COMMONWEALTH OF AUSTRALIA

THE PATENTS ACT 1952-1969

CONVENTION APPLICATION FOR A PATENT

We, FUJI JUKOGYO KABUSHIKI KAISHA

of 7-2 Nishishinjuku 1-chome,
Shinjuku-ku, Tokyo,
JAPAN.

hereby apply for the grant of a Patent for an invention
entitled: "AUTOMATIC TRANSMISSION FOR FOUR WHEEL DRIVE
AUTOMOTIVE VEHICLES"

which is described in the accompanying complete specification.

This application is a Convention application and is based on the
application(s) numbered: 54-117725; 54-117726 and 54-117727

for a patent or similar protection made in JAPAN in each case

on 13th September, 1979;
13th September, 1979 and
13th September, 1979

Our address for service is care of GRIFFITH, HASSEL & FRAZER,
Patent Attorneys, of 323 Castlereagh Street, Sydney 2000, in the
State of New South Wales, Commonwealth of Australia.

DATED this 14th day of August, 1980

FUJI JUKOGYO KABUSHIKI KAISHA

By their Patent Attorneys:

of GRIFFITH, HASSEL & FRAZER
Fellows, Institute of Patent
Attorneys of Australia

TO:

THE COMMISSIONER OF PATENTS

COMMONWEALTH OF AUSTRALIA:

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DECLARATION FORM FOR COMPANY APPLICATIONS, AUSTRALIA

Form 7, 8.
Regulations 12(1) and 12(2)
COMMONWEALTH OF AUSTRALIA
PATENTS ACT 1952-69

DECLARATION IN SUPPORT OF AN APPLICATION FOR A PATENT

61474/80

In support of the Application made by FUJI JUKOGYO KABUSHIKI KAISHA

for a patent for an invention entitled: "AUTOMATIC TRANSMISSION FOR FOUR WHEEL DRIVE AUTOMOTIVE VEHICLES"

1. Sadamichi Sasaki of the Applicant's address, do solemnly and sincerely declare as follows:

1. I am authorized by the applicant for the patent to make this Declaration on its behalf.

2. Toshio Takano and Toshio Kobayashi

1-3-2 Sakaecho, Hamuramachi, Nishitama-gun, Tokyo, JAPAN and Midori-so, 2-8-17 Midoricho, Koganei-shi, Tokyo, JAPAN respectively.

We are the actual inventor(s) of the invention and the facts upon which the applicant is entitled to make the application are as follows:

The applicant is the assignee of the said invention from the said inventors.

3. The basic application(s) as defined by Section 141 of the Act were made in JAPAN on the 13th day of September, 1979 by FUJI JUKOGYO KABUSHIKI KAISHA in each case.

4. The basic application(s) referred to in paragraph 3 of this Declaration were first application(s) made in a Convention country in respect of the invention, the subject of the application.

Declared at Tokyo, JAPAN this 14th day of July, 1980

(Signature)

To:
The Commissioner of Patents,
CANBERRA.

NOTE: Initial all Deletions and Alterations.
No-witnessing or legalisation required.
For a Non-Convention application delete paragraphs 3 and 4 and initial the deletion.
For Multiple Priorities incorporate details of all basic applications in paragraph 3.
For application for a Patent of Addition add "of Addition" after the word "patent" wherever the word occurs, and initial each such insertion.
1. An automatic transmission for a four wheel drive automotive vehicle comprising a torque converter connected to a crank shaft of an engine of said automotive vehicle, an automatic transmission of the trans-axle type connected to a turbine shaft of said torque converter, a final reduction gear located between said torque converter and said automatic transmission for transmitting the output of said automatic transmission to the front-wheel, a transfer gear provided in a rear portion of said automatic transmission for changing the rotating direction of the output shaft of the transmission and for establishing a final reduction ratio for the rear-wheel a clutch means for transmitting the output of said transfer gear to the rear-wheel, said clutch means comprising a fluid operated multiple-disk clutch.

2. An automatic transmission for an automotive vehicle comprising a torque converter connected to a crank shaft of an engine of said automotive vehicle, an automatic transmission...
means connected to a turbine shaft of said torque converter, said automatic transmission having a planetary gear and a plurality of fluid operated means for producing various operational ranges, a final reduction gear for transmitting the output of said automatic transmission to the front-wheel, a clutch means to transmit the output of said automatic transmission to the rear-wheel, said clutch means comprising a fluid operated multiple-disk clutch, and a pressure oil control means for operating said fluid operated means in said automatic transmission, said pressure oil control means including a pressure regulator valve to produce a line pressure according to the operational condition of the engine, said pressure oil control means being so arranged that said line pressure is raised with increase of load of the engine and said fluid operated multiple-disk clutch is actuated by said raised line pressure.

3. An automatic transmission for an automotive vehicle comprising a torque converter connected to a crank shaft of an engine of said automobile vehicle, an automatic transmission means connected to a turbine shaft of said torque converter, said automatic transmission having a planetary gear and a plurality of fluid operated means for producing various operational ranges, a final reduction gear for transmitting the output of said automatic transmission to the front-wheel, a clutch means for transmitting the output of said automatic transmission to the rear-wheel said clutch means comprising a fluid operated multiple-disk clutch, and a pressure oil control means for operating said fluid operated means in said automatic transmission, said pressure oil control means including a pressure regulator valve to produce a line pressure according to the operational
condition of the engine and a changeover valve to connect a conduit for the line pressure to said fluid operated multiple-disk, said pressure oil control means being so arranged that said line pressure is raised with increase of load of the engine and when said line pressure is raised, said changeover valve is actuated to apply the raised line pressure to said fluid operated multiple-disk clutch.
The following statement is a full description of this invention, with the best method of performing it known to me/us:-
TITLE OF THE INVENTION

Automatic Transmission for Four Wheel Drive Automotive Vehicles

BACKGROUND OF THE INVENTION

The present invention relates to an automatic transmission for an automotive vehicle for driving front and rear wheels, and more particularly to an automatic transmission of the trans-axle type which is adapted to drive either two-wheel or four-wheel.

In recent years, the front wheel drive automobile in which the engine is mounted in a front position of the vehicle is widely used, because of light weight and safe steering operation. Further, there has been provided a front wheel drive automobile with an automatic transmission, in which the automatic transmission is integrally assembled with the final reduction gear for the front wheel drive.

By the way, it occasionally occurs that it is difficult to drive the two-wheel drive vehicle at a low speed under a heavy load in such a driving condition as a rapid starting, rough road driving or steep slope climbing. To eliminate such a defect, there has been provided an automobile having a transmission adapted to drive either the front two-wheel or both of the front and rear four-wheel, in which the rear wheels are driven through a clutch means. Since the clutch means is a dog clutch operation for coupling the clutch must be performed in a stopped state of the vehicle or in a straight-forward driving state where no rotational difference between the front and rear wheel exists. In the automatic transmission for the rear-wheel drive, the lever for the clutch means must be operated, after the select lever of the transmission has been
shifted to the neutral position (N) or the parking position (P) for cutting off the power. Accordingly, manipulation of the levers and automobile is complicated, which means decrease the utility of the automatic transmission. Therefore, it is desirable that the front wheel drive is automatically changed to the four-wheel drive in accordance with the driving condition. Further, the four-wheel drive is desirable in the rearward driving in a slope and rough road.

SUMMARY OF THE INVENTION

The present invention seeks to provide an automatic transmission having a pressure-oil operated multiple-disk clutch for the rear-wheel drive, whereby the change between the front-wheel drive and the four-wheel drive can be performed according to various driving conditions of the automotive vehicle and further the multiple-disk clutch may be automatically operated by the pressure oil used in the automatic transmission in accordance with the driving condition of the vehicle.

In accordance with the present invention, there is provided an automatic transmission for an automotive vehicle comprising a torque converter connected to a crank shaft of an engine of said automotive vehicle, an automatic transmission means connected to a turbine shaft of said torque converter, said automatic transmission having a planetary gear and a plurality of fluid operated means for producing various operational ranges, a final reduction gear for transmitting the output of said automatic transmission to the front-wheel, a clutch means for transmitting the output of said automatic transmission to the rear-wheel, said clutch means comprising a fluid operated multiple-disk clutch, and a pressure oil control means including a pressure regulator valve to produce a line pressure according to the
operational condition of the engine, said pressure oil control means being so arranged that said line pressure is raised with increase of load of the engine and said fluid operated multiple-disk clutch is actuated by said raised line pressure.

DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view of a four-wheel driving automatic transmission according to the present invention,

Fig. 2 is a schematic illustration of the transmission of Fig. 1,

Fig. 3 is a circuit of pressure oil control means, and

Fig. 4 is a graph showing a relation between speed of a vehicle and line pressure in the circuit of Fig. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figs. 1 and 2, numeral 1 generally designates an automatic transmission which comprises a torque converter 2, an automatic transmission means 3, a final reduction gear 4 and a pressure oil control means 5 for pressure oil. In accordance with the present invention, a multiple-disk clutch means 6 is attached to the rear portion of the automatic transmission means 3.

The torque converter 2 comprises an impeller 2a, a turbine 2b and a stator 2c. The impeller 2a is connected to a crank shaft 8 of an engine through a drive plate 9 and a turbine shaft 10 of the turbine 2b is extended to the automatic transmission means 3. As well known, power of the engine is transferred to the turbine shaft 10 according to the load. A cover 11 secured to the drive plate 9 is connected to an oil pump-driving shaft 12 which passes through the turbine shaft 10 and is coupled to an oil pump 13 provided in the rear portion of the automatic transmission means 3. Thus, the oil pump 13 is driven by the
The automatic transmission means 3 comprises a planetary gear 15 and a plurality of fluid operated means for producing various operational ranges. The fluid operated means comprises a low and reverse brake 16, a forward clutch 17 and a reverse clutch 18. The turbine shaft 10 is connected to a forward sun gear 15a of the planetary gear 15 through the forward clutch 17 and is further connected to a reverse sun gear 15b through the reverse clutch 18 and connecting shell 19. By actuating the clutches 17 and 18 with pressure oil, power of the turbine shaft 10 is transmitted to the sun gear 15a or 15b. A brake band 20 is provided on a drum 18a secured to the connecting shell 19 to block the reverse sun gear 15b.

In connected with the planetary gear 15, a short pinion 15c and a long pinion 15d are supported by a carrier 15e on which the low and reverse brake 16 is provided. Between the brake 16 and a center support 21, a one-way clutch 22 is provided. The carrier 15e may be locked by operation of the brake 16 and one-way clutch 22. The ring gear 15f of the planetary gear 15 is connected to an output shaft 23 mounted on the turbine shaft 10. The planetary gear is also provided with a parking gear 24.

The output shaft 23 is rotatably supported in the case 25 between the housing 7 of the torque converter 2 and the case 14 of the automatic transmission means 3.

The final reduction gear 4 is located between the output shaft 23 in the case 25. The final reduction gear 4 for the front wheel drive comprises a drive pinion 26 and a crown gear 29 of a differential 28. The drive pinion 26 is driven by the output shaft 23 through a reduction gear 27.

The clutch means 6 comprises a rear drive shaft 31 rotatably
supported in a case 30 and a multiple-disk clutch 35 operated by pressure oil. The multiple-disk clutch 35 comprises a drum 35a secured to the rear drive shaft 31 and a hub 35b connected to a transfer gear 34. The transfer gear 34 is connected to a shaft 33 coupled to the drive pinion 26 by a joint 32. The rear drive shaft 31 is connected to a propeller shaft 37 through a universal joint 36.

The control means 5 is provided in a housing 38 secured in an oil pan 39. Referring to Fig. 3, a conduit 40' from the oil pump 13 is connected to a pressure regulator valve 41 to produce a line pressure in the pressure oil circuit. The line pressure is applied to a manual valve 42 through a conduit 40 and also applied to the torque converter 2 and to necessary lubricating portions through conduits 43. The manual valve 42 is adapted to change the operational range of the automatic transmission such as N-range (neutral), P-range (parking), R-range (reverse), D-range (driving 1, 2, 3), 1-range, 2-range. In the D-range, the line pressure is applied to a governor valve 45, a 1-2 shift valve 46 and the forward clutch 17 through conduits 44 and applied to a second lock valve 48 and a 2-3 shift valve 49 through conduits 47, and further applied to the valve 48 through a conduit 50.

In the R-range, line pressure is applied to the 1-2 shift valve 46 through a conduit 51 to inhibit the operation thereof and further applied to the low and reverse brake 18 through a conduit 52. The line pressure is also applied to the port 41a of the pressure regulator valve 41 and to the 2-3 shift valve 49 through conduits 53.

The governor valve 45 is adapted to produce a governor pressure according to the speed of the vehicle. The governor
pressure is supplied to shift valves 46 and 49, a 2-3 timing valve 55 and a pressure modifier valve 56 through conduits 54.

Further, line pressure in the conduit 40 is applied to a vacuum throttle valve 57 operated by a vacuum control diaphragm to produce a throttle pressure according to load of the engine. The throttle pressure is applied to a port 56a of the pressure modifier valve 56, the 2-3 shift valve 49, the 2-3 timing valve 55 and a port 41b of the line pressure-increasing side of the pressure regulator valve 41. Another port 56b of the pressure modifier valve 56 is connected to a port 41c of line pressure-decreasing side of the pressure regulator valve 41 by a conduit 59.

When governor pressure is low in the D-range, the pressure modifier valve 56 is not operated so that the throttle pressure acts on the port 41b only to increase the line pressure.

If the pressure modifier valve 56 is actuated by a higher governor pressure according to increase of speed of the vehicle, the ports 56a and 56b are communicated with each other so that a throttle pressure is applied to the port 41c of the valve 41 through the conduit 59. The throttle pressure acts on the plunger of the valve 41 against the throttle pressure from the port 41b, so that the line pressure by the valve 41 is decreased.

Fig. 4 shows variation of the line pressure in the system. When the throttle valve of the carburetor is fully opened, the line pressure varies as shown by line "a". The line "b" shows the line pressure in a throttle closed condition. It will be seen that the line pressure increases sharply when the speed of the vehicle lowers to a predetermined low speed. In the R-range, governor pressure is not produced from the governor 45 and hence the pressure modifier valve 56 is not operated. Therefore,
throttle pressure is applied to the port 41b of the valve 41 and line pressure in the conduit 53 is applied to the port 41a. Consequently the line pressure does not vary with the variation of vehicle speed as shown by the lines "c", "d", but pressure increases in the whole speed range.

Further, the 1-2 shift valve 46 is connected to an apply side of the servo 20' of the brake band 20 through the second lock valve 48 and conduit 60 to apply the line pressure. The 2-3 shift valve 49 is communicated to a release side of the servo 20', the 2-3 timing valve 55, and the reverse clutch 16 through conduits 61 to supply the line pressure.

In the above pressure oil circuit for the automatic transmission, a changeover valve 63 is provided to communicate conduit 40 to the clutch 35. The changeover valve 63 comprises a pluranger 63b slidably provided in a cylinder 63a and urged to the right by a spring 63d. An end port 63c opposite the spring is connected to the conduit 44 through a conduit 64 and a normally closed port 63e is connected to the conduit 40 through a conduit 65. The valve 63 further has a port 63f communicated to the clutch 35 through a conduit 66 and a drain port 63g. The spring 63d is adapted to balance with the line pressure $P_L$ in Fig. 4 higher than "d".

The system further comprises a throttle back up valve 67 for delaying the operation when shifted to the 2-range or 1-range, and a downshift valve 68 actuated by a solenoid 62.

In operation, line pressure regulated by the pressure regulator valve 41 is applied to the manual valve 42 and torque converter 2 to operate it. In a light load state in the D-range, the line pressure is low as shown in Fig. 4. Accordingly, the low line pressure is supplied to the forward clutch 17 through
the manual valve 42. Thus, output power of the turbine shaft 10 is transmitted to the forward sun gear 15a. Since the carrier 15e is locked by the one-way clutch 22, the output shaft 23 rotates in the maximum reduction ratio. The rotation of the output shaft 23 is transmitted to the differential 28 through the reduction gear 27 and to the clutch means 6 through the shaft 33 and gear 34.

Since the line pressure is low, the plunger 63b of the changeover valve 63 is in the right position so that the port 63e is closed and ports 63f and 63g are communicated with each other. Thus, the clutch 35 is in disengaged state and hence the only front-wheel is driven in the first-speed. When governor pressure increases with increase of speed of the vehicle, the 1-2 shift valve 46 operates to supply the line pressure in the conduit 44 to the servo 20' through the conduit 60 to clamp the brake 20. The reverse sun gear 15b is locked, so that the second-speed drive is established. When governor pressure further increases, the 2-3 shift valve 49 is also actuated to supply the line pressure in the conduit 47 to the release side of the servo 20' and to the reverse clutch 16 through the conduit 61. Thus, the brake 20 is released and the reverse clutch 16 is engaged, so that the automatic transmission becomes to the integrated state to couple the turbine shaft 10 with the output shaft 23. Output of the engine is directly transmitted to the output shaft as the third-speed drive. In a low speed state of the vehicle in such a condition, since governor pressure applied to the right side of the pressure modifier valve 56 is low, the plunger is in a right end position to close the port 56b. Therefore, the throttle pressure acts on the pressure regulator valve 41 through the port 41b, so that line pressure is in a high
When load of the engine increases and line pressure exceeds the line pressure $p_L$ in Fig. 4, the plunger 63b of the change-over valve 63 is moved to the left against the spring 63d to close the port 63g and to communicate ports 63e and 63f with each other. Thus, line pressure in the conduit 40 is applied to the clutch 35 to engage the drum 35a with the hub 35b, so that the rear-wheel is driven through the rear drive shaft 31 and the propeller shaft 37. Thus, the vehicle is driven by the four-wheel drive. When governor pressure increases as the speed of the vehicle increases, the plunger of the pressure modifier valve 56 is moved to the left to open the port 56b. Thus, throttle pressure is applied to the port 41b of the pressure regulator valve 41 through the conduit 59 to decrease the line pressure. As a consequence, the changeover valve 63 returns to the normal position to release the clutch, so that the system returns to the front-wheel drive.

When 1-range or 2-range is selected, line pressure is also applied to the changeover valve 63 through the line 44. Thus, four-wheel drive is automatically changed in the same manner as the previous operation.

In the R-range, line pressure in the conduit 40 is applied to the low and reverse brake 18 through the valve 42, conduit 51, 1-2 shift valve 46 and conduit 52, so that the brake is actuated. Further, the line pressure is applied to the reverse clutch 16 via the conduit 53, 2-3 shift valve 49 and conduit 61. Thus, output of the turb'ne shaft 10 is transmitted to the reverse sun gear 15b through the reverse clutch 16 and connecting shell 19. Since the carrier 15e is locked by the low and reverse brake 18, the output shaft 23 rotates reversely in a large
reduction ratio. In the R-range, line pressure in the conduit 53 is applied to the port 63c of the changeover valve 63 through the conduit 69. If the line pressure rises over the level $P_L$ according to increase of the load, the changeover valve 63 is operated to communicate the conduit 40 to the clutch 35. Thus, the vehicle is reversely driven with front and rear wheels. When the line pressure lowers with decrease of the load, the changeover valve 63 returns to the initial state to release the clutch 35 for front wheel drive.

It will be understood that line pressure other than the line pressure in conduits 44 and 53 may be employed for actuating the changeover valve 63, and further the line pressure in the conduit 40, which has no relation to the operational range of the automatic transmission, may be employed.

In accordance with the present invention, since a multiple-disk clutch operated by line pressure in the automatic transmission is provided to transmit the output of the engine of the automotive vehicle to the rear-wheels, changing operation from the front-wheel drive to the four-wheel drive may be performed in any driving condition. Further, the transmission is automatically changed to the four-wheel drive in a heavy load at a low speed of the vehicle, where the front-wheel is liable to slip. Thus, driving manipulation may be facilitated and start accelerating ability and driveability may be improved. Since the multiple-disk clutch for driving the rear-wheel is adapted to be operated by the line pressure of the automatic transmission, construction may be simplified and it is easy to convert a front-wheel drive automatic transmission into a four-wheel drive system.

Since the clutch 35 is actuated by the line pressure the capacity of the clutch varies with the variation of the engine
load. Accordingly, the clutch acts also as a torque limitter.

Thus, the torsional wind-up phenomenon in the power transmitting portion, which is caused by the difference between speeds of the front and rear wheel in four-wheel driving, may be relieved to protect the driving system. This further contributes to the improvement of the drivability.
WHAT IS CLAIMED IS: The claims defining the invention are as follows:

1. An automatic transmission for a four wheel drive automotive vehicle comprising a torque converter connected to a crank shaft of an engine of said automotive vehicle, an automatic transmission of the trans-axle type connected to a turbine shaft of said torque converter, a final reduction gear located between said torque converter and said automatic transmission for transmitting the output of said automatic transmission to the front-wheel, a transfer gear provided in a rear portion of said automatic transmission for changing the rotating direction of the output shaft of the transmission and for establishing a final reduction ratio for the rear-wheel a clutch means for transmitting the output of said transfer gear to the rear-wheel, said clutch means comprising a fluid operated multiple-disk clutch.

2. An automatic transmission for an automotive vehicle comprising a torque converter connected to a crank shaft of an engine of said automotive vehicle, an automatic transmission means connected to a turbine shaft of said torque converter, said automatic transmission having a planetary gear and a plurality of fluid operated means for producing various operational ranges, a final reduction gear for transmitting the output of said automatic transmission to the front-wheel, a clutch means to transmit the output of said automatic transmission to the rear-wheel, said clutch means comprising a fluid operated multiple-disk clutch, and a pressure oil control means for operating said fluid operated means in said automatic transmission, said pressure oil control means including a pressure regulator valve to produce a line pressure according to the operational condition of the engine, said pressure oil control means being so arranged that said line pressure is raised with
increase of load of the engine and said fluid operated multiple-disk clutch is actuated by said raised line pressure.

3. An automatic transmission for an automotive vehicle comprising a torque converter connected to a crank shaft of an engine of said automotive vehicle, an automatic transmission means connected to a turbine shaft of said torque converter, said automatic transmission having a planetary gear and a plurality of fluid operated means for producing various operational ranges, a final reduction gear for transmitting the output of said automatic transmission to the front-wheel, a clutch means for transmitting the output of said automatic transmission to the rear-wheel said clutch means comprising a fluid operated multiple-disk clutch, and a pressure oil control means for operating said fluid operated means in said automatic transmission, said pressure oil control means including a pressure regulator valve to produce a line pressure according to the operational condition of the engine and a changeover valve to connect a conduit for the line pressure to said fluid operated multiple-disk, said pressure oil control means being so arranged that said line pressure is raised with increase of load of the engine and when said line pressure is raised, said changeover valve is actuated to apply the raised line pressure to said fluid operated multiple-disk clutch.

4. An automatic transmission for an automotive vehicle according to claim 2 in which said pressure oil control means is so arranged that said changeover valve is actuated when said line pressure is raised in the forward driving state.

5. An automatic transmission for an automotive vehicle according to claim 2 in which said pressure oil control means is so arranged that said changeover valve is actuated when said line pressure is raised in the forward and rearward driving states.
6. An automatic transmission for an automotive vehicle substantially as depicted in Figures 1 to 4 of the accompanying drawings and substantially as hereinbefore described with reference thereto.

Dated this 14th day of August, 1980.

FUJI JUKOGYO KABUSHIKI KAISHA
By their Patent Attorneys
GRiffith, Hassel & FraZer.