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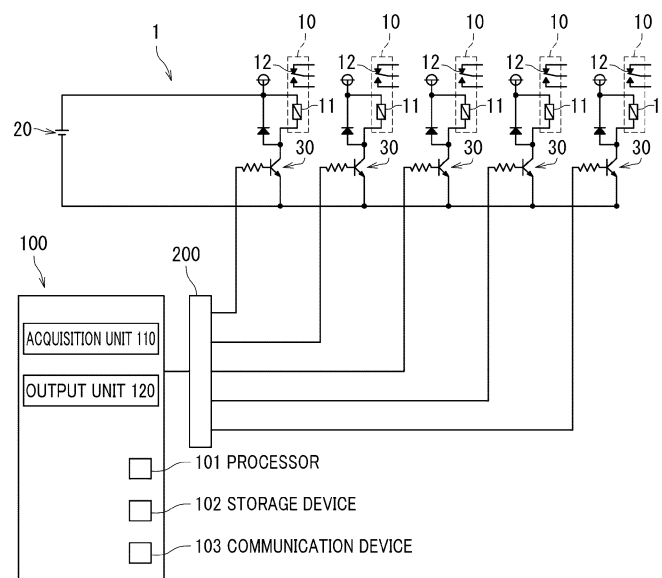
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(54) **CONTROL DEVICE AND CONTROL METHOD**

(57) A control device includes: an acquisition unit configured to acquire the number of relays to be driven having an identical specification; and an output unit configured to output a pulse current to a plurality of relays to be driven, at shifted output timings in a case where the number of relays acquired by the acquisition unit is plural.

The output unit is configured to determine a difference in output timing of the pulse current between relays adjacent in an order of output of the pulse current based on a duty ratio of the pulse current and the number of relays acquired by the acquisition unit.

FIG. 1



Description

TECHNICAL FIELD

[0001] The present disclosure relates to a control device and a control method capable of controlling a plurality of relays.

BACKGROUND ART

[0002] Patent Literature 1 discloses a relay drive circuit including a single relay. In the relay drive circuit of Patent Literature 1, the relay includes a switching element, and a pulse voltage is applied to a control terminal of the switching element.

PATENT DOCUMENT

PATENT LITERATURE

[0003] Patent Literature 1: JP 2006-114446 A

SUMMARY

TECHNICAL PROBLEM

[0004] When the relay drive circuit of Patent Literature 1 includes a plurality of relays and all the relays are turned on and off simultaneously, an amount of current supplied to the relays increases in proportion to the number of relays. In this case, charging and discharging of a power supply that supplies the current to the relays increase, and ripple of the power supply may undesirably increase.

[0005] An object of the present disclosure is to provide a control device and a control method capable of controlling a plurality of relays while suppressing ripple of a power supply.

SOLUTION TO PROBLEM

[0006] A control device according to an aspect of the present disclosure includes:

an acquisition unit configured to acquire the number of relays to be driven having an identical specification; and

an output unit configured to output a pulse current to a plurality of relays to be driven, at shifted output timings in a case where the number of relays acquired by the acquisition unit is plural, wherein the output unit is configured to determine a difference in output timing of the pulse current between relays adjacent in an order of output of the pulse current based on a duty ratio of the pulse current and the number of relays acquired by the acquisition unit.

[0007] A control method according to an aspect of the present disclosure includes:

acquiring the number of relays to be driven having an identical specification; and
outputting a pulse current to a plurality of relays to be driven, at shifted output timings in a case where the acquired number of relays is plural, wherein a difference in output timing of the pulse current between relays adjacent in an order of output of the pulse current is determined based on a duty ratio of the pulse current and the acquired number of relays.

ADVANTAGEOUS EFFECTS OF INVENTION

[0008] According to the control device according to the aspect, it is possible to realize a control device capable of controlling a plurality of relays while suppressing ripple of a power supply.

[0009] According to the control method according to the aspect, it is possible to realize a control method capable of controlling a plurality of relays while suppressing ripple of a power supply.

BRIEF DESCRIPTION OF DRAWINGS

[0010]

Fig. 1 is a block diagram illustrating a circuit including a control device according to an embodiment of the present disclosure;

Fig. 2 is a first timing diagram of a pulse current output by the control device of Fig. 1;

Fig. 3 is a second timing diagram of a pulse current output by the control device of Fig. 1;

Fig. 4 is a third timing diagram of a pulse current output by the control device of Fig. 1;

Fig. 5 is a fourth timing diagram of a pulse current output by the control device of Fig. 1;

Fig. 6 is a fifth timing diagram of a pulse current output by the control device of Fig. 1; and

Fig. 7 is a flowchart for explaining a method for controlling a relay by using the control device of Fig. 1.

DETAILED DESCRIPTION

[0011] Hereinafter, an example of the present disclosure will be described with reference to the accompanying drawings. The following description is merely exemplary in nature and is not intended to limit the present disclosure, its application, or its use. The drawings are schematic, and ratios of dimensions and the like do not necessarily match actual ones.

[0012] As illustrated in Fig. 1, a control device 100 according to an embodiment of the present disclosure constitutes a part of a circuit 1 configured to drive a plurality of relays 10 having an identical specification. In the present embodiment, the circuit 1 includes five relays 10, a power supply 20 configured to supply a current to each relay 10, five switching elements 30, five diodes D1, and a generation circuit 200. Each switching element 30 is

connected in series with a coil 11 of a corresponding one of the relays 10. Each diode D1 is connected in antiparallel with the coil 11 of a corresponding one of the relays 10. The control device 100 is configured to control the switching element 30 corresponding to the relay 10 to be driven, to output a pulse current to the coil 11 of the relay 10 to be driven.

[0013] Each relay 10 includes the coil 11 and a contact 12. For example, the contact 12 is switched from an off state to an on state when a pulse current is input to the coil 11. Each relay 10 is a relay having optionally-selected specifications (for example, input voltage, load voltage, and maximum load current). The power supply 20 includes, for example, a battery, and each switching element 30 includes, for example, an npn transistor. The generation circuit 200 generates, for example, a pulse voltage having a constant amplitude. A pulse width and the amplitude of the pulse voltage are set so that a maximum value of a current flowing through the coil 11 of each relay 10 becomes equal to or larger than a value necessary for turning on the relay 10.

[0014] As illustrated in Fig. 1, the control device 100 includes a processor 101, a storage device 102, and a communication device 103. Examples of the processor 101 include a CPU, an MPU, a GPU, a DSP, an FPGA, and an ASIC. The storage device 102 includes, for example, an internal recording medium or an external recording medium. Examples of the internal recording medium include a non-volatile memory. Examples of the external recording medium include a hard disk (HDD), a solid state drive (SSD), and an optical disk device. The communication device 103 includes, for example, a communication circuit or a communication module for transmitting and receiving data to and from an external device such as a server.

[0015] The control device 100 includes an acquisition unit 110 and an output unit 120. The acquisition unit 110 and the output unit 120 are realized, for example, by execution of a program stored in the storage device 102 by the processor 101.

[0016] The acquisition unit 110 is configured to acquire the number of relays 10 to be driven having an identical specification. The number of relays 10 to be driven may be acquired, for example, from a voltage of the circuit 1 at a time of output of a pulse current to each switching element 30 or may be acquired, for example, from data concerning the relay 10 to be driven input by a user or the like.

[0017] The output unit 120 is configured to output a pulse current to a plurality of relays 10 to be driven, at shifted or different output timings in a case where the number of relays 10 acquired by the acquisition unit 110 is plural (that is, two or more). In the present embodiment, the output unit 120 is configured to apply the pulse voltage generated by the generation circuit 200 to each switching element 30 and configured to output the pulse current to the coil 11 of the corresponding relay 10.

[0018] The output unit 120 is configured to determine

a difference in output timing of the pulse current between the relays 10 adjacent in an order of output of the pulse current on the basis of a duty ratio of the pulse current and the number of relays 10 acquired by the acquisition unit 110. For example, the output unit 120 determines the difference in output timing of the pulse current by at least one of the following methods (A) to (C).

[0019] (A) In a case where the product of the duty ratio (%) of the pulse current and the number of relays 10 acquired by the acquisition unit 110 is smaller than one hundred, the output unit 120 determines a time defined by "Expression (1): λ/B " as the difference in output timing of the pulse current. λ is a cycle (ms) of the pulse current, and B is the number of relays 10 acquired by the acquisition unit 110.

[0020] In a case of $\lambda = 100$ ms, $A = 30\%$, and $B = 2$, the difference in timing of the pulse current is $100/2 = 50$ ms. In this case, as illustrated in Fig. 2, a pulse current is output to one relay 10, and there is an ON/OFF gap in which no pulse current is output to any relay 10. That is, the ripple of the power supply 20 is suppressed to ripple in a case where the pulse current is output to one relay 10.

[0021] (B) In a case where the product of the duty ratio (%) of the pulse current and the number of relays 10 acquired by the acquisition unit 110 is equal to one hundred, the output unit 120 determines a time defined by "Expression (2): $\lambda \times A$ " as the difference in output timing of the pulse current. A is the duty ratio (%) of the pulse current.

[0022] In a case of $\lambda = 100$ ms, $A = 20\%$, and $B = 5$, the difference in timing of the pulse current is $100 \times 0.2 = 20$ ms. In this case, as illustrated in Fig. 3, the pulse current is always output to one relay 10. That is, the ripple of the power supply 20 is suppressed to be smaller than ripple in a case where the pulse current is output to one relay 10.

[0023] (C) In a case where the product of the duty ratio (%) of the pulse current and the number of relays 10 acquired by the acquisition unit 110 is larger than one hundred, the output unit 120 determines a time defined by "Expression (3): $\lambda/(A \times B \times 2)$ " as the difference in output timing of the pulse current.

[0024] In a case of $\lambda = 100$ ms, $A = 25\%$, and $B = 5$, the difference in timing of the pulse current is $100/(0.25 \times 5 \times 2) = 25$ ms. In this case, as illustrated in Fig. 4, the pulse current is always concurrently output to one relay 10 or two relays 10. That is, the ripple of the power supply 20 is suppressed to ripple in a case where the pulse current is output to one relay 10.

[0025] In a case of $\lambda = 100$ ms, $A = 50\%$, and $B = 4$, the difference in timing of the pulse current is $100/(0.5 \times 4 \times 2) = 25$ ms. In this case, as illustrated in Fig. 5, the pulse current is output to two relays 10, and the pulse current is not simultaneously output to three or more relays 10. That is, the ripple of the power supply 20 is suppressed to be smaller than ripple in a case where the pulse current is output to one relay 10.

[0026] In a case of $\lambda = 100$ ms, $A = 50\%$, and $B = 5$,

the difference in timing of the pulse current is $100/(0.5 \times 5 \times 2) = 20$ ms. In this case, as illustrated in Fig. 6, the pulse current is simultaneously output to two or three relays 10. That is, the ripple of the power supply 20 is suppressed to ripple in a case where the pulse current is output to one relay 10.

[0027] The output unit 120 determines an amount by which output timings are shifted, assuming that the number of relays 10 acquired by the acquisition unit 110 is a threshold value in a case where the number of relays 10 acquired by the acquisition unit 110 is larger than the threshold value. In a case where the number of relays 10 is larger than the threshold value, an excess relay 10 is regarded as any of relays 10 within the threshold value.

[0028] For example, in a case where the threshold value is 8 and $B = 13$, the output unit 120 determines the difference in timing of the pulse current assuming that $B = 8$. Excess relays, that is, the ninth to thirteenth relays 10 are each regarded as any of relays 10 within the threshold value. That is, the output unit 120 outputs the pulse current assuming that there are two relays 10 as each of the first to fifth relays 10 and there is one relay 10 as each of the sixth to eighth relays 10. As a result, the ripple of the power supply 20 is suppressed to ripple in a case where the pulse current is output to one relay 10 at a maximum.

[0029] The threshold value may be optionally set. It is preferable to set the threshold value so as not to make it difficult to divide or subdivide a cycle of the pulse current in consideration of a length of the cycle of the pulse current and the like.

[0030] An example of a method for controlling the relays 10 by using the control device 100 will be described with reference to Fig. 7. The method for controlling the relays 10 described below is realized, for example, by execution of a predetermined program by the processor 101.

[0031] As illustrated in Fig. 7, when output timing determination processing is started, the acquisition unit 110 acquires the number of relays 10 to be driven (step S1).

[0032] When the number of relays 10 to be driven is acquired, the output unit 120 determines whether or not the acquired number of relays 10 is two or more (step S2).

[0033] In a case where it is determined that the acquired number of the relays 10 is two or more, the output unit 120 determines a difference in output timing of the pulse current between the relays 10 adjacent in an order of output of the pulse current on the basis of a duty ratio of the pulse current and the acquired number of relays 10 (step S3).

[0034] In a case where the acquired number of relays 10 is two or more, the output unit 120 outputs the pulse current to the plurality of relays 10 to be driven at shifted output timings on the basis of the difference in output timing of the pulse current determined in step S3 (step S4), and the pulse current output process ends. In a case where it is not determined that the number of relays 10 acquired in step S2 is two or more, the output unit 120

outputs a pulse current of a preset duty ratio to one relay 10 to be driven (step S4), and the pulse current output process ends.

[0035] The control device 100 can exhibit the following advantageous effects.

[0036] The control device 100 includes the acquisition unit 110 configured to acquire the number of relays 10 to be driven having an identical specification, and the output unit 120 configured to output a pulse current to a plurality of relays 10 to be driven, at shifted output timings in a case where the number of relays 10 to be driven acquired by the acquisition unit 110 is plural. The output unit 120 is configured to determine a difference in output timing of the pulse current between relays 10 adjacent in an order of output of the pulse current on the basis of a duty ratio of the pulse current and the number of relays 10 acquired by the acquisition unit 110. According to such a configuration, the ripple of the power supply 20 is suppressed to ripple in a case where the pulse current is output to one relay 10 at a maximum. As a result, it is possible to realize the control device 100 capable of controlling the plurality of relays 10 while suppressing the ripple of the power supply 20.

[0037] The control device 100 may optionally adopt any one or more of the following plurality of configurations. That is, any one or more of the following plurality of configurations can be optionally deleted when included in the embodiment, and can be optionally added when not included in the embodiment. By adopting such a configuration, it is possible to realize the control device 100 capable of controlling the plurality of relays 10 while suppressing the ripple of the power supply 20 with more certainty.

[0038] In a case where the product of the duty ratio (%) of the pulse current and the number of relays 10 acquired by the acquisition unit 110 is smaller than one hundred, the output unit 120 determines a time defined by Expression (1): λ/B [in Expression (1), λ is a cycle (mS) of the pulse current, and B is the number of relays 10 acquired by the acquisition unit 110] as the difference in output timing of the pulse current.

[0039] In a case where the product of the duty ratio (%) of the pulse current and the number of relays 10 acquired by the acquisition unit 110 is equal to one hundred, the output unit 120 determines a time defined by Expression (2): $\lambda \times A$ [in Expression (2), λ is a cycle (mS) of the pulse current, and A is the duty ratio (%) of the pulse current] as the difference in output timing of the pulse current.

[0040] In a case where the product of the duty ratio (%) of the pulse current and the number of relays 10 acquired by the acquisition unit 110 is larger than one hundred, the output unit 120 determines a time defined by Expression (3): $\lambda/(A \times B \times 2)$ [in Expression (3), λ is a cycle (mS) of the pulse current, A is the duty ratio (%) of the pulse current, and B is the number of relays 10 acquired by the acquisition unit 110] as the difference in output timing of the pulse current.

[0041] In a case where the number of relays 10 acquired by the acquisition unit 110 is larger than a threshold value, the output unit 120 determines the difference in output timing of the pulse current assuming that the number of relays 10 acquired by the acquisition unit 110 is the threshold value.

[0042] The control method can exhibit the following advantageous effects.

[0043] The control method includes acquiring the number of relays 10 to be driven having an identical specification and outputting a pulse current to a plurality of relays 10 to be driven, at shifted output timings in a case where the acquired number of relays 10 is plural, and a difference in output timing of the pulse current between relays 10 adjacent in an order of output of the pulse current is determined on the basis of a duty ratio of the pulse current and the acquired number of relays 10. According to such a configuration, the ripple of the power supply 20 is suppressed to ripple in a case where the pulse current is output to one relay 10 at a maximum. As a result, it is possible to realize the control method capable of controlling the plurality of relays 10 while suppressing the ripple of the power supply 20.

[0044] The control device 100 may be configured as follows.

[0045] The difference in output timing of the pulse current between the relays 10 adjacent in the order of output of the pulse current may be determined by any method based on the duty ratio of the pulse current and the acquired number of relays 10.

[0046] The control device 100 may be applied not only to the circuit 1, but also to a circuit having any configuration in which a plurality of relays 10 having an identical specification are driven by a pulse current.

[0047] The present disclosure encompasses a program for causing a computer to execute the control method.

[0048] Various embodiments of the present disclosure have been described above in detail with reference to the drawings. Finally, various aspects of the present disclosure will be described. In the following description, as an example, reference signs are also added.

[0049] A control device 100 according to a first aspect of the present disclosure includes:

an acquisition unit 110 configured to acquire the number of relays to be driven having an identical specification; and

an output unit 120 configured to output a pulse current to a plurality of relays to be driven, at shifted output timings in a case where the number of relays acquired by the acquisition unit 110 is plural, wherein the output unit 120 is configured to determine a difference in output timing of the pulse current between relays adjacent in an order of output of the pulse current based on a duty ratio of the pulse current and the number of relays acquired by the acquisition unit 110.

[0050] The control device 100 according to a second aspect of the present disclosure is configured such that in a case where the product of the duty ratio (%) of the pulse current and the number of relays acquired by the acquisition unit 110 is smaller than one hundred, the output unit 120 determines a time defined by the following Expression (1) as the difference in output timing:

$$\lambda/B \quad \text{Expression (1)}$$

[in Expression (1), λ is a cycle (mS) of the pulse current, and B is the number of relays acquired by the acquisition unit 110].

[0051] The control device 100 according to a third aspect of the present disclosure is configured such that in a case where the product of the duty ratio (%) of the pulse current and the number of relays acquired by the acquisition unit 110 is equal to one hundred, the output unit 120 determines a time defined by the following Expression (2) as the difference in output timing:

$$\lambda \times A \quad \text{Expression (2)}$$

[in Expression (2), λ is a cycle (mS) of the pulse current, and A is the duty ratio (%) of the pulse current].

[0052] The control device 100 according to a fourth aspect of the present disclosure is configured such that in a case where the product of the duty ratio (%) of the pulse current and the number of relays acquired by the acquisition unit 110 is larger than one hundred, the output unit 120 determines a time defined by the following Expression (3) as the difference in output timing:

$$\lambda/(A \times B \times 2) \quad \text{Expression (3)}$$

[in Expression (3), λ is a cycle (mS) of the pulse current, A is the duty ratio (%) of the pulse current, and B is the number of relays acquired by the acquisition unit 110].

[0053] The control device 100 according to a fifth aspect of the present disclosure is configured such that in a case where the number of relays acquired by the acquisition unit 110 is larger than a threshold value, the output unit 120 determines the difference in output timing assuming that the number of relays acquired by the acquisition unit 110 is the threshold value.

[0054] A control method according to a sixth aspect of the present disclosure includes:

acquiring the number of relays to be driven having an identical specification; and
outputting a pulse current to a plurality of relays to be driven, at shifted output timings in a case where the acquired number of relays is plural, wherein a difference in output timing of the pulse current between relays adjacent in an order of output of the

pulse current is determined on the basis of a duty ratio of the pulse current and the acquired number of relays.

[0055] By appropriately combining any embodiments or modifications among the various embodiments or modifications, effects of the embodiments or modifications can be produced. In addition, combinations of embodiments, combinations of examples, or combinations of an embodiment and an example are possible, and combinations of features in different embodiments or examples are also possible.

[0056] Although the present disclosure has been fully described in connection with preferred embodiments with reference to the accompanying drawings, various changes and modifications will be apparent to those skilled in the art. Such variations and modifications should be understood as being encompassed within the scope of the present disclosure as set forth in the appended claims.

INDUSTRIAL APPLICABILITY

[0057] The control device and the control method of the present disclosure can be, for example, applied to an on-vehicle relay.

REFERENCE SIGNS LIST

[0058]

1	circuit
10	relay
11	coil
12	contact
20	power supply
30	switching element
100	control device
101	processor
102	storage device
103	communication device
110	acquisition unit
120	output unit
200	generation circuit

Claims

1. A control device (100), **characterized by** comprising:

an acquisition unit (110) configured to acquire the number of relays to be driven having an identical specification; and
an output unit (120) configured to output a pulse current to a plurality of relays to be driven, at shifted output timings in a case where the number of relays acquired by the acquisition unit (110) is plural, wherein

the output unit (120) is configured to determine a difference in output timing of the pulse current between relays adjacent in an order of output of the pulse current based on a duty ratio of the pulse current and the number of relays acquired by the acquisition unit (110).

2. The control device (100) according to claim 1, wherein the output unit (120) determines a time defined by the following Expression (1) as the difference in output timing in a case where the product of the duty ratio (%) of the pulse current and the number of relays acquired by the acquisition unit (110) is smaller than one hundred:

$$\lambda/B \quad \text{Expression (1)}$$

[in Expression (1), λ is a cycle (mS) of the pulse current, and B is the number of relays acquired by the acquisition unit (110)].

3. The control device (100) according to claim 1 or 2, wherein the output unit (120) determines a time defined by the following Expression (2) as the difference in output timing in a case where the product of the duty ratio (%) of the pulse current and the number of relays acquired by the acquisition unit (110) is one hundred:

$$\lambda \times A \quad \text{Expression (2)}$$

[in Expression (2), λ is a cycle (mS) of the pulse current, and A is the duty ratio (%) of the pulse current].

4. The control device (100) according to any one of claims 1 to 3, wherein the output unit (120) determines a time defined by Expression (3) as the difference in output timing in a case where the product of the duty ratio (%) of the pulse current and the number of relays acquired by the acquisition unit (110) is larger than one hundred,:

$$\lambda(A \times B \times 2) \quad \text{Expression (3)}$$

[in Expression (3), λ is a cycle (mS) of the pulse current, A is the duty ratio (%) of the pulse current, and B is the number of relays acquired by the acquisition unit (110)].

5. The control device (100) according to any one of claims 2 to 4, wherein the output unit (120) determines the difference in out-

put timing assuming that the number of relays acquired by the acquisition unit (110) is a threshold value in a case where the number of relays acquired by the acquisition unit (110) is larger than the threshold value.

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6. A control method, comprising:

acquiring the number of relays to be driven having an identical specification; and

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outputting a pulse current to a plurality of relays to be driven, at shifted output timings in a case where the acquired number of relays is plural, wherein

a difference in output timing of the pulse current between relays adjacent in an order of output of the pulse current is determined based on a duty ratio of the pulse current and the acquired number of relays.

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FIG. 1

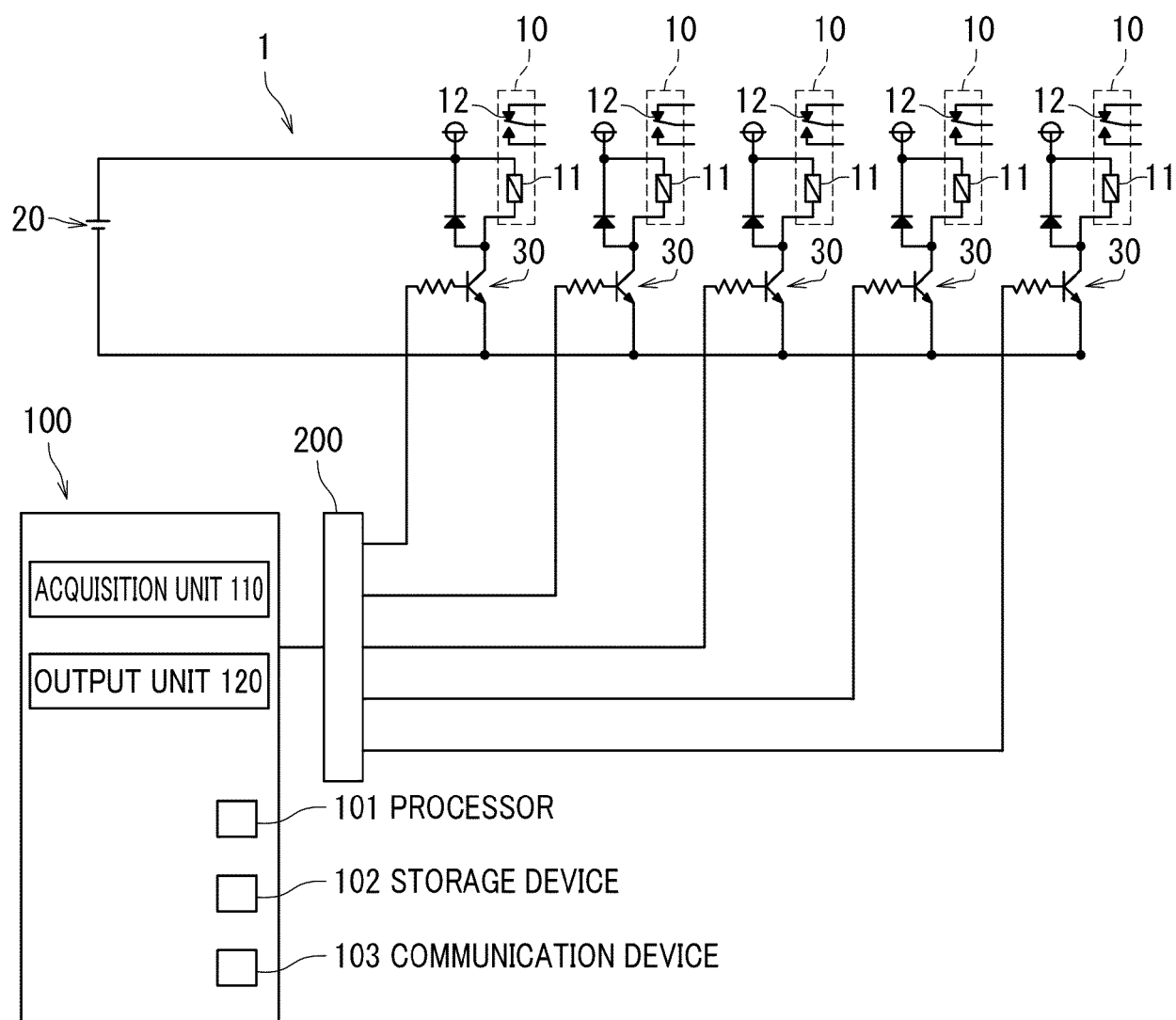


FIG. 2

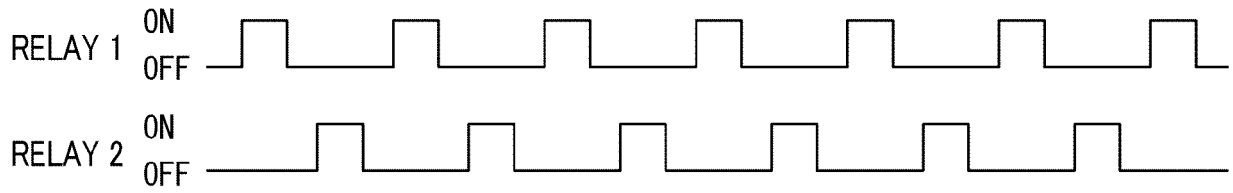


FIG. 3

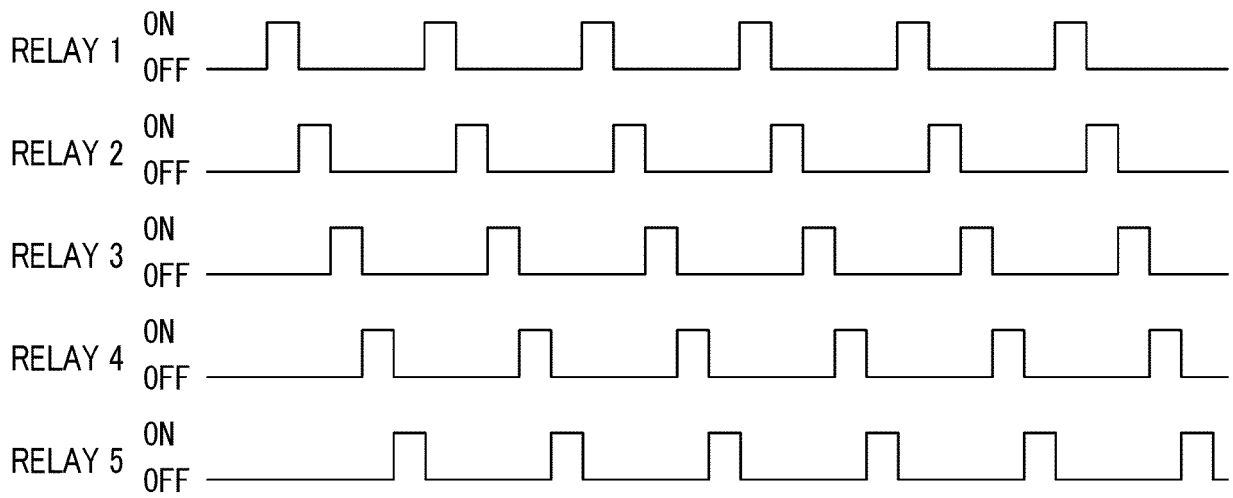


FIG. 4

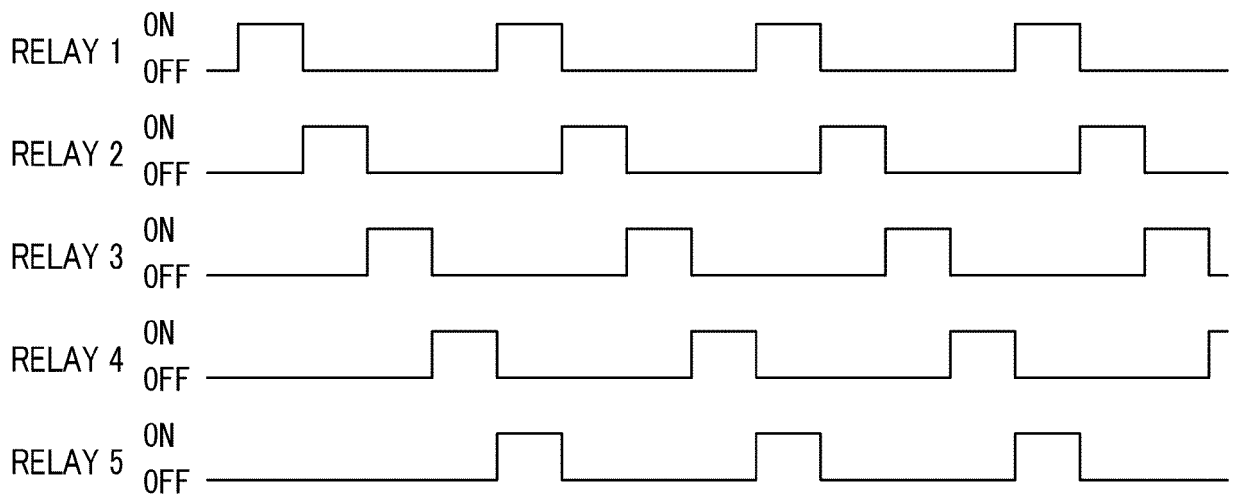


FIG. 5

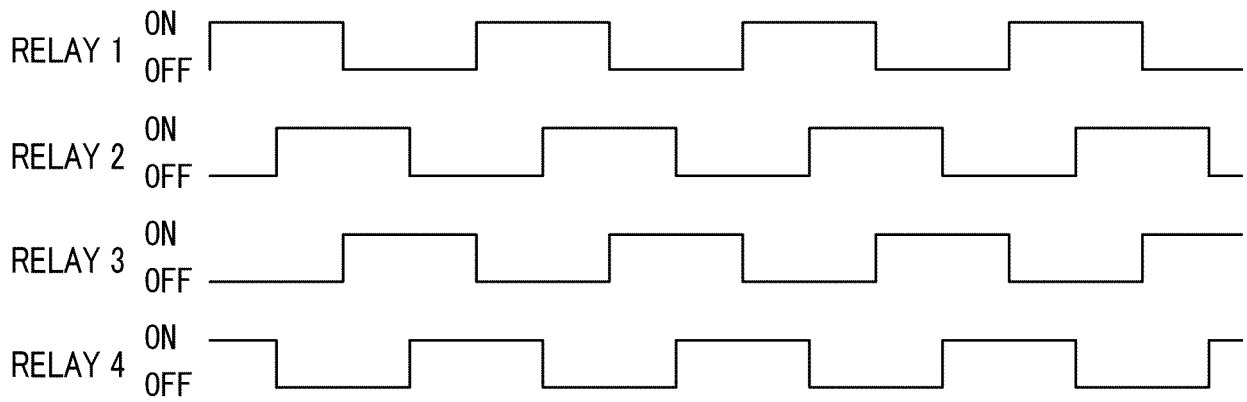


FIG. 6

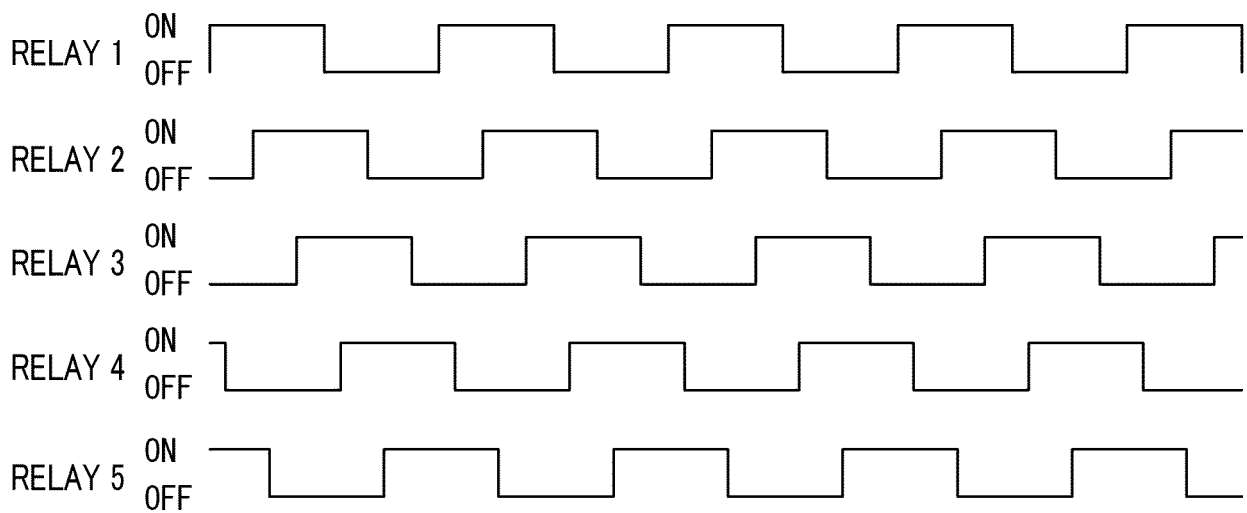
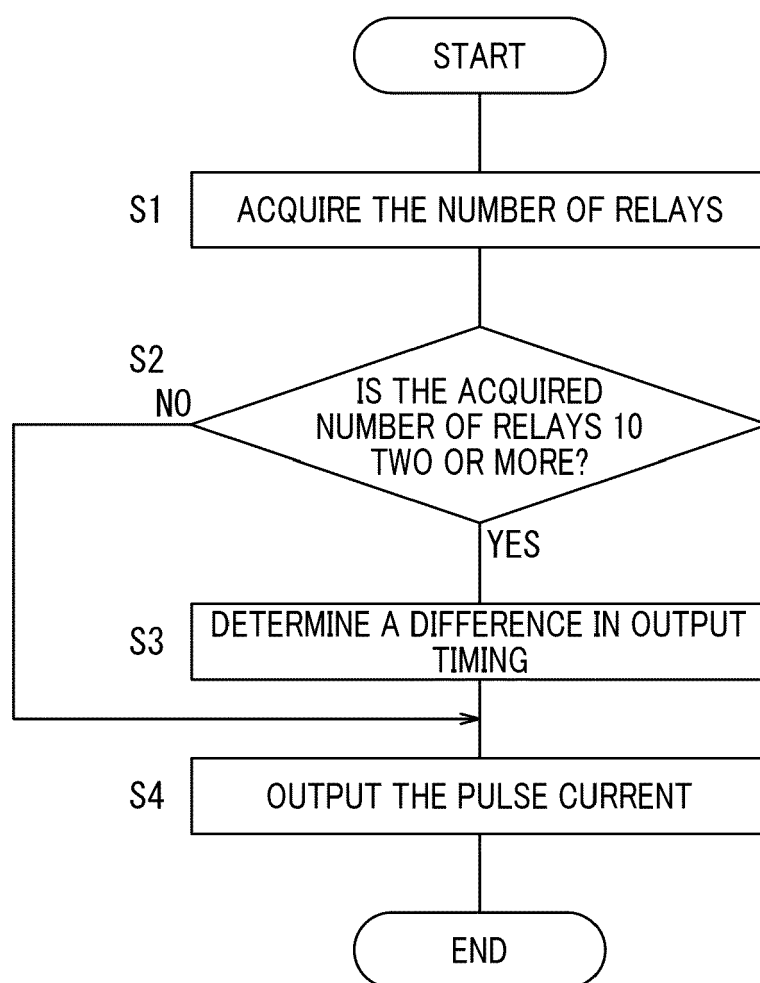


FIG. 7





EUROPEAN SEARCH REPORT

Application Number

EP 23 16 4827

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 6 232 675 B1 (SMALL KENNETH T [US]) 15 May 2001 (2001-05-15) * column 2, line 45 - line 56 * * column 12, line 5 - line 28 * * claims 1, 12 * * figure 3B *	1-6	INV. H01H47/00 H01H47/04 H01H47/18 H01H47/32
A	JP 2011 216229 A (SUZUKI MOTOR CORP) 27 October 2011 (2011-10-27) * paragraph [0002] * * paragraph [0018] - paragraph [0019] * * figures 1-3 *	1-6	
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			TECHNICAL FIELDS SEARCHED (IPC)
			H01H
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		26 July 2023	Fribert, Jan
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 23 16 4827

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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26-07-2023

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REFERENCES CITED IN THE DESCRIPTION

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