

Jan. 19, 1960

C. O. GLASGOW ET AL
HEATERS FOR PETROLEUM FLUIDS

2,921,774

Filed Feb. 18, 1957

4 Sheets-Sheet 1

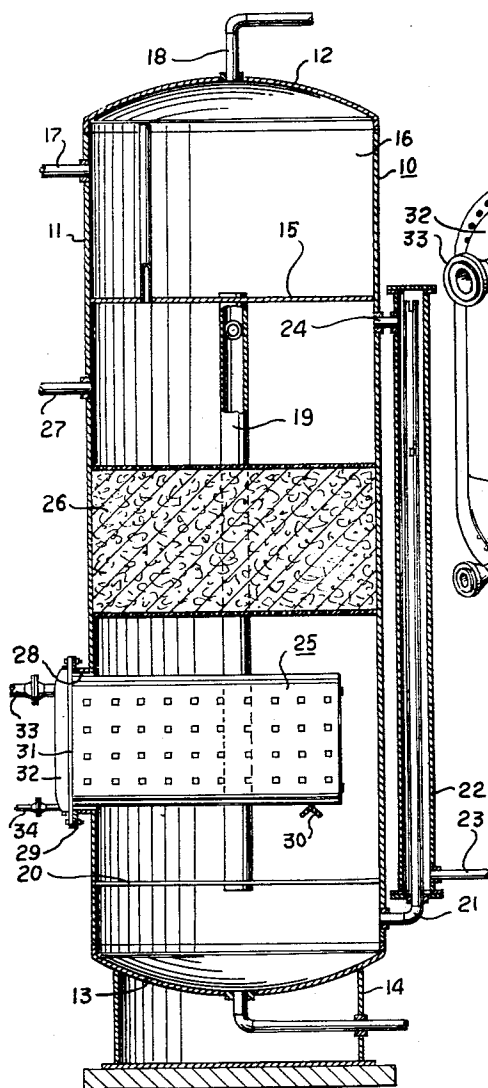


Fig. 1

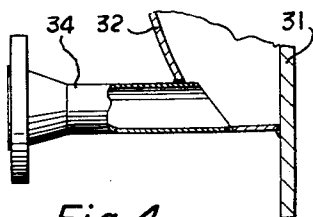


Fig. 4

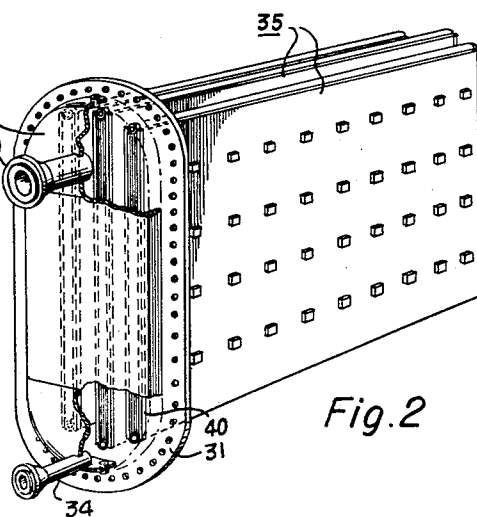


Fig. 2

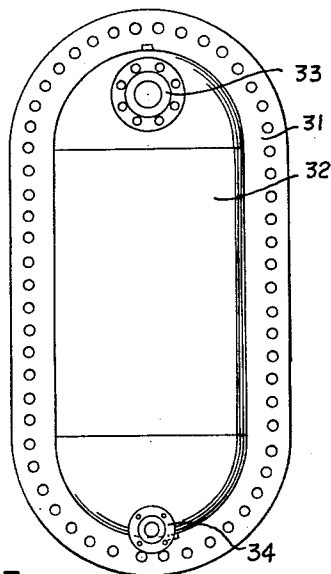


Fig. 3

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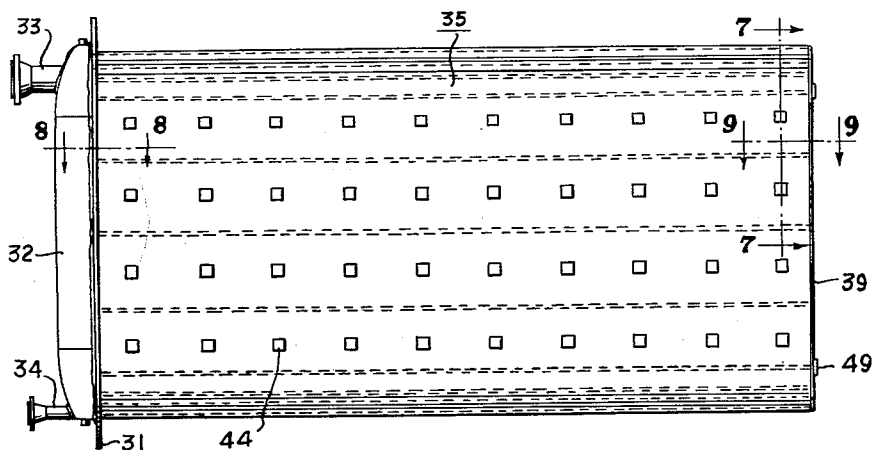


Fig. 5

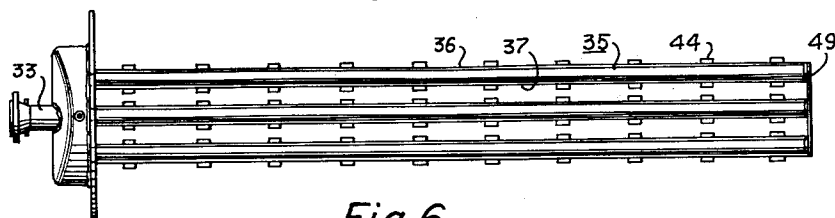


Fig. 6

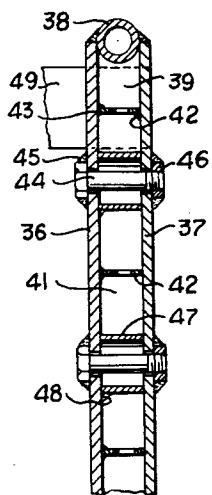


Fig. 7

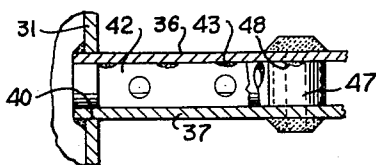


Fig. 8

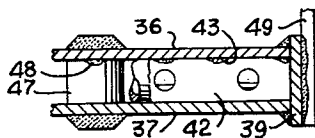


Fig. 9

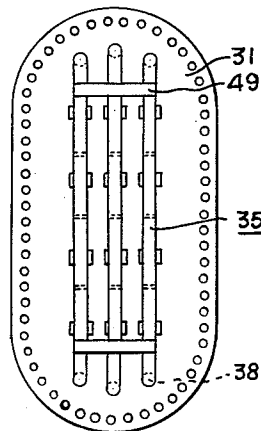


Fig. 10

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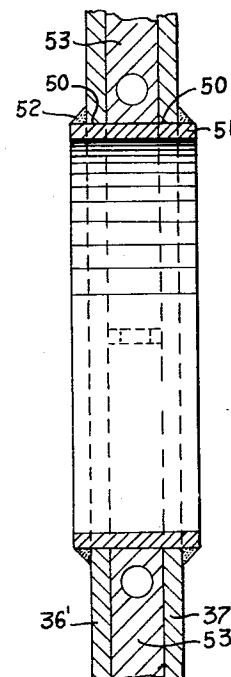
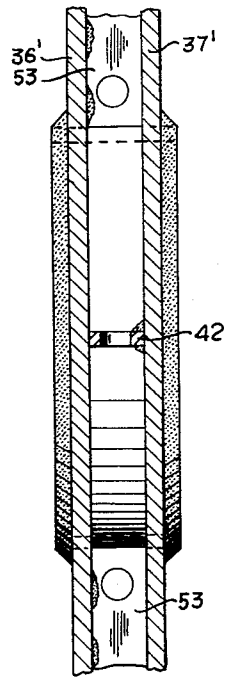
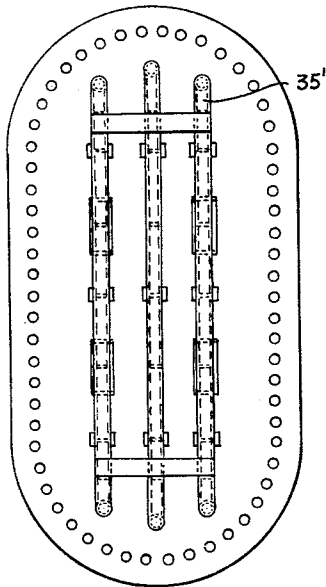
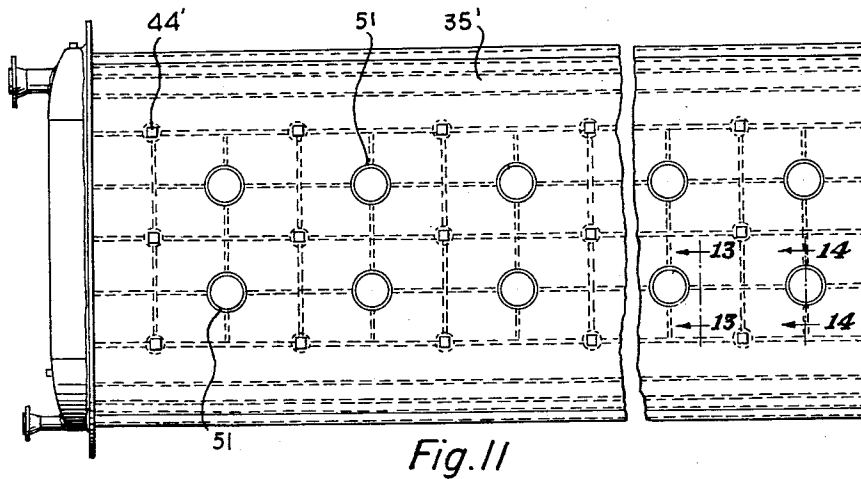
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4 Sheets-Sheet 3



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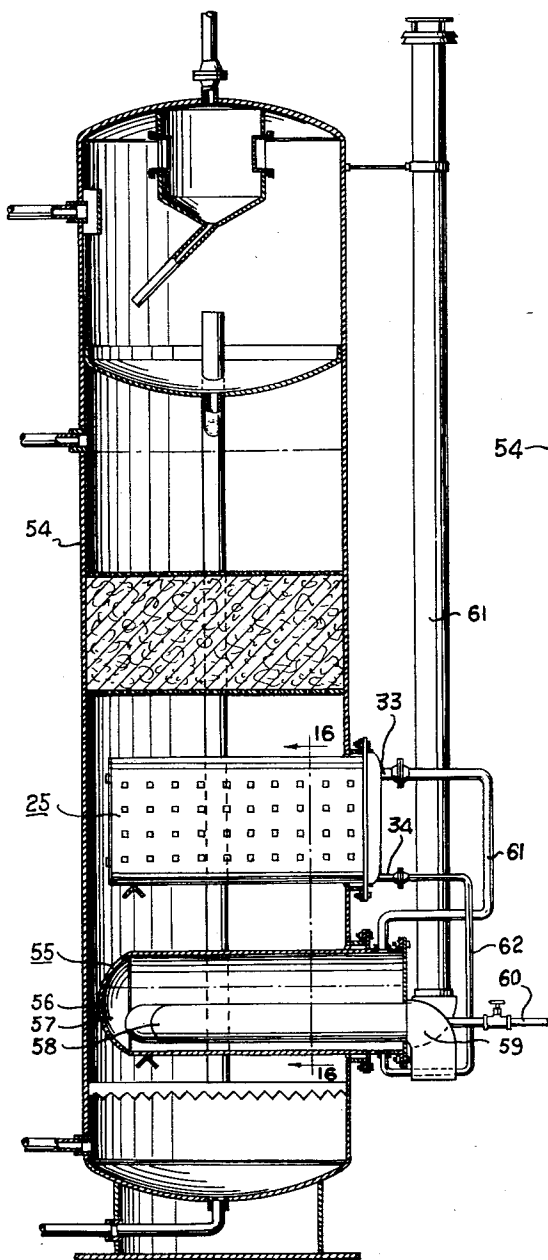


Fig. 15

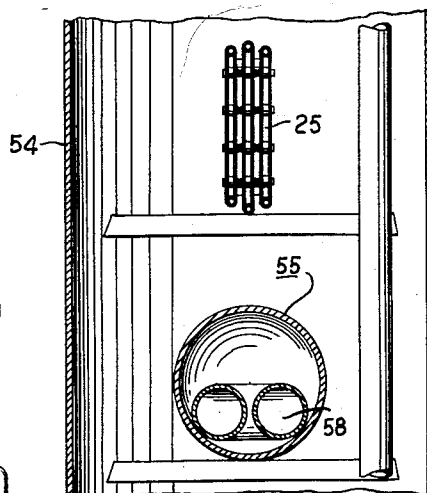


Fig. 16

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HEATERS FOR PETROLEUM FLUIDS

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Application February 18, 1957, Serial No. 640,874

4 Claims. (Cl. 257—256)

This invention relates to new and useful improvements in heaters for petroleum fluids.

The invention is particularly concerned with heaters for use in emulsion treaters as employed in the oil fields, but which may also be employed in the petroleum industry for heating various liquids and fluids under conditions where scaling of the heating surfaces is apt to occur.

In the heating of crude oil or petroleum, as well as in the heating of oil field waters such as oil field brines and the like, conditions are often encountered in which scale or deposits tend to accumulate upon the heating surfaces, reducing their efficiency and ability to deliver heat, and in some instances resulting in serious damage or destruction of the heating unit. Various types of heating structures are employed, many of them being of the direct-fired type in which oil, or more usually natural gas, is passed through a burner into a fire tube directly immersed in the liquid or fluid to be heated. Such heaters develop hot areas at which scale formation proceeds with great rapidity, and damage to the heating element or considerable loss of efficiency normally results. In some instances, a steam-type heating element has been employed in order to obtain a uniform overall skin temperature for the heating surfaces, as well as to employ a source of heat at a temperature lower than that of a flame, and to avoid the creation of hot areas in the heating structure. Even steam-type heating units, however, tend to scale rapidly under some conditions and in some areas, and accordingly, it has been found almost impossible, on a practical basis, to treat oil field emulsion streams in certain oil fields where scaling conditions are very severe, and to carry out such treating in the conventional fashion by heating of the emulsion followed by separation and stratification of the emulsion into its water and oil components.

Accordingly, it is a principal object of this invention to provide a steam-type heater, particularly adapted to the treating of oil field emulsion streams, in which the walls of the heating unit through which heat is transferred to the emulsion stream or other fluid are caused to flex under variations in the internal steam pressure whereby any scale forming upon the outer surfaces of the heating element will crack and be sloughed off of the heating surfaces.

It is also a problem with certain petroleum streams to prevent the accumulation of sand or other solids which tend to settle out of the petroleum or emulsion stream and collect upon the surfaces of the heating unit.

It is, therefore, a further important object of this invention to provide an improved steam-type heater having a plurality of large vertical surfaces exposed to the emulsion stream or other fluid being heated, the surfaces being of sufficient extent and magnitude as to provide more than ample heating area or surfaces, and being vertical so as to eliminate the accumulation of sand or other solid materials thereon.

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An additional object of the invention is to provide an improved steam-type heater comprising a plurality of spaced, vertically-disposed heating surfaces of large expanse with flow passages being provided in the outermost heating units to permit the escape of heated fluid from between the units or plates.

A still further object of the invention is to provide an improved heater of the character described which is particularly adapted for inclusion in an emulsion treater or other heating vessel in conjunction with a vapor phase heating element of the type containing a body of inert liquid such as fresh water covering a direct-fired fire tube for the generation of steam within an enclosure disposed in the vessel with heating steam being conducted from the enclosure to the steam-type heater for multiple heating of the liquids or fluids present.

An additional object of the invention is to provide an improved steam-type heater comprising one or more vertically-disposed relatively flat enclosures having side walls of considerable expanse joined at spaced intervals whereby the side walls may flex under variations in steam pressure and bow outwardly to crack from the outer surfaces of the plates any accumulations of scale or other material which may tend to collect thereon.

A construction designed to carry out the invention will be hereinafter described, together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, wherein examples of the invention are shown, and wherein:

Fig. 1 is a vertical sectional view of an emulsion treater having therein a steam-type heater constructed in accordance with this invention,

Fig. 2 is a view in perspective of the heater with portions thereof broken away,

Fig. 3 is an end elevational view of the heater,

Fig. 4 is an enlarged fragmentary view, partly in elevation, partly in section, of the condensate outlet of the heater,

Fig. 5 is an enlarged, side elevational view of the heater,

Fig. 6 is a plan view of the heater,

Figs. 7, 8, and 9 are sectional views taken upon the respective lines of Fig. 5,

Fig. 10 is an end elevational view of the heater taken from the end of the heater opposite the steam and condensate connections thereof,

Fig. 11 is a side elevational view of a modified form of the heater,

Fig. 12 is an end elevational view of the modified form of the invention, the view being taken from the end of the heater opposite the steam and condensate connections thereto,

Figs. 13 and 14 are enlarged sectional views taken upon the respective lines of Fig. 11,

Fig. 15 is a vertical, sectional view of an emulsion treater including a steam-type heater constructed in accordance with this invention and illustrating the combination of the steam-type heater with a vapor phase or indirect type heater, and

Fig. 16 is a vertical, sectional view taken upon the line 16—16 of Fig. 15.

In the drawings, the numeral 10 designates an emulsion treating vessel shown more or less schematically and as including the upright vessel 11 having a head 12 and bottom 13 and being carried upon a conventional base 14. An upper partition 15 defines a preliminary separation chamber 16 in the upper part of the vessel into which an emulsion stream inlet 17 is connected. A gas outlet pipe 18 leads from the head 12, and a flume 19 extends downwardly in the vessel from the partition 15 to a spreader

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plate 20. A water outlet 21 leads from the lower portion of the vessel to a conventional water siphon or water leg 22 having a water discharge pipe 23 and an upper, gas-equalizing connection 24. A heater 25 is disposed transversely of the vessel 11 above the baffle 20, and a filter or coalescing section 26, of the usual type, is positioned above the heating element. A clean oil outlet 27 is provided in the upper portion of the vessel below the partition 15 for receiving and discharging clean oil which has been separated and resolved from the incoming emulsion stream.

The emulsion treater shown in the drawings is for the purpose of illustration only, and the heater forming the subject matter of this invention is not limited to use therewith. It may be employed in other types of emulsion treaters as well as in other vessels and enclosures in which a petroleum liquid or fluid is to be subjected to heat or an elevation in temperature. It is convenient, however, to illustrate and describe the heater in conjunction with a particular emulsion treater so that the operation and principles thereof may be more fully explained.

In this type of treating vessel, the emulsion stream enters the chamber 16 through the inlet 17 and is caused to undergo a preliminary gas separation step before passing downwardly through the flume 19 into the lower portion of the treating vessel. The partially degassed emulsion stream then flows into the body of warm or hot liquid present in the lower portion of the treater and upwardly through the hot liquid and in adjacency with the heater 25. The heating of the emulsion stream, followed by its filtering and coalescing in the section 26, results in the resolving of the emulsion stream into its water and clean oil components, the clean oil rising for discharge through the outlet 27, while the separated water descends to the lower portion of the treater. The water siphon structure 22 functions to maintain a relatively constant water-oil interface level within the vessel, and of course, water is withdrawn through this siphon structure in accordance with the rate at which it is separated from the emulsion stream. With the exception of the heater 25, this general structure and operation is known in the art as exemplified by the patent to Jay P. Walker, No. 2,181,685.

It will be seen that the heater 25 is immersed in a body of warm or hot water or oil which, in the case of petroleum emulsion streams, is almost invariably of considerable salt content, that petroleum and petroleum emulsions are flowing over the surfaces of the heater during operation of the treater, and that, depending upon the location of the water-oil interface level, at least the upper portions of the heater may also be exposed to crude oil or petroleum, or to petroleum emulsion, or to a mixture of the two.

All of these liquids or fluids may contain various solids or various materials which tend to solidify upon a heated surface and result in the creation of a layer of scale or deposit thereon. It is also noted that such scaling or deposit formation will be more severe in areas of the heating surface which are at higher temperature, and accordingly, it is desirable to provide a heater having a relatively uniform overall surface temperature as well as the capacity of resisting the accumulation of scale or deposits thereon.

The vessel 11 is provided with an oval opening 28 provided with a marginal flange 29 for receiving and supporting the heater 25. There is also provided a transverse supporting bar 30 within the vessel and upon which the inner end of the heater may rest.

The heater 25 includes an oval plate 31 adapted to be bolted or otherwise secured to the flange 29 and having welded or otherwise secured upon its outer face a dished plate or manifold cover 32 which forms a steam jacket or chest. A steam inlet pipe 33 is connected through the plate 32 at its upper end, and a condensate

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drain conductor 34 extends from the lowermost portion of the plate, as shown in Fig. 4.

A plurality of vertically-disposed steam or heating units 35 extend inwardly from the plate 31 into the interior of the vessel 11, the heating units being disposed in spaced, substantially parallel relationship and each comprising a pair of rectangular sheets or plates joined together at spaced points and enclosing wide flat steam spaces in communication with the interior of the steam chest.

Although the heating units 35 may be formed in any suitable or desirable fashion, a specific structure is illustrated in Figs. 5 through 10. In this embodiment of the invention, each of the units 35 is formed of a pair of parallel, closely-spaced plates 36 and 37 joined at their upper and lower edges by tubular members 38 to which the plates are welded or otherwise secured, and having their inner ends closed by an elongate vertical strap 39 (Fig. 9), to which the ends of the plates are welded or otherwise secured. As shown in Fig. 8, the outer ends of the plates extend through elongate vertical slots 40 formed in the plate 31 and are welded to the plate so that each heating unit encloses a thin vertical steam space or enclosure 41 in communication with the steam chest enclosed by the plates 31 and 32.

A plurality of perforated spacer bars or straps 42 extend horizontally of the interior of each of the heating units 35, each of the straps being of such width as to span the space between the plates 36 and 37, and having one edge attached to one of the plates as by the spot welding shown at 43 in Figs. 8 and 9. Thus, each of the straps is held in position and prevents inward collapse of the plates 36 and 37 toward one another, but at the same time, the attachment of the straps to only one of the plates will permit outward bowing of the plates away from one another.

The plates 36 and 37 are joined to one another at spaced intervals by transverse bolts 44 extending through both plates and having their heads 45 welded to the outer surface of one plate and their nuts 46 welded to the outer surface of the other plate. A spacer sleeve 47 surrounds each of the bolts, and desirably is tack welded to one of the plates, as shown at 48 in Fig. 7. The bolts obviously limit outward movement of the plates 36 and 37 with respect to one another, but do not prevent bulging or bowing of those portions of the plates between the locations of the bolts 44.

Any suitable or desirable number of the heating units 35 may be employed, the particular embodiment of the invention illustrated in the drawings utilizing three of the units having their inner ends joined together in properly spaced relationship by transverse straps 49 welded or otherwise secured to the closure straps 39.

In the operation of the heater, steam from a suitable source, such as a boiler (not shown), is introduced through the inlet conductor 33 into the chest between the plates 31 and 32 from which the steam passes through the slots 40 into the spaces 41 enclosed within the several steam units or heating units 35. The relatively large plates 36 and 37 of the steam units will be rapidly brought to the temperature of the steam being supplied, and as the steam is condensed, it will be withdrawn through the outlet 34. The fluids or liquids in contact with the units 35 will thus be subjected to the heating action thereof, and in the case of the emulsion treater shown in Fig. 1, the liquid present around the heater and the water, emulsion stream, and oil flowing upwardly over or in proximity to the heating units of the heater will likewise be subjected to an efficient heating action. The vertical disposition of the units 35 minimizes the settling of sand or other foreign material thereon as well as facilitating and encouraging the upward flowing of the fluids being heated.

In heating installations of this type, the flow of fluids being heated will vary from time to time as well as the

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heating demands placed upon the heating units. Consequently, the supply and temperature of the steam being introduced between the plates 36 and 37 will vary from time to time resulting in changes in the internal pressure within the steam spaces or enclosures 41 and accordingly the pressure exerted upon the inner faces of the plates 36 and 37. The bolts 44 may be spaced at any suitable or desirable interval such as upon one or two-foot centers, and the unsupported portions of the plates 35 and 36 between the locations of the bolts 44 will tend to flex and bow outwardly and inwardly under the influence of the varying internal pressure. As a result, as scale or deposit tends to accumulate upon the outer surfaces of the plates 36 and 37, the repeated flexing and bowing of the plates will cause the scale or deposits to crack and to slough from the faces of the plates to fall downwardly into the lower portion of the enclosure. In this manner the outer surfaces of the heating units 35 are maintained relatively free of scale or deposits, accelerated corrosion of the plates is avoided, and the heating efficiency of substantially clean metallic plates is maintained. Since the scales or deposits which tend to form on the heating plates are relatively brittle in nature, it has been found that moderate flexing or bowing of the plates is adequate for cracking and sloughing of the scale or deposits, and that no great distortion of the plates is required. At the same time, however, the spacing of the bolts 44 over the areas of the heating units 35 may be varied as found suitable to increase or decrease the degree of flexing, it only being important that there be a sufficient number of the bolts 45 to withstand adequately and safely the maximum internal pressures anticipated within the steam spaces 41.

Since the steam or heating units are employed to elevate the temperature of liquids or fluids in close proximity to the units, thermal convection currents within the fluids will be created and the fluids will tend to flow upwardly between the several heating units. In some instances, it is desirable to provide for the escape of such fluids before reaching the upper edges of the heating units, one particular example being an emulsion treater in which the oil-water interface level is located below the upper edges of the heating units. In such circumstances, the layer of oil at the upper ends of the units would act as a dam or barrier to prevent heated water from escaping, and the proper and rapid upward passage of the heated water between the heating units may be impaired or retarded.

A modification of the invention is shown in Figs. 11 through 14, this structure being particularly adapted to permit the escape of fluids or liquids from between the heating units and including substantially the entire structure previously described with the exception that the plates 36' and 37' of the heating units 35' are provided at spaced intervals with aligned openings 50 receiving a short collar or nipple 51 which extends through the openings and is welded at 52 to both of the plates. The interiors of the heating units 35 are thus maintained pressure-tight, and at the same time, ports or passages are provided through the collars 51 through which heated fluids may escape. As shown in Fig. 12, it is not necessary to provide these ports or passages in the centermost heating unit, and only the lateral or outside units are therefore illustrated as being fitted with the collars 51.

If desired, this form of the invention may be provided with internal, vertical, perforated spacer bars 53 similar to the horizontally-extending bars 42'.

This heater is particularly useful when employed in conjunction with a vapor phase or indirect type of heating element as shown and described in United States Reissue Patent No. 23,628, issued to Clarence O. Glasgow et al. In this particular combination, an emulsion treater 54 of the same general descriptive nature as that shown in Fig. 1, may be provided with an indirect heating element 55 in its lower portion, the indirect heating element 55 including a drum 56 containing a body of fresh water

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or other suitable heating medium 57 in which a direct-fired heating tube 58 is disposed. The tube 58 is formed with a burner unit 59 having a fuel supply conductor 60 and an exhaust stack 61 through which combustion products are released. Being submersed in fresh water or another inert medium, the tube 58 is not subject to corrosion or scaling, but imparts heat to the medium 57 which, in turn, heats the drum 55 and the fluids present within the lower portion of the treater 54.

A heating medium supply conductor 61 is connected between the upper portion of the drum 56 and the inlet conductor 33 of the steam-type heater 25 which has previously been described and which is positioned within the treater 54 above the element 55. Likewise, the heating medium return conductor 62 is connected between the outlet conductor 34 of the steam-type heater 25 and the lower portion of the drum 56 for returning condensate or heating medium to the drum 56 for further heating or vaporization.

It is quite apparent that the heater 25 and the drum 56 may be substantially filled with a suitable heat transfer medium and thermal convection employed for circulation of the hot heating medium between the element 25 and the drum 56. The lower, indirect type heating element 55 may also be employed as a steam generator, being partially filled with fresh water for generating steam and heating the drum 56, as well as supplying steam to the heater 25 through the conductor 61 and thus providing greatly amplified heating surfaces over those available with conventional emulsion treater fire tubes. Here again, the firing of the burner 59 will vary in accordance with the load and demand placed upon the emulsion treater 54, so that there will be resultant pressure changes within the heater 25 and flexing of the heating plates thereof for cracking and removal of scale.

It is manifest that all forms of the invention utilize the vertically-disposed plates which resist accumulations of sand and other material which may tend to settle thereupon, and further, are inherently subject to varying internal pressures which result in bowing or flexing of the heating plates and the cracking and sloughing of scale or other deposits therefrom. Thus, there is provided not only an improved and more efficient steam-type heater, but also a heater which constantly rids all of its heating surfaces of scale or other deposits and remains clean and free of corrosion for maximum heat transfer efficiency.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

What we claim and desire to secure by Letters Patent is:

1. A heater for petroleum fluids including, a chest having connections for admitting and exhausting a heating fluid, and at least one heating unit extending from the chest, the heating unit comprising a pair of spaced vertically-disposed plates joined together at their exposed margins and enclosing a heating-fluid-receiving space in communication with the chest, a plurality of fastening members joining the plates to each other at spaced points only, whereby the portions of the plates between said points are free to flex laterally under changes of pressure internally of the heating unit, and a plurality of internal spacers within the heating unit and spaced from the fastening members for limiting movement of the plates toward one another between the fastening members, each of the spacers being secured to only one of the plates.

2. A heater for petroleum fluids including, a chest having connections for admitting and exhausting a heating fluid, and a plurality of heating units extending from the chest in spaced parallel relationship, each heating unit comprising a pair of spaced vertically-disposed plates joined together

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at their exposed margins and enclosing a heating-fluid-receiving space in communication with the chest, a plurality of fastening members joining the plates to each other at spaced points only, whereby the portions of the plates between said points are free to flex laterally under changes of pressure internally of the heating unit, and a plurality of internal spacers within each of the heating units and spaced from the fastening members for limiting movement of the plates of the units toward one another between the fastening members, each of the spacers being secured to only one of the plates of each unit.

3. A heater for petroleum fluids including, a chest having connections for admitting and exhausting a heating fluid, and plurality of heating units extending from the chest in spaced relationship, each heating unit comprising a pair of spaced vertically-disposed plates joined together at their exposed margins and enclosing a heating-fluid-receiving space in communication with the chest, a plurality of fastening members joining the plates to each other at spaced points only, whereby the portions of the plates between said points are free to flex laterally under changes of pressure internally of the heating unit, the outermost heating units having transverse passages therethrough for lateral flow of the petroleum fluids being heated, and a plurality of internal spacers within each of the heating units and spaced from the fastening members for limiting movement of the plates of the units to-

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ward one another between the fastening members, each of the spacers being secured to only one of the plates of each unit.

4. A heating unit including a pair of spaced substantially parallel plates joined together at their margins and enclosing a heating-fluid-receiving space and having means for admitting and exhausting a heating fluid, a plurality of fastening members joining the plates to each other at spaced points only, whereby the portions of the plates between said points are free to flex laterally under changes of pressure internally of the heating unit, and a plurality of internal spacers within the heating unit and spaced from the fastening members for limiting movement of the plates toward one another between the fastening members, each of the spacers being secured to only one of the plates.

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