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SINGLE TUBE BINARY COUNTER

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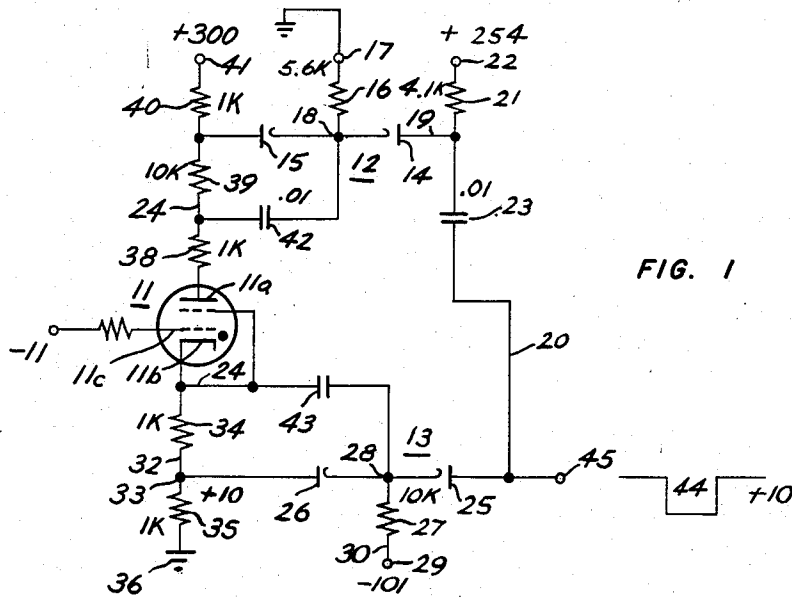


FIG. 1

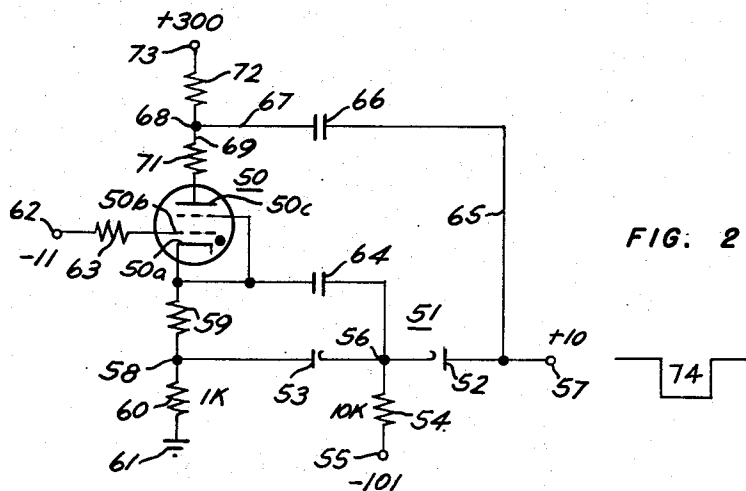
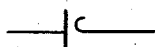


FIG. 2

KEY



Asymmetrical Conducting Element
(e.g. Thermionic or Crystal Diode)

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SINGLE TUBE BINARY COUNTER

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1 This invention relates in general to electronic computing apparatus, and is directed in general to the provision of an improved binary counting circuit which will effect a substantial simplification and elimination of circuit components hitherto deemed essential.

Before describing the functions and objectives attained in accordance with the precepts of the invention, it may be pointed out that in modern electronic computing apparatus, an enormous number of vacuum tubes are customarily employed with a corresponding complexity of circuitry, increased liability of component failure and heavy current consumption. As is well known, the average vacuum tube has a comparatively limited life, in view of the deterioration and/or failure of the filament and cathode elements. Replacements of the tubes on an extensive scale, therefore, it will be understood, are frequently required.

Recently, a reduction in the number of vacuum tubes used in electronic computing apparatus has been made possible, by substituting crystal diode rectifiers wherever feasible. Nevertheless, the associated circuits of the electronic computing apparatus still require many thousands of these tubes and the saving, therefore, made possible by the teachings of the present invention, will be appreciated in view of the many parallelisms of circuitry throughout the computing apparatus.

A salient object of the invention is to provide a single tube binary counter which will perform the functions of the customary two-tube binary counter.

Another object is the provision of a single tube binary counter having a single rectifier gate.

Another object is the simplification of the circuitry in electronic computing apparatus.

A further object is to effect a substantial saving in cost and material in electronic computing apparatus, whereby a single electron tube, optionally employing one or two rectifier gates in accordance with this invention, may perform all the functions of a conventional two-tube binary counter with its several rectifier gates.

Other objects and advantages residing in the novel circuitry and in the arrangement and disposition of parts will appear as the description proceeds and will be best understood when taken in connection with the accompanying drawings wherein:

Figure 1 is a diagrammatic representation of a single tube binary counter embodying one form of the invention; and

Figure 2 is a modified form of the circuit illus-

2 trated in Figure 1 and showing a further simplification and the elimination of additional components while achieving an efficient operative assembly.

Approximate values of potentials, resistances and capacities employed are designated in the drawing for convenience of understanding of the circuitry.

Referring now to the drawings wherein similar reference characters indicate corresponding parts, the numeral 11 designates an electron tube, such as a thyatron, having operatively coupled thereto a pair of crystal diode gates, designated generally at 12 and 13, respectively.

The gate 12 includes a pair of conductively coupled crystal diodes 14, 15, and the resistor 16. One terminal of the resistor 16 is connected to ground 17, and the other terminal to a point 18 common to the cathode terminals of the two diodes.

The diode 14 has an anode terminal connected to a lead from an input conducting line 20 which is connected in turn through a resistor 21 to a source of high potential, as at 22. The input line includes a coupling capacitor 23 in series therewith. The anode terminal of diode 15 is connected to a conductor 24 associated with the anode 11a of the thyatron 11, as hereinafter described.

The gate 13 also has a pair of conductively coupled crystal diodes 25, 26 and includes the resistor 27. The common junction point 28 of the cathodes of the diodes 25, 26 is biased from a source of negative polarity 29 through lead 30 and resistor 27. The anode terminal of the diode 25 is connected to the input conducting line 20.

The anode of crystal diode 26 is connected to a lead 32 associated with the cathode 11b of the thyatron at a junction point 33 located between two serially connected resistors 34, 35 on the same lead. The upper terminal of resistor 34 is directly connected to the cathode 11b of the thyatron, while the lower terminal of resistor 35 is connected to ground 36.

The anode 11a of the thyatron, whose control grid 11c is negatively biased from a suitable source 37, is connected to an adjacent terminal of a resistor 38 whose other terminal is connected to the serially associated resistors 39, 40, respectively on the conductor 24. The outer terminal of the resistor 40 connects to a positive source of high potential 41 which may be, for example, 300 volts.

Capacitive coupling, between gate 12 and anode 11a of the thyatron 11 and between gate 13

and the cathode 11b of the thyatron, is provided in the following manner:

In the case of gate 12, a coupling capacitor 42 is connected from junction point 18 between the cathodes of diodes 14, 15 across to the upper terminal of the resistance 38 connected to the anode 11a of the thyatron.

In the case of gate 13, a coupling capacitor 43 is connected from point 28 common to the cathodes of the two diodes 25, 26, to the cathode 11b of the thyatron.

The function and operation of the single tube binary counter has been in large measure indicated above, but may be summarized as follows:

Before energization, the thyatron 11 is in an initial nonconducting or zero state, the control grid 11c having been previously returned to cut-off bias. The power may now be assumed to be switched on. Prior to a pulse, the point 33 will be slightly negative, the control grid 11c, as noted, being at cut-off bias and no current flowing from the anode of the thyatron. Point 33, therefore, will be at a potential ineffective to inhibit the negative gate 13 formed by the crystal diodes 25, 26 and resistor 27.

Upon the occurrence of a negative pulse, indicated schematically at 44, via the input post 45 and conducting line 20, the tendency to lower the potential at point 18 and pass current through resistor 16 of the gate 12 will be checked at resistor 45 because of the latter's comparatively high positive potential connection, and no pulse, accordingly, will be coupled through capacitor 42 to the anode of the thyatron.

However, the negative pulse will pass through gate 13 at the cathode of the thyatron and be coupled through capacitor 43 to the said cathode. When the potential of the cathode is thus lowered, the thyatron will fire and its grid 11c will lose control. The circuit will thus have attained its second stable state.

Inspection and consideration of the two gates; viz., 12 and 13 described above will now make clear that, since at the second stable state the cathode 11b is at high potential and hence point 33 at high potential also, the cathode gate 13 is inhibited to negative pulses. At the same time, the anode gate 12 is no longer capable of inhibiting the input pulse because the gate input (diode 15) is at a lowered potential. Thus the next negative pulse will be coupled to the anode, but not to the cathode, and will lower the said anode below conduction level of the thyatron. The general circuit will now return to its original condition. Further pulses will merely continue the cyclic permutation indicated. It will be understood that it is only necessary that the pulse applied continue long enough for recovery time (not deionization time) in order that the grid may regain control and the tube return to its original condition.

The form of the invention shown in Figure 2

The modified form of the invention not only achieves the saving of component parts effected by the first form of the invention described above, but in addition, by its novel functioning and circuitry further permits the elimination of one of the two rectifier gates and of the components normally associated with the eliminated gate. The simplification of circuitry and the actual elimination of parts will be observed at first glance by comparison of the first form of the invention shown in Figure 1 with the simplified form of Figure 2.

Referring to the modified form of the invention, the numeral 50 designates the electron tube, which may be, as in the first form, a thyatron. The thyatron has coupled thereto a rectifier gate designated generally at 51 and including the serially connected crystal diodes 52, 53 and the resistor 54.

The resistor 54 is negatively biased from a source of potential 55 and is connected to the said diodes at a point 56 common to the cathodes of both. The anode terminal of diode 52 is on the input conducting line 57 while the anode terminal of diode 53 is connected at point 58 between the two resistors 59, 60, joined in series, the last-named resistor 60 being grounded at 61.

The upper terminal of resistor 59 connects with the cathode 56a of the thyatron whose grid 56b is normally biased from a source of negative polarity at 62 and through the resistor 63.

The input conducting line 57, which may have a positive potential of, for example, 10 volts, is connected through diode 52, junction point 56 and coupling capacitor 64 to anode 56a; and is also connected, via conductor 65 and coupling capacitor 66 and lead 67 to a junction point 68 on a lead 69 joining two serially connected resistors 71, 72.

The outer or lower terminal of resistor 71 is joined to the anode 56c of the thyatron, while the outer terminal of the resistor 72 is associated with the source of high potential 73.

The operation of the circuit embodying the modified form of the invention depicted in Figure 2 may be briefly explained as follows:

Assuming the electronic valve 50 to be in a nonconducting state with grid 56b at cut-off bias and point 58 at ground potential and further assuming the operating potentials indicated have been applied, a negative pulse, as indicated schematically at 74, via coupling capacitor 68 and resistor 72, arriving at the anode 56c will be inhibited by virtue of the high potential of the latter. Consequently, the thyatron will remain nonconductive.

As in the case of the first form of the invention, however, a negative pulse of proper potential will pass through gate 51 and coupling capacitor 64 and be operatively applied to the cathode 56a, thereby lowering the potential of the latter and consequently relatively raising the potential of grid 56b. The thyatron will now fire and the grid 56b will lose control. The circuit, in this manner, will attain its second stable state, with the cathode at comparatively high potential and inhibitive to negative pulses. At the same time, since the anode 56c, by reason of the potential drop across the resistor 72 is now at lowered potential and, therefore, now susceptible to reduction below conduction level of the thyatron, the next negative pulse will extinguish the thyatron and the circuit will return to its original condition.

While the invention has been described with particular reference to an ordinary type of thyatron, it will be understood that it is equally adaptable with other types of tubes such as so-called hard or highly evacuated electron tubes, with appropriate substitutions of conventional circuit components.

It will, of course, be understood that the description and drawings herein contained are illustrative merely, and that various modifications and changes may be made in the structure

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disclosed without departing from the spirit of the invention.

What is claimed is:

1. In signal responsive apparatus, in combination, an electric valve, said valve having anode, cathode and grid elements, a first gate connected to said anode, a second gate connected to said cathode, and circuit components associated with said gates and elements and effective to apply a pulse alternately to said anode and said cathode.

2. In signal responsive apparatus, comprising an electric valve, said valve having anode, grid and cathode elements, a single gate electrically connected to the anode and to the cathode elements, and a circuit associated with said gate, cathode and anode elements and effective to alternately energize and de-energize the said tube.

3. In signal responsive apparatus, an electric valve having a cathode, a control electrode and an anode, a control signal line, a first gate controlled by the potential of said anode governing the passage of signals from said signal line to said anode, and a second gate controlled by the potential of said cathode governing the passage of signals from said signal line to said cathode.

4. In signal responsive apparatus, in combination, an electric valve, said valve having anode, grid and cathode elements, a circuit associated with said elements and having a single rectifier gate, a pair of diodes included in said gate, a plurality of sources of potential operatively applied to said elements, a capacitor member associated with said anode element, a second capacitor associated with said cathode element, and resistances associated with said capacitors; said circuit being effective to apply negative pulses to the anode and alternately to the cathode.

5. A single tube binary counter comprising, in combination, a thyatron, said thyatron having

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anode, grid and cathode elements, a first gate connected to the anode element, a second gate connected to the cathode element, an input conductor electrically connected to said cathode and anode elements and effective to apply a negative pulse to said last-mentioned elements in alternation, and a plurality of sources of potential connected to said anode, grid and cathode elements.

6. A single tube binary counter comprising, in combination, a thyatron, said thyatron having anode, grid and cathode elements, a circuit associated with said elements and including a pair of gates, and a plurality of sources of potential applied to and biasing the said elements to predetermined initial voltages, said circuit being responsive to input pulses and effective to alternately flip the thyatron from one stable state to another with each input pulse.

7. In a signal responsive device, an electric valve having an anode, a control element and a cathode, a control signal line, a reactor connecting said control signal line with said anode, a cathode, potential controlled gate connecting said control signal line with said cathode, and circuit connections for applying an exciting potential between said cathode and anode.

8. In signal responsive apparatus, an electric valve having an anode, control element and cathode, a control signal line, an anode potential controlled gate reactively coupling said control signal line with said anode, a cathode potential controlled gate reactively coupling said control signal line with said cathode, and circuit connections for applying an exciting potential between said cathode and anode.

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