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Utility model

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[54] Title: CONTROL DEVICE WITH HIGH-EFFICIENCY COLD CATHODE FLUORESCENT LAMP

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[57] Claims:

1. A control device with a high-efficiency cold cathode fluorescent lamp, comprising: a Royer oscillation circuit, a cold cathode fluorescent lamp, current feedback and a pulse width modulation controller, the control device used for starting the cold cathode fluorescent lamp, wherein an input end of the Royer oscillation circuit is connected to a switch, the switch receives a signal of the current feedback, and the pulse width modulation controller generates a state to cause the switch to be turned on and off (ON/OFF), resulting in an oscillation signal generated by the Royer oscillation circuit to drive the cold cathode fluorescent lamp to continuously be in bright and dark states.
2. The control device with a high-efficiency cold cathode fluorescent lamp of claim 1, wherein a magnitude of a current of two transistors in the Royer oscillation circuit is determined by a transformer feedback line and a large resistor connected to a voltage source in parallel connection with a small resistor connected to the voltage source under control of the switch.

3. The control device with a high-efficiency cold cathode fluorescent lamp of claim 1 or 2, wherein the Royer oscillation circuit adopting parallel connection of large and small resistors of different resistance values to keep a closed circuit on a path of the large resistor is capable of preventing the cold cathode fluorescent lamp from going out, preventing the cold cathode fluorescent lamp from reducing efficiency due to frequent restarts, and also preventing reliability of the device from being reduced due to frequent restarts.
4. The control device with a high-efficiency cold cathode fluorescent lamp of claim 3, wherein a resistance value of the large resistor is much larger than a resistance value of the small resistor, and when the switch is closed, a current I_{BB} of bases of the two transistors of the Royer oscillation circuit is capable of being expressed by a formula:

$$I_{BB} = \frac{VDD - V_{BE}}{(R_{11} // R_{12})} \approx \frac{VDD - V_{BE}}{(R_{12})}$$

where VDD represents a voltage source, and a voltage V_{BE} is a base-emitter voltage when the two transistors are turned on.

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	English	
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領事館
7/年5月9日所提之
申請書已修正。



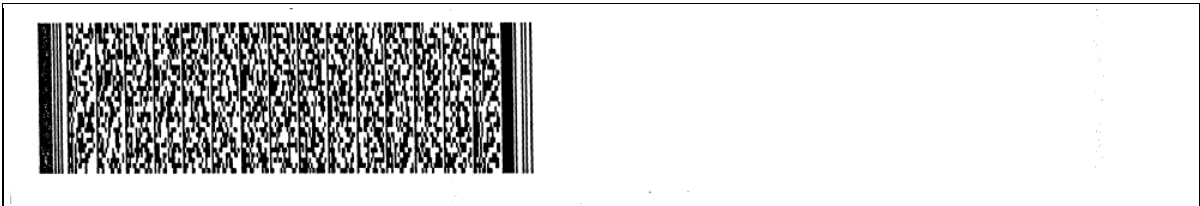
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This application has been filed in country (region) for a patent	Filing Date	Application Number	Priority Claim		
	None				

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IV. Chinese abstract of creation (title of creation: CONTROL DEVICE WITH HIGH-EFFICIENCY COLD CATHODE FLUORESCENT LAMP)

一種具高效率冷陰極螢光燈管控制裝置，包括有：一 Royer 振盪回路、冷陰極螢光燈管（CCFL）、電流回授及脈寬調變控制器（PWM）所組成，於前述 Royer 振盪回路輸入端連接有一開關，而 Royer 振盪回路受此開關控制產生之振盪信號可驅動冷陰極螢光燈管持續呈亮和暗之兩種狀態，在開關的（On/Off）工作週期（Duty Cycle）則由電流回授所回授之信號，經脈寬調變控制器決定。冷陰極螢光燈管所呈現的亮度即是由燈管呈現的亮度狀態出現的密度所控制。

English abstract of creation (title of creation:)



V. Description of creation (1)

The present creation relates to a control device with a high-efficiency cold cathode fluorescent lamp, and especially to a cold cathode fluorescent lamp control device for starting and adjusting brightness.

It is known that cold cathode fluorescent lamps (CCFLs) have advantages such as higher efficiency and longer life compared with traditional incandescent lamps. Therefore, at present, many liquid crystal displays (LCDs) adopt cold cathode fluorescent lamps to generate the required light sources.

The power supply frequency range required for stable operation of cold cathode fluorescent lamps is about a sinusoidal wave of 30 KHz-80 KHz without direct current (DC) components. The stable operating voltage of cold cathode fluorescent lamps is almost constant. The brightness of cold cathode fluorescent lamps is determined by the lamp current passing through the cold cathode fluorescent lamps. Starting cold cathode fluorescent lamps requires a voltage about 2-2.5 times higher than that during usual stable operation. The starting voltage and operating voltage of cold cathode fluorescent lamps are determined by the size of the lamps.

Generally, the starting voltage of cold cathode fluorescent lamps used in 14"and 15" liquid crystal displays is about 1400 Vrms, and the operating voltage of cold cathode fluorescent lamps when the maximum rated current is 7 mA is about 650 Vrms.

A typical cold cathode fluorescent lamp control loop is shown in FIG. 1 and includes a Royer oscillation circuit 45, a protective capacitor 46, current feedback 47, and a direct current-direct current converter (DC-DC converter) consisting of a pulse width modulator 48 plus a semiconductor switch 49, a choke coil 50 and a rectifier diode 51.



5. Description of the creation (2)

The Royer oscillation circuit 45 converts a direct current fed by an output 52 of the direct current-direct current converter into a high voltage alternating current. An output 53 of the Royer oscillation circuit 45 passes through the protective capacitor 46 to filter out the direct current components and then flows into a cold cathode fluorescent lamp 54. The current feedback 47 detects that the cold cathode fluorescent lamp 54 outputs 55 a current and generates a voltage output 56 detection signal. The pulse width modulation controller 48 adjusts a width of an output 57 pulse from the detection signal to achieve the purpose of starting and stabilizing an operating current of the cold cathode fluorescent lamp 54.

A traditional general-purpose PWM controller 48 may consist of a reference voltage generator 58, a triangular wave generator 59, an error amplifier 60 and a comparator 61. When the cold cathode fluorescent lamp 54 is started, the output 55 of a lamp current is zero, and an output 62 after inflow of current feedback 47 is inverted and integrated by the error amplifier 60 to obtain a higher DC voltage level output 63. This DC voltage level output 63 is then sent to the comparator 61 for comparison with a triangular wave 64 generated by the triangular wave generator 59. Because the DC voltage level 63 output by the error amplifier 60 is higher, the comparator 61 generates an output 57 having a larger duty cycle, promoting the semiconductor switch 49 causing the Royer oscillation circuit 45 to generate a high voltage output 53 to start the cold cathode fluorescent lamp 54.

After the cold cathode fluorescent lamp 54 is started, a current of the cold cathode fluorescent lamp 54 flows from the input 55 of the current feedback 47 to the current feedback 47. The output 62 of the current feedback 47 inverts and integrates an AC signal through the error amplifier 60 to obtain the DC voltage level 63 that gradually decreases with an increase of the input 62. Because the DC voltage level 63 output by the error amplifier 60 gradually decreases as the current of the cold cathode fluorescent lamp 54 increases after the cold cathode fluorescent lamp 54 is started, the comparator 61 generates an output 57 having a gradually smaller duty cycle, promoting the semiconductor switch 49 causing the Royer oscillation circuit 45 to generate a gradually smaller output 53 to supply the cold cathode fluorescent lamp 54. Finally, the cold cathode fluorescent lamp 54 operates steadily at a certain lamp current, and a voltage output generated by this lamp current through the current feedback 47 is equal to an input 64 of the reference voltage generator 58 to the error amplifier 60.



5. Description of the creation (3)

As shown in FIG. 1, the pulse width modulation DC-DC converter is utilized to change the current fed into the Royer oscillation circuit to stabilize the current of the cold cathode fluorescent lamp 54, and the efficiency of such a current adjustment method of the cold cathode fluorescent lamp 54 needs to be considered. The whole control device goes through a total of two conversions of one DC-DC converter and one DC-AC converter in a process of DC to AC, and the conversion efficiency is lower than that of one direct DC to AC conversion. At the same time, there is room for improvement in the cost of requiring additional power components such as a power switch 49, a power Schottky diode 51 and a power chock coil 50 over conventional methods; and therefore,

the first purpose of the present creation is that an input end of the Royer oscillation circuit is connected to a switch, the switch receives a signal of the current feedback, and the pulse width modulation controller generates a state to cause the switch to be turned on and off (ON/OFF), resulting in an oscillation signal generated by the Royer oscillation circuit to drive the cold cathode fluorescent lamp to continuously be in bright and dark states.

The second purpose of the present creation is to have high efficiency. Directly converting a DC voltage into an AC voltage can save the loss of DC-DC conversion in traditional circuits and improve the conversion efficiency of the system.

The third purpose of the present creation is a low cost. There is no need for additional high-power components such as power switches, power Schottky diodes and power choke coils. Low-power and low-speed switching components are used, which can greatly reduce costs.



5. Description of the creation (4)

The fourth purpose of the present creation is that the minimum value of the average current of the lamp that can be adjusted can be reduced arbitrarily according to the needs, so as to increase the elasticity and range of dimming.

The fifth purpose of the present creation is to keep the impedance of the lamp almost unchanged during operation, so operation can be performed at an almost fixed frequency and reduce the cost of overcoming EMI interference.

The sixth purpose of the present creation is that operation can be performed at a lower operating temperature because high-power components are not used, so that the safety and reliability of the device can be improved.

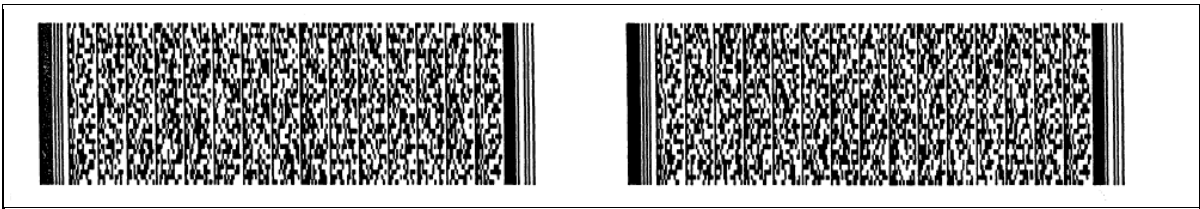
The seventh purpose of the present creation is to use a wave width density modulation method, which will interfere with the vertical scanning (V-Sync.) of the display during use. To solve this problem, this creation utilizes a CMOS integrated circuit for designing a triangular wave generator that can be controlled by an external signal for synchronous operation.

The technical content and structure of the present creation are now described in detail in accordance with the drawings as follows:

Please refer to "FIG. 2", which is the schematic diagram of a control device of a cold cathode fluorescent lamp and timing according to the present creation. As shown in the figure, the control device with the high-efficiency cold cathode fluorescent lamp of the present creation includes: a Royer oscillation circuit 1, a cold cathode fluorescent lamp 2, a current feedback 3 and a pulse width modulation controller (PWM) 4. The feedback signal is utilized to control the Royer oscillation circuit 1 to turn on and off, and the cold cathode fluorescent lamp 2 is started by adjusting a beam density, so that the liquid crystal display has higher brightness, more power saving and less expensive requirements.

The input end of the above-mentioned Royer oscillation circuit 1 is connected to a switch 5, and the output end is connected to the cold cathode fluorescent lamp 2, and the high voltage AC required by the cold cathode fluorescent lamp 2 is supplied by the Royer oscillation circuit 1. The state of an output 6 of the oscillator is controlled to only bright and dark states by the switch 5.





5. Description of the creation (5)

A magnitude of a current of two transistors 7, 8 in the Royer oscillation circuit 1 is determined by a transformer feedback line 9 and a large resistor 11 connected to a voltage source 10 in parallel connection with a small resistor 12 connected to the voltage source 10 under control of the switch 5. However, when the switch 5 is closed, the small resistor 12 and the voltage source 10 are closed, a current supplied to the bases 13 and 14 of the two transistors 7 and 8 in the oscillation circuit 1 is increased, so that a current of the two transistors 7 and 8 is increased, and the lamp is brightened; in addition, when the switch 5 is open, the small resistor 12 is disconnected from the voltage source 10, and the current supplied to the bases 13, 14 of the two transistors 7, 8 in the Royer oscillation circuit 1 is reduced, so that the current of the two transistors 7, 8 is reduced, and the lamp is dimmed.

The bright and dark states of the Royer oscillation circuit 1 are controlled by a clock lower than an operating frequency of the lamp to appear alternately, so that a duty cycle of the clock determines whether the Royer oscillation circuit appears bright or dark by a proportion in one clock time, so the clock in which the bright and dark states of the Royer oscillation circuit 1 appear alternately is provided by an output 15 of the PWM controller 4.

Therefore, the PWM controller 4 determines a duty cycle of the output clock according to a magnitude of a detected average current output 16 by the cold cathode fluorescent lamp 2 through current feedback 3, and thus determines opening/closing of the switch 5, and controls the average current of the cold cathode fluorescent lamp 2 by a proportion in one clock time.

In addition, an oscillation frequency of a triangular wave generator 17 in the PWM controller 4 described above can be operated in synchronization with an external synchronization signal 18 (as shown in FIG. 3). In this way, a control device with a high-efficiency cold cathode fluorescent lamp is constructed.



5. Description of the creation (6)

Please refer to "FIGS. 2 and 3", which is the schematic diagram of a control device of a cold cathode fluorescent lamp and timing according to the present creation. As shown in the figure, a control integrated circuit device with a cold cathode fluorescent lamp of the present creation utilizes components used by a traditional general-purpose PWM controller 4 at a low speed of 90-200 HZ and the principle of feedback control to control the current of the cold cathode fluorescent lamp 2 in a manner that controls the beam density.

However, unlike traditional PWM control, the current at the bases 13, 14 of the two transistors 7, 8 of the Royer oscillation circuit 1 is changed; assuming that the resistance value of the large resistor 11 is much larger than the resistance value of the small resistor 12, when the switch 5 is closed, a current I_{BB} of the bases 13, 14 of the two transistors 7, 8 of the Royer oscillation circuit 1 can be expressed by formula (1):

$$I_{BB} = \frac{VDD - V_{BE}}{(R_{11} // R_{12})} \approx \frac{VDD - V_{BE}}{(R_{12})} \quad (1)$$

where in formula (1), VDD represents a voltage source 10, and the voltage V_{BE} is a base-emitter voltage when the two transistors 7, 8 are turned on. When the switch 5 is open, a current I_{BD} of the bases 13, 14 of the transistors 7, 8 of the Royer oscillation circuit 1 can be expressed by formula (2):

$$I_{BD} = \frac{VDD - V_{BE}}{(R_{11})} \quad (2)$$



5. Description of the creation (7)

Moreover, $R_{12} < R_{11}$, and thus $I_{BB} > I_{BD}$, which causes an output 6 of the Royer oscillation circuit 1 to have different bright and dark results.

In addition, when the lamp current of the cold cathode fluorescent lamp 2 flows into the current feedback 3 of the lamp, after being rectified by the diode 19, the lamp current flows into a resistor 20 to obtain a half-wave rectified voltage. A resistor 21 of the current feedback 3 and an error amplifier 22 of the PWM controller 4 and a capacitor 25 connected between an amplifier output 23 and an inverting input end 24 form a low pass loop that takes out an average voltage of the half-wave rectification to be input 6. While the reference voltage of a non-inverting input end 27 of the input error amplifier 22 generated by a reference voltage generator 26 is compared with the average voltage of the half-wave rectification of the input inverting input end 24, if the average voltage of the half-wave rectification at the inverting input end 24 is relatively small, the output 23 of the error amplifier 22 is increased, and this relatively high voltage output 23 and a triangular wave 28 generated by the triangular wave generator 17 are compared by a comparator 29 to generate a square wave output 15 having a relatively long duty cycle, so that the switch 5 is closed for relatively long average time to increase the average output current of the Royer oscillation circuit 1.

On the contrary, if the average voltage of the half-wave rectification at the inverting input end 24 is relatively large, the output 23 of the error amplifier 22 is reduced, and this relatively low voltage output 23 and the triangular wave 28 generated by the triangular wave generator 17 are compared by the comparator 29 to generate a square wave output 15 having a relatively short duty cycle, so that the switch 5 is closed for relatively short average time to decrease the average output current of the Royer oscillation circuit 1.



5. Description of the creation (8)

In most applications, the brightness of the cold cathode fluorescent lamp 2 must be adjustable. For example, by changing the reference voltage, in this example, the higher reference voltage causes the PWM controller 4 to generate an output having a relatively long duty cycle, resulting in relatively high brightness. However, in ultra-low brightness situations, the low reference voltage will cause the PWM controller 4 to generate an output having an extremely short duty cycle. The control circuit of the present creation adopting parallel connection of large and small resistors 11, 12 of different resistance values to keep a closed circuit on a path of the large resistor 11 is capable of preventing the cold cathode fluorescent lamp 2 from going out, preventing the cold cathode fluorescent lamp 2 from reducing efficiency due to frequent restarts, and also preventing reliability of the device from being reduced due to frequent restarts.

Furthermore, when the cold cathode fluorescent lamp 2 is used in the backlight of an LCD display, the brightness is controlled by beam density modulation at a low frequency of 90 Hz, so it is to be noted that the beat frequency phenomenon may occur between the vertical scanning (V-Sync.) signal in the displayed video signal. Using the technique of synchronizing with the triangular wave generator 17 in the PWM controller 4, the circuit control system of the present creation can synchronize the output of the PWM controller 4 with the signal synchronized with the vertical scanning signal (V-Sync.) in the video signal by using the signal synchronized with the vertical scanning (V-Sync.) signal in an input end 30, thereby avoiding the beat frequency phenomenon that may occur.

In addition, in FIG. 3, the synchronization signal 18 determines the output frequency of the PWM controller 4; and 31, 32 represent that, when the cold cathode fluorescent lamp 2 is off, the output of the PWM controller 4 is synchronized by the synchronization signal 18, and the square wave having a relatively small duty cycle causes the Royer oscillation circuit 1 to generate a beam of a lower density. The waveforms 33 and 34 represent that the cold cathode fluorescent lamp 2 is on, the output of the PWM controller 4 is synchronized by the synchronization signal 18, and the square wave having a relatively small duty cycle causes the Royer oscillation circuit 1 to generate a beam of a higher density.



5. Description of the creation (9)

Please refer to "FIGS. 4 and 5", which is another schematic diagram of a use state and timing of the present creation. As shown in the figure: since the present creation uses a wave width density modulation method, it will interfere with the vertical scanning (V-Sync.) of the display during use. To solve this problem, this creation utilizes a CMOS integrated circuit for designing a triangular wave generator 35 that can be controlled by an external signal for synchronous operation.

In the triangular wave generator 35 of FIG. 4, there is a digital positive edge detection circuit 36, and a traditional triangular wave generator without a synchronization function shorts an output 38 of a comparator 37 with an input 40 of a NAND gate 39. In this example, in order to enable the triangular wave generator 35 to be synchronized with an external signal 41, a digital positive edge detection circuit 36 is added, using an AND gate 42, with the output 38 of the comparator 37 and an output 43 of the positive edge detection circuit 36 as an input to the AND gate 42. The operation of the triangular wave generator 35 is controlled by an output 40 of the AND gate 42 as an input of the NAND gate 39. The timing relationship of the entire circuit operation is shown in a waveform 44 of FIG. 5 and the positive edge detection circuit 36 of FIG. 4.

The waveform 44 is a triangular wave at point A of the triangular wave generator 35 of FIG. 4. The synchronization waveform 41 in FIG. 5 is an external synchronization control signal. From the waveforms 44, 41, whether or not the external synchronization signal 41 is added to the triangular wave generator 35, the change generated at the point A of the triangular wave output by the triangular wave generator is known.

Furthermore, in order to allow the Examiner of your esteemed Office to better understand the present creation, the advantages of the present creation are explained as follows.

1. High efficiency. Directly converting a DC voltage into an AC can save the loss of DC-DC conversion in traditional circuits and improve the conversion efficiency of the system.

2. Low cost. This device does not require additional high-power components such as power switches, power Schottky diodes and power choke coils. Low-power and low-speed switching components are used, which can greatly reduce costs.



5. Description of the creation (10)

3. Large dimming range. The traditional method of reducing the lamp current by reducing the feed current will produce the so-called thermal meter effect when the lamp current is not large enough, causing the entire lamp to be relatively bright at one end close to the transformer and relatively dark at the far end. This device does not have such problems. Therefore, the minimum value of the average current of the lamp that can be adjusted can be reduced arbitrarily according to the needs, so as to increase the elasticity and range of dimming.

4. Fixed frequency operation. The resonance frequency of the oscillation circuit is related to the impedance of the secondary side lamp. Changing the lamp current by the traditional way of changing the feed current will change the lamp impedance, which will change the oscillation frequency of the oscillation circuit. When the device is operated, the impedance of the lamp remains almost unchanged, so operation can be performed at an almost fixed frequency. The cost of overcoming EMI interference is reduced.

5. High reliability. Traditional devices require additional high-power components such as power switches, power Schottky diodes and power choke coils. When these power components are operated, the temperature rise problem can be completely avoided because the components are not used in the device. Operating at a lower operating temperature can improve the safety and reliability of the device.

The above has only described the preferred embodiments of the present creation, and is not intended to limit the scope of the present creation. That is, all equivalent changes and modifications made according to the claims of the present creation are encompassed by the claims of the present creation.



Brief description of the drawings

[Description of the drawings]

FIG. 1 is a schematic diagram of a control device with a conventional cold cathode fluorescent lamp.

FIG. 2 is a schematic diagram of a control device with a cold cathode fluorescent lamp according to the present creation.

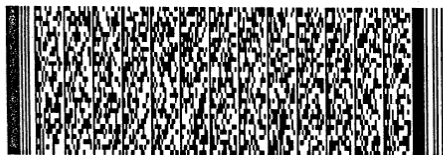
FIG. 3 is a schematic diagram of timing according to the present creation.

FIG. 4 is a schematic diagram of another use state according to the present creation.

FIG. 5 is a diagram of timing of FIG. 4.

[Description of the reference numerals]

Royer oscillation circuit	1, 45
Cold cathode fluorescent lamp	2, 54
Current feedback	3, 47
Pulse width modulation controller	4, 48
Switch.....	5
Output.....	6, 15, 16, 23, 6
3 , 3 8 , 4 3 , 4 0 , 5 2 , 5 3 , 5 5 , 5 7 , 6 2	
Transistor	7, 8
Transformer feedback line.....	9
Voltage source	10, 56
Large resistor	11
Small resistor	12
Base	13, 14
Triangular wave generator.....	17, 59, 35
Synchronization signal	18
Diode	19
Resistor.....	20, 21



Brief description of the drawings

Error amplifiers 22, 60

Inverting input end 24

Capacitor 25

Reference voltage generator..... 26, 58

Non-inverting input end 27

Triangular wave..... 28, 64

Comparator..... 29, 61, 37

Input end..... 30

Output frequency..... 31, 32

Waveform 33, 34, 41, 44

Digital positive edge detection circuit..... 36

NAND gate..... 39

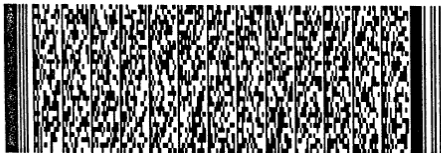
AND gate..... 42

Semiconductor switch 49

Choke coil 50

Rectifier diode 51

Protective capacitor 46



VI. Claims

1. A control device with a high-efficiency cold cathode fluorescent lamp, comprising: a Royer oscillation circuit, a cold cathode fluorescent lamp, current feedback and a pulse width modulation controller, the control device used for starting the cold cathode fluorescent lamp, wherein an input end of the Royer oscillation circuit is connected to a switch, the switch receives a signal of the current feedback, and the pulse width modulation controller generates a state to cause the switch to be turned on and off (ON/OFF), resulting in an oscillation signal generated by the Royer oscillation circuit to drive the cold cathode fluorescent lamp to continuously be in bright and dark states.

2. The control device with a high-efficiency cold cathode fluorescent lamp of claim 1, wherein a magnitude of a current of two transistors in the Royer oscillation circuit is determined by a transformer feedback line and a large resistor connected to a voltage source in parallel connection with a small resistor connected to the voltage source under control of the switch.

3. The control device with a high-efficiency cold cathode fluorescent lamp of claim 1 or 2, wherein the Royer oscillation circuit adopting parallel connection of large and small resistors of different resistance values to keep a closed circuit on a path of the large resistor is capable of preventing the cold cathode fluorescent lamp from going out, preventing the cold cathode fluorescent lamp from reducing efficiency due to frequent restarts, and also preventing reliability of the device from being reduced due to frequent restarts.

4. The control device with a high-efficiency cold cathode fluorescent lamp of claim 3, wherein a resistance value of the large resistor is much larger than a resistance value of the small resistor, and when the switch is closed, a current I_{BB} of bases of the two transistors of the Royer oscillation circuit is capable of being expressed by a formula:



6. Claims

$$I_{BB} = \frac{VDD - V_{BE}}{(R_{11} // R_{12})} \approx \frac{VDD - V_{BE}}{(R_{12})}$$

where VDD represents a voltage source, and a voltage V_{BE} is a base-emitter voltage when the two transistors are turned on.

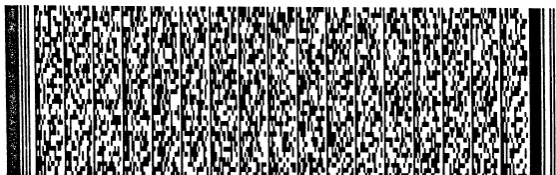
5. The control device with a high-efficiency cold cathode fluorescent lamp of claim 4, wherein when the switch is open, a current I_{BD} of the bases of the two transistors of the Royer oscillation circuit is capable of being expressed by a formula:

$$I_{BD} = \frac{VDD - V_{BE}}{(R_{11})}$$

and $R_{12} \ll R_{11}$, and thus $I_{BB} \gg I_{BD}$, which causes an output of the oscillation circuit to have different bright and dark results.

6. The control device with a high-efficiency cold cathode fluorescent lamp of claim 1 or 2, wherein the bright and dark states of the Royer oscillation circuit are controlled by a clock lower than an operating frequency of the lamp to appear alternately, so that a duty cycle of the clock determines whether the Royer oscillation circuit appears bright or dark by a proportion in one clock time.

7. The control device with a high-efficiency cold cathode fluorescent lamp of claim 6, wherein the clock in which the bright and dark states of the Royer oscillation circuit appear alternately is provided by an output of the PWM controller.

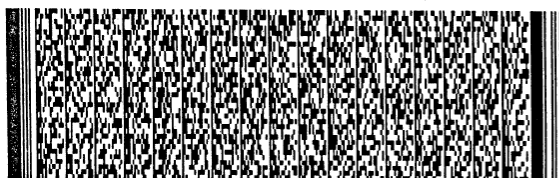


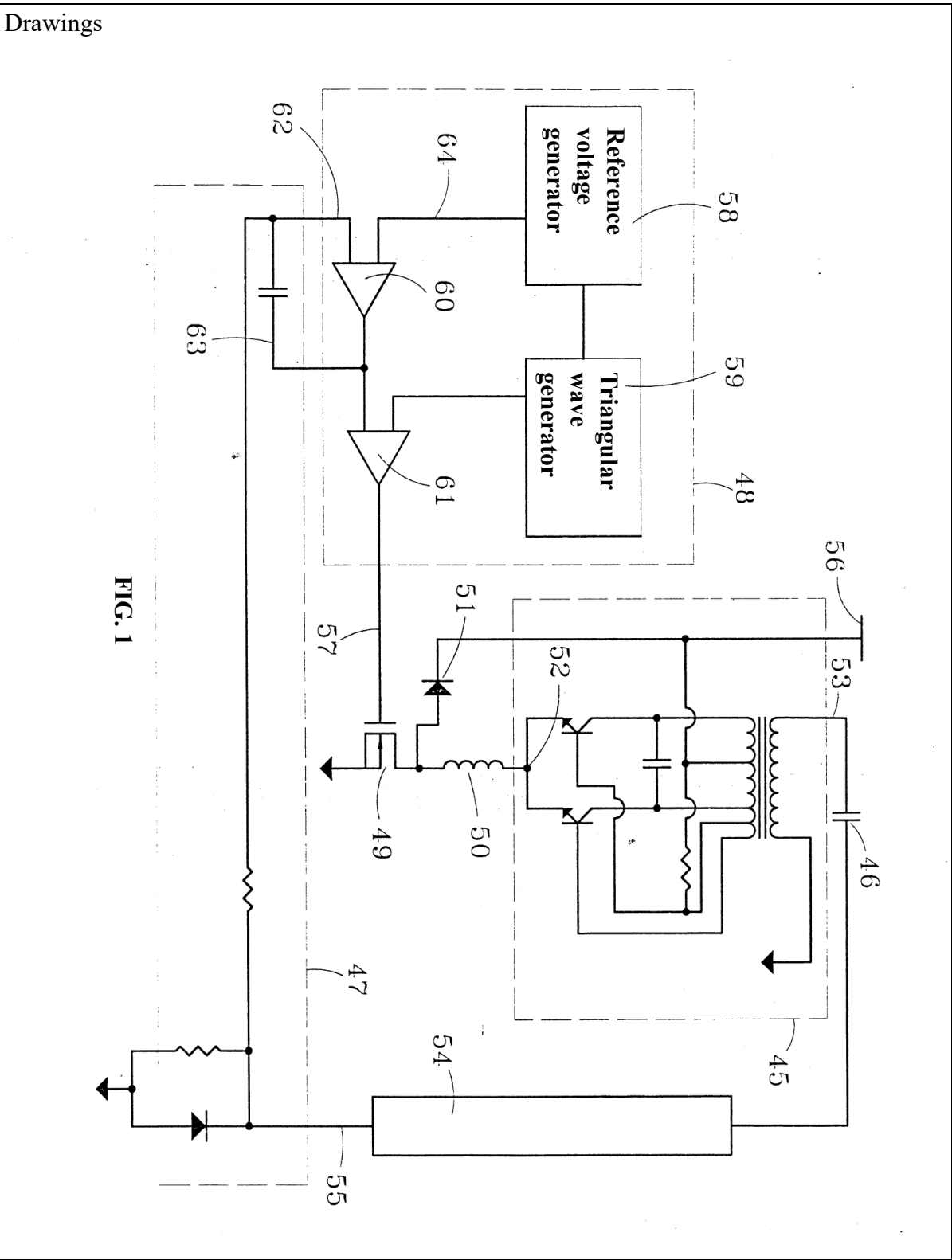
6. Claims

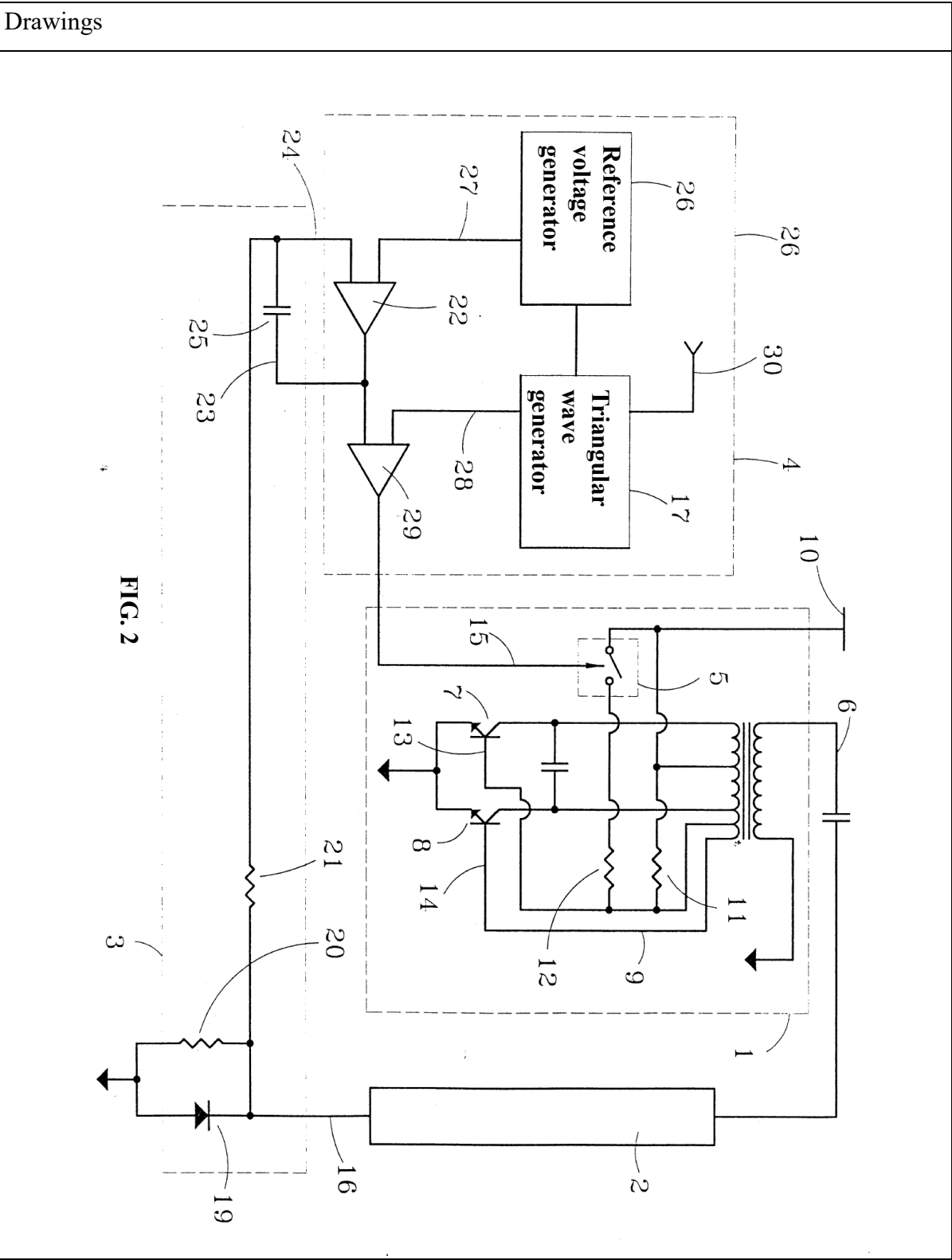
8. The control device with a high-efficiency cold cathode fluorescent lamp of claim 1, wherein the PWM controller determines a duty cycle of the output clock according to a magnitude of a detected average current output by the cold cathode fluorescent lamp through current feedback, and thus determines opening/closing of the switch, and controls the average current of the cold cathode fluorescent lamp by a proportion in one clock time.

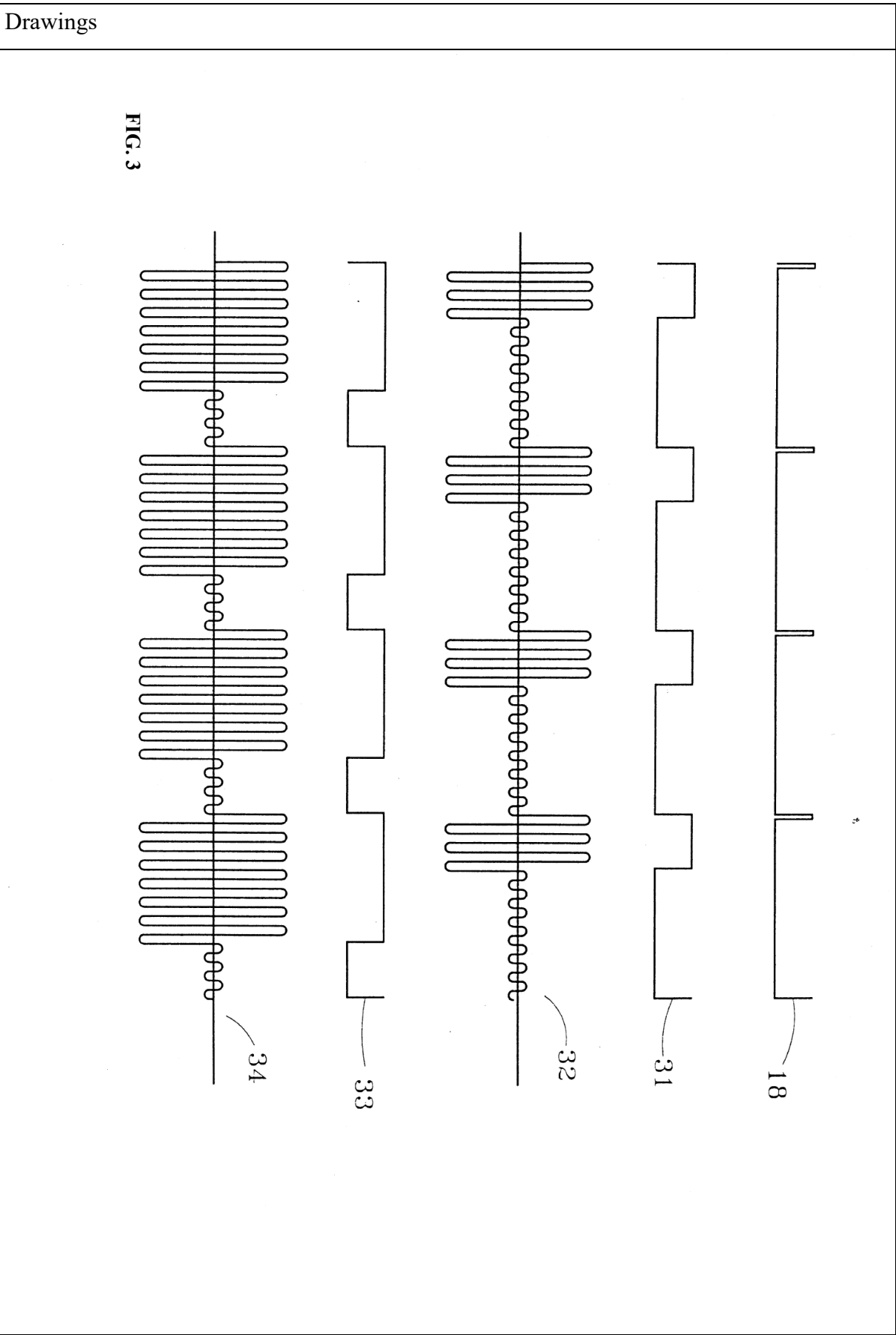
9. The control device with a high-efficiency cold cathode fluorescent lamp of claim 1, wherein a CMOS integrated circuit is further utilized for designing a triangular wave generator capable of being controlled by an external signal for a synchronous operation.

10. The control device with a high-efficiency cold cathode fluorescent lamp of claim 9, wherein the triangular wave generator can be synchronized with the external signal, a digital positive edge detection circuit is added, and an AND gate is used to control action of the triangular wave generator, an output of a comparator and an output of the positive edge detection circuit being used as an input of the AND gate, and an output of the AND gate being used as an input of a NAND gate.









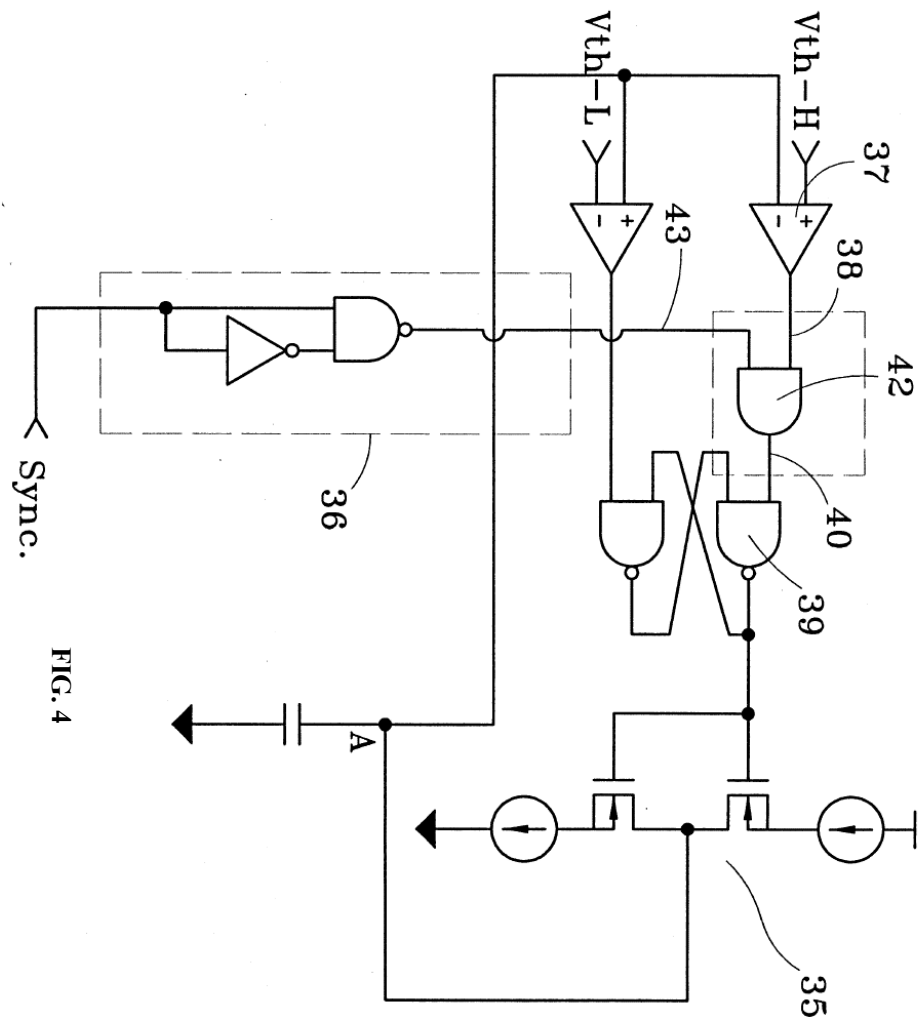
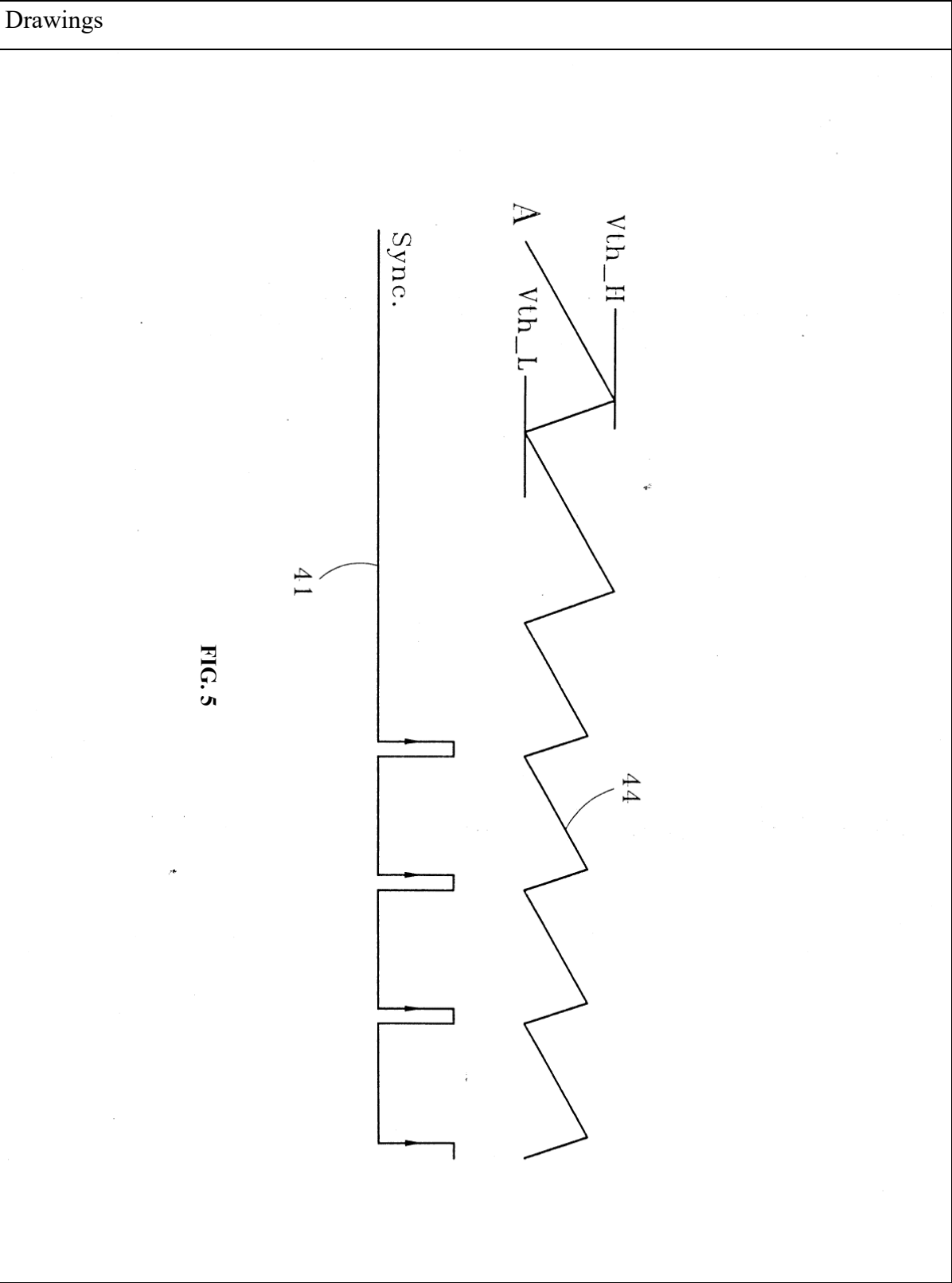


FIG. 4





TRANSLATOR'S CERTIFICATE OF TRANSLATION

Questel-Orbit, Incorporated
2331 Mill Road, Suite 600
Alexandria, VA 22314, U.S.A.
www.questel.com

Questel Project Number: KTS2440025UT-LZ_Q
Date: November 19, 2024

To whom it may concern:

I, Roger Chao, a translator fluent in the Traditional Chinese and English languages, on behalf of Questel, do solemnly and sincerely declare that the following is, to the best of my knowledge and belief, a true and correct translation of the document(s) listed below in a form that best reflects the intention and meaning of the original text.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

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Signed this 19th day of November, 2024

Signature

Roger Chao

Name