June 21, 1966 G. L. BENJAMIN, JR 3,257,544

HEATING CIRCUITS

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Fig. 1.

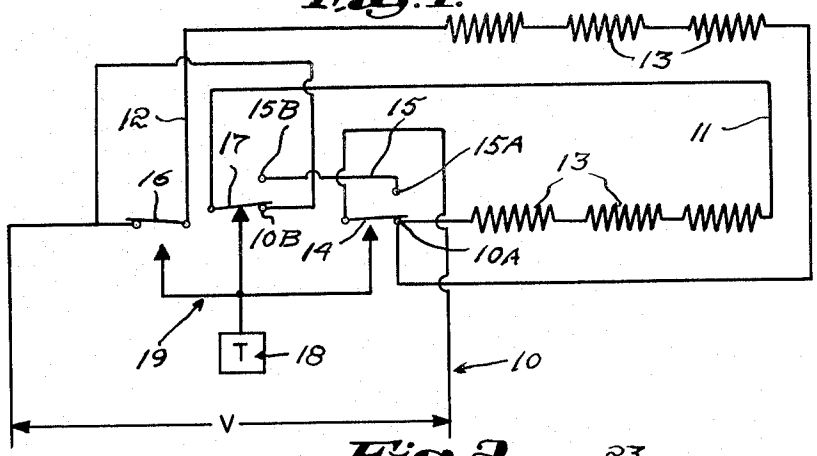


Fig. 2.

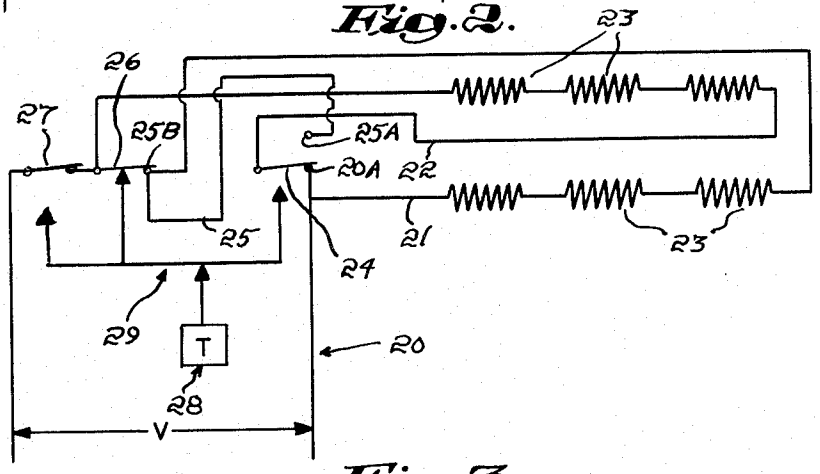
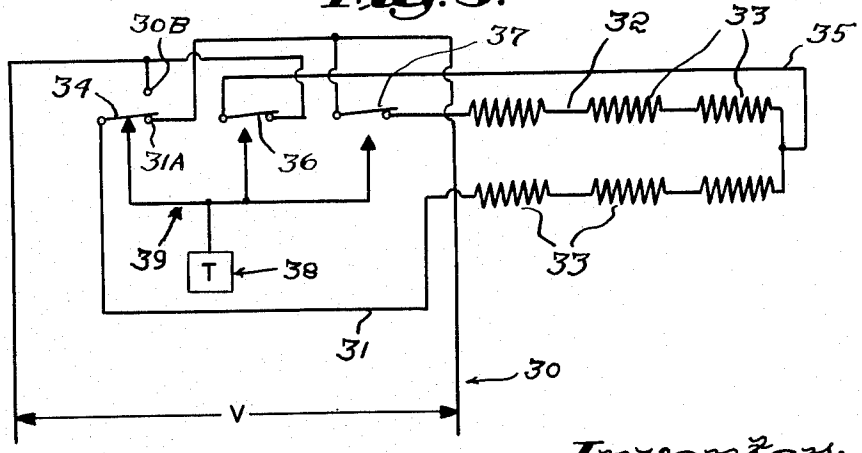


Fig. 3.



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Fig. 4.

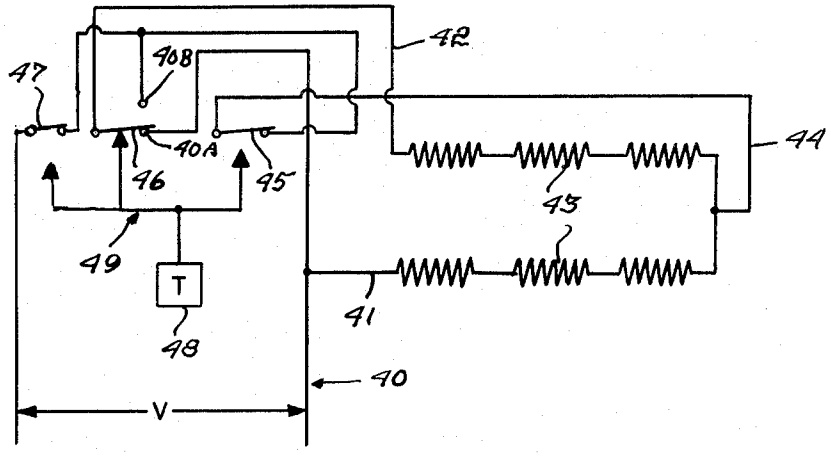
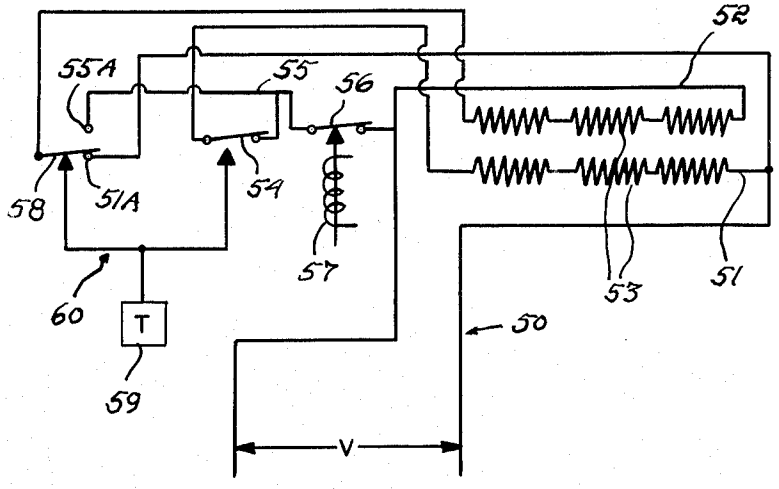


Fig. 5.



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HEATING CIRCUITS

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The present invention relates to heating circuits and particularly to such circuits for use in preheating heavy fuel oils.

A common practice is to preheat heavy fuel oils. This is done because, usually, fuel oil used for industrial heating, for example, is stored in outside tanks and hence, its temperature varies throughout a wide range, often below that in which efficient combustion can be attained. To avoid this difficulty, the oil is passed through a shell or chamber provided with heating elements by which its temperature is elevated.

Electric fuel oil heaters commonly have thermally responsive controls but the practice is to leave the heater line voltage on when the burner shuts down in order to maintain a reservoir of warm oil in readiness for the next firing cycle. When the burner is shut down, the only circulation with respect to the heating elements is due to thermal convection except in systems providing for continuous circulation to avoid the consequences attendant overheating the oil.

It is apparent that the heat required during burner shut-down conditions need be sufficient only to take care of radiation and convection heat losses, requiring far less electrical energy than during burner operation when there is a forced flow of oil through the heater chamber. Electric fuel oil heaters have had the heating elements of fixed density, i.e. the watts per square inch of heating surface has been fixed and varies only slightly due to slight, but uncontrolled, fluctuation in the voltage.

An objective of the present invention is to provide, on an inexpensive basis, means for changing, in response to demand conditions, wattage and watt densities so as to reduce the temperature of the heating elements as conditions permit, thus minimizing problems resulting when the temperature of the heating elements is higher than need be for those conditions and making it also possible to eliminate forced circulating systems with their substantial power demands.

In accordance with the invention, this objective is attained by providing a heating circuit including three leads, two being heater leads with each including at least one heating element. The circuit also includes switch means operable to provide at least three alternative operating circuits in the first of which the heater leads are operative and in parallel, in the second of which only one heater lead is in circuit, and in the third of which, the heater leads are operative and in series. Under most conditions, it is desirable to have the switch means also provide for the opening of the circuit when conditions so warrant.

The switches, in circuit in accordance with the invention, are commonly, but not necessarily operated by thermally responsive means and one particular objective of the invention is to provide means whereby one circuit switch is controlled either mechanically or electrically to be closed only when the burner is in service.

In the accompanying drawings there are shown illustrative embodiments of the invention from which these and other of its objectives and novel features and advantages will be apparent.

In the drawings:

FIGURE 1 is a somewhat schematic view of a circuit in accordance with the invention,

FIGURE 2 is a similar view of a circuit representing another embodiment of the invention,

FIGURE 3 is a like view of yet another embodiment of the invention,

FIGURE 4 is a view of still another circuit in accordance with the invention, and

FIGURE 5 illustrates a further embodiment of the invention.

In FIGURE 1, a heater circuit is generally indicated at **10** and it includes first and second heater leads **11** and **12**, respectively with each heater lead including a series of heating elements **13** for the fuel oil. The heater leads have a common contact **10A** shown as closed with respect to the circuit **10** by a single pole, double throw switch **14** which in its second position engages the contact **15A** of a third lead **15** thus to place the third lead **15** in the circuit **10**.

Regardless of the position of the switch **14**, the lead **12** may be opened by a switch **16** while the lead **11** has a single pole, double throw switch **17** shown as in engagement with a contact **10B** but operable to engage the contact **15B** of the third lead **15**.

A thermostatic device **18** is responsive to the temperature of the oil being heated and it actuates generally indicated switch operating means **19** so that the circuit switches are affected in a predetermined order as the temperature rises and falls. Assuming the temperature of the heating oil to be low, the switch operating means **19** establishes a first position of the switches, that shown in FIGURE 1, wherein the heat demand is high and the circuit **10** includes the heater leads **11** and **12** in parallel. As the temperature of the heating oil increases, the switch operating means **19** is so actuated by the thermostatic device **18** as to move the switch **17** into its second position in which the lead **11** is open and the contact **15B** of the lead **15** is engaged. The circuit is now operating with a partial heating capacity as only the heating elements in the lead **12** are now energized.

On a further increase in the temperature of the oil, the switch **14** is moved by the switch operating means **19** from engagement with the contact **10A** into engagement with the contact **15A** so that the leads **15**, **12** and **11** are now in series in the circuit **10**. All the heating elements **13** are now in series providing partial capacity with a reduced wattage per square inch.

On any further increase of the temperature of the oil, the thermostatic device **18** actuates the switch operating means **19** to open the switch **16** thus opening the circuit **10** until the oil temperature so falls as to cause the thermostatic device **18** again to dictate the necessary position of the switches for the proper pre-heating of the oil.

In FIGURE 2, the circuit is generally indicated at **20** and is shown as having first and second heater leads indicated at **21** and **22**, respectively, with each including a series of heating elements **23**. On the ground side of the lead **21** there is a switch **24** in the lead **22** of the single pole, double throw type shown as engaging the contact **20A** of the circuit **20** but having a second position in which it engages the contact **25A** of the third lead **25**. The leads **21** and **25** are shown as having, at their ground ends, a common contact **25B** shown as closed by the switch **26** to the ground side contact **20B** of which the lead **22** is connected. Regardless of the position of the

other switches, the circuit 20 may be opened by opening the switch 27.

A thermostatic device 28 is responsive to the temperature of the oil and when it is low, it actuates the generally indicated switch operating means 29 to provide a first position of the switches, that shown in the drawings, characterized by the heater leads 21 and 22 being connected in parallel in the circuit 20. When the temperature of the oil rises to a predetermined extent, the thermostatic device 28 so actuates the switch operating means 29 as to open the switch 26 establishing a partial heating capacity since the lead 21 is now open.

On a further increase in the temperature of the oil, the thermostatic device 28 so controls the switch operating means as to move the switch 24 from engagement with the contact 20A into engagement with the contact 25 so that the leads 21, 25, and 22 are now in series so that partial heating capacity results as the heating elements 23 are all in series. If the temperature of the oil increases further, the switch operating means 29 opens the switch 27 ending the heating cycle until heating demand is again sensed by the effect of the fuel oil on the thermostatic device 28.

The heating circuit of FIGURE 3 is generally indicated at 30 and it includes first and second heater leads 31 and 32, respectively, each including a series of heating elements 33. The heater lead 31 includes a contact 31A shown as engaged by a switch 34 which is shown as of the single pole, double throw type and which, in its second position, engages a contact 30B on the ground side of all the other leads. The heater leads 31 and 32 have a common ground 35 provided with a switch 36 which is shown as closed. The heater lead 32 has a switch 37 which is also shown as closed. A thermostatic device 38, responsive to the temperature of the fuel oil being preheated, actuates a generally indicated switch operating means 39 which establishes the various switch positions.

In the first position of the switches, that illustrated by FIGURE 3, the leads 31 and 32 are included in parallel, in the circuit 30 to satisfy a high heat demand. As the temperature of the oil being preheated increases, the thermostatic device 38 operates the switch operating means 39 to first move the switch 34 out of engagement with the contact 31A and into engagement with the contact 30B so that the circuit satisfies a partial demand since the lead 31 is now open. Should the temperature of the oil then increase, the switch operating means 39, in response to the thermostatic device 38, opens the switch 36 placing the leads 31 and 32 in series in the circuit 30 establishing partial heating capacity. On a predetermined further increase in the temperature of the oil, the thermostatic device 38, through the switch operating means 39, opens the switch 37 thus opening the circuit 30 until a heating demand for the fuel oil is again sensed.

The heating circuit of FIGURE 4 is generally indicated at 40 and includes first and second heater leads 41 and 42, respectively, having a series of heating elements 43. The two heater leads have a common ground 44 including a switch 45, shown as closed. On the ground side of the lead 41, there is a second lead switch 46 of the single pole, double throw type, shown as engaging the contact 40A but having a second position in which it engages the contact 40B enabling the second lead 42 to be connected to the ground side of the circuit 40. The circuit 40 also has a switch 47 which, when open, opens the circuit 40 regardless of the position of the other switches.

A thermostatic device 48, responsive to the temperature of the heating oil, controls generally indicated switch operating means 49 to establish the several switch positions. The first of these, when the heat demand is high, as shown in FIGURE 4 and is characterized by the leads 41 and 42 being in parallel in the circuit 40. In the next position of the switches, when the oil temperature has increased to a predetermined extent, the switch 46 is actuated to be disengaged from the contact 40A and to engage the contact 45A to establish partial heating capacity since the lead 42 is then open. When a predetermined further increase in the heat of the oil is sensed by the thermostatic device 48, the switch operating means 49 is operative to open the switch 45 thus placing the leads 41 and 42 in series. When the temperature of the oil reaches a maximum level, the switch operating means 49 opens the switch 47 to end the fuel oil heating cycle.

In FIGURE 5, the generally indicated circuit 50 is provided with a first heater lead 51 and a second heater lead 52 both having a series of heating elements 53. On the ground side of the elements 53 of the lead 51, there is a switch 54, shown as closed, connecting the lead 51 to a third lead 55 having a switch 56, also shown as closed. The switch 56 is to be closed whenever the burner to which the preheated oil is fed is in series and this control may be effected in various ways as by linkage of the draft or other controls or whenever the burner or blower circuits are closed. For convenience the switch 56 is shown as operated by the relay 57 which may be assumed to be in a circuit in parallel with the blower relay. A switch 58 of the single pole, double throw type is shown as engaging the contact 51A of the lead 51 but having a second position in which it engages the contact 55A of the third lead 55.

A thermostatic device 59, responsive to the temperature of the oil being preheated actuates generally indicated switch operating means 60 by which several switch positions are established to meet different heat demands. In the position of the switch shown in FIGURE 5, the heater leads 51 and 52 are in parallel in the circuit 50 representing the circuitry when a high heat demand exists.

When the oil temperature rises to a predetermined extent, the thermostatic device 59 causes the switch operating means to so actuate the switch 57 that it moves from engagement with the contact 51A into engagement with the contact 55A of the third lead 55 providing partial capacity. On a further rise in the temperature of the oil, and with the oil burner not operating, the switch 56 is open and the two leads 51 and 52 are now in series and both are energized.

On a further increase in the temperature of the oil, the switch 54 is opened to open the circuit 50 whether or not the burner is still in service. If it is not operating, then the switch 56 is open. Both heater circuits are never in parallel service unless the oil burner is operating.

From the foregoing, it will be apparent that heating circuits in accordance with the invention are adapted to meet a wide range of requirements and are particularly well suited for use in heating fuel oils.

I claim:

1. A heating circuit including a main circuit, first and second switches, both switches having first and second operative positions, and three leads, two of said leads being first and second heater leads, each heater lead including at least one heating element, said switches providing three alternative operating circuits, in the first, the first switch is in its first position and connects the two heater leads in parallel, the second heater lead including the second switch and the second switch being in its first position and placing the second lead in the main circuit, the third lead being open, in the second alternative operating circuit, said second switch being in its second position and connected to said third lead, said third lead being still open and said first switch is in its first position, said first heater lead now being open, and in the third alternative operating circuit, said first switch being in its second position and then placing the third lead in the main circuit, the second switch still being in its second position, said first and second heater leads now being in series, and means to operate said switches to establish said three operating circuits in the named or reverse order depending on whether the temperature of the medium exposed to said heaters is rising or falling.

2. The heating circuit of claim 1 in which there is a third switch operated by the switch operating means to open said third alternative circuit at a predetermined temperature of the medium.

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