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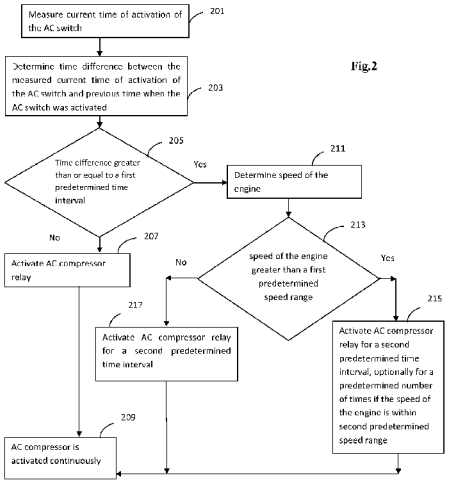


Fig.2

(57) **Abstract**: The present disclosure is related to an Air Conditioning (AC) system of a vehicle. In order to avoid seizure/ failure of an AC compressor when the AC compressor is activated after a long duration, the control unit configured in the AC system activates the AC compressor relay for a predetermined time interval when the engine is idling. Therefore, at high engine speeds, the AC compressor can operate safely. If the AC compressor is activated after a long duration and if the vehicle is in operation, the control unit waits till the engine speed falls within a safe band range to activate the AC compressor for a second predetermined time interval. The compressor is activated for a predetermined number of times to provide sufficient lubrication to the internal parts of the AC compressor.

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# A METHOD OF OPERATING A VEHICLE AIR CONDITIONING SYSTEM

## TECHNICAL FIELD

The present disclosure is related to a mobile air conditioning (MAC) system. In particular, the present disclosure relates to a method of operating a vehicle AC system to avoid seizure/failure of an AC compressor.

## BACKGROUND

AC compressor is a critical component in a mobile heating ventilating air conditioning (HVAC) system. The AC compressor in a vehicle is driven by the engine of the vehicle. The AC compressor operates at high speed in the vehicle. Being operational at high speed, the AC compressor is filled with lubricating oil. Polyalkylene glycol (PAG) oils were developed as lubricants for automotive air conditioning systems and mainly incorporated in the AC system for the purpose of AC compressor lubrication. During operation of the AC system, due to the miscibility property of oil with refrigerant, it flows from the AC compressor along with the refrigerant to other parts of the AC system like condenser, receiver dryer, expansion valve, evaporator, and plumbing finally comes back to the AC compressor again. If the AC system is not used for a long duration say for example 15 days, the AC compressor lubrication oil gets settled at the bottom of the compressor because of which most of the internal parts of the AC compressor parts free from lubrication oil film/layer and they are almost in dry condition. If an operator/ user/ driver start the vehicle after the long duration, due to vehicle battery drain or weak, the operator/user/driver tends to accelerate the engine and at the same time starts the AC system. As the engine is accelerated and engine speed RPM is high, the speed RPM of the AC compressor becomes high, due to the AC system drive pulley ratio. The instantaneous starting of the AC compressor at high speed after a long time does not provide a chance to the internal moving parts of the AC compressor to get lubricated sufficiently and hence results in seizure/ failure of the AC compressor.

Hence, there exists a need to operate an air conditioning system of the vehicle such that there is no failure /seizure of the AC compressor.

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## OBJECTIVES OF THE DISCLOSURE

One objective of the present disclosure is to avoid seizure /failure of the AC compressor when the AC compressor is operated after a long duration.

A second objective of the present disclosure is to eliminate the complexity of using a preliminary lubricating device when vehicle is idling.

Further to it, a third objective of the present disclosure is to improve reliability of the AC system in the vehicle.

## SUMMARY

The shortcomings of the prior art are overcome and additional advantages are provided through the present disclosure. Additional features and advantages are realized through the techniques of the present disclosure. Other embodiments and aspects of the disclosure are described in detail herein and are considered a part of the claimed disclosure.

In one embodiment, the present disclosure provides a method of operating an Air Conditioning (AC) system. The method comprises measuring current time of activation of an AC switch by a control unit configured in the air conditioning system when speed of the vehicle is greater than a first predetermined speed range. The control unit compares the measured current time of activation of the AC switch with previous time when the AC switch was activated to determine time difference between the measured current time of activation of the AC switch and the previous time when the AC switch was activated. If the time difference is greater than a first predetermined time interval, the control unit determines whether the RPM of the vehicle is within a second predetermined speed range. The control unit activates the AC compressor relay for a second predetermined time interval if the RPM of the vehicle is within the second predetermined speed range.

In one embodiment, the present disclosure provides an air conditioning system. The air conditioning system comprises an AC compressor relay, an AC switch, an AC compressor and a control unit. The AC compressor relay is configured to perform at least one of activating and deactivating the AC compressor. The control unit measures current

time of activation of an AC switch when speed of the vehicle is greater than a first predetermined speed range and compares the measured current time of activation of the AC switch with previous time when the AC switch was activated to determine time difference between the measured current time of activation of the AC switch and the previous time when the AC switch was activated. If the time difference is greater than a first predetermined time interval, the control unit determines whether speed of the vehicle is within a second predetermined speed range. The control unit activates the AC compressor relay for a second predetermined time interval if the RPM of the vehicle is within the second predetermined speed range.

The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects and features described above, further aspects, and features will become apparent by reference to the drawings and the following detailed description.

## BRIEF DESCRIPTION OF THE DRAWINGS

The novel features and characteristic of the disclosure are set forth in the appended claims. The embodiments of the disclosure itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings. One or more embodiments are now described, by way of example only, with reference to the accompanying drawings.

**Fig.1** illustrates a block diagram of a vehicle air conditioning system in accordance with an embodiment of the present disclosure; and

**Fig.2** illustrates a method of operating a vehicle air conditioning system in accordance with an embodiment of the present disclosure.

The figures depict embodiments of the disclosure for purposes of illustration only. One skilled in the art will readily recognize from the following description that alternative

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embodiments of the structures and methods illustrated herein may be employed without departing from the principles of the disclosure described herein.

## DETAILED DESCRIPTION

The foregoing has broadly outlined the features and technical advantages of the present disclosure in order that the detailed description of the disclosure that follows may be better understood. Additional features and advantages of the disclosure, which form the subject of the claims will be described hereinafter.. It should be appreciated by those skilled in the art that the conception and specific aspect disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the present disclosure. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the disclosure as set forth in the appended claims. The novel features which are believed to be characteristic of the disclosure, both as to its organization and method of operation, together with further objects and advantages will be better understood from the following description when considered in connection with the accompanying figures. It is to be expressly understood, however, that each of the figures is provided for the purpose of illustration and description only and is not intended as a definition of the limits of the present disclosure.

In an embodiment, the present disclosure is related to a method of operating an air conditioning system of a vehicle.

**Fig.1** illustrates block diagram of an air conditioning (AC) system **100** of a vehicle in accordance with an embodiment of the present disclosure. The AC system **100** comprises an AC switch **103**, a control unit **105**, an AC compressor relay **107** and an AC compressor **109**. The control unit **105** is at least one of an electronic control unit (ECU), body control modules (BCM), fully automatic temperature control electronic control unit (FATC ECU) and any other control unit for the purpose of controlling the operation of the AC system **100** of the vehicle. The control unit **105** comprises of one or more sensors to detect revolutions per minute (RPM) of the vehicle. The control unit **105** also

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comprises a timer circuit to preconfigure time intervals for activation and deactivation of the AC compressor relay **107**.

When the AC switch **103** is activated, an activation signal is provided to the control unit. The control unit measures current time of activation of the AC switch **103.** The control unit **105** compares the measured current time of activation of the AC switch **103** with previous time when the AC switch was activated. Here, the AC switch was activated scenario covers the aspect of when the AC switch was last activated. The control unit **105** keeps track of activation time of the AC switch **103.** If the time difference is less than a first predetermined time interval the control unit **105** activates the AC compressor relay **107** which in turn activates the AC compressor **109** continuously. The first predetermined time interval is in the range of 15-20 days. If the time difference is greater than or equal to the first predetermined time interval, the control unit **105** determines Revolutions per Minute (RPM) of the vehicle. The one or more sensors configured in the control unit **105** detect the RPM of the vehicle. In one embodiment, if the detected RPM of the vehicle is within a first predetermined speed range, the control unit **105** activates the AC compressor relay **107** for a second predetermined time interval. The AC compressor relay **107** in turn activates the AC compressor **109** for the second predetermined time interval during which the internal parts of the AC compressor is lubricated. After the second predetermined time interval the control unit **105** activates the AC compressor relay **107** continuously. The first predetermined speed range is 500-1000 RPM. In one embodiment the first predetermined speed range is the idle speed of the vehicle. The second predetermined time interval is in the range of 20-30 seconds.

In one embodiment, if the detected RPM of the vehicle is greater than the first predetermined speed range, the control unit **105** determines if the RPM of the vehicle is within a second predetermined speed range. The second predetermined speed range is 1000-1500 RPM. If the RPM of the vehicle is within the second predetermined speed range, the control unit **105** activates the AC compressor relay **107** for the second predetermined time interval. In one embodiment, the activation of the AC compressor relay **107** for the second predetermined time interval is performed for a predetermined number of times. The time interval between each activation of the AC compressor relay

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**107** is in the range of 10-20 seconds. The second predetermined time interval is in the range of 20-30 seconds. The predetermined number of times is in the range of 2-3. When the AC compressor relay **107** is activated for the second predetermined time interval, the internal parts of the AC compressor **109** is lubricated and thus the failure/seizure of the AC compressor **109** when the AC compressor **109** is operated at high speed is avoided when the AC compressor relay **107** is activated as described above for the predetermined number of times for better lubrication.

In one embodiment if the RPM of the vehicle goes beyond the second predetermined speed range, the control unit **105** deactivates the AC compressor relay **107** and waits till the RPM of the vehicle falls within the second predetermined speed range.

Consider the example of activating the AC switch **103** in a vehicle after 15 days. In this scenario, the control unit **105** determines whether the vehicle is in operation or stationary. If the vehicle is stationary i.e RPM of the vehicle is less than 1000 RPM, the control unit **105** activates the AC compressor relay **107** for 30 seconds. The AC compressor relay **107** keeps the AC compressor **109** in activation for 30 seconds. During the activation period of the AC compressor **109**, the internal parts of the AC compressor **109** is lubricated. Then, the AC compressor relay **107** is activated continuously by the control unit **105**. If the vehicle is in operation and the AC switch **103** is activated after 15 days, the control unit **105** determines RPM of the vehicle. If the RPM of the vehicle is within 1000-1500 range, the control unit **105** activates the AC compressor relay for 30 seconds. The activation of the AC compressor relay **107** for 30 seconds is performed three times so that the internal parts of the AC compressor **109** are lubricated within the activation time period. The time interval between each activation of the AC compressor relay **107** is 20 seconds. After performing the activation of the AC compressor relay **107** for 30 seconds and for three times, the control unit **105** activates the AC compressor relay **107** continuously. If the RPM of the vehicle is above 1500, the control unit **105** deactivates the AC compressor relay **107** and waits till the RPM of the vehicle is within 1000-1500 RPM range to activate the AC compressor **107**.

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**Fig.2** illustrates a method of operating an air conditioning system **100** of a vehicle in accordance with an embodiment of the present disclosure. At step **201**, the control unit **105** measures current time of activating the AC switch **103**. The control unit **105** determines time difference between the measured current time of activating of the AC switch **103** and previous time when the AC switch **103** was activated at step **203**. The previous time when the AC switch **103** was activated is stored in the control unit **105**. At step **205**, the control unit **105** determines whether the time difference is greater than or equal to a first predetermined time interval. If the time difference is greater than or equal to the first predetermined time interval, the control unit determines RPM of the vehicle at step **211**. If the time difference is less than the first predetermined time interval, the control unit **105** activates the AC compressor relay **107** at step **207**. At step **213**, the control unit **105** determines whether the RPM of the vehicle is greater than a first predetermined speed range. If the RPM of the vehicle is greater than the first predetermined speed range and within the second predetermined speed range, the control unit **107** activates the AC compressor relay **107** for a second predetermined time interval at step **215**. The AC compressor relay **107** is activated for a predetermined number of times. If the RPM of the vehicle is less than the first predetermined speed range, the control unit **105** activates the AC compressor relay **107** for the second predetermined time interval at step **217**.

Referral Numerals

| Reference Number | Description |
|---|---|
| Air conditioning system | **100** |
| AC switch | **103** |
| Control unit | **105** |
| AC Compressor Relay | **107** |
| AC compressor | **109** |

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Advantages:

The present disclosure increases reliability of the AC system of a vehicle by avoiding seizure/failure of the AC compressor.

The present disclosure eliminates the use of a preliminary lubricating device for lubricating AC compressor during idle RPM of the vehicle.

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We claim:

1. A method of operating an air conditioning (AC) system of a vehicle, the method comprising:

measuring, by a control unit, current time of activation of an AC switch configured in the vehicle;

determining, by the control unit, a time difference between the measured current time of activation of the AC switch and a previous time when the AC switch was active;

determining, by the control unit, an engine speed of the vehicle when the time difference is greater than a first predetermined time interval;

determining, by the control unit, an engine speed range of the vehicle by comparing determined engine speed of the vehicle with at least one of a first predetermined engine speed range and a second predetermined engine speed range;

performing, by the control unit, at least one of activating an AC compressor relay, associated with the AC switch, for a second predetermined time interval if the engine speed range of the vehicle is within the first predetermined engine speed range, and activating the AC compressor relay for the second predetermined time interval for a predetermined number of times if the engine speed range of the vehicle is within the second predetermined engine speed range; and

deactivating the AC compressor relay if the engine speed range is greater than the second predetermined engine speed range, wherein the AC compressor relay is again activated when the engine speed range is within at least one of the first predetermined engine speed range and the second predetermined engine speed range.

2. The method as claimed in claim 1, wherein the second predetermined time interval is in the range of 20-30 seconds.

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3. The method as claimed in claim 1 or claim 2, wherein the second predetermined engine speed range is 1000-1500 RPM.

4. The method as claimed in any one of the preceding claims, wherein the predetermined number of times is in the range of 2-3.

5. The method as claimed in any one of the preceding claims, wherein time interval between each activation of the AC compressor relay for a predetermined number of times is in the range of 10-20 seconds.

6. The method as claimed in any one of the preceding claims further comprising activating the AC compressor relay, by the control unit, when the time difference is less than the first predetermined time interval.

7. The method as claimed in any one of the preceding claims, wherein the first predetermined time interval is in the range of 15-20 days.

8. The method as claimed in any one of the preceding claims, wherein the first predetermined engine speed range is 500-1000 RPM.

9. An air conditioning (AC) system of a vehicle comprising:

an AC compressor relay, configured to perform at least one of activating and deactivating an AC compressor in the AC system; and

a control unit configured to:

measure current time of activation of an AC switch, configured in the vehicle;

determine a time difference between the measured current time of activation of the AC switch and ae previous time when the AC switch was active;

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determine an engine speed of the vehicle when the time difference is greater than a first predetermined time interval;

determine an engine speed range of the vehicle by comparing the engine speed of the vehicle with at least one of a first predetermined engine speed range and a second predetermined engine speed range;

perform at least one of activating the AC compressor relay for a second predetermined time interval if the engine speed range of the vehicle is within the first predetermined engine speed range, and activating the AC compressor relay for the second predetermined time interval for a predetermined number of times if the engine speed range of the vehicle is within the second predetermined engine speed range; and

deactivate the AC compressor relay if the engine speed range is greater than the second predetermined engine speed range, wherein the AC compressor relay is again activated when the engine speed range is within at least one of: the first predetermined engine speed range and the second predetermined engine speed range.

10. The system as claimed in claim 9, wherein the first predetermined time interval is in the range of 15-20 days.

11. The system as claimed in claim 9 or claim 10, wherein the second predetermined time interval is in the range of 20-30 seconds.

12. The system as claimed in any one of claims 9 to 11, wherein the first predetermined engine speed range is 500-1000 RPM.

13. The system as claimed in any one of claims 9 to 12, wherein the second predetermined engine speed range is 1000-1500 RPM.

14. The system as claimed in any one of claims 9 to 13, wherein the speed of the vehicle is determined by one or more sensors configured with the control unit.

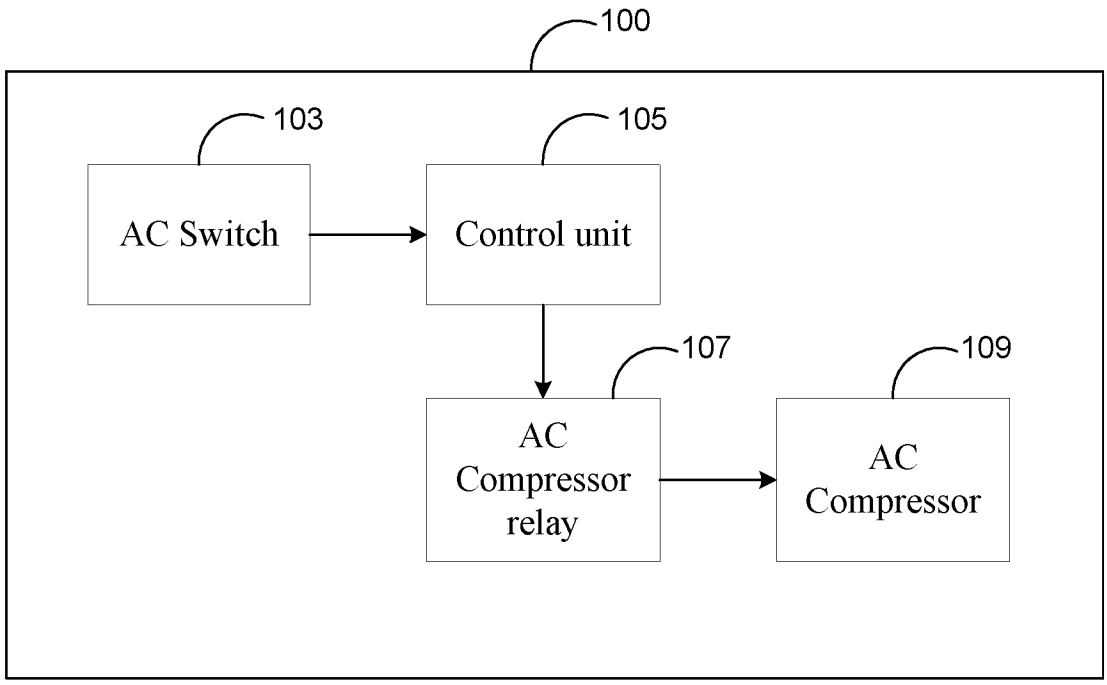
100
103
AC Switch
105
Control unit
107
AC Compressor relay
109
AC Compressor

Fig.1

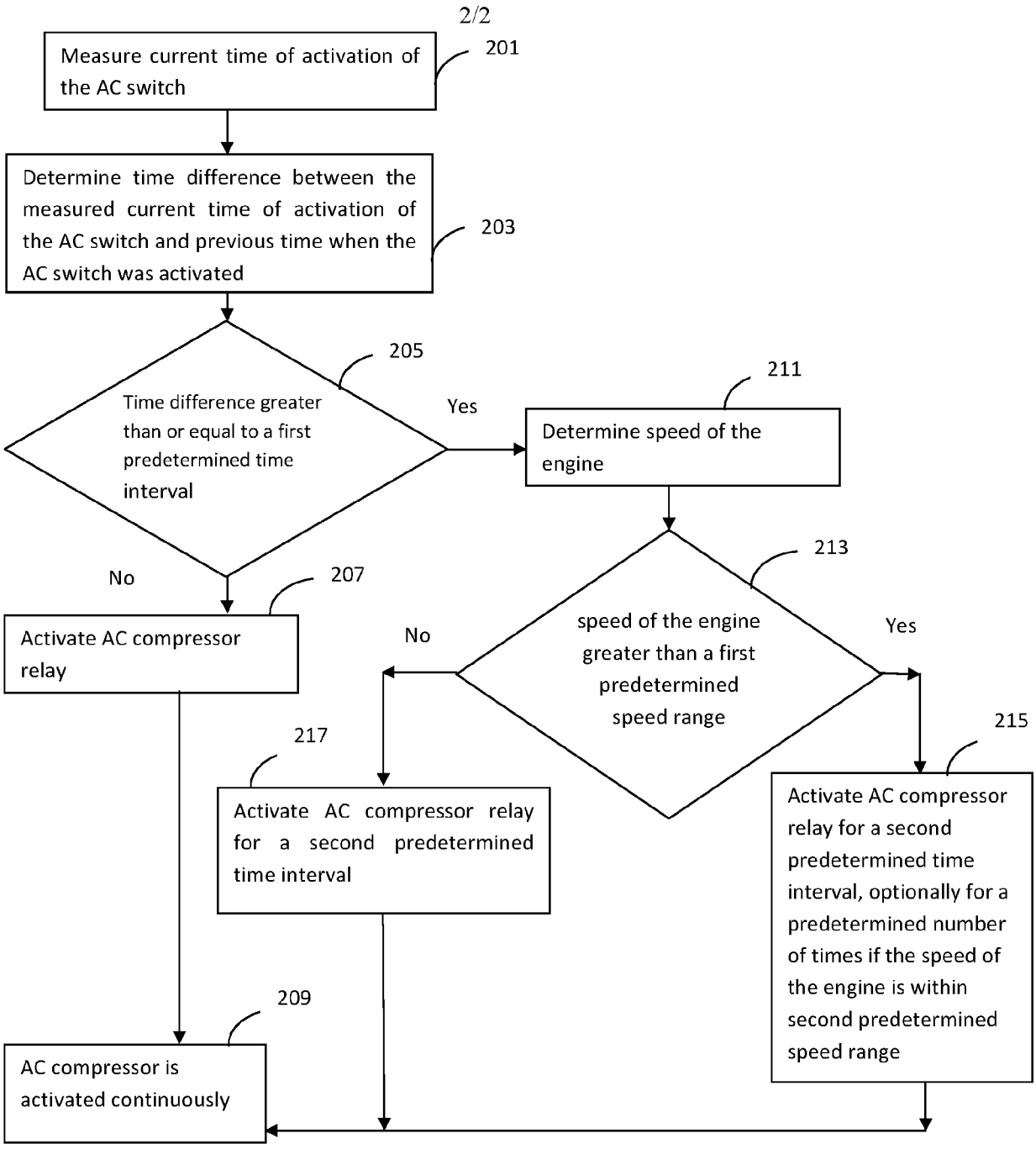
Measure current time of activation of the AC switch
201
Determine time difference between the measured current time of activation of the AC switch and previous time when the AC switch was activated
203
Time difference greater than or equal to a first predetermined time interval
205
Yes
No
Determine speed of the engine
211
speed of the engine greater than a first predetermined speed range
213
Yes
No
Activate AC compressor relay
207
Activate AC compressor relay for a second predetermined time interval
217
Activate AC compressor relay for a second predetermined time interval, optionally for a predetermined number of times if the speed of the engine is within second predetermined speed range
215
AC compressor is activated continuously
209

**Fig.2**