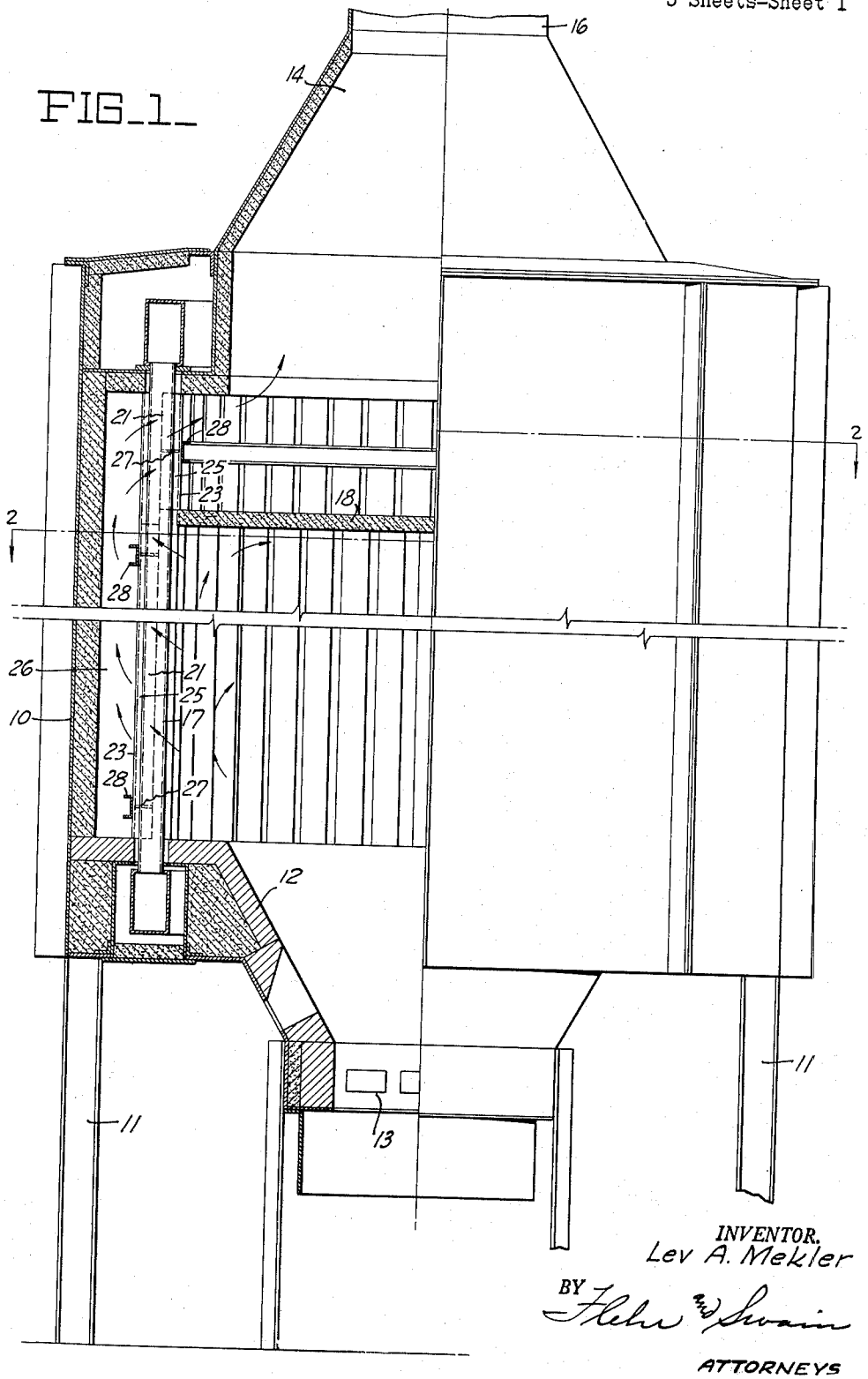
Aug. 9, 1955 L. A. MEKLER 2,714,878

PETROLEUM HEATER

Filed Oct. 3, 1950 5 Sheets-Sheet 1

FIG_1_



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PETROLEUM HEATER

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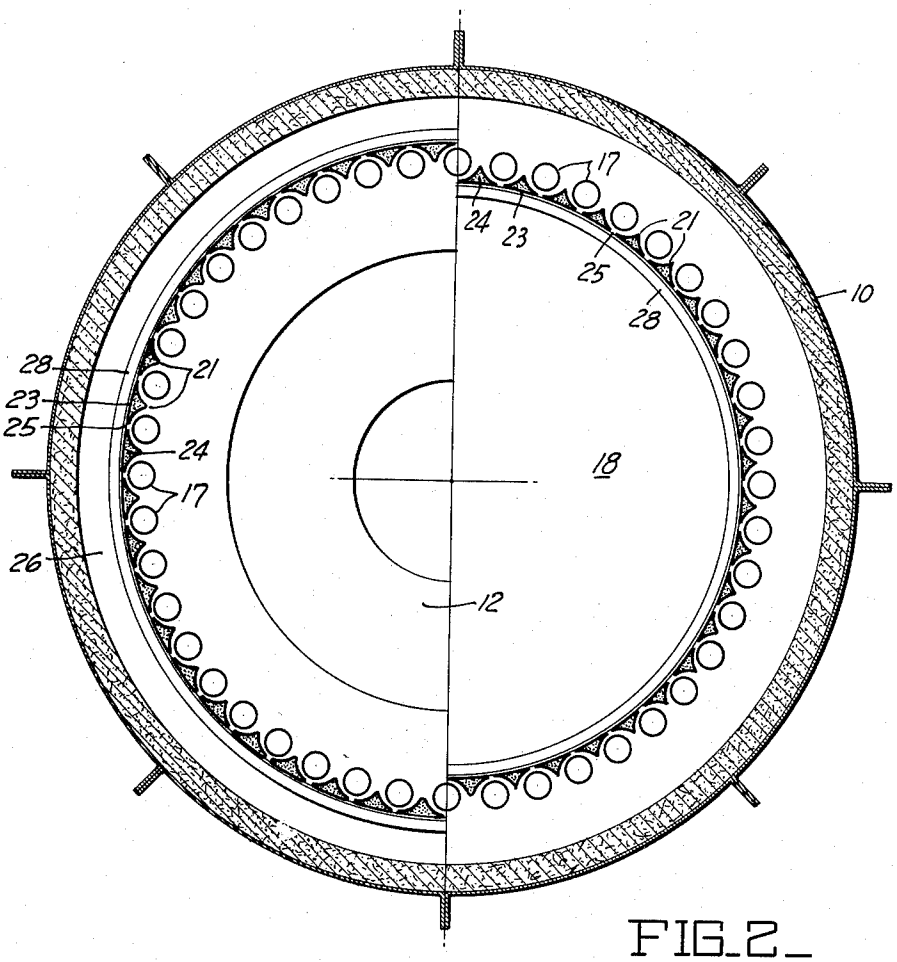


FIG_2_

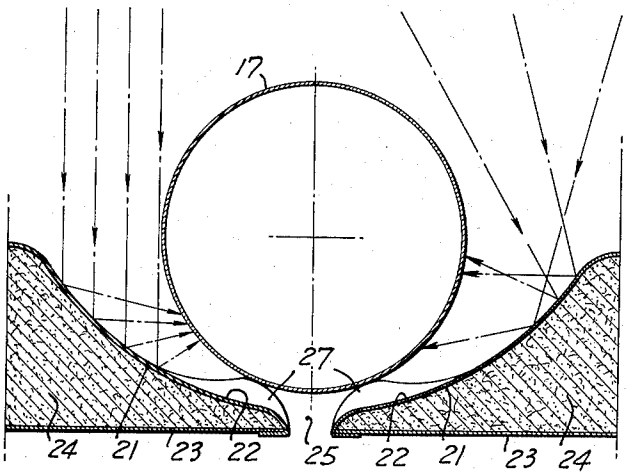


FIG_5_

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PETROLEUM HEATER

Filed Oct. 3, 1950 5 Sheets-Sheet 3

FIG. 3

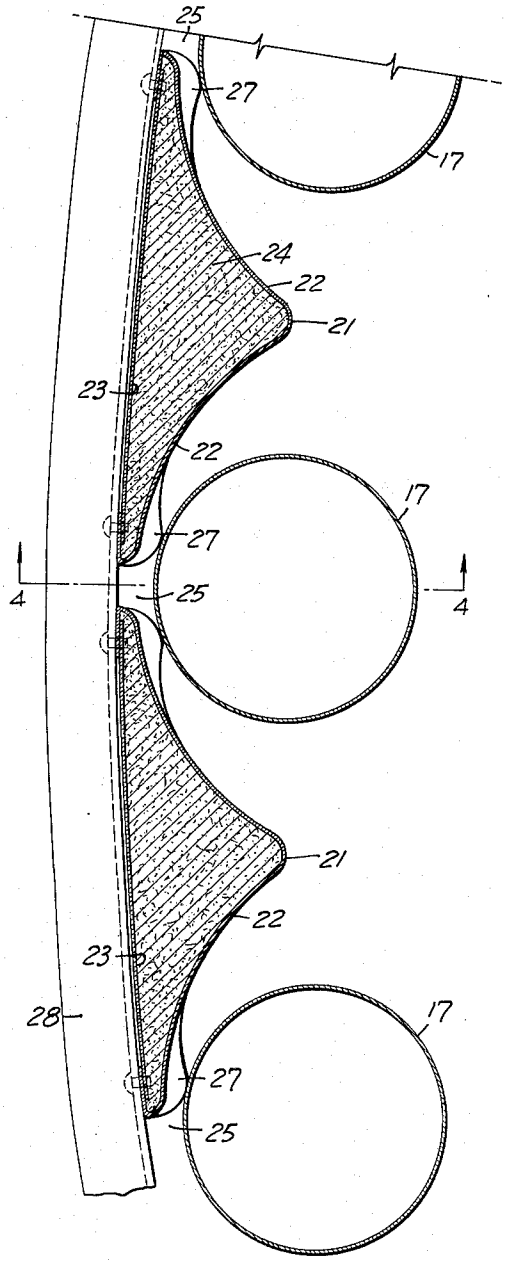
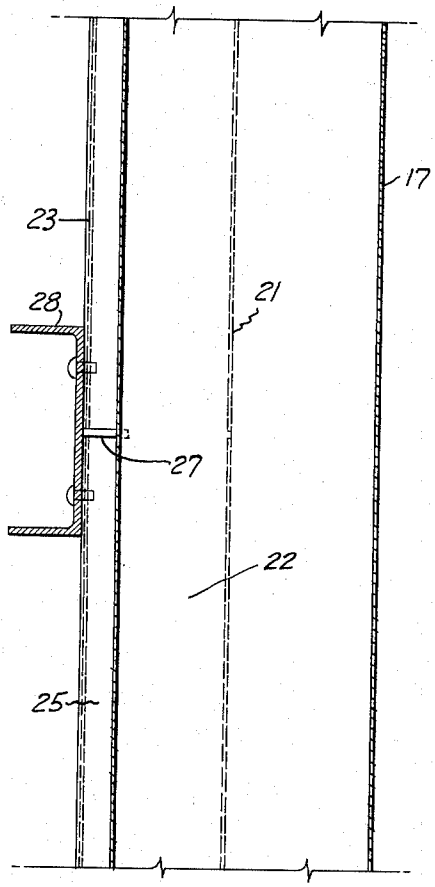


FIG. 4



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Aug. 9, 1955 L. A. MEKLER 2,714,878

PETROLEUM HEATER

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FIG_6_

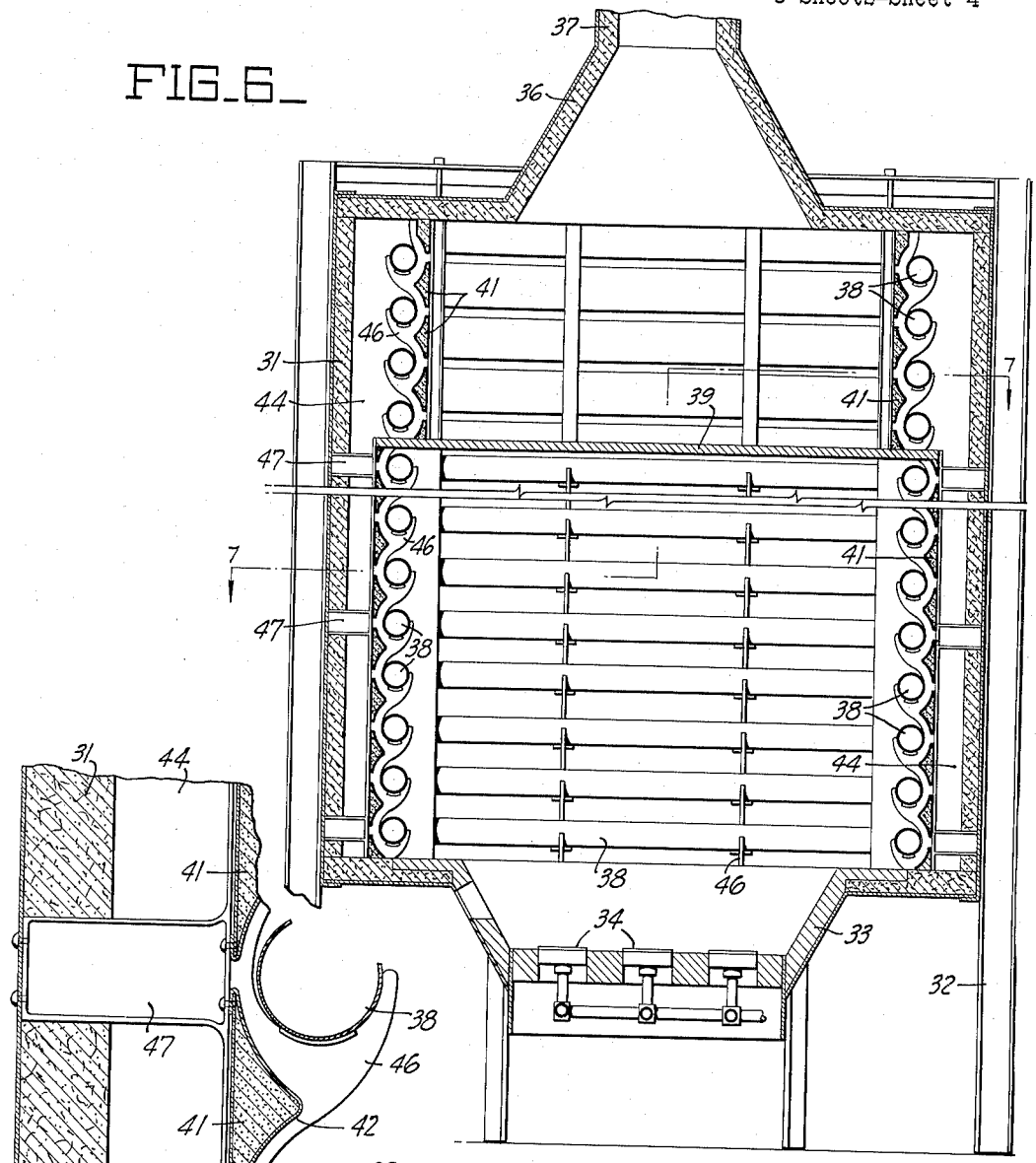


FIG_8_

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PETROLEUM HEATER

Filed Oct. 3, 1950 5 Sheets-Sheet 5

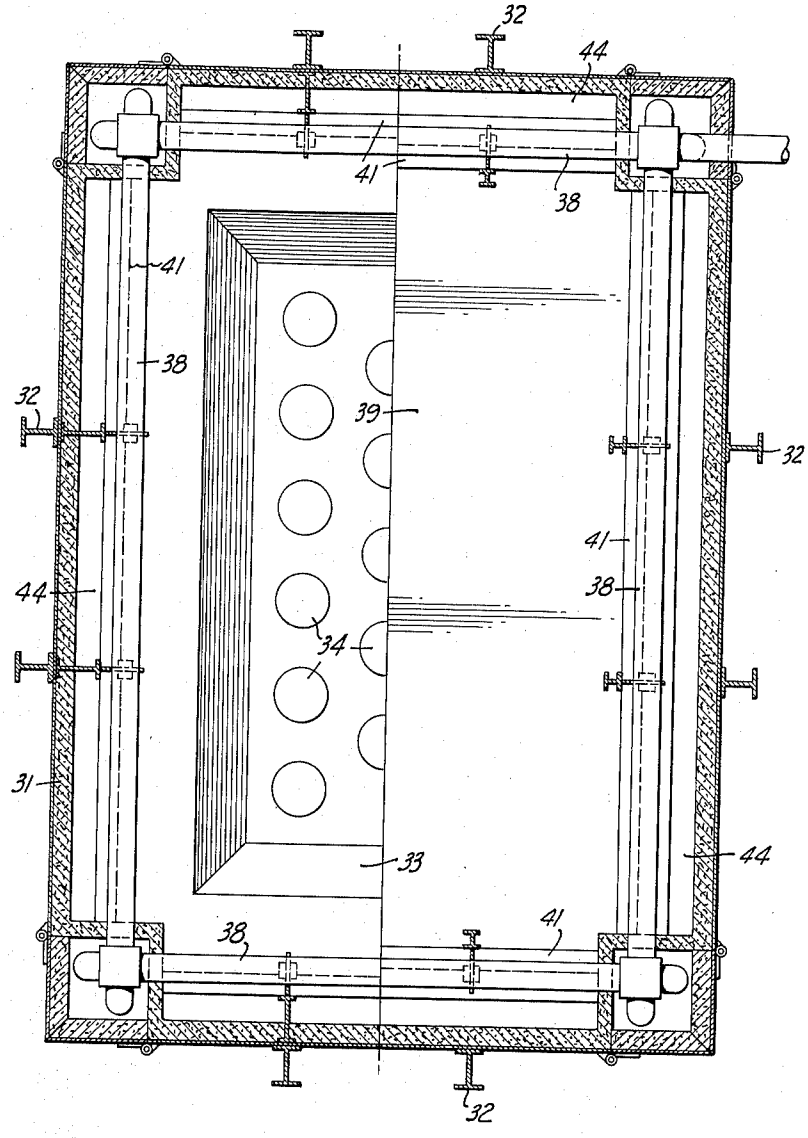


FIG_7_

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United States Patent Office

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2,714,878

PETROLEUM HEATER

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Application October 3, 1950, Serial No. 188,187

3 Claims. (Cl. 122—235)

This invention relates to an apparatus and method for heating fluids and particularly to an apparatus and method for effectively utilizing the heat produced in such a device.

In the past it has been common practice to heat fluids by passing them through tubular conduits which may be placed in banks adjacent the refractory surfaces forming the enclosure of the apparatus. With the tubes so positioned, that portion of each tube which is exposed directly to the source of heat absorbs approximately twice as much heat as the surface of the tube which is adjacent to or facing the refractory surface.

It is an object of this invention to provide a device of this character which increases the portion of radiant heat supplied by re-radiation and reflection to the surface of the tube adjacent to or facing the refractory surface. This will permit higher average rates of heat input along the whole circumference of the tube surface for any given maximum rates on the portion of the surface exposed directly to the source of heat.

As I have previously pointed out, various heaters have utilized re-radiating walls adjacent banks of tubes. However, said radiating walls are normally planes or cylinders of a diameter many times the diameter of the tubes so that a secton of the radiating wall immediately behind or corresponding to a pair of tubes is substantially planar, whereby radiant rays passing between the tubes normal to the re-radiating wall or striking the same at right angles are reflected and re-radiated back into the furnace, thereby missing the tubes. Only those rays striking the re-radiating wall at an angle are reflected and re-radiated to the tubes. Because of the cosine rule of radiant heat intensity, the slanted rays are weaker than the normal rays so that with the continuous planes or cylindrical surfaces not only is a portion of the rays falling upon these surfaces not utilized to supply heat to portions of the tubes facing these surfaces, but the re-radiation from the remainder of the rays is of relatively lower intensity than from the normal rays.

In addition to reflecting the heat rays and the reflected rays, which can be considered as single linear rays following the cosine rule of heat intensity, these surfaces also re-radiate the heat. Re-radiation produces a spherical sector of radiant rays in which the individual rays also follow the rule of cosine. A flat surface or a curved surface substantially parallel with the periphery of the tube bank and behind the tubes, therefore, re-radiates to the tubes only a part of the radiant rays within the sector. The rays so utilized are not as strong as those reflected between the tubes back to the source of heat. It is an object of my invention to deflect to the back surfaces of the tubes the major portion of the radiant heat not absorbed directly by the surfaces facing the source of heat.

A further object of this invention is to provide a heater which is so constructed that combustion gases generated within the heater will be prevented from channeling.

Fresh combustion gases flowing through a heater towards an outlet located at or near the top or the bottom of the heater have a tendency to channel themselves through only a portion of the cross section of the heater and thus to produce relatively hotter and colder zones within the heater. One defect of prior heaters has been uneven distribution of heat due to the tendency of an appreciably large portion of the total combustion gases to channel themselves to the outlet with the result that one portion of the heater would be heated at higher rates of heat input than another portion. Attempts to overcome this channeling by placing baffles in the stream of heated gases or by restricting the flow of gases by a damper in the stack and by using other means of restricting the flow of heat by a common outlet from the heater to the atmosphere have been unsuccessful unless such obstruction so reduced the cross section near the outlet as to impose a positive pressure on the heater chamber. This is undesirable because it prevents operation of the heater under natural draft and thus requires operation with forced draft and use of mechanical power to supply air required for combustion. Also even a small positive pressure in the heater requires a gas-tight setting which is often not practical and is always more expensive than a setting for a heater operating under negative pressure or draft, no matter how small the negative pressure or draft may be.

It is a further object of this invention to provide a tubular heater in which there is a uniformity of heat input to the various portions of the bank of tubes and a uniformity of heat along the length of the tubes without the use of positive gas pressure in the heater chamber.

It is also an object of this invention to obtain more uniform heat distribution around the circumference of each tube than can be obtained normally in similar heater structures.

In some operations, if the variations of heat distribution are sufficiently great and the material being treated is sufficiently sensitive to heat treatment, a portion of the material being heated will be overtreated or a portion of the same will be undertreated, which will adversely affect quality and yield of the product desired. More uniform heat distribution obtained in a heater assures more uniform heat treatment to the whole body of the material being processed and, therefore, results in optimum yield and quality of the product.

Other objects and advantages of this invention will appear from the following specification taken in conjunction with the accompanying drawings in which:

Figure 1 illustrates, in cross section, a circular heater incorporating my invention;

Figure 2 is a cross-sectional view of a heater taken along the lines 2—2 of Figure 1;

Figure 3 is an enlarged detail showing the arrangement and positioning of the tubes and baffles;

Figure 4 is an enlarged fragmentary view taken along the line 4—4 of Figure 3;

Figure 5 is an enlarged detail of a tube and baffle arrangement illustrating, by arrows, the heat rays directed toward the tube by the baffle;

Figure 6 illustrates the embodiment of my invention in a heater of the type employing horizontal or substantially horizontal tubes;

Figure 7 is a cross-sectional view taken along the line 7—7 of Figure 6; and

Figure 8 is an enlarged cross-sectional detail illustrating the position of the tubes, baffles, and the means for supporting the same.

My heater consists of a shell **10** adapted to be supported by members **11**. Shell **10** may be made of any conventional material and of any size desired and, as shown in Figure 1, may be circular in cross-section. At the lower end of the shell **10**, I have provided a truncated conical portion **12** which is adapted to accommodate one

or more burners **13** of any conventional type adapted to receive and burn suitable fuel material and to discharge the products of combustion into the interior of the shell **10**. At the upper end of the shell **10** I provide a similar truncated portion which serves as a gathering duct **14** for the products of combustion and directs them to the exhaust or outlet stack **16**.

The fluid conducting conduits **17** consist of a plurality of vertical tubes or conduits adapted to carry the fluid to be treated and which are disposed in a single circular row coaxial with the shell **10**. The tubes **17** may be arranged in series to provide in effect one stream throughout the heater or may be so connected as to form two or more such parallel streams. The manner of connecting the conduits **17** is substantially conventional and may vary to suit particular conditions.

As illustrated in Figure 1, I provide a horizontal partition **18** near the upper end of the heater. The horizontal partition **18** is constructed of any suitable material and is mounted in such a manner that it substantially blocks the flow of gases from the burner **13** to the stack **16** and divides the heater into a lower primary zone and an upper secondary zone.

I also provide a plurality of vertical baffles **21** arranged generally as illustrated in Figures 1 and 2. Those baffles **21** below the partition **18** are arranged in a circle outside of the bank of tubes **17** while those baffles **21** above the partition **18** are arranged in a circle within the bank of tubes **17**.

As illustrated particularly in Figure 3, the baffles **21** provide a pair of curvilinear surfaces **22**. The surfaces **22** are preferably made of a high temperature oxidation resistant alloy which will retain, at the operating conditions at which the heater is adapted to be operated, its relatively low emissivity and relatively high reflecting power. In addition to smooth high temperature alloy sheets, glazed or semiglazed refractories may be used. In the event alloy sheets are used the baffles **21** may be constructed as illustrated in Figure 3, in which the sheet forming the surfaces **22** may be formed generally as illustrated and secured to a flat plate **23** which may be formed of less expensive material. The void between the plate **23** and the front of the baffle may be filled with loose granular insulation **24** of any particular type.

The baffle surfaces **22** facing the tubes **17** form portions of cylinders whose radius is from one and one-half to two and one-half times the diameter of one of the tubes **17**. The baffles **21** and tubes **17** serve to form constantly decreasing passages **25** for the gases from the center of the heater to the area beyond the baffles and are so positioned as to form a Venturi-like section for the discharge of gases into the annular space **26** around the baffles. The space **26** between baffles **21** and the interior of the shell **10** forms an annular flue for the passage of gases upwardly into the area above the partition **18**. As is more particularly illustrated in Figure 1, the baffles **21** in that portion of the shell above the partition **18** are placed within the circular bank of tubes **17** in such a manner that they form decreasing Venturi-like passageways to openings between the baffles **21** permitting the flow of gases from within the annular flue **26** to the gathering duct **14** immediately underlying the stack **16**.

I also provide a number of horizontal separator plates **27** which act as partitions within the baffles and as spacers to support the granular material within the baffles and as guides for the baffles **21** with respect to the tubes **17**. The girth members **28** secure the baffles **21** as indicated. In addition, the girth members **28** provide a suitable support and a unitary structure for the baffles and may be mounted in any suitable manner upon the shell **10** to provide additional rigidity to the entire structure.

Operation of the device may briefly be described as follows: Let it be assumed that heat is generated within the burner **13** as indicated, with the result that combustion gases are distributed in the area within the bank of tubes **17**. The combustion gases would normally flow directly from the burner **13** to the stack **16**. However, the area of the cross section of the heater is normally considerably greater than the area required to carry the fresh gases from the burners **13** to the stack **16** and unless means are provided to disperse the fresh gases through the main body of the gas in the heater, the gases leaving the burner **13** will form a channel through the main body of the gas in the heater. Partition **18** prevents passage of gas directly to the stack **16** so that the gases can leave the heater only through the passageways between the tubes **17** and baffles **21**. Because the gases can leave the heater only along the periphery of the gas body by passing over and between the tubes, the fresh gases must pass through and mix with the main body of the gases before leaving the heater. This results in substantial uniformity of temperature of gas near the tubes along horizontal planes. In addition, the tubes serve to form a cold plane in the path of the gases. This cold peripheral plane on the outside of the mass of gas and the hot center within the mass induce appreciable thermal siphon circulation upward in the center and downward along the tubes **17**, which further assists in establishing uniform heat distribution in the heater and permits the use of high input rates without fear that zones of local overheating may greatly exceed these rates.

As has previously been pointed out, the front portions **22** of the baffles **21** are so shaped and so placed with respect to each other as to form a Venturi-like section for discharge of gases into the annular space **26** between the shell **10** and the outer walls **23** of the baffles **21**. The Venturi-like shape of the passageways **25** from the heater into the annular space **26** serves to reduce the pressure drop and to provide the highest velocity near the relatively narrow space near the gas outlet. The deposit of soot or ash on the tubes or the baffles is minimized because there are no sharp turns in the path of the gases or long narrow passageways along the tubes, as is the case with tubes with extended surfaces in a relatively long narrow passage as exist in some heaters, and as is the case with very long narrow passages lined with refractories as utilized in other types. The baffles will, therefore, retain their effectiveness over a long period of time.

Furthermore, in addition to defining the path of combustion gases from the center of the heater to the annular space **26** surrounding the tubes **17** and baffles **21** and directing relatively high velocity gases against the shielded portion of the circumference of each of the tubes, the baffles serve as re-radiating and reflecting surfaces to supply heat to the shielded half of the tubes to a considerably greater extent than would be supplied by the cylindrical surface of the shell **10** of the heater where there are no baffles. In Figure 5 I have attempted to represent schematically by arrows the heat rays directed toward the surface **22** of the baffles **21**. The arrows directed toward the tubes represent the central radii of the spherical sectors of re-radiation and the paths of reflected heat. It will be seen that practically all of the re-radiated and reflected heat is directed toward the back half or shielded surfaces of the tubes with very little of the heat re-radiating or being reflected back into the center of the heater. Because the walls of the baffles are preferably made of a material having relatively low emissivity and relatively high reflecting power, a greater portion of the incident radiant heat striking the surface of the baffles will be reflected heat which will follow more closely the paths shown by the arrows.

Calculations indicate that with the shape and space relationship of the baffles as shown and assuming that the baffles are made of an alloy with an emissivity of 0.45, the combined equivalent emissivity of the baffles for re-radiation and reflection is close to 0.95 as against 0.63 for a plane or a large diameter cylindrical refractory surface. The equivalent emissivity of the baffles will be somewhat lower if the baffles are made of a material of

higher emissivity and lower reflecting power than herein specified. The baffles, therefore, are instrumental in increasing the amount of radiant heat available to the shielded half of the tubes by approximately 50%.

It will be apparent, therefore, that the use of these baffles results in higher rates of radiant heat input to the shielded half of the tube surface for a given maximum heat flux on the exposed half and thus permits the use of higher average heat input rates along the total circumference of the tube for a given maximum rate on the exposed surface, or to put it in another way, results in lower maximum rates for the same average circumferential rates than can be obtained with bare tubes without such baffles, or with tubes placed in front of a flat or planar re-radiating surface.

It would appear that the increased radiant heat absorption by the shielded half of the tubes due to the baffles will result in an increase of approximately 15% in the average heat input rates about the total circumference of the tubes. Superimposed convection from the gases adds from 1,000 to 1,500 B. t. u. per square foot to the heat supplied to the tubes so that the total increase in average heat transfer rates for a given maximum heat flux on the exposed face is 18 to 20%. By way of example, without baffles and at an average rate of heat input of 10,000 B. t. u. per square foot, the exposed half of the tubes will have an average rate of 14,700 B. t. u. and a maximum flux of 17,500, whereas the shielded half will absorb merely 5,300 B. t. u. With my baffles and at the same average and maximum rates on the exposed half, the shielded half will absorb an average of 9,000 B. t. u. and the average for the total circumference will be approxiately 11,800 B. t. u. The advantages of the baffles are even more pronounced at the higher average heat input rates. Without baffles and assuming average rates of 12,000 B. t. u. the maximum flux is approximately 21,000. With baffles, average rates of 14,200 B. t. u. are obtained with the same flux. The maximum flux will be over 25,000 if 14,200 B. t. u. average rates are obtained without the baffles.

The problem of channeling gases is an old one and is well recognized. For example, others have sought to accomplish the same result, that is, to obstruct the flow of gases from the heater and to break up the total flow into a number of small streams by placing baffles in the normal path of the gases. However with one type of heater with which I am familiar, I have found that the gases in their natural flow, due to the hydraulics of hot gases to flow upwards, will not flow through all of the baffles at substantialy uniform rate and will tend to channel.

In a heater incorporating my invention, however, gas hydraulics does not effect the flow of gases through the baffles. On the contrary, the baffles make gases flow in a direction substantially at right angles to the hydraulic effect and from the periphery of the main body or stream of gases. By the utilization of the partition **18**, therefore, the hydraulic effect of the flow of gases is overcome and substantially eliminated. By providing equally spaced slots of equal section between the baffles, the gases will tend to flow through the slots uniformly in the same plane.

Other designers have utilized baffle bricks and have placed the tubes within longitudinal annular spaces to effect convection components by increasing the velocity of gases around the otherwise shielded circumference of the tubes. Devices of this type have shielded the backs of the tubes from radiation. On the contrary it will be observed that my design not only does not obstruct radiant heat from passing between the tubes but redirects this heat to the back surface of the tubes, thereby increasing the radiant heat input by reflecting forward to the back of the tube a major portion of the heat that would otherwise be re-radiated into the furnace and lost to the back of the tube. In the prior devices of which I speak

all rays which are normal or at right angles to the surface are reflected back into the furnace through the same aperture between the tubes through which they entered. These rays miss the tubes. Only the slanted rays, which are the weakest, are reflected to the rear side of the tube. By virtue of the curvilinear surfaces which I provide, substantially all rays falling upon the surfaces are reflected towards the back or shielded portion of the tube surface at an angle equal to the angle formed by the ray and the radius of curvature of the surface at the point thereby increasing the radiant heat input to the otherwise protected portion of the tube. This is strictly true only for reflected heat rays which I have considered as single linear rays for the purposes of this discussion. However, it will be noted that the smooth alloy or glazed ceramic which I utilize will provide the maximum of reflection and will, therefore, act as described to a greater extent than dull relatively rough surfaces with lower reflecting properties. However, the surfaces I provide are also effective even though to a somewhat lesser extent to re-radiation. Re-radiation I prefer to consider as being spherical with a sector of radiant rays radiating from the point hit by a ray from the interior of the furnace. By the law of cosines applied to radiation the rays near the center of the re-radiation sector will be the strongest while those near the edge of the sector will be the weakest. In the event the baffles behind the tubes were flat, the strongest rays, that is those nearest the center of the sector, would tend to be re-radiated back into the center of the heater and those rays nearest the outer edge of the sector would strike the tube. With the baffles, the rays near the center of the sector are deflected towards the tube surface facing them.

In addition to acting as directional reflecting and re-radiating surfaces for radiations from the heat source to increase radiant heat input to the tube surfaces they face, the baffles act as solid partitions between tubes which prevent re-radiation between the tube surfaces. Without such partitions the surface of one tube faces the relatively cold heat absorbing surfaces of the adjoining tubes so that the effectiveness of the tubes is reduced appreciably. The baffles isolate the tube surfaces they face from adjoining tube surfaces and substitute relatively high temperature and substantially nonabsorbing surfaces which materially increase the effectiveness of the tube surfaces facing the baffles by "shading" the tube surfaces from each other.

Prior devices have also sought to increase the fluid heat component supplied from the combustion gases to the rear of the tubes by providing spaced refractories in close proximity to that portion of the tube shielded from the source of heat and by causing the combustion gases, which have given up a major portion of their heat by radiation to the exposed portions of the tube bank and to the refractories, to pass about and in intimate contact with shielded portions of the tube at relatively high velocity through the spaces provided between the refractory shapes and the tubes. Such devices, however, are effective for heat transfer only by convection and reduce rather than increase radiant heat input to the surfaces affected so that they are less effective in their over-all effect than the present design.

In the embodiment of my invention illustrated in Figures 6, 7 and 8, I illustrate a petroleum heater in which the tubes or conduits are horizontal or substantially horizontal.

As illustrated particularly in Figures 6 and 7, the heater consists of a shell **31** which is adapted to be supported by members **32**. The shell **31** may be made of any conventional material and of any size desired, and, as particularly illustrated in Figure 7, is preferably square or rectangular in section. At the lower end of the shell **31** I have provided a truncated pyramidal portion **33** which is adapted to accommodate one or more burners **34** of any particular type adapted to receive and burn suitable fuel material and to discharge the products of combustion

into the interior of the shell **31**. At the top of the shell **31** I provide a similar truncated pyramidal portion **36** which serves as a gathering duct for the products of combustion and directs them to the exhaust or outlet stack **37**.

The fluid conducting conduits **38**, which are adapted to carry the fluid to be treated, are disposed in a vertical plane parallel with the walls of the heater. The conduits **38** may be arranged in series to provide in effect one stream throughout the heater or they may be so connected as to form two or more parallel streams. The manner of connecting the conduits **38** is substantially conventional and may vary to suit particular conditions.

As illustrated in Figure 6, I provide a horizontal partition **39** near the top of the heater. The partition **39** is constructed of any suitable material and may be mounted in such a manner that it substantially blocks the flow of gases from the burners **34** to the stack **37** and divides the heater into a lower primary zone and an upper secondary zone.

I also provide a plurality of horizontal baffles **41** which are substantially identical to the baffles **21** previously described herein. Those baffles **41** below the partition **39** are arranged in a vertical plane outside of the bank of tubes **38** while those baffles **41** above the partition **39** are raised in a vertical plane within the bank of tubes **41**.

As illustrated particularly in Figure 8 the baffles **41**, like the baffles **21** previously described herein, provide curvilinear surfaces **42** which, together with the tubes **38**, serve to form constantly decreasing passages **43** for the gases from the center of the heater to the area beyond the baffles and are so positioned as to form a Venturi-like section for the discharge of gases into the space **44** around the baffles.

The tubes **38** are supported at their ends by the vertical tube sheets **46** and intermediate supports **47**. The intermediate supports **47** are attached to the structural members of the side walls **31** of the heater, with the exception, however, that the intermediate supports above the partition **39** may be suspended from the structural members of the heater.

The operation of the heater constructed as indicated in Figures 6, 7 and 8 will be substantially identical with the heater illustrated in Figures 1 to 4 inclusive and will provide the same pattern of gas flow and heat distribution. The functioning of the baffles **41** is the same as has previously been described herein in connection with Figures 1 to 4 inclusive.

It must be borne in mind that my heater can be equipped with a convection section, air preheater or waste heater boiler if it is economically justifiable to further cool the gases before they are exhausted from the heater.

It will be obvious from the foregoing that I have provided a heater construction consisting of an arrangement of tubes and baffles whereby the maximum re-radiation and reflection of heat to the rear shielded portion of the tubes is obtained, and whereby the rear shielded portion of the tube is subjected to superposed convection by gases passing over this portion at relatively high velocity before the gases leave the heating chamber.

In addition, I have provided a device in which the channeling of combustion gases with its attendant disadvantages is substantially eliminated.

I have provided a device providing for more uniform heat distribution about the periphery of the heater along the length of the tube and around the circumference of the tube than can be obtained without this device. Greater uniformity at the same horizontal plane is obtained by the means provided to draw off the gases from the heater through the spaces between the baffles and at an angle with the direction of flow induced by the stack effect of the height of the heater. In addition, because of the increased thermal circulation within the heater chamber brought about by the thermal siphon effect of the relatively cold periphery formed by the tubes and the relatively hot center of the gas body, the gas temperatures at the top and bottom of the heater tend to equalize so that the heat input along the length of each particular tube is also equalized. Also, because of the increased re-radiation and reflection, together with the convection component produced by the Venturi-like section between the walls of the baffles and the tubes, the difference in heat input to the shielded and exposed portions of the tube is decreased so that the heat input around the circumference of the tube tends to be much more uniform.

I claim:

1. In a fluid heater, a housing, a horizontally disposed partition within said housing dividing the interior of said housing into an upper chamber and a lower chamber, burner means for conducting combustion within said lower chamber, a plurality of fluid heating tubes grouped to form a wall area in said lower chamber about said burner means, a plurality of fluid heating tubes grouped to form a wall area in said upper chamber, a plurality of spaced baffles in said lower chamber interposed between the tubes and spaced from the tubes in said lower chamber, said baffles in said lower chamber facing the burner means in a position between the fluid heating tubes in said lower chamber and the housing to provide a space between the baffles and the housing leading to the upper chamber, a plurality of spaced baffles in said upper chamber interposed between and spaced from the fluid heating tubes in the upper chamber, said baffles being oppositely faced to those in the lower chamber, each of the baffles in the upper and lower chambers having two heat reflecting surfaces for reflecting heat towards the adjacent tubes whereby each tube receives heat reflections from two such surfaces formed on adjacent baffles, said heat reflecting surfaces in section having radii considerably greater than the radii of said tubes to increase the portion of radiant heat supplied by reradiation and reflection to the tubes opposite the source of heat, said baffles being spaced from each other and said tubes to provide in section Venturi-like flow passages therebetween whereby the velocity of flow of the combustion gases through the Venturi-like passages increases and is the greatest at the side of the tubes opposite the source of heat to thereby minimize the deposit of soot and ash on the tubes and baffles, said combustion gases passing out of the lower chamber past the heating tubes in the lower chamber through the baffles in the lower chamber into the space between the baffles and the housing to pass upwardly into the upper chamber past the heating tubes in said upper chamber and past the baffles in said upper chamber.

2. In a fluid heater, a housing, a horizontally disposed partition within said housing dividing the interior of said housing into an upper chamber and a lower chamber, burner means for conducting combustion within said lower chamber, a plurality of fluid heating tubes grouped to form a wall area in said lower chamber about said burner means, a plurality of fluid heating tubes grouped to form a wall area in said upper chamber, said tubes in said upper and lower chambers being interconnected and in section embracing equal areas, a plurality of spaced baffles in said lower chamber interposed between the tubes and spaced from the tubes in said lower chamber, said baffles in the lower chamber facing the burner means and being positioned between the fluid heating tubes on said lower chamber and the housing to provide a space between the baffles and the housing, a plurality of spaced baffles in said upper chamber interposed between and spaced from the fluid heating tubes in the upper chamber, said baffles being oppositely faced to those in the lower chamber, each baffle in the upper and lower chambers having two heat reflecting surfaces for reflecting heat towards adjacent tubes whereby each tube receives heat reflection from two such surfaces formed on adjacent baffles, said heat reflecting surfaces in section having radii considerably greater than the radii of said tubes to increase the por-

tion of radiant heat supplied by reradiation and reflection to the tubes opposite the source of heat, said baffles being spaced from each other and said tubes to provide in section Venturi-like flow passages therebetween whereby the velocity of flow of combustion gases through the Venturi-like passages increases and is the greatest at the side of the tubes opposite the source of heat to thereby minimize the deposit of soot and ash on the tubes and baffles, and means for connecting the baffles to the tubes in such a manner that the baffles will follow the movement of the tubes.

3. In a fluid heater, burner means for conducting combustion, a plurality of fluid heating tubes grouped to form a wall area about the burner means, and a plurality of spaced heat reflecting baffles interposed between the tubes on the sides of said tubes opposite the source of heat, each baffle having two reflecting surfaces for reflecting heat towards two adjacent tubes whereby each tube receives heat reflection from two of said surfaces formed on adjacent baffles, said heat reflecting surfaces in section having radii considerably greater than the radii of said tubes to increase the portion of radiant heat supplied by re-radiation and reflection to the sides of the tubes opposite the source of heat, said baffles being spaced from each other and said tubes to provide in section venturi-like flow passages therebetween whereby

the velocity of flow of the combustion gases through the venturi-like passages increases and is the greatest at the side of the tubes opposite the source of heat to thereby minimize the deposit of soot and ash on the tubes and baffles, said baffles comprising smooth, high temperature alloy sheets formed to provide said heat reflecting surfaces, a flat plate secured to the rear of said heat reflecting surfaces, separator plates spaced along the length of the heat reflecting surfaces, the space between said heat reflecting surfaces and said flat plate being filled with granular insulation, said separator plates serving to support the granular insulation and also to position the baffles with respect to the heating tubes.

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