United States Patent

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[54] **ELECTRIC HEATING SYSTEM FOR ASPHALT EQUIPMENT**
10 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** ..... **219/326,** 122/33, 126/343.5 A, 219/282, 219/297, 219/312, 219/321, 222/146 HE
[51] **Int. Cl.** **H05b 3/82,** F24h 1/00
[50] **Field of Search** ..... 219/421, 325, 302, 303, 306, 280–283, 310–312, 314–316, 320–326, 378, 530; 126/343.5, 343.5 A, 344, 362; 222/146, 146 HE, 146 HS, 146 H; 122/33, 37, 16

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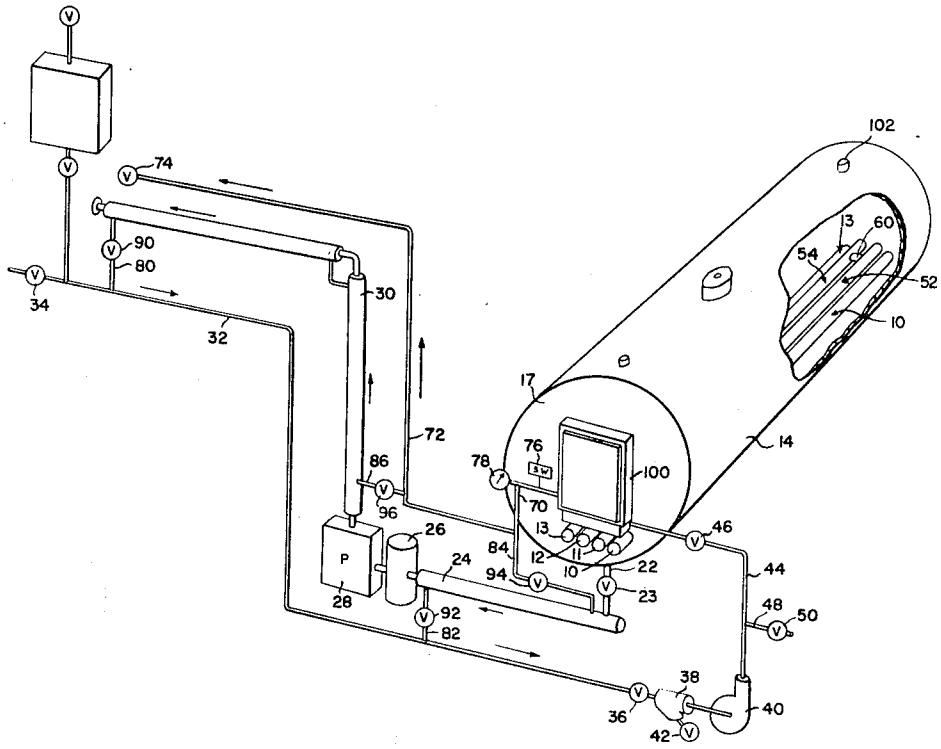
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Primary Examiner—A. Bartis
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ABSTRACT: A tank-heating system for fluids, such as asphalt, in which an electric tank-heating means extends generally horizontally within the tank for producing heat which is absorbed by the contents of the tank. A conduit provides a flow path for the flow of a second fluid, such as oil, to be heated by the contents of the tank. The conduit extends within the tank and is positioned in the region above the proximate to the tank-heating means so that the fluid passing through the conduit is in effective heat exchange relationship to the tank-heating means and the contents of the tank in the region. A second electric heating means is associated with the conduit for applying heat directly to the fluid flowing through the conduit. The tank-heating means, the conduit and the second heating means are structurally interconnected so as to form a unitary assembly for installation within the tank as a single unit.



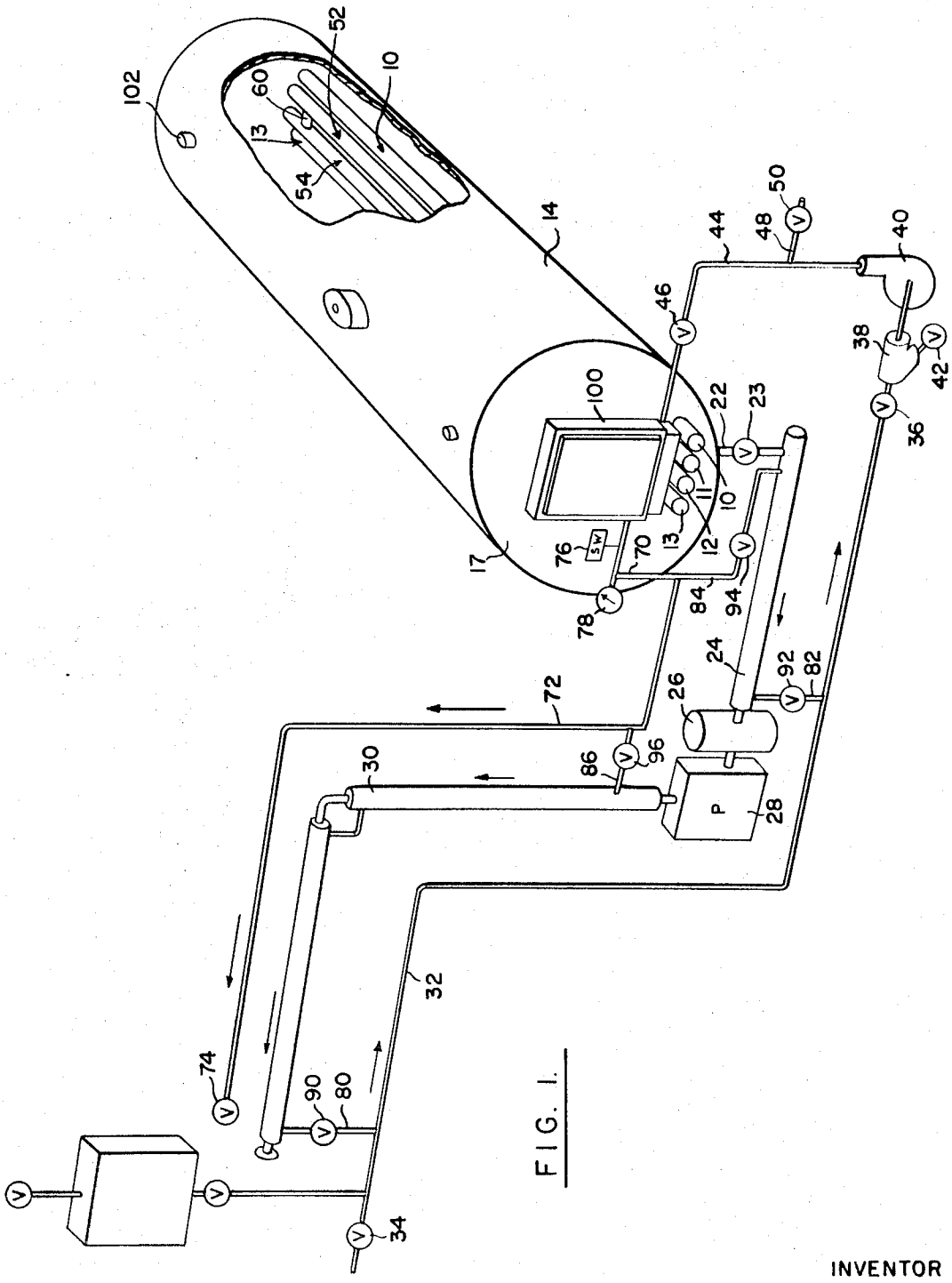


FIG. 1.

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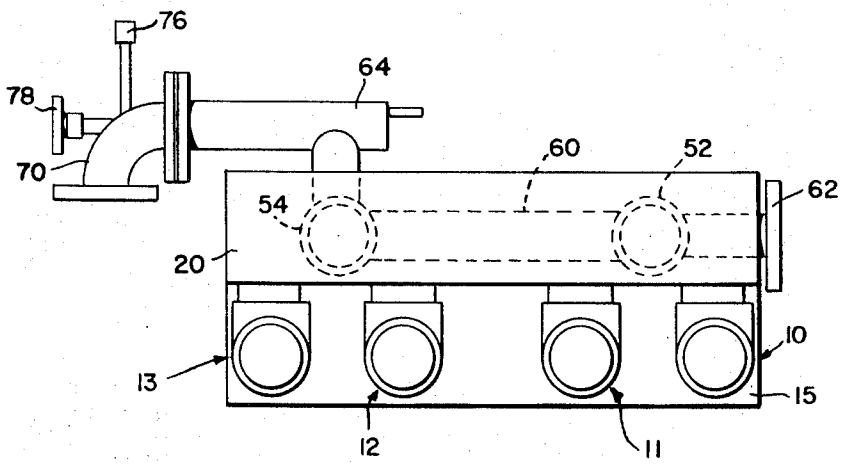


FIG. 3.

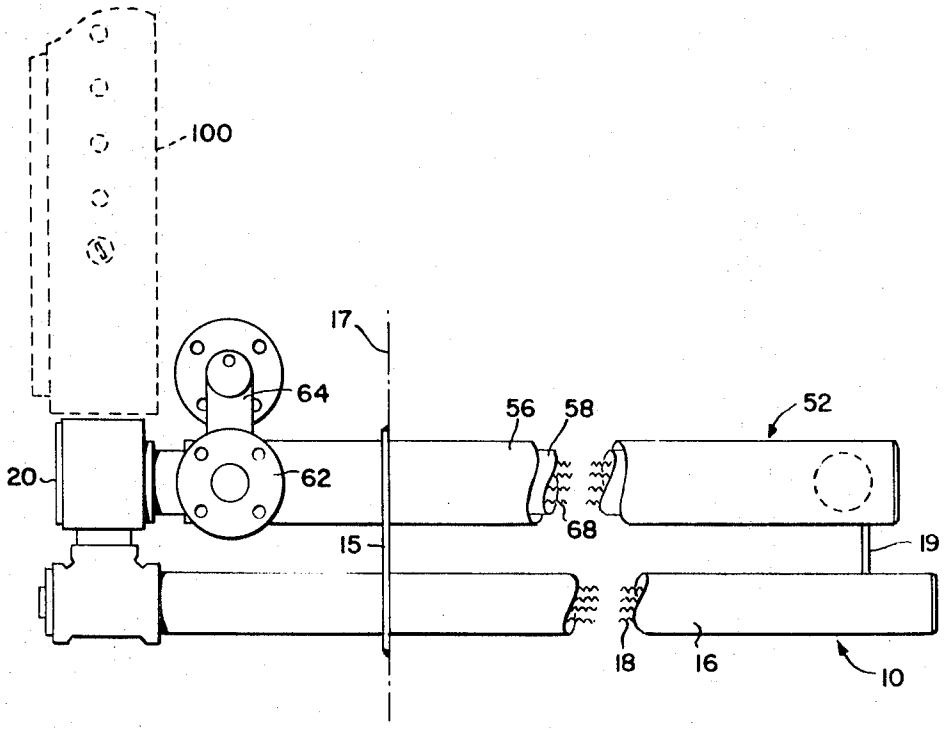


FIG. 2.

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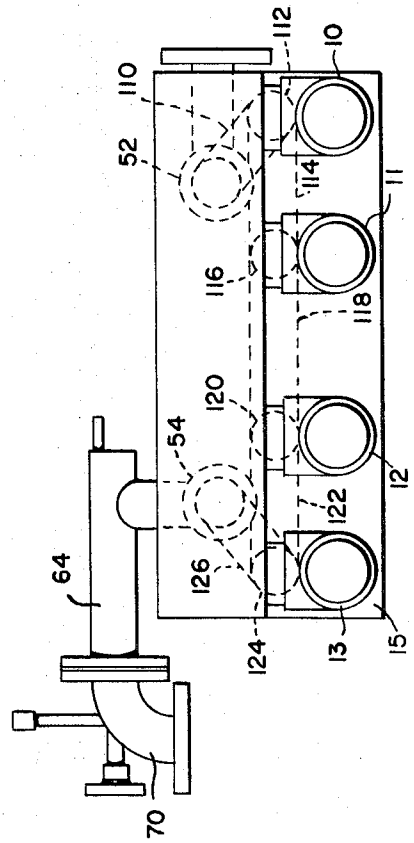


FIG. 5.

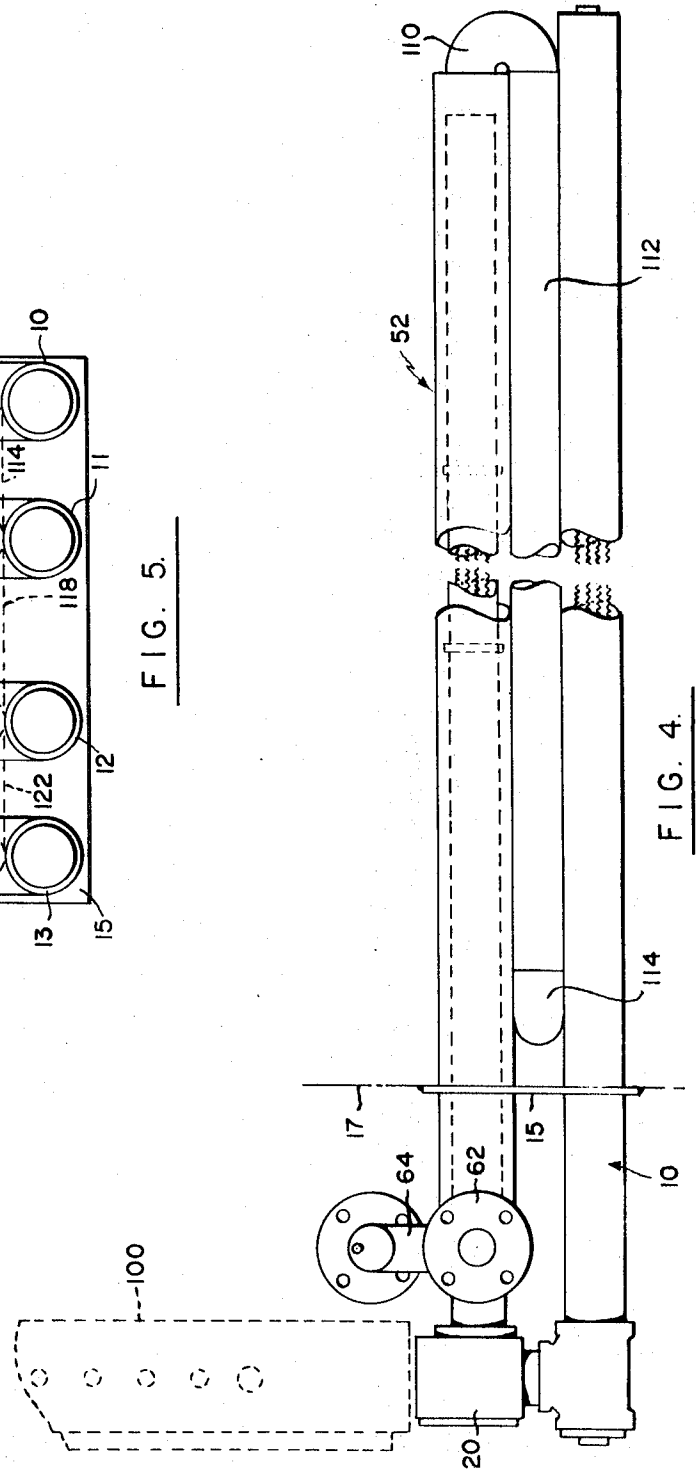


FIG. 4.

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ELECTRIC HEATING SYSTEM FOR ASPHALT EQUIPMENT

This invention relates generally to heating systems and, more particularly, to a heating system comprising a heater for the contents of a storage tank in combination with a heat transfer system within the tank for heating a fluid passed through a conduit in the tank.

It is the general object of the invention to provide a heating system of the indicated type wherein the tank-heating means and the fluid heating means are constructed and arranged relative to one another and relative to the tank contents so that there is achieved a maximum of use of the energy input into the system to heat both the contents of the tank and the fluid.

Briefly stated, the general object of the invention is achieved by providing tank-heating means extending generally horizontally within the tank and producing heat which is absorbed by the contents of the tank. There is also provided a fluid system comprising a conduit means within the tank located close to and within the vertical confines of the tank-heating members so as to receive heat from the tank contents at a relatively high temperature. There is provided a fluid-heating means which produces heat which will be absorbed by the fluid within the conduit means. By this arrangement, the heat produced by the tank-heating means is absorbed by the contents of the tank and transferred to the fluid passing through the conduit means under an effective heat transfer condition. Furthermore, since the conduit means for the fluid is preferably placed above the tank-heating means, the rising heat flow from the tank-heating means will pass over the conduit means. Accordingly, there is provided a very effective heat exchange relationship between the tank-heating means, the contents of the tank, the fluid passing through the conduits and the oil-heating means whereby a very high percentage of the heat produced by the two heating means is absorbed. Also, in accordance with the invention, there is provided large heat transfer surfaces to increase the efficiency of the heating.

Another object of the invention is to provide a heating system of the indicated type involving a substantial dwell time for the fluid passing through the tank.

While, for the sake of simplicity of description, the invention will be described as applied to a heating system for a storage tank containing asphalt to be supplied to a bituminous concrete plant and involving a heat transfer system for oil supplied to the plant, it will be apparent that the invention is more generally applicable to heating systems for storage tanks for materials other than asphalt, such as for example, storage tanks for various chemicals, caustics and similar materials. Moreover, fluids other than oil may be involved.

The above and other objects and features of the invention will become apparent from a consideration of the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a schematic view illustrating a heating system in accordance with the invention for an asphalt storage tank and including an oil-heating system;

FIG. 2 is a side view of the tank-heating means and the oil-heating means shown in FIG. 1;

FIG. 3 is a front end view of FIG. 2;

FIG. 4 is a side view of a modified form of tank-heating means and oil-heating means in accordance with the invention; and

FIG. 5 is a front end view of FIG. 4.

In the form of the heating system shown in FIG. 1, there are provided four tank heating members 10, 11, 12 and 13 arranged in parallel relation to extend horizontally along the bottom of a cylindrical storage tank 14 which is in a horizontal position. The heating members are supported by suitable means so as to be spaced only a small amount above the tank bottom in accordance with conventional practice. Near their forward ends the heating members are supported on a plate 15 which is welded to the front end 17 of the storage tank 14, this front end 17 being shown in dashed lines in FIG. 2. Each heating member comprises a tube 16 containing an electrical heating element 18 extending longitudinally therein. The electrical heating element 18 is preferably of the type disclosed in my U.S. Pat. No. 3,045,097. The electrical supply for each heating element 18 is provided from a suitable source connected to the heating element through a terminal box 20 in accordance with conventional procedure. By this arrangement heat is supplied to the tank contents by the heating members from a generally rectangular, horizontal heating zone the extremities of which are defined by the two outer heating members 10 and 13 and planes extending across the ends of the heating members. The heat supplied to the contents by the heating members will be concentrated in this heating zone and the region spaced vertically therefrom a certain extent. Asphalt heated in this zone will rise vertically, cooler asphalt will flow down the sides of the tank outside this zone to the heating area providing convection circulation. Accordingly, the asphalt in this lower heating region will be at a relatively higher temperature and in a more fluid state than the asphalt to the sides and below this heating area. The heating means will maintain the asphalt in this lower region in a fluid state sufficient to permit flow to the asphalt plant as will be described hereafter, the drain for the tank 14 being connected to the tank bottom. Of course, the heat transmitted from the heating members and the asphalt in the lower region heated thereby will flow upwardly to maintain a relatively high temperature for a substantial vertical extent.

Means are provided for delivering the asphalt from the bottom of the tank 14 to the plant where it is to be used. Such means comprises a drain line 22 connected at its upper end to the lowermost portion of the tank 14 and containing a control valve 23. The drain line 22 is connected at its lower end to one end of a horizontally extending jacketed pipe 24 which is connected to the inlet of a strainer 26. The outlet of the strainer 26 is connected to the inlet of an asphalt pump 28. The discharge of the pump 28 is connected to a jacketed pipe line 30 which extends upwardly and then horizontally and has its outlet end connected to the supply end of the plant. In this way, the asphalt at the lower portion of the tank 14, which is maintained in a fluid state by the heating members 10–13, is pumped through the drain line 22, the pipe 24, the strainer 26 and the pipeline 30 to the plant as needed.

A bituminous concrete plant utilizes heated oil for various purposes, such as for the heating of piping pumps, pug-mills and other jacketed components of a plant that will freeze at shut down and have to be heated to put back in operation. The heated oil supplies the required heat to these components by circulating through these jackets. After utilization by the plant, the oil is delivered by return line 32, which has an inlet valve 34 at one end. Line 32 is connected through a pump inlet valve 36 and a strainer 38, to the inlet side of pump 40. Strainer 38 has a fill valve 42 controlling flow to the inlet side thereof. The oil pump discharge is connected by a line 44, having a control valve 46 therein, to the inlet of the oil heating means in accordance with the invention. Connected to line 44 is a pump discharge line 48 and valve 50. If it is desired to pump oil from system, valve 46 would be closed, valve 36 open and oil can then be pumped through open valve 50 into suitable container.

The oil-heating means comprises conduit means within the tank 14 defining a flow path for the oil in heat exchange relationship with the contents of the tank and in proximity with the tank-heating members 10–13. In FIG. 1, such conduit means comprises a pair of conduits 52 and 54 extending horizontally from the front to the rear of the tank. Each of these conduits 52 and 54 comprises a pair of concentric inner and outer tubes 56 and 58, respectively. Each of the inner tubes 56 is closed at its rear end and extends outwardly from the front end 17 of the tank 14 through plate 15 into the terminal box 20 for a purpose to be described hereafter. At the rear ends of the conduits 52 and 54 there is provided a transversely extending pipe 60 which provides the flow communication between the outer tubes 58 of each conduit front and 54. By this arrangement, there is provided an oil flow path

consisting of a pair of annular passages between each pair of concentric tubes **56** and **58** extending from the front to the rear of the tank and a flow passage extending transversely between the rear ends of these annular passages. The inlet **62** of the conduit means for the oil-heating means is connected to the forward end of the conduit **52** while an outlet **64** is connected to the forward end of the conduit **54**. By this arrangement, the oil flows into the annular chamber in the conduit **52** by ways of the inlet **62** and rearwardly therethrough to the transversely extending pipe **60**. After passing through the pipe **60**, the oil flows forwardly from the rear end of the conduit **54** to the outlet **64**.

It will be apparent that the above-described arrangement provides a very effective heat exchange relationship between the oil flowing through the oil conduit means and the contents of the tank **14**. By reason of the annular flow passages provided by the conduits **52** and **54** there is provided a large heat exchange surface for the oil, which, of course, improves the heat transfer between the asphalt and the oil. Moreover, the oil conduit is within the heating zone of the heating members described above whereat the temperature of the asphalt is relatively high.

In order to assist the heating of the oil by the contents of the tank, there is provided a separate heating means for the oil. This heating means comprises a pair of electrical heating elements **68** arranged to extend longitudinally within the inner tubes **58** of the oil conduits **52** and **54**. The heating elements **68** for the oil-heating means are also preferably of the type disclosed in my U.S. Pat. No. 3,045,097. The heating elements **68** are supplied from the same electrical source as the elements **18** by way of the terminal box **20** in accordance with conventional electrical connections.

As is best shown in FIG. **3**, each of the conduits **52** and **54** is arranged to extend parallel to and above the heating members **10–13** for the tank **14**. Moreover, each conduit **52** and **54** is arranged to be approximately equally spaced from a pair of the heating members and in relatively close relation.

By reason of the above-described arrangement there will be a very effective heat transfer relationship between the tank-heating members **10–13**, the contents of the tank within the heating zone and the oil passing through the oil conduit means. The heat produced by the heating members **10–13** will be transferred to the asphalt which is in heat exchange relationship therewith and will be transmitted by way of this heated asphalt to the oil which is in heat exchange relationship therewith. Thus, the heat produced by the tank heating means **10–13** is transferred to both the contents of the tank and to the oil passing through the oil conduit means. The oil-heaitng means is also operative to heat the oil from the inside of the conduit means and the heat produced by the oil heater is transferred to the oil. It will be noted that if the asphalt on the exterior of the oil conduit is at a temperature less than the oil (a condition which could exist if the asphalt were delivered to the tank in a relatively cold condition), this asphalt will be heated by heat transferred from the oil.

The outlet **64** of the oil conduit means is connected through an elbow **70** to a line **72** which is connected at its outlet end to the oil supply portion of the plant, a control valve **74** being provided in this line **72**. As is shown in FIG. **3**, the elbow **70** is provided with a pressure switch **76** and a temperature indicator **78**, which are used in connection with the control of the heating system but are not pertinent to the invention described herein.

As shown in FIG. **1**, there is provided a plurality of pipes **80**, **82**, **84** and **86** having regulating valves **90**, **92**, **94** and **96**, respectively, connected therein. These pipes interconnect the oil system with the jackets for the asphalt pipes **24** and **30** and direct flow therethrough for heating the asphalt being delivered to the plant. The valves may be adjusted to regulate the flow as desired.

The supply system shown in FIG. **1** may be automated as desired and to this end there is provided a control panel **100** from which the various automatic operations are controlled. It will be apparent that the desired controls may be achieved by conventional means and such controls form no part of the present invention.

In the operation of the heating system shown in FIG. **1**, the asphalt will be delivered to the tank **14** by way of a suitable inlet **102** in the top thereof. The asphalt is generally delivered directly from the refinery in insulated tanks so that the temperature of this asphalt, as delivered, is generally higher than that of the oil which is to be used by the plant. The tank heaters **10–13** serve to maintain the asphalt in a fluid state and at a temperature such that the plant may use the same. When the plant requires the addition of asphalt, the valve **23** is opened and pump **28** is operated to deliver asphalt from the drain line **22** through the pipe **24**, the strainer **26** and the pipe line **30** to the asphalt plant.

When the asphalt plant required hot oil, the valves **34**, **36**, **46** and **74** are opened and oil is pumped from line **32** through the strainer **38** to the inlet **62** of the oil conduit means. The oil flows rearwardly through the annular passage in conduit **52**, across through the pipe **60** to the rear end of the conduit **54** and forwardly through the annular passage therein to the outlet **64** of the oil conduit means. From the outlet **64** the oil passes through the elbow **70** and the pipe line **72** to the oil supply for the asphalt plant.

It will be apparent that as the oil flows through the conduit system within the storage tank **14**, its temperature will be raised by reason of the heat transfer relationship between the oil and the asphalt in the tank and the heat transfer relationship between the heating elements **68** within the inner tubes **56** of the conduits **52** and **54**. Moreover, it will be apparent that the heat exchange relationship is very effective one involving large heat transfer surfaces. Not only does the oil receive heat from the heated asphalt externally thereof, but also the oil receives heat from the heating elements **68** internally of the oil passages.

In FIGS. **4** and **5** there is shown another form of oil-heating conduit in accordance with the invention. The arrangement here is essentially the same as that shown in FIGS. **1** to **3**. The only essential difference is that instead of the transversely extending pipe **60** between the rear ends of the two conduits **52** and **54**, there is provided an additional pair of loops in the flow path. The structure for forming these loops comprises an elbow **110** connected at one end to the rear end of the conduit **52** and at its other end to a horizontally extending pipe **112**. The pipe **112** is mounted on top of the heating member **10** and extends in alignment therewith. The elbow **110** extends at a 45 angle with respect to the horizontal in order to provide communication between conduit **52** and pipe **112**. At its forward end, the pipe **112** is connected by a horizontally extending elbow **114** to a pipe **116** mounted on top of and in alignment with the heating member **11**. At its rear end, the pipe **116** is connected by a horizontal elbow **118** to another pipe **120** which is mounted on top and of in alignment with the heating member **12**. At its forward end, the pipe **116** is connected by way of a forward elbow **122** to the front end of a fourth horizontally extending pipe **124** which is mounted on top of and in alignment with the heating member **13**. The rear end of the pipe **124** is connected by an elbow **126** extending at 45° to the horizontal to the rear end of the conduit **54**.

It will be apparent that by the arrangement shown in FIGS. **4** and **5**, the dwell time of the oil within the tank is increased considerably. Thus, instead of the oil passing directly between the rear ends of the two conduits **52** and **54**, the oil will pass from the rear end of the conduit **52** forwardly the length of the tank **14** by way of the first pipe **112** then rearwardly the same distance by way of the second pipe **116**, then forwardly by way of the third pipe **120** and again rearwardly by way of the fourth pipe **124** to the rear end of the second conduit **54** through which it flows to the outlet **64** of the oil conduit system.

In operation, of course, the system shown in FIGS. **3** and **4** is the same as that shown in FIG. **1** with the exception that the oil flow within the tank is different and, as mentioned above,

the dwell time of the oil within the tank is increased considerably. It will be noted that by this arrangement, the temperature of the oil will be raised a greater amount because of the longer dwell time and the larger heat exchange area provided. Moreover, since the four pipes **112, 116, 120** and **124** are positioned on top of the tank-heating members **10–13**, as is best shown in FIG. **5**, the oil within the pipes will receive heat almost directly from these tank-heating members.

The heating system in accordance with the invention has several advantages over heating systems of the prior art. In the first place, it permits shorter startup times in the heating of a cold plant since the heat in the asphalt within the tank supplements the oil heater capacity. Also, the structural arrangement provides a convenient location for the oil heater and reduces the cost of installation of the oil heater since there is no requirement for insulation. Further, the heating system in accordance with the invention provides greater safety to the oil-heating means in case the control means therefor should fail. In this regard, it is noted that the oil heater will not overheat excessively since the heat produced thereby is absorbed by the asphalt in the tank.

Another feature of the invention is that the arrangement provided permits the use of a storage tank in a manner whereby heat energy may be stored and the system can be operated at a lower cost. The electrical energy for a bituminous concrete plant, and similar plants, is usually charged on a demand plus usage basis. The motor load in such an installation far exceeds the electrical requirement of the electrical heating elements in the storage tank. Thus, by operating the electrical while the plant is not in operation, there would be no demand charge for the electric heat so that the electrical energy would be purchased at the most favorable rate. It will be apparent that the heating system in accordance with the invention permits the addition of additional heat energy to the contents of the tank while the plant is not in operation, a portion of this energy being absorbed into the oil system when the plant is in operation with a reduction in the amount of electrical energy required to be used while the plant is in operation. Moreover, a portion of the extra heat energy in the asphalt when it is delivered at a temperature higher than required for use, which is the normal situation, can also be absorbed into the oil system.

Another feature of the invention is that the tank-heating means and the oil-heating means are constructed in a single assembly. As shown in FIGS. **2** and **3** and in FIGS. **4** and **5**, the parts of the oil heater are mounted together with the parts of the tank heater in a single assembly. For example, in the form of the invention shown in FIGS. **1** to **3**, the front ends of the tank-heating members **10–13** and the oil heater conduits **58** are secured to the terminal box **20** by suitable connections and the rear ends of these heating members are secured together by a support plate **19**. In the form of the invention shown in FIGS. **4** and **5**, the oil heater conduit is secured to the tank-heating members **10–13** by reason of the arrangement wherein the pipes forming the additional loops are mounted on top of the various tank-heating members. This assembly can be installed in the tank by simply welding the plate **15** to the end of the tank in the position best shown in FIG. **1**.

Another feature of the invention is that in view of the very efficient transfer relationship between the oil conduit means and the other elements of the assembly, it is possible to utilize a lower capacity oil heater.

A further feature of the heating system in accordance with the invention is that there is provided a compact assembly. This, of course, reduces construction cost.

It will be apparent that various changes may be made in the construction and arrangement of parts without departing from the scope of the invention. For example, the invention is applicable to heating means of types other than electrical heating elements, although electrical heating elements would achieve the best results. Also, there may be provided various numbers of tank-heating members and oil-heating members, the invention not being limited to the specific arrangement described or to the use of four tank heaters in combination with two oil heaters. Accordingly, it is not desired to be limited except as required by the following claims.

I claim:

1. A heating system for use with a storage tank for fluids such as asphalt or other similar fluids which are solid or viscous under unheated conditions, comprising a tank, a first heating means extending generally horizontally within the tank for delivering heat to a heating zone within the tank, a conduit means providing a flow path for the flow of a fluid, said conduit means extending generally horizontally within the tank and having a substantial portion positioned above and proximate to said first heating means and within the vertical confines of said heating zone whereby the fluid passing through said conduit means is in effective heat exchange relationship with said first heating means and the contents of the tank within said heating zone, and second heating means extending generally horizontally within the tank associated with said conduit means for applying heat to said fluid passing through said conduit means, said first and second heating means and said conduit means being structurally interconnected at the ends of their horizontal extent so as to form a unitary assembly for installation within the tank.

2. A heating system for use with a storage tank for fluids such as asphalt or other similar fluids which are solid or viscous under unheated conditions, comprising a tank, a first heating means extending generally horizontally within the tank for delivering heat to a heating zone within the tank, a conduit means providing a flow path for the flow of a fluid, said conduit means extending within the tank and having a substantial portion positioned above and proximate to said first heating means and within the vertical confines of said heating zone whereby the fluid passing through said conduit means is in effective heat exchange relationship with said first heating means and the contents of the tank within said heating zone, and second heating means associated with said conduit means for applying heat to said fluid passing through said conduit means, said first heating means comprising a plurality of spaced elongated heating members located at the bottom of the tank, said heating members defining the border of said heating zone whereby said heating zone has a substantial width and length, said conduit means having an elongated portion adapted to be heated directly by second heating means and a portion cooperating with said elongated portion to form at least one loop which extends across said heating zone.

3. A heating system according to claim **2** wherein said elongated portions of said conduit means comprises an inner pipe and an outer pipe defining an annular flow path for the fluid which flows through the space between said pipes.

4. A heating system according to claim **2** wherein said first and second heating means are comprised of electrical heating elements.

5. A heating system according to claim **2** wherein said first heating means comprises electrical heating elements.

6. A heating system according to claim **2** wherein said second heating means comprises electrical heating elements.

7. A heating system for use with a storage tank for fluids such as asphalt or other similar fluids which are solid or viscous under unheated conditions, comprising a tank, a first heating means extending generally horizontally within the tank for delivering heat to a heating zone within the tank, a conduit means providing a flow path for the flow of a fluid, said conduit means extending within the tank and having a substantial portion positioned above and proximate to said first heating means and within the vertical confines of said heating zone whereby the fluid passing through said conduit means is in effective heat exchange relationship with said first heating means and the contents of the tank within said heating zone, and second heating means associated with said conduit means for applying heat to said fluid passing through said conduit means, said first heating means comprising a plurality of spaced elongated heating members, said heating members defining the border of said heating zone whereby said heating

zone has a substantial width and length, said conduit means having a pair of spaced elongated portions adapted to be heated directly by said second heating means and a conduit portion joining said elongated portions and including a coil at least one loop which extends across said heating zone.

8. A heating system according to claim 7 wherein said coil formed by said conduit means comprises portions located directly above said tank heating members of said first heating means.

9. A heating system according to claim 7 wherein said elongated portions of said conduit means comprises an inner pipe and an outer pipe, the fluid being arranged to flow in the space between said pipes, said second heating means being located within said inner pipe, and wherein said conduit means extends horizontally across said heating members of said first heating means and including elongated sections directly above and in contact with each of said elongated heating members of said first heating means.

10. A heating system for use with a storage tank for fluids such as asphalt or other similar fluids which are solid or viscous under unheated conditions, comprising a tank, a first heating means extending generally horizontally within the tank for delivering heat to a heating zone within the tank, a conduit means providing a flow path for the flow of a fluid, said conduit means extending within the tank and having a substantial portion positioned above and proximate to said first heating means and within the vertical confines of said heating zone whereby the fluid passing through said conduit means is in effective heat exchange relationship with said first heating means and the contents of the tank within said heating zone, and second heating means associated with said conduit means for applying heat to said fluid passing through said conduit means, said first and second heating means comprising a plurality of heating elements extending horizontally across the bottom of the tank and said conduit means comprising a plurality of elongated elements extending horizontally across the bottom of the tank above said first heating means, and including means for structurally interconnecting said first and second heating means and said conduit means in supporting relation to one another.

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