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(54) **ASSEMBLY FOR AND METHOD OF MONITORING THE STATUS OF A RELAY**

(57) The invention relates to an assembly (100) for monitoring the status of a relay (200) having an armature (210) and a coil (220) for moving the armature (210), wherein the assembly (100) comprises an inductance measurement device adapted for measuring the inductance of the coil (220), and a method of monitoring the status of a relay (200) having an armature (210) and a coil (220) for moving the armature (210), wherein an inductance of the coil (220) is measured.

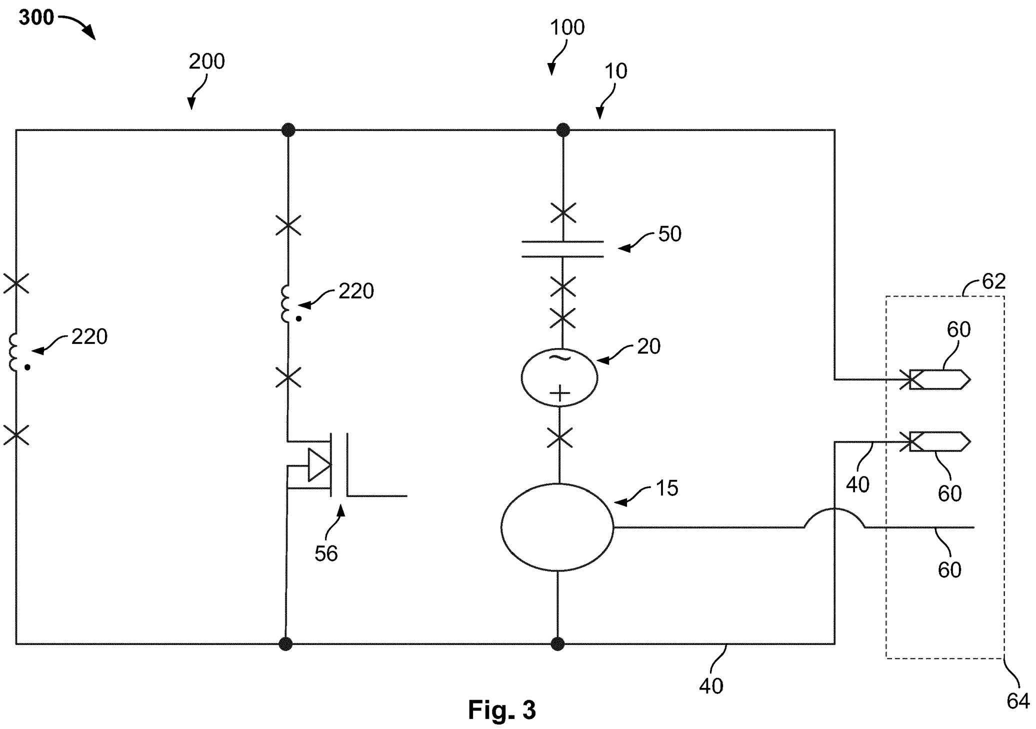

Fig. 3

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Description

[0001] The invention relates to an assembly for and a method of monitoring the status of a relay having an armature and a coil for moving the armature.

[0002] Relays are often used for switching currents with a contact bridge that is movable relative to stationary or fixed contacts. Under faulty conditions the contact bridge can be welded to the stationary contacts for example due to an overcurrent. As this is a dangerous configuration, it is necessary to be able to monitor the switching state and/or detect such a welding. Current solutions for doing this are, however, very bulky.

[0003] It is the object of the invention to provide a solution that is more compact.

[0004] This object is achieved by an assembly for monitoring the status of a relay having an armature and a coil for moving the armature, wherein the assembly comprises an inductance measurement device adapted for measuring the inductance of the coil.

[0005] The object is also achieved by a method of monitoring the status of a relay having an armature and a coil for moving the armature, wherein an inductance of the coil is measured.

[0006] This solution does not require additional measurement devices so that a more compact configuration can be achieved.

[0007] The solution according to the invention can further be improved by the following further developments and advantageous embodiments, which are independent of each other and can be combined arbitrarily, as desired.

[0008] The inductance measurement device can comprise a current measurement device to allow a simple implementation.

[0009] The circuit can discriminate the inductance difference between partially closed armature and fully open armature.

[0010] In an advantageous embodiment, the assembly can comprise an oscillator adapted for creating an alternating current. This can allow a quick measurement.

[0011] The inventive solution can be part of a relay assembly comprising a relay and an assembly according to the invention.

[0012] In order to simplify the electrical layout and to save space, the relay and the assembly can have a common ground.

[0013] The assembly can be connected to a control circuit of the relay. This can keep the configuration simple and compact. The assembly can be adapted to be connected to the control circuit of the relay. It can be added to existing relays.

[0014] In a further embodiment, the control circuit and the assembly are arranged on the same PCB. This keeps the overall device simple and compact. Such a PCB can comprise additional elements for performing the measurement.

[0015] To achieve a good decoupling, in particular during the operation of the relay, the assembly can be connected to the relay via a capacitor. Relays are often operated with a direct current (DC) or a current that is similar to a direct current. The capacitor can thus achieve a good decoupling.

[0016] In an advantageous embodiment, the assembly can be arranged within a housing of the relay. This keeps the configuration compact.

[0017] In order to be able to process the results of a measurement, a connector of the relay assembly can comprise at least one pin for a signal of the assembly. Through this pin, signals indicative of a measurement can be transmitted. For example, the signal could indicate a position or a status of the contact bridge or whether a fault condition exists. In easier embodiments, the pin can be used to output current or voltage that has to be processed in additional elements.

[0018] In a further embodiment, the assembly can be arranged outside a housing of the relay. The assembly can then be added to existing relays without big modifications. The assembly can, for example, be at least partially located in a control circuit, e.g. an engine control unit.

[0019] In a space-saving configuration, the armature can be at least partially located in the coil. Preferably, the armature is located entirely or almost entirely within the coil. For example, the armature can be located in a space defined by the outlines of the coil and/or a housing of the coil.

[0020] In an advantageous development of the method, the inductance can be measured at at least one frequency with an alternating current. The frequency can be selected such that a certain difference in the inductance values exists between a normal and a fault state.

[0021] In a preferred embodiment, the method can comprise a step of detecting a fault state of the armature. Such a fault state can in particular be a state in which the switching has not taken place although a corresponding control signal is applied.

[0022] The detection of the fault state can be made by comparing the measured inductance to a predefined value. If the measured inductance is below or above a certain threshold value, a fault state can be diagnosed. The predefined value can depend on the inductance value of a normal state and can, for example, be 20% higher or lower than such a normal state value.

[0023] To improve the accuracy, the inductance can be measured at at least two frequencies.

[0024] In order to not intervene with the operation of the relay, the assembly or the method can be such that the status is only monitored in a non-energized state of the relay.

[0025] The application also covers a computer program comprising instructions which, when the program is executed by a computer, cause the computer to carry out the inventive method.

[0026] Further, the application covers a computer-readable medium comprising instructions which, when executed by a computer, cause the computer to carry out the inventive method.

[0027] The invention will now be described in greater detail and in an exemplary manner using advantageous embodiments and with reference to the drawings. The described embodiments are only possible configurations in which, however, the individual features as described above can be provided independently of one another or can be omitted.

[0028] In the figures:

Fig. 1 shows a schematic cross-sectional view through a relay in a first state;

Fig. 2 shows a schematic cross-sectional view through a relay in a second state;

Fig. 3 shows an electrical lay out of a first embodiment of a relay assembly;

Fig. 4 shows an electrical lay out of a second embodiment of a relay assembly;

Fig. 5 shows a graph depicting the difference in the inductance between an open state and a fault state.

[0029] In Figs. 1 and 2, the operation of a relay 100 is depicted. Fig. 1 can be seen as an energized state 401 of a coil 220 that results in a closed state 411 of a load circuit 255. A current runs through the coil 220, which generates a magnetic field that pulls an armature 210 inwards. The armature 210 is coupled to a contact bridge 240 via a transfer rod 246 and an attachment assembly 247. A contact bridge 240 is thus pushed onto two fixed contacts 250 of a load circuit 255 and closes the load circuit 255.

[0030] In Fig. 2, a non-energized state 402 of the coil 220 resulting in an open state 412 of the load circuit 255 is shown. When no current flows through the coil 220, the armature 210 is pushed outwards by a spring 245. The contact bridge 240 is thus pulled away from the fixed contacts 250 so that the load circuit 255 is open.

[0031] Under certain circumstances, for example too high load currents, the contact bridge 240 can be welded to at least one of the fixed contacts 250. This is a dangerous fault condition that should be detected so that the operation of the relay 200 can be discontinued. Fig. 1 can also be seen as showing such a fault state 406 in which the load circuit 255 is closed or almost closed although the coil 220 is in a non-energized state 402.

[0032] To monitor the position and/or status of the contact bridge 240 and/or the armature 210, the relay assembly 300 can comprise an assembly 100 that comprises an inductance measurement device 10 adapted for measuring the inductance of the coil 220. Details of such embodiments are shown in Figs. 3 and 4.

[0033] The inductance of the coil 220 depends on the position of the armature 210 in the coil 220. In case of a fault condition, in which the contact bridge 240 is welded to at least one fixed contact 250, the armature 210 cannot move back although the coil 220 is not energized. In the embodiment of Fig. 3, two coils 220 are present, wherein one of the coils 220 can be activated selectively by a transistor 56.

[0034] The assembly 100 can more generally be adapted to detect or measure the position of the armature 210. Such a position measurement can, for example, be used to detect further fault conditions. For example, the movement profile of the armature 210 can be analyzed to check whether the friction is increased. Further, the assembly 100 could be used to detect the tear and wear of contact elements 241 located on the contact bridge 240 and the fixed contacts 250. Such contact elements 241 are used up during the lifetime of the relay 200. The lack of enough material in the contact elements 241 can cause dangerous situations. The assembly 100 can be adapted to detect such conditions, for example by detecting an increased movement span of the armature 210.

[0035] The assembly comprises an oscillator 20 adapted for creating an alternating current. The frequency of the alternating current can be constant or variable. The alternating current is used for measuring the inductance in the coil 220.

[0036] In particular, the inductance measurement device 10 comprises a current measurement device 15 that measures the current resulting in the circuit. The current in the circuit depends on the inductance of the coil 220.

[0037] In the present example, the inductance measurement device 10 is adapted to calculate the maximum current measured with the current measurement device 15.

[0038] The relay 200 and the assembly 100 have a common ground 40 in order to simplify the electrical layout and in order to keep the number of pins 60 that are necessary for contacting the relay assembly 300 low. In the depicted examples, three pins 60 are necessary, which is only one pin more than a relay 200 without an assembly 100. A schematically shown connector 62 having the pins in a housing 64 can thus be similar in size to a connector with only two pins 60.

[0039] The assembly 100 is connected to a control circuit 215 of the relay 200, which is shown only schematically. For example, the assembly 100 can be arranged on the same PCB as the control circuit 215.

[0040] A capacitor 50 can be used to decouple a control signal for the switching of the relay 200, which is a direct current, or a signal similar to a direct current, from the alternating current used in the assembly 100.

[0041] In a space-saving configuration, the assembly 100 is arranged within a housing 230 of the relay 200.

[0042] In another embodiment, the assembly 100 can be arranged outside a housing 230 of the relay 200, for example in an external control circuit or an engine control unit. In such a configuration, it could suffice to use only two pins 60 in the connector 62, as the necessary contacts to the circuit of the coil 220 can be made outside of the housing 230.

[0043] In the depicted embodiment, the armature 210 is at least partially located in the coil 220 and/or in the housing 230 of the coil 220.

[0044] In the inventive method of monitoring the status of the relay 200 having an armature 210 and a coil 220 for moving the armature 210, an inductance of the coil 220 is measured.

[0045] The method can be adapted to detect a fault state of the armature 210 by comparing the measured inductance to a predefined value.

[0046] To improve the reliability, the inductance can be measured at at least two frequencies.

[0047] Preferably, the method is only used and the status is only monitored in a non-energized state of the relay. It is then not necessary to compensate effects due to the operation of the relay 200.

[0048] In Fig. 5, a graph showing the different inductive behavior of a relay 200 in an open position 412 and a fault state 406 is shown. The graph shows an inductance signal in arbitrary units on the ordinate over the frequency of the alternating current used for the measurement on the abscissa. It can be seen that at certain frequencies, a distinct difference between the two conditions exists. The measurement should be made at such a frequency. The frequency at which such a difference exists of course depends on the specific case.

REFERENCE NUMERALS

[0049]

10	inductance measurement device
15	current measurement device
20	oscillator
40	ground
50	capacitor
55	resistor
56	transistor
60	pin
62	connector
64	connector housing
100	assembly
200	relay
210	armature
215	control circuit
220	coil
230	housing
240	contact bridge
241	contact element
245	spring
246	transfer rod
247	attachment assembly
250	fixed contact
255	load circuit
260	PCB
300	relay assembly
401	energized state
402	non-energized state
406	fault state
411	closed state
412	open state

Claims

1. Assembly (100) for monitoring the status of a relay (200) having an armature (210) and a coil (220) for moving the armature (210), wherein the assembly (100) comprises an inductance measurement device adapted for measuring the inductance of the coil (220).

2. Assembly (100) according to claim 1, wherein the inductance measurement device (10) comprises a current measurement device (15).

3. Assembly according to claim 2, wherein the inductance measurement device (10) is adapted to calculate the maximum current measured with the current measurement device (15).

4. Assembly (100) according to one of claims 1 to 3, wherein the assembly (100) comprises an oscillator (20) adapted for creating an alternating current.

5. Relay assembly (300) comprising a relay (200) and an assembly (100) according to one of claims 1 to 4.

6. Relay assembly (300) according to claim 5, wherein the relay (200) and the assembly (100) have a common ground (40).

7. Relay assembly (300) according to claim 5 or 6, wherein the assembly (100) is connected to a control circuit (215) of the relay (200).

8. Relay assembly (300) according to one of claims 5 to 7, wherein the assembly (100) is connected to the relay (200) via a capacitor (50).

9. Relay assembly (300) according to one of claims 5 to 8, wherein the assembly (100) is arranged within a housing (230) of the relay (200).

10. Method of monitoring the status of a relay (200) having an armature (210) and a coil (220) for moving the armature (210), wherein an inductance of the coil (220) is measured.

11. Method according to claim 10, wherein the inductance is measured at at least one frequency with an alternating current.

12. Method according to one of claims 10 or 11, wherein

a fault state of the armature (210) is detected.

13. Method according to one of claims 10 to 12, wherein the status is only monitored in a non-energized state of the relay (200).

14. A computer program comprising instructions which, when the program is executed by a computer, cause the computer to carry out the method of one of claims 10 to 13.

15. A computer-readable medium comprising instructions which, when executed by a computer, cause the computer to carry out the method of one of claims 10 to 13.

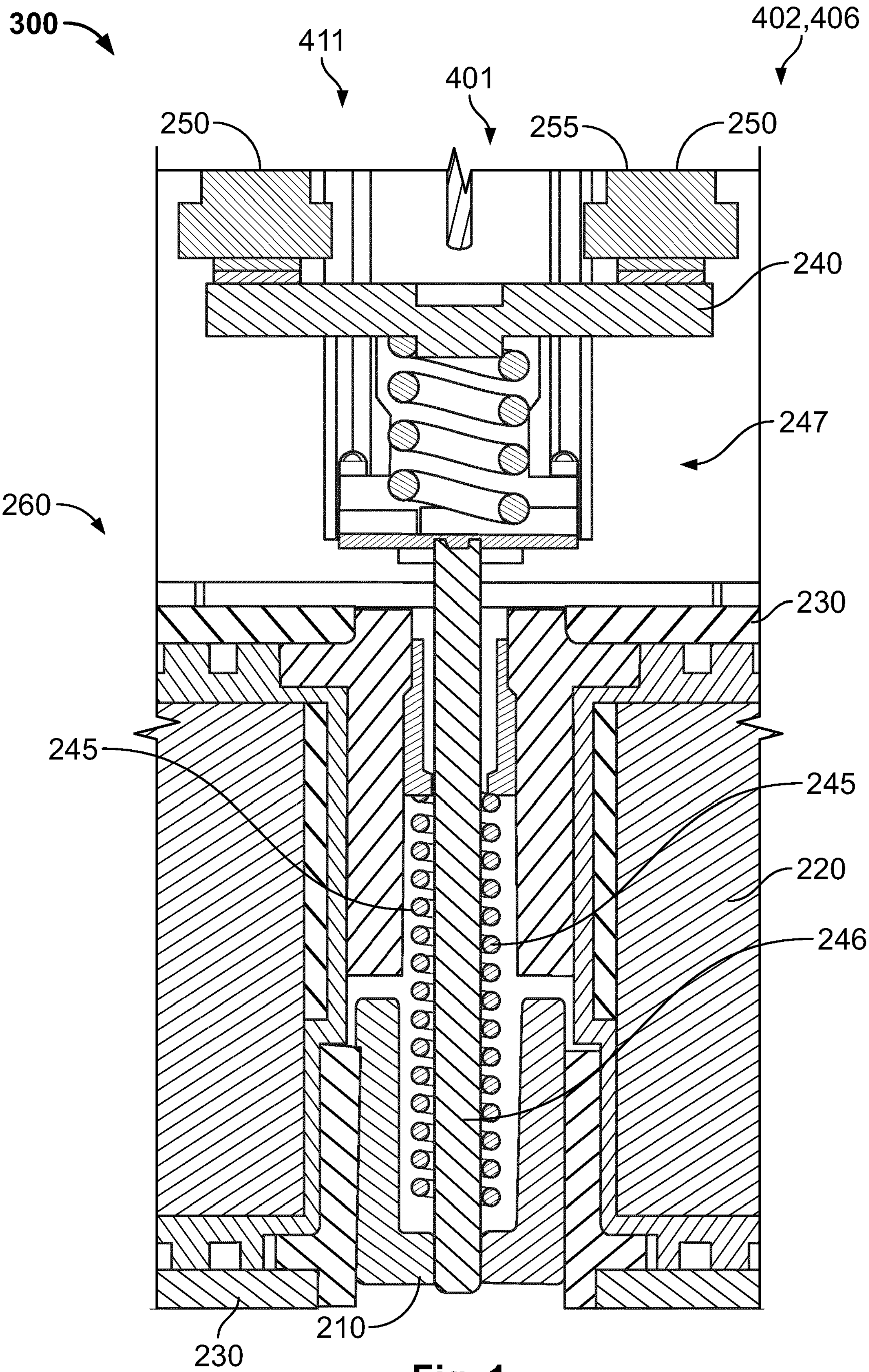
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Fig. 1

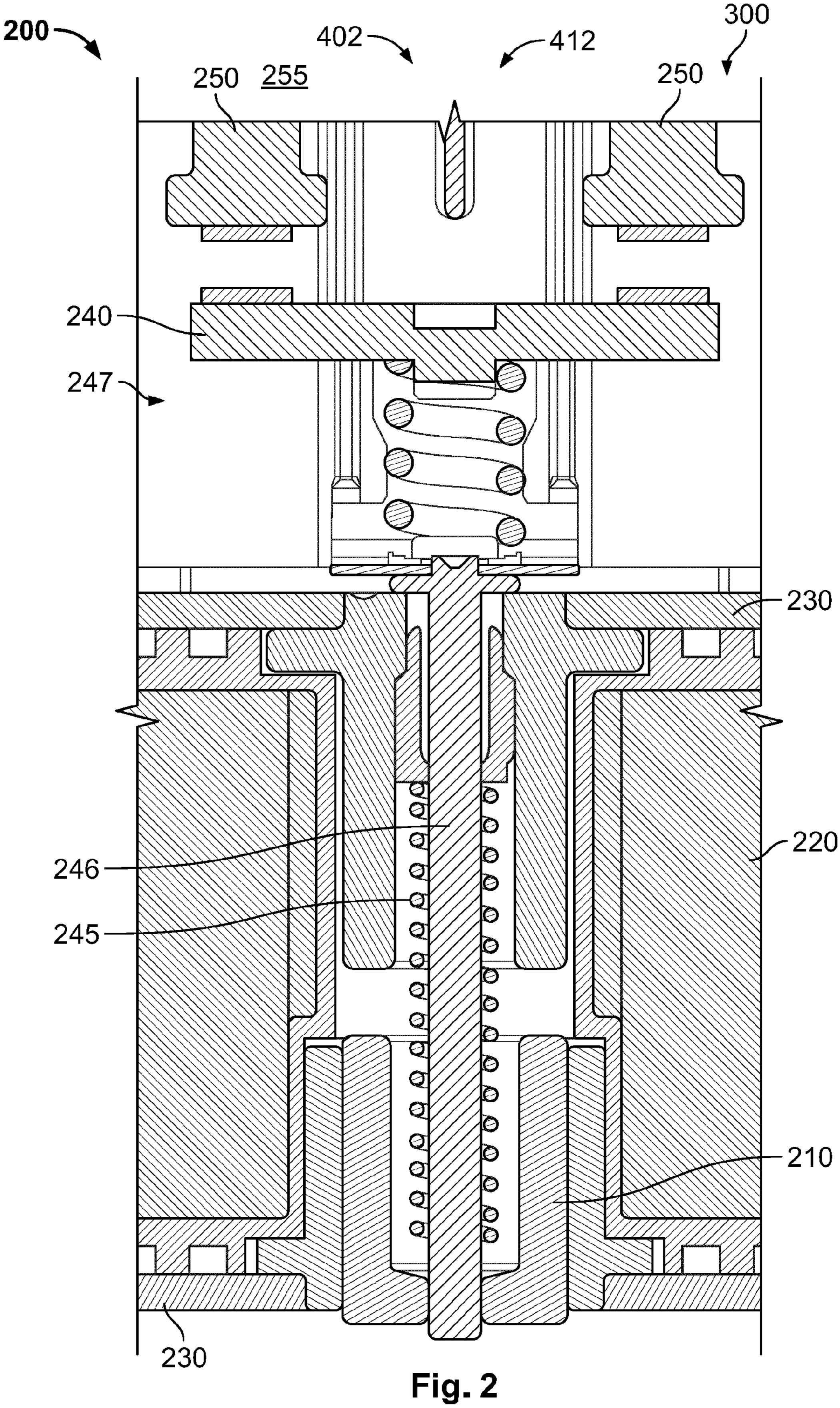

Fig. 2

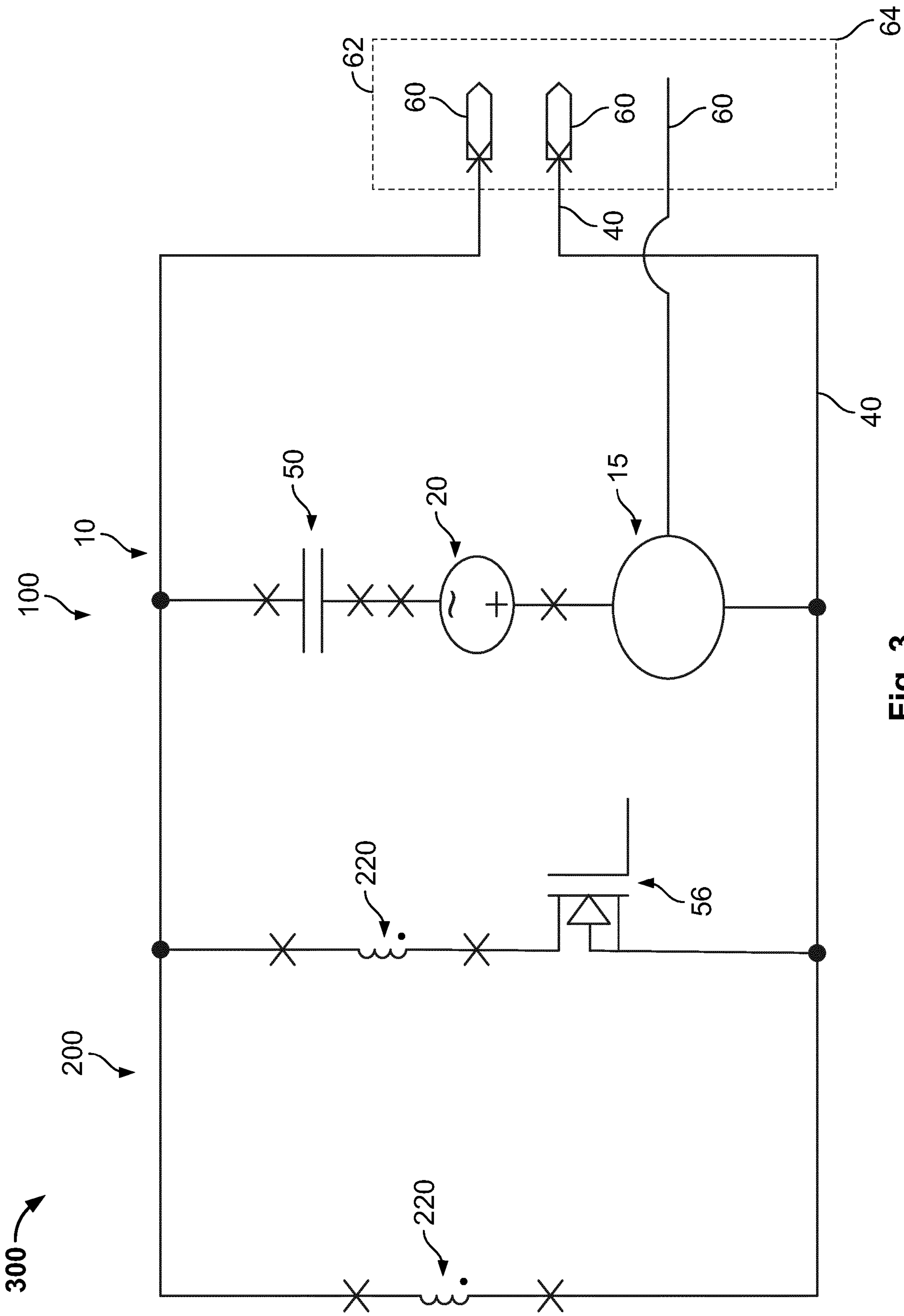

Fig. 3

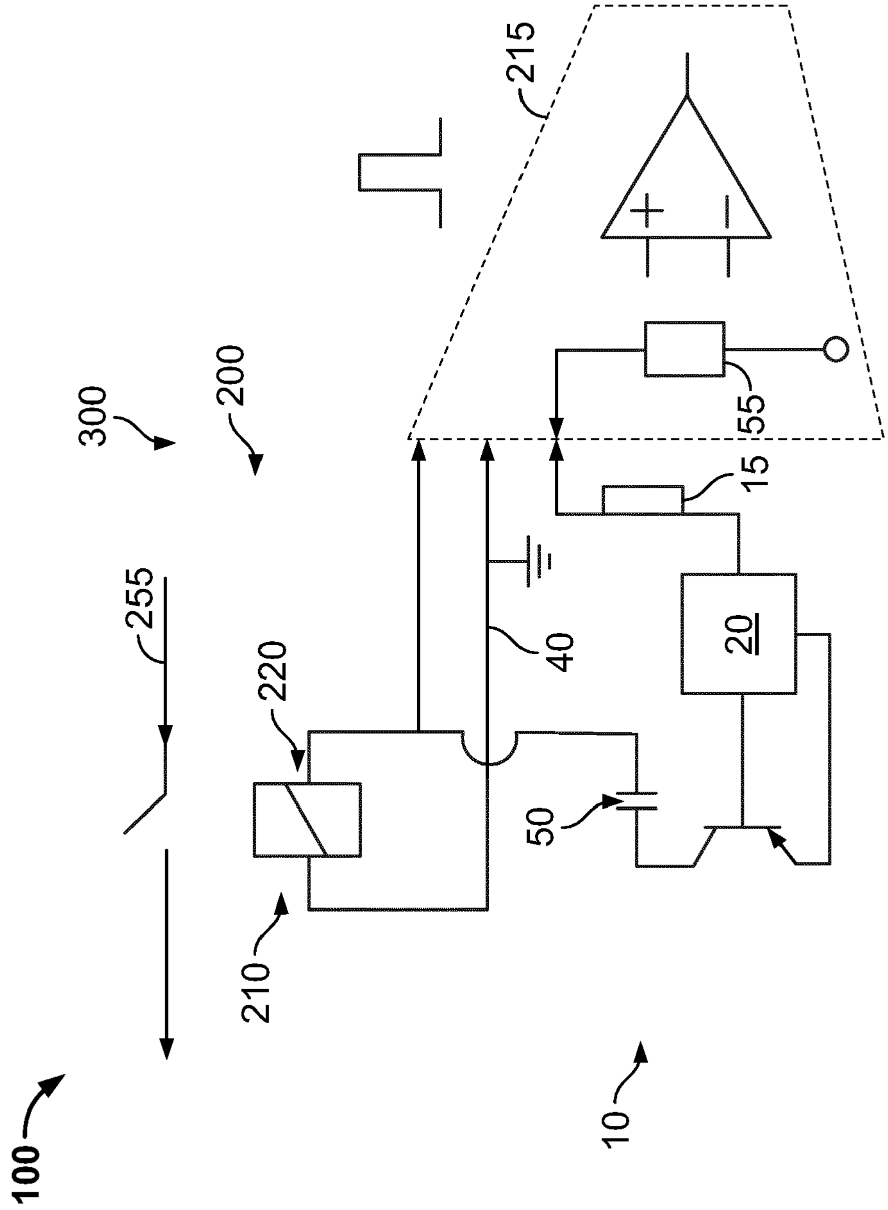

Fig. 4

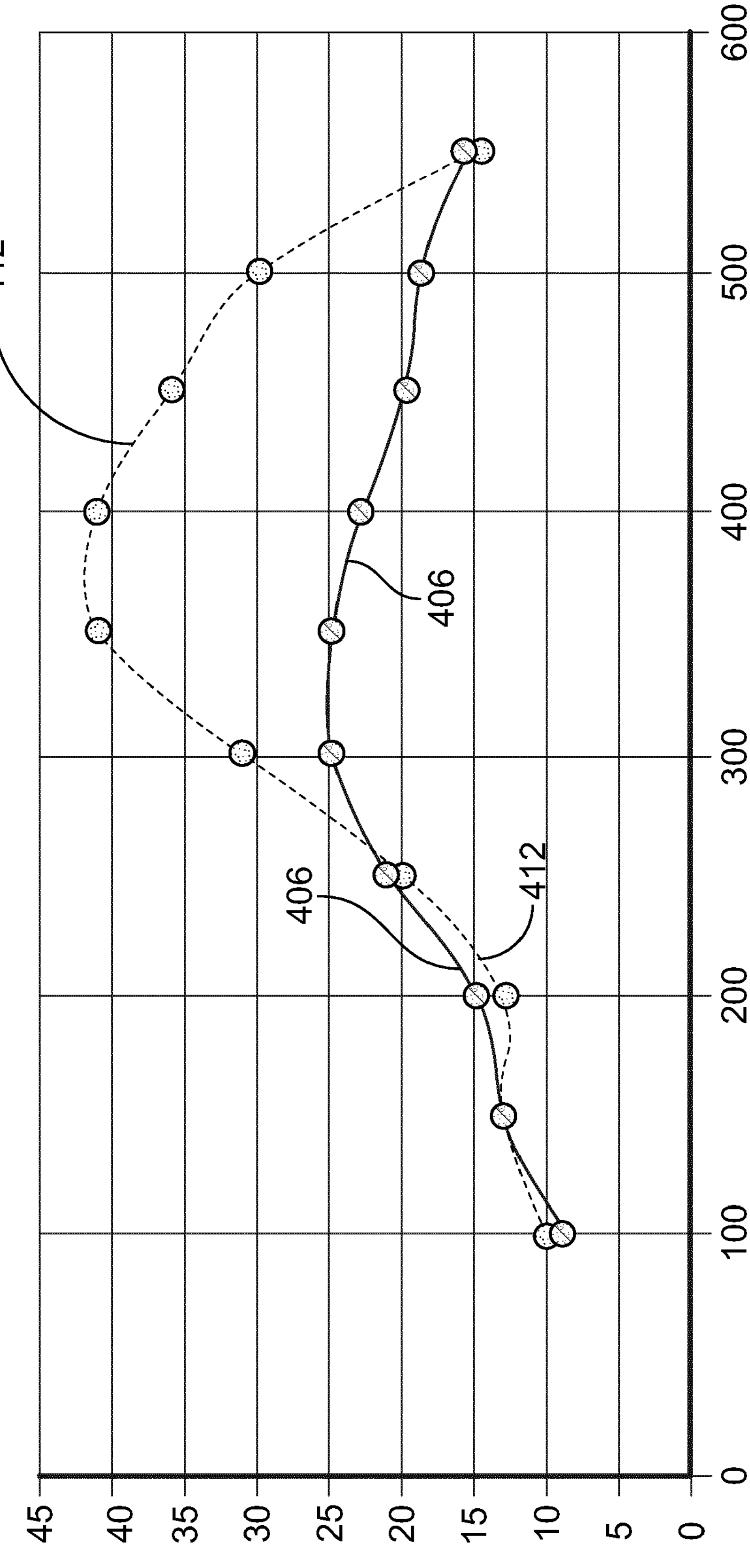

Fig. 5

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Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	3 April 2020	Serrano Funcia, J

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