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(54) **HEAT FINS AND RELATED SYSTEMS AND METHODS**

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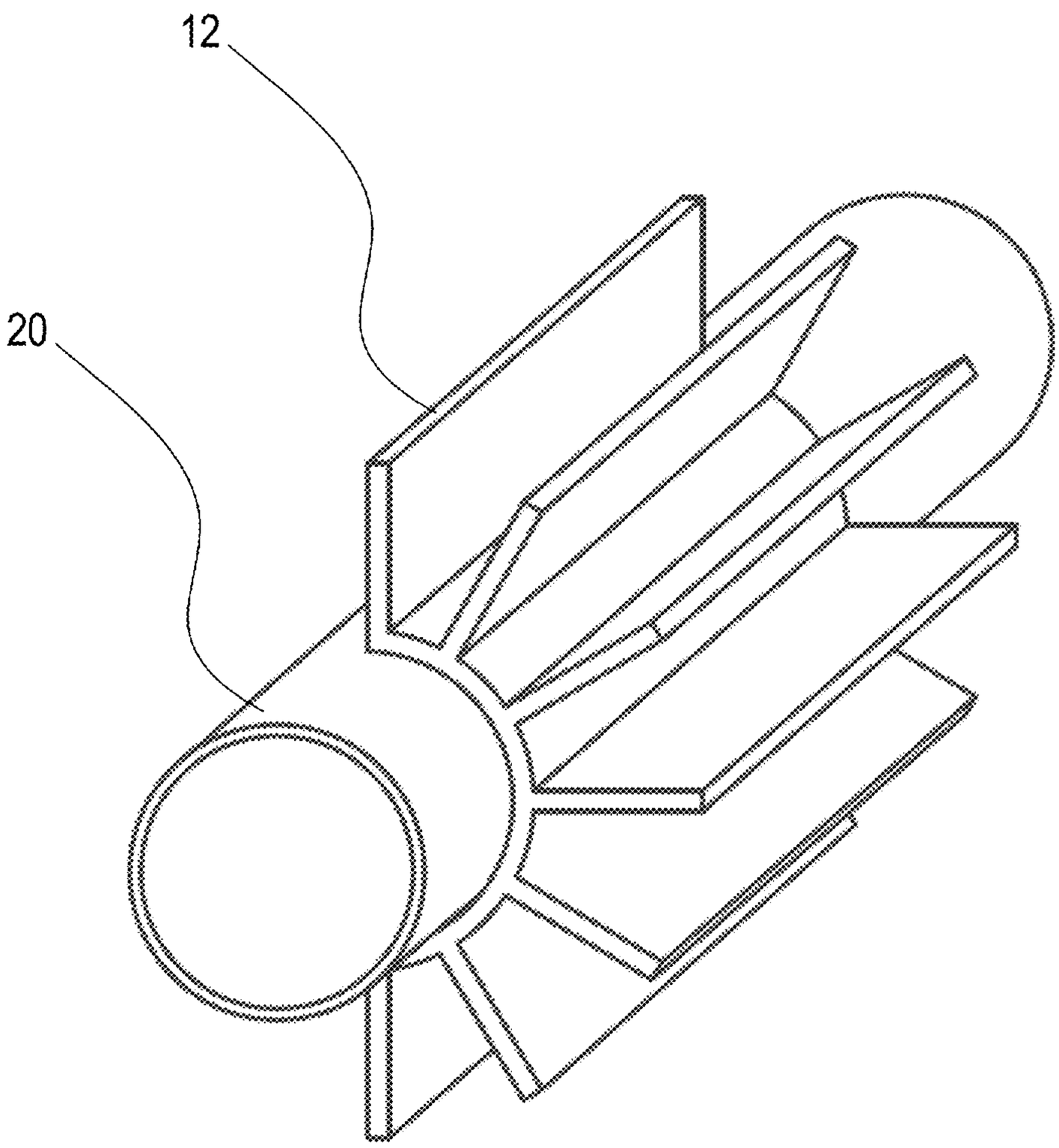
(57) **ABSTRACT**

A heat fin includes first and second halves, each half including a curved portion configured to partially surround a pipe, and a plurality of planar portions spaced generally evenly from one another. Each of the planar portions extends outwardly from the curved portion and generally runs along the entire length of the respective half it is part of. The first and second halves are configured to be bolted to one another around a pipe. A system includes a large scale container having product contained therein, an internal coil within the large scale container having a heating medium flowing therethrough, and a heat fin secured to the internal coil. The heat fin increases heat transfer from the heating medium flowing through the internal coil into the product contained in the large scale container.



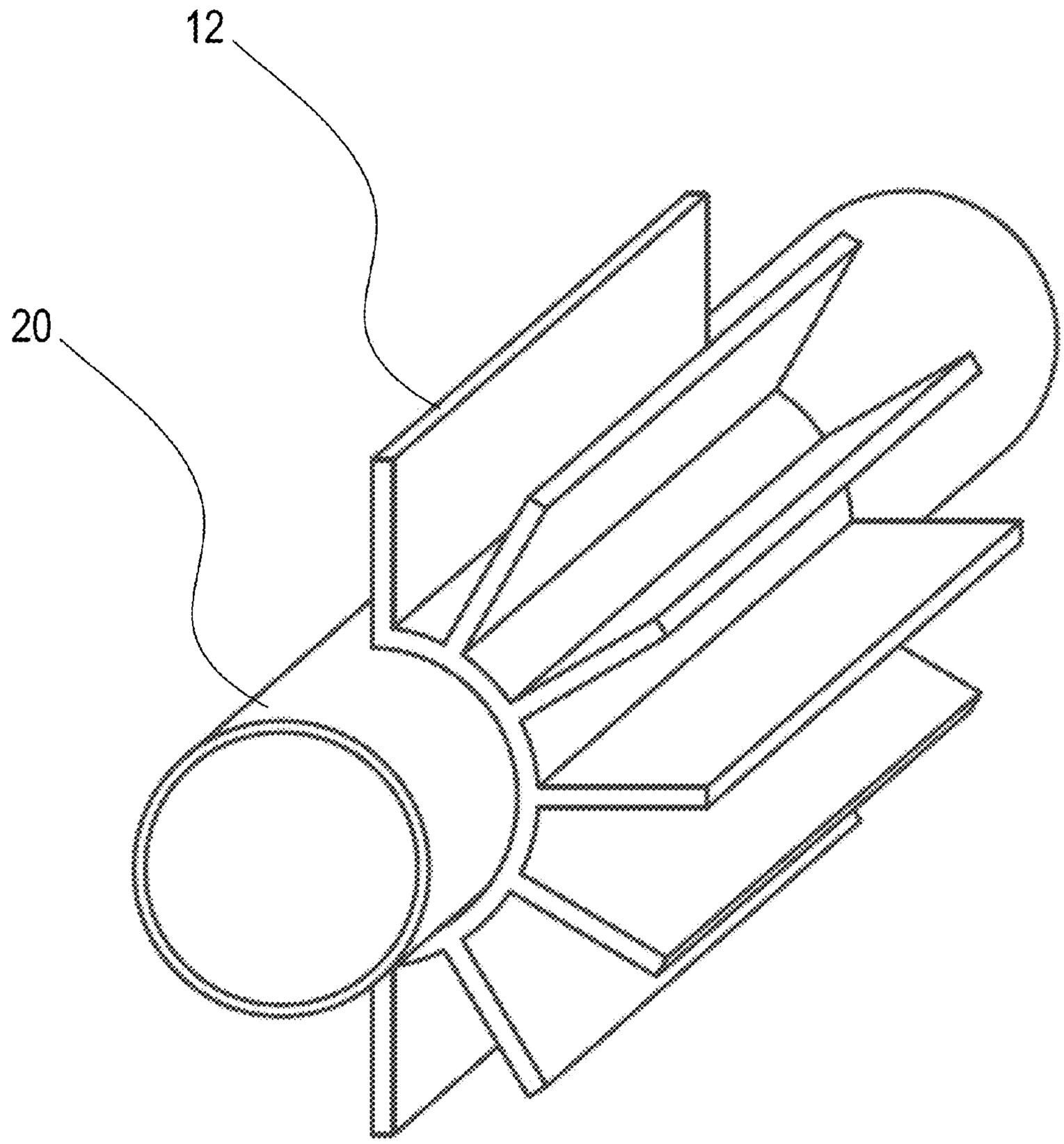


FIG. 1

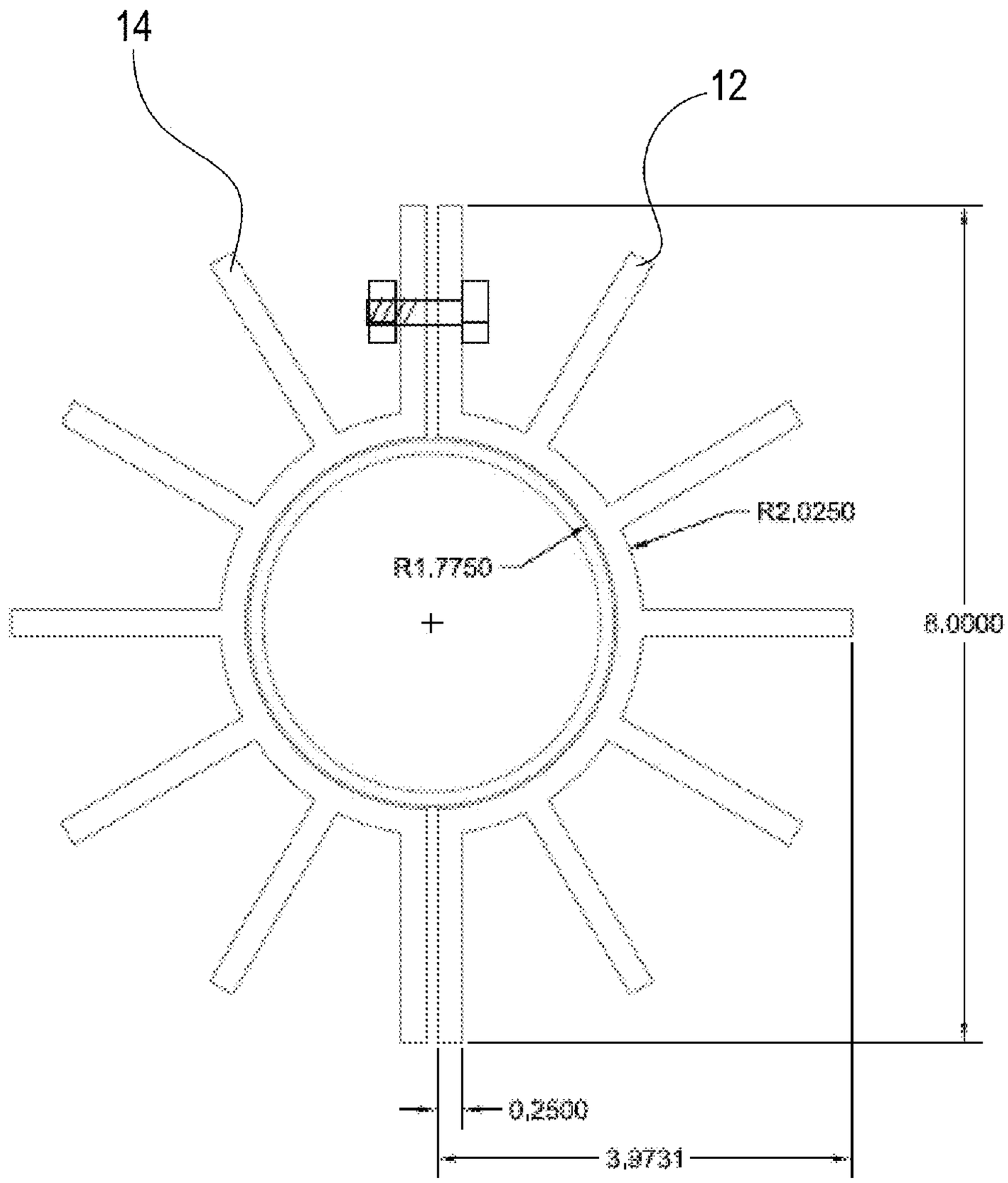


FIG. 2

Calculations:					
P = 2 * (W + t3)				0.521	ft
Afin = P * L				0.521	ft^2
Aprime = pi * D2				1.021	ft^2
m = (2 h / k1 * t) ^.5				0.705	
nf = tanh(m * L) / (m * L)	**(fin efficiency)**			**0.862**	
qprime = h * Aprime * (ABS (Twall - Tprocess))				**25**	BTU/hr/ft
qfin = nf * h * Afin * (ABS (Twall-Tprocess)				**11**	BTU/hr/ft
qfins = X * qfin				**134**	BTU/hr/ft
qtotal = qprime + qfins =				**159**	BTU/hr/ft
Qtotal = qtotal * Total footage (Y1) =				**15,913**	**BTU/hr**
% Increase in Total Heat Transfer =				**628%**	

Table 1: Summary of Calculations for Exemplary Scenario

FIG. 3

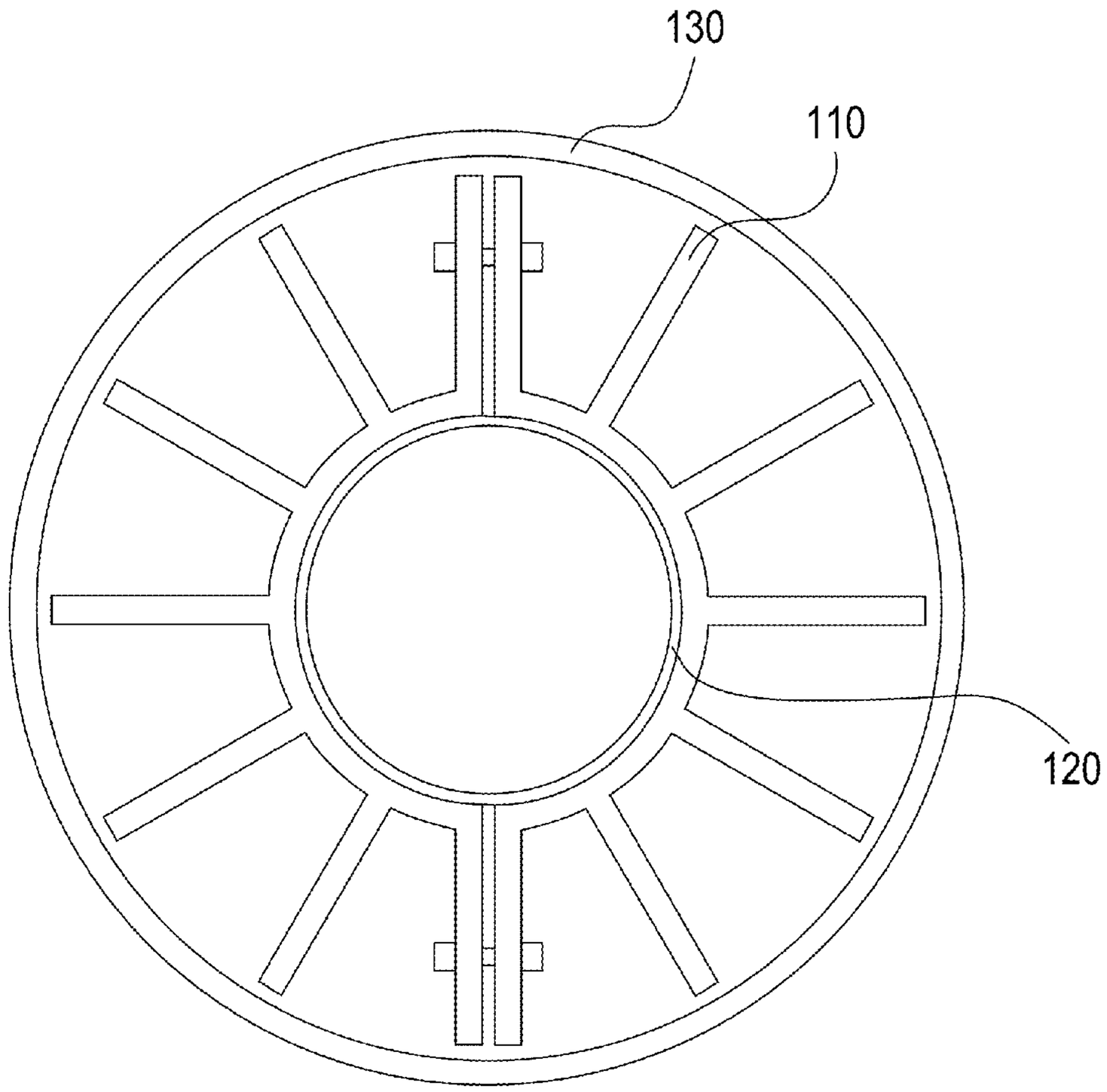


FIG. 4

HEAT FINS AND RELATED SYSTEMS AND METHODS

CROSS REFERENCE TO RELATED APPLICATION

[0001] The present application is a U.S. continuation patent application of, and claims priority under 35 U.S.C. §120 to, international patent application no. PCT/US2011/25415, filed Feb. 18, 2011, which published as WO 2011/103410, which patent application and patent application publication are hereby incorporated herein by reference, and which international patent application is, for purposes of the U.S., a U.S. nonprovisional patent application of, and claims priority under 35 U.S.C. §119(e) to, U.S. provisional patent application Ser. No. 61/306,233, filed Feb. 19, 2010. This provisional patent application is hereby incorporated herein by reference.

COPYRIGHT STATEMENT

BACKGROUND OF THE INVENTION

[0003] The present invention generally relates to providing heat to product stored in large scale containers.

[0004] Large scale containers, such as, for example, tanks, vessels and drums, are often used by processing plants to hold liquids needed for processing, storage and/or resale. Plants which process or store water, solvents, additives, chemicals, petrochemicals, crude oil, asphalt or edible oils commonly use such containers. Many of these products require additional heat to prevent the product inside the container from freezing or to keep the product below a certain viscosity.

[0005] There are several methods used to add heat to product inside a vessel. One such method utilizes internal heating coils, sometimes referred to simply as internal coils.

[0006] Such an internal coil may comprise a small diameter pipe (2" to 3") installed along the bottom (and sometimes the sides) of a vessel or tank. A heating medium, such as, for example, steam, hot water or hot oil, flows through the pipe, thereby causing the pipe to act as a heating element. The heating medium has a higher temperature than the process inside the tank, thereby creating a temperature difference.

[0007] Heat transfer from the heating medium to the process can be determined using the equation $Q=UAdT$, where Q is the heat transfer from the heating medium to the process, U is the overall heat transfer coefficient from the heating medium to the process, A is the total surface area of the heating medium against the process, and dT is the difference in temperature between the heating medium and the process. This equation allows one to calculate how much heat energy is transferred from the heating medium into the process for any application.

[0008] Typically, the goal would be to add enough heat into the process so as to replace heat that is lost through:

[0009] the tank walls and insulation;

[0010] the bottom of the tank into the earth; and

[0011] the air space atop the process (but inside the tank) through the roof wall and then through the insulation.

[0012] Internal heating coils are commonly utilized in large vessels such as, for example, asphalt tanks, heavy crude oil tanks, vacuum bottom tanks and No. 6 fuel oil tanks, because:

[0013] the product (e.g. crude oil) is normally not completely unsalvageable if the heating medium leaks into the product;

[0014] the product's temperature range is not normally small; and

[0015] it is very straightforward to design and maximize surface area (A), for example by installing additional footage of pipe, because the heat transfer from the heating medium to the product (Q), the overall heat transfer coefficient from the heating medium to the product (U), and the difference in temperature between the heating medium and the product (dT) are all known.

[0016] One potential problem, specifically when using internal coils to heat petroleum-based products inside tanks, is that these products (asphalt, coker feeds, vacuum residues and No. 6 fuel oil) may solidify on the outside of the internal coils over time. This process is commonly known as "coking". When product "cooks" on the outside wall of an internal coil, it adheres to the outside of the internal coil and leaves a heavy residue that will not naturally dissipate. This presents two problems.

[0017] First, the cooked on material hinders heat transfer from the heating medium to the process because it has very poor thermal conductivity, as it is comprised of mostly carbon. So, the thermal performance of the coil is diminished over time as the layer grows and eventually requires total replacement of the coil.

[0018] Second, the cooked on material is very costly to remove from the coil during scheduled cleaning. Hydroblasting is the typical method of cleaning such cooked on material off of a coil, and this can be very costly.

[0019] A need exists for improvement in providing heat to product stored in large scale containers. This, and other needs, are addressed by one or more aspects of the present invention.

SUMMARY OF THE INVENTION

[0020] The present invention includes many aspects and features. Moreover, while many aspects and features relate to, and are described in, the context of providing heat to product stored in large scale containers, the present invention is not limited to use only in this context, as will become apparent from the following summaries and detailed descriptions of aspects, features, and one or more embodiments of the present invention.

[0021] One aspect of the present invention relates to a heat fin. The heat fin includes first and second halves, each half comprising a curved portion configured to partially surround a pipe, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The first and second halves are configured to be bolted to one another around a pipe.

[0022] In a feature of this aspect of the invention, the heat fin was extruded.

[0023] In a feature of this aspect of the invention, the heat fin comprises aluminum.

[0024] In a feature of this aspect of the invention, the heat fin comprises carbon steel.

[0025] In a feature of this aspect of the invention, the heat fin comprises stainless steel.

[0026] In a feature of this aspect of the invention, the heat fin comprises a silicon-based compound.

[0027] In a feature of this aspect of the invention, the heat fin comprises a graphite-based compound.

[0028] In a feature of this aspect of the invention, the heat fin comprises a high-conductivity polymer.

[0029] In a feature of this aspect of the invention, the heat fin is forty feet long.

[0030] In a feature of this aspect of the invention, the heat fin is nine feet and six inches long.

[0031] Another aspect of the present invention relates to a heat fin. The heat fin includes first and second halves, each half comprising a curved portion configured to partially surround a pipe, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion in a direction generally perpendicular to a line tangential to the curved portion at the point that planar portion joins the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The first and second halves are configured to be bolted to one another around a pipe.

[0032] Another aspect of the present invention relates to a system. The system includes an internal coil having a heating medium flowing therethrough, and a heat fin secured to the internal coil. The heat fin includes first and second halves, each half comprising a curved portion configured to partially surround the internal coil, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The first and second halves are bolted to one another around the internal coil. The heat fin is configured to increase heat transfer from the heating medium flowing through the internal coil into product contained in a large scale container.

[0033] Another aspect of the present invention relates to a system. The system includes a large scale container having product contained therein, an internal coil within the large scale container having a heating medium flowing therethrough, and a heat fin secured to the internal coil. The heat fin includes first and second halves, each half comprising a curved portion configured to partially surround the internal coil, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The first and second halves are bolted to one another around the internal coil. The heat fin increases heat transfer from the heating medium flowing through the internal coil into the product contained in the large scale container.

[0034] Another aspect of the present invention relates to a system. The system includes an internal coil having a heating medium flowing therethrough, and a heat fin secured to the internal coil. The heat fin includes first and second halves, each half comprising a curved portion configured to partially surround the internal coil, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The first and second halves are bolted to one another around the internal coil. A heat transfer compound is disposed in one or more gaps between the internal coil and the heat fin. The heat fin is configured to increase heat transfer from the heating medium flowing through the internal coil into product contained in a large scale container.

[0035] Another aspect of the present invention relates to a system. The system includes an internal coil having a heating medium flowing therethrough, and a heat fin secured to the internal coil. The heat fin includes first and second halves, each half comprising a curved portion configured to partially surround the internal coil, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The first and second halves are bolted to one another around the internal coil.

[0036] Another aspect of the present invention relates to a method of manufacturing a heat fin. The method includes extruding first and second halves of a heat fin, each half of the heat fin comprising a curved portion configured to partially surround a pipe, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The first and second halves are configured to be bolted to one another around a pipe.

[0037] Another aspect of the present invention relates to a method. The method includes extruding first and second halves of a heat fin, each half of the heat fin comprising a curved portion configured to partially surround a pipe, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The first and second halves are configured to be bolted to one another around a pipe. The method further includes cutting each of the first and second halves into nine feet six inch long sections, and shipping each of the first and second halves.

[0038] Another aspect of the present invention relates to a method. The method includes partially surrounding an internal coil with each of first and second halves of a heat fin, each half of the heat fin comprising a curved portion configured to partially surround the internal coil, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The first and second halves are configured to be bolted to one another around a pipe. The method further includes securing the heat fin around the internal coil by bolting the first and second halves of the heat fin together.

[0039] Another aspect of the present invention relates to a method. The method includes partially surrounding an internal coil with each of first and second halves of a heat fin, each half of the heat fin comprising a curved portion configured to partially surround the internal coil, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The first and second halves are configured to be bolted to one another around a pipe. The method further includes securing the heat fin around the internal coil by bolting the first and second

halves of the heat fin together, and applying a heat transfer compound to one or more gaps between the heat fin and the internal coil.

[0040] Another aspect of the present invention relates to a method. The method includes unsecuring first and second halves of a first heat fin from around an internal coil, each half of the first heat fin comprising a curved portion configured to partially surround the internal coil, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The method further includes partially surrounding the internal coil with each of first and second halves of a second heat fin, each half of the second heat fin comprising a curved portion configured to partially surround the internal coil, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of of the second heat fin. The first and second halves of the second heat fin are configured to be bolted to one another around the internal coil. The method further includes securing the second heat fin around the internal coil by bolting the first and second halves of the heat fin together.

[0041] Another aspect of the present invention relates to a method. The method includes unsecuring first and second halves of a heat fin from around an internal coil, each half of the first heat fin comprising a curved portion configured to partially surround the internal coil, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The method further includes cleaning the heat fin, partially surrounding the internal coil with the first and second halves of the heat fin, and securing the second heat fin around the internal coil by bolting the first and second halves of the heat fin together.

[0042] Another aspect of the present invention relates to a heat fin. The heat fin includes first and second halves, each half comprising a curved portion configured to partially surround a pipe, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. The first and second halves are configured to be bolted to one another around a pipe.

[0043] Another aspect of the present invention relates to a system for asphalt tank heating. The system includes a tank containing asphalt, an internal coil disposed within at least partially within the tank having a heating medium flowing therethrough, the internal coil being positioned to heat the asphalt, and a heat fin secured to the internal coil. The heat fin includes first and second halves, each half comprising a curved portion configured to partially surround the internal coil, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The first and second halves are secured to one another around the internal coil. The heat fin is configured to increase heat transfer from the heating medium flowing through the internal coil into the asphalt contained in the tank.

[0044] Another aspect of the present invention relates to a heat fin. The heat fin includes first and second halves. Each half includes a curved portion configured to partially surround a pipe, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The first and second halves are configured to be secured to one another around a pipe.

[0045] Another aspect of the present invention relates to a heat fin. The heat fin includes first and second halves, each half comprising a curved portion configured to partially surround a pipe, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion in a direction generally perpendicular to a line tangential to the curved portion at the point that planar portion joins the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The first and second halves are configured to be secured to one another around a pipe.

[0046] Another aspect of the present invention relates to a system. The system includes a first pipe, and a heat fin secured to the first pipe. The heat fin includes first and second halves, each half comprising a curved portion configured to partially surround the pipe, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The first and second halves are secured to one another around the pipe. The system further includes a second pipe secured around the outside of the first pipe and heat fin secured therearound. The heat fin is configured to increase heat transfer from one of the pipes to the other of the pipes;

[0047] whereby the system functions as a heat exchanger.

[0048] In a feature of this aspect, the securement of the second pipe was effected by welding.

[0049] Another aspect of the present invention relates to a system for heat exchange. The system includes a first pipe, and a heat fin secured to the first pipe. The heat fin includes first and second halves, each half comprising a curved portion configured to partially surround the pipe, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The first and second halves are secured to one another around the pipe. The system further includes a second pipe secured around the outside of the first pipe and heat fin. The heat fin is configured to increase heat transfer from one of the pipes to the other of the pipes.

[0050] In a feature of this aspect, the securement of the second pipe was effected by welding.

[0051] Another aspect of the present invention relates to a method. The method includes partially surrounding an internal coil with each of first and second halves of a heat fin, each half of the heat fin comprising a curved portion configured to partially surround the internal coil, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The first and second halves are configured to be secured to one another

around a pipe. The method further includes securing the heat fin around the internal coil by securing the first and second halves of the heat fin together.

[0052] Another aspect of the present invention relates to a method. The method includes partially surrounding a first pipe with each of first and second halves of a heat fin, each half of the heat fin comprising a curved portion configured to partially surround the internal coil, and a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion. Each of the plurality of planar portions generally runs along the entire length of the respective half it is part of. The first and second halves are configured to be secured to one another around a pipe. The method further includes securing the heat fin around the first pipe by securing the first and second halves of the heat fin together, and securing a second pipe around the outside of the first pipe and heat fin.

[0053] In addition to the aforementioned aspects and features of the present invention, it should be noted that the present invention further encompasses the various possible combinations and subcombinations of such aspects and features.

BRIEF DESCRIPTION OF THE DRAWINGS

[0054] One or more preferred embodiments of the present invention now will be described in detail with reference to the accompanying drawings, wherein the same elements are referred to with the same reference numerals, and wherein,

[0055] FIG. **1** is a perspective illustration of a fragmented portion of a first half of a bolt-on heat fin partially surrounding an internal heating coil in accordance with one or more preferred embodiments.

[0056] FIG. **2** is a cross-sectional schematic view of a heat fin bolted onto a three inch diameter carbon steel pipe.

[0057] FIG. **3** includes a table which provides a summary of calculations for an exemplary scenario.

[0058] FIG. **4** illustrates an exemplary single pass heat exchanger utilizing a smaller pipe, a heat fin, and a larger pipe.

DETAILED DESCRIPTION

[0059] As a preliminary matter, it will readily be understood by one having ordinary skill in the relevant art ("Ordinary Artisan") that the present invention has broad utility and application. Furthermore, any embodiment discussed and identified as being "preferred" is considered to be part of a best mode contemplated for carrying out the present invention. Other embodiments also may be discussed for additional illustrative purposes in providing a full and enabling disclosure of the present invention. As should be understood, any embodiment may incorporate only one or a plurality of the above-disclosed aspects of the invention and may further incorporate only one or a plurality of the above-disclosed features. Moreover, many embodiments, such as adaptations, variations, modifications, and equivalent arrangements, will be implicitly disclosed by the embodiments described herein and fall within the scope of the present invention.

[0060] Accordingly, while the present invention is described herein in detail in relation to one or more embodiments, it is to be understood that this disclosure is illustrative and exemplary of the present invention, and is made merely for the purposes of providing a full and enabling disclosure of the present invention. The detailed disclosure herein of one or more embodiments is not intended, nor is to be construed, to limit the scope of patent protection afforded the present invention, which scope is to be defined by the claims and the equivalents thereof. It is not intended that the scope of patent protection afforded the present invention be defined by reading into any claim a limitation found herein that does not explicitly appear in the claim itself.

[0061] Thus, for example, any sequence(s) and/or temporal order of steps of various processes or methods that are described herein are illustrative and not restrictive. Accordingly, it should be understood that, although steps of various processes or methods may be shown and described as being in a sequence or temporal order, the steps of any such processes or methods are not limited to being carried out in any particular sequence or order, absent an indication otherwise. Indeed, the steps in such processes or methods generally may be carried out in various different sequences and orders while still falling within the scope of the present invention. Accordingly, it is intended that the scope of patent protection afforded the present invention is to be defined by the appended claims rather than the description set forth herein.

[0062] Additionally, it is important to note that each term used herein refers to that which the Ordinary Artisan would understand such term to mean based on the contextual use of such term herein. To the extent that the meaning of a term used herein—as understood by the Ordinary Artisan based on the contextual use of such term—differs in any way from any particular dictionary definition of such term, it is intended that the meaning of the term as understood by the Ordinary Artisan should prevail.

[0063] Regarding applicability of 35 U.S.C. §112, ¶6, no claim element is intended to be read in accordance with this statutory provision unless the explicit phrase "means for" or "step for" is actually used in such claim element, whereupon this statutory provision is intended to apply in the interpretation of such claim element.

[0064] Furthermore, it is important to note that, as used herein, "a" and "an" each generally denotes "at least one," but does not exclude a plurality unless the contextual use dictates otherwise. Thus, reference to "a picnic basket having an apple" describes "a picnic basket having at least one apple" as well as "a picnic basket having apples." In contrast, reference to "a picnic basket having a single apple" describes "a picnic basket having only one apple."

[0065] When used herein to join a list of items, "or" denotes "at least one of the items," but does not exclude a plurality of items of the list. Thus, reference to "a picnic basket having cheese or crackers" describes "a picnic basket having cheese without crackers", "a picnic basket having crackers without cheese", and "a picnic basket having both cheese and crackers." Finally, when used herein to join a list of items, "and" denotes "all of the items of the list." Thus, reference to "a picnic basket having cheese and crackers" describes "a picnic basket having cheese, wherein the picnic basket further has crackers," as well as describes "a picnic basket having crackers, wherein the picnic basket further has cheese."

[0066] Referring now to the drawings, one or more preferred embodiments of the present invention are next described. The following description of one or more preferred embodiments is merely exemplary in nature and is in no way intended to limit the invention, its implementations, or uses.

[0067] In accordance with one or more preferred embodiments, a heat fin made from aluminum or other high-conductivity material is configured to be bolted onto an internal

heating coil. The heat fin is configured such that, when bolted onto an internal heating coil of a large scale container, it forms an external and removable heat enhancer to increase heat transfer from a heating medium flowing through the internal coil into product contained in the large scale container.

[0068] FIG. **1** is a perspective illustration of a fragmented portion of a first half **12** of a bolt-on heat fin partially surrounding an internal heating coil **20** in accordance with one or more preferred embodiments. The portion is described as being fragmented because, in at least some preferred implementations, the heat fin will extend substantially the entire length of an internal heating coil it surrounds. In a preferred implementation, heat fins are extruded in approximately forty foot (40') length sections, although in at least some preferred implementations such heat fins may be cut to nine feet six inch (9'6") length sections so as to be shippable overnight by truck or air.

[0069] The first half **12** is configured to be bolted to a second half **14** of the heat fin such that the heat fin is secured to an internal heating coil, as illustrated in FIG. **2**, which is a cross-sectional schematic view of the heat fin bolted onto a three inch (3") diameter (three and a half inch (3.5") nominal) carbon steel pipe. It will be appreciated that although only a single bolt is illustrated in cross-section, bolts likely will be utilized to secure the halves **12**,**14** together at both top and bottom portions of the halves **12**,**14** along the length of the halves **12**,**14**.

[0070] The heat fin is configured to increase the heat transfer area of a coil it is secured to. In an exemplary scenario, such a heat fin can increase the total heat transfer of normal pipe internal coils by 600%. Table 1 of FIG. **3** provides a summary of calculations for such exemplary scenario.

[0071] In this exemplary scenario, the total footage of internal coil required to meet a particular thermal duty of an application could be reduced by as much as six (6) times, or possibly even more in some cases. For example, if an internal coil was used to heat asphalt with a very low convection coefficient (1 BTU/hr ft^2 F), six hundred feet (600') of standard internal coil might be equal to the heating capabilities of one hundred feet (100') of internal coil with a heat fin installed over the internal coil. This would make internal coils much more economical to install and maintain.

[0072] Further, because the heat fin is bolted on, instead of hydro-blasting the coils clean, the bolted-on heat fin can be removed, cleaned and replaced, or removed and replaced entirely.

[0073] As noted above, in preferred implementations, heat fins (or heat fin halves) are extruded, such as, for example, from aluminum, and machined for bolting purposes, although in at least some implementations halves of heat fins may be secured together in some other manner, and may be configured for such securement in some other manner. Preferably, heat fins are anodized to extend their life under harsh conditions.

[0074] In at least some alternative implementations, a heat fin is made from carbon steel, stainless steel, copper, a silicon-based compound, a graphite-based compound, and/or one or more high conductivity polymers or plastics.

[0075] In preferred implementations, one or more heat fins are specifically selected and/or designed for a particular application by calculating heat lost through ambient conditions and overcoming such loss by adding enough heat into the process by way of heat fin installation onto internal heating coils. A heat fin may also be selected or designed to meet a specific heat-up requirement of the product.

[0076] In at least some implementations, there exists a gap between a heat fin bolted onto an internal coil and the internal coil. In at least some such implementations, this gap is preferably bridged utilizing common heat transfer compounds. When used in thin layers, these compounds can provide rapid heat transfer from, for example, the carbon steel surface of an internal heating coil to an aluminum surface of a heat fin. These compounds can have a thermal conductivity of twenty five (25) to fifty (50) BTU/hr ft^2 F when used in very thin layers.

[0077] In preferred implementations, heat fins are applied to pipes or tubes, including pre-existing pipes or tubes, in a wide variety of contexts, including contexts outside of an internal heating coil context. For example, in a preferred implementation, a heat fin is secured to the outside of tubing to cool hydrogen inside of a purification system.

[0078] In another preferred implementation, one or more heat fins are utilized in a heat exchanger implementation. For example, in a simple heat exchanger implementation, a heat fin **110** is installed on the outside of a smaller pipe **120**, such as a one inch pipe, and a larger pipe **130** is then secured (e.g. by welding) around the outside of the smaller pipe and heat fin, thereby creating a single pass heat exchanger, as illustrated in FIG. **4**.

[0079] Although described and illustrated herein primarily as including a plurality of planar portions extending from a curved portion, it will be appreciated that the extending portions may in fact be curved, or otherwise shaped, in at least some implementations.

[0080] Based on the foregoing description, it will be readily understood by those persons skilled in the art that the present invention is susceptible of broad utility and application. Many embodiments and adaptations of the present invention other than those specifically described herein, as well as many variations, modifications, and equivalent arrangements, will be apparent from or reasonably suggested by the present invention and the foregoing descriptions thereof, without departing from the substance or scope of the present invention. Accordingly, while the present invention has been described herein in detail in relation to one or more preferred embodiments, it is to be understood that this disclosure is only illustrative and exemplary of the present invention and is made merely for the purpose of providing a full and enabling disclosure of the invention. The foregoing disclosure is not intended to be construed to limit the present invention or otherwise exclude any such other embodiments, adaptations, variations, modifications or equivalent arrangements, the present invention being limited only by the claims appended hereto and the equivalents thereof.

1. A heat fin, comprising:

(a) first and second halves, each half comprising

(i) a curved portion configured to partially surround a pipe, and

(ii) a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion,

(iii) wherein each of the plurality of planar portions generally runs along the entire length of the respective half it is part of;

(b) wherein the first and second halves are configured to be bolted to one another around a pipe.

2. (canceled)

3. A system, comprising:
(a) an internal coil having a heating medium flowing therethrough;
(b) a heat fin secured to the internal coil, the heat fin comprising:
(i) first and second halves, each half comprising
(A) a curved portion configured to partially surround the internal coil, and
(B) a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion,
(C) wherein each of the plurality of planar portions generally runs along the entire length of the respective half it is part of;
(ii) wherein the first and second halves are bolted to one another around the internal coil;
(c) wherein the heat fin is configured to increase heat transfer from the heating medium flowing through the internal coil into product contained in a large scale container.

4-6. (canceled)

7. The heat fin of claim **1**, wherein the heat fin was extruded.

8. The heat fin of claim **1**, wherein the heat fin comprises aluminum.

9. The heat fin of claim **1**, wherein the heat fin comprises carbon steel.

10. The heat fin of claim **1**, wherein the heat fin comprises stainless steel.

11. The heat fin of claim **1**, wherein the heat fin comprises a silicon-based compound.

12. The heat fin of claim **1**, wherein the heat fin comprises a graphite-based compound.

13. The heat fin of claim **1**, wherein the heat fin is forty feet long.

14. The heat fin of claim **1**, wherein the heat fin is nine feet and six inches long.

15-24. (canceled)

25. A system, comprising:
(a) a first pipe,
(b) a heat fin secured to the first pipe, the heat fin comprising:
(i) first and second halves, each half comprising
(A) a curved portion configured to partially surround the pipe, and
(B) a plurality of planar portions spaced generally evenly from one another, each planar portion extending outwardly from the curved portion,
(C) wherein each of the plurality of planar portions generally runs along the entire length of the respective half it is part of;
(ii) wherein the first and second halves are secured to one another around the pipe; and
(c) a second pipe secured around the outside of the first pipe and heat fin secured therearound;
(d) wherein the heat fin is configured to increase heat transfer from one of the pipes to the other of the pipes;
whereby the system functions as a heat exchanger.

26-41. (canceled)

42. The heat fin of claim **1**, wherein each planar portion extends outwardly from the curved portion in a direction generally perpendicular to a line tangential to the curved portion at the point that planar portion joins the curved portion.

43. The system of claim **3**, wherein, with respect to the heat fin, each planar portion extends outwardly from the curved portion in a direction generally perpendicular to a line tangential to the curved portion at the point that planar portion joins the curved portion.

44. The system of claim **3**, wherein the system further includes a large scale container having product contained therein, and wherein the internal coil is disposed within the large scale container.

45. The system of claim **3**, wherein the system further includes a heat transfer compound disposed in one or more gaps between the internal coil and the heat fin.

46. The system of claim **3**, wherein the heat fin comprises aluminum.

47. The system of claim **3**, wherein the heat fin comprises stainless steel.

48. The system of claim **3**, wherein the heat fin is forty feet long.

49. The system of claim **3**, wherein the heat fin is nine feet and six inches long.

50. The system of claim **24**, wherein the securement of the second pipe was effected by welding.

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