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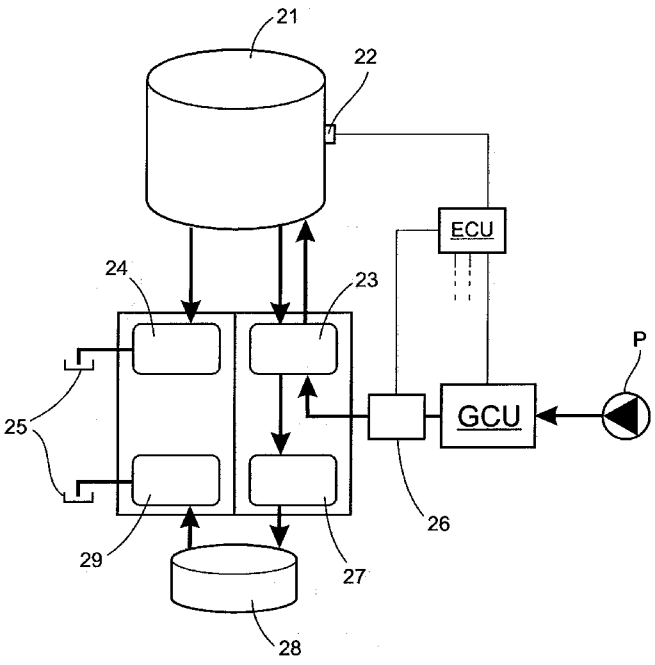
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(54) Title: METHOD AND ARRANGEMENT FOR AIR LEAK DIAGNOSIS



(57) Abstract: The invention relates to a method for detecting leakage in a fluid system in a vehicle comprising a transmission controlled by the fluid system, which fluid system comprises multiple controllable valves and at least one fluid cylinder; a clutch cylinder (21; 31) provided with a reciprocable piston; a sensor (22; 32) indicative of the pressure in the clutch cylinder (21; 31); wherein the clutch cylinder comprises a controllable first valve (23; 33) connected to a source of fluid pressure (P) and a controllable second valve (24; 34) connected to a drain (25; 35); and a control unit (ECU) arranged to receive an input signal from the sensor (22; 32) and to control each controllable valve and the at least one fluid cylinder. The method steps of opening the first valve (23; 33) and controlling a fluid shut-off valve (26; 36) to pressurize the clutch cylinder (21; 31) to a predetermined pressure; actuating a controllable component (27, 28, 29; 37, 38, 39) to be tested by closing ports or valves connected to drain (25; 35) and venting any fluid circuit connected to the component remote from the clutch cylinder (21; 31) to drain (25; 35); opening the first valve (23; 33) of the clutch cylinder (21; 31) to pressurize a fluid circuit upstream of the cylinder between the clutch cylinder and the component to be tested; and monitoring the sensor signal to detect a change in the signal indicating a leakage.

Fig.2

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METHOD AND ARRANGEMENT FOR AIR LEAK DIAGNOSIS

TECHNICAL FIELD

The invention relates to a method for detecting leakage in a fluid system in a vehicle comprising an automated manual transmission controlled by the fluid system. The invention also relates to a computer program, a computer program product and a storage medium arranged to perform said method.

BACKGROUND OF THE INVENTION

Conventional automated manual transmission for vehicles can be controlled by a fluid system that is built into a transmission unit such as a gearbox. Typically, one or more clutch cylinders and associated components for controlling gear shifts, such as controllable valves for actuating shift forks or similar devices are built into the transmission unit and are supplied with a suitable pressurized fluid from a source of fluid pressure, such as a pump or accumulator.

Performing fault tracing for leakages in transmissions comprising such built in systems can require a lot of demounting of components and special equipment for testing separate components. Demounting components for fault tracing is time consuming, expensive and requires specialist equipment. As a result, functioning components can be exchanged by new components at random, merely to save time and without performing the correct fault tracing. The result is that components are replaced unnecessarily and that proper operation of the transmission is not ensured, as operation may be continued without the leakage problem being solved.

In order to ensure proper operation of a transmission of this type, it is desirable to facilitate a method for correct and efficient fault tracing.

The object of the invention is to provide an improved method for detecting leakage that solves or minimises the above problems.

INVENTION

The above problems have been solved by a method as claimed in the appended claims.

In the subsequent text, terms relating to direction of fluid flow are to be interpreted relative to the flow of fluid into a main clutch cylinder of a vehicle transmission during normal operation,

unless otherwise specified. Hence, the normal flow into the clutch cylinder passes through a supply valve and is drained through a drain valve. Fluid flow in the "upstream" direction of the clutch cylinder, occurring during a leakage detection test, takes place in the opposite direction, from the clutch cylinder towards the supply valve. Fluid flow in this direction is not desirable during normal operation of the transmission.

The invention relates to a method for detecting leakage in a fluid system in a vehicle comprising a manual or automatic transmission controlled by the fluid system. The invention will be described in connection with an automated manual transmission. The fluid system comprises a fluid circuit, multiple controllable valves and at least one fluid cylinder, in the form of a clutch cylinder provided with a reciprocable piston. The controllable valves can be any suitable mechanically or electrically actuatable type of valve. The fluid circuit further comprises at least one sensor indicative of the pressure in the clutch cylinder. The clutch cylinder comprises a controllable first valve connected to a source of fluid pressure and a controllable second valve connected to a drain. Alternatively, the clutch cylinder can comprise two controllable first valves, wherein one is used for fast filling and one is used for slow filling of the clutch cylinder. In the subsequent text only one controllable first valve will be referred to. In this context, either of the slow or fast filling valves could be used for performing the leakage test. For instance, from the perspective of valve wear, the valve that is least used during normal operation could be used during the leakage test. A control unit is arranged to receive an input signal from the at least one sensor and to control each controllable valve and the at least one fluid cylinder.

The control unit can comprise a gearbox control unit having interfaces for both pressurized fluid and electrical signals. In this case an electronic control unit which is electrically connected to all relevant sensors and fluid valves is integrated in the gearbox control unit. The sensors can be pressure sensors, e.g. for the clutch cylinder, or position sensors, e.g. for indicating the current position for cylinders or actuators in the fluid system. The electronic control unit is configured to generate signals to open or close one or more controllable valves in accordance with the invention during the leakage test. A controllable shut-off valve can be integrated into the gearbox control unit, or be arranged as a separate valve connected to the gearbox control unit. The latter example is suited for the application of the invention on an existing vehicle (aftermarket). The gearbox control unit is supplied with fluid pressure from a suitable source of pressure, such as a compressor or an accumulator. The fluid circuit to be tested can be isolated from the source of pressure by means of the shut-off valve.

Alternatively, the control unit can comprise a gearbox control unit having an interface for pressurized fluid and a separate electronic control unit which is electrically connected to the gearbox control unit and all relevant sensors and fluid valves. The electronic control unit is configured to operate as described above. The controllable shut-off valve can be integrated into the gearbox control unit, or be arranged as a separate valve connected to the gearbox control unit. As described above, the gearbox control unit is supplied with fluid pressure from a suitable source of pressure.

The at least one sensor indicative of the pressure in the clutch cylinder can be arranged in the clutch cylinder or in the gearbox control unit. For instance, if the shut-off valve is integrated in the gearbox control unit, then a sensor is provided in the gearbox control unit can be used. Alternatively, if the shut-off valve is arranged between the gearbox control unit and the clutch cylinder, then a sensor is provided in the clutch cylinder can be used. Similarly, if the shut-off valve is arranged between the gearbox control unit and the source of pressure, then a sensor is provided in the clutch cylinder can be used. The latter case allows for testing a gearbox control unit lacking a pressure sensor.

The method involves the steps of;

- opening the first valve and controlling a fluid shut-off valve to pressurize the clutch cylinder to a predetermined pressure;
- actuating a controllable component to be tested by closing valves connected to drain and venting any fluid circuit connected to the component remote from the cylinder to drain;
- opening the first valve of the clutch cylinder to pressurize a fluid circuit upstream of the cylinder, which circuit is connected to the component to be tested; and
- monitoring the sensor signal to detect a change in the signal indicating a leakage.

Prior to performing a test for detecting leakage, the control unit is arranged to close the second valve to allow the clutch cylinder to be pressurized. In order to pressurize the clutch cylinder, a shut-off valve connecting the clutch cylinder and/or the first valve to a source of fluid pressure is opened. The shut-off valve and the first valve are both closed when the clutch cylinder has been pressurized to a predetermined pressure and the shut-off valve remains closed during the duration of the leakage detection, unless a re-pressurization of the clutch cylinder is required. The shut-off valve can be controlled automatically or manually. The source of fluid pressure can be a pump or a suitable accumulator. In order to minimize the number of re-pressurizations, the predetermined pressure is preferably the maximum available pressure.

According to a first example, the method according to the invention involves opening, in sequence, each consecutive component in the fluid circuit connecting upstream of the clutch cylinder and the pressurized portion of the fluid circuit with a non-pressurized portion to pressurize a subsequent component upstream of the clutch cylinder. In this context, the term "upstream" defines a direction of flow out of the clutch cylinder that is opposite to the normal direction of flow when pressurizing the clutch cylinder. Subsequently, the sensor signal is monitored after each pressurization in order to detect a pressure drop indicating a leak in the pressurized portion.

In this first example, the method involves opening the first valve of the clutch cylinder to pressurize an initial component adjacent the clutch cylinder. If a leakage is detected by the control unit at this point, then a signal can be generated to indicate that the initial component is faulty and requires service or replacement. If no leakage is detected, then the subsequent component upstream of the clutch cylinder is actuated by closing ports or valves connected to drain. Any fluid circuit connected to the component remote from the clutch cylinder is vented to drain. The initial component is then opened, connecting the subsequent component to the clutch cylinder to pressurize the subsequent component. After pressurization the sensor signal is monitored in order to detect a pressure drop indicating a leak in the subsequent component. This process is repeated for each consecutive component upstream of the clutch cylinder, in a direction away from the clutch cylinder, until each component in the fluid circuit connected to the clutch cylinder has been pressurized.

According to a second example, the method involves closing, in sequence, each component in the fluid circuit connecting the clutch cylinder and a pressurized portion of the fluid circuit and venting any fluid circuit connected to the closed component remote from the clutch cylinder to drain. Subsequently, the sensor signal is monitored after each pressurization in order to detect a pressure drop indicating a leak in the pressurized portion.

In this second example, the method involves opening the first valve of the clutch cylinder to pressurize the entire fluid circuit and any intermediate component up to a final component remote from the clutch cylinder. In this case, the initial component to be tested is the component located last in the fluid circuit connected to the clutch cylinder. The portion of the fluid circuit connected to the final component and located remote from the clutch cylinder is vented to drain. If a leakage is detected by the control unit at this point, then this indicates that any one component in the fluid circuit may be faulty and requires service or replacement. If no leakage is detected, then the final component in the fluid circuit is operating correctly. The subsequent component in the direction towards the clutch cylinder is then actuated by

closing ports or valves connected to drain. Any fluid circuit connected to the subsequent component remote from the clutch cylinder is vented to drain. The subsequent component is then fully pressurized, that is, all ports and valves associated with the component are subjected to the pressure from the clutch cylinder. After pressurization the sensor signal is monitored in order to detect a pressure drop indicating a leak in the subsequent component. This process is repeated for each consecutive component upstream of the clutch cylinder, in a direction towards the clutch cylinder, until each component in the fluid circuit connected to the clutch cylinder has been pressurized.

According to the method, the shut-off valve can be opened to pressurize the clutch cylinder when the fluid pressure in the clutch cylinder drops below a predetermined limit. The method according to the first and second examples will both cause a gradual pressure drop in the clutch cylinder. In the first example, the pressure drop is gradual as each subsequent component is actuated to pressurize an additional portion of the fluid circuit. In the second example there will be an initial pressure drop as the entire fluid circuit to be tested is pressurized. In both examples, any leakage flow will contribute to the pressure loss. Re-pressurization of the clutch cylinder can be performed at any time during the test, either prior to or following a completed pressure monitoring cycle. During re-pressurization, any actuation of a component to be tested is suspended.

Pressurizing of the clutch cylinder can be achieved by connecting the fluid shut-off valve to the first valve. As indicated above, the fluid shut-off valve must be closed when the clutch cylinder has been pressurized or re-pressurized.

According to the invention, the method involves connecting the clutch cylinder to a fluid circuit upstream of the clutch cylinder to pressurize one or more controllable components upstream of the clutch cylinder. The one or more components can be in the form of mechanically or electrically controllable valves or additional cylinders upstream of the clutch

As indicated above, the control unit is arranged to receive an input signal from the at least one sensor monitoring the clutch cylinder pressure. Suitable sensors for this purpose can be a pressure sensor or a position sensor for the clutch piston. The control unit is arranged to monitor the sensor signal during a predetermined time period. The time period must be sufficient to allow the pressure in the pressurized portion in the fluid circuit to settle and to allow detection of a possible leakage flow in excess of a predetermined flow rate. This can be calculated by the control unit using an input signal representing a change in pressure or piston position over a predetermined time interval.

If a leakage is detected, the control unit is arranged to generate an error signal if the signal indicates a pressure drop exceeding a predetermined limit. Alternatively an error signal can be generated if the signal indicates a leak flow rate exceeding a predetermined limit.

The method according to the invention solves the problem relating to fault tracing for leakages in transmissions comprising built-in fluid systems and integrated components which would normally require a lot of demounting of components and special equipment for testing separate components. Accordingly, only malfunctioning components will be removed for repair or exchanged by new components, which saves time and costs. The result of a fault tracing according to the invention is that components are only replaced when necessarily and that proper operation of the transmission is ensured.

FIGURES

In the following text, the invention will be described in detail with reference to the attached drawings. These schematic drawings are used for illustration only and do not in any way limit the scope of the invention. In the drawings:

Figure 1 shows a schematically indicated vehicle for use with the method according to the invention;

Figure 2 shows a schematically indicated fluid circuit in a transmission to be tested using the method according to the invention; and

Figure 3 shows a schematically indicated alternative fluid circuit in a transmission to be tested using the method according to the invention.

DETAILED DESCRIPTION

Figure 1 shows a schematically indicated vehicle for use with the method according to the invention. Figure 1 shows a vehicle 11 with a transmission arrangement 13 comprising fluid components to be tested for leakage. In this particular example the fluid is compressed air. The vehicle 11 is provided with an internal combustion engine (ICE) 12 drivingly connected to a transmission 13, such as an automated manual transmission (AMT), for transmitting torque from the ICE to a vehicle drive axle (not shown). The ICE 12 is connected to a radiator arrangement 14 for cooling engine coolant and oil from the ICE 12. The transmission 13 is controlled by the driver or automatically via an electronic control unit (ECU) 15. The ECU 15 is provided with control algorithms for controlling the transmission independently during, for instance, an engine start requested by the driver. The transmission is controlled to select a gear ratio between the engine 12 and a pair of driven wheels 16.

Figure 2 shows a schematically indicated fluid circuit in a transmission to be tested using the method according to the invention. In this example the method is used for detecting leakage in a fluid system in a vehicle transmission, such as an automated manual transmission controlled by the fluid system. The fluid system comprises a fluid circuit using compressed air. The transmission comprises at least one main clutch (not shown) operated by a first clutch cylinder 21. The first clutch cylinder 21 is provided with a reciprocable piston arranged to be displaced axially within the first clutch cylinder by means of compressed air. The fluid circuit further comprises a pressure sensor 22 indicative of the pressure in the first clutch cylinder 21. The output signal from the pressure sensor 22 is transmitted to an electronic control unit ECU, which in turn is electrically connected to all valves that need to be controlled during the test. In Figure 2, the ECU is shown as a separate unit with a number of electrical conduits (only a few shown). However, the ECU can also form an integral part of a gearbox control unit GCU, which comprises an interface for at least the pressurized fluid. The first clutch cylinder 21 is connected to a controllable first valve 23, which is a supply valve for at least the first clutch cylinder 21. The controllable first valve 23 is connected to a source of fluid pressure P via the gearbox control unit GCU. The first clutch cylinder 21 is further connected to a controllable second valve 24 connected to drain 25. A controllable shut-off valve 26 is arranged between the gearbox control unit GCU and the controllable first valve 23, which shut-off valve is open during normal operation of the vehicle transmission. The shut-off valve 26 is controlled by the electronic control unit ECU.

The example in Figure 2 shows the shut-off valve 26 arranged between the clutch cylinder 21 and the gearbox control unit GCU. Alternatively, a shut-off valve (not shown) can be placed between the gearbox control unit GCU and the source of pressure. In this alternative example, the pressure sensor in the clutch cylinder 21 would be used for detecting a leak in the system including the gearbox control unit GCU. This arrangement could be used when the gearbox control unit GCU is not provided with a pressure sensor.

The example shown in Figure 2 describes a pressure sensor 22, but this can be replaced by an alternative sensor that can measure a pressure related parameter. For instance, a position sensor can be used for detecting a displacement of the piston in the clutch cylinder caused by a pressure drop.

The controllable shut-off valve 26 can be arranged as a separate valve (see Fig.2) or be integrated into the gearbox control unit GCU (see Fig.3). The valve is controlled by an on-board diagnostics (OBD) function in the electronic control unit ECU. Alternatively, a shut-off valve can be connected into the fluid circuit for the purpose of performing a leakage detection

test in a workshop. Also, the controllable shut-off valve can be connected directly to the first clutch cylinder, allowing it to by-pass the controllable first valve in order to pressurize the first clutch cylinder.

The controllable first valve 23 is connected to a fluid system comprising at least one auxiliary supply valve 27 (one shown). The auxiliary supply valve 27 is in turn arranged to supply pressure to an auxiliary cylinder 28, which could be a cylinder for actuating a shift fork (not shown) in the transmission. The auxiliary cylinder 28 is further connected to a controllable auxiliary drain valve 29 connected to drain 25. In the example shown in Figure 2, the first and second valves 23, 24, the auxiliary supply valve 27 and the auxiliary drain valve 29 are all arranged in a common valve unit. The electronic control unit ECU is arranged to control the opening and closing of all the controllable valves described above.

In normal operation of the transmission, the electronic control unit ECU is arranged to control the first clutch cylinder 21 by means of the first and second valves 23, 24, in order to actuate or release the clutch. The electronic control unit ECU is further arranged to control the at least one auxiliary clutch cylinder 28 by means of the auxiliary supply and drain valves 27, 29, in order to actuate or release individual shift forks during gear changes in the transmission. During normal operation fluid will flow from the first valve 23 to the first clutch cylinder 21, as indicated by the right-hand arrow in Figure 2.

During servicing of the vehicle, or in response to an error message indicating a leak in the transmission fluid system, a test of the fluid circuit is performed to detect a leakage. Prior to performing a test for detecting leakage, the electronic control unit ECU is arranged to close the second valve 24 to allow the first clutch cylinder 21 to be pressurized. In order to pressurize the first clutch cylinder 21, the shut-off valve 26 connecting the first clutch cylinder and the first valve 23 to the source of fluid pressure P is opened. The shut-off valve 26 and the first valve 23 are both closed when the first clutch cylinder 21 has been pressurized to a predetermined pressure. The shut-off valve 26 remains closed during the duration of the leakage detection to isolate the gearbox control unit GCU from the fluid circuit to be tested, unless a re-pressurization of the clutch cylinder is required. The source of fluid pressure P can be a pump or a suitable accumulator. Typically, the pressure provided can be 5-10 bars. The electronic control unit ECU is arranged to receive a signal from the pressure sensor 22 and to monitor the pressure in the first clutch cylinder 21 during the test.

The method for performing the test involves the steps of;

- opening the first valve 23 and controlling the fluid shut-off valve 26 to pressurize the first clutch cylinder 21 to a predetermined pressure;
- actuating a controllable component 23;27;28;29 to be tested by closing ports or valves connected to drain 25 and venting any fluid circuit connected to the component 23;27;28;29 remote from the first clutch cylinder 21 to drain 25;
- opening the first valve 23 of the first clutch cylinder 21 to pressurize a fluid circuit upstream of the first clutch cylinder 21, which circuit is connected to the component 23;27;28;29 to be tested; and
- monitoring the signal from the pressure sensor 22 to detect a change in the signal indicating a leakage.

According to a first example, the method according to the invention involves opening, in sequence, each consecutive component 23;27;28;29 upstream of the first clutch cylinder 21 in the fluid circuit and connecting and the pressurized portion of the fluid circuit with a non-pressurized portion to pressurize a subsequent component upstream of the first clutch cylinder 21. The signal from a pressure sensor 22 is monitored after each pressurization in order to detect a pressure drop in the first clutch cylinder 21 indicating a leak in the pressurized portion between the first clutch cylinder 21 and the currently actuated component 23;27;28;29. During a leakage test fluid will flow from the first clutch cylinder 21 to the first vale 23, against the normal direction of flow, as indicated by the left-hand arrow in Figure 2.

In this first example, the method involves actuating the auxiliary supply valve 27 and opening the first valve 23 of the first clutch cylinder 21 to pressurize the auxiliary supply valve 27 and the fluid circuit adjacent the first clutch cylinder 21. The electronic control unit ECU will then monitor the pressure sensor signal during a predetermined time period. If a leakage is detected by the electronic control unit ECU at this point, then a signal is generated to indicate that the auxiliary supply valve 27 is faulty and requires service or replacement.

If no leakage is detected, then the subsequent component upstream of the first clutch cylinder 21, in this case the auxiliary drain valve 29, is actuated by closing ports or valves connected to drain 25. The fluid circuit connected to this component remote from the clutch cylinder is already vented to drain 25. The auxiliary supply valve 27 is then opened, connecting the auxiliary cylinder 28 and the auxiliary drain valve 29 to the first clutch cylinder 21 in order to pressurize these subsequent components. After pressurization the pressure sensor signal is again monitored in order to detect a pressure drop indicating a leak in the auxiliary cylinder 28 or the auxiliary drain valve 29. If a leakage is detected by the electronic

control unit ECU at this point, then a signal is generated to indicate that the auxiliary cylinder 28 or the auxiliary drain valve 29 is faulty and requires service or replacement.

Once this fluid circuit has been tested, the first component adjacent the first valve 21 in the direction upstream of the first clutch cylinder 21 is closed. In this example the auxiliary supply valve 27 is closed. The method can then be implemented on additional parts of the fluid circuit connected to the first clutch cylinder 21. An example of this is described in connection with Figure 3, which shows an additional auxiliary cylinder with associated valves.

Figure 3 shows a schematically indicated alternative fluid circuit in a transmission to be tested using the method according to the invention. The component parts of this fluid circuit are substantially identical to those of Figure 2.

In this second example an alternative method is used for detecting leakage in a fluid system 30 in a vehicle transmission. As in Figure 2, the transmission comprises at least one main clutch (not shown) operated by a first clutch cylinder 31. The fluid circuit further comprises a pressure sensor 32 indicative of the pressure in the first clutch cylinder 31. The output signal from the pressure sensor 32 is transmitted to an electronic control unit ECU. The first clutch cylinder 31 is connected to a controllable first valve 33, which is a supply valve for at least the first clutch cylinder 31. The controllable first valve 33 is connected to a source of fluid pressure P via a gearbox control unit GCU and a controllable shut-off valve 36 is arranged in the gearbox control unit GCU. In Figure 3, the electronic control unit ECU is shown as a separate unit with a number of electrical conduits (only a few shown). Alternatively, both the controllable shut-off valve 36 and the electronic control unit ECU can be integrated in the gearbox control unit GCU (not shown), which would then comprise interfaces for the pressurized fluid and electrical signals.

The example in Figure 3 shows the pressure sensor 32 arranged in the clutch cylinder 31. Alternatively, the gearbox control unit GCU, when comprising an integrated shut-off valve, can be provided with a pressure sensor (not shown). The output signal from this pressure sensor would be transmitted to the electronic control unit ECU as described above. In this alternative example, the pressure sensor in the gearbox control unit GCU would be used for detecting a leak in the system.

The first clutch cylinder 31 is further connected to a controllable second valve 34 connected to drain 35. The shut-off valve 36 is open during normal operation of the transmission. The shut-off valve 36 is controlled by the electronic control unit ECU. The controllable first valve 33 is connected to at least one auxiliary supply valve 37, 37' (two indicated). The auxiliary

supply valve 37 is in turn is arranged to supply pressure to an auxiliary cylinder 38, such as a cylinder for actuating a shift fork (not shown) in the transmission. The auxiliary cylinder 38 is further connected to a controllable auxiliary drain valve 39 connected to drain 35. The electronic control unit ECU is arranged to control the opening and closing of all the controllable valves described above. During normal operation fluid will flow from the first valve 33 to the first clutch cylinder 31, as indicated by the right-hand arrow in Figure 3.

The example shown in Figure 3 describes a pressure sensor 32, but this can be replaced by an alternative sensor that can measure a pressure related parameter. For instance, a position sensor can be used for detecting a displacement of the piston in the clutch sensor caused by a pressure drop.

According to the second example, the method involves closing, in sequence, each component 33;37;38;39 in the fluid circuit connecting the first clutch cylinder 31 and a pressurized portion of the fluid circuit and venting any fluid circuit connected to the closed component remote from the first clutch cylinder 31 to drain 35 Subsequently, the signal from the pressure sensor 32 is monitored after each pressurization in order to detect a pressure drop in the first clutch cylinder 31 indicating a leak in the pressurized portion. During a leakage test fluid will flow from the first clutch cylinder 31 to the first vale 33, against the normal direction of flow, as indicated by the left-hand arrow in Figure 3.

In this second example, the method involves opening the first valve 33 of the first clutch cylinder 31 to pressurize the entire fluid circuit and any intermediate component 33, 37,38 up to a final component. In this case the final component is an auxiliary drain valve 39, remote from the first clutch cylinder 31. In this case, the initial component to be tested is the component 39 located last in the fluid circuit connected to the first clutch cylinder 31. The portion of the fluid circuit connected to the final component 39 and located remote from the first clutch cylinder 31 is vented to drain 35. If a leakage is detected by the control unit ECU at this point, then this indicates that any one component in the fluid circuit may be faulty and requires service or replacement. If no leakage is detected, then the final component 39 in the fluid circuit is operating correctly. The subsequent component, in this case the auxiliary supply valve 37, in the direction towards the first clutch cylinder 31 is then actuated by closing ports or valves connected to drain 35. Any fluid circuit connected to this subsequent component 37 remote from the first clutch cylinder 31 is then vented to drain 35. The subsequent component 37 is then fully pressurized, that is, all ports and valves associated with the component are subjected to the pressure from the first clutch cylinder 31. After pressurization the pressure sensor signal is monitored in order to detect a pressure drop in

the first clutch cylinder 31 indicating a leak in the subsequent component 37. If a leakage is detected by the electronic control unit ECU at this point, then a signal is generated to indicate that the auxiliary drain valve 37 or the auxiliary cylinder 38 is faulty and requires service or replacement.

If no leakage is detected, then the final component(-s) in the fluid circuit, that is, the auxiliary drain valve 39 and the auxiliary cylinder 38 are operating correctly. The subsequent component in the direction towards the first clutch cylinder 31, in this case the auxiliary supply valve 37, is then actuated by closing ports or valves connected to drain 25. The fluid circuits connected to any subsequent component remote from the first clutch cylinder 31 is vented to drain 25. In this case the auxiliary drain valve 39 and the auxiliary cylinder 38 will be vented. The auxiliary supply valve 37 is then fully pressurized, that is, all ports and valves associated with this component are subjected to the pressure from the first clutch cylinder 31. After pressurization the pressure sensor signal is again monitored in order to detect a pressure drop indicating a leak in the s auxiliary supply valve 37.

This process is repeated for each consecutive component and/or fluid circuit upstream of the first clutch cylinder 31, in a direction towards the first clutch cylinder 31, until each component in the relevant fluid circuit connected to the first clutch cylinder 31 has been pressurized.

As indicated in Figure 3, the fluid circuit connected to the first clutch cylinder 31 can comprise at least one additional auxiliary cylinder 38' (shown in dashed lines) with associated auxiliary supply and drain valves 37', 39' in a parallel fluid circuit. While keeping the first auxiliary supply valve 37 closed, the components in the parallel fluid circuit can be tested for leaks in the same way as described above. The transmission described in this example is provided with a number of individually actuated shift forks, each controlled by an auxiliary cylinder in a separate fluid circuit. All components in fluid circuits upstream of the first clutch cylinder 31 and connected to the first valve 33 can be tested using this method.

The invention should not be deemed to be limited to the embodiments described above, but rather a number of further variants and modifications are conceivable within the scope of the following patent claims.

CLAIMS

1. Method for detecting leakage in a fluid system in a vehicle comprising a transmission controlled by the fluid system, which fluid system comprises multiple controllable valves and at least one fluid cylinder; a clutch cylinder (21; 31) provided with a reciprocable piston; a sensor (22: 32) indicative of the pressure in the clutch cylinder (21; 31); wherein the clutch cylinder comprises a controllable first valve (23; 33) connected to a source of fluid pressure (P) and a controllable second valve (24; 34) connected to a drain (25; 35); and an electronic control unit (ECU) arranged to receive an input signal from the sensor (22; 32) and to control each controllable valve and the at least one fluid cylinder, characterized by the method steps of;

- opening the first valve (23; 33) and controlling a fluid shut-off valve (26; 36) to pressurize the clutch cylinder (21; 31) to a predetermined pressure;
- actuating a controllable component (27, 28, 29; 37, 38, 39) to be tested by closing ports or valves connected to drain (25; 35) and venting any fluid circuit connected to the component remote from the clutch cylinder (21; 31) to drain (25; 35);
- opening the first valve (23; 33) of the clutch cylinder (21; 31) to pressurize a fluid circuit upstream of the clutch cylinder (21; 31) between the clutch cylinder and the component to be tested; and
- monitoring the sensor signal to detect a change in the signal indicating a leakage.

2. Method according to claim 1, characterized by

- opening, in sequence, each consecutive component (27, 28, 29; 37, 38, 39) upstream of the clutch cylinder (21; 31) in the fluid circuit and connecting the pressurized portion of the fluid circuit with a non-pressurized portion to pressurize a subsequent component upstream of the clutch cylinder (21; 31); and
- monitoring the sensor signal after each pressurization, in order to detect a pressure drop indicating a leak in the pressurized portion.

3. Method according to claim 1 or 2, characterized by opening the first valve (23; 33) of the clutch cylinder (21; 31) to pressurize an initial component (27; 37) adjacent the clutch cylinder (21; 31).

4. Method according to claim 1, characterized by

- closing, in sequence, each component in (29, 27; 39, 37) the fluid circuit connecting the clutch cylinder (21; 31) and a pressurized portion of the fluid circuit and venting any fluid

circuit connected to the closed component remote from the clutch cylinder (21; 31) to drain (25; 35); and

- monitoring the sensor signal after each pressurization, in order to detect a pressure drop indicating a leak in the pressurized portion.

5. Method according to claim 1 or 4, characterized by opening the first valve (23; 33) of the clutch cylinder (21; 31) to pressurize the fluid circuit and any intermediate component (27, 28; 37, 38) located between the clutch cylinder (21; 31) and an initial component (29; 39) to be tested.

6. Method according to any one of claims 1-5, characterized by opening the shut-off valve to pressurize the clutch cylinder (21; 31) when the fluid pressure in the clutch cylinder (21; 31) drops below a predetermined limit.

7. Method according to any one of claims 1-6, characterized by pressurizing the clutch cylinder (21; 31) by connecting the fluid supply directly to the clutch cylinder.

8. Method according to any one of claims 1-6, characterized by pressurizing the clutch cylinder (21; 31) by connecting the fluid shut-off valve (26; 36) to the first valve (23; 33).

9. Method according to any one of claims 1-8, characterized by closing the fluid shut-off valve (26; 36) when the clutch cylinder (21; 31) has been pressurized.

10. Method according to any one of claims 1-9, characterized by connecting the clutch cylinder (21; 31) to a fluid circuit upstream of the clutch cylinder to pressurize one or more controllable components (27, 28, 29; 37, 38, 39) upstream of the clutch cylinder (21; 31).

11. Method according to claim 10, characterized by connecting the clutch cylinder (21; 31) to pressurize one or more components (27, 29; 37, 39) in the form of controllable valves upstream of the clutch cylinder (21; 31).

12. Method according to claim 10 or 11, characterized by connecting the clutch cylinder (21; 31) to pressurize one or more components in the form of additional cylinders (28; 38) upstream of the clutch cylinder (21; 31).

13. Method according to any one of claims 1-12, characterized by monitoring the clutch cylinder pressure using a pressure sensor (22; 32).

14. Method according to any one of claims 1-12, characterized by monitoring the clutch cylinder pressure using a position sensor for the clutch piston.

15. Method according to any one of claims 1-14, characterized by y monitoring the sensor signal during a predetermined time period.

16. Method according to any one of claims 1-15, characterized by generating an error signal if the signal indicates a pressure drop exceeding a predetermined limit.

17. Method according to any one of claims 1-15, characterized by generating an error signal if the signal indicates a leak rate exceeding a predetermined limit.

18. A computer program comprising program code means for performing all the steps of any one of the claims 1 to 17 when said program is run on a computer (ECU, GCU).

19. A computer program product comprising program code means stored on a computer readable medium for performing all steps of anyone of the claims 1 to 17 when said program product is run on a computer (ECU, GCU).

20. A storage medium, such as a computer memory or a non-volatile data storage medium, for use in a computing environment (ECU, GCU), the memory comprising a computer readable program code to perform the method of the claims 1 to 17.

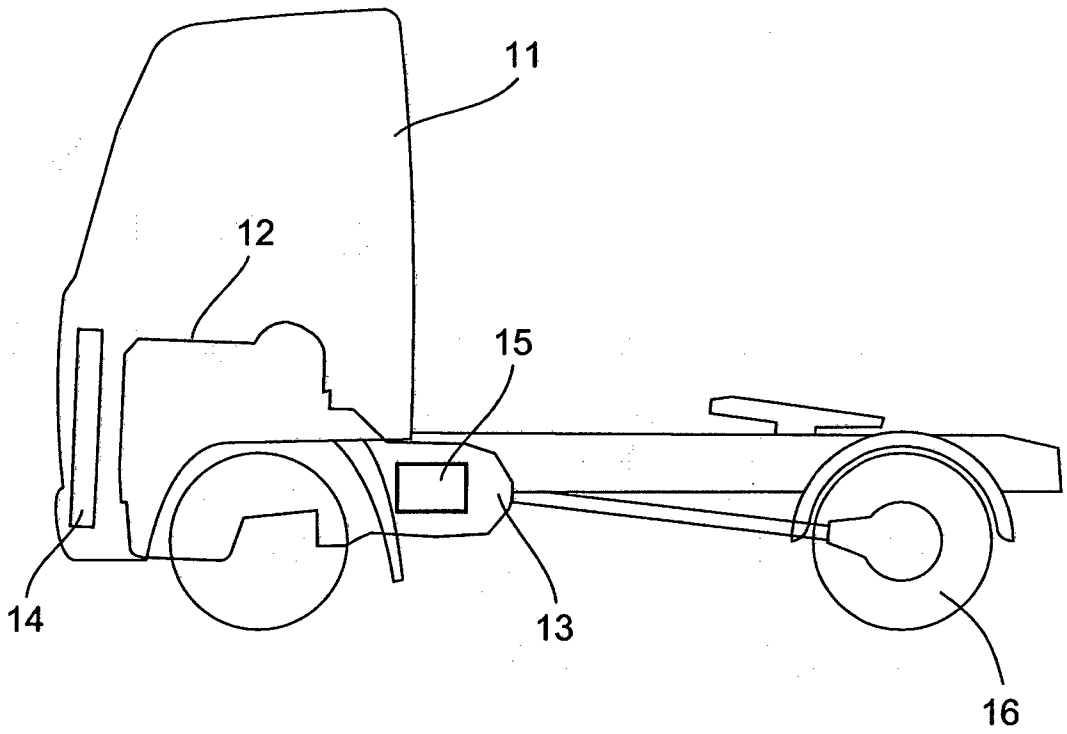


Fig.1

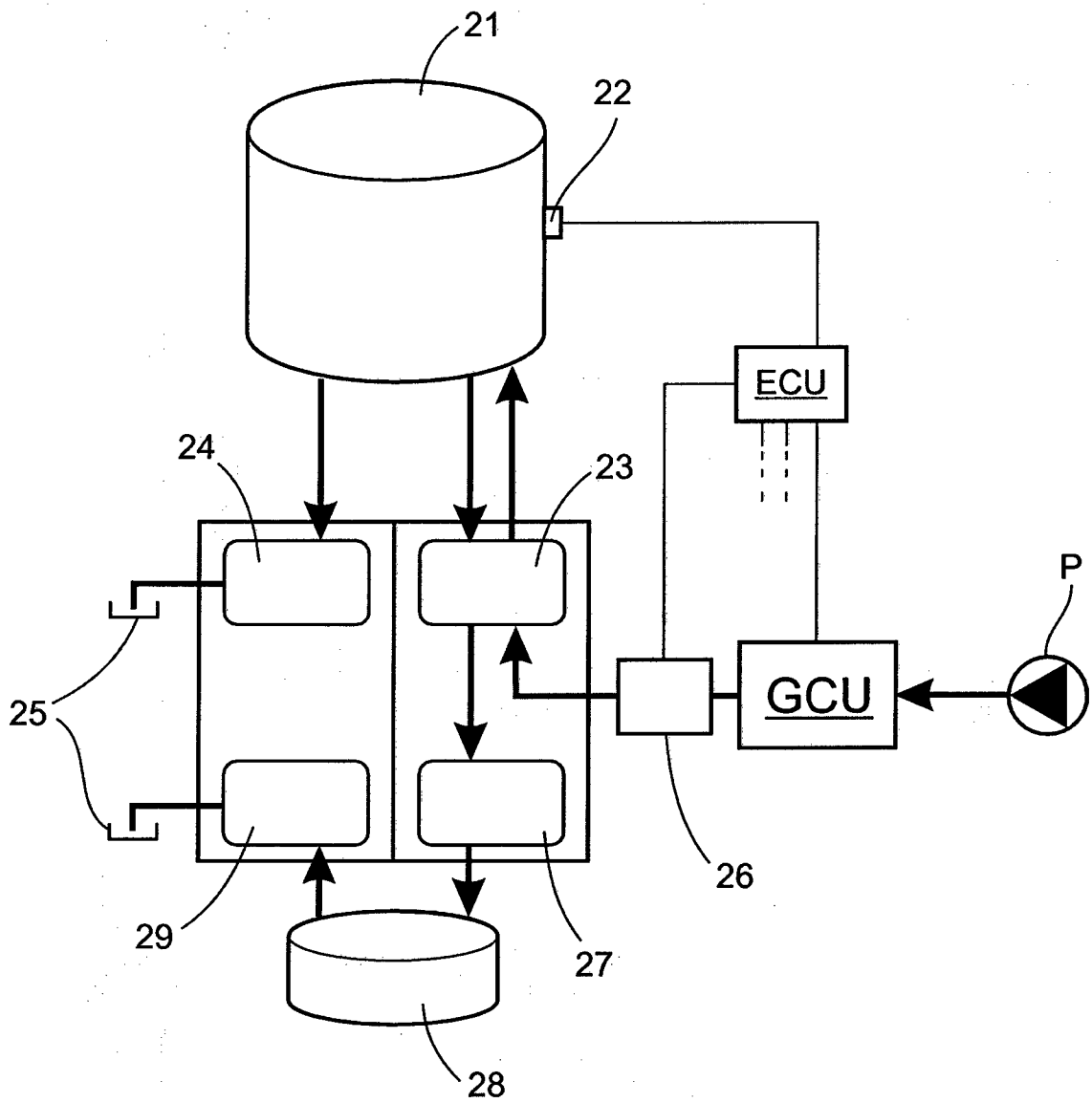


Fig.2

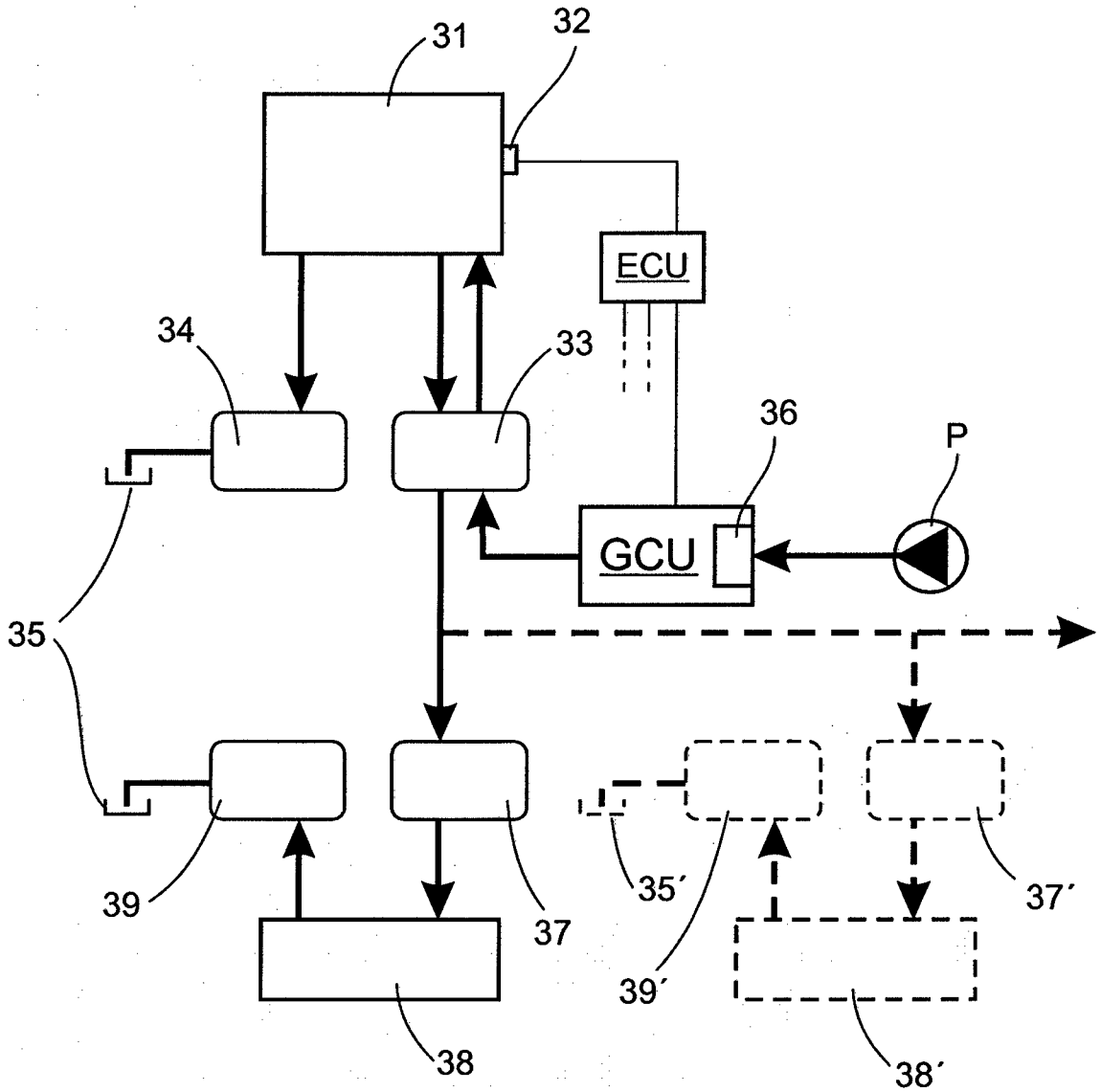


Fig.3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/003639

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01M3/26
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)
G01M F16D

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

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

[X] See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 August 2014	03/09/2014

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	Ridha, Philipp

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/003639

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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