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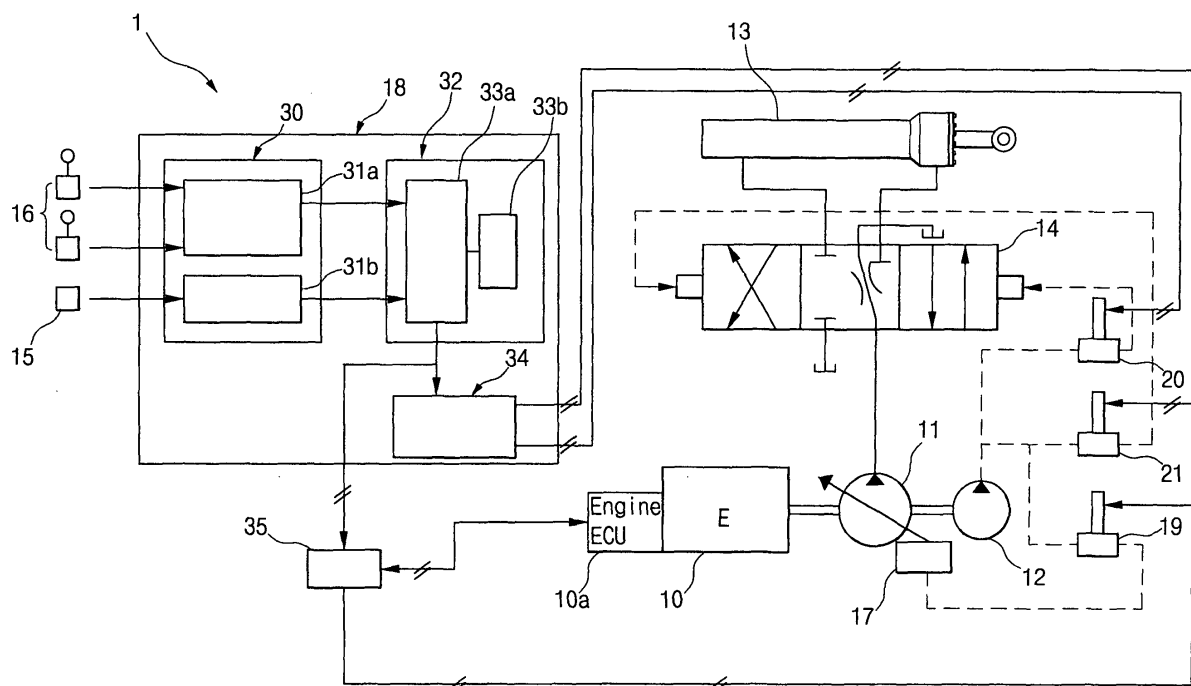
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(54) **Method for setting response modes of construction vehicle operation lever**

(57) The present invention discloses a method for freely setting response modes of the operation lever (16) of construction vehicle, according to driver's skills or proficiency and work characteristics, in which the method includes the steps of: receiving a mode signal

(S200) from a mode selection means (15), and selecting one of a plurality of selection modes; receiving an operation signal (S300) from the operation lever (16); filtering the operation signal through a filter (32) which is operating in response to the selected response mode (S400); and outputting a filtered control signal (S800).

Fig.1



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates in general to an operation lever of a construction vehicle, and more particularly, to a method for freely setting response modes of the operation lever of a construction vehicle according to the skills or proficiency of a driver and work characteristics.

2. Description of the Related Art

[0002] In general, construction vehicle including an excavator has an operational lever like a joystick, which operates working apparatus such as a boom, arm, bucket, and swing unit. Hydraulic pressure from an engine-driven hydraulic pump is a driving power source of operations of the working apparatus. The construction vehicle also have a controller that controls a control valve according to the control signal of the operation lever and thus, controls the pressure, direction and flow of hydraulic fluid supplied to working apparatus.

[0003] Sometimes drivers tend to move the operation lever quickly to finish work within time. When the operation lever is manipulated fast, the control valve's spool, which supplies hydraulic fluid to an actuator for driving a working apparatus, starts moving violently. Therefore, shock-induced vibration is generated at the start or end of the operation of the actuator, and repeatedly generated vibration makes drivers feel more tired.

[0004] Even though an experienced driver is able to operate the operation lever with great delicacy and skill and to move the working apparatus gently, a beginner often has difficulty in handling the operation lever, especially for starting and finishing the operation of the lever because of shock-induced vibration generated by the inertia of the working apparatus.

[0005] As aforementioned, the vibration generated at the start or end of the operation of the construction vehicle adds to the fatigue of the drivers, which not only reduces work efficiency but also shortens lifespan of the vehicle. Thus, there have been a number of attempts to resolve the above problems.

[0006] One of generally used techniques for relieving shocks generated from a sudden operation of the operation lever is a delay circuit technique in which a pressure sensor is used to sense the sudden operation state of the operation lever, and if the operation lever makes a sudden operation, a pressure compensation valve delayed the flow of hydraulic fluid.

[0007] Although the above technique could absorb shocks caused by the sudden operation and thus, secure the safety of using the construction vehicle, the response of the operation lever became noticeably worse and this in turn lowered work speed, consequently re-

ducing overall work efficiency.

[0008] Moreover, because response of the operation lever was fixed regardless of different skills of drivers and work characteristics, both skilled drivers and beginners were not satisfied with the related art operation levers and it was impossible to adjust response modes of the operation lever appropriate for various work characteristics.

SUMMARY OF THE INVENTION

[0009] It is, therefore, an object of the present invention to provide a method for setting response modes of an operation lever in construction vehicle, allowing a driver to freely set a response mode of the operation lever according to the driver's skills and work characteristics.

[0010] Another object of the present invention is to reduce driver's fatigue by relieving vibration and shocks on working apparatus caused by the sudden operation of an operation lever, and to secure an initial response of the operation lever, whereby improving work efficiency.

[0011] To achieve the above object, there is provided a method for setting response modes of an operation lever in construction vehicle, in which one of response modes is selected and response characteristics of the operation lever change according to a selected response mode.

[0012] One aspect of the invention provides a method for setting response modes of an operation lever for construction vehicle comprising an actuator for driving a working apparatus using hydraulic fluid supplied from a hydraulic pump, a control valve for supplying the hydraulic fluid from the hydraulic pump to the actuator, an operation lever for generating an operation signal to drive the actuator, and a controller for changing the operation signal and generating a control signal therefrom to control the control valve, the method including the steps of: receiving a mode signal from a mode selection means, and selecting one of a plurality of selection modes; receiving the operation signal from the operation lever; filtering the operation signal through a filter which is operating in response to the selected response mode; and outputting a filtered control signal.

[0013] Preferably, the filter used for the filtering step is a low pass filter.

[0014] Preferably, parameters applied to the filter for the filtering step are predetermined appropriate for the actuator which is driven by the operation lever and the respective response mode characteristics, and are stored in the controller.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The above objects; features and advantages of the present invention will become more apparent from the following detailed description when taken in con-

junction with the accompanying drawings, in which:

Fig. 1 is a schematic diagram of a hydraulic system to which a method for setting response modes of an operation lever according to one embodiment of the present invention is applied;

Fig. 2 is a flow chart describing a control flow of a method for setting response modes of an operation lever according to one embodiment of the present invention; and

Fig. 3 is a graph illustrating different outputs of filtered control signals in each response mode, where a method for setting response modes of an operation lever according to one embodiment of the present invention is applied.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] A preferred embodiment of the present invention will be described herein below with reference to the accompanying drawings. In the following description, well-known functions or constructions are not described in detail since they would obscure the invention in unnecessary detail.

[0017] Fig. 1 is a schematic diagram of a hydraulic system to which a method for setting response modes of an operation lever according to one embodiment of the present invention is applied.

[0018] The hydraulic system to which a method for setting response modes according to one embodiment of the present invention is applied includes hydraulic pump 11 driven by an engine 10, an actuator 13 for driving a working apparatus (not shown) using hydraulic fluid supplied from the hydraulic pump 11, a control valve 14 for supplying the hydraulic fluid in the hydraulic pump 11 to the actuator 13, an operation lever 16 for generating an operation signal to drive the actuator 13, a controller 18 for changing the operation signal and generating a control signal therefrom, and valve drivers 20, 21 for receiving the control signal from the controller 18 and controlling the control valve 14.

[0019] The valve drivers 20, 21 are connected to a pilot pump 12 and form a pilot pressure in response to the control signal from the controller 18 and supply the pilot pressure to the control valve 14 to control the operation of the control valve 14.

[0020] In Fig. 1, reference numeral 35 denotes an equipment ECU(Electronic control unit), 10a denotes an engine ECU(Electronic control unit), 17 denotes a pump regulator, and 19 denotes an EPPRV(Electro proportional pressure reducing valve).

[0021] An operation lever control system 1, to which the method for setting response modes of an operation lever according to one embodiment of the present invention is applied, includes an operation lever 16, a mode selection means 15, and a controller 18. Here, the controller 18 includes a data receiving unit 30, a filtering

unit 32, and a valve driving unit 34.

[0022] Through the mode selection means 15, a driver can select one of a plurality of response modes according to his skills and work characteristics. When the driver selects one response mode using the mode selection means 15, a mode signal is inputted to a mode signal receiving part 31 b in the data receiving unit of the controller 18.

[0023] The available response modes which can be selected through the mode selection means 15 are active mode, normal mode, and soft mode. Apparently, more response modes can be added as desired.

[0024] The operation lever 16, as aforementioned, is a device for generating an operation signal to drive the actuator 13. The operation signal of the operation lever 16 is inputted to an operation signal receiving part 31 a in the data receiving unit of the controller 18.

[0025] The operation signal and the mode signal inputted to the data receiving unit 30 are then transferred to the filtering unit 32. A filter 33a of the filtering unit 32 filters the operation signal in response to the response mode that the driver selected through the mode selection means 15.

[0026] The filtering process of the filter 33a is realized through a 1st-order Bessel low pass filter. The cutoff frequency of the filter 33a varies in each mode, i.e. in active mode, normal mode, and soft mode. Parameters for changing the cutoff frequency of the filter are preset in a memory 33b according to each mode and actuator. Therefore, the filter 33a performs the filtering process on the basis of the parameters corresponding to each mode and actuator.

[0027] The valve driving unit 34 of the controller 18 changes the filtered operation signal from the filtering unit 32 to a control signal, and provides the control signal to the valve drivers 20, 21 to control the operation of the control valve 14.

[0028] Fig. 2 is a flow chart describing a control flow of the method for setting response modes of the operation lever according to one embodiment of the present invention.

[0029] The method for setting response modes of the operation lever according to one embodiment of the present invention includes mode selection step (S200), operation signal receiving step (S300), filtering step (S400, S500, S600 and S700), and output step (S800).

[0030] In the mode selection step (S200), the control system 1 receives a response mode selection signal from the response mode selection signal 15, and allows the driver to select one of a plurality of response modes. In consideration of skills and the type of work to be done, the driver can select one of available modes including active mode, normal mode and soft mode.

[0031] The response speed to the operational signal from the operation lever 16 is fastest in active mode, then in normal mode and in soft mode (active mode > normal mode > soft mode). Therefore, an experience driver usually selects the active mode and a beginner

selects the soft mode for driving the construction vehicle.

[0032] In the operation signal receiving step (S300), the operation signal from the operation lever 16 is received. In the filtering step (S400, S500, S600 and S700), the operation signal is filtered by a filter 33a corresponding to the response mode that is selected in the mode selection step (S200).

[0033] For example, the filtering step is divided into three sub-steps: a first filtering step (S500) through filter 'A' of active mode, a second filtering step (S600) through filter 'B' of normal mode, and a third filtering step (S700) through filter 'C' of soft mode.

[0034] The 1st-order Bessel low pass filter is employed for the filter 33a in the filtering step. Preferably, the filtering process is performed based on following equations;

$$x(k-1) = x(k);$$

$$x(k) = (\text{operation signal}) / a;$$

$$y(k-1) = y(k);$$

$$y(k) = (x(k-1) + x(k)) + b \times y(k-1),$$

wherein, $y(k)$ denotes the controller's output; $y(k-1)$ denotes a time delay value of one sampling time of $y(k)$; $x(k-1)$ denotes a time delay value of one sampling time of $x(k)$; and a , b are parameters.

[0035] Now that the filter 33a for the filtering step applies the above equations for each sampling time of the controller 18, the preceding $y(k)$ and $x(k)$ are respectively substituted for $y(k-1)$ and $x(k-1)$ whenever one sampling time passes. The $y(k)$ value becomes a final output value of the filter 33a, and is outputted to the valve driving unit 34 in every sampling time.

[0036] The parameters a , b expressed in the above equations for the filtering step are predetermined appropriate for the actuator 13 which is driven by the operation lever 16 and for the characteristics of each response mode. Preferably, the parameters a , b are stored in a memory 33b. In short, what the filters 'A', 'B', and 'C' for the filtering step (S500, S600 and S700) means is that the filter 33a performs filtering function in each mode corresponding to the values of parameters a , b .

[0037] In the output step (S800), the filtered control signal through the filtering step is outputted. More specifically, the valve driving unit 34 of the controller 18 changes a filtered operation signal to a control signal and outputs the control signal to the valve driving units 20, 21.

[0038] Fig. 3 is a graph illustrating different outputs of filtered control signals in each response mode, where

the method for setting response modes of an operation lever according to one embodiment of the present invention is applied. In Fig. 3, trajectory 'r' shows the operation signal of the operation lever 16; trajectory 'I' shows the control signal in active mode; trajectory 'II' shows the control signal in normal mode; and trajectory 'III' shows the control signal in soft mode.

[0039] As shown in Fig. 3, the response speed to the operation signal is fastest in order of active mode, normal mode, and soft mode (active mode > normal mode > soft mode). Therefore, the active mode where the movement of working apparatus becomes sensitive is suitable for the skilled driver. The soft mode, which is safe mode because the working apparatus does not move rapidly, is suitable for the beginner.

[0040] In conclusion, the method for setting the response modes of the operation lever of the present invention allows the driver to freely choose the response mode of the operation lever according to his skills and work characteristics. Moreover, by relieving vibration and shocks on working apparatus caused by a sudden manipulation of an operation lever, driver's fatigue from work is much reduced, and the initial response of the operation lever can be secured, thereby improving work efficiency.

[0041] While the invention has been described in conjunction with various embodiments, they are illustrative only. Accordingly, many alternative, modifications and variations will be apparent to persons skilled in the art in light of the foregoing detailed description. The foregoing description is intended to embrace all such alternatives and variations falling within the spirit and broad scope of the appended claims.

Claims

1. A method for setting response modes of an operation lever for construction vehicle comprising an actuator for driving a working apparatus using hydraulic fluid supplied from a hydraulic pump, a control valve for supplying the hydraulic fluid from the hydraulic pump to the actuator, an operation lever for generating an operation signal to drive the actuator, and a controller for changing the operation signal and generating a control signal therefrom to control the control valve, the method comprising the steps of:

receiving a mode signal from a mode selection means, and selecting one of a plurality of selection modes;
receiving the operation signal from the operation lever;
filtering the operation signal through a filter which is operating in response to the selected response mode; and
outputting a filtered control signal.

2. The method according to claim 1, wherein the filter used for the filtering step is a low pass filter.
3. The method according to claim 2, parameters applied to the filter for the filtering step are predetermined appropriate for the actuator which is driven by the operation lever and the respective response mode characteristics, and are stored in the controller.

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Fig.1

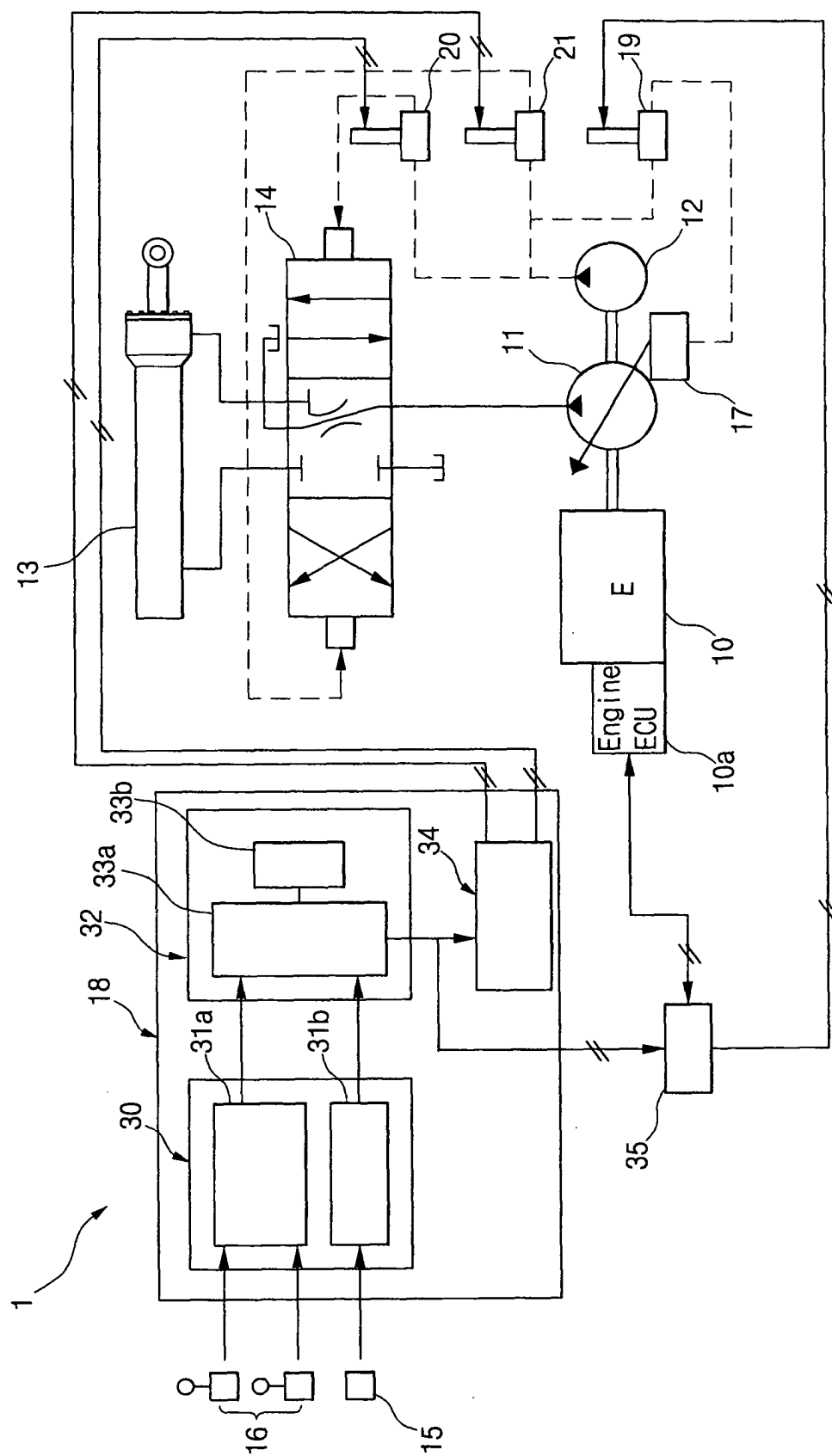


Fig.2

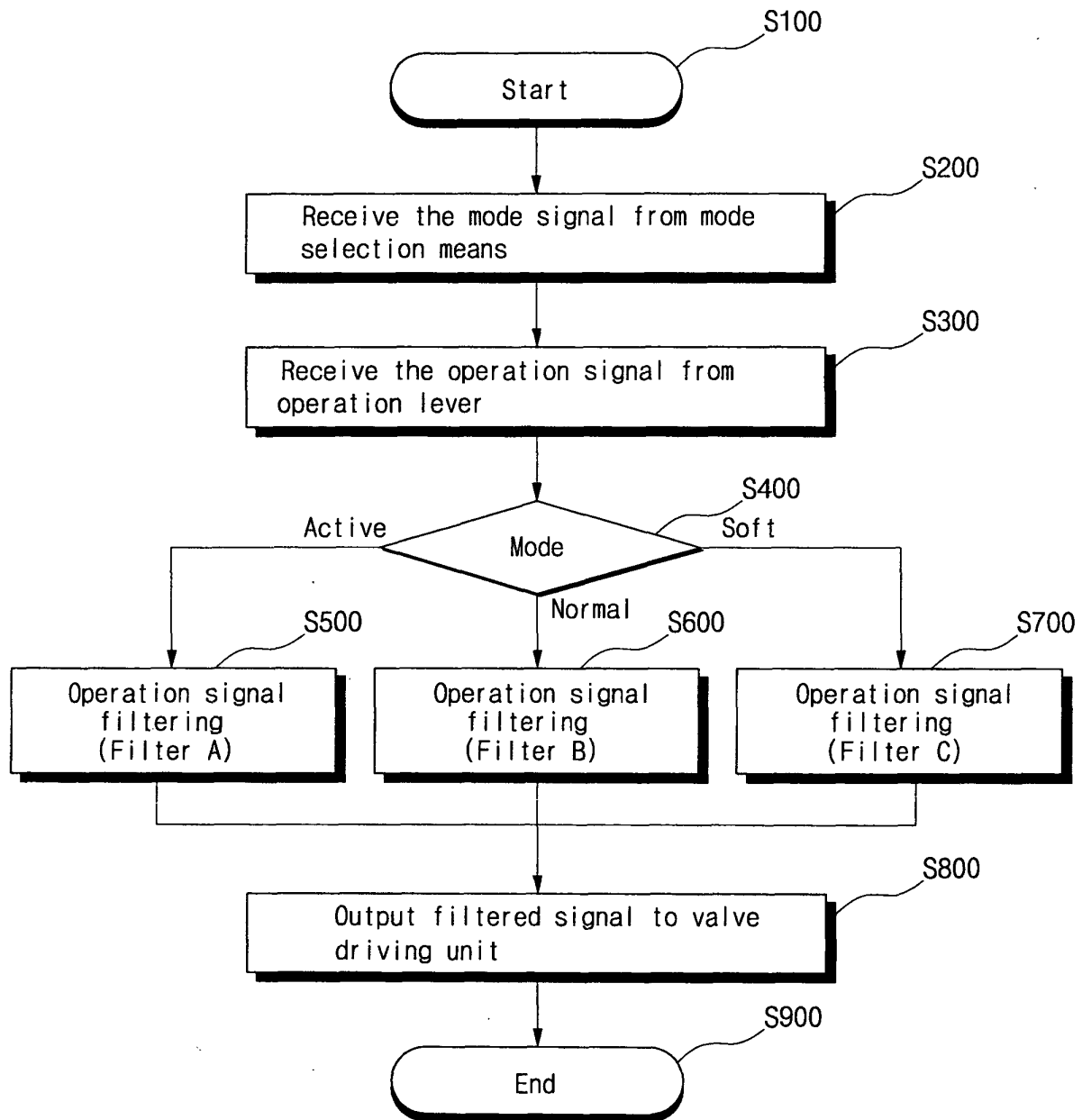
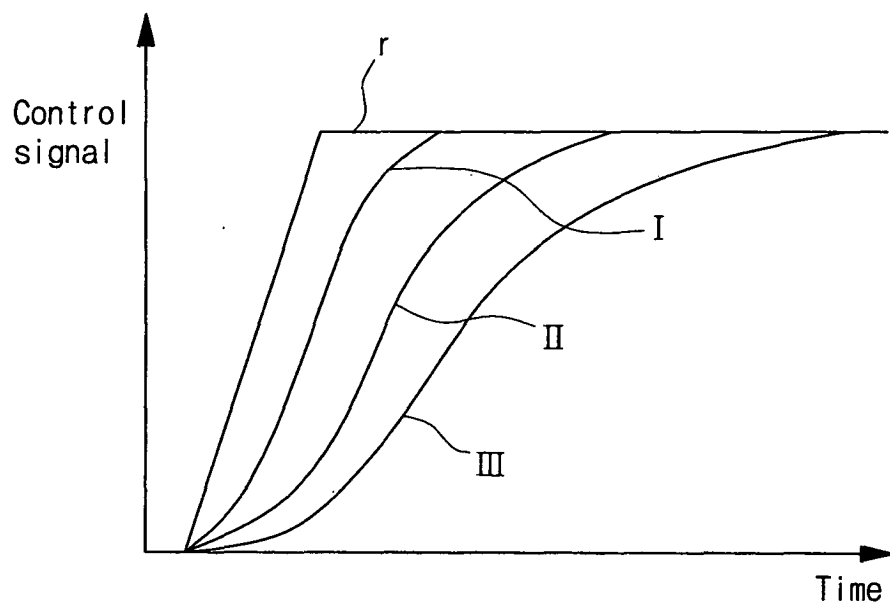


Fig.3





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EUROPEAN SEARCH REPORT

Application Number
EP 04 01 6423

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CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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