

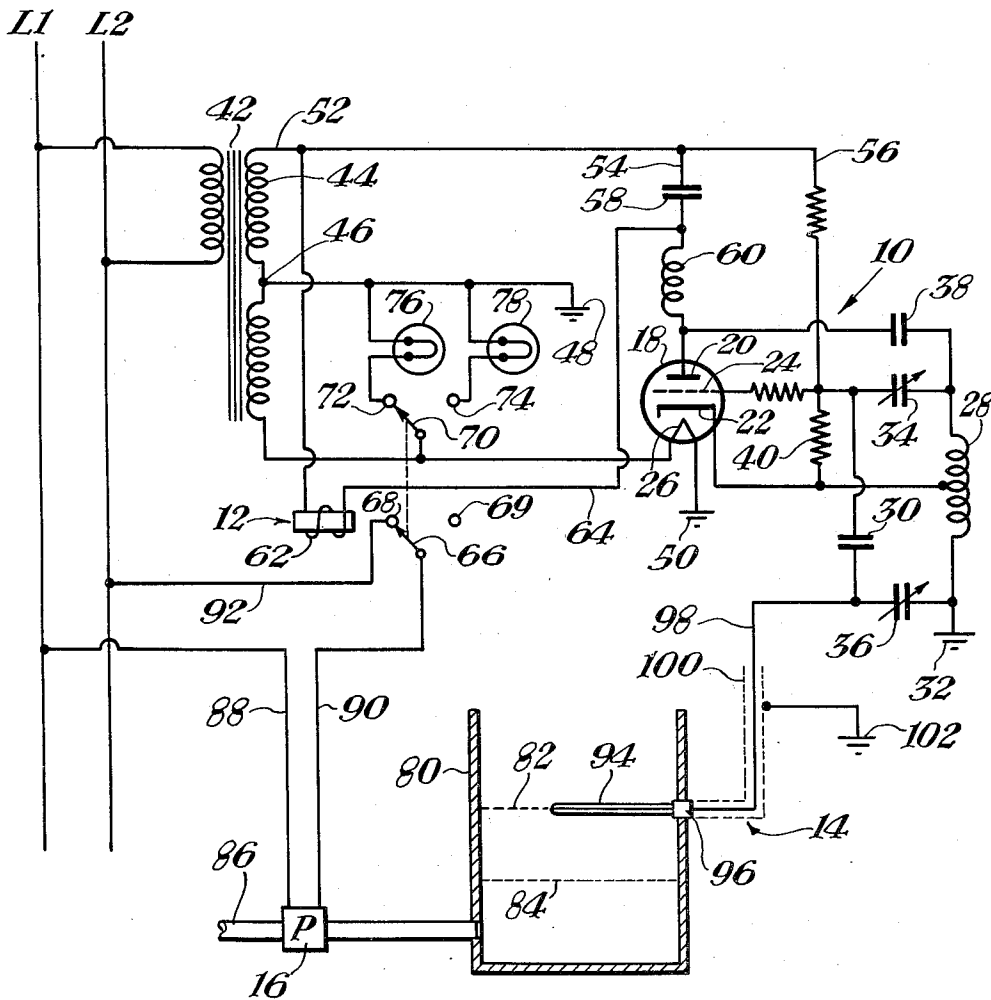
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CAPACITY SENSITIVE RELAYS

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CAPACITY SENSITIVE RELAYS

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This invention relates to capacity sensitive relays and more particularly to capacity type high level fail-safe control switches.

It is an object of this invention to control a relay for operating a pump in response to slight variations in a controlling capacity.

Another object of this invention is to prevent the possibility of a vessel running over in the event of line voltage failure or tube filament burn out.

Still another object of this invention is to indicate a high level in the event of line voltage failure or tube filament burn out.

With these and other objects in view, the invention may take the form of an oscillator circuit including an oscillatory tank circuit coupled to an electron discharge tube with a source of alternating voltage for the anode of the electron discharge tube. A work circuit including a relay is connected in the anode circuit of the discharge tube and serves to operate a pump switch and an indicator light depending upon the normal operation of the device. A capacity sensitive probe is connected to the oscillatory tank circuit and is utilized to pick up the stray capacitance which varies according to the level of the fluid in a vessel thereby varying the feedback generated in the tank circuit. Relay operated switches are affected by the current developed in the anode circuit to cause a high level indication. With this arrangement, operation of the pump is prevented in the event of circuit failure caused by power failure or tube filament burn out, such failure being indicated as high level.

Other objects and advantages will become apparent from the following specification taken in connection with the accompanying drawing in which the single figure is a diagrammatic showing of the essential elements of a capacity sensitive relay embodying this invention.

Referring more particularly to the drawing, the system embodying this invention is shown as comprising an oscillator circuit 10 controlling the operation of a relay 12, a probe 14 for picking up stray capacitance for the oscillator circuit 10 and a pump 16 operable in response to the energization of the relay 12.

The oscillator circuit 10 comprises an electron discharge tube 18 having an anode 20, cathode 22, grid 24 and cathode heater 26. Coupled to the electron discharge tube 18 is an oscillatory tank circuit consisting of a coil 28 connected in parallel with a capacitor 30, one end of the coil 28 being grounded at 32. Completing the tank circuit are capacitors 34, 36 connecting the ends of the coil 28 to the parallel circuit of capacitor 30. The cathode 22 of the tube 18 is connected to a center tap in the coil 28. The anode 20 of the tube 18 is coupled to one end of the tank circuit through a blocking capacitor 38. Interposed between the grid 24 and capacitors 30, 34 is that grid leak resistor 40.

Power is supplied to the oscillator circuit 10 by a transformer 42, the primary winding of which is connected across a source of alternating current supply and indicated by lines L1, L2. A secondary winding 44 of the transformer 42 has a tap 46 grounded at 48. One terminal of the secondary winding 44 is connected to the cathode heater 26 and thence grounded at 50 while the other terminal 52 is coupled to the oscillator circuit 10 by a lead 54 to the anode 20 and by a lead 56 to the center tap of the coil 28. A suitable capacitor 58 and a

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small R. F. choke 60 are in series in this anode circuit. The terminal 52 of the secondary winding 44 is also connected to the anode 20 of the electron discharge tube 18 through the exciter coil 62 of the relay 12 thence through the lead 64 to the anode circuit and connected thereat between the capacitor 58 and the choke 60.

As is shown in the drawing, the relay 12 is equipped with a movable contact 66 which engages a fixed contact 68 to operate the necessary pump circuit to be described hereinafter, when a change occurs in a condition of the oscillator circuit 10. Mechanically coupled to the movable contact 66 is a second movable contact 70 which engages either one of two fixed contacts 72, 74 of an indicator system including a high level red lamp 76 and a low level green lamp 78, respectively. A suitable lead connects fixed contact 72 to the lamp 76 and another suitable lead connects fixed contact 74 to the lamp 78. Suitable leads complete the indicator circuit to the center tap of the secondary winding 44.

The control apparatus of this invention may be of the usual industrial type comprising a closed container 80 wherein 82, 84 represent various levels of fluid in the container and the supply pipe 86 supplying the container 80 from any suitable source (not shown). The pump 16 is interposed in the pipe 86 and serves to pump fluid in the container at predetermined conditions to be described hereinafter. The pump 16 may be of any well-known type having a conductor 88 connected to supply line L1 and another conductor 90 connected to the movable contact 66 of the relay 12. The conductor 92 completes the relay and pump circuit to the source of electrical supply.

That portion of the mechanism of the invention which constitutes the control mechanism therefor, and may be located at a point near the top portion of the closed container 80 is as follows: Mounted on the closed container 80 is the probe 14 having its electrode 94 secured thereto by any suitable insulated mounting means 96. The electrode may consist of a bare extremity exposed to the atmosphere above the fluid level and may be of any desired construction. A conductor 98 connects the electrode 94 to the oscillator circuit 10 and is shielded by a shield 100 which is grounded at 102. The capacitance between the electrode 94 and the ground is effectively in parallel with the capacitor 36 and is the varying element of the inductance-capacitance bridge circuit consisting of the capacitors 34, 36, 30 and the two portions of the coil 28.

Operation

Assuming that the fluid level in the closed container 80 is at level 84 and the green lamp 76 is energized for indicating the closed pump circuit and the low level of the fluid, the impedance ratio of capacitors 34, 36 is greater than the impedance ratio of the two halves of coil 28 and the positive feedback to the tank circuit is insufficient to sustain oscillation. Since discharge tube 18 is not oscillating, it is conducting current at its maximum rate thereby energizing relay 12 so that the movable contact 66 engages the fixed contact 68. This allows a continuing source of electric current to energize the pump 16 and fluid continues to flow into the container 80. As the fluid level rises toward the electrode 94, the capacitance between electrode 94 and ground increases because the surrounding air having a dielectric constant of (1) is replaced by a material of some higher dielectric constant. The increase of capacitance between electrode 94 and ground being effectively added to capacitor 36 decreases the impedance ratio of capacitors 34, 36. When the level of the fluid reaches level 82 and is in contact or near contact with the electrode 94, the impedance ratio between the two halves of the coil 28 becomes

greater than the impedance ratio of the capacitors 34, 36 whereby a positive feedback is generated and the grid 24 will be supplied with alternating potential of the proper phase to initiate and sustain oscillation. The oscillation develops a grid leak bias on the resistor 40 which greatly reduces the anode current of the discharge tube 18 causing the deenergization of the relay 12 where it follows that the movable contact 66 will become disengaged from the fixed contact 68 and the movable contact 70 thereupon will be rotated from the fixed contact 72 to the fixed contact 74. From this it is obvious that the circuit to the pump 16 is open and the red indicator lamp 78 energized while the green indicator lamp 76 is deenergized.

The control apparatus of the invention operates as a capacity type high level fail-safe control switch since in the event of power failure or filament tube burn out, the relay 12 will be deenergized or remain in its deenergized position. The level of the fluid in the container 30 will appear to be at the level 82 regardless of its actual level in the container, such appearance being indicated by the red lamp 78. In either event, that is, if the level of the fluid is at 82, or there is a failure in the circuit, the operator of the control apparatus will be warned that the tank is either filled or that the system is inoperative without experiencing the danger of an overflowing container.

It will be apparent to those skilled in the art that many modifications of the disclosed embodiment of this invention may be made without departing from the scope thereof, which is to be measured by the appended claims.

We claim:

1. In a device for controlling the level of flowable material in a container, the combination comprising an oscillator circuit including an anode, a cathode, a grid and a tank circuit, a source of voltage connected to said anode, a probe capacitor operatively connected to said tank circuit and sensitive to variations in the level of said flowable material to decrease the conductivity of said tube with increase in the level of said flowable material in said container, a relay circuit connected to said anode and including a control switch operable to a closed position for supplying flowable material to said container in response to an increase in conductivity of said tube, an indicating circuit connected to said source including electric indicating means and a switch connected to control energization of said indicating means, and means including said relay circuit for actuating the last said switch to energize said indicating means.

2. In a device for controlling the level of flowable material in a container, the combination comprising an oscillator circuit including an anode, a cathode, a grid and a tank circuit, a source of voltage connected to said anode, a probe capacitor operatively connected to said tank circuit and sensitive to variations in the level of said flowable material to decrease the conductivity of said tube with increase in the level of said flowable material in said container, a relay circuit connected to said anode and including switch means operable from one position to another in response to a decrease in the conductivity of said tube, means including said switch means for supplying flowable material to said container in response to an increase in conductivity of said tube, and means including said switch means for indicating the level of flowable material in said container.

3. In a device for controlling the level of a flowable material in a container and having a source of voltage, the combination comprising an oscillator circuit including an electron discharge tube having an anode, a cathode, a grid and a tank circuit, means including an inductive member for connecting said anode to the source, capacitive means connecting said anode to said tank circuit, a probe capacitor associated with said tank circuit and sensitive to variations in the level of the material to decrease the conductivity of said tube in response to an

increase in the level of the material and to increase the conductivity in response to a decrease in the level of the material, a relay circuit connected to said anode including a switch operable to a closed position for supplying flowable material to the container in response to an increase in conductivity of said tube, and indicating circuit connected to the source and including first and second indicating lamps, and a second switch for controlling said indicating circuit associated with said relay circuit and having a first position for energizing said first lamp and a second position for energizing said second lamp, said second switch being operative from said first position to said second position in response to an increase in the conductivity of said tube.

4. In a device for controlling the level of a flowable material in a container and having a source of voltage, the combination comprising an oscillator circuit including an electron discharge device having an anode, a cathode and a grid, an oscillatory tank circuit operatively connected to said grid and including an inductive member having one end thereof connected to one side of the source, means including inductive means for connecting the other side of the source to said anode, capacitive means for connecting said anode to the other end of said inductive member, means for connecting the electrical center of said tank circuit to said cathode, a probe capacitor operatively associated with said tank circuit and sensitive to variations in the level of said material to decrease the conductivity of said tube in response to an increase in the level of the material and to increase the conductivity in response to a decrease in the level of the material, a relay circuit connected to said anode including a switch operable to a closed position for supplying flowable material to the container in response to an increase in conductivity of said tube, an indicating circuit connected to the source including first and second indicating lamps, and a second switch for controlling said indicating circuit associated with said relay circuit and having a first position for energizing said first lamp and a second position for energizing said second lamp, said second switch being operative from said first position to said second position in response to an increase in the conductivity of said tube.

5. In a device for controlling the level of a flowable material in a container and having a source of voltage, the combination comprising an oscillator circuit including an electron discharge device having an anode, a cathode and a grid, an oscillatory tank circuit operatively connected to said grid and including an inductive member having one end thereof connected to one side of the source, a choke means connecting said anode to the other side of the source, a by-pass capacitor connecting said anode to the other end of said inductive member, means for connecting the electrical center of said tank circuit to said cathode, a probe capacitor operatively associated with said tank circuit and sensitive to the variations in the level of the material to decrease the conductivity of said tube in response to an increase in the level of the material and to increase the conductivity in response to a decrease in the level of the material, a relay circuit connected to said anode including a switch operable to a closed position when said tube is conducting, said switch being operative to control the supply of flowable material to said container, and means to indicate the energization of said relay when the level of said flowable material reaches a point adjacent said probe.

References Cited in the file of this patent

UNITED STATES PATENTS

70	2,635,225	Hadady	Apr. 14, 1953
	2,655,933	Odell	Oct. 20, 1953
	2,763,283	Griffith et al.	Sept. 18, 1956

FOREIGN PATENTS

75	663,643	Great Britain	Dec. 27, 1951
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