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(71)(72) Applicant and Inventor: KLOTZ, E., John [US/US]; Rt. 1, Box 39, East Bernard, TX 77435 (US).

(74) Agent: EGBERT, John, S.; 1018 Preston, Suite 100, Houston, TX 77002 (US).

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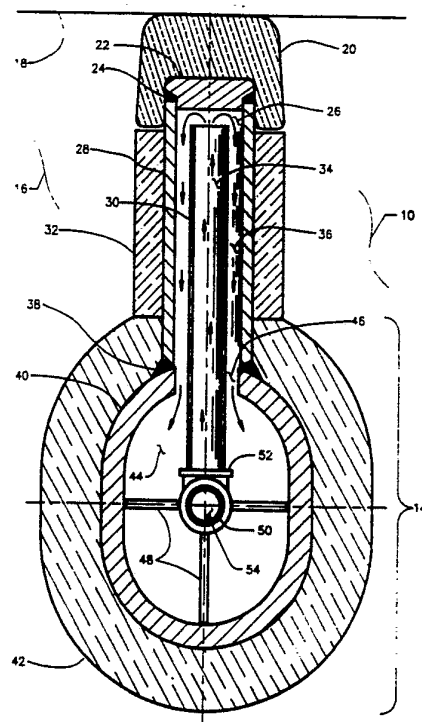
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(54) Title: SKID SYSTEM FOR REHEAT FURNACES

(57) Abstract

A skid system (14) for a reheat furnace (16) including a first support element extending within the reheat furnace, a second support element extending within the reheat furnace in a skewed relationship with the first support element, a plurality of pipe members (28) extending upwardly from the first and second support elements, and a skid button (20) positioned on an end of each of the pipe members (28) opposite the first and second support elements. The pipe members have an interior in fluid communication with an interior of the first and second support elements. The skid button (20) supports a product (18) thereon. A fluid circulation system is positioned in the first and second support elements and in the plurality of pipe members. This fluid circulation system delivers a cooling fluid in heat exchange relationship with the pipe members. The skid button is supported at least four inches above the first and second support elements.



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SKID SYSTEM FOR REHEAT FURNACES

TECHNICAL FIELD

The present invention relates to skid systems for reheat furnaces. More particularly, the present invention relates to the button assemblies and the structural supports for such button assemblies as used on skid systems.

BACKGROUND ART

Reheat furnaces are used to heat workpieces prior to being introduced into subsequent processing, such as rolling into sheet material. The uniformity of such heating of the workpieces has a substantial effect on the end product (i.e., the sheet material) as well as influencing the reheat furnace thermal efficiency. Such metallurgical furnaces include walking beam types. In the walking beam type of furnace, multiple support rails extend for the length of the furnace and support the workpieces as they are being conveyed through the furnace by the moving (walking) beams.

Three separate heat transfer effects of this walking beam type furnace and support rail configuration limit the heating efficiency and temperature uniformity of the heated workpieces. The reduced heating effects are characterized as "cold spots" or localized cooler regions within the heated workpiece having distinctly different temperatures with locations corresponding to the respective support rail positions. The first heat transfer effect is due to the close proximity of the support rails to the workpiece. This proximity produces a shadow effect whereby the support rails block radiation or shade the workpiece from the heat source of the furnace. A second heat transfer effect is that rails tend to cool the workpieces by conduction in response to direct contact of the workpiece with the skid buttons or support elements affixed to the top of the support rail. The support rail is typically liquid cooled and has a temperature which is cooler than that of the skid buttons or support elements. The third heat transfer effect is that the rails tend to cool the workpieces by secondary radiation heat

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exchange occurring between the cooler top surface of the liquid cooled rail interacting with the bottom of the workpiece.

Efforts have been made in the past to increase heating uniformity and to minimize cold spots by adding insulation to the support rails. U.S. Patent Nos. 4,095,937 and 4,228,826 show such support rails. Support rail insulation is widely employed within the industry to counteract the localized workpiece cooling by secondary radiation exchange with the liquid cooled support rails. Other attempts to solve this problem are disclosed in U.S. Patent Nos. 4,427,187 and 4,368,038 which involve various "hot rider tiles", "skid buttons", or support elements which are attached or otherwise mounted directly to the support rails. These prior inventions represent the current state of the art and employ high temperature resistant (ceramic and/or alloy) materials to provide a suitable high temperature wear surface or support element with sufficient thickness and height to elevate the workpiece above the support rails and reduce the shadow effect.

The use of the state of the art walking beam reheat furnace support rails and support elements (skid buttons) persists, as previously described, and continues to suffer from reduced heating efficiency and poor temperature uniformity. The history and use of these conventional designs supports particular notions concerning furnace heat transfer effects. Skid system engineers and designers have long understood the radiation viewfactor benefits and have attempted to achieve practical elevated skid button designs so as to distance the workpiece from the necessary, but detrimental, underlying liquid cooled support rails. Using such conventional design guidelines, high temperature alloy skid button materials are used which have demonstrated practical height limits of three to four inches (75-100 mm) when operated continuously within a 2,400°F (1315°C) reheat furnace. Above the practical height limit, these components soon fail in service due to heat-checking, sigma

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phase embrittlement, plastic deformation and general overheating as the temperature dependent physical material strength limits are repeatedly reached and exceeded by actual furnace operation and service. To achieve practical and durable skid buttons, U.S. Patent No. 4,293,299 addressed these physical material limits with direct additional skid button cooling by submerging the root or bottom of the support button within the liquid cooled stream of the main support rail. This development advocated the additional skid button cooling to reduce material operating temperatures. However, the intent of this patent was only to enhance the durability and longevity of the skid button. Normally, skid buttons are operated continuously in the harsh reheat furnace environment. The prior art has noticeably ignored the separate direct cooling of an elevated skid button.

U.S. Patent No. 4,609,347 proposed high temperature refractory skid button materials. While still under development, ceramic and admixture-type skid buttons of this height generally fail prematurely due to the inherently low compressive and mechanical strength of ceramics when submitted to a typical industrial reheat furnace service.

The foregoing is offered to confirm the previous reluctance of furnace skid system designers to significantly elevate workpieces above the main support rails. The direct cooling of elevated skid buttons has previously been ignored because of the perceived detrimental effect caused by localized workpiece conduction cooling. If the skid buttons were cooled, it was typically reasoned that any product placed on top of these cooled skid buttons would also be cooled by conduction. This was considered to be against the desired purpose of the reheat furnace. As such, no attempts have been made, in the past, to directly cool elevated skid buttons. Typical skid buttons are of a height much less than four inches and are made of solid material. It has been the typical goal, in the prior art, to have the skid buttons retain as much heat as possible.

Through exhaustive heat transfer calculations of the heating process, the present inventor has identified,

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quantified and evaluated the pertinent design criteria governing the furnace heating efficiency and final workpiece temperature uniformity.

It was found that elevated skid buttons significantly separate or distance the workpiece from the support rails and thereby greatly enhance workpiece heating. Additional beneficial radiation heating from the hot furnace (the first heat transfer effect identified hereinabove), and re-radiation from the hotter rails (previously identified as the third heat transfer effect) have been found to overcome, and indeed, far outweigh the detrimental conduction cooling effect (identified as the second heat transfer effect hereinabove) incurred by direct workpiece contact with the individually cooled elevated skid buttons.

It is an object of the present invention to provide increased heating efficiency and workpiece temperature uniformity as produced by walking beam type reheat furnaces.

It is another object of this invention to suitably and practically support workpieces a significant distance above the main support rails to minimize detrimental shadow effects and increase radiation heating from the hot furnace to the workpiece.

It is another object of the present invention to elevate workpieces a significant distance above the main support rails to allow heating of these rails and to promote additional workpiece heating by re-radiation at these locations.

It is another object of the present invention to effectively support workpieces a significant distance above the main support rails by means of individually cooled extensions from the main support rails.

It is still a further object of the present invention to reduce the conduction effects by skewing the workpiece support along the main support rails.

These and other objects and advantages of the present invention will become apparent from a reading of the attached specification and appended claims.

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SUMMARY OF THE INVENTION

The present invention is a skid system for a reheat furnace that comprises a plurality of support elements extending upwardly within the reheat furnace, a pipe arrangement extending upwardly from the support elements and attached to the support elements, and a fluid circulation system contained within the pipe arrangement so as to deliver fluid in heat exchange relationship with the pipe arrangement. The pipe arrangement has a surface for supporting a product thereon within the reheat furnace. Each of the support elements is a tubular member that extends through the reheat furnace. The tubular member has a fluid pathway therein for the passage of a cooling fluid. The pipe arrangement is rigidly affixed to the tubular member and extends vertically upwardly therefrom. The fluid circulation system is in communication with the fluid pathway of the tubular member such that the cooling fluid passes in heat exchange relationship with the pipe arrangement. A supply pipe is positioned within the fluid pathway. The fluid circulation system includes an extender pipe cooling tube which extends interior of the pipe arrangement. This extender pipe cooling tube is in fluid communication with the supply pipe. The supply pipe delivers the cooling fluid to this extender pipe cooling tube. An annular passageway is disposed between the extender pipe cooling tube and the pipe arrangement. This extender pipe cooling tube opens within each of the pipes so as to deliver cooling fluid into the annular passageway.

The pipe arrangement comprises a pipe member which is affixed to at least one of the support elements, and a cap which is fastened to an end of the pipe member opposite the support elements. The cap serves to close an interior of the pipe member. A skid button is fastened to and extends above the pipe member. The skid button is of a heat resistive material for supporting the product thereon within the reheat furnace. An insulation sleeve also extends around the exterior of the pipe member. This insulation sleeve is also of a heat resistive material.

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Ideally, the pipe member will have a length of greater than four inches. The cap is positioned in fluid-tight relationship to an end of the pipe member so as to contain the cooling fluid within the pipe member. The skid button generally covers the exterior of the cap.

The pipe arrangement is generally skewed along the plurality of support elements in such a way that the surface for supporting the product is in contact with different areas along a surface of the product.

The present invention is also an improved skid button assembly for the skid system of a reheat furnace which includes the pipe member, the a skid button fastened to the top of the pipe member, and the fluid circulation system. The skid button is supported above the support structure of the skid system by a distance of greater than four inches.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a cross-sectional view of the skid button assembly in accordance with the preferred embodiment of the present invention.

FIGURE 2 is a plan view showing the skid button assembly and supporting structure as supporting a product within a reheat furnace.

FIGURE 3 is a diagram, illustrating the heat transfer effects of the prior art arrangement of skid button assemblies.

FIGURE 4 is a diagram illustrating the improved heat transfer effects of the system in accordance with the present invention.

FIGURE 5 is a top diagrammatic view of a reheat furnace showing, in particular, the skewed nature of the supporting structure for the skid button assemblies.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is a "elevated skid button" which represents an effective and suitable design so as to adequately elevate, support and convey product (typically steel slabs) through high temperature industrial reheat

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furnaces operating at approximately 2400°F while the product is heated from ambient for charging temperature to a suitable roll forming temperature of approximately 2200°F.

Referring to FIGURE 1, there is shown the basic components of the elevated skid button assembly of the present invention. FIGURE 1 shows at 10 the preferred embodiment of the present invention. Many suitable alternatives of the configuration illustrated in FIGURE 1 are possible within the confines of the present invention.

As illustrated in FIGURE 1, the relatively massive product of the steel slabs is supported and conveyed within a furnace by a water-cooled skid system 14. A cross-section of such a water-cooled skid system is illustrated in FIGURE 1. Usually, steel slabs have a bottom surface 18 which is heated by radiant and convective heat transfer from the furnace environment 16.

The water-cooled skid system 14 typically consists of numerous (eight to twelve) tubular steel support pipes 40 which run the longitudinal length of 100 to 150 feet through the furnace. Each skid is water or steam cooled by adequate coolant flow through the internal annular area 44. The skid system is also protected from the hot furnace environment 16 by an external refractory insulation cover layer 42.

The present invention of the "elevated skid buttons", as described by the preferred embodiment, includes additional coolant service 54 to suitably cool the elevated skid button 20. The design of FIGURE 1 shows a conventional water-cooled longitudinal skid 40 provided with a smaller extender pipe 28. Extender pipe 28 is welded to the main support skid 40. Watertight and structurally solid welds 38 are used to attach this pipe to the longitudinal skid. The extender pipe 28 provides the principal function of this invention by elevating the support button 20 a desired distance above the main longitudinal support skids 14 while providing mechanical support and the required annular conduits 36 for the additional extender pipe and button coolant flows. In the preferred embodiment of the present invention, the extender pipe will have a length so as to elevate the top surface of

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the skid button 20 a distance of greater than four inches above the main support skid 40.

The extender pipe 28 is further provided with external protection from the hot furnace environment 16 by means of an insulation sleeve 32. Sleeve 32 is generally circular in shape with a hollow interior to fit snugly around the extender pipe 28. The length of sleeve 32 is selected to virtually cover all exposed portions of the extender pipe 28 between the main support skid insulation 42 and the skid button 20. Sleeve 32 is made of any refractory material, such as fireclay or alumina compounds, suitably selected for high temperature compatibility with the furnace atmosphere and the thermal insulating properties.

It is intended that the outer sleeve surface, in contact with the hot furnace gases, operates at or near the furnace temperature, while the inner sleeve surface next to the extender pipe 28, operates at a much lower temperature. Properly selected insulating refractory materials used for the sleeve 32 will exhibit a temperature difference or gradient due to their inherent relatively low thermal conductivity.

Extender pipe 28 is furnished with an extender pipe cap 22 which is attached, in fluid-tight connection, to the extender pipe 28 by weld 24. This cap 22 serves a dual purpose. First, cap 22 provides adequate mechanical support for the skid button 20. The cap 22 also forms a water-tight seal of the extender pipe coolant flow 26. The combined system of the main longitudinal support skid 14, the extender pipe 28, the cap 22, and the button 20 represents the structural and functional elements for supporting the heated product 18 within the confines of furnace 16.

Elevated skid button 20 is the final interface between the underlying support system and the heated product. Button 20 is included in the illustration of FIGURE 1, but is not absolutely necessary in the present invention. As an alternative, the extender pipe 28 may simply be lengthened to allow the product 18 to be supported directly on the extender pipe cap 22. Such "button-less" designs may be entirely

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satisfactory for applications where operating conditions, mainly temperature, permit, such as cooler regions of the furnace. When employed, skid button 20 is cast or otherwise manufactured using any suitable durable material. The skid button 20 generally covers the cap 22 and is juxtaposed against the top of the insulation sleeve 32. The button materials may be high temperature resistant steel alloys which include high percentages of nickel, chromium, cobalt, and additions of tungsten, molybdenum, and niobium to achieve sufficient high temperature strength and wear resistance as needed for the required service. As used, button 20 is affixed to the extender pipe 28 by welding or by mechanical cleat arrangements. The button 20 may also be attached by using its own weight or by a locking configuration integral to its shape. A variety of other attachment methods may be used in the present invention.

Individual coolants flow to each elevated skid button is further illustrated in FIGURE 1. Many similar coolant piping arrangements are possible within the scope of the present invention. The present invention should not be limited by the preferred piping arrangement illustrated herein.

FIGURE 1 depicts a supply pipe 50 centrally located within the interior of support rail 40. Supply pipe 50 is further maintained in position within the support rail 40 by means of one or more mechanical supports 48 serving to stabilize and maintain supply pipe 50 at its proper location.

At each appropriate location corresponding to the elevated skid buttons, the supply pipe 50 is provided with a branch "T" fitting 52 so as to allow separate upward cooling fluid to each skid button. Branch "T" fitting 52 is connected to extender pipe cooling tube 30. By supplying sufficient cooling fluid flow and pressure to pipe 50, through separate pumping means (not shown), the piping arrangement described above provides individual coolant fluid to each elevated skid button element along the length of the support rail 40 and the supply pipe 50.

Cooling fluid flows through the annular opening 54 of supply pipe 50 and is suitably diverted by pressure effects

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upwardly through internal flow area 34 of extender pipe cooling tube 30. Coolant flow then strikes the bottom surface of extender pipe cap 22 to impart convective cooling to this element and subsequent conductive cooling to the elevated skid button 20 by contact conductance. Coolant flow further proceeds downward through annular area 36 between the interior surface of extender pipe 28 and the outside of cooling tube 30. This downward coolant flow serves to cool extender pipe 28 by convective means. The coolant flow next passes through annular opening 46 in the support rail 40 and combines with the main rail coolant stream flowing through annular area 44.

By the above-stated means of extender pipes 28, suitable separate coolant supply line 50, extender pipe cooling tubes 30 and the ensuing coolant flows, the skid buttons supporting the workpiece are feasibly and effectively elevated to significant, if not extreme, distances above the main support rails as described by the present invention.

FIGURE 2 illustrates a practical configuration of the present invention of elevated skid buttons for a walking beam type reheat furnace. Elevated skid buttons are most easily employed in walking beam type furnaces. However, the use of such elevated skid buttons for such walking beam type furnaces is not intended as a limitation on the present invention. The elevated skid buttons can be used in various other types of furnaces so as to assist in the support of product within the furnace. For example, the present invention can be used in pusher-type furnaces.

The preferred embodiment of the present invention utilizes numerous elevated skid button assemblies 100, as shown in FIGURE 2, whose details have been described above and are shown, in particular, in FIGURE 1. Skid button assemblies 100 are intermittently located and suitably affixed to support rails 90 to form the liquid-cooled workpiece support system within the interior of furnace 70. Individual elevated skid button assemblies are separated from each other along the longitudinal length of the main support rails 90. This separation distance is ideally the maximum

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possible to allow radiation heating of the workpiece 80 from the hot furnace 70. Contrary to such maximum skid button spacings desired for heating purposes, a functional design must also provide adequate workpiece support. A compromise spacing is thus indicated which balances improved workpiece heating against required workpiece size and support requirements.

With reference to FIGURE 2, it can be seen that each of the elevated skid buttons supports the product 80 in the desired position. However, FIGURE 5 illustrates an alternative, and perhaps preferred, embodiment in which the main support rails 90 are skewed relatively to each other. In FIGURE 5, it can be seen that the furnace 200 has a plurality of support rails 210 formed therein. The environment around the support rails 210 is greatly heated by the action of furnace 200. The refractory walls 212 surround the main support rails 210 so as to provide the confining environment of the furnace. Each of the main support rails 210 includes elevated skid button assemblies 214. These elevated skid button assemblies 214 extend upwardly from the main support rails 210 in the manner shown in FIGURE 2. The product 216 is supported by these elevated skid button assemblies 214. In the "walking beam" type of furnace, the product 216 will move in the direction indicated by arrow 218.

It can be seen that the main support rails 210 are generally skewed in area 220. After experimentation, it has been found that the skewing of the elevated skid button assemblies 214 enhances the ability to furnish a product 216 having consistent temperatures throughout. If there is any conduction effect from the individual skid button assemblies 214, then such conduction effect is transmitted to the product 216 at separate locations along the surface of the product 216. For example, in the position indicated in FIGURE 5, the elevated skid buttons will have a conduction effect on the product 216 in one location. As the product 216 moves onward, the conduction effect will generally move in the direction of the support rails 210. As a result,

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excessive conduction effects affecting a single line area along the bottom surface of the product 216 is properly avoided. In keeping with the present invention, the support rails 210 may be skewed or offset as desired. This skewing effect greatly enhances the capabilities of the present invention.

The "elevated skid button" support design provides for increased heating to the underside of supported (product) steel slabs as well as by inducing greater temperature uniformity within the final reheated steel slab itself. Higher heating rates and improved thermal uniformity are desirable to furnace operators within the hot strip steel rolling industry for improving production throughput and final strip quality.

The elevated skid button design of the present invention provides these benefits by establishing a means and suitable design to continuously support and convey thick (eight to fourteen inches) steel slabs weighing twenty to forty tons each to a modern industrial walking beam slab reheat furnace where the slab product is heated (or reheated) to approximately 2200°F in a 2400°F operating furnace. The elevated skid button design principal was developed by exhaustive radiation heat transfer calculations of distancing and thereby reducing the cooling effects (on the steel slab product) of the water cooled skid support structure. The elevated skid button design allows the bottom of the steel slab to be totally heated by raising it approximately eight to twenty inches above the main skid structure supporting the product load within the slab reheat furnace. This elevation advantage exhibits several heating benefits as are discussed hereinafter. The benefits are derived from the appropriate elevation of the steel slab above the water-cooled skid structure.

To demonstrate evidence of improved heating on behalf of the elevated skid buttons, the following are assumed and fully confirmed within the slab reheating art. Within high temperature (steel slab) reheat furnaces operating at about 2400°F, heating is almost exclusively radiation heat

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transfer from the hot furnace to the cooler steel slab product. It is necessarily affected by the well-established "radiation viewfactor" (F) contained in the imperial Stefan-Boltzman equation governing radiation heat exchange between objects at differing temperatures. While the complete investigation and evaluation of such calculations within the complete furnace system may become considerably involved requiring elaborate computer calculations for exact determination, these principals simply illustrate that radiation heat transfer is "viewangle" dependent just as standing in the shade or out of the "view" of the sun is cooler than standing in direct sunlight.

To this end, it is readily demonstrated and shown by simple geometry that increasing the viewangle and subsequent heating of steel slabs is increased and improved by elevating the (product) steel slab approximately twenty inches above the water cooled skid support structure. Upon further examination and through heat transfer evaluation of such an elevated skid button slab support system design, several overall heating benefits are realized, as are described in the following.

First and foremost, the increased distance between (product) steel slab and skid support system provides a greatly increased view of the hot furnace by the steel slab and subsequent improved heating of the steel. This relationship is illustrated by geometric inspection of FIGURES 3 and 4. FIGURES 3 and 4 show the subtended radiation viewangles from point "J" and "K" on the slab bottom surface which are visible to the heating effects of the hot furnace environment below. For comparison purposes, FIGURE 3 shows a typical slab and supporting skid configuration generally found in slab reheat furnaces throughout the steel heating industry. FIGURE 4 illustrates a similar slab/skid arrangement with the notably greater elevation difference of the skids with respect to the bottom slab surface. FIGURE 4 shows the arrangement which is possible through the use of the cooling fluid circulation in the skid button assembly of the present invention.

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For a given point on the bottom slab surface, the heating by radiation from the hot furnace gases and enclosure is governed by the radiation viewfactor or portion of the hot furnace which each such point "sees" and is not blocked by interfering obstructions (such as other skids). For point "J" in FIGURE 3, the viewfactor consists of three separate viewangles shown as JF1, JF2 and JF3 measuring approximately 44°, 63° and 7°, respectively, for a combined sum of 114°. This sum of 114 degrees represents sixty-three percent (63%) of the maximum possible viewangle of 180°. The remaining thirty-seven percent (37%) or sixty-six degrees (66°) being blocked by the presence of the two typical skid rails shown.

FIGURE 4 demonstrates the increased viewangle radiation viewfactor and ensuing additional slab heating made possible by the separating of the skid position from the slab bottom surface. Corresponding viewfactors KF1, KF2, and KF3 are shown for an identical point "K" on the bottom slab surface. In this case, the viewangles measure "approximately" 73°, 47°, and 30°, respectively, for a sum of 150°. This elevated configuration, shown in FIGURE 4, represents a markedly increased viewangle to some eighty-three percent (83%) of the available maximum of 180° and a significant additional viewangle when compared with the traditionally skid arrangement of FIGURE 3. The increased/additional (slab to furnace) viewangle and radiation viewfactor achieved with the "Elevated Skid Button" design of FIGURE 4 has the natural and desired consequence of increased or additional steel slab heating within the furnace in accordance with the Stephan-Boltzman law mentioned above.

In addition, similar viewangle determinations for any other point on the slab bottom surface also produces higher viewangles and greater (slab-to-furnace) radiation viewfactors for the elevated skid button configuration as shown in FIGURE 4.

As described above, it can be seen that the present invention demonstrates enhanced slab heating and improved thermal performance benefits by the employment of the

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elevated skid button design of the present invention. It should be noted that the technique of elevating skid buttons has been overlooked by reheat furnace designers and engineers for many years. Ideal conditions for virtually any radiant or convective furnace and heating process require "levitation" of the reheated product of the furnace to allow maximum and efficient heat transfer by heating the product from all sides. Traditional reheat furnace designs achieve a practical compromise by supporting the massive steel product load on a structural grid of water-cooled skidpipes and support posts. This conventional design provides complete radiation/convection heating to the top slab surface while the skid support system underneath the slab is built as prudently as possible to allow the greatest amount of radiation and furnace heat to reach the bottom slab surface.

Principally, the (product) steel slabs must be adequately supported and conveyed through these furnaces. A temperature and wear resistant contact surface construction is required for the skid support system. Within the realm of industrial economic reality, exhaustive trials and efforts with various ceramic and exotic metal alloys have recently yielded operational designs of slab support/wear surfaces, or "buttons" as they are known in the industry, with effective heights of elevations above the support skid limited to approximately three to four inches.

Based on present knowledge, it is reasonable to conclude that the use of the "close proximity" skid designs compromise increased heating efficiencies for the sake of perceived practical, physical and material considerations. However, the development of the present invention was realized through the use of intensive radiation and heat transfer investigation of elevated skid button designs. The elevated skid button design accomplishes superior slab heating and improved furnace performance. The elevated skid button design of the present invention employs conventional wear surface/button materials at the contact/interface surface utilizing reasonable industry proven metal material configurations and thicknesses (typically two or three inches

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of high temperature cobalt base heat alloy). In contrast with traditional designs, these elevated wear surface buttons are located on elevated and separated water cooled posts to ensure adequate individual cooling to each elevated button. The present invention is thus able to accomplish what has not been accomplished in the prior art, that is, the ability to elevate the skid buttons for the purpose of improving the heating characteristics of the furnace operation.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof. Various changes in the details of the illustrated apparatus may be made within the scope of the appended claims without departing from the true spirit of the invention. The present invention should only be limited by the following claims and their legal equivalents.

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CLAIMS

I CLAIM:

1. A skid system for a reheat furnace comprising:
a plurality of support elements extending within the reheat furnace;
a pipe means extending upwardly from said support elements, said pipe means affixed to said support elements, said pipe means having a surface for supporting a product thereon; and
fluid circulation means contained within said pipe means, said fluid circulation means for delivering a fluid in heat exchange relationship with said pipe means.
2. The skid system of Claim 1, each of said plurality of support elements comprising a tubular member extending through the reheat furnace, said tubular member having a fluid passageway therein for the passage of a cooling fluid.
3. The skid system of Claim 2, said pipe means rigidly affixed to said tubular member, said pipe means extending vertically upwardly therefrom.
4. The skid system of Claim 3, said fluid circulation means in fluid communication with said fluid pathway of said tubular member such that said cooling fluid passes in heat exchange relationship with said pipe means.
5. The skid system of Claim 4, said tubular member comprising:
a supply pipe positioned within said fluid pathway, said fluid circulation means comprising an extender pipe cooling tube extending interior of said pipe means, said extender pipe cooling tube in fluid communication with said supply pipe, said supply pipe for delivering said cooling fluid to said extender pipe cooling tube.

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6. The skid system of Claim 5, said fluid circulation means further comprising:

an annular passageway disposed between said extender pipe cooling tube and said pipe means, said extender pipe cooling tube opening within said pipe means so as to deliver said cooling fluid into said annular passageway.

7. The skid system of Claim 1, said pipe means comprising:

a pipe member affixed to at least one of said support elements; and

a cap fastened to an end of said pipe member opposite said support elements, said cap for closing an interior of said pipe member.

8. The skid system of Claim 7, further comprising:

a skid button fastened to said pipe means, said skid button extending above said cap, said skid button of a heat resistive material for supporting the product thereon.

9. The skid system of Claim 8, further comprising:

an insulation sleeve extending around an exterior of said pipe means, said insulation sleeve of a heat resistive material.

10. The skid system of Claim 8, said pipe member having a length of greater than four inches, said cap positioned in fluid-tight relationship to an end of said pipe member, said skid button covering said cap.

11. The skid system of Claim 1, said pipe means being skewed along said plurality of support elements such that said surface for supporting the product is in contact with different areas on a surface of said product.

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12. An improved skid button assembly for a skid system of a rehear furnace comprising:

a pipe member extending upwardly from a support structure of the skid system;

a skid button fastened to a top of said pipe member, said skid button for supporting a product thereon; and

a fluid circulation means within said pipe member for passing a fluid in heat exchange relationship with said pipe member.

13. The skid button assembly of Claim 12, said pipe member having a length of greater than four inches.

14. The skid button assembly of Claim 12, further comprising:

a cap fastened in fluid-tight relationship to an end of said pipe member opposite the skid system.

15. The skid button assembly of Claim 14, said skid button comprised of a heat resistive material, said skid button covering said cap.

16. The skid button assembly of Claim 12, further comprising:

an insulation sleeve extending around an exterior of said pipe member, said insulation sleeve of a heat resistive material.

17. The skid button assembly of Claim 12, further comprising:

a fluid supply interconnected to said fluid circulation means, said fluid supply containing a heat exchange fluid for delivery to said fluid circulation means.

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18. A skid system for a reheat furnace comprising:
- a first support element extending within said reheat furnace;
 - a second support element extending within said reheat furnace, said second support element having at least a portion in skewed relationship to said first support element;
 - a plurality of pipe members extending upwardly from said first and second support elements, said pipe members having an interior in fluid communication with an interior of said first and second support elements; and
 - a skid button positioned on an end of each of said pipe members opposite said first and second support elements, said skid button for supporting a product thereon.

19. The skid system of Claim 18, further comprising:
- fluid circulation means positioned in said first and second support elements and said plurality of pipe members, said fluid circulation means for delivering a cooling fluid in heat exchange relationship with said pipe members.

20. The skid system of Claim 18, said skid button supported at least four inches above said first and second support elements.

1 / 5

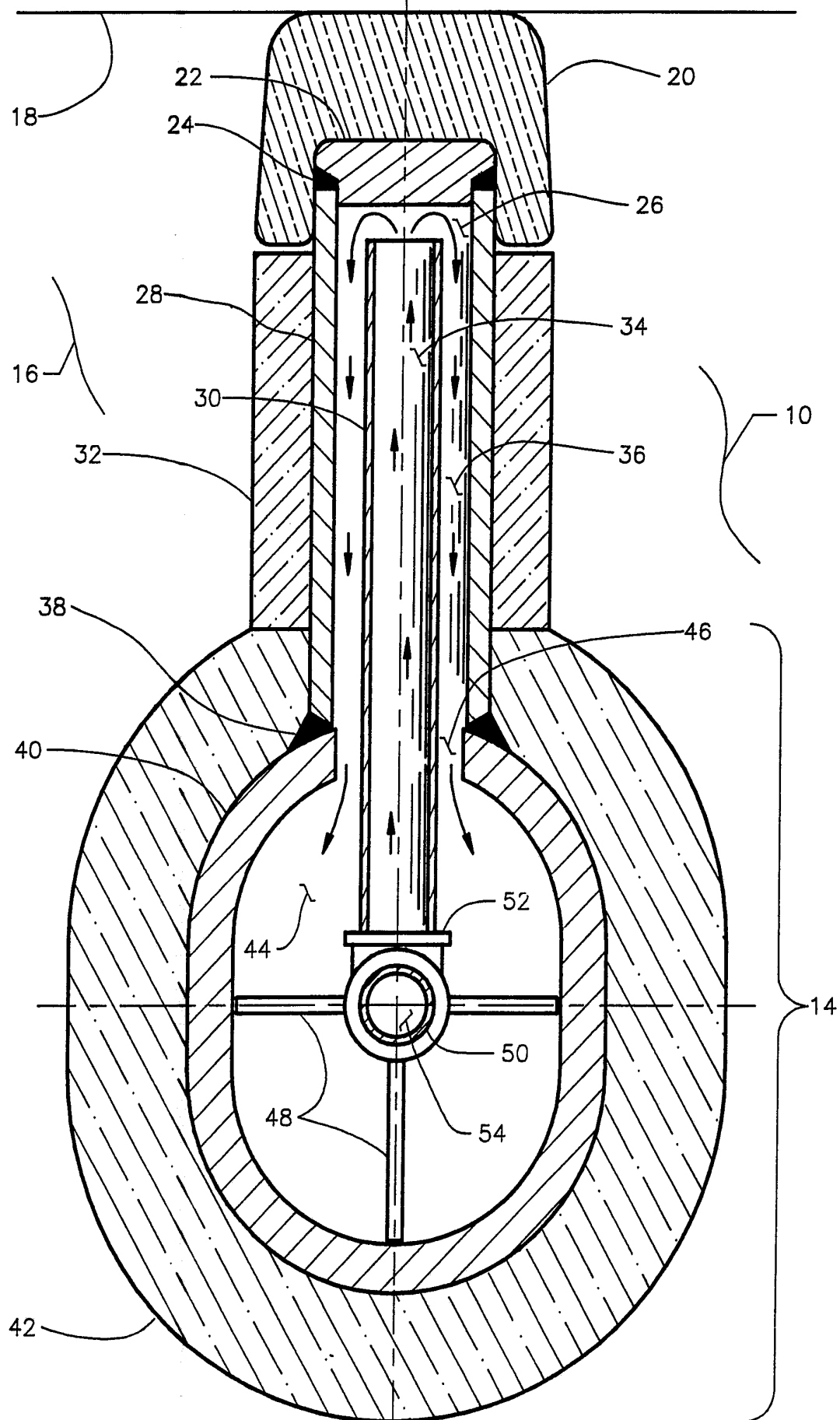


FIGURE 1.

SUBSTITUTE SHEET

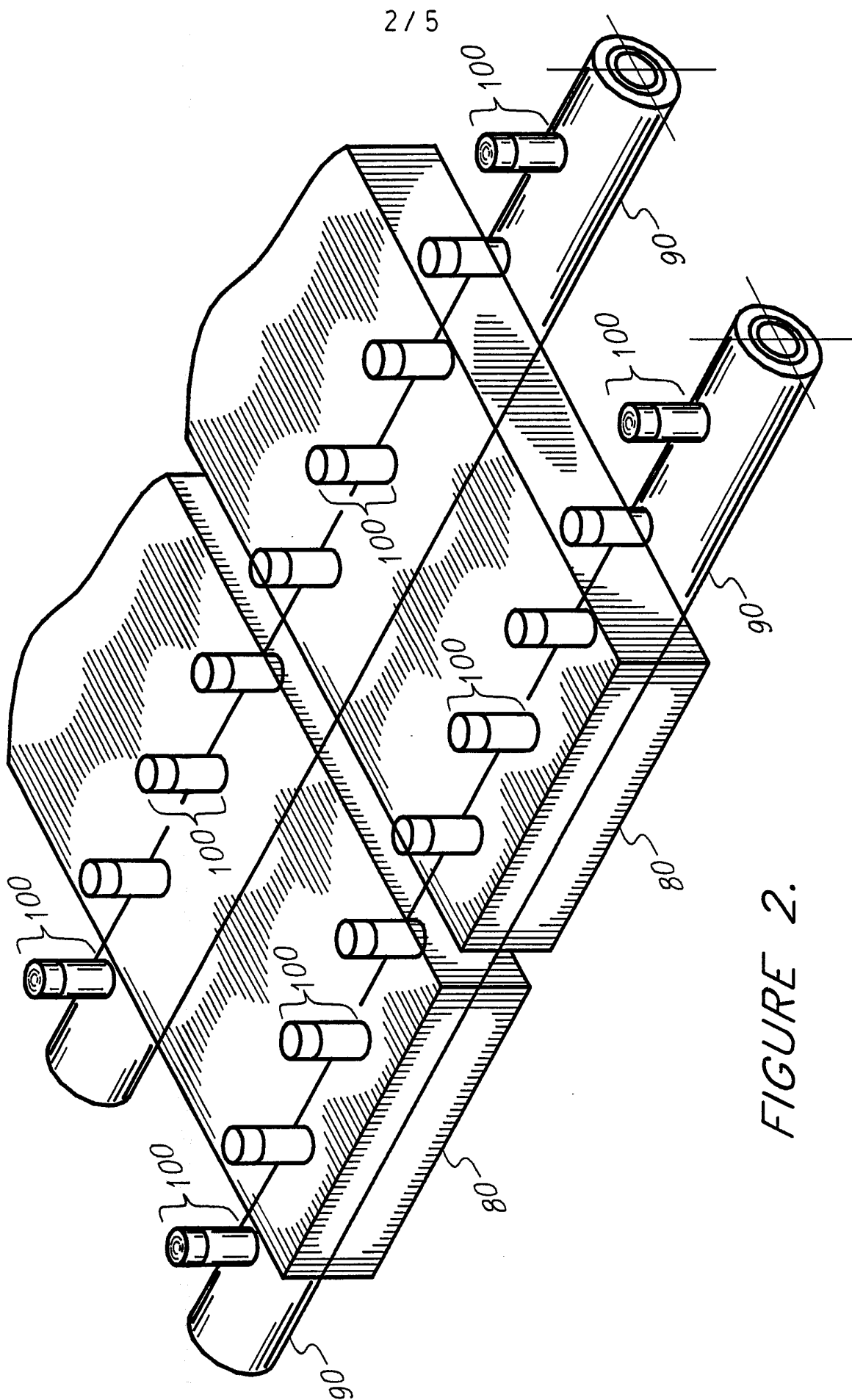
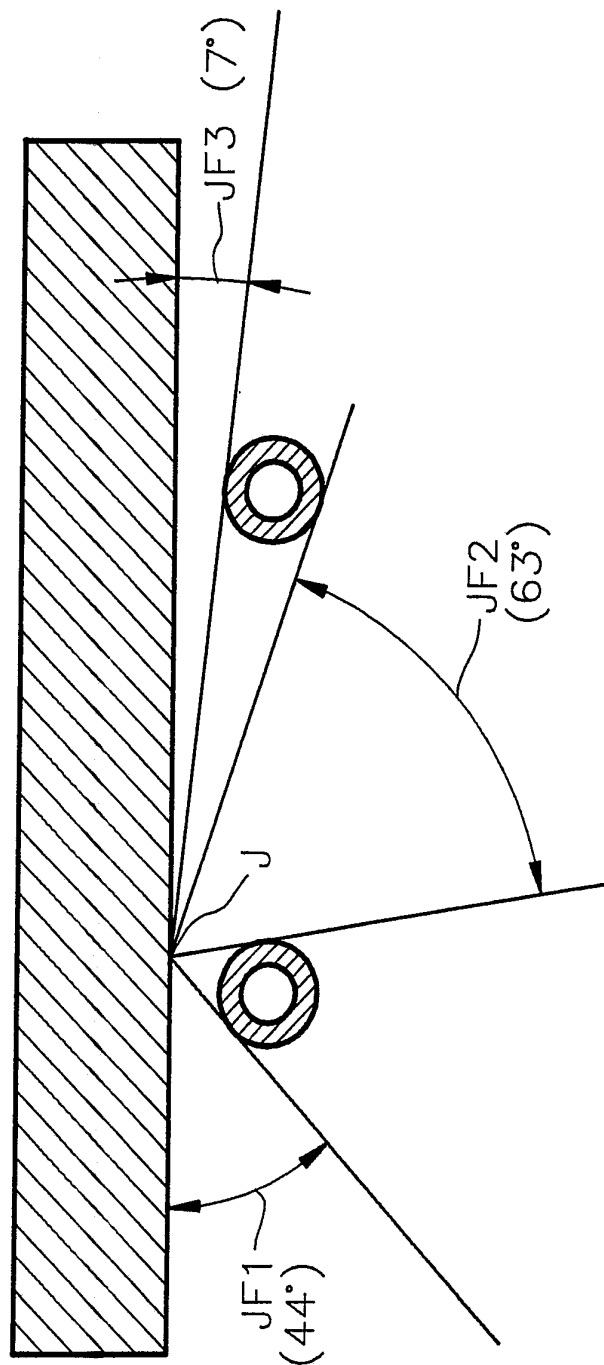


FIGURE 2.



PRIOR ART

FIGURE 3.

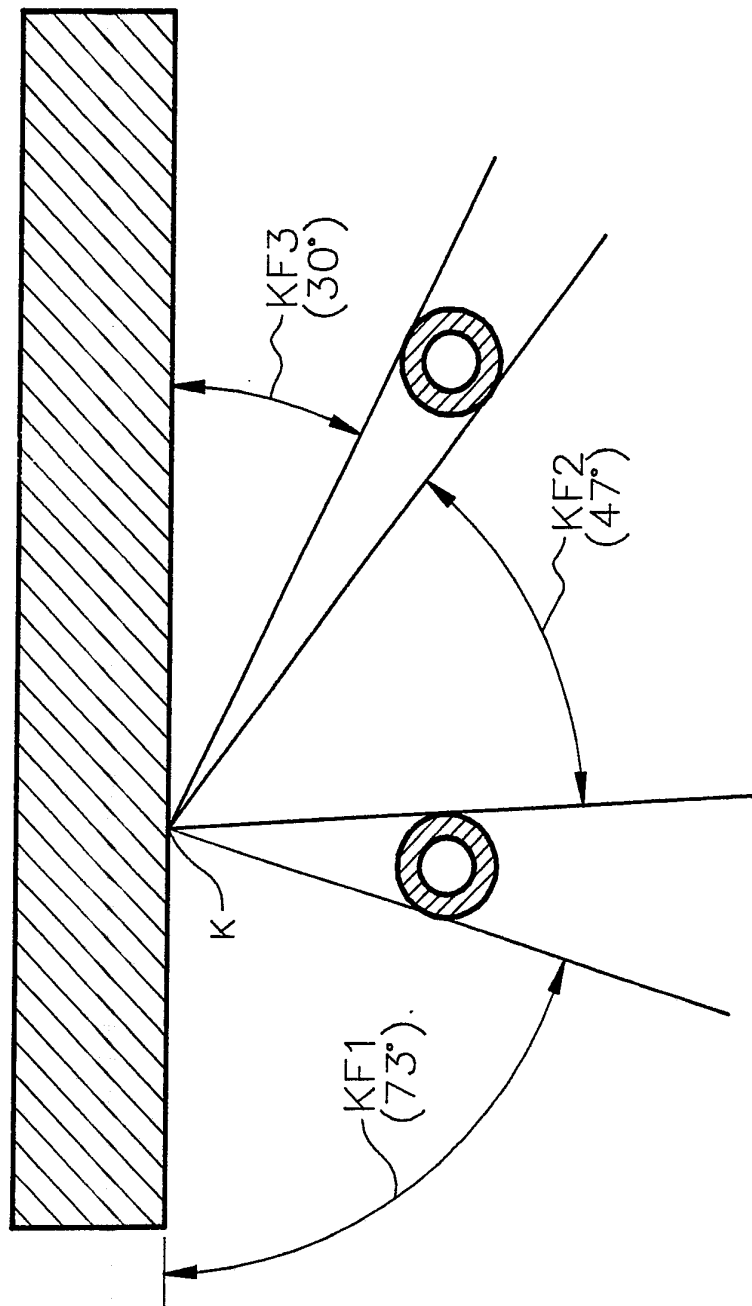


FIGURE 4.

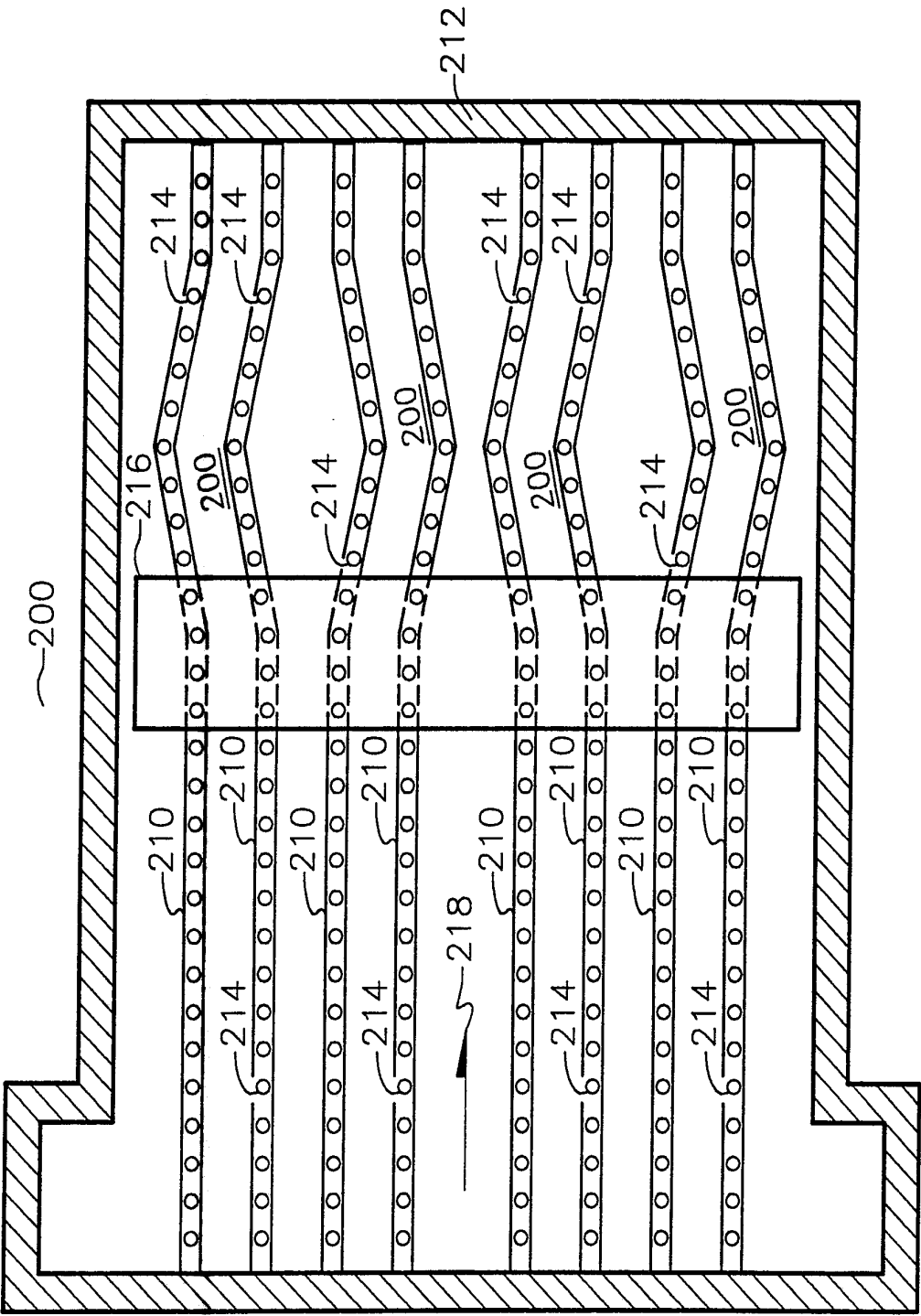


FIGURE 5.

INTERNATIONAL SEARCH REPORT

International Application No. **PCT/US91/05435**

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) * According to International Patent Classification (IPC) or to both National Classification and IPC IPC(5): F27D 3/02																	
II. FIELDS SEARCHED Minimum Documentation Searched ⁷ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 25%; border: 1px solid black; text-align: left; padding: 2px;">Classification System</th> <th style="border: 1px solid black; text-align: left; padding: 2px;">Classification Symbols</th> </tr> <tr> <td style="border: 1px solid black; text-align: center; padding: 10px;">US</td> <td style="border: 1px solid black; padding: 10px;">432/234 432/236</td> </tr> </table> Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched ⁸			Classification System	Classification Symbols	US	432/234 432/236											
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III. DOCUMENTS CONSIDERED TO BE RELEVANT * <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 5px;"> <tr> <th style="width: 10%; text-align: left; padding: 2px;">Category *</th> <th style="width: 60%; text-align: left; padding: 2px;">Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²</th> <th style="width: 30%; text-align: left; padding: 2px;">Relevant to Claim No. ¹³</th> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">X</td> <td style="padding: 5px;">US, A, 3,567,195 02 March 1971</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1,7</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">X</td> <td style="padding: 5px;">US, A, 3,015,478 02 January 1962</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1,7</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">Y</td> <td style="padding: 5px;">US, A, 4,900,248 13 February 1990</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-20</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">Y</td> <td style="padding: 5px;">US, A, 3,471,134 07 October 1969</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-20</td> </tr> </table>			Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	X	US, A, 3,567,195 02 March 1971	1,7	X	US, A, 3,015,478 02 January 1962	1,7	Y	US, A, 4,900,248 13 February 1990	1-20	Y	US, A, 3,471,134 07 October 1969	1-20
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* Special categories of cited documents: ¹⁰ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family																	
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse; margin-top: 5px;"> <tr> <td style="width: 50%; border: 1px solid black; padding: 5px;"> Date of the Actual Completion of the International Search 05 SEPTEMBER 1991 </td> <td style="width: 50%; border: 1px solid black; padding: 5px;"> Date of Mailing of this International Search Report 10 OCT 1991 </td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;"> International Searching Authority ISA/US </td> <td style="border: 1px solid black; padding: 5px;"> Signature of Authorized Officer NGUYEN NGOC-HO INTERNATIONAL DIVISION HENRY C. YUEN </td> </tr> </table>			Date of the Actual Completion of the International Search 05 SEPTEMBER 1991	Date of Mailing of this International Search Report 10 OCT 1991	International Searching Authority ISA/US	Signature of Authorized Officer NGUYEN NGOC-HO INTERNATIONAL DIVISION HENRY C. YUEN											
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