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(54) Four-wheel drive vehicle transmission

(57) A four-wheel drive vehicle has front and rear transmission systems for transmitting the output of a change-speed gearbox to the front and rear wheels, respectively. A forward one-way clutch (8) and a reverse one-way clutch (9) are provided in the transmission system transmitting drive to the front wheels. One of the one-way clutches is selected according to the chosen forward or reverse driving direction of the vehicle. The forward one-way clutch (8) operates to transmit the power to the front wheels and to allow those front wheels to rotate faster than the rear wheels when the vehicle corners. The appropriate clutch (8) or (9) is brought into operation by a pneumatic actuator (20) controlled in response to signals from a reverse switch (26), a four-wheel drive switch (27), an accelerator pedal switch (31), and a vehicle speed switch (32). A clutch (6) selects two or four wheel drive.

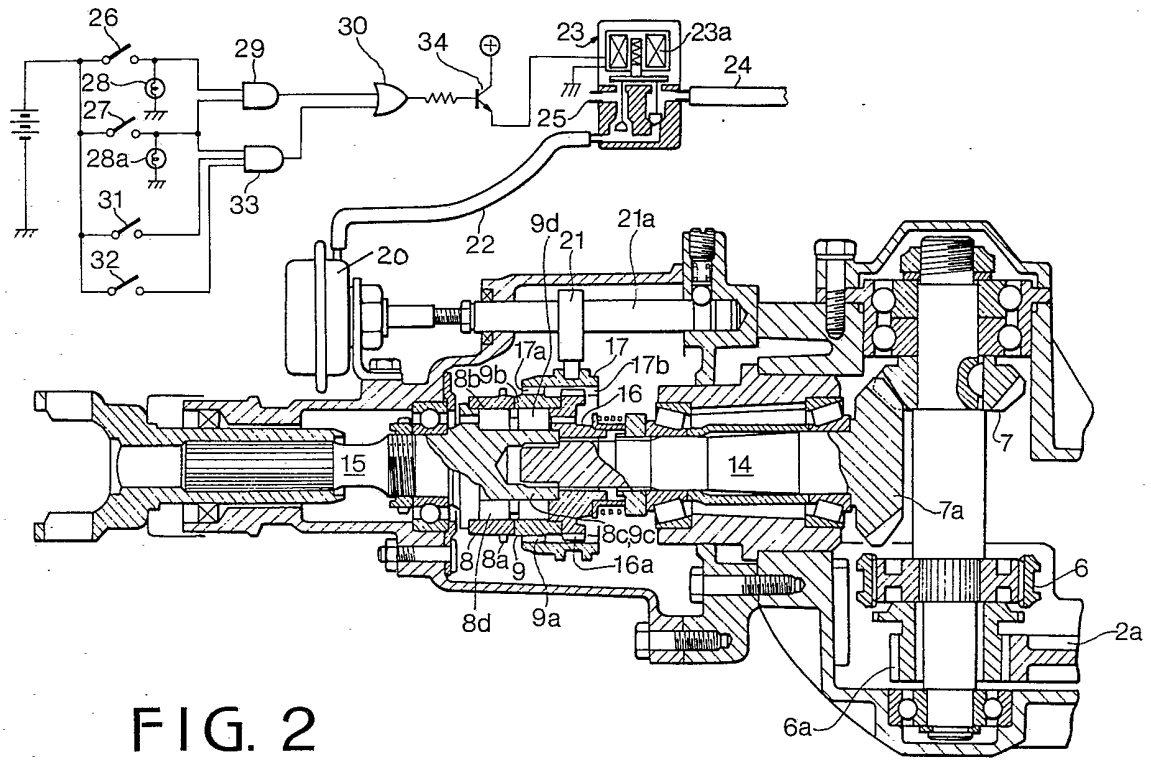

FIG. 2

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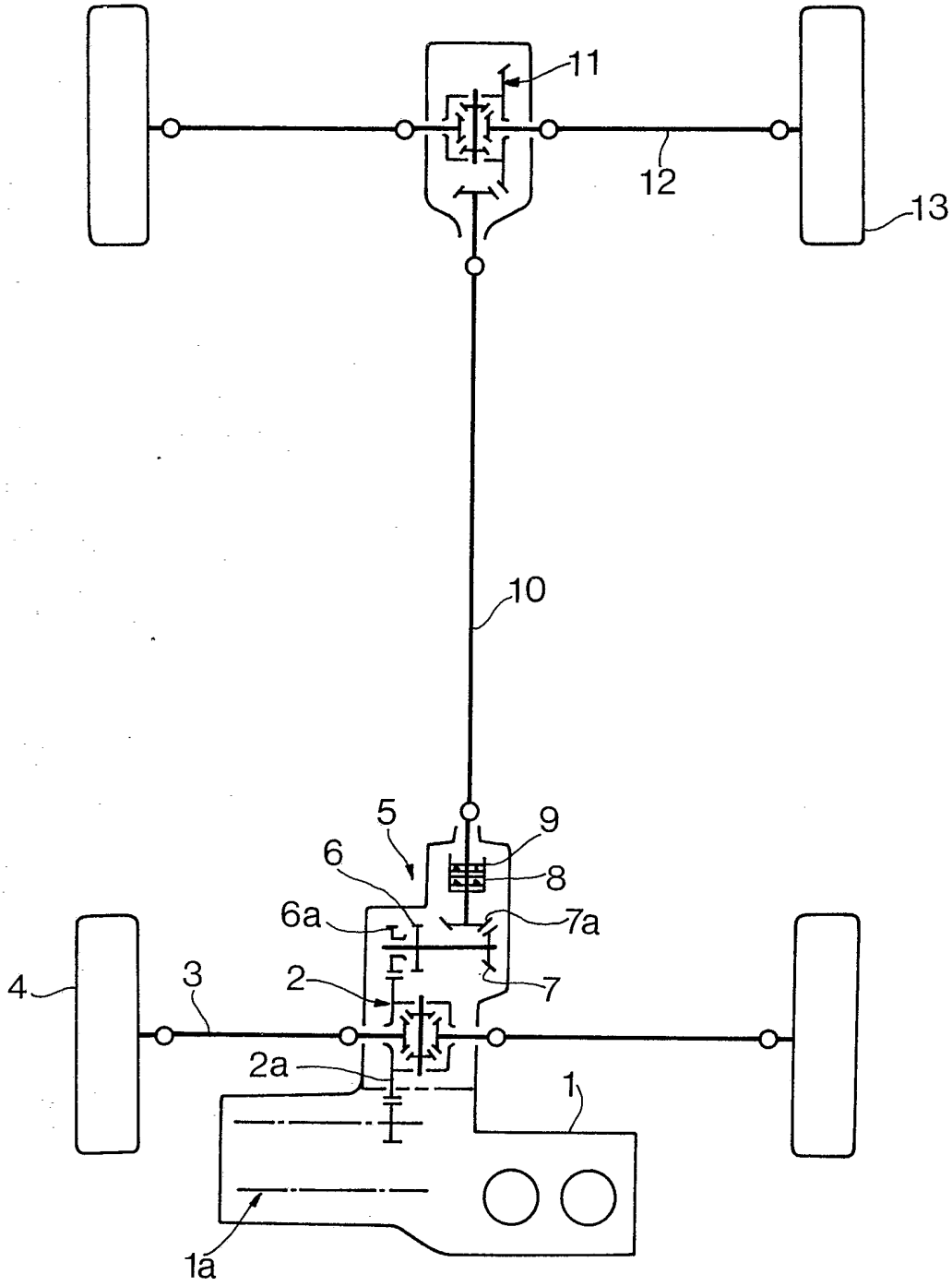
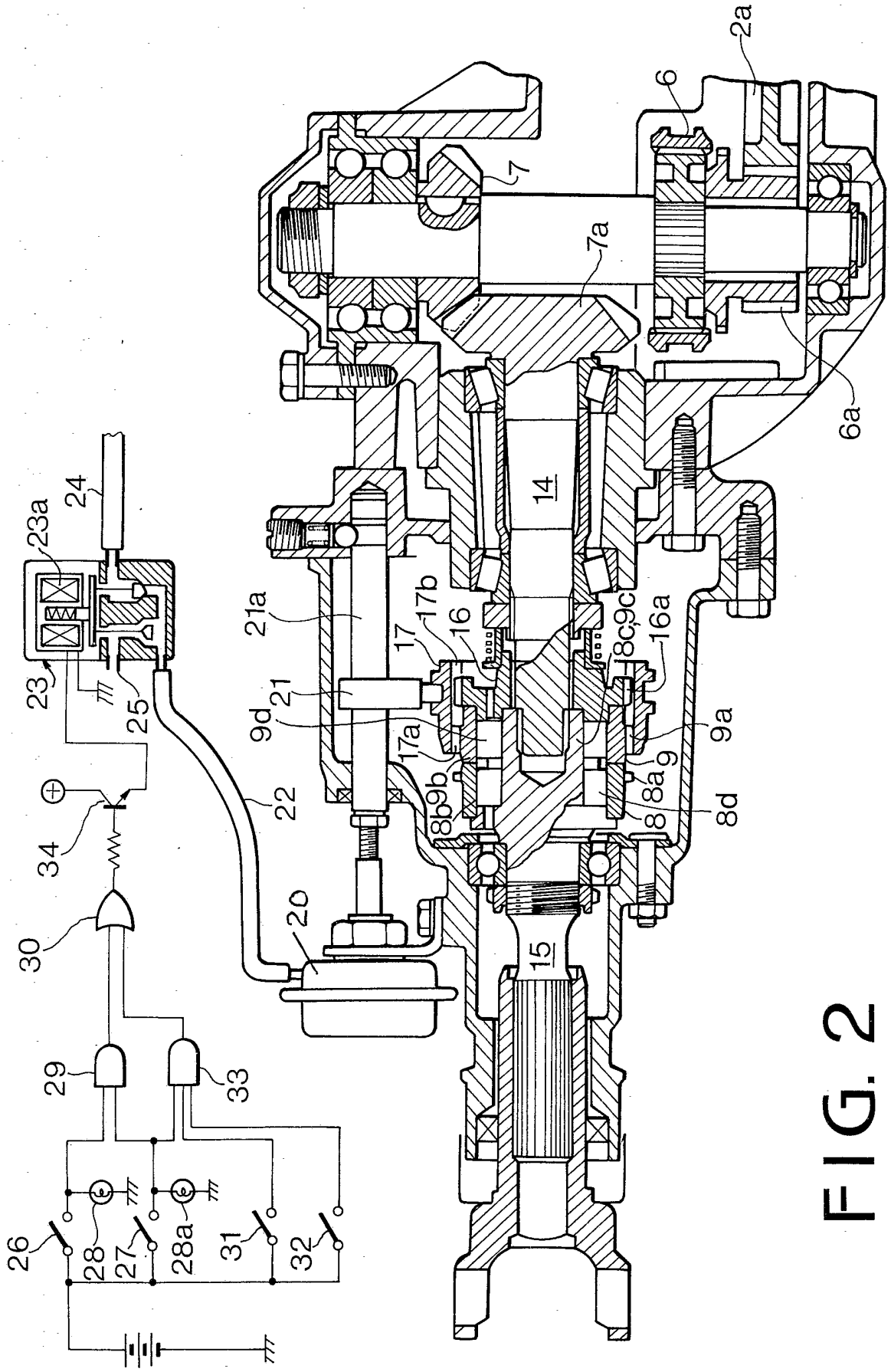


FIG. 1


2a
6
7
7a
6a
14
15
20
21a
17
17b
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16a
18c,9c
21
9d
17a
18b,9b
9a
9
8a
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8d
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23a
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26
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27
28a
31
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FIG. 2

SPECIFICATION

Power transmission system for a four-wheel drive vehicle

The present invention relates to a power transmission system for a four-wheel drive vehicle having a mechanism for absorbing the difference between the speeds of the front and rear wheels.

In a 2/4-wheel drive vehicle, the power transmission system can be selectively converted from 2-wheel drive to 4-wheel drive by engaging a clutch which is manually operated by a selector lever.

A four-wheel drive vehicle is desirably driven by the two-wheel drive on paved dry surfaces. The reason is as follows: when the vehicle negotiates corners, the front wheels run through an arc of greater radius than that of the rear wheels and therefore tend to rotate faster than the rear wheels; such a difference between speeds of front and rear wheels causes the braking of the vehicle, known as "tight corner braking". In order to prevent that braking phenomenon, a four-wheel drive vehicle a transmission system of which is automatically changed to two-wheel drive transmission system at a large steering angle is disclosed in Japanese patent laid opon 57-15019. However, such a system is complicated in construction.

An object of the present invention is to provide a power transmission system having relatively simple means for absorbing the difference between the speeds of the front and rear wheels.

A power transmission system for a four-wheel drive vehicle having a change-speed gear box which include provision for reverse speed comprises first and second power transmissions for transmitting the output of the change-speed gear box to the front wheels and the rear wheels respectively; a forward one-way clutch and a reverse one-way clutch in one of the power transmissions and effective for forward drive and reverse drive respectively; and means for selectively transmitting the output of the change-speed gear box to one or other of the one-way clutches, in order to effect forward or reverse four-wheel drive through the appropriate one-way clutch.

The invention will be more readily understood by way of example from the following description of a 2/4 drive vehicle, reference being made to the accompanying drawings, in which

Figure 1 is a schematic illustration showing the power transmission system of the vehicle; and

Figure 2 is a sectional view of a main portion of the system.

Referring to Figure 1, an engine unit 1 is mounted on a rear portion of a vehicle. The engine unit has a change-speed transmission or gearbox 1a. The output of the transmission is transmitted to rear wheels 4 through a rear wheels driving power transmission system comprising a differential 2 and axles 3. The output of the change-speed transmission 1a is also transmitted to front wheels 13 through a front wheels driving power transmission system comprising a transfer device 5, propeller shaft 10, differential 11, and axles 12. The transfer device 5 comprises a gear 6a engaged with a ring gear 2a of the differential 2, a clutch 6 for four-wheel drive, bevel gears 7 and 7a, forward one-way clutch 8, and reverse one-way clutch 9.

Referring to Figure 2, a transfer drive shaft 14 of the bevel gear 7a and a driven shaft 15 connected to the propeller shaft 10 are co-axially disposed, and both shafts 14 and 15 are coupled through a one-way clutch assembly which includes one-way clutches 8 and 9. The one-way clutch assembly comprises an interconnecting annular member 16 secured to the shaft 14 and a slidable sleeve 17. One-way clutches 8 and 9 comprise outer races 8b and 9b and rollers 8d and 9d disposed between races and shaft 15, respectively. The sleeve 17 has two internal sets of teeth 17a and 17b. The set of teeth 17b is permanently engaged with a set of teeth 16a of the interconnecting annular member 16. The set of teeth 17a is selectively engaged with a set of teeth 8a of the one-way clutch 8 or with a set of teeth 9a of the one-way clutch 9 by axially shifting the sleeve 17. The forward one-way clutch 8 is so arranged as to transmit the rotation of the outer race 8b in the forward driving direction to the shaft 15 and as to allow the rotation of the shaft 15 in the direction at higher speed than the outer race in advance of the race. The reverse one-way clutch 9 is arranged oppositely.

The sleeve 17 has an annular groove on the periphery thereof, in which a shifter arm 21 is slidably engaged. The shifter arm 21 is operatively connected to a diaphragm (not shown) in a vacuum operated actuator 20 through a rod 21a. A vacuum chamber in the acuator 20 is selectively communicated with an intake manifold (not shown) of the engine through a passage 22, solenoid operated valve 23 and passage 24, or with the atmosphere through passage 22, valve 23 and port 25.

In order to detect driving conditions of the vehicle, there is provided a reverse switch 26 which is turned ON when reverse is engaged in gearbox 1a, a four-wheel drive (4WD) switch 26 which is ON when clutch 6 is engaged to gear 6a for four-wheel drive, an accelerator pedal switch 31 which is ON when the accelerator pedal of the vehicle is released, and a vehicle speed switch 32 which is ON when vehicle speed exceeds a predetermined value. Lamps 28 and 28a are connected to switches 26 and 27 so as to indicate closing of switches, respectively.

Switches 26 and 27 are connected to inputs of an AND gate 29, and switches 27, 31, 32 are connected to inputs of an AND gate 33. The outputs of AND gates 29 and 33 are connected to inputs of an OR gate 30, the output of which is applied to the base of a transistor 34. Transistor 34 is connected in the circuit of a solenoid 23a of the valve 23.

In operation, during forward drive, reverse switch 26 and accelerator pedal switch 31 are OFF, so that the outputs of AND gates 29 and 33 are at low levels. Accordingly, the output of OR gate 30 is at low level causing the transitor 34 to turn off. Thus the solenoid 23a is in de-energized state and connects actuator 20 to atmosphere through port

25. The diaphragm in the actuator 20 is deflected by a spring to draw the rod 21a to the left (in Figure 2). Thus, the sleeve 17 is shifted to the left, so that the set of teeth 17a engages with teeth 8a of the forward one-way clutch 8. Accordingly, when the clutch 6 is engaged, the output of the change-speed transmission 1a is transmitted to the front wheels through shaft 14, one-way clutch 8, shaft 15 and propeller shaft 10 to give four-wheel drive. When the vehicle turns a corner, the front wheels rotate faster than the rear wheels, i.e. shaft 15 rotates faster than the outer race 8b in advance of it. However, the one-way clutch 8 permits such a faster rotation of the shaft 15. Thus, the difference between speeds of front and rear wheels is absorbed in the one-way clutch, and the vehicle turns the corner smoothly without braking.

When the accelerator pedal is released for deceleration of the vehicle at a speed higher than the predetermined speed, switches 31 and 32 are turned ON. Since switch 27 is ON, the output of AND gate 33 goes to a high level, causing the transistor to turn on. Accordingly, the solenoid 23a is energized to connect the vacuum chamber of actuator 20 with the intake manifold through passage 22, valve 23 and passage 24. The intake manifold vacuum is applied to the vacuum chamber to deflect the diaphragm against the spring to shift the rod 21a to the right. Thus, the teeth 17a engages with teeth 9a of the reverse one-way clutch 9. The engagement of sets of teeth 17a and 9a causes the clutch 9 to prevent faster rotation of the front wheels. That is, front wheels are braked by the engine through the engagement of the reverse one-way clutch 9. Thus, engine-braking operates on both the front and the rear wheels.

When the change-speed transmission 1a is changed to reverse driving state, the reverse switch 26 is closed. Accordingly, when the four-wheel drive switch 27 is closed, the output of AND gate 29 goes to high level. The reverse one-way clutch 9 is then selected in the same manner as described above but for the reverse driving. In reverse driving, the same operation as the forward driving is performed.

Although the above described vehicle has a clutch enabling 2 or 4 wheel drive to be selected, the present invention can be applied to a four-wheel drive vehicle which has no such selecting clutch (known as a full-time four-wheel drive vehicle).

While the presently preferred embodiment of the present invention has been shown and described, it is to be understood that this disclosure is for the purpose of illustration and that various changes and modifications may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

CLAIMS

1. A power transmission system for a four-wheel drive vehicle having a change-speed gearbox which include provision for reverse speed, the system comprising: first and second power transmissions for transmitting the output of the change-speed gear box to the front wheels and the rear wheels respectively; a forward one-way clutch and a reverse one-way clutch in one of the power transmissions and effective for forward drive and reverse drive respectively; and means for selectively transmitting the output of the change-speed gear box to one or other of the one-way clutches, in order to effect forward or reverse four-wheel drive through the appropriate one-way clutch.

2. A power transmission system according to claim 1, wherein each of the forward and reverse one-way clutches comprises an outer race operatively connected to a drive shaft and rollers disposed between the outer race and a driven shaft.

3. A power transmission system according to claim 2, wherein the first means comprises a first set of teeth provided on the drive shaft, a sleeve having an internal second and third sets of teeth, of which the second set is axially slidably engaged with the first set of teeth, fourth and fifth sets of teeth provided on peripheries of the forward and reverse one-way clutches, the third set of teeth being so arranged as to be selectively engageable with one of the fourth and fifth sets of teeth, and means for shifting the sleeve in dependence on the selection of forward drive or reverse drive.

4. A power transmission system according to claim 3, wherein the sleeve shifting means comprise a vacuum operated actuator, a solenoid operated valve for selectively supplying engine intake manifold vacuum to the actuator, and an electric circuit for operating the solenoid operated valve in dependence on driving conditions of the vehicle.

5. A power transmission system for a four-wheel drive vehicle, substantially as herein described with reference to the accompanying drawings.

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