Nov. 25, 1952 W. E. PAKALA 2,619,617

VAPOR-ELECTRIC DEVICE

Filed March 9, 1949 2 SHEETS—SHEET 1

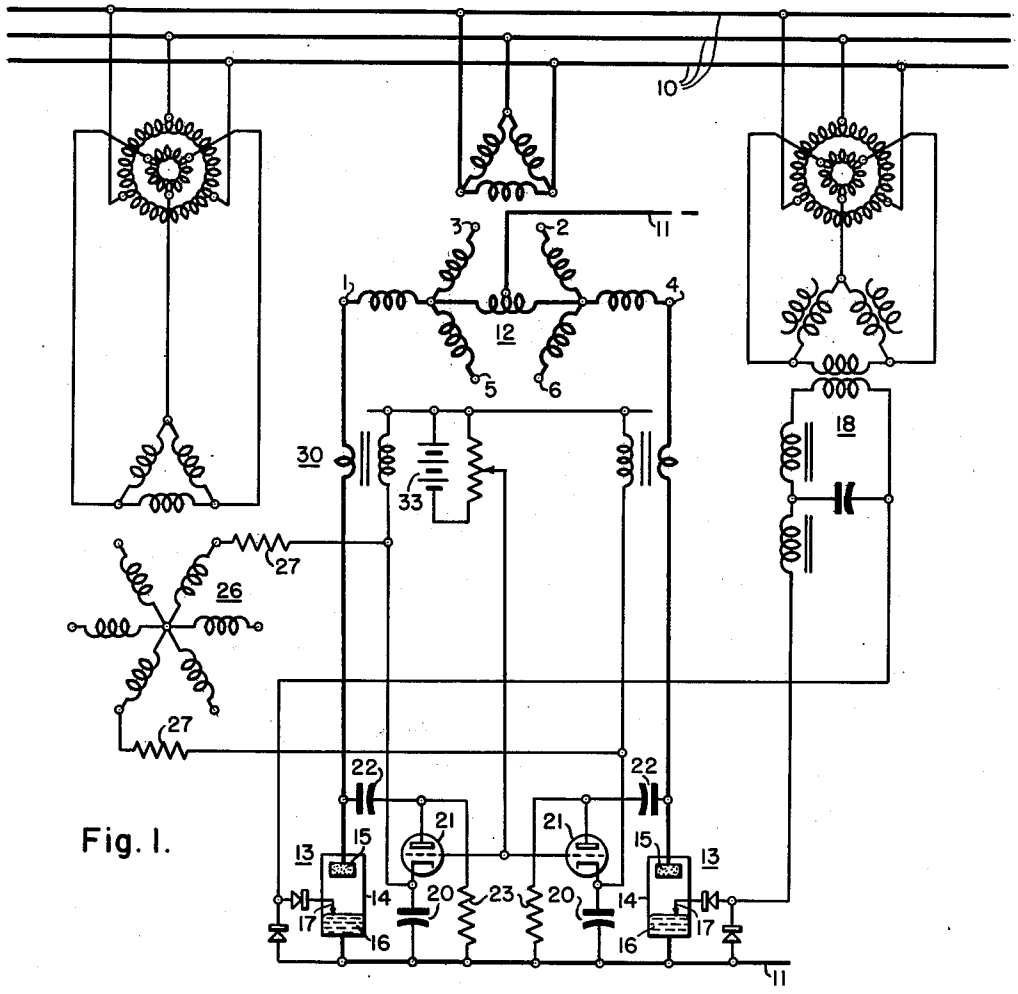


Fig. 1.

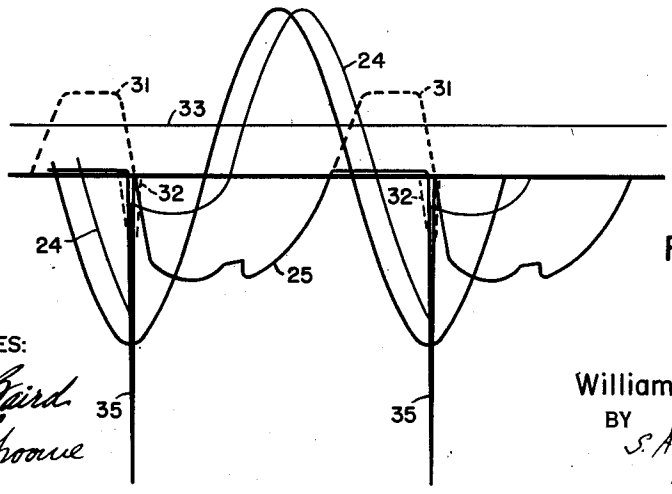


Fig. 2.

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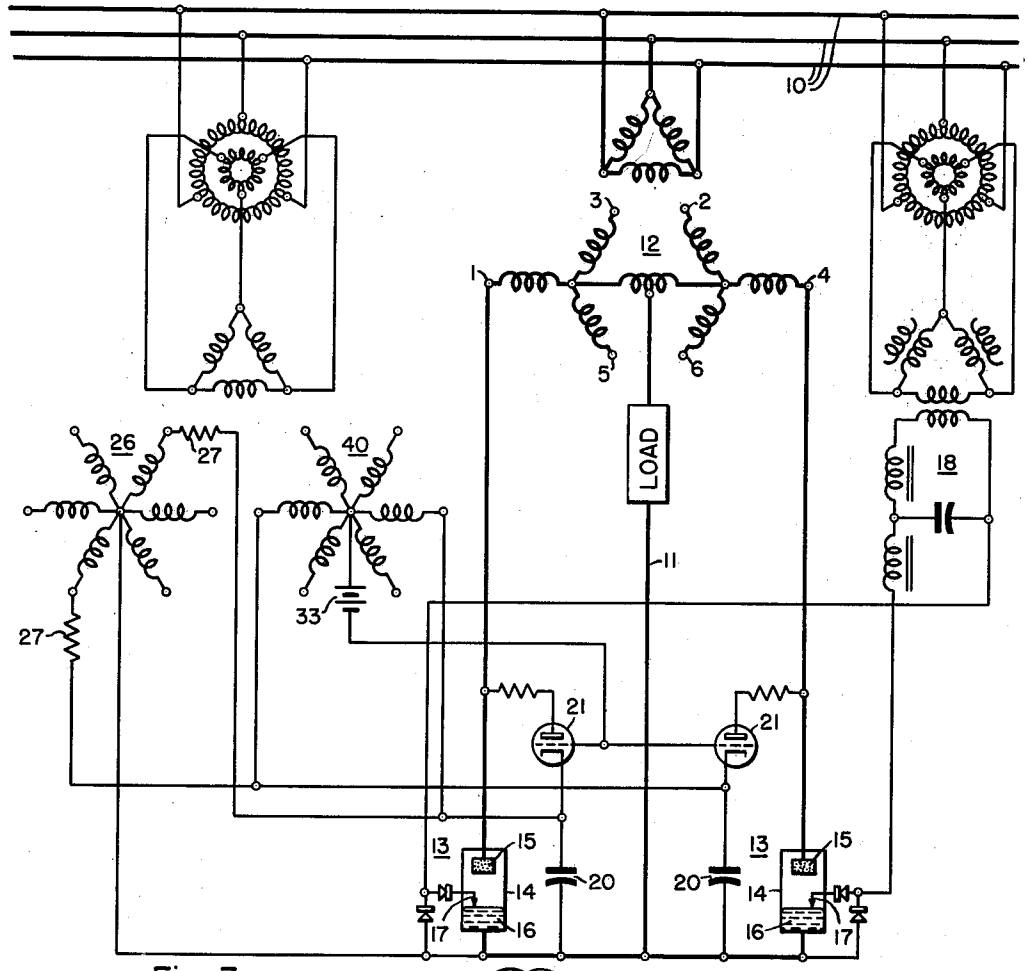


Fig. 3.

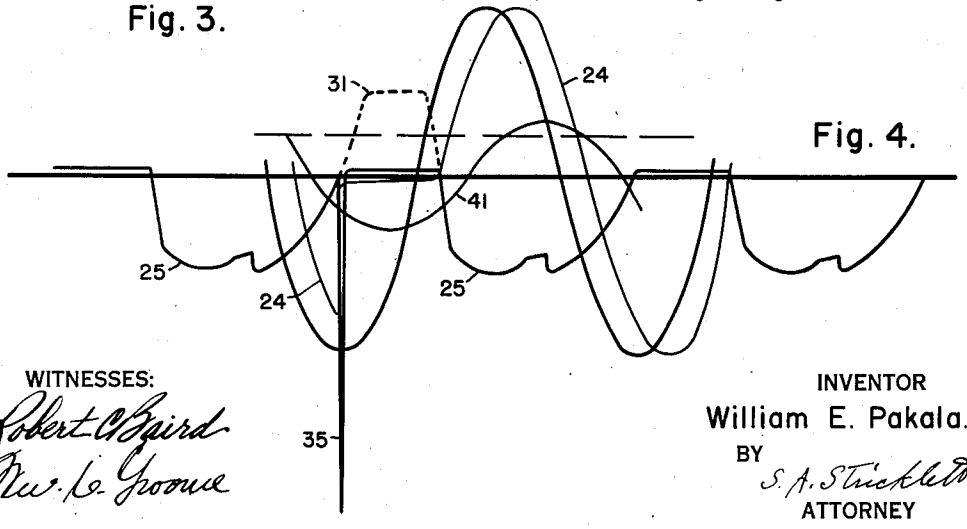


Fig. 4.

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VAPOR-ELECTRIC DEVICE

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4 Claims. (Cl. 315—171)

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My invention relates to a vapor-electric device, and particularly to a method and apparatus for reducing the probability of arc-back in a vapor-electric valve.

The most serious difficulty encountered in the operation of vapor-electric valves is the tendency of such valves to arc back at random times. Experiments have indicated that these arc-backs are probably the results of so-called arc-back causes established at the surface of the anode; and while these arc-back causes are not exactly known, they are believed to be the result of contamination of the surface of the anode. Experiments have indicated that these arc-back causes may be burnt off or eliminated when an inverse discharge is established to the anode for a period of the order of five microseconds—or rather between three and ten microseconds and do not reappear. In a series of five hundred experiments, only one arc-back cause was found to exist after an inverse discharge lasting approximately five microseconds.

According to my invention, I provide apparatus for causing inverse negative pips or discharges having a time of the order of five microseconds during each of the scheduled non-conducting intervals of the valve. Preferably, these negative pips occur either at the beginning or the end of the non-conducting interval although apparently they will be effective regardless of the time during the interval at which they are applied. In the apparatus according to my invention, a capacitor is connected across the anode and cathode of the electric valve, and this capacitor is charged to a potential substantially twice the normal inverse potential appearing between the anode and cathode; that is, the potential appearing during the normal non-conducting period of the valve. A grid control valve is placed in series with the anode and cathode of the valve, and the capacitor to control the time of discharge of the capacitor, through the vapor-electric valve.

It is, accordingly, an object of my invention to provide a method of reducing the probabilities of arc-back in a vapor-electric valve.

It is a further object of my invention to provide apparatus for producing negative pips in a vapor-electric valve.

It is a further object of my invention to provide a system for applying timed negative discharges in a vapor-electric valve.

Other objects and advantages of my invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

Figure 1 is a schematic illustration of a preferred embodiment of my invention;

Figure 2 is a diagrammatic illustration of the currents and voltages involved in the apparatus in Figure 1;

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Figure 3 is a modification showing independent timing of the negative pips; and

Figure 4 is a diagrammatic illustration of the potentials and currents existing in the modification according to Figure 3.

In an exemplary embodiment of my invention according to Figure 1, an alternating-current circuit 10 is connected to a direct-current circuit 11 by means of a rectifier transformer 12, and the flow of current between the circuits 11 and 10 is controlled by means of vapor-electric valves 13 connected to the terminals 1 to 6 of the rectifier transformer 12.

For simplicity of illustration, only two of the vapor-electric valves 13 are illustrated, but it is apparent that valves 13 will be attached to all of the valve terminals 1 to 6 of the transformer 12. In the illustrated embodiment of vapor-electric valves, each valve 13 comprises a container 14 having therein a main anode 15, a vaporizable, reconstructing cathode 16 and a make-alive electrode 17. Associated with the make-alive electrodes is an impulsing system 18 preferably of the so-called saturable reactor type.

Connected in shunt with each of the vapor-electric valves 13 is a capacitor 20 having in series therewith a grid control valve 21 by which the potential of the capacitor 20 may be discharged between the anode 15 and cathode 16 of the vapor-electric valve 13. Preferably, a blocking capacitor 22 is installed in series circuit relation between the control capacitor 20 and the anode and cathode circuit to produce a definite termination of current flow in the protective circuit. Usually a discharge resistor 23 is connected to dissipate the charge received by the blocking capacitor 22.

Preferably, the control capacitor 20 is charged to a potential 24 substantially double the normal potential 25 appearing between the anode 15 and cathode 16 during the inverse or non-conducting interval. The potential 24 may most readily be supplied from a periodic source herein indicated as a polyphase transformer 26 supplied from the alternating-current circuit 10. Usually charging impedances 27 are placed between the terminals of the periodic source of potential 26 and the capacitors 20 to control the rate of charge of the capacitors 20.

In the preferred embodiment, the discharge of the control capacitor 20 is established by means of a transformer 30 associated with the anode conductor so that the decay or termination of the normal anode current 31 will produce a potential 32 which will render the grid of the grid control valve 21 positive and permit the discharge of the capacitor 20 in an inverse direction between the anode 15 and cathode 16 of the vapor-electric device 13. If necessary to control the timing, a biasing potential 33 may be inserted between the

current-controlled transformer 30 and the grid of the grid control valve 21.

In the operation of a protective system according to Figure 2, the periodic control potential 24 will be applied to the control capacitor 20 charging up the capacitor 20 to a potential substantially twice the normal inverse potential 25 of the valve 13. At the termination of the normal anode current 31, the decay of the anode current will produce a voltage pip 32 in the control transformer 30 which will overcome the bias 33 and trip the grid of the grid control valve 21 permitting the discharge of the capacitor 20 to produce a high-current impulse 35 of very short duration usually of the order of three to five microseconds. In operation, this discharge 35 burns off or dissipates the backfire causes and then is itself extinguished before an inverse current can be established in the power circuits feeding the vapor-electric valves 13. In other words, the brief negative impulse is applied during the normally non-conducting period of the main power-circuit, preferably near the beginning or end of said normally non-conducting power-circuit period, that is, at a time when the inverse voltage of the main power-circuit is near zero, or low enough not to sustain the arc formed by the brief negative impulse, the duration of the normally non-conducting power-circuit period being much longer than the impulse-period. Usually, the normal inductance of the anode leads and the transformer windings is such that no inverse current can start in a period less than ten microseconds. However, in the event a low-impedance transformer 12 should for some reason be utilized, the time interval could readily be lengthened by providing a reactor (not shown) in the anode circuit.

In the modification according to Figure 3, the firing circuit has been made totally independent of the anode current so that if desired the negative pips 35 may be established at any time interval such as the termination of the normal inverse period. While it is not known when or how the backfire causes are established, it is believed that they are established during a normal non-ionized and non-conducting interval in the valve 13. Consequently, it may be desirable in some instances to have the negative pips 35 preceding the normal conducting interval. This may be particularly true in inverters.

The control for the grids of the valves 21 is provided by an auxiliary winding 40 on the transformer 26 and instead of impulses 32 the firing potential may be of substantially sine wave form as shown at 41.

In the operation of this modification, the phase is adjusted so that the discharge of the capacitor 20 occurs at any desired point in the non-conducting interval and preferably near the end of the non-conducting interval. The inverse discharge then burns off or dissipates any arc back causes that may have accumulated during the preceding cycle.

For the purpose of illustration, I have shown and described exemplary embodiments of my invention and described the same to the best of my present knowledge, but it will be apparent that changes and modifications can be made therein without departing from the true spirit of my invention or the scope of the appended claims.

I claim as my invention:

1. A de-contamination system for a vapor-electric valve having a main anode and cathode subject to an alternating potential and having alternate conducting and normally non-conducting periods with inverse potential between said cathode and anode during said non-conducting period comprising a source of auxiliary potential, circuit means including a grid-controlled electric valve applying said auxiliary potential inversely between said anode and cathode and grid control means for periodically energizing said grid-controlled electric valve to produce a short time discharge of said auxiliary source inversely between said cathode and anode during the normally non-conducting period.

2. In a vapor-electric device having a main anode and cathode subject to alternating potentials, an arc-back restraining system comprising a source of potential having a value in excess of the normal back voltage impressed on the anode, and an electric valve connected to impress the potential of said source in the reverse direction between said cathode and anode for an interval of the order of five microseconds during a normally non-conducting interval in said valve.

3. A de-contamination system for a vapor-electric valve having a main power-circuit including a main anode and cathode subject to a power-circuit alternating potential and having alternate conducting and normally non-conducting periods with inverse potential between said cathode and anode during said non-conducting period, comprising a source of auxiliary potential, circuit means including a grid-controlled electric valve for applying said auxiliary potential inversely between said anode and cathode, and grid control means for periodically energizing said grid-controlled electric valve to produce a short time discharge of said auxiliary source inversely between said cathode and anode during the normally non-conducting power-circuit period at a time in said power-circuit period when the inverse power-circuit voltage is near zero, the duration of said normally non-conducting power-circuit period being much longer than the duration of said short-time discharge.

4. In a vapor-electric device having a main power-circuit including a main anode and cathode subject to alternating main-circuit potentials, an arc-back restraining system comprising a source of potential having a value in excess of the normal main-circuit back-voltage impressed on the anode, and an electric valve connected to impress the potential of said source in the reverse direction between said cathode and anode for an impulse-interval of the order of five microseconds during a normally non-conducting power-circuit interval in said valve at a time in said power-circuit interval when the normal main-circuit back-voltage is low, the duration of said normally non-conducting power-circuit interval being much longer than the impulse-interval.

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