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(54) Title: THROTTLE CONTROL DEVICE, VEHICLE WITH SUCH A THROTTLE CONTROL DEVICE AND A METHOD FOR OPERATING SUCH A THROTTLE CONTROL DEVICE

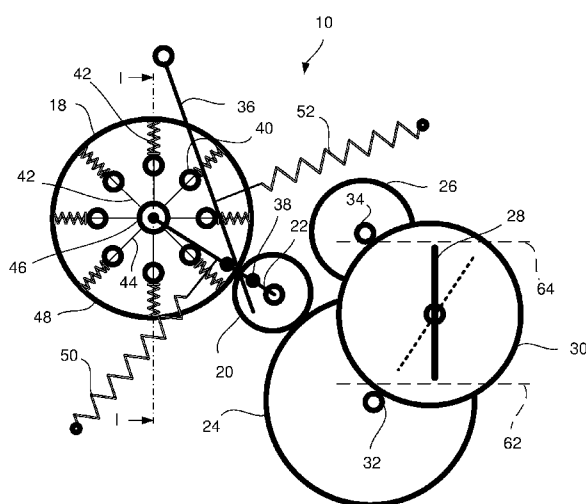


Fig. 2

(57) Abstract: The invention relates to a damper control device (1) comprising a drive engine (12), a first cogwheel (18), connected to the drive engine (12) and arranged to be rotated by the drive engine (12), a second cogwheel (20), arranged in engagement with the first cogwheel (18), a third cogwheel (24), arranged in engagement with the second cogwheel (20) when the second cogwheel (20) is arranged in a first position, a fourth cogwheel (26), arranged in engagement with the second cogwheel (20) when the second cogwheel (20) is arranged in a second position, and a damper element (28) arranged to be turned by the third and fourth cogwheel (24, 26). The second cogwheel (20) is arranged so that it may be moved between the first and the second position along the periphery of the first cogwheel (18). The invention also relates to a vehicle (1) with such a damper control device (10) and a method to operate such a damper control device (10), as well as a computer program (P) and a computer program product.

Throttle control device, vehicle with such a throttle control device and a method for operating such a throttle control device

BACKGROUND OF THE INVENTION AND PRIOR ART

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The present invention relates to a damper control device according to the preamble of claim 1. The invention also relates to a vehicle with such a damper control device according to the preamble of claim 7 and a method to operate such a damper control device according to the preamble of claim 8.

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Dampers are used in different contexts, among other to control the gas flow and gas pressure in combustion engines. For example, dampers are used to control the flow and pressure of air to the inlet system of combustion engines. Other areas of use for these dampers are to control the flow and pressure of exhausts in the exhaust brake
15 in the combustion engine's exhaust system, and to adjust exhaust gas recirculation (EGR).

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The requirements relating to accurate and fast adjustability of damper devices for combustion engine are stringent. When the load in the combustion engine has to be changed quickly, the damper control device for the combustion engine's inlet air must react quickly, often in the range of 100 ms as of the damper being fully open to it being substantially closed, and reversely. It must also be possible to adjust the damper in a precise way, when only minor adjustments of the combustion engine's load are desired. A minor change in the supplied air flow may, during certain operating points
25 of the combustion engine, have a powerful impact on the combustion engine's emitted torque, so that a precise adjustment of the damper is desirable.

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The requirement regarding simultaneous, fast and precise adjustability of the damper entails stringent requirements in relation to the construction of the damper control device. The damper moves within an angle range of 90°, and an electric drive motor, which sometimes has to be able to control the damper quickly to different positions within this angle range, and, on another occasions, has to be able to control the damper very precisely with very small angular displacements, is both complex and costly to design and manufacture. Instead, the damper control device is equipped

with a transmission, which changes the gearing ratio between the different states when fast or precise control of the damper is required.

Methods to provide different gearing ratios in a damper control device have been presented before. With the help of a lesser gearing of the damper control device's transmission, a high accuracy of the damper element's position is obtained, and accordingly, increased control of the gas damper is facilitated. In an engine condition requiring increased throttle, the damper may be controlled to open at very small values, in order to obtain a more precise control of the air flow into the inlet conduit of the combustion engine. With the help of a larger gearing in the transmission, faster control of the damper element is facilitated in case of fast engine load changes.

Document US2010/0009804 shows a variable transmission for a damper. The transmission is variable and operated by an electric motor.

Document JPH04301145 shows a damper, which is operated by a variable transmission with a belt drive.

SUMMARY OF THE INVENTION

Despite prior art solutions, there is a requirement to further develop a damper control device, which may quickly and efficiently change the adjustability of the damper element between a position where precise adjustability is desired, and another position where fast adjustability is desired.

The objective of the present invention is thus to provide a damper control device, which may quickly and efficiently change the adjustability of a damper element.

This objective is achieved with a damper control device of the type specified at the beginning, which method is characterised by the features specified in claim 1.

With the damper control device according to the invention, the adjustability of the damper element may change quickly and efficiently between a first position where precise adjustability is desired, and a second position where fast adjustability is de-

sired. Since the second cogwheel is arranged so that it may be moved between the first and the second position along a periphery of the first cogwheel, a smooth and automatic change of the gearing in the damper device is obtained.

- 5 According to one embodiment of the invention, bodies that may be shifted radially are arranged around the central axis of the first cogwheel, which bodies are arranged to be shifted radially by a centrifugal force in a direction outwards from the central axis, and in a direction towards the central axis by a spring device, and which bodies in-
10 teract with a second arm to swing the second arm around its first end. Thus, an automatic shifting in the damper device is obtained when the engine speed of the driving motor increases.

- The above objective is achieved also with a vehicle of the type specified at the be-
ginning, which is characterised by the features specified in claim 7 and by
15 the method of the type mentioned above, which is characterised by the features specified in claim 8.

Other advantages of the invention are set out in the detailed description below.

20 BRIEF DESCRIPTION OF THE DRAWINGS

Below is a description, as an example, of preferred embodiments of the invention with reference to the enclosed drawings, in which:

- 25 Fig. 1 shows a side view of a schematically displayed vehicle with a damper control device according to the present invention,

Fig. 2 shows a side view of a schematically displayed damper control device in a first position according to the present invention,

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Fig. 3 shows a cross-sectional view along the line I - I in Fig. 2,

Fig. 4 shows a side view of a schematically displayed damper control device in a second position according to the present invention,

Fig. 5a shows a diagram of engine speed in relation to time lapsed for the damper control device according to the present invention

5 Fig. 5b shows a diagram of current in relation to time lapsed for the damper control device according to the present invention, and

Fig. 6 shows a flow chart of the method to control a hybrid powertrain according to the present invention.

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DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

Fig. 1 shows a schematic side view of a vehicle 1, comprising a combustion engine 2, which is connected to a gearbox 4. The gearbox 4 is also connected to the driving
15 wheels 6 of the vehicle 1, via a propeller shaft 8. The vehicle 1 is equipped with a damper control device 10 according to the present invention.

The damper control device 10 according to the invention will also be described in connection with Figures 2 - 4. The damper control device 10 comprises a drive en-
20 gine 12, which preferably is an electric motor, connected via electrical conduits 14 to an energy storage device 16, such as an electric accumulator. A first cogwheel 18 is connected to the drive engine 12, which first cogwheel 18 is arranged to be rotated by the drive engine 12 when the latter is supplied with power. A second cogwheel 20 is arranged in engagement with the first cogwheel 18, and is rotated by the first cog-
25 wheel 18 when the first cogwheel 18 rotates.

The second cogwheel 20 is arranged so that it may be moved between a first and a second position along the periphery of the first cogwheel 18. This is achieved with a first arm 22, which is arranged pivotally with its first end at the central axis of the first
30 cogwheel 18, and arranged with its second end at a central axis of the second cogwheel 20.

When the second cogwheel 20 is arranged in the first position, the second cogwheel 20 is arranged in engagement with a third cogwheel 24. Accordingly, the second

cogwheel 20 will operate the third cogwheel 24, when the second cogwheel 20 is in engagement with the third cogwheel 24, as displayed by Fig. 2.

When the second cogwheel 20 is arranged in the second position, the second cogwheel 20 is arranged in engagement with a fourth cogwheel 26. Accordingly, the second cogwheel 20 will operate the fourth cogwheel 26, when the second cogwheel 20 is in engagement with the fourth cogwheel 26, as displayed by Fig. 4.

A damper element 28 is arranged on a fifth cogwheel 30, which is arranged to be operated by the third and the fourth cogwheel 24, 26. Preferably the fifth cogwheel 30 is in engagement with a sixth cogwheel 32, arranged on the central axis of the third cogwheel 24, and in engagement with a seventh cogwheel 34 arranged on a central axis of the fourth cogwheel 26. Accordingly, a gearing ratio which is suitable for the transmission may be obtained. The damper element 28 is arranged in the centre of the fifth cogwheel 30, and is rotated by the fifth cogwheel 30 when the fifth cogwheel 30 rotates.

A second arm 36 is pivotally arranged at its first end, and connected to the first arm 22 in a shiftable manner. The second arm 36 interacts with the first arm 22 by way of extending between two control elements 38 arranged on the first arm 22, which are arranged alternately to abut against the second arm 36.

Radially shiftable control bodies 40 are arranged around the central axis of the first cogwheel 18, which control bodies 40 are arranged to be shifted radially by the centrifugal force in a direction outwards from the central axis, when the first cogwheel 18 rotates. A spring device 42 acts on the control bodies 40 in a direction towards the central axis. When the first cogwheel 18 rotates, the centrifugal force will impact the control bodies 40, so that the spring force from the spring device 42 is overcome. Accordingly, the control bodies 40 will be shifted radially outwards from the central axis of the first cogwheel 18. The control bodies 40 may be arranged in a shiftable manner on spokes 44, extending from a hub 46 of the first cogwheel 18 to a peripheral outer ring 48 of the first cogwheel 18. Preferably the spring device 42 consists of one screw spring arranged for each control body 40, which screw spring strives to move the respective control body 40 in a direction towards the central axis of the first

cogwheel 18 with pressure or traction. Alternatively, an annular spring device 42 may extend around the control bodies 40, and strive to move the respective control bodies 40 in a direction towards the central axis of the first cogwheel 18.

5 The control bodies 40 interact with the second arm 36, in such a manner that they pivot the second arm 36 around its first end when the control bodies 40 are shifted from and towards the central axis of the first cogwheel 18. When the control bodies 40 are shifted outwards from the central axis of the first cogwheel 18, the control bodies 40 will abut against the second arm 36 and press the second arm 36 in a direction away from the central axis of the first cogwheel 18. Since the second arm 36 interacts with the control elements 38 on the first arm 22, the second arm 36 will drag along the first arm 22, which will thus pivot around its first end, which is placed around the central axis of the first cogwheel 18. When the first arm 22 pivots around the central axis of the first cogwheel, the second cogwheel 20 will move from the first position in a direction towards the second position. When the control bodies 40 continue to be shifted in a direction outwards from the central axis of the first cogwheel 18 because of the increased rotational speed of the first cogwheel 18, leading to an increased centrifugal force on the control bodies 40, the control bodies 40 will pivot the second arm 36 further in a direction away from the central axis of the first cogwheel 18, until the second cogwheel 20 reaches its second position and engages with the third cogwheel 24.

By arranging, in connection with the first arm 22, a first spring element 50, which strives to pivot the first arm 22 around the central axis of the first cogwheel 18, so that the second cogwheel 20 is moved in a direction towards its first position, the second cogwheel 20 will be moved in a direction towards its first position, and in the first position it will engage with the third cogwheel 24. As a complement or an alternative to the first spring element 50, a second spring element 52 may be arranged in connection with the second arm 36, so that the second spring element 52 strives to pivot the second arm 36 in a direction towards the central axis of the first cogwheel 18, which entails that the second spring element 52 fills the same function as the first spring element 50.

When the second cogwheel 20 has been moved to the second position, as described above, the second cogwheel 20 will be returned to its first position if the drive engine 12 stops. When the drive engine 12 stops, the control bodies 40 will be moved in a direction towards the central axis of the first cogwheel 18 with the help of the spring device 42. Since the first and the second arm 36 are impacted by the first and the second spring element 52, the first and the second arm 36 will pivot, so that the second cogwheel 20 is moved to the first position, and engages with the third cogwheel 24.

The spring force in the spring device 42 acting on the control bodies 40, and the spring force in the first and second spring elements 50, 52 acting on the first and the second arm 36, respectively, must, jointly with the mass of the respective control body 40, be dimensioned so that the above described function is possible. Accordingly, the spring force in the first and the second spring elements must be overcome by the force of the control bodies 40 acting on the second arm 36, when the control bodies 40 are shifted radially outwards by a centrifugal force.

By providing the cogwheels 18, 20...34 with suitable diameters, a first gearing ratio may be obtained when the second cogwheel 20 is in the first position, and a second gearing ratio may be obtained when the second cogwheel 20 is in the second position. Figures 2 - 4 show that the first gearing ratio is lower than the second gearing ratio.

In the event the drive engine 12 operates the first cogwheel 18 with a rotational speed below a certain predetermined threshold value, the centrifugal force acting on the control bodies 40 will not overcome the spring force in the spring device 42.

Thus, it is possible to adjust the damper element 28 very precisely with the drive engine 12, when the drive engine 12 operates at a low speed. When a quick adjustment of the damper element 28 is desired, the speed of the drive engine 10 is increased, which entails that the control bodies 40 will be shifted radially outwards by a centrifugal force. Accordingly, the first and the second arms 22, 36 will move the second cogwheel 20 out of engagement with the third cogwheel 24, and instead move the second cogwheel 20 into engagement with the fourth cogwheel 26, as described above. Thus, the gearing ratio is altered via the damper control device 10, so that the

increased drive engine speed is increased, which entails that the damper element 28 will be turned quickly to the desired position. When the damper element 28 has been turned to the desired position and the combustion engine operates at a speed and with a load corresponding to the position of the damper element 28, the drive engine 12 stops and the second cogwheel 20 is moved back to the first position, in order to engage with the third cogwheel 24. If smaller and more precise adjustments of the speed and load of the combustion engine 2 need to be made at the damper element's 28 set position, the damper element 28 is controlled by way of turning the drive engine 12 with a speed below the threshold value, so that the second cogwheel 20 is shifted to the second position.

The drive engine 12 may rotate the first cogwheel 18 in both directions. If the damper element 28 is in an open position and must be returned to a closed position, the drive engine 12 is rotated in an opposite direction to the direction described above. If a quick adjustment of the damper element 28 is desired, the speed of the drive engine 10 is increased to the threshold value when the control bodies 40 are moved radially outwards by a centrifugal force, so that the second arm 36 moves the first arm 22, and thus the second cogwheel 20 to the second position.

The drive engine 12 is preferably connected to a control device 54, which controls the speed of the drive engine 12 depending on the combustion engine's 2 different operating conditions. A number of sensors may be arranged at the combustion engine 2 and in the vehicle 1. Accordingly, a speed sensor 56 may be arranged at the combustion engine 2 in order to detect the speed of the combustion engine 2, a temperature sensor 58 in order to detect the temperature of the combustion engine 2, a pressure sensor 60 in order to detect the pressure in the inlet channel 62 in the inlet system 64 of the combustion engine 2, a position sensor 66 in order to detect the position of an accelerator pedal 68 of the vehicle 1, a position sensor 72 in order to detect the position of the first arm 22 and a mass flow sensor 74 in order to detect mass flow. These sensors are connected to the control device 54 and emit signals to the control device 54, which controls the drive engine 12 based on the signals received.

In order to facilitate synchronisation and engagement of the second cogwheel 20 with the fourth cogwheel 26 when the second cogwheel 20 is moved to the second position, the speed of the drive engine 12 may be temporarily reduced just before the second cogwheel 20 reaches the second position. This may be achieved by way of detecting and controlling the power to the drive engine 12. When the speed of the drive engine 12 is controlled to quickly bring the damper element 28 to a new position, the speed of the drive engine 10 is increased above a certain threshold speed value. This is illustrated by Fig. 5a. When the engine speed reaches the threshold value, in order to make the control bodies 40 pivot the first and the second arm 36 due to a centrifugal force, so that the second cogwheel 20 begins to be shifted from the first position, the power provided to the drive engine 12 will drop. This occurs when the second cogwheel 20 is disengaged from the third cogwheel 24, which entails that the resistance to rotating the second, and also the first cogwheel 18, is reduced. This indication entails that the speed of the drive engine 12 may be reduced or maintained at a speed just above the threshold value. The second cogwheel 20 is then moved further towards the second position, and is moved into engagement with the fourth cogwheel 26. When the second cogwheel 20 engages with the fourth cogwheel 26, the resistance to operating the first and the second cogwheels 18, 20 increases, following which the power I to operate the drive engine 12 increases again, which is an indication that there is an engagement between the second and the fourth cogwheel 26. Accordingly, the speed of the drive engine 12 may be increased, in order to turn the damper element 28 as quickly as possible into the desired position. Fig. 5b shows how the speed N is controlled to achieve the above described synchronisation of the engagement between the second cogwheel 20 and the fourth cogwheel 26.

Above is a description of how a damper control device 10 is used to control the flow and pressure of the air to the inlet system 64 of a combustion engine 2. Other areas of use for the damper control device 10 are to control the flow and pressure of exhausts in the exhaust brake in the exhaust system (not displayed) of a combustion engine 2 and to adjust exhaust gas recirculation (EGR) in a combustion engine 2. Above is a description of the different transmission elements, such as cogwheels. However, it is possible to design the transmission elements as friction wheels, where

torque is transmitted via friction when the peripheral surfaces of the friction wheels abut against each other.

Fig. 6 shows a flow chart of a method to operate a damper control device 10. The

5 method comprises the following steps:

a) operating the drive engine 12 with a first speed N_1 , so that the second cogwheel 20 is arranged in the first position,

b) operating the drive engine 12 with a second speed N_2 , which is greater than the first speed N_1 , so that the second cogwheel 20 is moved to the second position

10 along the periphery of the second cogwheel 20.

The method also comprises the additional steps:

c) detecting power I to operate the drive engine 12,

d) controlling the second speed N in relation to the detected power I .

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The method also comprises the additional steps:

e) limiting the second speed N_2 when the second cogwheel 20 is moved to the second position,

f) increasing the second speed N_2 when the second cogwheel 20 has assumed the second position.

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According to the invention, a computer program P is provided, which may comprise procedures to control the damper control device 10 according to the present invention.

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The computer program P may comprise procedures for control of the damper control device 10 according to the above mentioned method steps.

The program P may be stored in an executable manner, or in a compressed manner, in a memory M and/or a read/write memory R .

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The invention also relates to a computer program product, comprising program code stored on a medium readable by a computer 70, in order to perform the method steps specified above, when said program code is executed in the control device 54, or in

another computer 70 connected to the control device 54. Said program code may be stored in a non-volatile manner on said computer-readable medium.

The components and features specified above may, within the framework of the invention, be combined between different embodiments specified.

Claims

1. Damper control device comprising a drive engine (12), a first cogwheel (18), which
5 is connected to the drive engine (12) and arranged to be rotated by the drive engine
(12), a second cogwheel (20), arranged in engagement with the first cogwheel (18), a
third cogwheel (24), arranged in engagement with the second cogwheel (20) when
the second cogwheel (20) is arranged in a first position, a fourth cogwheel (26), ar-
ranged in engagement with the second cogwheel (20) when the second cogwheel
10 (20) is arranged in a second position, and a damper element (28), arranged to be
turned by the third and fourth cogwheel (24, 26), **characterised in that** the second
cogwheel (20) is arranged, so that it may be shifted between the first and the second
position along a periphery of the first cogwheel (18).
- 15 2. Damper control device according to claim 1, **characterised in that** a first arm (22)
is pivotally arranged with its first end at the central axis of the first cogwheel (18) and
with its second end at the central axis of the second cogwheel (20).
3. Damper control device according to claim 2, **characterised in that** a second arm
20 (36) is pivotally arranged at its first end, and shiftably connected to the first arm (22).
4. Damper control device according to claim 3, **characterised in that** radially
shiftable control bodies (40) are arranged around the central axis of the first cog-
wheel (18), which control bodies (40) are arranged to be shifted radially by a cen-
25 trifugal force, in a direction outwards from the central axis of the first cogwheel (18),
and to be shifted by a spring device (42) in a direction towards the central axis of the
first cogwheel (18), which control bodies (40) interact with the second arm (36), in
order to pivot the second arm (36) around its first end.
- 30 5. Damper control device according to any of claims 3 - 4, **characterised in that** a
spring element (50, 52) is arranged to pivot turn the second arm (36) around its first
end.

6. Damper control device according to any of the previous claims, **characterised in that** a damper element (28) is arranged on a fifth cogwheel (30), which is arranged to be operated by the third and the fourth cogwheel (26).

5 7. Vehicle (1), **characterised by** comprising a damper control device (10) according to any of claims 1 - 6.

8. Method to operate a damper control device (10) comprising a drive engine (12), a first cogwheel (18), which is connected to the drive engine (12) and which is arranged to be rotated by the drive engine (12), a second cogwheel (20), arranged in engagement with the first cogwheel (18), a third cogwheel (24), arranged in engagement with the second cogwheel (20) when the second cogwheel (20) is arranged in a first position, a fourth cogwheel (26), arranged in engagement with the second cogwheel (20) when the second cogwheel (20) is arranged in a second position, and a damper element (28), arranged to be turned by the third and the fourth cogwheel (24, 26), **characterised in that** the method comprises the following steps:

a) operating the drive engine (12) with a first speed (N1), so that the second cogwheel (20) is arranged in the first position,
b) operating the drive engine (12) with a second speed (N2), which is greater than the first speed (N1), so that the second cogwheel (20) is moved to the second position along the periphery of the second cogwheel (20).

9. Method according to claim 8, **characterised by** the additional steps:

c) detecting power (I) to operate the drive engine (12),
25 d) controlling the second speed (N2) in relation to the detected power (I).

10. Method according to claim 9, **characterised by** the additional steps:

e) limiting the second speed (N2) when the second cogwheel (20) is moved to the second position,
30 f) increasing the second speed (N2) when the second cogwheel (20) has assumed the second position.

11. Computer program (P) for controlling a damper control device (10), wherein said computer program (P) comprises program code to cause an electronic control device

(54), or another computer (70) connected to the electronic control device (54), to perform the steps according to any of claims 8-10.

- 5 12. Computer program product, comprising a program code stored in a medium readable by a computer (70), in order to perform the method steps according to any of claims 8-10, when said program code is executed in an electronic control device (54) or in another computer (70) connected to the electronic control device (54).

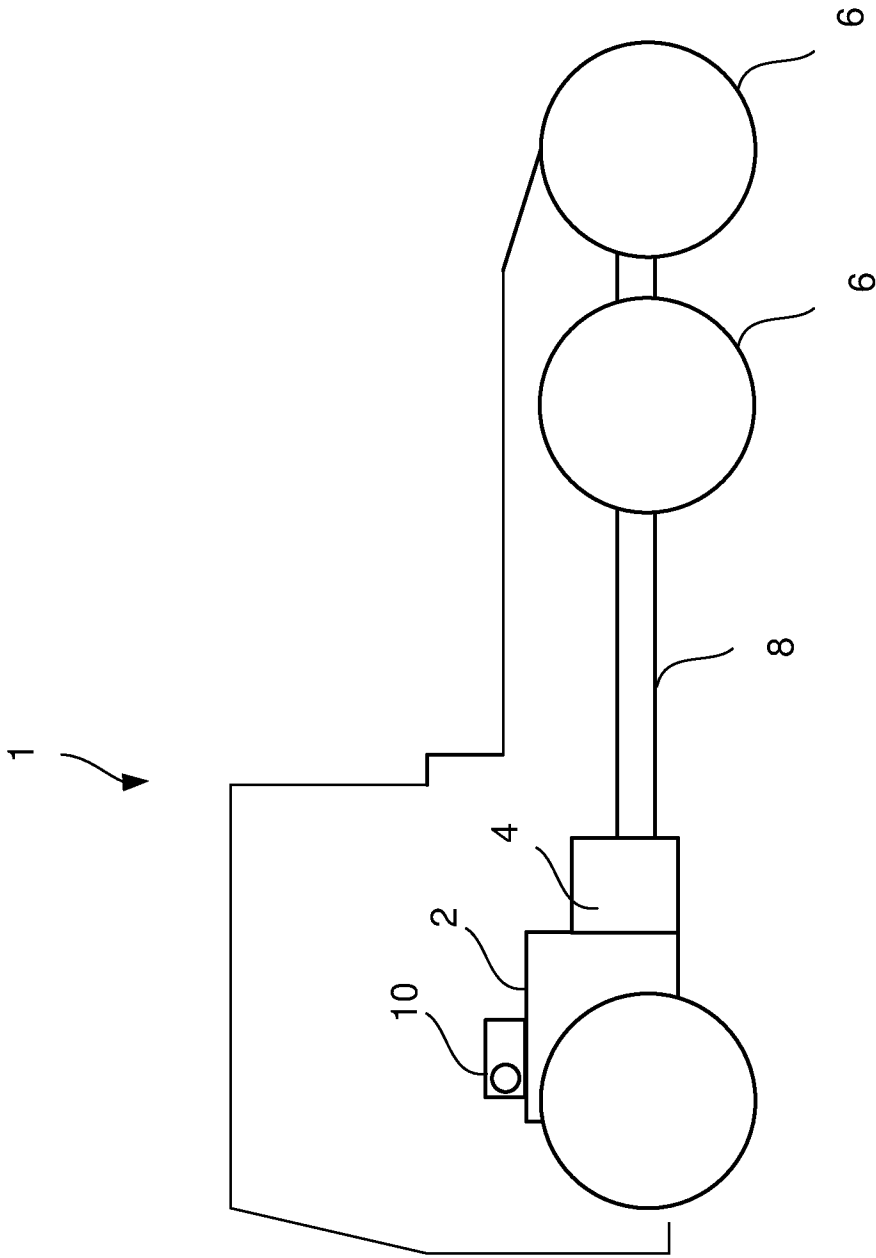


Fig. 1

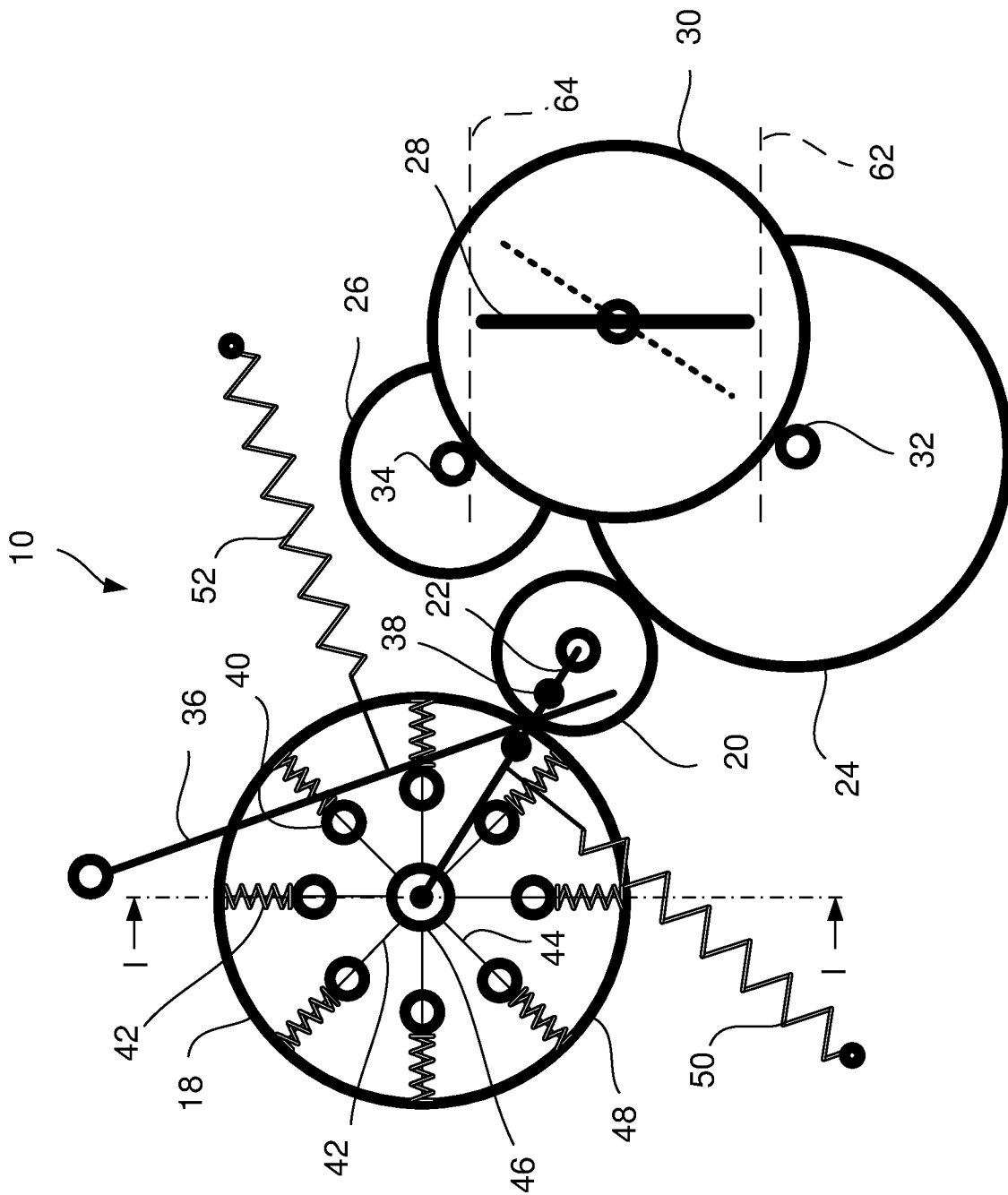


Fig. 2

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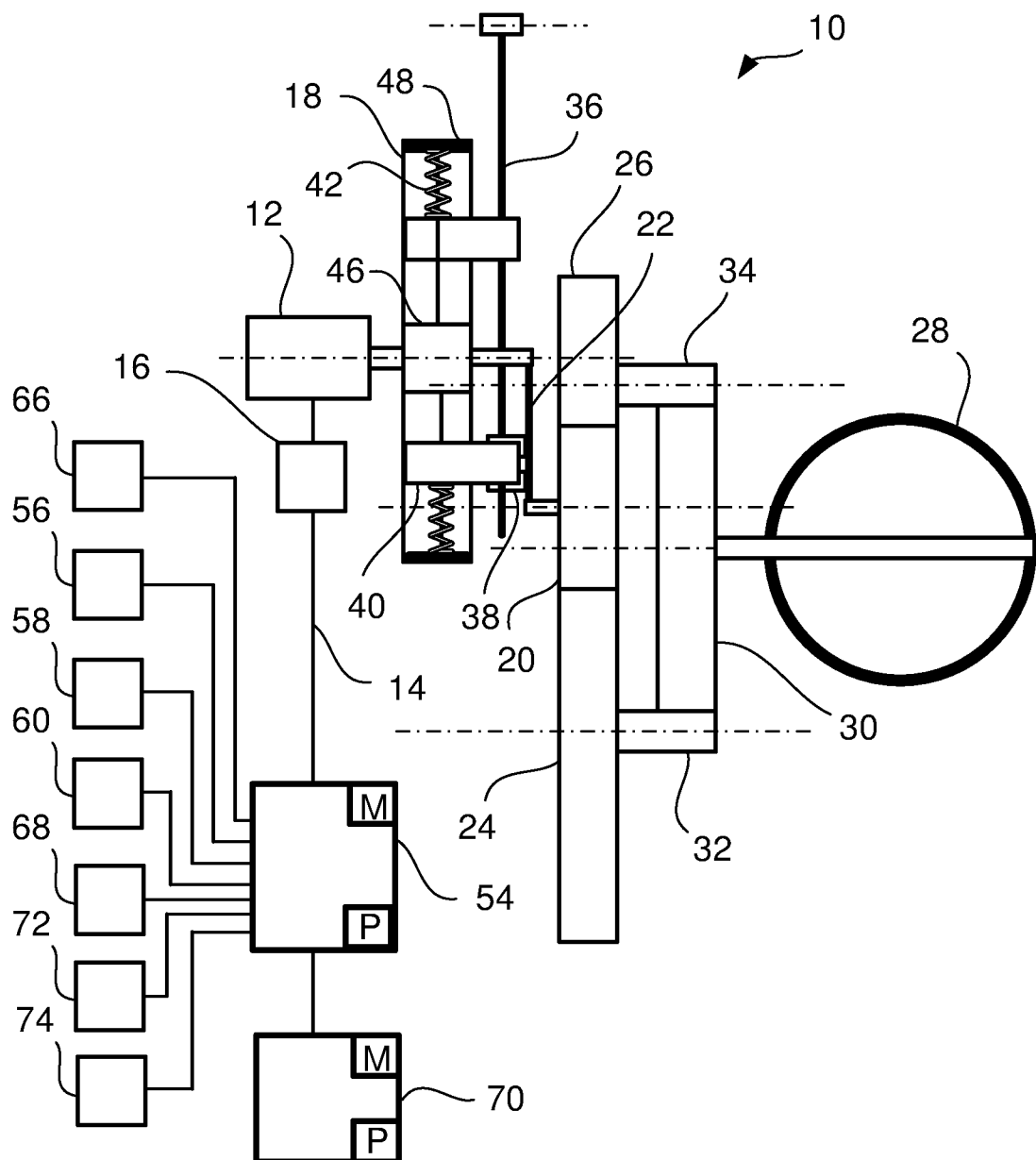


Fig. 3

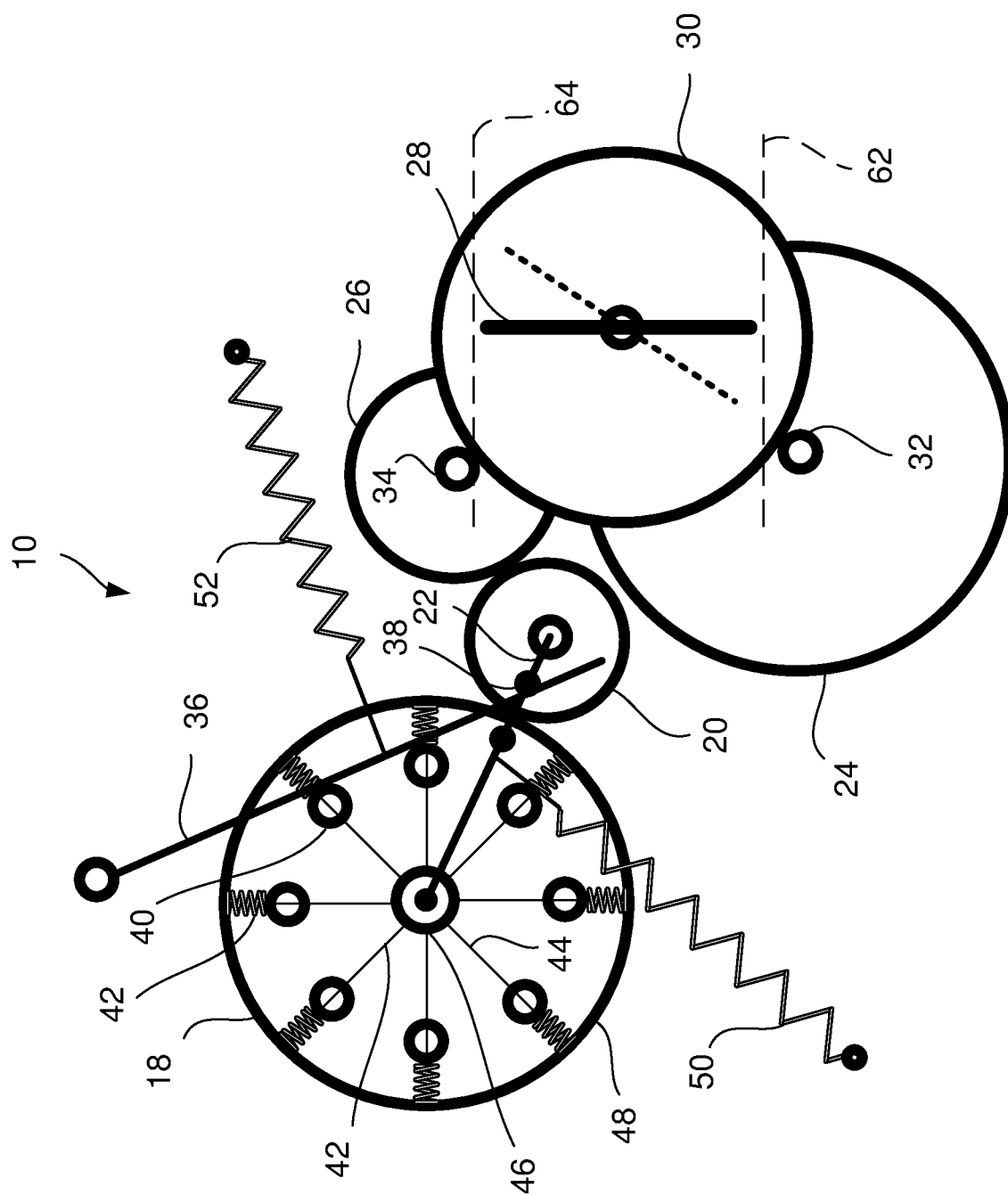


Fig. 4

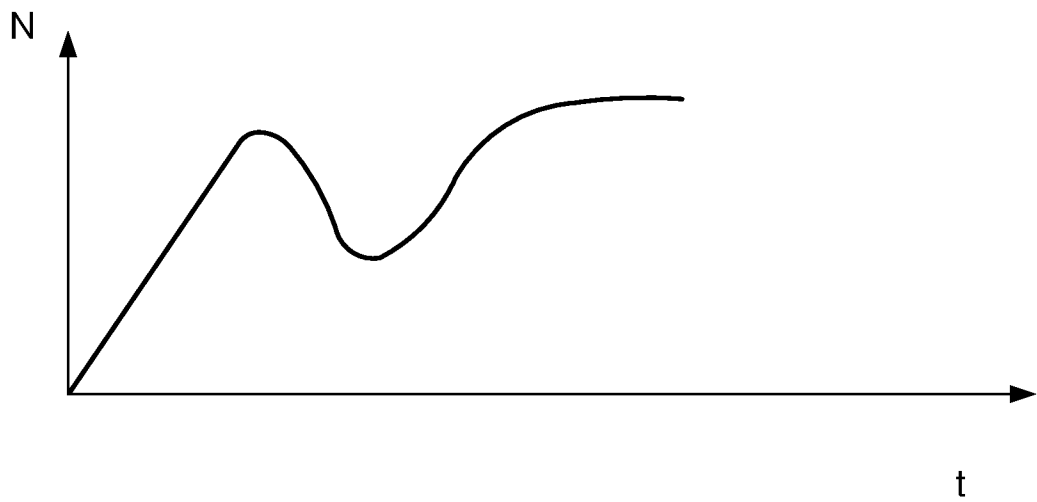


Fig. 5a

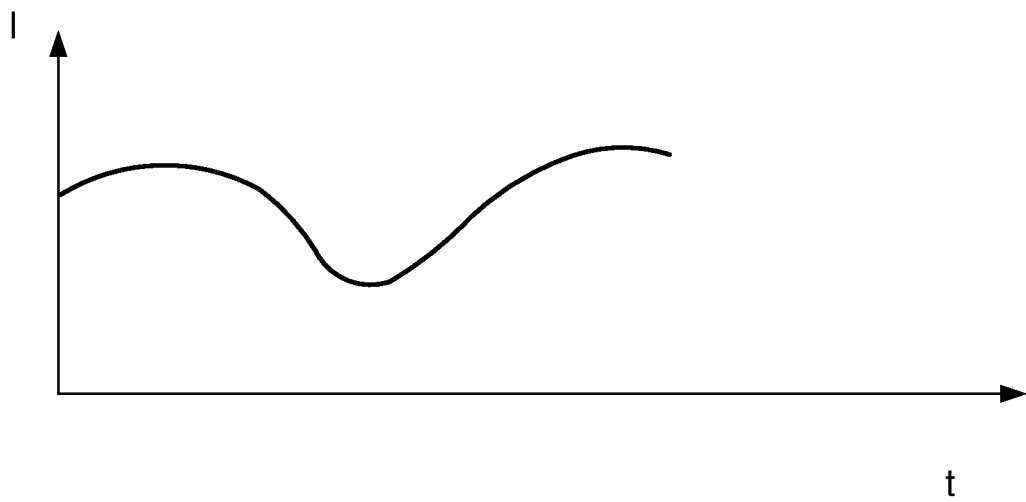


Fig. 5b

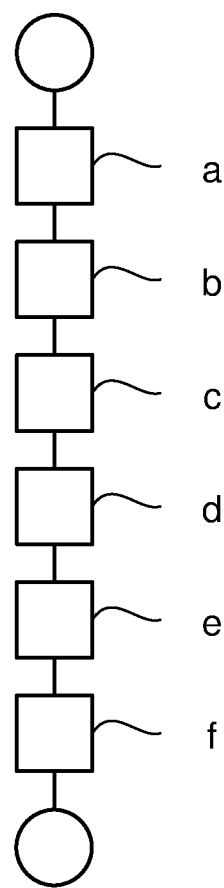


Fig. 6

INTERNATIONAL SEARCH REPORT

 International application No.
 PCT/SE2015/050468

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, F16H, F16K

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 20100009804 A1 (REYNOLDS BRIAN), 14 January 2010 (2010-01-14); abstract; figures --	1-12
A	JP 4301145 A (MAZDA MOTOR CORP), 23 October 1992 (1992-10-23); figures 4-7; See PAJ Abstract --	1-12
A	FR 2897135 A1 (VINET JIM JEAN LEON), 10 August 2007 (2007-08-10); abstract; figures --	1-12
A	FR 2601107 A1 (DUHAMEL), 8 January 1988 (1988-01-08); abstract; figures --	1-12



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2015/050468

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	EP 0173853 A1 (OKI ELECTRIC IND CO LTD), 12 March 1986 (1986-03-12); abstract; figures -- -----	1-12

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International Patent Classification (IPC)

F16K 31/53 (2006.01)

F02D 9/10 (2006.01)

F16H 3/34 (2006.01)

F16K 31/04 (2006.01)

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Information on patent family members

International application No.

PCT/SE2015/050468

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