

Dec. 7, 1965

A. A. THIELE

3,222,578

SILICON CONTROLLED RECTIFIER ACTUATED LIQUID GAS FILLER

Filed Sept. 26, 1963

2 Sheets-Sheet 1

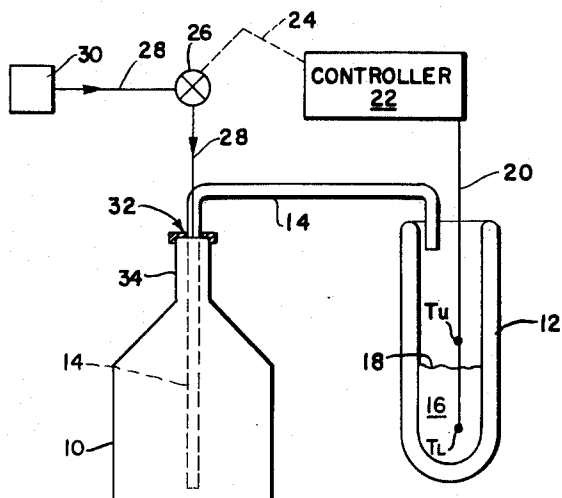


FIG. 1.

FIG. 2.

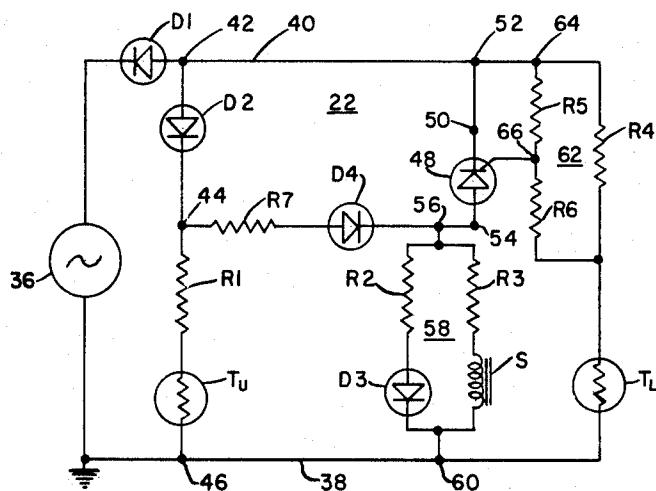
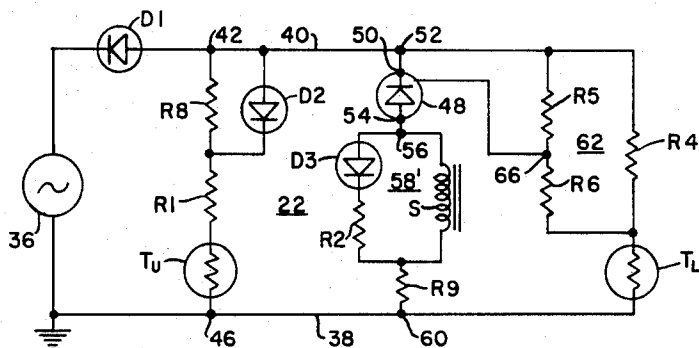


FIG. 3.

BY *Birch and O'Brien*

INVENTOR

Alfred A. Thiele

ATTORNEYS

Dec. 7, 1965

A. A. THIELE

3,222,578

SILICON CONTROLLED RECTIFIER ACTUATED LIQUID GAS FILLER

Filed Sept. 26, 1963

2 Sheets-Sheet 2

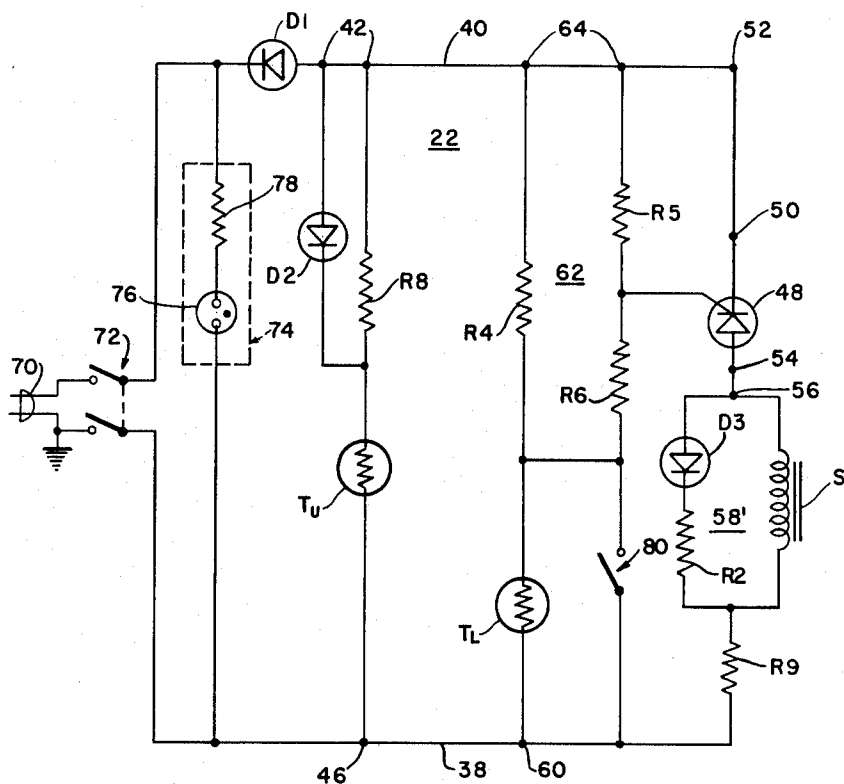


FIG. 4.

INVENTOR
Alfred A. Thiele

BY *Birch and O'Brien*

ATTORNEYS

1

3,222,578

**SILICON CONTROLLED RECTIFIER ACTUATED
LIQUID GAS FILLER**

Alfred Almstedt Thiele, Box 307C, Graduate House,
305 Memorial Drive, Cambridge, Mass.
Filed Sept. 26, 1963, Ser. No. 311,902
11 Claims. (Cl. 317-148.5)

This invention relates to automatic filler systems for liquid gases and the like, such as liquid nitrogen, and more particularly to intermittent automatic filler systems which regulate the level of liquid gas in a particular receptacle.

It is an object of this invention to provide a novel intermittent automatic filler system for liquid gas and the like.

It is another object of this invention to provide a novel intermittent automatic filler system for liquid gas and the like characterized by small size and simplicity.

Another object of this invention is to provide a novel intermittent automatic filler for liquid gas and the like which maintains the level of liquid gas in a receptacle between predetermined limits.

Still another object of this invention is to provide a novel intermittent automatic filler for liquid gas and the like having a novel silicon controlled rectifier circuit and a filler valve controlled thereby.

These and other objects of the invention will become more fully apparent with reference to the following specification and drawings which relate to several preferred embodiments of the invention.

In the drawings:

FIGURE 1 is a schematic of a liquid gas filler system of the present invention;

FIGURE 2 is a circuit diagram of a first embodiment of the invention;

FIGURE 3 is a circuit diagram of a second embodiment of the invention; and

FIGURE 4 is a circuit diagram of a commercial embodiment of the invention.

Referring in detail to the drawings, and more particularly to FIGURE 1, the filler system is shown as generally comprising a first or storage dewar 10 and a second or supplied dewar 12 interconnected by a transfer tube 14, the latter extending substantially to the bottom of the first dewar 10 and slightly into the second dewar 12.

Liquid gas 16, such as liquid nitrogen is generally shown in the second dewar 12 as having a level 18 which level is to be regulated under the present invention.

Sensor means for detecting upper and lower limits of the liquid level 18 is provided in the form of an upper limit thermistor T_U and a lower limit thermistor T_L connected by circuit means 20 with an electronic controller means 22.

The controller means 22 has an output comprising driving means 24 for a control valve 26.

The control valve 26 is connected in a pneumatic line 28 which is connected at one end to a source 30 of dry air or nitrogen and at the other end to the inlet 32 of the storage dewar 10 in the neck portion 34 thereof. The inlet 32 is suitably sealed around the pneumatic line 28 and the transfer tube 14.

The control valve 26 is a two-way valve in that it is controllable to either connect the storage dewar 10 with the pneumatic source 30 or vent the storage dewar 10 to atmosphere.

Referring now to FIGURE 2, one embodiment of the electronic controller means 22 will now be described in detail.

An alternating current source 36 is connected at one side to a common ground lead 38 and at the other side

2

to a common lead 40 via a first half-wave rectifier diode D1.

A first branch circuit is connected between common leads 38 and 40 comprising a second diode D2 extending from anode terminal 42 at the line 40 to a first junction point 44 comprising its cathode terminal, and a first resistor R1 and the upper limit thermistor T_U , connected in series from the junction point 44 to a terminal 46 at the ground line 38.

A second branch circuit is connected between common leads 38 and 40 comprising a silicon controlled rectifier 48, hereinafter referred to as SCR48, connected via its cathode terminal 50 to a terminal 52 on the line 40 and connected at its anode terminal 54 to a second junction point 56, and a solenoid circuit 58 connected between the junction point 56 and a terminal 60 at the ground line 38.

The solenoid circuit 58 comprises a first parallel branch having a second resistor R2 connected at the second junction point 56 to the anode side of a third diode D3 which is connected at its cathode to the terminal 60; and a second parallel branch having a third resistor R3 connected from the second junction point 56 to one side of a solenoid winding S which, in turn, is connected at its other end to the terminal 60. The solenoid winding S comprises the control winding for the control valve 26 which is of the solenoid type.

A third branch circuit is connected across the common lines 38 and 40 and comprises a parallel branch biasing circuit 62 connected at one end to a terminal 64 on the common line 40 and at its other end to the lower limit thermistor T_L , the latter being connected to the common ground line 38 via the terminal 60 of the solenoid circuit.

The biasing circuit 62 comprises a fourth resistor R4 in parallel with a voltage divider having fifth and sixth series resistors R5 and R6, respectively, with a junction therebetween comprising the gate terminal 66 of the SCR48.

The first and second branch circuits are interconnected at the respective junction points 44 and 56 via a seventh resistor R7 extending from the junction point 44 to the anode of a fourth diode D4, the latter being connected at its cathode to the junction point 56.

Referring now to FIGURE 3, another embodiment of the invention is shown which includes many like parts to the embodiment of FIGURE 2, these being indicated by like numerals.

In this embodiment, the second diode D2 in the first branch circuit is shunted by an eighth resistor R8. The rest of the first branch circuit is identical to that of the embodiment of FIGURE 2.

The solenoid circuit 58 of FIGURE 2 is replaced in FIGURE 3 by a solenoid circuit 58' comprising the third diode D3 and second resistor R2 in exchanged positions in the first parallel branch thereof and a second parallel branch consisting solely of the solenoid winding S. A common terminal 68 is provided for the second resistor R2 and the solenoid winding S and is connected via a ninth resistor R9 to the terminal 60 on the common ground line 38.

The SCR48 and the third branch circuit are identical to the corresponding elements of FIGURE 2. However, the seventh resistor R7 and the fourth diode D4 of FIGURE 2 are not present in FIGURE 3.

Referring now to FIGURE 4, a commercial embodiment of the invention is shown as including a power plug 70 and an on-off switch 72 connecting the power plug 70 with the common lines 38 and 40.

An on-off indicator means 74 comprising a neon bulb 76 and series resistor 78 connected as a branch circuit across the common lines 38 and 40 adjacent the switch 72.

The remainder of the circuit is substantially identical

with that of FIGURE 3 with the exception that a switch 80 is provided in shunt with the lower limit thermistor T_L and the first resistor R1 has been removed.

OPERATION

Referring now to FIGURES 1 and 2, the operation of the embodiment of FIGURE 2 will now be described.

Assuming that the fluid level 18 has fallen below the lower limit thermistor T_L , the lower thermistor T_L will no longer be cooled by the liquid gas 16. Since the first diode D1 passes negative half-cycles of current from the source 36, a current path through lower thermistor T_L via the fourth resistor R4 and common lines 38 and 40 is established. This causes the lower thermistor T_L to heat up by the energy dissipated therein and cause a decrease in the resistance thereof. The current thus increases, the temperature further increases and the resistance further decreases comprising a runaway action in the lower thermistor T_L .

The values of the fifth and sixth resistors R5 and R6 are chosen so that they present the proper firing potential to the gate terminal 66 of the SCR48, derived from the voltage drop across the fourth resistor R4, when the lower thermistor T_L is out of the fluid 16 and the above-defined runaway action has commenced.

When the SCR48 fires, a current path is created through the solenoid winding S via common line 38, terminal 60, third resistor R3, which limits the current in the winding S, junction 56, SCR48, terminal 52 and common line 40. During positive half cycles at the source 36, the second resistor R2 and third diode D3 provide a path for the current in the inductive winding S. As a result, the solenoid valve 26 is actuated to connect the pressure source 30, via pneumatic line 28, with the storage dewar 10. This forces liquid gas in the storage dewar 10 into the controlled dewar 12 via the transfer tube 14.

The firing of the SCR48 results in a heating of the upper thermistor T_U via the current path comprising the SCR48, fourth diode D4, seventh resistor R7 and first resistor R1 between the common lines 38 and 40.

The fluid level 18 is now rising and the fluid 16 envelops the lower thermistor T_L which cools to low conductivity and thus prevents the firing potential from being provided at the gate terminal 66.

However, because of the inductive memory or storage characteristics of the winding S, the voltage thus provided across the limiting third resistor R3 drives a current through the upper thermistor T_U and its above-defined current path to maintain the SCR48 on.

The fluid level 18 continues to rise until the fluid 16 envelops the upper thermistor T_U causing the latter to cool. A resulting rise in resistance in the upper thermistor T_U causes the holding current to effectively cut off below the value needed to sustain the SCR48 in an on condition. Thus the SCR48 cuts off, de-energizing the solenoid winding S and causing the two-way solenoid valve 26 to vent the storage dewar 10 to atmosphere via the pneumatic line 28. This removes the pressure differential which causes the liquid therein to pass through the transfer tube 14 and thus the control cycle is complete. The cycle does not repeat until the fluid level 18 falls below the lower thermistor T_L .

In the embodiment of FIGURE 3, the initiation of the filling cycle is identical with that of the embodiment of FIGURE 2.

However, because of the second diode D2 and the memory characteristic of the winding S, the SCR48 will be held on during positive half cycles when the upper thermistor T_U is out of the fluid 16 and the lower thermistor T_L is immersed in the fluid 16. As soon as the upper thermistor T_U becomes immersed its impedance substantially increases such that on the next occurring positive half cycle of the source 36 the SCR48 is cut off.

Referring now to FIGURE 4, the operation is identical to that of FIGURE 3. However, certain variations may

be effected by means of the power switch 72 and the shunt switch 80.

By opening the power switch 72 during a filling cycle the fluid level 18 may be selectively positioned, since this causes the SCR48 to cut off by removing the energy supply thereto.

Additionally, even though the lower thermistor T_L is submerged in the fluid 16, the level 18 may be changed selectively by closing the shunt switch 80, shorting out the lower thermistor T_L and initiating the filling cycle.

The cycle may be permitted to terminate normally or the power switch 72 may subsequently be opened to selectively position the fluid level 18.

The on-off indicator is energized by the closing of the power switch 72, the resistor 78 acting to limit the current through the neon lamp 76.

A table of relative values for the circuit parameters of FIGURE 3 is as follows:

Elements:	Value or type
SCR48	2N2326.
S	General Controls K273DA4322BDE.
T_U and T_L	Carborundum T-1.
D1, D2, D3	1N441B.
R2	390 ohms 1 watt.
R4	7.5K 1 watt.
R5	1K ½ watt.
R6	43K ½ watt.
R8	7.5K 1 watt.
R9	250 ohms 10 watt.

As can be seen from the foregoing specification and drawings, this invention provides a new and novel liquid gas filling system with a novel silicon controlled rectifier control circuit utilizing the thermal conductivity characteristics of a pair of thermistors to effect upper and lower limits of operation and further utilizing the inherent memory characteristics of a controlled means to effect a holding on of the silicon controlled rectifier between said limits of operation.

It is to be understood that the several embodiments of the invention shown and described herein are for the purpose of example only and are not intended to limit the scope of the appended claims.

What is claimed is:

1. For use in a liquid gas filler system including a solenoid filler valve, having a solenoid winding therein, for effecting a transfer of liquid gas from a first container to maintain a fluid level in said second container between preselected upper and lower limits, a control circuit for said solenoid valve selectively energizing said solenoid winding in response to said fluid level comprising a power source supplying half-wave rectified power pulses to said circuit; first and second common power lines connected one on either side of said source; a first branch circuit across said power lines including first thermistor means adapted to be submerged in said liquid gas at said upper limit providing a maximum electrical resistance at said upper limit and a minimum electrical resistance at lesser fluid levels; a second branch circuit across said power lines including second thermistor means adapted to be submerged in said liquid gas above said lower limit providing a maximum resistance in response to fluid levels greater than said lower limit and a minimum resistance at or below said lower limit, and biasing means in series with said second thermistor means; a third branch circuit across said power lines including a silicon controlled rectifier, having an anode-cathode current path and a gate terminal, and said solenoid winding of said valve connected in series with said anode-cathode path; first circuit means connecting said gate terminal with said biasing means; and second circuit means connecting said first thermistor means in series with said anode-cathode current path of said controlled rectifier in the interim between said half-wave power pulses; said first circuit means, said gate terminal, said biasing means and said

5

second thermistor means rendering said controlled rectifier conductive and effecting energization of said solenoid winding in response to a fluid level less than said lower limit; said second circuit means, said first thermistor means and said solenoid winding cooperating to apply a holding current to said anode-cathode path and maintain the previously energized controlled rectifier continuously conductive when said fluid level is between said lower and upper limits.

2. The invention defined in claim 1, wherein said first branch circuit further includes diode means and resistance means connected at a first junction and in series with said first thermistor and said third branch circuit includes a second junction between said solenoid winding and said controlled rectifier, and said second circuit means comprising unidirectional conducting means interconnecting said first and second junctions.

3. The invention defined in claim 1, wherein said third branch circuit further includes resistance means in series with said solenoid winding and means including diode means in shunt with said resistance means and solenoid winding.

4. The invention defined in claim 1, wherein said third branch circuit further includes means including diode means in shunt with said solenoid winding and resistance means mutually in series therewith.

5. The invention defined in claim 1, wherein said control circuit further includes first switch means in shunt with said second thermistor and second switch means interconnecting said common lines and said source.

6. The invention defined in claim 1, wherein said first branch circuit further includes diode means.

7. For use in a means for maintaining the level of a liquid between an upper and a lower limit in a container, said means including storage means for said liquid and motive means for transferring said liquid from said storage means to said container, a control circuit for said motive means comprising a solenoid winding adapted to effect actuation of the said motive means; first thermistor means adapted to be submerged in said liquid at the upper limit thereof; second thermistor means adapted to be submerged in said liquid above said lower limit thereof; a power source; a silicon controlled rectifier means in circuit with said solenoid winding and said power source selectively controlling the flow of power from said power source through said winding; bias circuit means connected across said power source controlled by and including said second thermistor means, rendering said controlled rectifier means conductive and energizing said

6

winding when the level of the said liquid is below said lower limit; and holding circuit means including said first thermistor and said solenoid winding maintaining said controlled rectifier means conductive once the latter has been rendered conductive by said bias means and until the said liquid reaches its upper level.

8. The invention defined in claim 7, wherein said bias means further includes switch means selectively shunting said second thermistor to fire said controlled rectifier means when said fluid level is above said lower limit.

9. In a means for maintaining the level of a liquid in a container between upper and lower limits including solenoid means for selectively effecting a supply of liquid to said container, a control circuit for said solenoid means comprising a solenoid winding for said solenoid means, a power source, a first thermistor positioned at said upper limit and a second thermistor positioned at said lower limit in said container, both of said thermistors being connected across said source, silicon controlled rectifier means controlling said solenoid means and connected in circuit with said solenoid winding across said power source, bias means controlled by and including said second thermistor, in circuit with said power source and said controlled rectifier means firing said controlled rectifier means when the level of said liquid is below said lower limit, and holding means controlled by and including said first thermistor and said solenoid winding maintaining said controlled rectifier means on when the level of said liquid is between said upper and lower limits, subsequent to the firing of said controlled rectifier means.

10. The invention defined in claim 9, wherein said bias means further includes switch means selectively shunting said second thermistor to fire said controlled rectifier means when said fluid level is above said lower limit.

11. The invention defined in claim 1, wherein said second circuit means comprises unidirectional conducting means in series with said first thermistor means and said anode-cathode path of said silicon controlled rectifier and in shunt with a portion of said first branch circuit.

References Cited by the Examiner

UNITED STATES PATENTS

3,049,887	8/1962	Sharp et al.	62—51 X
3,050,611	8/1962	Kamide.	
3,084,708	4/1963	Herrero	137—392

ISADOR WEIL, *Primary Examiner.*

ROBERT A. O'LEARY, *Examiner.*