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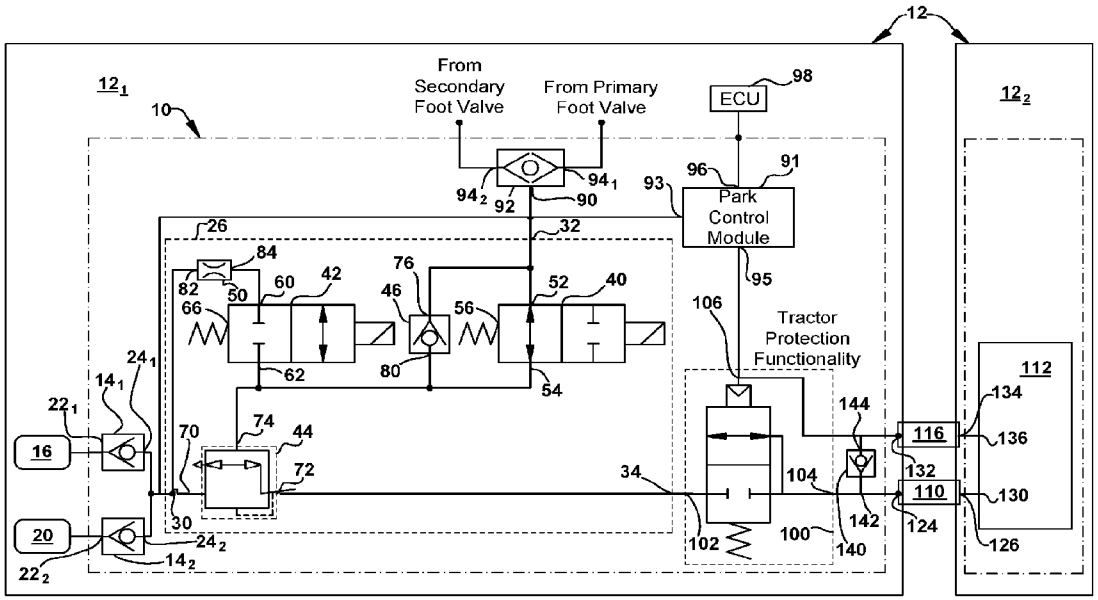


FIG. 1

(57) Abstract: A valve system includes a control module on a tractor portion of a vehicle adapted to receive a supply pressure as a control module supply pressure, receive a control module control pressure, and deliver a control module delivery pressure based on the control module supply pressure and the control module control pressure. A park control module selectively transmits the pneumatic fluid at the supply pressure based on a park brake control signal. A supply glad-hand fluidly communicates the selectively transmitted supply pressure of the pneumatic fluid. A control glad-hand fluidly communicates the control module delivery pressure to control the brake on the associated trailer portion of the vehicle. An exhaust valve, which fluidly communicates with both the selectively transmitted supply pressure and the control module delivery pressure, exhausts the control module delivery pressure of the pneumatic fluid from the control glad-hand.

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VALVE SYSTEM AND METHOD FOR CONTROLLING THE SAME

Background

[0001] The present invention relates to a tractor protection function. It finds particular application in conjunction with delivering pneumatic fluid from a tractor to a trailer based on a trailer park brake pressure and will be described with particular reference thereto. It will be appreciated, however, that the invention is also amenable to other applications.

[0002] Current trailer control strategies involve using a relay valve to apply full system air pressure to a supply port of an antilock braking system (ABS) modulator. The ABS modulator is set to hold off pressure, and pulses to send a set volume of air into the trailer control line to apply trailer brakes. Check valves are currently used at respective delivery ports of air reservoirs to protect pressure in the reservoirs in the event of a downstream failure (e.g., an air leak) in the air system. However, there is no mechanism to compensate for any loss of air volume in the trailer and/or verify that the required air pressure has been delivered to the trailer.

[0003] The present invention provides a new and improved apparatus and method for compensating for any loss of air volume in the trailer and/or verifying that the required air pressure has been delivered to the trailer.

Summary

[0004] In one aspect of the present invention, it is contemplated that a valve system includes a control module on a tractor portion of a vehicle adapted to receive a supply pressure as a control module supply pressure of the pneumatic fluid, receive a control module control pressure of the pneumatic fluid, and deliver a control module delivery pressure of the pneumatic fluid based on the control module supply pressure and the control

module control pressure. A park control module selectively transmits the pneumatic fluid at the supply pressure based on a park brake control signal. A supply glad-hand fluidly communicates the selectively transmitted supply pressure of the pneumatic fluid to supply a brake on an associated trailer portion of the vehicle. A control glad-hand fluidly communicates the control module delivery pressure of the pneumatic fluid to control the brake on the associated trailer portion of the vehicle. An exhaust valve, which fluidly communicates with both the selectively transmitted supply pressure and the control module delivery pressure, exhausts the control module delivery pressure of the pneumatic fluid from the control glad-hand.

Brief Description of the Drawings

[0005] In the accompanying drawings which are incorporated in and constitute a part of the specification, embodiments of the invention are illustrated, which, together with a general description of the invention given above, and the detailed description given below, serve to exemplify the embodiments of this invention.

[0006] **FIGURE 1** illustrates a schematic representation of a simplified component diagram of an exemplary valve system in a first state while an associated vehicle is in a first state in accordance with one embodiment of an apparatus illustrating principles of the present invention;

[0007] **FIGURE 2** illustrates a schematic representation of a simplified component diagram of an exemplary valve system in the first state while the associated vehicle is in a second state in accordance with one embodiment of an apparatus illustrating principles of the present invention;

[0008] **FIGURE 3** is an exemplary methodology of controlling the valve system in accordance with one embodiment illustrating principles of the present invention;

[0009] **FIGURE 4** illustrates a schematic representation of a simplified component diagram of an exemplary valve system in a second state while the associated vehicle is in the second state in accordance with one embodiment of an apparatus illustrating principles of the present invention; and

[0010] **FIGURE 5** illustrates a schematic representation of a simplified component diagram of an exemplary valve system in a third state while the associated vehicle is in the second state in accordance with one embodiment of an apparatus illustrating principles of the present invention.

Detailed Description of Illustrated Embodiment

[0011] With reference to **FIGURE 1**, a simplified component diagram of an exemplary valve system **10** is illustrated in accordance with one embodiment of the present invention. The valve system **10** is part of an associated vehicle **12**, which includes a tractor $\mathbf{12_1}$ and a trailer $\mathbf{12_2}$, and includes at least one isolation check valve $\mathbf{14_1}$, $\mathbf{14_2}$ (e.g., two (2) check valves collectively referenced as **14**). The first isolation check valve $\mathbf{14_1}$ receives a pneumatic fluid (e.g., air) from a first source such as, for example, a first reservoir **16**, and the second isolation check valve $\mathbf{14_2}$ receives the pneumatic fluid from a second source such as, for example, a second reservoir **20**. It is to be assumed that the first and second reservoirs **16, 20** are part of respective fluidly independent pneumatic circuits . The first isolation check valve $\mathbf{14_1}$ includes a first pneumatic supply port $\mathbf{22_1}$ and a first pneumatic delivery port $\mathbf{24_1}$. The second isolation check valve $\mathbf{14_2}$ includes a second pneumatic supply port $\mathbf{22_2}$ and a second pneumatic delivery port $\mathbf{24_2}$. The first pneumatic delivery port $\mathbf{24_1}$ fluidly communicates with the second pneumatic delivery port $\mathbf{24_2}$. A higher of the respective pressures (e.g., supply pressures) of the pneumatic fluid at the first and second pneumatic supply ports $\mathbf{22_{1,2}}$ is present at both the first and second pneumatic delivery ports $\mathbf{24_{1,2}}$.

[0012] A control module **26** includes a supply port **30**, a control port **32**, and a delivery port **34**. The control module **26** also includes a first control valve **40**, a second

control valve **42**, a relay valve **44**, a control module check valve **46**, and a restrictor **50**. The first control valve **40** includes a supply port **52** (e.g., a pneumatic supply port), a delivery port **54** (e.g., a pneumatic delivery port) and a control port **56** (e.g., an electrical control port). The second control valve **42** includes a supply port **60** (e.g., a pneumatic supply port), a delivery port **62** (e.g., a pneumatic delivery port) and a control port **66** (e.g., an electrical control port). The relay valve **44** includes a supply port **70** (e.g., a pneumatic supply (input) port), a delivery port **72** (e.g., a pneumatic delivery (output) port), and a control port **74** (e.g., a pneumatic control port). The check valve **46** includes a pneumatic supply port **76** (e.g., input port) and a pneumatic delivery port **80** (e.g., output port). The restrictor **50** includes an pneumatic supply port **82** (e.g., input port) and a pneumatic delivery port **84** (e.g., output port).

[0013] In the illustrated embodiment, both the relay valve supply port **70** and the restrictor input port **82** fluidly communicate with the control module supply port **30**. Both the first control valve supply port **52** and the check valve supply port **76** fluidly communicate with the control module control port **32**. Each of the first control valve delivery port **54**, the second control valve delivery port **62** and the check valve delivery port **80** fluidly communicates with relay valve control port **74**. The check valve **46** opens to permit fluid communication between the check valve supply port **76** and the check valve delivery port **80** when a pressure of the pneumatic fluid at the check valve supply port **76** is greater than a pressure at the check valve delivery port **80**; otherwise, the check valve **46** remains closed to prevent fluid communication between the check valve supply port **76** and the check valve delivery port **80**. The relay valve delivery port **72** fluidly communicates with the control module delivery port **34**.

[0014] The higher of the respective supply pressures of the pneumatic fluid at the first and second pneumatic supply ports $\mathbf{22_{1,2}}$, which is present at both the first and second pneumatic delivery ports $\mathbf{24_{1,2}}$, is fluidly communicated to the control module supply port **30** as a control module supply pressure. The control module supply pressure is, therefore, fluidly communicated to the restrictor input port **82** and the relay valve supply port **70**. The

restrictor output port **84** fluidly communicates the control module supply pressure to the second control valve supply port **60**. The restrictor **50** slows airflow from the first and second reservoirs **16, 20** to help control the second control valve **42**. In addition, the restrictor **50** allows a leak from the supply port **60** to the control port **62** of the second control valve **42** to exhaust through the delivery port **54** of the first control valve **40** before such a leak acts on the control port **74** of the relay valve **44**.

[0015] The control module control port **32** receives a pneumatic control signal, based on a level of operator demanded braking, from an output port **90** of a double check valve **92**. For example, the operator of an associated vehicle **12** depresses a pedal of a foot valve (not shown) to demand braking. The level of the operator demanded braking is dependent on an amount the pedal is depressed. The pneumatic fluid from the first and second reservoirs **16, 20** is fluidly transmitted to respective first and second input ports $\mathbf{94_1}$, $\mathbf{94_2}$ of the double check valve **92** based on the level of operator demanded braking. The higher of the respective pneumatic pressures at the first and second input ports $\mathbf{94_1}$, $\mathbf{94_2}$ is fluidly communicated to the double check valve output port **90** and, therefore, to the control module control port **32**. The higher of the respective pneumatic pressures at the first and second input ports $\mathbf{94_1}$, $\mathbf{94_2}$ is also fluidly communicated from the control module control port **32** to both the first control valve supply port **52** and the check valve supply port **76**.

[0016] A park control module **91** includes a supply port **93**, a delivery port **95**, and a control port **96**. In one embodiment, the park control module supply port **93** and the park control module delivery port **95** are pneumatic ports, and the park control module control port **96** is an electronic port. However, any combination of pneumatic and electronic ports are contemplated for the park control module supply port **93**, the park control module delivery port **95** and the park control module control port **96**. The park control module supply port **93** fluidly communicates with both the control module supply port **30** and the relay valve supply port **70**. Therefore, the pneumatic pressure at the park control module supply port **93** is substantially equal to the pneumatic pressure at both the control module

supply port **30** and the relay valve supply port **70**. The park control module control port **96** electrically communicates with an electronic control unit **98**.

[0017] The ECU **98** electrically transmits an electronic control signal to the park control module control port **96** based on a desired status of the park brakes (not shown) of the trailer $\mathbf{12_2}$. For example, the ECU **98** receives a command (e.g., an electrical command) from an operator of the vehicle **12** to either engage the park brakes of the trailer $\mathbf{12_2}$ (e.g., set the trailer $\mathbf{12_2}$ to the parked state) or disengage the park brakes of the trailer $\mathbf{12_2}$ (e.g., set the trailer $\mathbf{12_2}$ to the unparked state). If the park brakes of the trailer $\mathbf{12_2}$ are not desired to be engaged, the ECU **98** electrically transmits a first electronic control signal to the park control module control port **96**; and if the park brakes of the trailer $\mathbf{12_2}$ are desired to be engaged, the ECU **98** electrically transmits a second electronic control signal to the park control module control port **96**. It is contemplated that the first electronic signal is the absence of an electric signal (e.g., an electric signal less than a predetermined voltage), and the second electronic signal is the presence of an electric signal (e.g., an electric signal at least the predetermined voltage).

[0018] The park control module supply port **93** selectively fluidly communicates with the park control module delivery port **95** based on the electronic control signal at the park control module control port **96** (e.g., a park brake control signal). For example, if the park brakes of the trailer $\mathbf{12_2}$ are desired to be engaged (e.g., if the associated vehicle **12** is desired to be in a parked state), the first electronic signal is transmitted from the ECU **98** to the park control module control port **96** and the park control module supply port **93** is selected to not fluidly communicate with the park control module delivery port **95**. Otherwise, if the park brakes of the tractor $\mathbf{12_1}$ are desired to not be engaged (e.g., if the associated vehicle **12** is desired to be in an unparked state), the second electronic signal is transmitted from the ECU **98** to the park control module control port **96** and the park control module supply port **93** is selected to fluidly communicate with the park control module delivery port **95**.

[0019] A tractor protection module **100** includes a supply port **102** (e.g., input), a delivery port **104** (e.g., output) and a control port **106**. The tractor protection supply port **102** fluidly communicates with the tractor protection delivery port **104** based on a pneumatic pressure at the tractor protection control port **106**. In the illustrated embodiment, the tractor protection control port **106** fluidly communicates with the park control module delivery port **95**. The pneumatic pressure at the tractor protection control port **106** is referred to as a trailer park brake pneumatic pressure. The trailer park brake pneumatic pressure at the tractor protection control port **106** (e.g., trailer park brake pressure) is at least a predetermined threshold if the associated vehicle **12** is in an unparked state (see **FIGURE 2**) and below the predetermined threshold if the associated vehicle **12** is in a parked state (see **FIGURE 1**). While the vehicle **12** is in the unparked state (see **FIGURE 2**), the tractor protection supply port **102** fluidly communicates with the tractor protection delivery port **104** so that the pneumatic pressure at the tractor protection supply port **102** is fluidly communicated to the tractor protection delivery port **104**, during which time the tractor protection module is also in an unparked state. While the vehicle **12** is in the parked state, as illustrated in **FIGURE 1**, the tractor protection supply port **102** does not fluidly communicate with the tractor protection delivery port **104**, during which time the tractor protection module is also in an parked state.

[0020] Each of a control glad-hand **110** and a supply glad-hand **116** fluidly communicates with a trailer brake system **112** on the trailer $\mathbf{12_2}$ of the vehicle **12**. The control glad-hand **110** includes a supply port **124**, which fluidly communicates with the tractor protection delivery port **104** of the tractor protection module **100**, and a delivery port **126**, which fluidly communicates with a control port **130** of the trailer brake system **112**. The supply glad-hand **116** includes a supply port **132**, which fluidly communicates with the tractor protection control port **106**, and a delivery port **134**, which fluidly communicates with a supply port **136** of the trailer brake system **112**.

[0021] A tractor protection check valve **140** is fluidly positioned between the control glad-hand supply port **124** and the supply glad-hand supply port **132**. More specifically, a

supply port **142** of the tractor protection check valve **140** fluidly communicates with the control glad-hand supply port **124** and, consequently, also the tractor protection delivery port **104**. In addition, a delivery port **144** of the tractor protection check valve **140** fluidly communicates with the supply glad-hand supply port **132** and, consequently, also the tractor protection control port **106**.

[0022] When the associated vehicle **12** changes from the unparked state (see **FIGURES 2, 4 and 5**) to the parked state (see **FIGURE 1**), the tractor protection delivery port **104** of the tractor protection module **100** stops from fluidly communicating with the tractor protection supply port **102**. Although the tractor protection delivery port **104** continues to fluidly communicate with the control glad-hand supply port **124** and the tractor protection check valve supply port **142** while the associated vehicle **12** is in the parked state (see **FIGURE 1**), any pneumatic fluid at the tractor protection delivery port **104** cannot fluidly communicate with the tractor protection supply port **102**. Therefore, without the tractor protection check valve **140**, any pneumatic fluid at the tractor protection delivery port **104**, the control glad-hand supply port **124** and the tractor protection check valve supply port **142** becomes "trapped" and cannot escape when the associated vehicle **12** changes from the unparked state (see **FIGURES 2, 4 and 5**) to the parked state (see **FIGURE 1**).

[0023] However, in the illustrated embodiment, any pneumatic fluid trapped at the tractor protection delivery port **104**, the control glad-hand supply port **124** and/or the tractor protection check valve supply port **142** may be exhausted via the tractor protection check valve **140**. More specifically, if the pressure of the pneumatic fluid at the tractor protection check valve supply port **142** is at least a tractor protection check valve cracking pressure, the pneumatic fluid is exhausted via the tractor protection check valve delivery port **144** until the pneumatic pressure at the tractor protection check valve supply port **142** drops below the tractor protection check valve cracking pressure. Therefore, the tractor protection check valve **140** is referred to as an exhaust valve.

[0024] Pneumatic pressure trapped at the control glad-hand supply port **124** may cause service brakes on the trailer $\mathbf{12_2}$ to actuate at undesirable times. For example, it is undesirable to simultaneously engage both the service brakes and the park brakes on, for example, the trailer $\mathbf{12_2}$, which is referred to as brake compounding. Therefore, the park control module **91**, the tractor protection module **100** and the tractor protection check valve **140** act as a means for preventing compounding (e.g., anti-compounding) the service brakes and the park brakes on the trailer $\mathbf{12_2}$.

[0025] With reference to **FIGURE 3**, an exemplary methodology of the operation of the valve system **10** shown in **FIGURES 1, 2, 4 and 5** is illustrated. As illustrated, the blocks represent functions, actions and/or events performed therein. It will be appreciated that electronic and software systems involve dynamic and flexible processes such that the illustrated blocks and described sequences can be performed in different sequences. It will also be appreciated by one of ordinary skill in the art that elements embodied as software may be implemented using various programming approaches such as machine language, procedural, object-oriented or artificial intelligence techniques. It will further be appreciated that, if desired and appropriate, some or all of the software can be embodied as part of a device's operating system.

[0026] With reference to **FIGURES 1–5**, the operation starts in a step **210**. Then, in a step **212**, the status of the tractor protection module **100** is detected. For example, the status of the park brakes (not shown) of the trailer $\mathbf{12_2}$ is set in the step **212** as either "unparked" or "parked." More specifically, the ECU **98** electrically transmits the electronic control signal to the park control module control port **96** based on the desired status of the park brakes of the trailer $\mathbf{12_2}$ and the park control module **91** receives the electronic control signal. In a step **214**, a current braking mode is determined. For example, one of the following three (3) current braking modes is identified in the step **214**: an operator initiated braking mode (see **FIGURES 1 and 2**), a system increasing pressure mode (see **FIGURE 5**), and a system holding pressure mode (see **FIGURE 4**). During the operator initiated braking mode (see **FIGURES 1 and 2**), the amount of braking of the associated

vehicle **12** is based on how much the operator depresses the pedal of the foot valve. During the system increasing pressure mode (see **FIGURE 5**), the amount of braking of the associated vehicle **12** is being increased by an automatic braking system (e.g., antilock braking system (ABS), electronic braking system (EBS), etc). During the system holding pressure mode (see **FIGURE 4**), the amount of braking of the associated vehicle **12** is being held by the automatic braking system (e.g., antilock braking system (ABS), electronic braking system (EBS), etc).

[0027] Then, in a step **216**, the first and second control valves **40, 42**, respectively, are set to respective states based on the current braking mode. For example, if the current braking mode is the operator initiated braking mode (see **FIGURES 1 and 2**), then in the step **216** the first control valve **40** is set to an open state and the second control valve **42** is set to a closed state. If the current braking mode is the system increasing pressure mode (see **FIGURE 5**), then in the step **216** the first control valve **40** is set to a closed state and the second control valve **42** is set to an open state. If the current braking mode is the system holding pressure mode (see **FIGURE 4**), then in the step **216** both the first and second control valves **40, 42**, respectively, are set to the closed state.

[0028] While in the open state, the first control valve **40** is set so that the first control valve supply port **52** fluidly communicates with the first control valve delivery port **54**. Similarly, while in the open state, the second control valve **42** is set so that the second control valve supply port **60** fluidly communicates with the second control valve delivery port **62**. While in the closed state, the first control valve **40** is set so that the first control valve supply port **52** does not fluidly communicate with the first control valve delivery port **54**. Similarly, while in the closed state, the second control valve **42** is set so that the second control valve supply port **60** does not fluidly communicate with the second control valve delivery port **62**.

[0029] In a step **220**, the relay valve control port **74** receives a relay valve control pressure from at least one of the first control valve **40**, the second control valve **42** and the

check valve **46**. For example, if the first control valve **40** is set to the open state and the second control valve **42** is set to a closed state (e.g., if the current braking mode is the operator initiated braking mode), the relay valve control pressure is received from the first control valve **40** and represents the level of operator demanded braking. If the first control valve **40** is set to the closed state and the second control valve **42** is set to a open state (e.g., if the current braking mode is the system increasing pressure braking mode), the relay valve control pressure is received from the second control valve **42** and represents the level of system demanded braking. If both the first control valve **40** is set to the closed state and the second control valve **42** is set to a closed state (e.g., if the current braking mode is the system holding pressure braking mode), the relay valve control pressure is received from the check valve **46** and represents the level of system demanded braking during, for example, a hill start assist.

[0030] In a step **222**, the relay valve **44** passes the pneumatic pressure at the control module supply port **30** to the control module delivery port **34** based on the pneumatic pressure received at the relay valve control port **74**.

[0031] In another embodiment, the pneumatic pressure passed from the control module supply port **30** to the control module delivery port **34** changes (e.g., proportionally) as the pneumatic pressure at the relay valve control port **74** changes. For example, the pneumatic pressure delivered from the control module supply port **30** to the control module delivery port **34** changes (e.g., proportionally) as the pneumatic pressure at relay valve control port **74** increases or decreases. It is also contemplated that the pneumatic pressure delivered from the control module supply port **30** to the control module delivery port **34** changes linearly as the pneumatic pressure at relay valve control port **74** increases or decreases.

[0032] In a step **224**, the pneumatic pressure at the control module delivery port **34** is delivered to the control module delivery port **34** and, consequently, the tractor protection module supply port **102**.

[0033] Then, in a step **226**, the pneumatic pressure at the tractor protection module supply port **102** is delivered to the tractor protection delivery port **104** based on the status of the tractor protection module **100** detected in the step **212**. For example, if the status of the tractor protection module **100** is unparked (see **FIGURE 2**), the pneumatic pressure at the tractor protection delivery port **104** is transmitted, during the step **226**, to the control glad-hand **110**, which fluidly communicates with the trailer brake system **112** on the trailer $\mathbf{12_2}$ of the vehicle **12**. The supply glad-hand **116** fluidly communicates with trailer brake system **112**. The trailer brake system **112** on the trailer $\mathbf{12_2}$ is controlled based on the pneumatic pressure delivered from the tractor protection delivery port **104**. On the other hand, if the status of the tractor protection module **100** is parked (see **FIGURE 1**), the pneumatic pressure at the tractor protection delivery port **104** is not transmitted to the control glad-hand **110** during the step **226**.

[0034] In addition, if the status of the tractor protection module **100** is parked (see **FIGURE 1**), the pneumatic pressure at the tractor protection delivery port **104** and the control glad-hand supply port **124** is exhausted via the tractor protection check valve **140** in a step **230**. Therefore, the step **230** ensures compounding of the service brakes and the park brakes on the trailer $\mathbf{12_2}$ does not occur.

[0035] The operation stops in a step **232**.

[0036] In one embodiment, it is contemplated that the at least one isolation check valve **14**, the first control valve **40**, the second control valve **42**, the control module check valve **46**, the relay valve **44**, the park control module **91** and the tractor protection module **100** act as a means for controlling the pressure at the delivery port **104** of the tractor protection module **100**.

[0037] While the present invention has been illustrated by the description of embodiments thereof, and while the embodiments have been described in considerable detail, it is not the intention of the applicants to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear

to those skilled in the art. Therefore, the invention, in its broader aspects, is not limited to the specific details, the representative apparatus, and illustrative examples shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of the applicant's general inventive concept.

I/We claim:

1. A valve system, including:

a control module on a tractor portion of a vehicle, the control module adapted to:

receive a supply pressure as a control module supply pressure of the pneumatic fluid;

receive a control module control pressure of the pneumatic fluid; and

deliver a control module delivery pressure of the pneumatic fluid based on the control module supply pressure and the control module control pressure;

a park control module selectively transmitting the pneumatic fluid at the supply pressure based on a park brake control signal; and

a supply glad-hand fluidly communicating the selectively transmitted supply pressure of the pneumatic fluid to supply a brake on an associated trailer portion of the vehicle;

a control glad-hand fluidly communicating the control module delivery pressure of the pneumatic fluid to control the brake on the associated trailer portion of the vehicle; and

an exhaust valve, fluidly communicating with both the selectively transmitted supply pressure and the control module delivery pressure, exhausting the control module delivery pressure of the pneumatic fluid from the control glad-hand.

2. The valve system as set forth in claim 1, wherein:

the exhaust valve exhausts the pneumatic fluid trapped at a supply port of the exhaust valve after control module no longer delivers the control module delivery pressure.

3. The valve system as set forth in claim 1, wherein:

the control module delivery pressure of the pneumatic fluid rises above the cracking pressure of the exhaust valve when the park control module selectively exhausts the supply pressure of the pneumatic fluid transmitted to the supply glad-hand.

4. The valve system as set forth in claim 3, wherein:

the park control module selectively exhausts the supply pressure of the pneumatic fluid transmitted to the supply glad-hand when a park brake of the trailer portion of the vehicle is engaged.

5. The valve system as set forth in claim 4, further including:

a tractor protection valve set to one of a parked state and an unparked state based on the supply pressure of the pneumatic fluid transmitted from the park control module, the tractor protection valve delivering the control module delivery pressure to the control glad-hand based on the state of the tractor protection valve.

6. The valve system as set forth in claim 4, wherein:

selectively exhausting the supply pressure of the pneumatic fluid transmitted to the supply glad-hand when a park brake of the tractor portion of the vehicle is engaged provides anti-compounding of a service brake and the park brake.

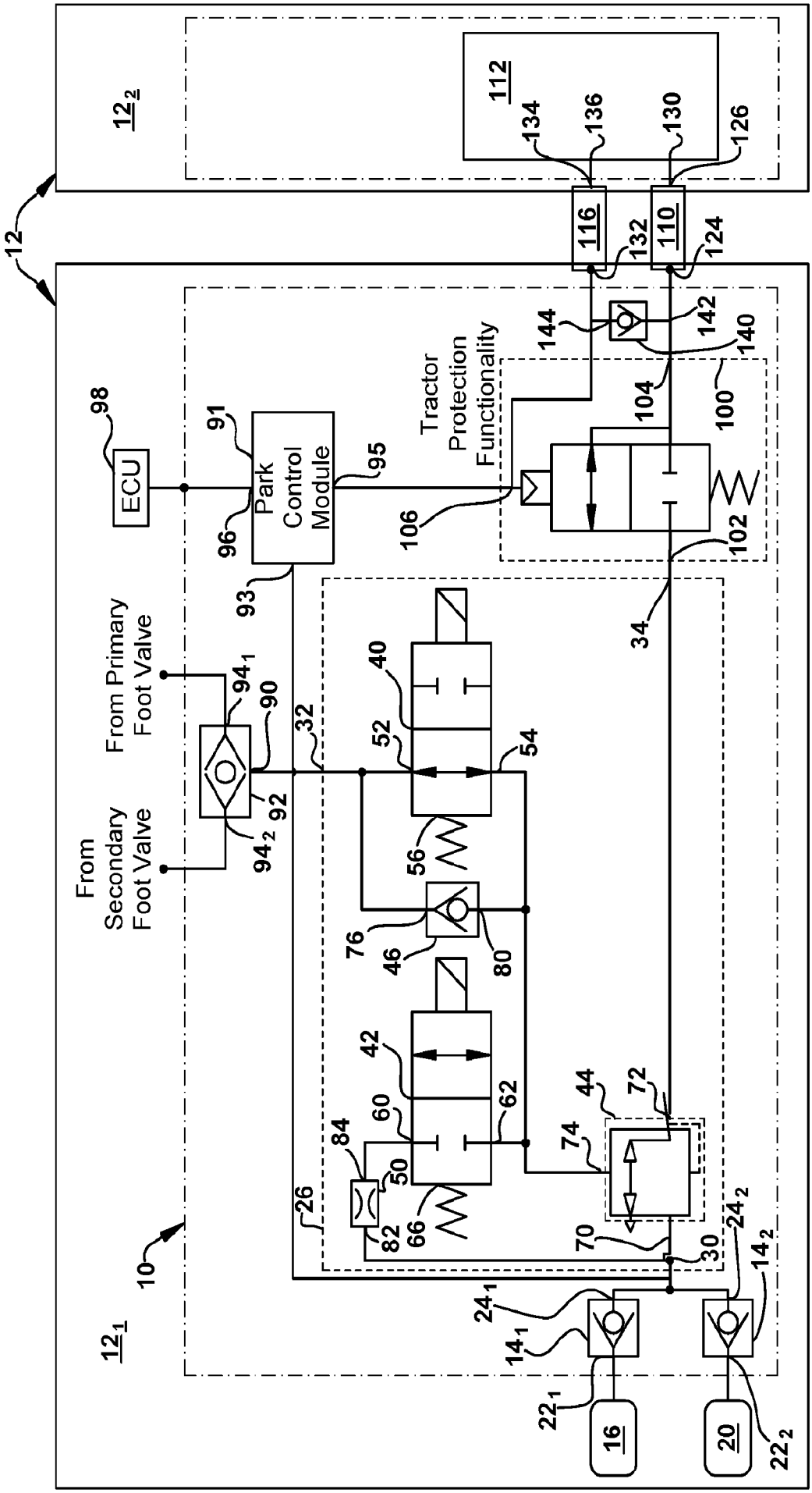

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Tractor Protection Functionality
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Park Control Module
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FIG. 1

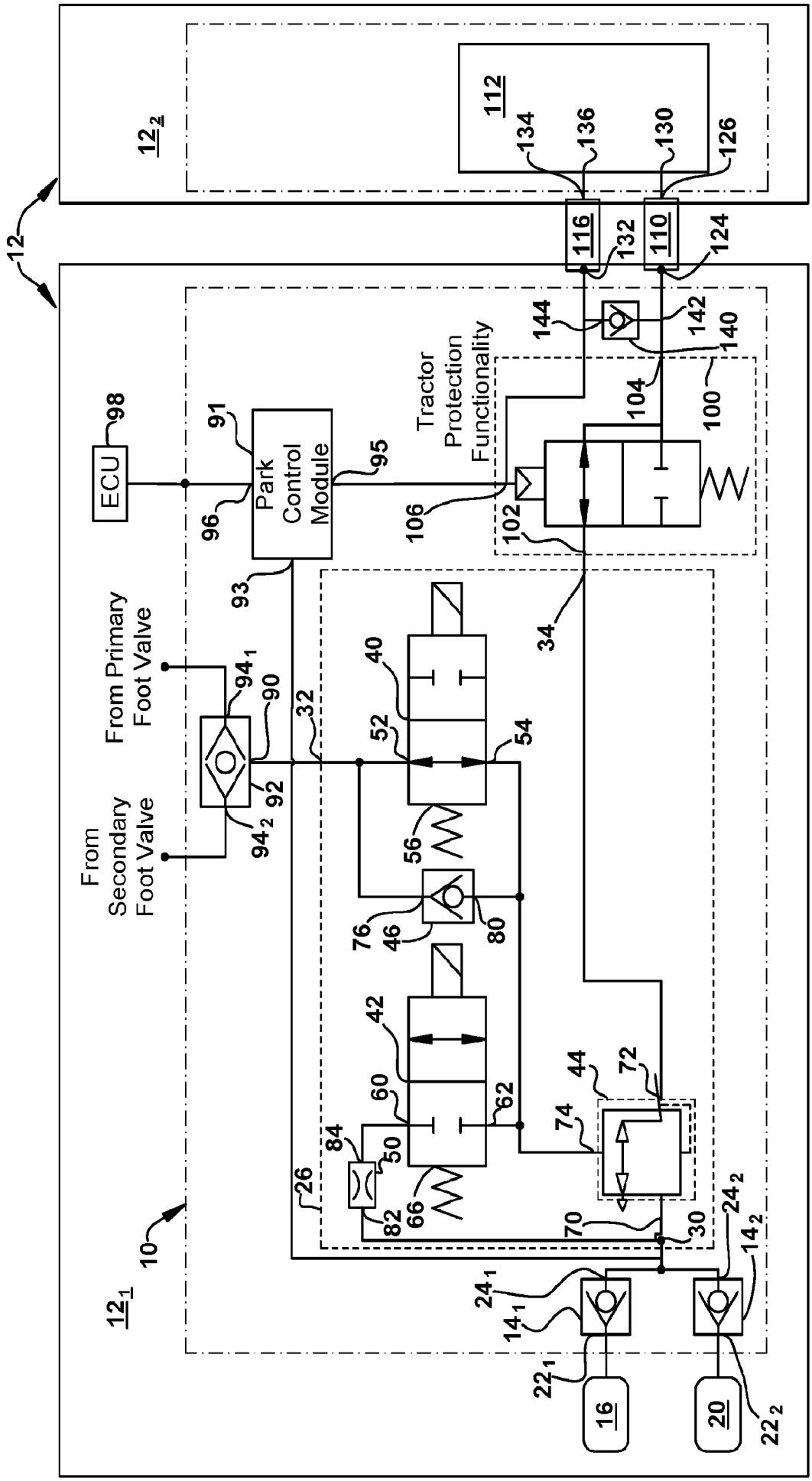

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FIG. 2

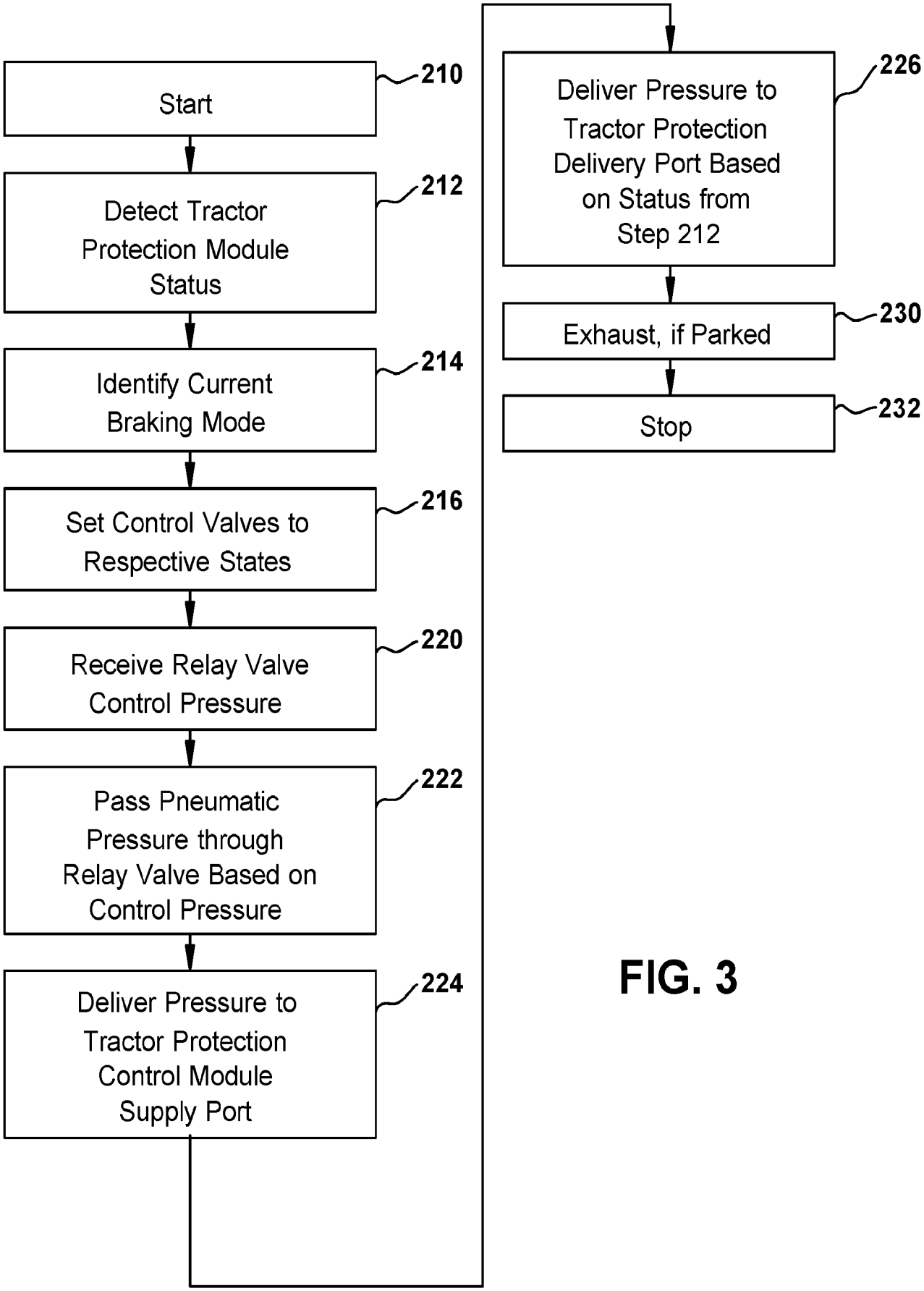

Start
210
Detect Tractor Protection Module Status
212
Identify Current Braking Mode
214
Set Control Valves to Respective States
216
Receive Relay Valve Control Pressure
220
Pass Pneumatic Pressure through Relay Valve Based on Control Pressure
222
Deliver Pressure to Tractor Protection Control Module Supply Port
224
Deliver Pressure to Tractor Protection Delivery Port Based on Status from Step 212
226
Exhaust, if Parked
230
Stop
232

FIG. 3

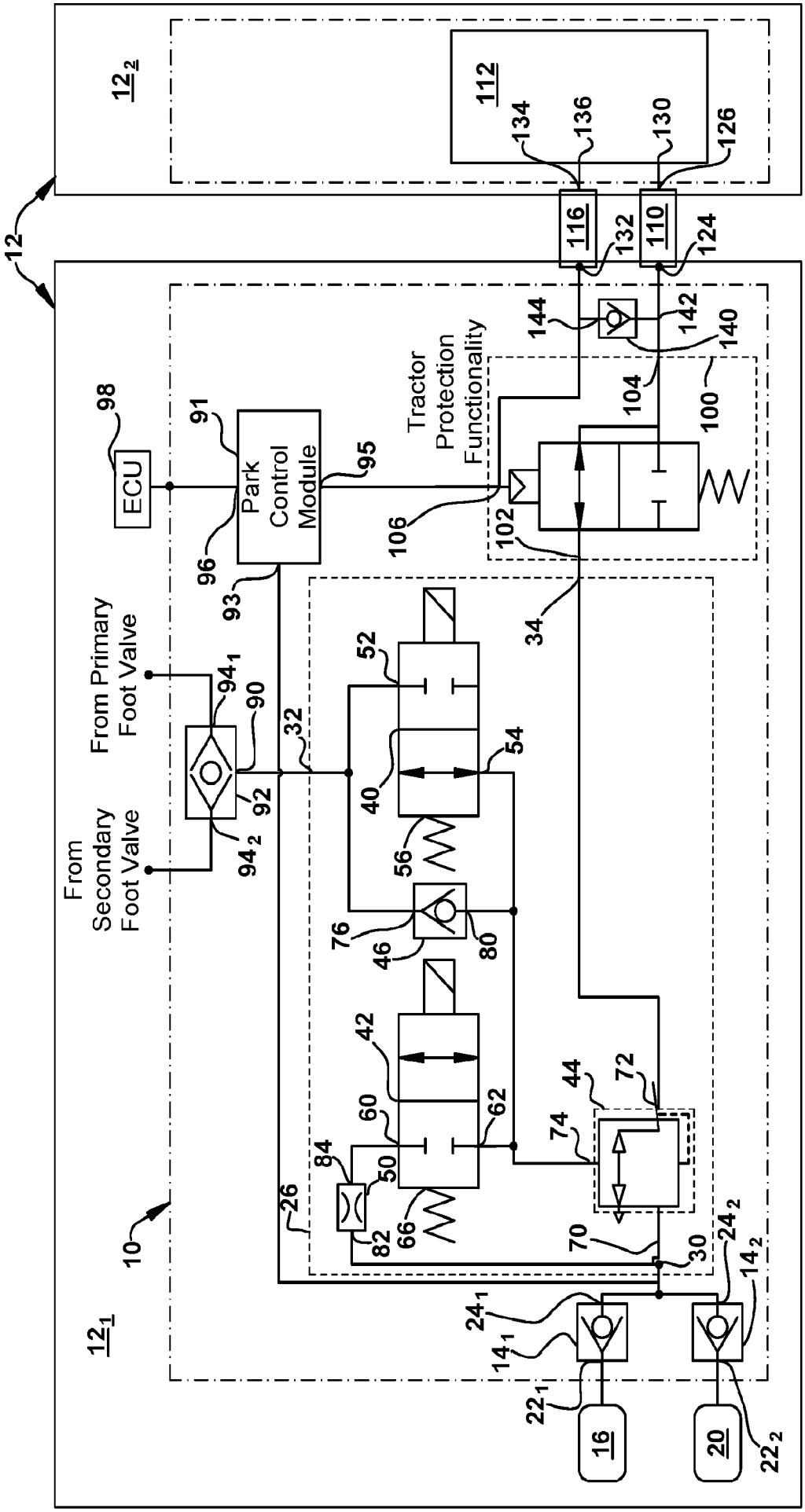

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FIG. 4

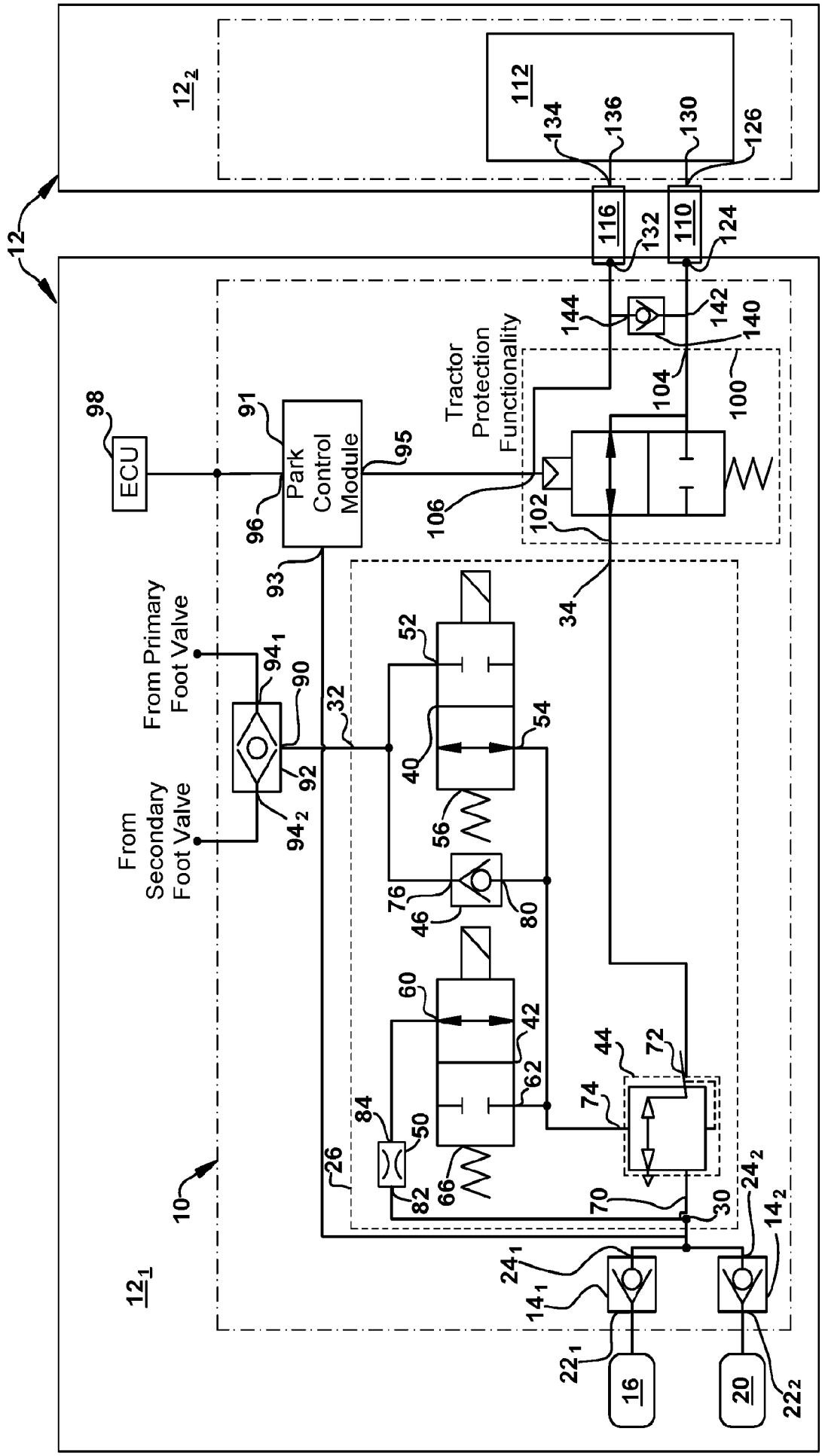

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FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2018/024535

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60T7/04 B60T7/08 B60T13/66 B60T13/68
ADD.

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)
B60T

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2016/177475 A1 (KNORR-BREMSE SYSTEME FÜR NUTZFAHRZEUGE GMBH [DE]) 10 November 2016 (2016-11-10)	1,2,6
Y	pages 8, 9, 11 and 12 and figure 1	3-5
X	EP 2 905 190 A1 (WABCO GMBH [DE]) 12 August 2015 (2015-08-12)	1
Y	paragraphs 1, 5, 6, 9, 11, 12, 13, 14, 19, 25-27, 29, 31 and figure 1	4
Y	DE 34 44 639 A1 (WABCO WESTINGHOUSE FAHRZEUG [DE]) 19 June 1986 (1986-06-19) pages 19, 20 and 25	3
Y	US 2011/193407 A1 (DIRK WOHLTMANN; THOMAS WOLF; THOMAS LENZ) 11 August 2011 (2011-08-11) paragraphs 29 and 33-39	5

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
9 July 2018	20/07/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Ranieri, Sebastiano

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2018/024535

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 3 112 231 A1 (WABCO GMBH [DE]) 4 January 2017 (2017-01-04) the whole document	1-6
A	DE 10 2012 025400 A1 (WABCO GMBH [DE]) 26 June 2014 (2014-06-26) the whole document	1-6
A	DE 10 2008 048207 A1 (HALDEX BRAKE PROD GMBH [DE]) 10 June 2010 (2010-06-10) the whole document	1-6
A	DE 10 2008 014458 A1 (WABCO GMBH [DE]) 17 September 2009 (2009-09-17) the whole document	1-6
A	WO 2009/152982 A2 (KNORR BREMSE SYSTEME [DE]; HERGES MICHAEL [DE]; ROETHER FRIEDBERT [DE]) 23 December 2009 (2009-12-23) the whole document	1-6
A	DE 10 2006 041010 A1 (WABCO GMBH [DE]) 6 March 2008 (2008-03-06) the whole document	1-6

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2018/024535

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2016177475 A1	10-11-2016	CN 107580571 A	12-01-2018
		DE 102015107125 A1	10-11-2016
		EP 3292030 A1	14-03-2018
		WO 2016177475 A1	10-11-2016
EP 2905190 A1	12-08-2015	DE 102014001237 A1	30-07-2015
		EP 2905190 A1	12-08-2015
DE 3444639 A1	19-06-1986	NONE	
US 2011193407 A1	11-08-2011	NONE	
EP 3112231 A1	04-01-2017	DE 102015008379 A1	29-12-2016
		EP 3112231 A1	04-01-2017
DE 102012025400 A1	26-06-2014	DE 102012025400 A1	26-06-2014
		EP 2934971 A1	28-10-2015
		JP 2016503740 A	08-02-2016
		WO 2014094936 A1	26-06-2014
DE 102008048207 A1	10-06-2010	NONE	
DE 102008014458 A1	17-09-2009	CN 101970270 A	09-02-2011
		DE 102008014458 A1	17-09-2009
		EP 2254779 A1	01-12-2010
		ES 2444125 T3	24-02-2014
		JP 2011518065 A	23-06-2011
		WO 2009112065 A1	17-09-2009
WO 2009152982 A2	23-12-2009	AT 554978 T	15-05-2012
		DE 102008029310 A1	14-01-2010
		EP 2288523 A2	02-03-2011
		JP 5456030 B2	26-03-2014
		JP 2011524299 A	01-09-2011
		RU 2011101984 A	27-07-2012
		US 2011144855 A1	16-06-2011
		WO 2009152982 A2	23-12-2009
DE 102006041010 A1	06-03-2008	AT 505375 T	15-04-2011
		CN 101495353 A	29-07-2009
		DE 102006041010 A1	06-03-2008
		EP 2059427 A1	20-05-2009
		US 2009309413 A1	17-12-2009
		WO 2008025398 A1	06-03-2008