

According to this invention, there is provided an automotive vehicle comprising a driving engine,

an engine output shaft,
5 a multi-speed power transmission including an input shaft,

hydraulic coupling means for transmitting torque from the engine output shaft to the transmission input shaft,

10 set of frictional engaging elements for providing a plurality of forward speeds in an automatic drive range and including a member providing the highest forward speed,

15 hydraulic circuit means for delivering a controlled fluid pressure to said frictional engaging elements for selective engagement and disengagement thereof, said circuit means including two conduits which are under fluid pressure when the highest speed is selected,

hydraulically operated frictional engaging means for providing a direct connection between the engine output and transmission input shafts exclusive of said hydraulic coupling means, said frictional engaging means having a fluid pressure chamber and being engaged when a high fluid pressure is established in said chamber, while being disengaged when the fluid pressure in said chamber drops below a predetermined value,

25 a hydraulically operated valve assembly located in said hydraulic circuit means, said valve assembly having a spool movable for providing fluid communication between one of said two conduits and the fluid pressure chamber of said frictional engaging means simultaneously when the fluid pressure is established in both said conduits, while blocking said fluid communication to discharge the fluid pressure from said fluid chamber of the friction engaging means when the fluid pressure in one of said two conduits is discharged.

In the accompanying drawings:-

Fig. 1 is a view in section of part of the power transmission with a direct drive clutch according to this invention;

50 Fig. 2 is a general diagrammatic view showing a hydraulic control circuit used with the power transmission of Fig. 1;

Fig. 3 is a schematic view of a direct drive clutch control valve in accordance with this invention and incorporated in the hydraulic circuit shown in Fig. 2;

Fig. 4(a) is a graphical representation of the shift operation characteristics obtained by the automotive power transmission according to a prior art, while Fig. 4(b) is that obtained by the transmission according to this invention.

Referring now to Fig. 1, the illustrated transmission comprises a drive shaft 1 directly driven by the engine (not shown), a

flywheel 2 fixed to the shaft 1, a transmission input shaft 9, a hydraulic torque converter T and a direct drive friction clutch A. The transmission further comprises a planetary gear set and several frictionally engaging elements for selective engagement of the respective gears, though not shown in Fig. 1.

The hydraulic torque converter T is of the ordinary three element type and comprises an impeller 4, a turbine runner 5 and a reactor 6. The impeller 4 is connected to and driven by the shaft 1, while the turbine runner 5 is fixed to a hub 10 which is splined to the shaft 9. The reactor 6 is fixed to a short sleeve shaft (no numeral) integral with an oil pump 8 via a one-way clutch 7.

The direct drive clutch A is located within the torque converter casing and is of a usual frictional multi-disk type essentially comprising an axially movable piston 11 and a clutch disk assembly (no numeral). The assembly comprises clutch drive plates 12 and a retaining plate 14 rotating with the torque converter casing 3, clutch driven plates 13 each disposed between the corresponding drive plates 12 or between the drive plate and the retaining plate. Each of the clutch driven plates has known clutch facings provided on its both sides. The clutch driven plates are coupled to a clutch disk 18 which in turn is connected by means of a torsion spring 17 with a clutch hub 19 which is splined to the shaft 9.

The outer surface of the piston 11 defines with the inner surface of the torque converter casing a fluid chamber 23 which communicates through a passageway consisting of a restrictor 24 formed in the torque converter casing, an axial elongate bore 25 in the shaft 9 and a passage 26 leading to the pump 8, with a housing of the direct drive clutch control valve 80 which will be later described in detail.

To engage the direct drive clutch A, a pressurized fluid is delivered through the valve 80 into the chamber 23 through the aforementioned passageway. When thus the pressure established in the chamber 23 exceeds the pressure in the torque converter casing, the piston 11 is axially moved rightwardly in the drawing, whereupon the drive plates 12 are tightly engaged with the driven plates 13 for rotation together. The torque transmitted to the driven plates 13 is then transferred to the shaft 9 through the clutch disc 16 and spring 17, thus completing a direct drive between the engine output shaft and the transmission input shaft.

As the pressure in the chamber 23 drops below the torque converter pressure by discharging all or some of the fluid in this chamber, the piston 11 is then leftwardly moved to disconnect the drive plates 12 from the driven plates 13. Thus, the torque is transmitted through the usual path including

the torque converter.

In Fig. 2 shown is a typical arrangement of known hydraulic control circuits used in automatic transmissions providing three forward drives and one reverse drive.

As is conventional, the circuit basically comprises a pressure regulator valve 60, a manual selector valve 61, first and second governor valves 62, 63, an intake vacuum responsive throttle valve 67 and automatic shift valves 64 and 65. The fluid from the pump 8 is controlled by the regulator valve 60 to a suitable line pressure and distributed through the manual selector valve 61 to the corresponding conduits in accordance with the manually selected gearshift positions. The automatic shift valves are operated in relation with the governor pressure produced by the governor valves in response to the vehicle speed and the throttle pressure produced by the valve 67 in response to the engine manifold vacuum. The valve 64 serves for shifting between the first and second drives, while the valve 65 for shifting between the second and the third drives. The illustrated hydraulic circuit further includes several hydraulic elements such as pressure modifier valve 67, a throttle backup valve 68, a solenoid downshift valve 69, a second lock valve 70, a timing valve 71, which are all known in the art and hence further detailed explanation is not believed necessary.

The illustrated transmission also comprises as frictional engaging elements, a front clutch 75, rear clutch 76, drum brake 73 and low and reverse brake 74. The front clutch 75 is engaged by applying a fluid pressure through a conduit 30, while the rear clutch 76 is engaged by pressurizing a conduit 31. The servo unit 72 of the drum brake 73 has an apply side and a release side which are respectively connected with a conduit 40 and the aforesaid conduit 30. When the apply side is pressurized through the conduit 40, a brake band is tightened on a drum surface (no numeral) to apply the brake, while the brake is disengaged when the conduit 30 leading to the release side is pressurized. The low and reverse brake 74 is likewise engaged and disengaged by the fluid pressure delivered through a conduit 41.

In actual operation of the hydraulic circuit, the low or first forward drive is completed by applying the rear clutch 76 by pressurizing the conduit 31. The conduits 30 and 40 are both under no fluid pressure. To provide the intermediate or second forward drive, the pressure builds up in the conduits 31 and 40 and hence the rear clutch 76 and the drum brake 73 are both engaged. The high or third forward drive is completed only when both the front clutch 75 and the rear clutch 76 are engaged. Since the conduit 30 is under pressure, the drum brake 73 is then disengaged. For the reverse drive, the front clutch 75 and

the low and reverse brake 74 are engaged, while the rear clutch 76 and the drum brake 73 are disengaged. It should be noted from the foregoing that it is only at the third or top speed drive that the conduits 30 and 31 are both under pressure and clutches 75, 76 engaged.

Reference is now made to Fig. 3, which illustrates the direct drive clutch control valve 80 according to this invention, which is located in the hydraulic circuit shown in Fig. 2. The valve essentially consists of a valve spool 81 with two lands 81a and 81b slidably received in an elongate, substantially uniform diameter bore 89. The bore 89 has one axial end closed and the other axial end communicating with the conduit 30 in Fig. 2 through a port inlet 86. The bore further has a port 88 communicating with the aforementioned passage 26 and a port 84 communicating with the conduit 31 in Fig. 2, the two ports being communicable with each other by selected axial movement of the spool 81. The spool 81 is loaded by a spring 82 toward the port inlet 86 in communication with the conduit 30. A drain port 90 is provided to discharge the fluid in the bore 89.

The direct drive clutch control valve as mentioned above operates in the following manner. During shifting from the second to third drive, the fluid pressure builds up in the conduit 31 and therefore in the bore 89 through the port 84. As soon as shift to the third drive is completed, the fluid pressure is delivered also to the conduit 30 through the shift valve 65, the port inlet 86 is also under fluid pressure which acts on the pressure acting areas of the land 81b. The spool 81 is then moved rightwardly in the drawing against the spring 82 until communication is established between the ports 84 and 88. The fluid is thus admitted through the port 88 into the passage 26 and therefore into the fluid chamber 23 in Fig. 1. The direct drive clutch is then engaged in the manner previously described.

As soon as downshift from the third to second drives occurs, the fluid in the port inlet 86 is discharged and therefore the spool 81 is urged leftwardly in the drawing by the action of the spring 82. Consequently, the port 88 is brought into communication with the drain port 90 to discharge the fluid from the chamber 23 through the passage 26.

As has been already mentioned, the conduits 30 and 31 in Fig. 2 are constantly pressurized as long as the top or third forward drive is maintained. Accordingly, the fluid connection of the direct drive clutch control valve in Fig. 2 may be so arranged that the port inlet 86 is connected with the conduit 31 and the port 84 with the conduit 30.

Fig. 5(a) and 5(b) graphically illustrate the characteristic operational curves respectively of the prior art transmission with a direct drive clutch and that according to this

invention for comparison with each other. As is clearly seen in the graphs, shift operation practically occurs three times in the prior art, between the first and second drives, between the second and third drives, and between the third and direct drives. On the other hand, the shift operation occurs only twice in this invention as shown in Fig. 4(b) since the shift between the second and third drives is accomplished substantially simultaneously with the shift between the second and direct drives. Several advantages resulting from this fact are already specified in the foregoing description and are therefore not repeated here.

WHAT WE CLAIM IS:-

1. An automotive vehicle comprising
 - a driving engine
 - an engine output shaft,
 - a multi-speed power transmission including an input shaft,
 - hydraulic coupling means for transmitting torque from the engine output shaft to the transmission input shaft,
 - a set of frictional engaging elements for providing a plurality of forward speeds in an automatic drive range and including a member providing the highest forward speed,
 - hydraulic circuit means for delivering a controlled fluid pressure to said frictional engaging elements for selective engagement and disengagement thereof, said circuit means including two conduits which are under fluid pressure when the highest speed is selected,
 - hydraulically operated frictional engaging means for providing a direct connection between the engine output and transmission input shafts exclusive of said hydraulic coupling means, said frictional engaging means having a fluid pressure chamber and being engaged when a high fluid pressure is established in said chamber, while being disengaged when the fluid pressure in said chamber drops below a predetermined value,
 - a hydraulically operated valve assembly located in said hydraulic circuit means, said valve assembly having a spool movable for providing fluid communication between one of said two conduits and the fluid pressure chamber of said frictional engaging means simultaneously when the fluid pressure is established in both said conduits, while blocking said fluid communication to discharge the fluid pressure from said fluid chamber of the friction engaging means when the fluid pressure in one of said two conduits is discharged.
2. An automotive vehicle, as defined in claim 1, in which said hydraulic coupling means includes a hydraulic torque converter.
3. An automotive vehicle as defined in claim 2, in which said hydraulically operated

frictional engaging means includes a multiple disc type friction clutch housed in a torque converter casing and having a piston axially movable by the differential fluid pressure acting on the opposite sides thereof.

4. An automotive vehicle substantially as described with reference to Figs. 1 to 3 of the accompanying drawings.

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Fig. 1

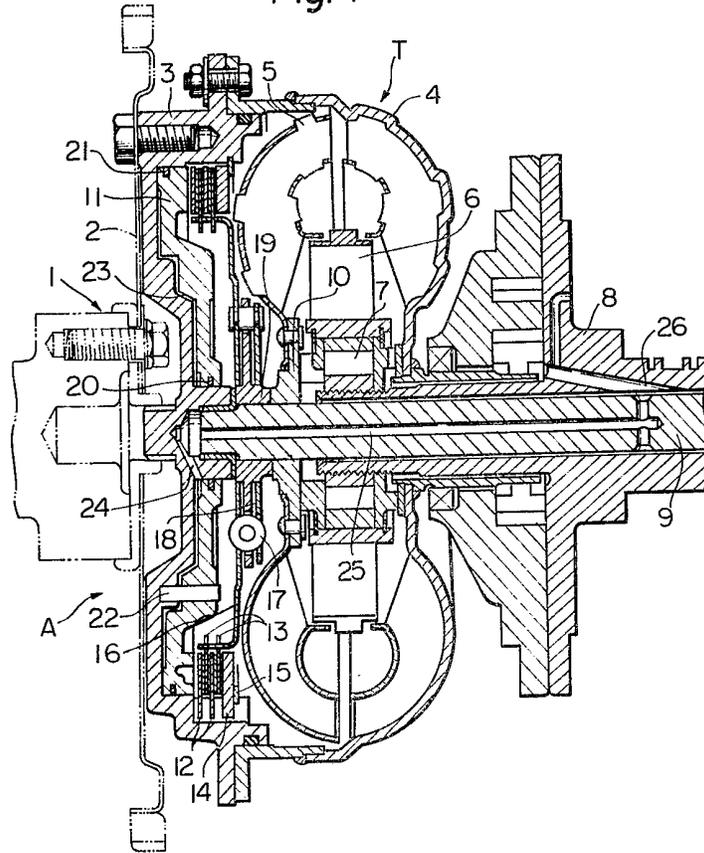


Fig. 2

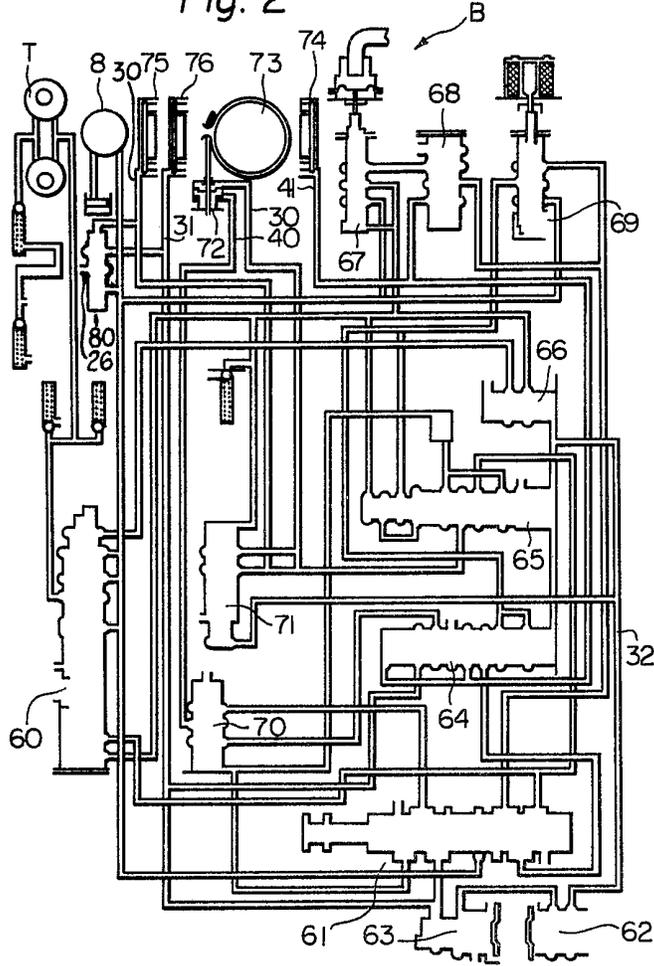


Fig. 3

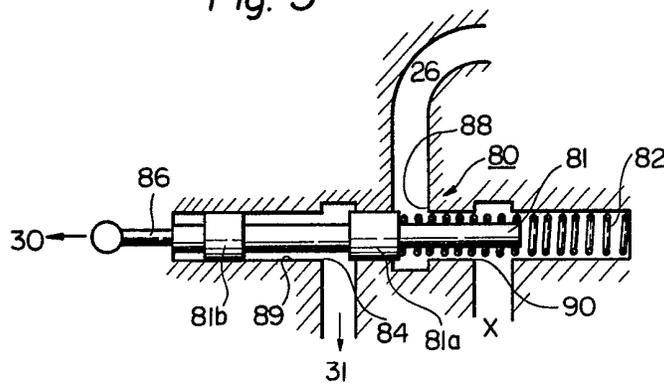


Fig. 4 (a)

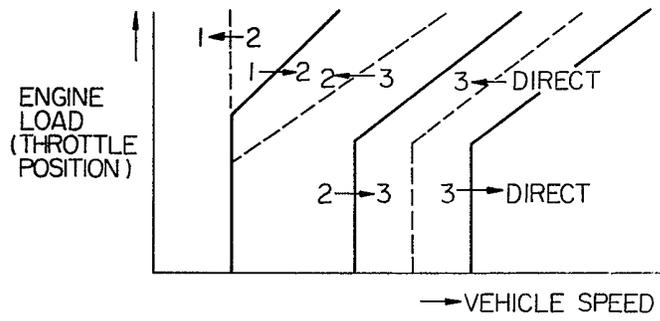


Fig. 4 (b)

