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(54) A CONTROL METHOD FOR ACTUATING A MOVEMENT INVERSION OF AT LEAST ONE OF A BOOM AND AN IMPLEMENT IN A WORK VEHICLE, A CORRESPONDING CONTROL SYSTEM AND A WORK VEHICLE COMPRISING SUCH CONTROL SYSTEM

(57) A control method for actuating a movement inversion of at least one of a boom and an implement in a work vehicle powered by a motor is disclosed. Actuating the boom and the implement occurs by means of a joystick controlled by a user, a movement of the joystick in a predetermined control area according to a first preset direction causing the actuation of the boom by a first hydraulic actuator and a movement of the joystick in the control area according to a second preset direction causing the actuation of the implement by a second hydraulic actuator. Each hydraulic actuator includes a respective open centre directional solenoid valve whose opening degree is controlled by means of a driving current as a function of the position of the joystick. The control method comprises acquiring a position of the joystick over time as well as a rotational speed of the motor, determining that a direction inversion manoeuvre is requested when a travel of the joystick from a first operating position to a second operating position includes at least one of the first and the second component of the joystick position being reversed with respect to the neutral position; and - when a direction inversion manoeuvre is requested - applying a modified driving current of at least one of the first and the second open centre directional solenoid valve, respectively, based on a predetermined reference model of the modified driving current, indicative of a nominal relation between between the rotational speed of the motor and the evolution over time of the driving current of the respective first and second open centre directional solenoid valve.

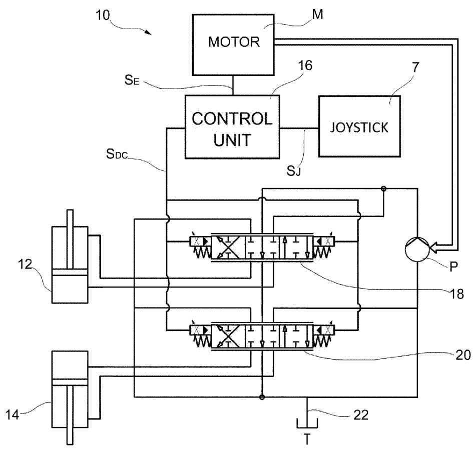

FIG.4

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Description

Technical field

[0001] The present invention relates generally to a work vehicle, such as for example a compact wheel loader, and particularly to a control method of actuating a movement inversion of at least one of a boom and an implement in a work vehicle, and to a corresponding control system.

Prior art

[0002] Motorized work vehicles are well known for use in material handling that carry an implement and have a hydraulically operated lifting arm for moving the implement. Examples of such vehicles are tractors and loaders.

[0003] A loader is a heavy equipment machine used in construction to move aside on the ground or load materials such as asphalt, demolition debris, dirt, snow, feed, gravel, logs, raw minerals, recycled material, rock, sand, woodchips, etc. into or onto another type of machinery (such as a dump truck, conveyor belt, feed-hopper, or railroad car). There are many types of loader, which, depending on design and application, are called by various names, including bucket loader, front loader, front-end loader, payloader, scoop, shovel, skip loader, wheel loader, or skid-steer. In particular, compact wheel loaders are compact vehicles that have road wheels and carry a working implement, such as a bucket, attached to a lift arm or boom, that is hydraulically powered.

[0004] Referring to figure 1, a work vehicle 1, such as a compact wheel loader, is shown. However, the invention is not limited to such a kind of work vehicle, but is applicable to any other kind of work vehicle.

[0005] A compact wheel loader includes a bucket 2 connected to a frame 3 of the work vehicle for movement relative thereto. As shown, a pair of booms 5 (only one being shown) is each pivotally connected at one end on opposite sides of frame 3. The bucket 2 is pivotally connected at the opposite end of booms for tilting movement relative to the frame 3 about a generally horizontal axis. The above-described features form no substantial part of the present invention and are generally well known in the art. A bucket may be replaced in operation by any other implement or attachment.

[0006] Usually, the movement of the boom 5 and of the bucket 2 is controlled by the user through a joystick 7 placed inside an operator's cab or cabin 9 of the work vehicle 1.

[0007] As can be seen in figure 2, which shows a control diagram of the work vehicle 1, the boom 3 and the bucket 2 are moved by an hydraulic control circuit 10 comprising a first and a second hydraulic actuators 12, 14 which are controlled by an electronic control unit 16 through respective solenoid valves 18, 20 according to the position of the joystick 7 controlled by the user.

[0008] Further attachments that can be operated in parallel to the bucket (and the boom) by means of respective hydraulic actuators (not shown) which are controlled by an electronic control unit 16 through respective solenoid valves in a like manner, e.g. by means of push-buttons embodied in the joystick or according to the position of a separate joystick controlled by the user.

[0009] Load-sensing valves allow a pressure compensation so that downstream channels take proportional allocation of flow depending on the load. The flow rate at a predetermined opening degree is not dependent upon the load downstream each valve and is not dependent upon the pump inlet flow. When a plurality of loads is actuated, load-sensing valves with flow sharing also prevent the working fluid from taking the path of least resistance. However, this solution is very expensive. Advantageously, open centre directional solenoid valves are less expensive than load-sensing valves.

[0010] For example, each hydraulic actuator comprises an hydraulic cylinder operatively connected respectively to the boom and the implement, that uses hydraulic power of a working fluid to facilitate mechanical operation, the working fluid being controlled by means of open centre directional solenoid valves 18, 20. As liquids are nearly impossible to compress, a hydraulic actuator can exert a large force. The rate of actuation of the boom and implement is controlled by the opening degree of the respective open centre directional solenoid valve 18, 20 by means of a driving current thereof as a function of the position of the joystick.

[0011] The hydraulic flow rate of the working fluid required to operate the boom and the implement is produced by a hydraulic fixed displacement pump P connected to a fluid reservoir T and driven by an internal combustion engine or an electrical motor M (hereinafter simply referred to as motor) of the vehicle, e.g. by a mechanical linkage. The same motor is also used to drive the wheels as a propulsion means of the work vehicle. Therefore, the rate of movement of the boom and the implement at a predetermined joystick position is dependent upon the motor rotational speed. For instance, when the motor is working at a high rotational speed, it is necessary a minimum movement of the joystick by the user to start the movement of the boom and/or the implement. On the contrary, when the motor is working at a low rotational speed, or at idle, it is necessary a large movement of the joystick by the user to start the movement of the boom and/or the bucket.

[0012] Figure 3 shows an exemplary joystick of a work vehicle. A movement of the joystick in an associated bi-dimensional control area A according to a first direction y causes the actuation of the boom and a movement of the joystick in said bi-dimensional control area A according to a second direction x causes the actuation of the implement. The intersection of said x and y directions is defined as origin O of the control area A, and corresponds to the neutral position of the joystick.

[0013] A neutral region N around the neutral position of the joystick is a region where the boom and implement are not actuated. A region externally surrounding the neutral region is defined a driving region and indicated D in this figure.

[0014] For example, according to the orientation depicted in figure 3, in an embodiment where the implement is a bucket when the joystick is moved up from the origin O of the control area A according to the y direction the boom is lowered with respect to ground and when the joystick is moved down from the origin O according to the y direction the boom is lifted towards ground. Further, when the joystick is moved right from the origin O according to the x direction the implement, e.g. a bucket, is tilted towards a dumping position, and when the joystick is moved left from the origin O according to the x direction the implement, e.g. the bucket, is tilted towards a dig or rollback position and beyond.

[0015] A combination of movement in both directions x and y of the joystick is allowed in order to move simultaneously the boom and the bucket.

[0016] Disadvantageously, in open centre directional solenoid valves the flow rate at a predetermined opening degree is dependent upon the force driving the pump, the number of valves supplied by the pump and the load downstream each valve. As a consequence thereof, a direction inverse manoeuvre is usually jerky and sensitive to motor rotational speed

Summary of the invention

[0017] The aim of the present invention is to provide a solution that avoids the drawbacks of the prior art. Particularly, an aim of the present invention is to improve the controllability of a boom and an implement in a work vehicle in a direction inversion manoeuvre. A further aim of the present invention is to increase the comfort of the user when such manoeuvre occurs, without impacting the cycle time.

[0018] According to the invention, this aim is achieved by a control method for actuating a movement inversion of at least one of a boom and an implement in a work vehicle, having the features claimed in claim 1.

[0019] Preferred embodiments are defined in the dependent claims, whose content is also to be considered an integral part of the present description. Features of the dependent claims may be combined with the features of the independent claims as appropriate, and in combinations other than those explicitly set out in the claims.

[0020] Further subjects of the invention are a control system for actuating a movement inversion of at least one of a boom and an implement in a work vehicle, as well as a work vehicle, as claimed.

[0021] In summary, an actuation strategy of at least one of a boom and an implement of a work vehicle is disclosed according to which, based on information about the joystick position - that can be retrieved as an electronic signal provided by a position sensor associated with the joystick - and about the current rotational speed of the motor - that can be retrieved as an electronic signal provided on a CAN network of the vehicle - actuation is controlled by recognizing if the user is performing a direction inversion manoeuvre of at least one of the boom and the implement and, in the affirmative, by modulating the driving current of the open centre directional solenoid valve of the hydraulic actuating means associated with said at least one of the boom and the implement, depending on the motor rotational speed.

Brief description of the drawings

[0022] Further functional and structural characteristics and advantages of the present invention are set out in the detailed description below, provided purely as a non-limiting example, with reference to the attached drawings, in which:

- figure 1 shows a prior art exemplary work vehicle, in particular a compact wheel loader;
- figure 2 shows a prior art control diagram of a work vehicle;
- figure 3 shows a prior art exemplary joystick of a work vehicle;
- figure 4 shows a control diagram of a work vehicle according to the invention; and
- figure 5 shows curves representing the modified driving current of an open centre directional solenoid valve of an hydraulic actuator for a boom or an implement corresponding to the movement of the joystick along a predetermined direction, according to the invention.

Detailed description

[0023] In the following description, unless otherwise defined, all terms (including technical and scientific terms) are to be interpreted as is customary in the art. It will be further understood that terms in common usage should also be interpreted as is customary in the relevant art and not in an idealized or overly formal sense unless expressly so defined herein. All orientation terms, such as upper and lower, are used in relation to the drawings and should not be interpreted as limiting the invention.

[0024] In the following, a preferred embodiment of a control method for actuating a movement inversion of at least one of a boom and an implement, such as a bucket connected to the boom, in a work vehicle is described. Reference is made to the control diagram of Figure 4, where the electronic control unit 16 is configured to implement the control method of the invention.

[0025] As disclosed above and with further reference to Figure 3, actuation of the boom 5 and the implement 2 occurs by means of joystick 7 controlled by a user, whose movement in the control area A according to direction y causes the actuation of the boom 5 by first hydraulic actuating means 12 and whose movement in the control area A according to direction x causes the actuation of the implement 2 by second hydraulic actuating means 14.

[0026] Each hydraulic actuating means 12, 14 include an hydraulic cylinder operatively connected respectively to the boom 5 and the implement 2, and a respective first and second open centre directional solenoid valve 18, 20 whose opening degree is adapted to control the flow of a working fluid to the respective hydraulic cylinder.

[0027] The rate of actuation of the boom 5 is controlled by the opening degree of the first open centre directional solenoid valve 18 by means of the driving current thereof as a function of a first component of the position P of the joystick 7 along direction y in the control area A. The rate of actuation of the implement 2 is controlled by the opening degree of the second open centre directional solenoid valve 20 by means of the driving current thereof as a function of a second component of the position P of the joystick 7 along direction x in the control area A. The first component of the position P of the joystick 7 along direction y is indicated y_P in figure 3 and is the projection over y axis of a vector representing the position P of the joystick in the control area A. The second component of the position P of the joystick 7 along direction x is indicated x_P in figure 3 and is the projection over x axis of the vector representing the position P of the joystick in the control area A. First and second components y_P, x_P of the position of the joystick may take on any combination of a "positive" value and a "negative" value on the y axis and x axis, respectively with respect to origin O of the control area A that corresponds to the neutral position of the joystick. A travel of the joystick from a first operating position to a second operating position where at least one of the first and the second component of the joystick position is reversed with respect to the neutral position, i.e. passes through a null value, is defined as a direction inversion manoeuvre of at least one of the boom and the implement. As an example, a travel of the joystick along the y direction and passing through the neutral position corresponds to an inversion manoeuvre of the movement of the boom - from lifting to lowering or vice versa. As a further example, a travel of the joystick along a straight direction at an angle from the x axis and the y axis and passing through the neutral position corresponds to an inversion manoeuvre of both the movement of the boom - from lifting to lowering or vice versa - and the implement - from dumping to rollback or vice versa.

[0028] The electronic control unit 16 has first input means adapted to receive at least a signal S_J indicative of a position of the joystick in the control area as well as second input means adapted to receive at least a signal S_E indicative of the rotational speed of the motor M, and output means adapted to issue at least a signal S_{DC} indicative of the respective driving currents intended to control an opening degree of the open centre directional solenoid valve 18, 20.

[0029] The electronic control unit has also memory means (not shown) storing at least a predetermined reference model of a modified driving current of each open centre directional solenoid valve 18, 20, indicative of a nominal relation between the hydraulic flow rate of the working fluid and the evolution of the driving current over time, and preferably also the actuation command of the boom and/or the implement. Specifically, said reference model is an analytical relationship between, or a map of numerical values in a bijective correspondence of, the rotational speed of the motor - corresponding to the hydraulic flow rate of the working fluid and the evolution over time of the driving current of the open centre directional solenoid valves 18, 20 for actuation of the boom and the implement, and preferably also the target operating position of the joystick - corresponding to the actuation command of the boom and the implement.

[0030] In a preferred embodiment, different reference models are provided, for a manoeuvre of movement inversion of the boom and the implement, respectively. It is also possible that different models be provided depending upon the manoeuvre direction.

[0031] An exemplary predetermined reference model in shown in Figure 5 as a plurality of curves representing the evolution of the modified driving current of an open centre directional solenoid valve of an hydraulic actuator for a bucket as a function of the time when the inversion manoeuvre occurs (on the x-axis). By way of example, the Figure depicts the evolution of the modified driving current over time upon a rollback request from a dump position, i.e. the rate of change of the driving current as a function of the rotational speed of the motor. Different curves A, B and C are depicted by way of example that correspond to different rotational speeds of the work vehicle motor driving the pump supplying the working fluid under pressure to the hydraulic actuator of the bucket. In the figure, the evolution from curve A to curve C correspond to an increasing rotational speed of the motor. The reference model is not limited to the depicted curves, but the number of curves depends upon the granularity of the rotational speed measurement, or a predetermined number of curves is provided, each being applicable in a respective range of rotational speeds of the motor.

[0032] According to a preferred, non-limitative, embodiment of the invention, each modified driving current curve A, B, C has a rate of change (slope) varying as a function of the target operating position of the joystick.

[0033] According to the preferred, non-limitative, embodiment, the modified driving current curves are linear, and they have a plurality of constant slope ranges, including at least a first range having a first slope which is associated with a target operating position of the joystick (along the x-axis, in the non-limitative example of Figure 5) having a distance from the neutral position lower than a predetermined threshold, and a second range having a second slope associated with a target operating position of the joystick (along the x-axis, in the non-limitative example of Figure 5) having a distance from the neutral position greater than said predetermined threshold, where the first slope is higher than the second slope.

[0034] In operation, the electronic control unit 16 is configured to acquire over time the signal S_J indicative of the position of the joystick 7 in the control area A, particularly a position in a driving region D of the control area A external to the neutral region N. The electronic control unit is also configured to acquire the signal S_E indicative of the rotational speed of the motor M.

[0035] By receiving the signal S_J indicative of the joystick position over time, the electronic control unit acquires or determines the evolution of the first component Y_P of the position P of the joystick 7 along direction y and the second component X_P of the position P of the joystick 7 along direction x, and it is therefore able to detect a travel of the joystick from a first operating position to a second, target, operating position where at least one of the first and the second component of the joystick position is reversed with respect to the neutral position, i.e. passes through a null value, which corresponds to a direction inversion in the actuation of the boom and/or the implement.

[0036] If the electronic control unit does not detect a travel of the joystick position that determines a direction inversion in the actuation of the boom and/or the implement, the electronic control unit applies the nominal driving current to the open centre directional solenoid valves 18, 20 of the boom and the implement by means of the signal S_{DC}. Otherwise, if the electronic control unit detects a travel of the joystick position that determines a direction inversion in the actuation of the boom and/or the implement, the electronic control unit applies, by means of the signal S_{DC}, a modified driving current to the open centre directional solenoid valves 18, 20 of the boom and the implement according to the stored predetermined reference model, based on the target operating position of the joystick acquired through the signal S_J, and the current rotational speed of the motor acquired through the signal S_E.

[0037] Referring to the exemplary operation depicted in Figure 5, a bucket is actuated from a dump position to a rollback position, by moving the joystick from a dump control position at time t_0 to a target rollback control position, a driving current I_D corresponding to the dump control position and a driving current I_{RB} corresponding to the rollback control position. A predetermined driving current threshold is indicated I_{th}, that corresponds to a predetermined distance threshold of the joystick target position from the neutral position. In the case where the current rotational speed of the motor is the one at idle, represented by curve A, the electronic control unit that has detected a travel of the joystick position that determines a direction inversion in the actuation of the bucket applies to the open centre directional solenoid valve 18 of the bucket a modified driving current varying in time according to the rate of curve A, until the driving current I_{RB} corresponding to the target rollback control position is reached at time t_1. If the user had set a target rollback control position having a related driving current I_{RB}' higher than the predetermined driving current threshold I_{th}, the electronic control unit would apply a modified driving current varying in time according to the rate of curve A until time t_2, the modified driving current varying in time according to a first rate from t_0 to t' and according to a second, lower, rate from t' to t_2.

[0038] In a preferred embodiment, a plurality of reference models may be considered, depending upon different control modes of the work vehicle that may be provided by the manufacturer, such as a "smooth" mode, a "moderate" mode, an "aggressive" mode. Depending on the control mode selected by the user, the electronic control unit is configured to select the corresponding reference model.

[0039] Where the present invention has been described referring to a joystick configured to be operated by movement in a bi-dimensional control area combining the actuation of the boom and the actuation of the implement, it would be clear to a skilled person that a pair of independent joysticks or levers movable along respective, separate unidimensional control tracks are comprised within the scope of the invention as an equivalent embodiment, the principle of the invention being the same.

[0040] Therefore, by virtue of the present invention, the opening degree of the open centre directional solenoid valve of the hydraulic actuating means associated with at least one of the boom and the implement is modulated depending on the motor rotational speed so as to achieve a smooth direction inversion manoeuvre of said at least one of the boom and the implement.

[0041] The example embodiments are described in sufficient detail to enable those of ordinary skill in the art to implement a control system in a work vehicle arranged to carry out the disclosed control method herein described.

[0042] Naturally, the principle of the invention remaining unchanged, the embodiments and the constructional details may vary widely from those described and illustrated purely by way of non-limiting example, without thereby departing from the scope of the invention as defined in the appended claims.

Claims

1. A control method for actuating a movement inversion of at least one of a boom and an implement in a work vehicle powered by a motor,
   wherein actuating the boom and the implement occurs by means of a joystick controlled by a user, a movement of the joystick in a predetermined control area according to a first preset direction causing the actuation of the boom by first hydraulic actuating means and a movement of the joystick in said control area according to a second preset direction causing the actuation of the implement by second hydraulic actuating means,
   wherein the first hydraulic actuating means and the second hydraulic actuating means each include an

hydraulic cylinder operatively connected respectively to the boom and the implement, and a respective first and second open centre directional solenoid valve whose opening degree is adapted to control the flow of a working fluid to the respective hydraulic cylinder,
the rate of actuation of the boom being controlled by the opening degree of the first open centre directional solenoid valve by means of a driving current thereof as a function of a first component of the position of the joystick along said first preset direction in the control area, and the rate of actuation of the implement being controlled by the opening degree of the second open centre directional solenoid valve by means of a driving current thereof as a function of a second component of the position of the joystick along said second preset direction in the control area,
the control method comprising the steps of:

a) acquiring a signal or data indicative of a position of the joystick in said control area over time;
b) acquiring a signal or data indicative of a current rotational speed of the motor;
c) determining that a direction inversion manoeuvre is requested when a travel of the joystick from a first operating position to a second operating position includes at least one of the first and the second component of the joystick position being reversed with respect to the neutral position; and
d) when a direction inversion manoeuvre is requested, applying a modified driving current of at least one of the first and the second open centre directional solenoid valve, respectively, based on a predetermined reference model of the modified driving current, indicative of a nominal relation between the rotational speed of the motor and the evolution over time of the driving current of the respective first and second open centre directional solenoid valve.

2. The control method according to claim 1, wherein said predetermined reference model is an analytical relationship between, or a map of numerical values in a bijective correspondence of, the rotational speed of the motor and the evolution over time of the driving current of the respective first and second open centre directional solenoid valve.

3. The control method according to any one of the preceding claims, wherein said reference model includes a plurality of modified driving current curves as a function of the rotational speed of the motor.

4. The control method according to claim 3, wherein said reference model includes a first set of modified driving current curves as a function of the rotational speed of the motor for actuating a movement inversion of a boom and a second set of modified driving current curves as a function of the rotational speed of the motor for actuating a movement inversion of an implement.

5. The control method according to any one of the preceding claims, wherein each modified driving current curve has a slope varying as a function of the target operating position of the joystick.

6. The control method according to claim 5, wherein each modified driving current curve is a linear curve.

7. The control method according to claim 6, wherein each modified driving current curve has a plurality of constant slope ranges, including at least a first range having a first slope associated with a target operating position of the joystick having a distance from the neutral position lower than a predetermined threshold or with a modified driving current lower than a predetermined driving current threshold, and a second range having a second slope associated with a target operating position of the joystick having a distance from the neutral position greater than a predetermined threshold or with a modified driving current higher than a predetermined driving current threshold, where the first slope is higher than the second slope.

8. The control method according to any one of the preceding claims, wherein said predetermined reference model is one of a plurality of predetermined reference models associated with different control modes of the work vehicle.

9. A control system for actuating a movement inversion of at least one of a boom and an implement in a work vehicle powered by a motor, comprising:

- first input means adapted to receive at least a signal indicative of a position in a control area of a joystick controlled by a user for actuating the boom and the implement;
- second input means adapted to receive at least a signal indicative of the rotational speed of the motor;
- output means adapted to issue at least a first signal indicative of a driving current intended to control an opening degree of at least one of a first and a second open centre directional solenoid valve of respective first and second hydraulic actuating means of said boom and said implement, respectively; and
- memory means adapted to store a predetermined reference model of a modified driving current, indicative of a nominal relation between the

rotational speed of the motor and the evolution over time of the driving current of the respective first and second open centre directional solenoid valve;
the system being arranged to carry out a control method according to any one of claims 1 to 8.

10. Work vehicle, in particular compact wheel loader, comprising

- a motor for propulsion of the work vehicle;
- a boom and an implement connected to the boom;
- a joystick operatively controlled by a user for actuating the boom and the implement, the joystick being movable in a predetermined control area according to a first preset direction for actuating the boom and in a second preset direction for actuating the implement;
- first hydraulic actuating means for actuating the boom and second hydraulic actuating means for actuating the implement, wherein the first hydraulic actuating means and the second hydraulic actuating means each include an hydraulic cylinder operatively connected respectively to the boom and the implement, and a respective first and second open centre directional solenoid valve whose opening degree is adapted to control the flow of a working fluid supplied by pumping means to the respective hydraulic cylinder, the pumping means being driven by the motor of the work vehicle,
wherein the opening degree of said first and second open centre directional solenoid valve is operatively controlled by means of a respective driving current; and
- a control system for actuating a movement inversion of at least one of the boom and the implement, according to claim 9.

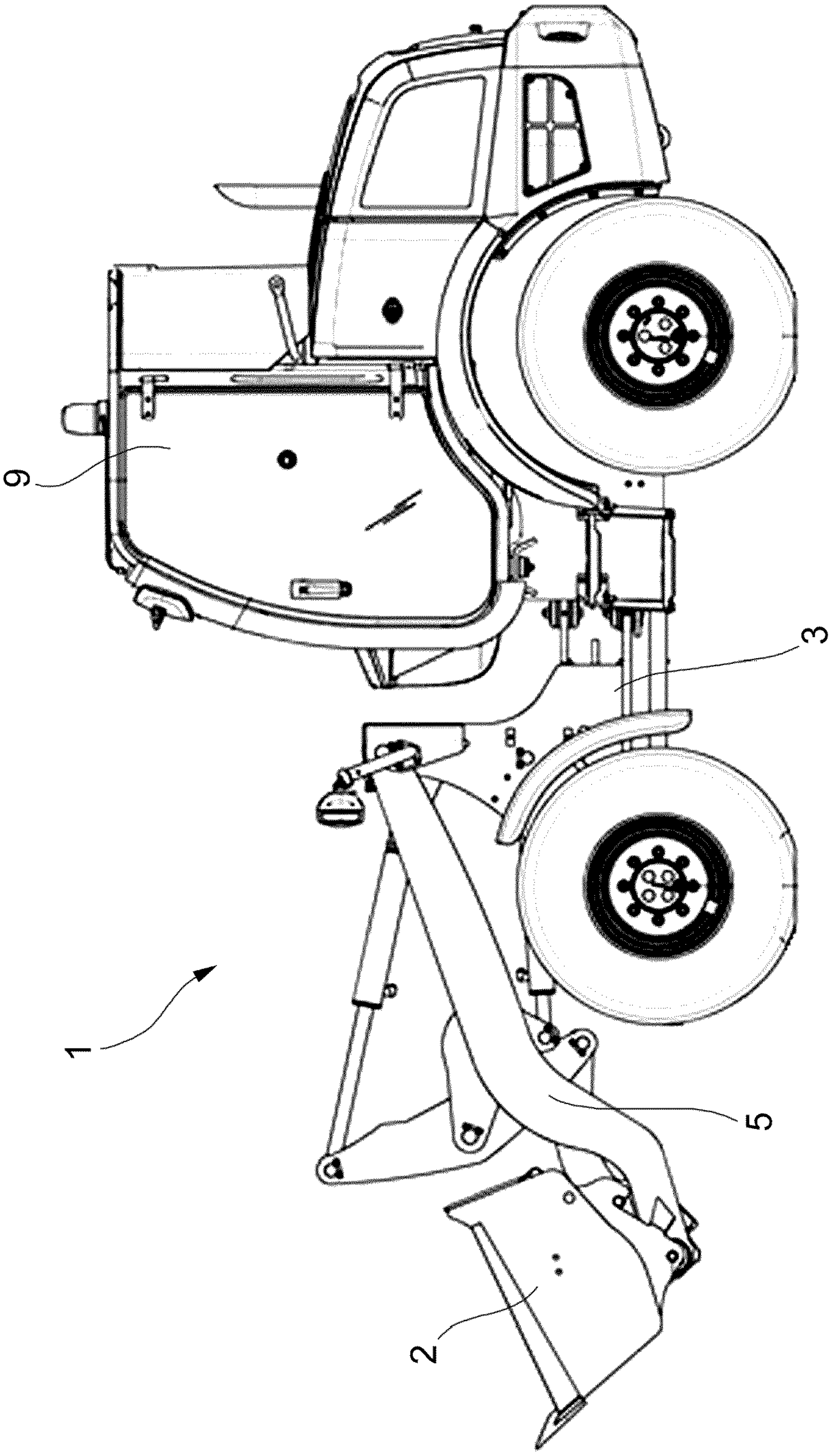

FIG.1
(PRIOR ART)

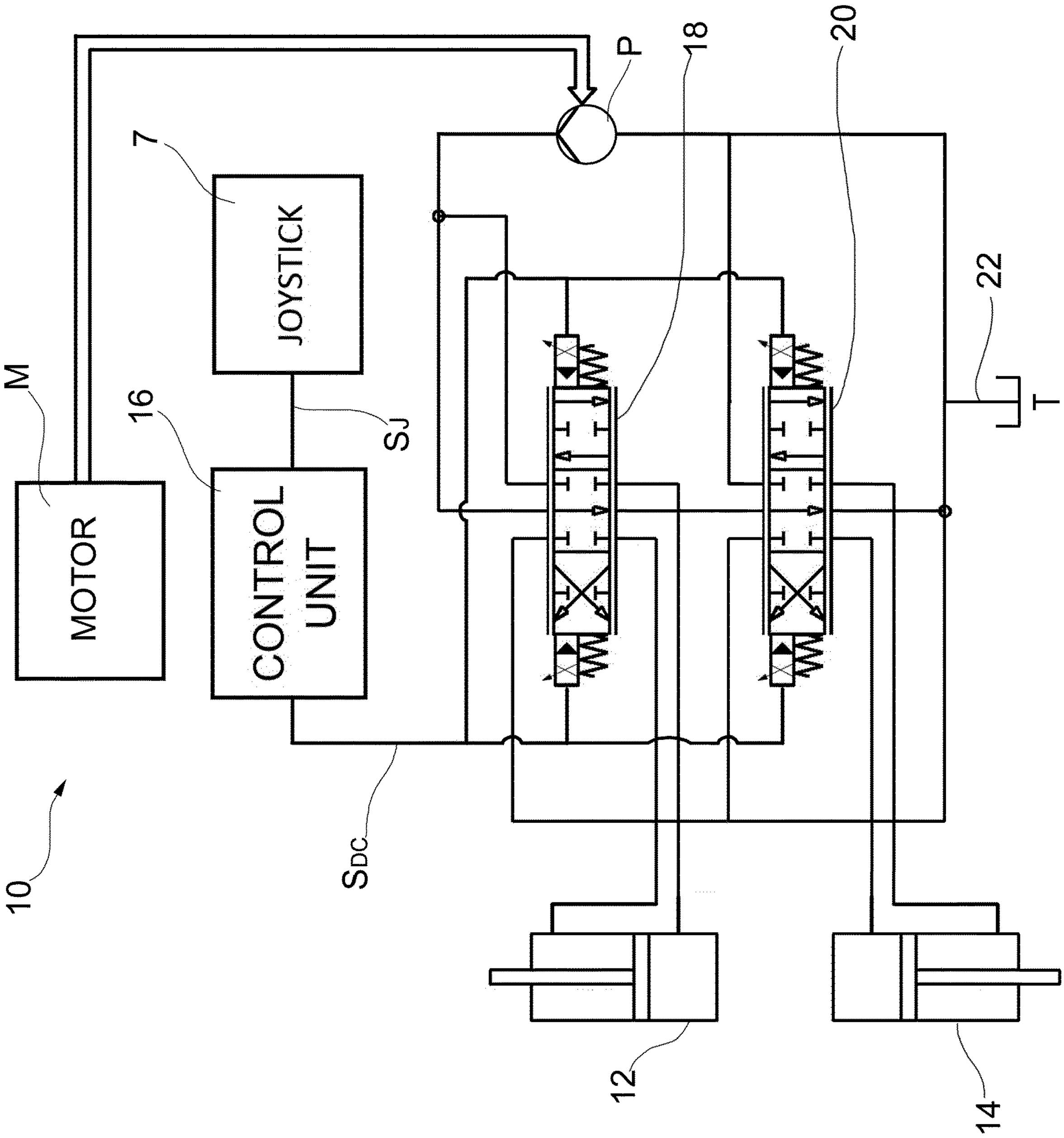

FIG.2
(PRIOR ART)

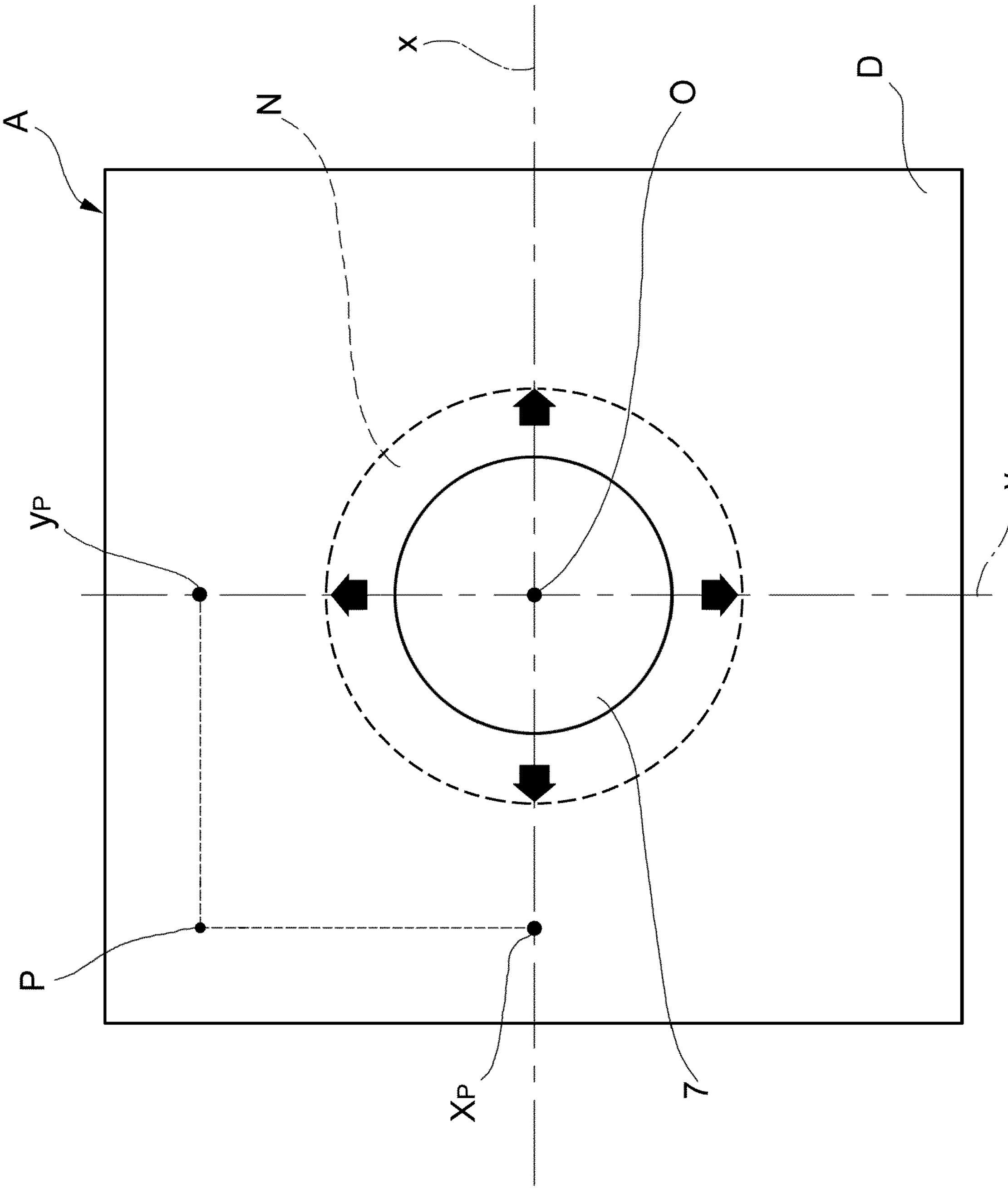

FIG.3
(PRIOR ART)

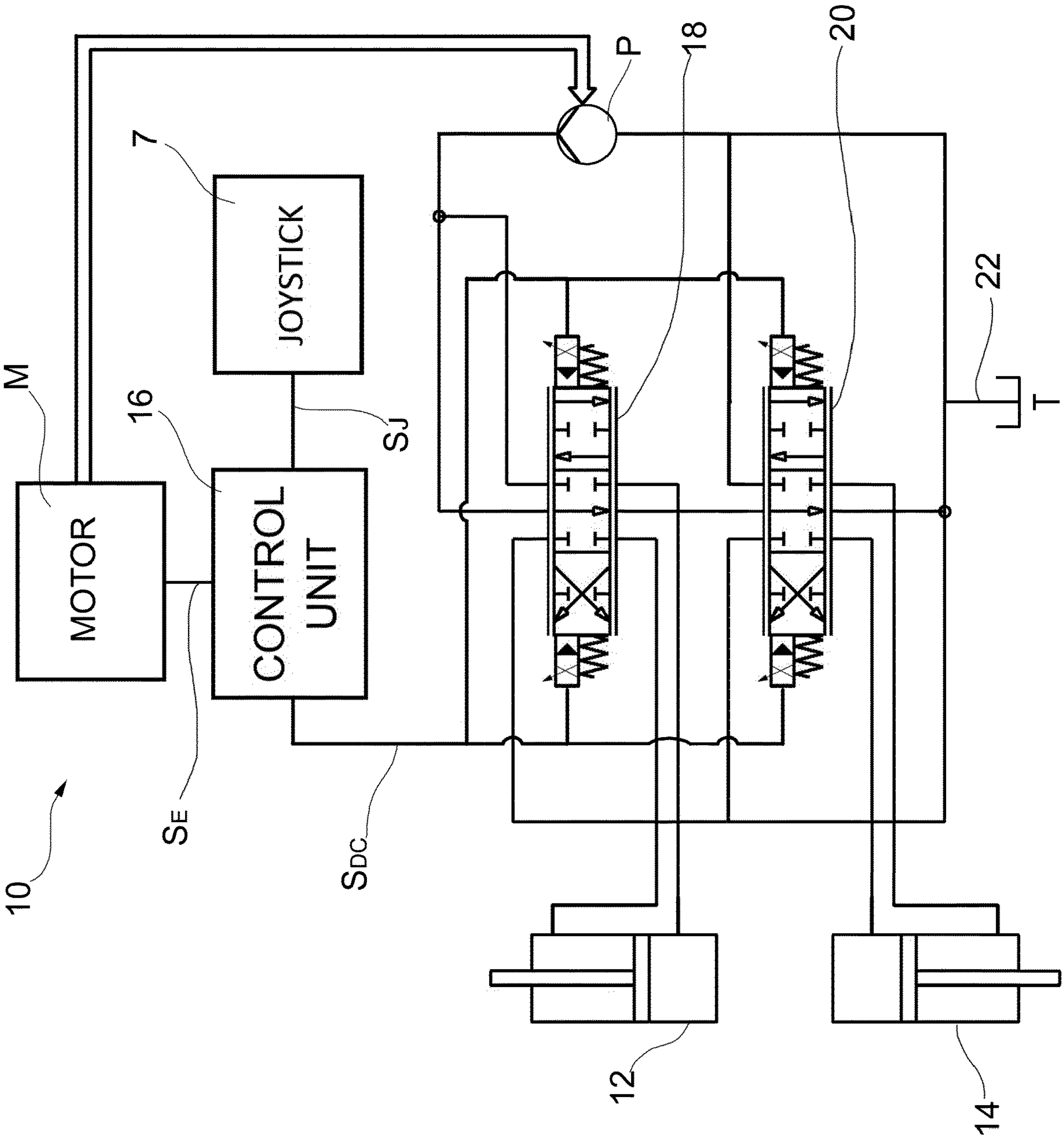

FIG.4

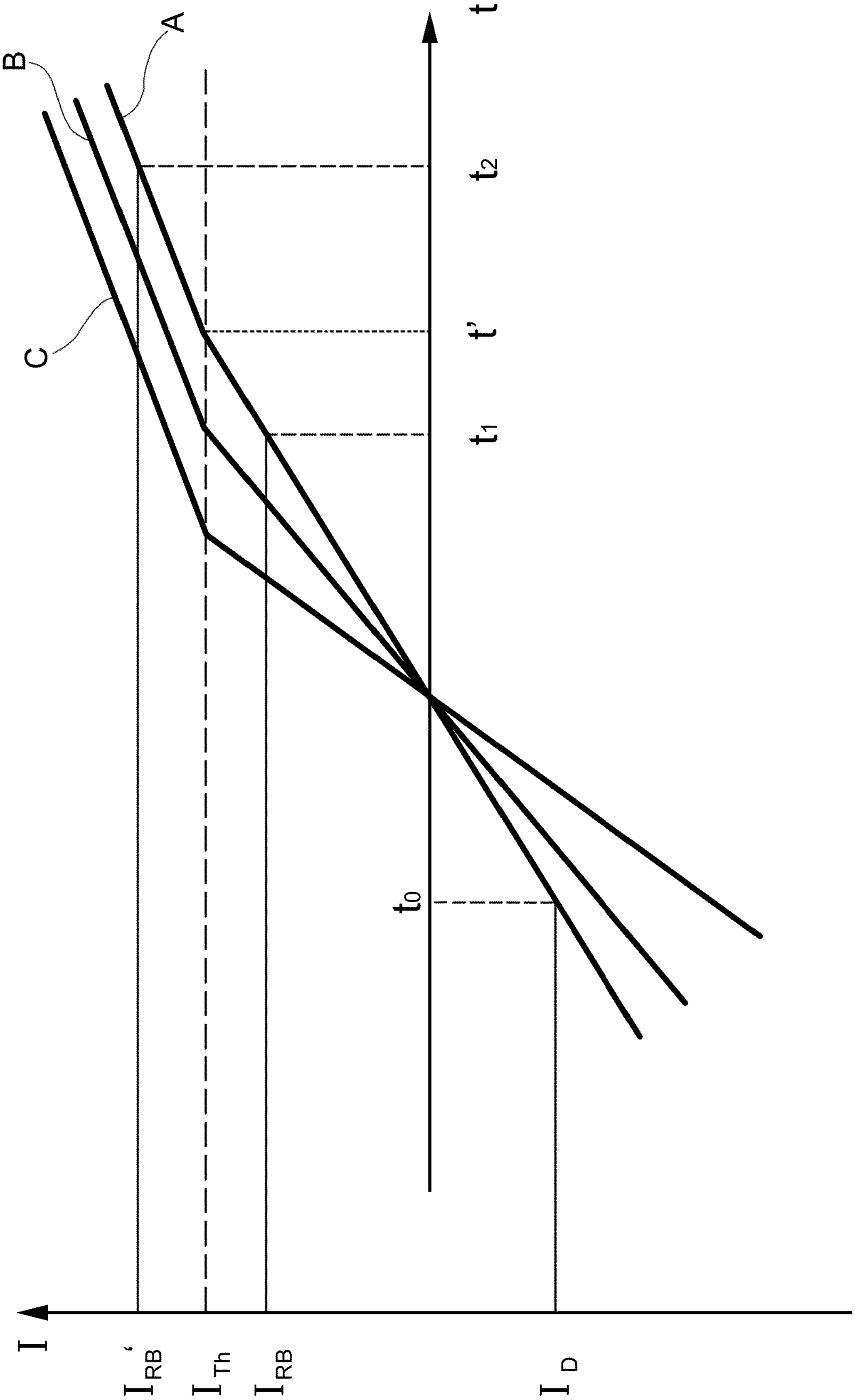

FIG.5

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EUROPEAN SEARCH REPORT

Application Number
EP 20 16 8285

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2017/107696 A1 (FUKUDA YUJI [JP] ET AL) 20 April 2017 (2017-04-20) * the whole document * -----	1-10	INV. E02F9/20 E02F9/22 E02F3/43
A	JP 2016 125282 A (SUMITOMO HEAVY IND LTD) 11 July 2016 (2016-07-11) * abstract; figures 1,2,5 * -----	1-10	
A	US 2014/283508 A1 (HIRAKU KENJI [JP] ET AL) 25 September 2014 (2014-09-25) * abstract; figures 1-11 * -----	1-10	

TECHNICAL FIELDS SEARCHED (IPC)

E02F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	29 May 2020	Ferrien, Yann

CATEGORY OF CITED DOCUMENTS

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2017107696 A1	20-04-2017	JP 6259371 B2	10-01-2018
		JP 2016033392 A	10-03-2016
		US 2017107696 A1	20-04-2017
		WO 2016017209 A1	04-02-2016
JP 2016125282 A	11-07-2016	CN 105756119 A	13-07-2016
		JP 6695620 B2	20-05-2020
		JP 2016125282 A	11-07-2016
US 2014283508 A1	25-09-2014	CN 104011400 A	27-08-2014
		DE 112012005636 T5	09-10-2014
		JP 5805217 B2	04-11-2015
		JP WO2013105357 A1	11-05-2015
		US 2014283508 A1	25-09-2014
		WO 2013105357 A1	18-07-2013

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82