(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
13 July 2017 (13.07.2017)

(10) International Publication Number
WO 2017/119833 A1

(51) **International Patent Classification**:
F02D 11/10 (2006.01) ***F16K 31/04*** (2006.01)
F02D 9/02 (2006.01) ***H02P 7/00*** (2016.01)

(21) **International Application Number**:
PCT/SE2016/051246

(22) **International Filing Date**:
12 December 2016 (12.12.2016)

(25) **Filing Language**: English

(26) **Publication Language**: English

(30) **Priority Data**:
1650011-8 5 January 2016 (05.01.2016) SE

(71) **Applicant**: **SCANIA CV AB** [SE/SE]; 151 87 Södertälje (SE).

(72) **Inventors**: **STRÅÅT, Fredrik**; Karlbergsvägen 66 A, 113 35 Stockholm (SE). **ZAMANI, Sebastian**; Lustgårdsgatan 4, 112 18 Stockholm (SE).

(74) **Agent**: **WESTMAN, Mimmi**; Scania CV AB, 151 87 Södertälje (SE).

(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

(54) **Title**: SPRING RETURN THROTTLE ACTUATOR, METHOD OF CONTROL THEREOF AND THROTTLE ASSEMBLY

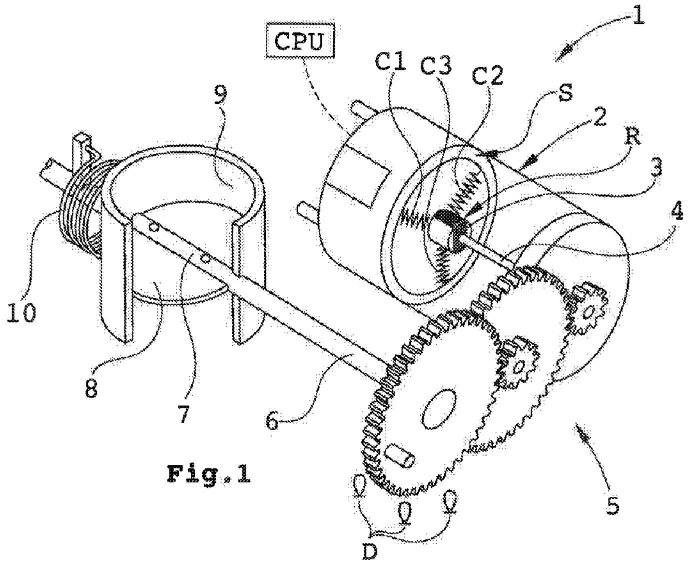

Fig.1

(57) **Abstract**: A spring return throttle actuator (1) including: an electric, plural-coil (C1, C2, C3), DC motor (2) having an output shaft 4, a throttle return spring (10), a gear transmission (5) connected to the output shaft, a control unit (CPU) adapted to control power supply to the DC motor (2), wherein the spring return throttle actuator (1) has a movement range between closed throttle and opened throttle. The control unit (CPU) is arranged to short-circuit at least two DC motor coils (C1, C2, C3) in order to create a DC motor return resist torque, and the control unit (CPU) includes a movement monitoring circuit being arranged to monitor actuator movement forced by the throttle return spring (10) and resisted by the DC motor return resist torque. The invention also relates to a method and a throttle assembly.

WO 2017/119833 A1

SPRING RETURN THROTTLE ACTUATOR, METHOD OF CONTROL THEREOF AND THROTTLE ASSEMBLY

FIELD OF THE INVENTION

The invention relates to a spring return throttle actuator including: an electric, plural-coil, DC motor having an output shaft, a throttle return spring, a gear transmission connected to the output shaft, a control unit adapted to control power supply to the DC motor, wherein the actuator has a movement range between closed throttle and opened throttle. The invention also relates to a method for control thereof and a throttle assembly.

BACKGROUND OF THE INVENTION

Throttle assemblies are employed to control gas streams in respect of vehicle engines. The actuator DC motor is typically supplied with an electric current to switch from a normally open to a closed throttle position or from a normally closed to an open throttle position.

It could be mentioned that in respect of for example an air inlet throttle valve, the throttle is normally open whereas in an EGR valve the throttle is normally closed.

As a rule, the return spring tend to move the throttle to a determined “normal” position which will guarantee operation also in the event that the DC motor is without current. It is thereby an aim to maintain the required exhaust gas values etc.

In a background art throttle assembly, for reaching intermediate positions between closed throttle and fully opened throttle, the DC motor is supplied with current to create a dynamic electromotive force which, by virtue of the control unit, balances the spring force to obtain a desired stationary throttle position between closed throttle and fully open throttle.

It is previously known that there are occasionally problems with throttles for example because of a mechanical deficiencies or some sort of obstruction preventing unrestricted movement of the throttle. This might depend on the formation of ice or the accumulation of dirt around the seat of the throttle or in throttle shaft bearings, or a defective spring which for example has been damaged and obtained unwanted properties.

The throttle can hereby be impossible or difficult to move properly and at proper speed over the whole or part of its movement range which is detrimental to the operation of the vehicle. Also relatively small restrictions and influences on throttle movements may impair engine control.

AIM AND MOST IMPORTANT FEATURES OF THE INVENTION

It is an aim of the present invention to provide measures to be able to address the problems of the background art so as to be able to at least reduce these problems.

This aims are obtained in a respect of a throttle actuator according to the above in that the control unit is arranged to short-circuit at least two of the coils of the DC motor in order to create a DC motor return resist torque (counteracting electromotive force EMF), and that the control unit includes a movement monitoring circuit being arranged to monitor actuator movement forced by the spring and resisted by the DC motor return resist torque.

With the term “DC motor return resist torque” is meant that a counteracting electromotive force is generated which resists return torque generated by the spring.

The invention makes it possible to monitor the condition of the return spring in an advantageous manner. Basically the return spring is dimensioned such that generated spring torque over the whole movement range of the actuator exceeds said DC motor return resist torque for the chosen number of short-circuit coils.

Furthermore, the actuator movement is possible to monitor in the complete range, in an intermediate range or part ranges, between fully opened and fully closed.

According to the invention, in a system where a plurality of elements co-act it is important to be able to analyze each single component such that the problem can be isolated and the failing component or existing problem be attended to.

In order to monitor the condition of the return spring, the spring is typically maximally stretched and strained by maximally actuating the throttle against the spring force, whereupon the system is made currentless and a selected number of coils are short-circuited. By thereupon monitoring the movement pattern and compare it as regards movement speed etc. with a desired stored reference movement pattern, it is possible to establish the condition of the spring. This also means that if the spring is unable to move the throttle with the chosen number of coils short-circuited, the spring is probably defective.

The invention can also be used to determine the mechanical spring constant for a perfectly operating component. It is thereupon possible to adapt possible control systems to this information in order to optimize control performance.

Having knowledge of a throttle actuation problem that exists and in which part of the movement range of the throttle there are, in fact, deviations, it is also possible, according to the invention, to adapt engine control to the prevailing throttle actuation conditions. Hereby vehicle control can be performed with increased usability and reduced error value.

According to the invention, two or more coils of the DC motor are short-circuited, thereby creating a determined resistance (electro motive force) for a spring to act against. This electro motive force can be more or less continuous or even at the same level through the entire movement range.

Furthermore, the control system can be taught where the throttle meets resistance, in which part of the range the throttle meets resistance and therefore moves unpredictably, and to determine whether the throttle has become stuck or moves with restricted speed and, in that case, in which position it has got stuck or moves with restricted speed.

In these cases it is not necessary to take notice of elapsed time, since it is possible to perform digital monitoring over the entire throttle movement range.

With the aid of the inherent feedback from the DC motor and/or from movement detectors such as Hall effect sensors or the like the movement pattern can be established since throttle movement hereby is easily detected.

Furthermore, the invention makes it possible to determine that the spring is jamming which could depend on it being broken so that it has obtained unwanted characteristics.

For example, according to the invention, elapsed time to open and close the throttle can be measured and compared to stored, prescribed values. Also, even movement speed per time unit and/or other suitable movement parameters of the throttle in question can be measured and compared to stored, prescribed movement curves reflecting movement speed per time unit and other respective suitable parameters of a throttle operating as prescribed.

The term “movement pattern” is basically intended to be interpreted broadly and can in its simplest form reflect time consumed for a complete opening or closing movement. In a more complex analysis, time consumed for a part of a complete opening or closing movement can be analyzed. In a more sophisticated analysis, the movement speed or acceleration over the complete movement range or part or parts thereof is compared to an exemplary curve reflecting a throttle moving as prescribed.

It is also possible to store different movement pattern curves for actuators having respective differently damaged or otherwise defective return springs giving an opportunity to easily analyze the nature of a defect.

The inventive actuator basically does not require any particular hardware components for the purpose of monitoring. Instead the properties and characteristics of the DC motor can basically be exploited. As an example, information from the DC motor can be obtained by measuring motor voltage which easily gives momentary rotational speed.

When coils of the DC motor are short-circuited, a current flows through the stator which leads to the creation of a counter-force even when a very small movement is induced to the rotor. This is in particular the case for brushless DC-motors and permanent magnet synchronic motors.

Suitably the DC motor includes three coils and two or all three coils may be subject to short-circuiting.

The control unit preferably includes a bridge circuit having one branch connected to each one of the coils. This circuitry makes the actuator easily controlled in an economic and logical manner. This advantage is even more enhanced when each branch includes a transistor switch connected to each one of the coils.

At least one movement sensor is preferably positioned to detect DC motor rotor movements in order to guarantee stability and maintained settings and adjustability. In particular it is advantageous when a plurality of Hall sensors is positioned to detect DC motor rotor movements, the Hall sensors of said plurality being distributed around the rotor to increase measurement accuracy. The sensors can also be positioned such that they detect the position of the throttle itself or an element of the transmission, since the position of the motor can be derived therefrom.

Controlling pulses from the Hall sensors easily gives the possibility to obtain rotational position and rotational speed.

It is preferred that the control unit includes an evaluation circuit arranged to evaluate output signals from the movement monitoring circuit for deviations from stored values. Evaluation can result in the problem or problems being diagnosed, in turn making it possible to address the true problem or problems to produce a solution.

Preferably said stored values relate to various exemplary problem situations whereby comparing the obtained signal values with stored example signals values makes it possible to specify or at least assume the existing or at least probable problem.

In an inventive method of controlling a spring return throttle actuator, wherein the actuator includes: an electric, plural-coil DC motor having an output shaft, a throttle return spring, a gear transmission connected to the output shaft, a control unit adapted to control power supply to the DC motor, wherein the actuator has a movement range between closed throttle and fully opened throttle,

- wherein at least two DC motor coils are short-circuited by the control unit in order to create a DC motor return resist torque, and wherein the movement forced by the spring and resisted by the return resist force is monitored over the whole movement range of the actuator.

Advantages corresponding to the above are gained in respect of the inventive method.

The DC motor advantageously includes three coils and two or all three coils are preferably short-circuited.

The coils are preferably supplied with power from each one branch of a bridge circuit being included in the control unit.

Advantageously each branch is switched through separate transistor switches.

DC motor rotor movements are preferably detected by at least one movement sensor and more preferred by a plurality of Hall sensors being rotationally distributed to increase measurement accuracy.

Preferably, the control unit issues a condition message to the user in the cases where it is appropriate, for example when service is required.

Output signals from the movement monitoring circuit are preferably evaluated by an evaluation circuit of the control unit for deviations from a stored values.

It is highly preferred, in order to enhance analysis of the spring that result obtained from movement forced by the spring being monitored with at least two DC motor coils being short-circuited is supplemented with movement forced by the spring being monitored without any one of the DC motor coils being short-circuited in order to create DC motor return resist torques of different levels. Hereby the movement pattern/return speed will differ with the different resist torques allowing more detailed analysis and possibilities of discovering also relatively small defects.

A typical sequence to monitor the condition of the return spring could for example include the following steps:

- the spring is stretched and strained by maximally actuating the throttle against the spring force.
- the system is made currentless and no coils are short-circuited.

- the movement pattern/return speed is monitored.
- the spring is stretched and strained by maximally actuating the throttle against the spring force.
- the system is made currentless and two coils are short-circuited.
- the movement pattern/return speed is monitored
- the spring is stretched and strained by maximally actuating the throttle against the spring force.
- the system is made currentless and three coils are short-circuited.
- the movement pattern/return speed is monitored.
- the results of the three captured movements indicated above (or only two therof) are compared with desired stored reference movement pattern/return speed.

The invention also relates to a throttle assembly including a throttle and a throttle actuator wherein the throttle actuator is according to what is stated above.

Further features of and advantages of the invention will be explained below at the background of embodiments.

BRIEF DESCRIPTION OF DRAWINGS

The invention will now be described in greater detail by way of embodiments and with reference to the annexed drawings, wherein:

Fig. 1 illustrates a throttle assembly including a spring return throttle actuator according to the invention,

Fig. 2 shows a control circuit for the inventive throttle actuator, and

Fig. 3 shows a simplified flow chart over an inventive method.

DESCRIPTION OF EMBODIMENTS

Fig. 1, shows a throttle assembly whereof a spring return throttle actuator is generally depicted with reference number 1. The actuator 1 includes a DC motor 2 having three coils C1, C2 and C3 in its stator S. The rotor R is as usual provided with a permanent rotor magnet 3 and an output shaft 4.

A gear transmission 5 is connected to the output shaft 4 and an outgoing shaft 6 from the gear transmission 5 is coupled with its distal end to a throttle shaft 7 of a throttle 8. The actuator has a movement range between closed throttle and fully opened throttle.

The throttle 8 is arranged in a channel 9 to control a gas stream flowing through the channel 9.

A throttle return spring 10 is positioned around the outgoing shaft 6 and functions to provide a spring torque urging the outgoing shaft 6 to rotate towards a “normal” position of the throttle 8 which may be fully open or fully closed depending on the nature of the throttle as explained above.

A control unit CPU is connected to the DC motor and is adapted to control supply of power to the DC motor and thereby to control the throttle position. Movement sensors, preferably Hall effect sensors, are indicated with D.

Fig. 2 illustrates a bridge circuit 11 positioned between a 24 Volts current source 12 for the supply of power to the three coils C1, C2 and C3 of the DC motor 3.

The bridge circuit includes a set of transistor switches T_1-T_6 that are made conductive – non conductive to controllably power supply the DC motor 3.

In order to short-circuit all coils C1, C2 and C3, the transistor switches T_1-T_6 are made conductive and electric voltage is cut off. It is possible to make variations of the duration of conductivity of the transistor switches in order to apply force of different magnitudes by varying and by controlling transistor switches. It is also possible to short-circuit only two of the coils, whereby obviously a reduced rotation resist torque will arise compared to when all three coils are short-circuited.

It is possible to receive information from the DC motor and associated cables about its operation. If the motor is rotated, the rotational speed is directly proportional to the voltage. It is also possible to measure voltage which momentarily results in knowledge of rotational speed. For detection of rotational position of the rotor of the motor, a plurality of detectors is preferably being used. This gives information about throttle position.

The detectors are suitably stationary and for example co-operating with a ring being rotationally associated with the rotor or with one of the shafts, said ring having a great number of evenly distributed marks or holes. Monitoring the durations between pulses from three distributed mark or hole detectors results in information of position and rotational speed. There is also a possibility to detect rotor acceleration if required for some reason.

In the simplified flow chart in Fig. 3, an exemplary method sequence related to the invention is briefly illustrated.

13 indicates start of sequence.

14 indicates initiating DC motor to position throttle in desired position where the return spring is strained and stretched and verifying that throttle has reached the desired position.

15 indicates cutting current to DC motor and initiating circuit to short-circuit DC motor coils to obtain a resist torque.

16 indicates monitoring throttle or rotor movements effected by the return spring with short-circuited coils.

17 indicates evaluating monitored throttle movement pattern in relation to a stored exemplary movement curve.

18 indicates amending and adapting engine control values to established prevailing throttle actuation conditions.

19 indicates issuing a condition message to the user and ending of sequence.

The sequence may be supplemented with additional steps and is repeated as required.

The invention can be modified within the scope of the annexed claims. For example, the control circuitry can be laid out differently as can be the DC motor, for instance, the number of coils of the DC motor can be other than three.

The feature “closed throttle” is intended to include a case with totally blocked opening as well as a case with a certain minimum opening that might exist. With the feature “opened throttle” is intended the maximum opening achievable for the throttle in question.

Different kinds of sensors may be employed and they can be positioned in various places in association with the throttle assembly, for example close to the throttle itself.

CLAIMS:

1. Spring return throttle actuator (1) including:
- an electric, plural-coil (C1, C2, C3), DC motor (2) having an output shaft 4,
- a throttle return spring (10),
- a gear transmission (5) connected to the output shaft,
- a control unit (CPU) adapted to control power supply to the DC motor (2),
wherein the spring return throttle actuator (1) has a movement range between closed throttle and opened throttle,
characterized in
- that the control unit (CPU) is arranged to short-circuit at least two DC motor coils (C1, C2, C3) in order to create a DC motor return resist torque, and
- that the control unit (CPU) includes a movement monitoring circuit being arranged to monitor actuator movement forced by the throttle return spring (10) and resisted by the DC motor return resist torque.

2. Actuator according to claim 1, **characterized in**
- that the DC motor (2) includes three coils (C1, C2, C3).

3. Actuator according to claim 1 or 2, **characterized in**
- that the control unit (CPU) includes a circuit (11) having one branch connected to each one of the coils (C1, C2, C3).

4. Actuator according to claim 3, **characterized in**
- that each branch includes a transistor switch (T_1 - T_6) connected to each one of the coils (C1, C2, C3).

5. Actuator according to any one of claims 1 - 4, **characterized in**

- that at least one movement sensor (D) is positioned to detect DC motor rotor movements.

6. Actuator according to claim 5, **characterized in**
- that a plurality of Hall sensors (D) are positioned to detect DC motor rotor movements, said plurality of Hall sensors (D) being rotationally distributed to increase measurement accuracy.

7. Actuator according to any one of claims 1 - 6, **characterized in**
- that the control unit includes an evaluation circuit arranged to evaluate output signals from the movement monitoring circuit for deviations from a stored values.

8. Method of controlling a spring return throttle actuator including:
- an electric, plural-coil, DC motor (2) having an output shaft (4),
- a throttle return spring (10),
- a gear transmission (5) connected to the output shaft (4),
- a control unit (CPU) adapted to control power supply to the DC motor (2),

wherein the actuator (1) has a movement range between closed throttle and fully opened throttle,

characterized in
- that at least two DC motor coils (C1, C2, C3) are short-circuited by the control unit (CPU) in order to create a DC motor return resist torque and that movement forced by the spring and resisted by the return resist force is monitored over the whole movement range of the actuator.

9. Method according to claim 8, wherein the DC motor includes three coils, **characterized in**
- that two or three coils (C1, C2, C3) are short-circuited.

10. Method according to claim 8 or 9, **characterized in**
- that the coils (C1, C2, C3) are supplied with power from each one branch of a circuit (11) being included in the control unit (CPU).

11. Method according to claim 10, **characterized in**
- that each branch is switched through separate transistor switches (T_1 – T_6).

12. Method according to any one of claims 8 - 11, **characterized in**
- that DC motor rotor movements are detected by at least one movement sensor (D).

13. Method according to claim 12, **characterized in**
- that DC motor rotor movements are monitored by a plurality of Hall sensors (D) being distributed around the rotor to increase measurement accuracy.

14. Method according to any one of claims 8 - 13, **characterized in**
- that output signals from the movement monitoring circuit are evaluated by an evaluation circuit of the control unit for deviations from a stored values.

15. Method according to any one of claims 8 - 14, **characterized in**
- that result obtained from movement forced by the spring being monitored with at least two DC motor coils (C1, C2, C3)

being short-circuited is supplemented with movement forced by the spring being monitored without DC motor coils (C1, C2, C3) being short-circuited in order to create DC motor return resist torques of different levels.

16. Throttle assembly including a throttle (8) and a throttle actuator (1) according to any one of claims 1 – 7.

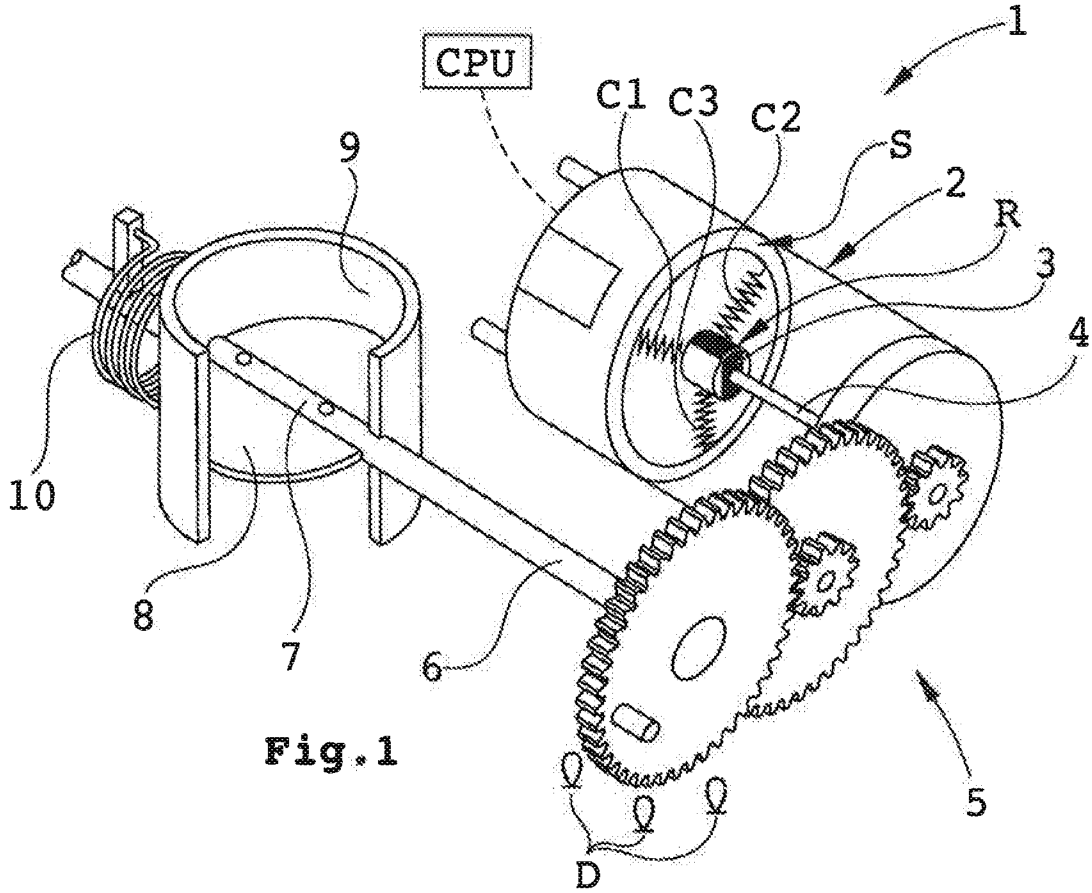

Fig.1

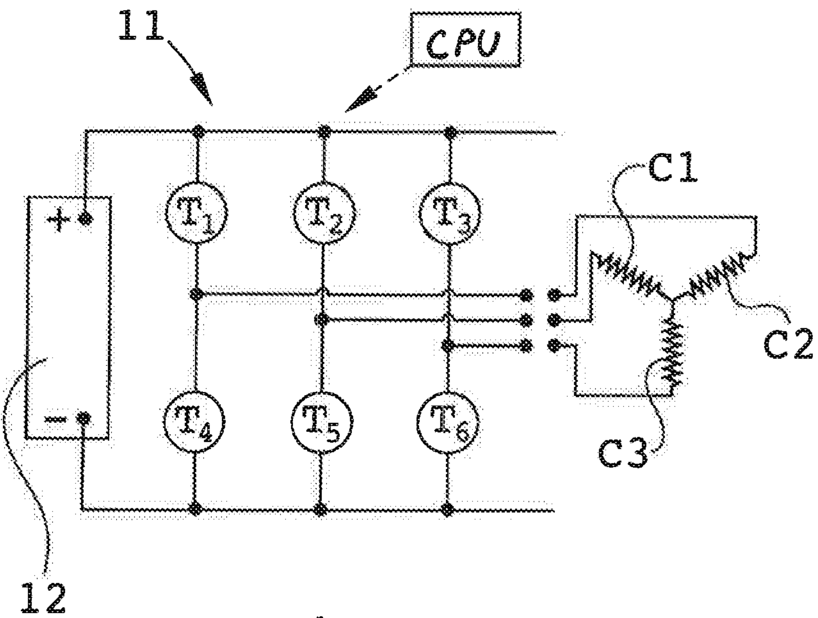

Fig.2

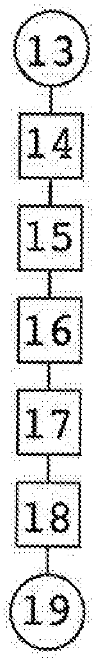

Fig.3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2016/051246

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F02D, F16K, H02P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20090009115 A1 (GROGG SILVIO ET AL), 8 January 2009 (2009-01-08); abstract; paragraphs [0026]-[0027], [0053] --	1-16
A	US 20040059496 A1 (PURSIFULL ROSS D ET AL), 23 March 2004 (2004-03-23); paragraphs [0029], [0052] --	1-16
A	US 20040212336 A1 (MCMILLAN SCOTT D ET AL), 28 October 2004 (2004-10-28); abstract; paragraphs [0048]-[0052] --	1-16
A	US 20060016427 A1 (UDA TOSHIAKI ET AL), 26 January 2006 (2006-01-26); abstract; paragraphs [0006], [0049] --	1-16

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27-02-2017	28-02-2017

Name and mailing address of the ISA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Marianne Dickman Telephone No. + 46 8 782 28 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2016/051246

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, A	EP 3104518 A1 (BELIMO HOLDING AG), 14 December 2016 (2016-12-14); abstract; paragraphs [0018], [0069]-[0070], [0077]-[0080] -- --------	1-16

International application No.
PCT/SE2016/051246

Continuation of: second sheet
International Patent Classification (IPC)

F02D 11/10 (2006.01)
F02D 9/02 (2006.01)
F16K 31/04 (2006.01)
H02P 7/00 (2016.01)

US	20090009115	A1	08/01/2009	DK	1751845 T3	15/02/2016
				EP	2871769 B1	04/01/2017
				HK	1102204 A1	19/02/2010
				US	8314580 B2	20/11/2012
				WO	2005119898 A2	15/12/2005
US	20040059496	A1	23/03/2004	DE	10337428 A1	01/04/2004
				GB	2394562 B	29/12/2004
				US	6711492 B1	23/03/2004
US	20040212336	A1	28/10/2004	CN	1809712 A	26/07/2006
				EP	1616117 A1	18/01/2006
				US	6979965 B2	27/12/2005
				WO	2004097276 A1	11/11/2004
US	20060016427	A1	26/01/2006	DE	102005033693 A1	16/03/2006
				JP	2006029526 A	02/02/2006
				JP	4428163 B2	10/03/2010
				US	7143743 B2	05/12/2006
EP	3104518	A1	14/12/2016	NONE		