Jan. 27, 1953 | M. J. PARKER ET AL | 2,626,754

TEMPERATURE CONTROL SYSTEM

Filed Nov. 2, 1950 | 2 SHEETS—SHEET 1

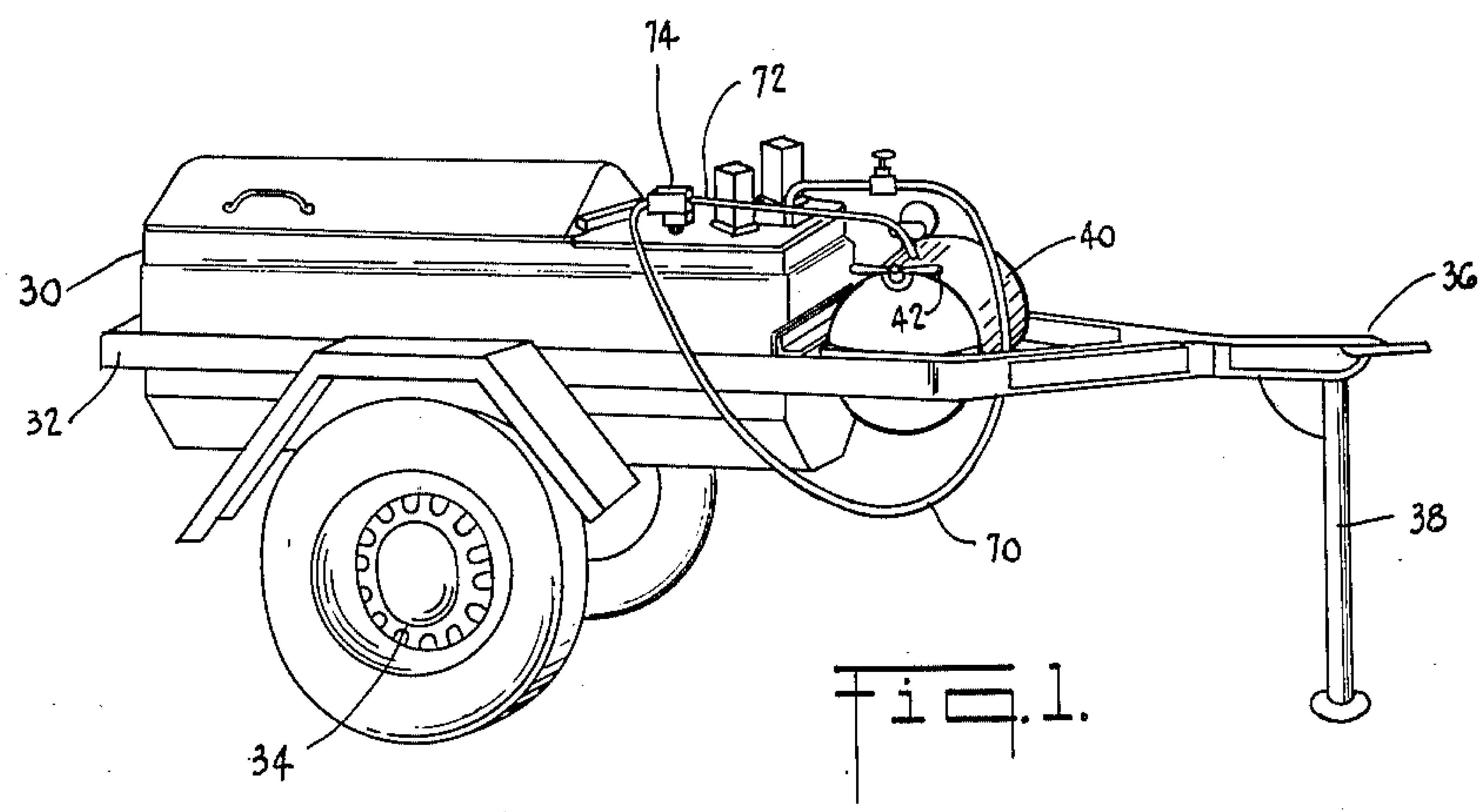

Fig. 1.

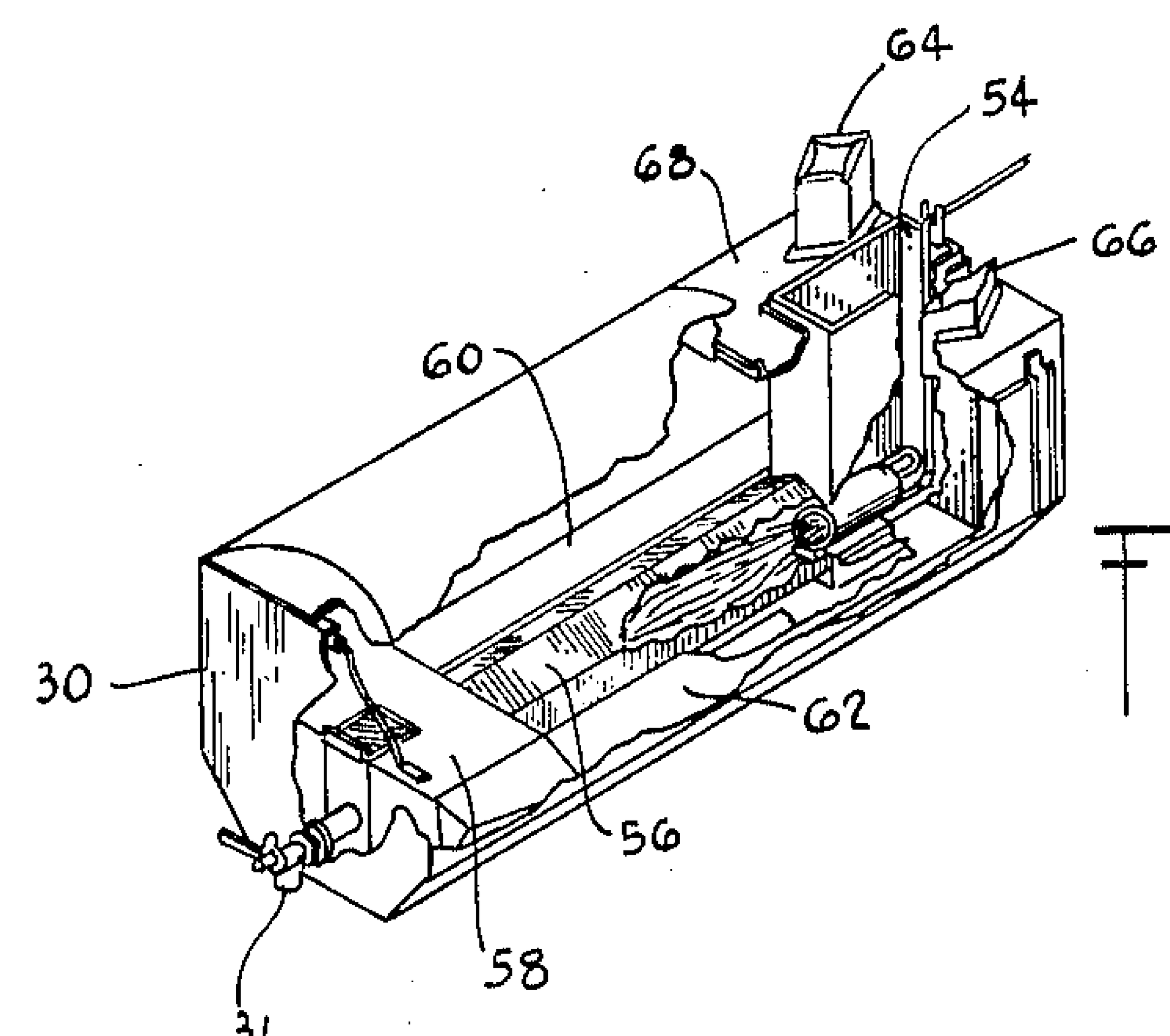

Fig. 2.

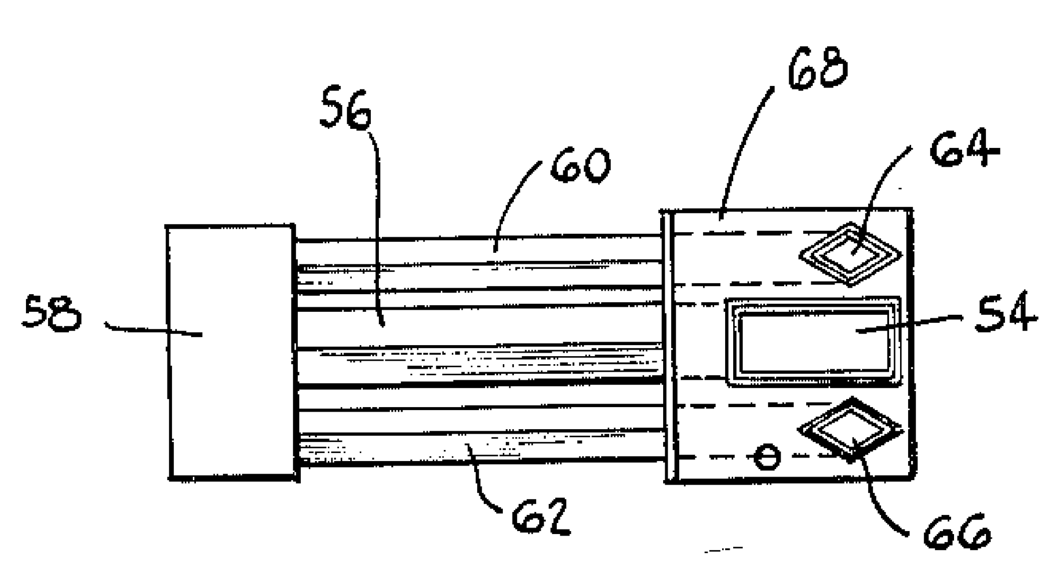

Fig. 3.

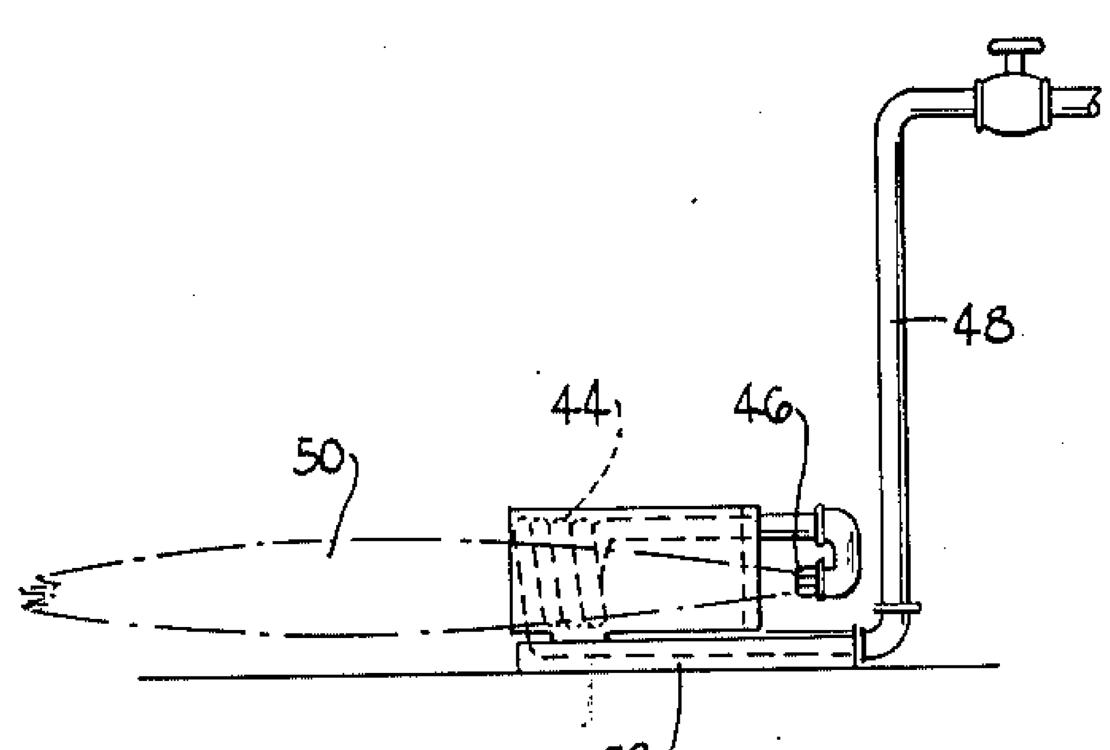

Fig. 4.

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TEMPERATURE CONTROL SYSTEM

Filed Nov. 2, 1950 | 2 SHEETS—SHEET 2

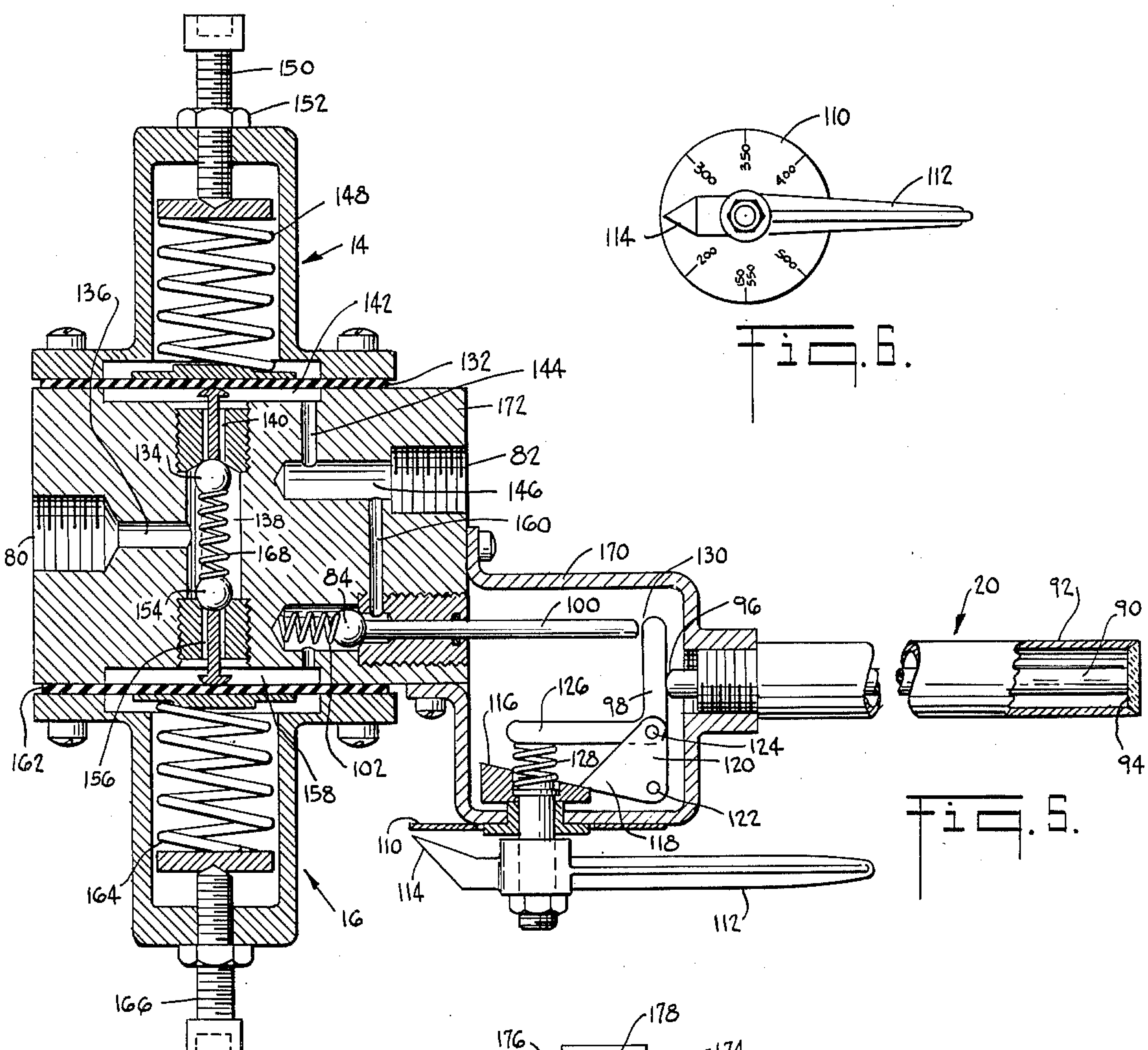

Fig. 6.

Fig. 5.

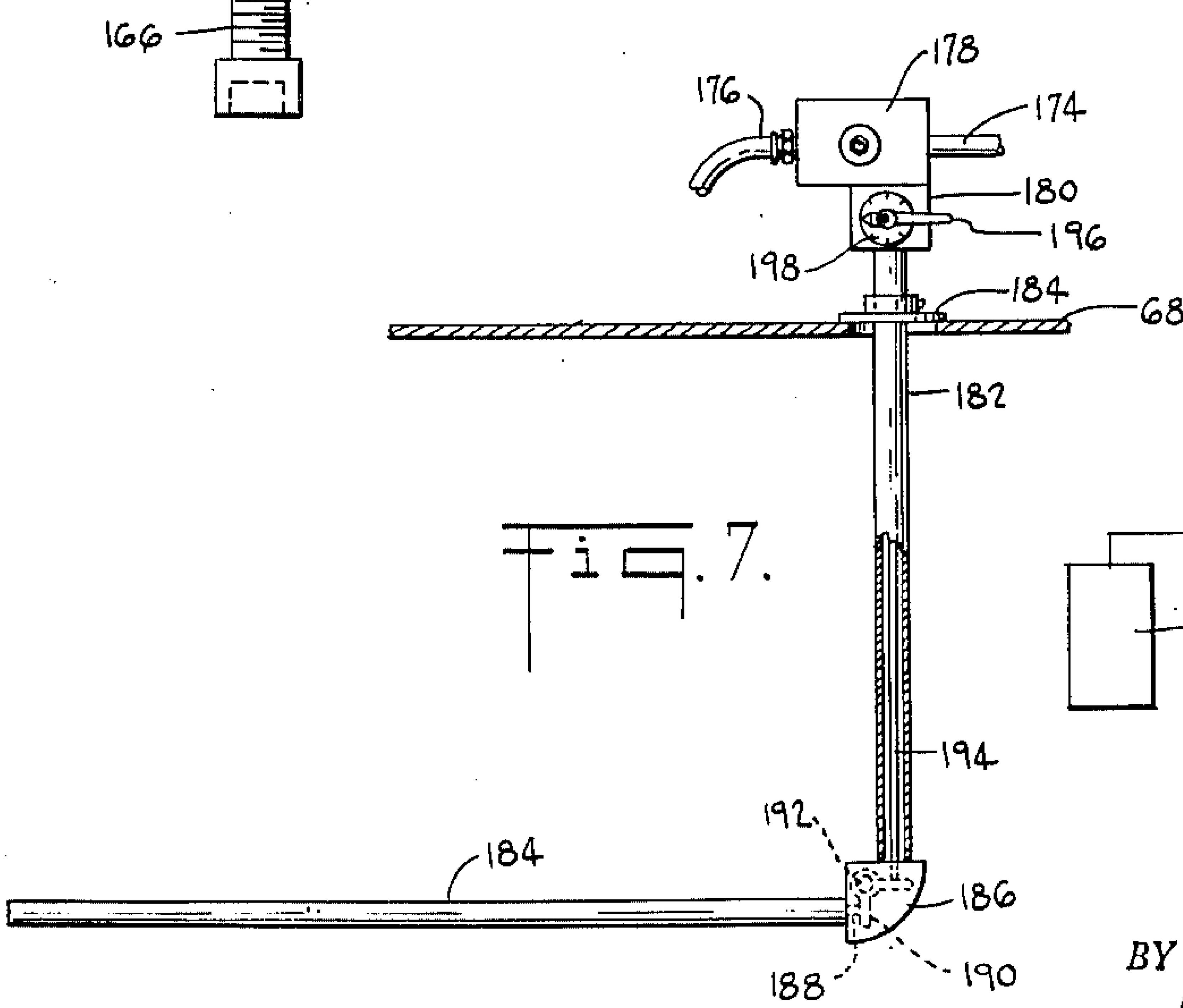

Fig. 7.

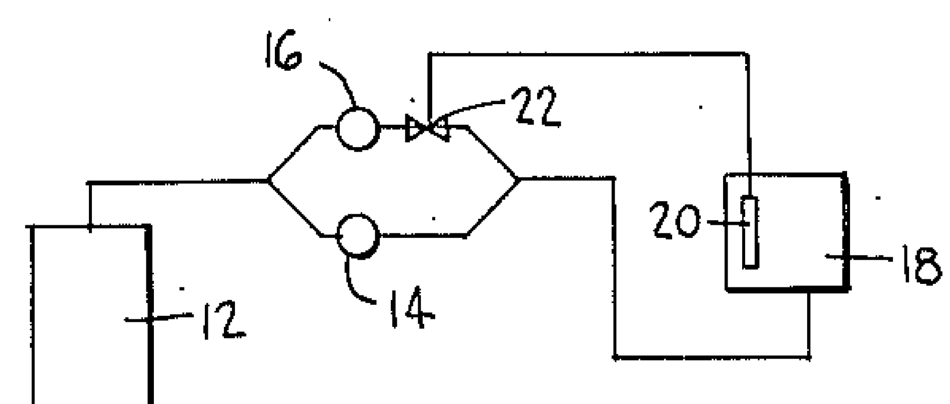

Fig. 8.

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Patented Jan. 27, 1953

2,626,754

UNITED STATES PATENT OFFICE

2,626,754

TEMPERATURE CONTROL SYSTEM

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Application November 2, 1950, Serial No. 193,672

12 Claims. (Cl. 236—92)

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This invention relates to temperature control systems, and more particularly a system for controlling a burner supplied with a fluid fuel from a variable pressure source.

The primary object of the invention is to generally improve temperature control systems involving the control of a heating fluid supplied from a variable pressure source. The invention is applicable with great advantage to portable systems having a supply tank which is intermittently pumped by hand and from which fuel is supplied to a burner, especially a vaporizing burner. Such burners are rather critical to adjust, for the flame will be extinguished as a result of either overcooling, in which case there is insufficient vaporization of the liquid fuel, or overheating, in which case there may be excessive vaporization and back pressure which interrupts the feed of liquid fuel to the burner. The difficulty of adjusting the fuel supply to such a burner is aggravated by the variable pressure of the supply source itself, for with a hand pump the pressure is built up only intermittently.

A further object is to provide for a fully automatic temperature control, thus overcoming the disadvantage of a mere thermometer system which requires the presence of a workman to watch the thermometer and to adjust the burner, apart from the difficulty of adjusting a burner when it is of the self-vaporizing type.

To accomplish the foregoing general objects, and other more specific objects which will hereinafter appear, our invention resides in the temperature control elements and their relation one to another as are hereinafter more particularly described in the following specification. The specification is accompanied by drawings, in which:

Fig. 1 is a perspective view of a portable tar kettle embodying features of our invention;

Fig. 2 is a perspective view with portions broken away to show the burner and immersion flue tubes;

Fig. 3 is a plan view of the immersion flue tube unit;

Fig. 4 is a side elevation of the self-vaporizing burner, drawn to enlarged scale.

Fig. 5 is a partially sectioned diagrammatic view of a high and low pressure regulator unit arranged for thermostatic control;

Fig. 6 is a detail thereof;

Fig. 7 is a partially sectioned elevation of a modification; and

Fig. 8 is a schematic diagram explanatory of the underlying concept of the invention.

Referring to the drawing, and more particularly to Fig. 8, the system comprises a variable

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pressure source 12 of a heating fluid. There is a first pressure regulator 14 connected to the source 12 and set for a relatively low pressure, and a second pressure regulator 16 connected to the source 12 and set for a relatively high pressure. These have a common outlet connected to a unit 18 symbolically representing the product or unit to be heated. A temperature responsive element 20 is connected to means such as a valve 22 to make the high pressure regulator 16 operative or inoperative. In this way the fluid is delivered from the source 12 intermittently at low and high pressure in such increments as will tend to maintain a desired temperature at the unit 18.

Referring now to Fig. 1 of the drawing, in the present example the invention is shown applied to a portable tar kettle, the body 30 of which is carried in a frame 32 supported on pneumatically tired wheels 34, thus constituting a trailer having a coupling arm 36 provided with a stand 38 which may be turned up out of the way when the trailer is being transported. It will be understood that such tar kettles are made with wheels having hard rubber rims and steel rims, and also with skids instead of wheels, the latter being transported on a truck instead of being pulled as a trailer.

The trailer unit includes a tank 40 for a liquid fuel, which is ordinarily kerosene but which may also be light furnace oil, range oil, or gasoline. The tank is provided with a hand-operated pump, the handle of which is indicated at 42, and this is manually operated at intervals to build up pressure in the tank. The liquid fuel is fed from the tank to a self-vaporizing burner housed in submerged flues which are surrounded by the tar in the kettle. Tar may be withdrawn from the kettle through a suitable draw-off cock, shown at 31 in Fig. 2, and after many pails of tar have been withdrawn the cover of the kettle may be raised and the kettle reloaded with large chunks of cold tar.

Such kettles are employed for various purposes, a common one being for use by roofers. Many roofers supply a so-called "twenty-year bonded roof," but it has been found that if the tar is heated to wrong temperature the roof may deteriorate in as short a time as five years instead of the guaranteed twenty years. It is therefore highly important to be able to maintain a predetermined desired temperature in the tar kettle.

Referring now to Fig. 4 of the drawing, the self-vaporizing burner is essentially a form of blow torch, it comprising a preheating coil 44 as well as a nozzle 46. The liquid fuel is supplied through a pipe 48 and flows through coil 44 and thence to nozzle 46. The heat of the flame 50 vaporizes the fuel in coil 44 and the resulting vapor is burned at the nozzle 46. Thus the burner is self-generating. This necessitates that it be started, and for that purpose the common practice is to saturate a rag with kerosene or other fuel, to place the rag in the preheating pan 52, and to light it. The resulting heat vaporizes some of the fuel in the coil 44, and vapor escaping at the nozzle 46 is ignited by the flame from the pan 52. After the burner settles down to a steady, dependable flame it is lowered bodily into the burner well of the kettle.

Referring to Figs. 2 and 3, the immersion flue tube unit comprises a vertical burner well 54, the lower end of which is connected to a horizontal central flue tube 56. The forward end of horizontal flue tube 56 is connected to a header 58, which in turn is connected to two side flue tubes 60 and 62. These are connected at their other ends to vertical chimney-like risers 64 and 66, respectively. In the particular unit here shown the center flue tube 56 is hexagonal in cross section, while the side flue tubes 60 and 62 are diamond shape in cross section. The unit further includes a top plate or cover plate 68.

The entire immersion unit is carried in the kettle 30, as is best shown in Fig. 2, the cover plate 68 acting as a part of the top of the kettle. The remainder of the top is openable for the addition of tar. The location of the burner will be clear from Fig. 2, it being lowered to the bottom of the burner well 54 where it rests opposite the end of the center flue tube 56. Thus the hot combustion gases flow along the tube 56, divide in header 58, flow back through the side tubes 60 and 62, and thence upwardly through the risers 64 and 66. The burner well is made large enough in dimension so that the entire burner may be lowered into the well after it has been started, it having been removed from the well and left on the ground during the preliminary starting operation previously described. It is for that reason that the fuel supply line to the burner includes a relatively long length of flexible hose, indicated at 70 in Fig. 1.

In accordance with out invention, instead of connecting the tank 40 directly to the burner, the tank is connected by means of a pipe 72 to a thermostatically controlled regulator unit 74. The flexible hose 70 previously referred to leads from the outlet of the regulator unit 74 to the burner.

Referring now to Fig. 5, the regulator unit is there shown in greater detail, though in some respects schematically for the purpose of clarity. The unit comprises a low pressure regulator 14 and a high pressure regulator 16. These are arranged in parallel, there being a common inlet 80 and a common outlet 82. There is a suitable means 84 to make the high pressure regulator operative or inoperative, and said means is controlled by a suitable temperature responsive element, in this case a thermostat 20. In the specific structure shown the means 84 is a check valve located in the flow circuit through the high pressure regulator 16 from the inlet 80 to the outlet 82. Thus whenever the valve 84 is closed the high pressure regulator is inoperative, and when the valve 84 is opened the high pressure regulator is operative.

The thermostat 20 comprises a rod 90 housed within a tube 92, the two being brazed or otherwise secured together at the end 94. The rod and tube have different temperature co-efficients of expansion. In this case the rod 90 is made of invar which has a negligible temperature coefficient of expansion, while the tube 92 is made of brass which has a substantial temperature coefficient of expansion. The free end 96 of the rod 90 bears against a lever 98, which in turn operates a rod 100 which bears against the valve 84. Thus when the temperature is reduced, contraction of the tube 92 causes a movement of the end 96 to the left, which in turn opens the valve 84 and so permits a high pressure supply of fuel to the burner. On the other hand, when the temperature rises the resulting expansion of the tube 92 moves the end 96 to the right, and so permits the valve 84 to close under the influence of its spring 102. This makes the high pressure regulator inoperative, whereupon fuel is supplied to the burner at low pressure through the low pressure regulator.

In the particular apparatus here shown the burner is so designed that it is adapted to operate in a range of pressure of from five to forty pounds. The tank pressure may be built up substantially higher by means of the hand pump. In operation, fuel is delivered alternately at low and high pressure, in such increments as will tend to maintain the desired temperature, and the adjustment and operation is not affected by variation in the pressure in the fuel tank in any range above forty pounds. Moreover, the pressure may be permitted to drop well below forty pounds, and the temperature nevertheless will be maintained, although a somewhat greater time may be required to bring a cold kettle up to desired temperature. For example, if the tank pressure drops to 30 pounds, the burner supply will alternate between 5 and 30 pounds, for increments determined by the thermostat.

The temperature control mechanism shown in Fig. 5 includes a manually adjustable means for fixedly adjusting the value of the desired temperature. In the specific mechanism shown this includes a temperature scale 110 (Figs. 5 and 6) for cooperation with a handle 112 having a pointer 114. The particular linkage employed may vary, but the essential idea of that shown here is quite simple, it being to interpose a wedge between the thermostat part 96 and the rod 100, thereby changing the temperature which marks the threshold between closing and opening of the valve 84. In the present case the wedge is circular, that is, handle 112 turns a helical cam 116 which bears against a cam follower 118. The follower 118 forms part of an angle lever 120 pivoted at 122 and carrying a floating or movable pivot 124. This in turn carries the lever 98 previously referred to, and which lever is interposed between the invar rod 96 and the valve opening rod 100.

Lever 98 may have an arm 126 against which a compression spring 128 bears, the latter serving to keep all of the parts in snug contact, except at the point 130 where a clearance may form when the temperature is high and the valve is closed. In other words, the spring 128 serves to move the lever 98 clockwise about pivot 124 and therefore in contact with the invar rod at 96, and by reaction the resulting tendency of the floating pivot 124 to move to the left serves to keep the cam follower 118 in contact with the cam 116. It will be understood that by swinging the handle 112 to change the position of the pointer 114 on the temperature scale 110, the position of the helical cam 116 is changed, thus shifting the position of the floating pin 124 toward the left or the right, and that this in turn changes the clearance at 130, or more particularly, changes the relation between the invar rod 96 and the valve 84.

The pressure regulators may each individually be of conventional construction. In the particular case here shown the low pressure regulator 14 includes a diaphragm 132 controlling the seating of a valve 134. The inlet 80 is connected to the outlet 82 by means of passages 136 and 138, valve 134, passage 140, the diaphragm clearance space 142, and passages 144 and 146 to the outlet 82. The diaphragm is loaded by means of a compression spring 148, the tension of which is adjustable by means of an adjusting screw 150 locked at 152. The spring pressure is opposed by the back pressure from outlet 82 which is exerted against the bottom of the diaphragm. Thus whenever the back pressure falls below the low-pressure adjustment, the spring urges the diaphragm downward and opens the valve 134 and so supplies more fluid, which in turn builds up the outlet pressure to the desired value, whereupon the valve 134 is closed to prevent the outlet pressure from becoming excessive.

The high pressure regulator 16 is similar in construction to the low pressure regulator 14, the fluid flowing from inlet 80 through passages 136 and 138 to a valve 154. The valves 134 and 154 are both urged in closing direction by means of a single compression spring 168. When the valve is opened the fluid flows through passage 156 and diaphragm clearance space 158 to the temperature control valve 84. When the latter is open the fluid flows past the valve through passage 160 to the outlet 82. The diaphragm 162 is loaded by a compression spring 164 adjusted by means of an adjusting screw 166. Whenever the temperature is too low the valve 84 is pushed open, and in such case the high pressure regulator 16 is made operative and permits a flow of fuel from the inlet to the outlet.

The outlet pressure is built up to the desired high value, whereupon the back pressure acting on the inner side of diaphragm 160 causes closing of the valve 154. This prevents the outlet pressure from being built up to the tank pressure, which preferably is even higher than the adjustment of the high pressure regulator. In this way fuel is supplied to the burner continuously at a regulated high pressure, and the resulting intense burner flame builds up the kettle temperature until it reaches the desired temperature value.

During all this time the low pressure regulator is, of course, closed, for the back pressure is far in excess of the adjustment of the low preessure regulator. When the temperature reaches the desired value the valve 84 closes and thus makes the high pressure regulator effectively inoperative, for whether the valve 154 is open or closed no fluid can be delivered from the high pressure regulator to the outlet 84. In such case the outlet pressure begins to fall and drops to the low pressure adjustment, at which time the burner flame is small. It is maintained uniform at the desired small value by the resulting operation of the low pressure regulator.

The showing in Fig. 5 has been made somewhat simplified and schematic in order to better explain the nature of the mechanism. One respect in which it has been simplified is that the rod 100 and the thermostat 20 have been shown in the same plane as the inlet and outlet. In practice it is somewhat more convenient to turn the rod 100 and thermostat 20 downward to a position perpendicular to the plane of the paper so that the inlet and outlet are adapted for horizontal pipe connections, while the housing 170 for the temperature adjusting means is disposed beneath the block 172 of the pressure regulators. Thus referring to Fig. 7, pipe 174 is connected to the inlet, while hose 176 is connected to the outlet formed in a regulator block 178 corresponding to the block 172 in Fig. 5. The housing 180 corresponds to the housing 170 in Fig. 5, and is disposed beneath the block 178. The pipe 182 depends vertically, and may be provided with a flange 184 to fix its position relative to the top plate 68 of the immersion flue unit.

As so far described the thermostat would be vertical, but we believe it preferable to dispose the thermostat in a horizontal position so that it will be immersed throughout its length, regardless of the level of the tar. When the thermostat is vertical the upper portion will be immersed in tar when the kettle has been newly filled, and not when pails of tar have been withdrawn from the kettle. Fig. 7 shows the thermostat 184 disposed horizontally. It is connected to an elbow-like housing 186, which in turn is carried by the pipe 182. The free end 188 of the invar rod bears against an angle lever 190 pivoted at 192. The other arm of the angle lever bears against the lower end of a rod 194 disposed in pipe 182. The rod 194 and the pipe 182 are preferably made of like metal, or metals having the same temperature co-efficient of expansion, so that there is no relative movement in response to temperature change. In the usual case both the rod and the pipe are made of steel, whereas in the thermostat 184 the outer pipe is preferably made of brass, and the rod of invar, in order to produce a relative movement in response to temperature change.

It will be understood from the description of Fig. 5 previously given that one effect of the compression spring 128 there shown will be to urge the rod 194 (Fig. 7) downward and thus to urge the angle lever 190 against the end 188 of the invar rod. The resulting operation is the same as that previously described, for the horizontal movement produced at 188 by a temperature change is translated into a vertical movement of the rod 194, which in turn controls the valve which makes the high pressure regulator operative or inoperative. The temperature maintained is regulatable exactly as previously described by means of a manually adjustable control handle 196 cooperating with a temperature scale 198.

It is believed that the construction and operation of our improved temperature control system for controlling the flow of a heating fluid, as well as the advantages thereof, will be apparent from the foregoing detailed description. The use of a single valve body for three valve seats, three valves, a single inlet, and a single outlet, leads to great economy in manufacture, and convenience in use. The invention is of particular value as applied to portable vaporizing burners supplied with a liquid fuel because, on the one hand, the pressure of the supply source is variable, it being built up only intermittently by means of a hand pump, and, on the other hand, the operation of the burner is itself critical, for the pressure of the fuel supplied to the burner must not be allowed to go below a lower limit nor above an upper limit, either of which may cause the flame to be extinguished.

It will be understood that while we have described the invention as applied to a tar kettle, it is not limited to that, for portable kettles are employed for the melting of pipe joint compound, the melting of lead, and even the heating of water. The invention also is not limited to a burner placed in an immersion flue tube system, for it is equally well applicable to underfired kettles. Moreover, the invention is not to be deemed limited to a particular fuel, nor to a vaporizing burner. For example, it is of value with a portable burner supplied with gas from a tank of compressed or liquified gas. Such a tank is a variable pressure source, which is anyway preferably followed by a reducing valve. Furthermore, the invention is not necessarily limited to a portable burner, nor even to a burner, although it is of greatest importance in that field.

It will therefore be understood that while we have shown and described our invention in a preferred form, many changes may be made in the structure shown without departing from the scope of the invention as sought to be defined in the following claims.

We claim:

1. A temperature control system for controlling the flow of a heating fluid from a variable pressure source, said system comprising a first automatic pressure regulator connected to said source and set for a relatively low pressure, a second automatic pressure regulator connected to said source and set for a relatively high pressure, a temperature responsive element subjected to the temperature to be controlled, means responsive to said element to make the second pressure regulator operative or inoperative, and means connecting both regulators to the unit using the heating fluid, whereby the fluid is delivered alternately at low and high pressure in such increments as will tend to maintain the desired temperature.

2. A temperature control system for controlling the flow of a liquid fuel from a variable pressure source to a vaporizing burner, said system comprising a first automatic pressure regulator connected to said source and set for a relatively low pressure, a second automatic pressure regulator connected to said source and set for a relatively high pressure, a temperature responsive element subjected to the temperature to be controlled, means responsive to said element to make the second pressure regulator operative or inoperative, and means connecting both regulators to the burner, whereby the fuel is delivered alternately at low and high pressure in such increments as will tend to maintain the desired temperature.

3. A temperature control system for controlling the flow of a fluid fuel from a variable pressure source to a burner, said system comprising a first automatic pressure regulator connected to said source and set for a relatively low pressure, a second automatic pressure regulator connected to said source and set for a relatively high pressure, a thermostat subjected to the temperature to be controlled, means responsive to said thermostat to make the second pressure regulator operative or inoperative, and means connecting both regulators to the burner, whereby the fuel is delivered alternately at low and high pressure in such increments as will tend to maintain the desired temperature, and manually adjustable means forming a part of the aforesaid thermostat responsive means for fixedly adjusting the desired temperature.

4. A temperature control system for controlling the flow of a liquid fuel from a variable pressure source to a vaporizing burner, said system comprising a first automatic pressure regulator connected to said source and set for a relatively low pressure, a second automatic pressure regulator connected to said source and set for a relatively high pressure, a thermostat subjected to the temperature to be controlled, means responsive to said thermostat to make the second pressure regulator operative or inoperative, and means connecting both regulators to the burner, whereby the fuel is delivered alternately at low and high pressure in such increments as will tend to maintain the desired temperature, and manually adjustable means forming a part of the aforesaid thermostat responsive means for fixedly adjusting the desired temperature.

5. A temperature control system for controlling the flow of a fluid fuel from a variable pressure source to a burner, said system comprising a pair of automatic pressure regulators arranged in parallel and having a common inlet connected to said source and a common outlet connected to said burner, one of said automatic pressure regulators being set for a relatively low pressure and the other being set for a relatively high pressure, the flow circuit from inlet to outlet through the high pressure regulator including a valve serving to make the high pressure regulator either operative or inoperative, a temperature responsive element subjected to the temperature to be controlled, and means responsive to said element to open or close the aforesaid valve, whereby the fuel is delivered alternately at low and high pressure in such increments as will tend to maintain the desired temperature, and manually adjustable means associated with said element for fixedly adjusting the desired temperature.

6. A temperature control system for controlling the flow of a liquid fuel from a variable pressure source to a vaporizing burner, said system comprising a pair of automatic pressure regulators arranged in parallel and having a common inlet connected to said source and a common outlet connected to said burner, one of said automatic pressure regulators being set for a relatively low pressure and the other being set for a relatively high pressure, the flow circuit from inlet to outlet through the high pressure regulator including a valve serving to make the high pressure regulator either operative or inoperative, a temperature responsive element subjected to the temperature to be controlled, and means responsive to said element to open or close the aforesaid valve, whereby the fuel is delivered alternately at low and high pressure in such increments as will tend to maintain the desired temperature, and manually adjustable means associated with said element for fixedly adjusting the desired temperature.

7. A temperature control system for controlling the flow of a fluid fuel from a variable pressure source including an intermittently operated hand pump to a portable burner, said system comprising a pair of pressure regulators arranged in parallel and having a common inlet connected to said source and a common outlet connected to said burner, each of said regulators including a spring loaded diaphragm subjected to the outlet pressure, one of said pressure regulators being set for a relatively low pressure and the other

being set for a relatively high pressure, the flow circuit from inlet to outlet through the high pressure regulator including a valve serving to make the high pressure regulator either operative or inoperative, a thermostat subjected to the temperature to be controlled, means responsive to said thermostat to open or close the aforesaid valve whereby the fuel is delivered alternately at low and high pressure in such increments as will tend to maintain the desired temperature, and manually adjustable means including a temperature scale and a cam between the thermostat and the valve for fixedly adjusting the desired temperature.

8. A temperature control system for controlling the flow of a liquid fuel from a variable pressure source including an intermittently operated hand pump to a portable vaporizing burner, said system comprising a pair of pressure regulators arranged in parallel and having a common inlet connected to said source and a common outlet connected to said burner, each of said regulators including a spring loaded diaphragm subjected to the outlet pressure, one of said pressure regulators being set for a relatively low pressure and the other being set for a relatively high pressure, the flow circuit from inlet to outlet through the high pressure regulator including a valve serving to make the high pressure regulator either operative or inoperative, a thermostat subjected to the temperature to be controlled, means responsive to said thermostat to open or close the aforesaid valve, whereby the fuel is delivered alternately at low and high pressure in such increments as will tend to maintain the desired temperature, and manually adjustable means including a temperature scale and a cam between the thermostat and the valve for fixedly adjusting the desired temperature.

9. A temperature control system for controlling the flow of a heating fluid from a variable pressure source, said system comprising a single valve body having three valve seats, three valve members movable at said seats, an inlet and an outlet, two of said valves acting as automatic pressure regulators arranged in parallel and having said common inlet connected to said source and having said common outlet connected to the unit utilizing the heating fluid, one of said automatic pressure regulators being set for a relatively low pressure and the other being set for a relatively high pressure, the flow circuit from said inlet to said outlet through the high pressure regulator including the aforesaid third valve serving to make the high pressure regulator either operative or inoperative, a temperature responsive element subjected to the temperature to be controlled, means responsive to said element to open or close the aforesaid valve, whereby the fluid is delivered alternately at low and high pressure in such increments as will tend to maintain the desired temperature.

10. A temperature control system for controlling the flow of a liquid fuel from a variable pressure source to a vaporizing burner, said system comprising a single valve body having three valve seats, three valve members movable at said seats, an inlet, and an outlet, two of said valves acting as automatic pressure regulators arranged in parallel and having said common inlet connected to said source and having said common outlet connected to said burner, one of said automatic pressure regulators being set for a relatively low pressure and the other being set for a relatively high pressure, the flow circuit from said inlet to said outlet through the high pressure regulator including the aforesaid third valve serving to make the high pressure regulator either operative or inoperative, a temperature responsive element subjected to the temperature to be controlled, and means responsive to said element to open or close the aforesaid valve, whereby the fuel is delivered alternately at low and high pressure in such increments as will tend to maintain the desired temperature.

11. A dual regulator unit for a temperature control system for controlling the flow of a heating fluid from a variable pressure source, said unit comprising a single valve body having three valve seats, three valve members movable at said seats, an inlet, and an outlet, two of said valves acting as pressure regulators arranged in parallel and having said common inlet adapted to be connected to said source and having said common outlet adapted to be connected to the unit utilizing the heating fluid, each of said regulators including a spring loaded diaphragm subjected to the outlet pressure, one of said pressure regulators being set for a relatively low pressure and the other being set for a relatively high pressure, the flow circuit from said inlet to said outlet through the high pressure regulator including the aforesaid third valve serving to make the high pressure regulator either operative or inoperative, a thermostat, and means responsive to said thermostat to open or close the aforesaid valve.

12. A temperature control system for controlling the flow of a liquid fuel from a variable pressure source including an intermittently operated hand pump to a portable vaporizing burner, said system comprising a single valve body having three valve seats, three valve members movable at said seats, an inlet, and an outlet, two of said valves acting as pressure regulators arranged in parallel and having said common inlet connected to said source and having said common outlet connected to said burner, each of said regulators including a spring loaded diaphragm subjected to the outlet pressure, one of said pressure regulators being set for a relatively low pressure and the other being set for a relatively high pressure, the flow circuit from said inlet to said outlet through the high pressure regulator including the aforesaid third valve serving to make the high pressure regulator either operative or inoperative, a thermostat subjected to the temperature to be controlled, means responsive to said thermostat to open or close the aforesaid valve, whereby the fuel is delivered alternately at low and high pressure in such increments as will tend to maintain the desired temperature, and manually adjustable means including a temperature scale and a cam between the thermostat and the valve for fixedly adjusting the desired temperature.

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