current from said source to said outlet, a fluid conducting tube formed in a coil about an axis generally parallel to the axis of combustion gas flow, a plurality of fins in heat transfer contact with said tubing and extending laterally outwardly therefrom transverse to the direction of gas flow and generally parallel to the axis of the tubing at their contact junction therewith, said fins extending outwardly and inwardly of the coil in both directions substantially restricting the open flow area outside of the coil and inside of the coil whereby the gas flow will follow generally the contour of the fluid conducting tube.

2. The structure set forth in claim **1** wherein said fins are mechanically maintained in contact with said fluid conducting tube and are metallurgically bonded thereto.

3. A heat transfer element comprising a conduit formed in a coil having a plurality of turns along its longitudinal axis for distribution of a heat transfer fluid, fins secured to said conduit and projecting laterally thereof and generally parallel to the axis of the conduit, and mechanical means for retaining said fins on said conduit, the innermost and outermost edges of the fins being substantially constant along said coil and the innermost edges of the fins substantially blocking the interior of said coil.

4. In combination in a heat exchanger, means providing a source of high combustion gas, a gas outlet, and means providing a gas flow current from said source to said outlet a fluid conducting tube formed in a coil about an axis generally parallel to the axis of combustion gas flow, a plurality of fins in heat transfer contact with said tubing and extending laterally outwardly therefrom transverse to the direction of gas flow and generally parallel to the axis of the tubing at their contact junction therewith, and means on said fins co-operable with spaced turns of said coil to retain said fins between adjacent coils in mechanical contact with and positioned by said adjacent coils.

5. In combination in a heat exchanger, means providing a source of high combustion gas, a gas outlet, and means providing a gas flow current from said source to said outlet a fluid conducting tube formed in a coil about an axis generally parallel to the axis of combustion gas flow, a plurality of fins in heat transfer contact with said tubing and extending laterally outwardly therefrom transverse to the direction of gas flow and generally parallel to the axis of the tubing at their contact junction therewith, means on said fins co-operable with spaced turns of said coil to retain said fins between adjacent coils in mechanical contact with and positioned by said adjacent coils, and metallurgical bonding means for bonding said fin to at least one of the coils with which it has contact.

6. A heat transfer fin for cooperation with a tubular heat transfer conduit, which comprises a sheet of heat-conducting material having a channel stamped therein to co-operate in surface-to-surface contact with said conduit, and means integral with said sheet and co-operating with said conduit whereby said fin snaps mechanically into position on said conduit in a mechanically secure position thereon, said last-named means comprising a tang struck from the body of said sheet and snapping over a projecting portion of said conduit for applying pressure to opposite sides of said conduit to retain said fin thereon.

7. In combination in a heat exchanger, a fluid conducting conduit formed in a coil about an axis generally parallel to the axis of combustion of gas flow in said heat exchanger, a plurality of fins in heat transfer contact with said conduit and extending laterally outwardly and inwardly therefrom transverse to the direction of gas flow and generally parallel to the axis of the conduit at their contact junction therewith, an insulated housing surrounding said coil and in immediate proximity to the outer edges of said fins whereby gas flow generally parallel to the said axis and outside said fins, said fins projecting inwardly of said coil to substantially block free flow of said gas longitudinally of said coil within the confines thereof whereby combustion gases are restricted to tortuous paths through said coil.

8. In combination in a heat exchanger, a fluid conducting conduit formed in a coil about an axis generally parallel to the axis of combustion of gas flow in said heat exchanger, a plurality of fins in heat transfer contact with said conduit and extending laterally outwardly and inwardly therefrom transverse to the direction of gas flow and generally parallel to the axis of the conduit at their contact junction therewith, said fins extending substantially continuously along said coil conduit to provide said conduit with at least one complete spiral turn, an insulated housing surrounding said coil and in immediate proximity to the outer edges of said fins whereby combustion gas flow generally parallel to the said axis and outside said fins is restricted, said fins projecting inwardly of said coil to substantially block free flow of said gas longitudinally of said coil within the confines thereof whereby combustion gases are restricted to tortuous paths through said coil.

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