Dual Range Hydramatic - Power Flow

by Larry Gorden, February 29, 2012. Updated March 4, 2012.

This article is the result of misconceptions regarding how the dual range Hydramatic operates in third and fourth gears. I and others have claimed that the transmission is mechanically driven in third and fourth gears -- and power does not flow through the fluid coupling making the transmission very efficient in those gears. That is not correct! Power does flow through the fluid coupling in third and fourth gears. I will attempt to explain and set the record straight.

1. References

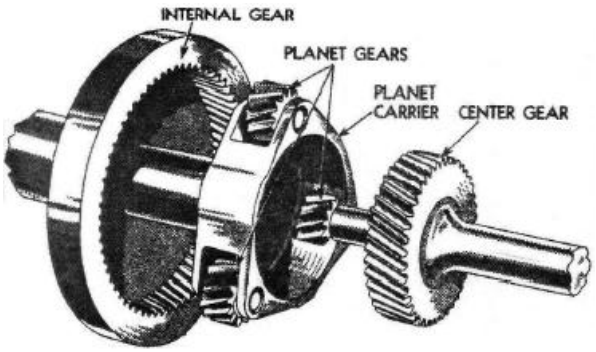
1. Pontiac Shop Manual dual range Hydramatic Principles of Operation. Pontiac 1956 Hydramatic Shop Manual description of planetary gearsets and flow of power through the dual range transmission. Understand those few pages; however, the description leaves out critical details which will be explained.
2. Pontiac Master Parts Catalog planetary gearsets illustration. Shows all parts of the planetary gearsets.
3. Wikipedia Article on Hydramatics. A description of Hydramatic transmissions history and design. The "Design" description in that article appears to be a description of the dual range Hydramatic but not a description of later Hydramatics. I believe the article makes erroneous statements about power transfer between the mechanically driven and fluid coupling driven components in third/fourth gears – more on that below. Otherwise it is a good article.
4. Article on Planetary Gearsets. See this link if you don't fully understand operation of planetary gearsets in Reference 1.

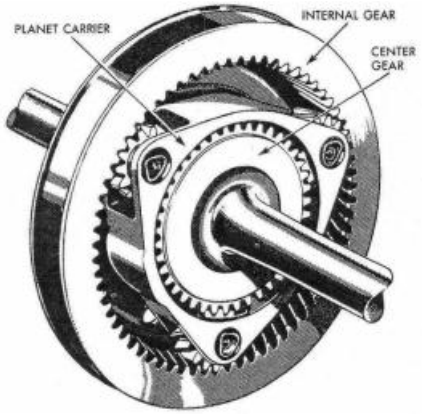
2. Terminology

You will need a good understanding of planetary gearsets to follow this article. The Pontiac Hydramatic Shop Manual description of a planetary gearset (Reference 1) is good but uses different terminology than is common which made it a little difficult for me to follow. Reference 1 calls a *planetary gearset* a "*Planetary Gear Train*". Following are Pontiac vs. Common terminology of the three major components in a planetary gearset.

Pontiac Terminology	*Common Terminology*
Internal Gear	Ring Gear
Center Gear	Sun Gear
Planet Gears & Planet Carrier	Planetary Gears & Planet Carrier

I will use the Pontiac terminology since I'll be referencing the Pontiac Hydramatic Shop Manual.



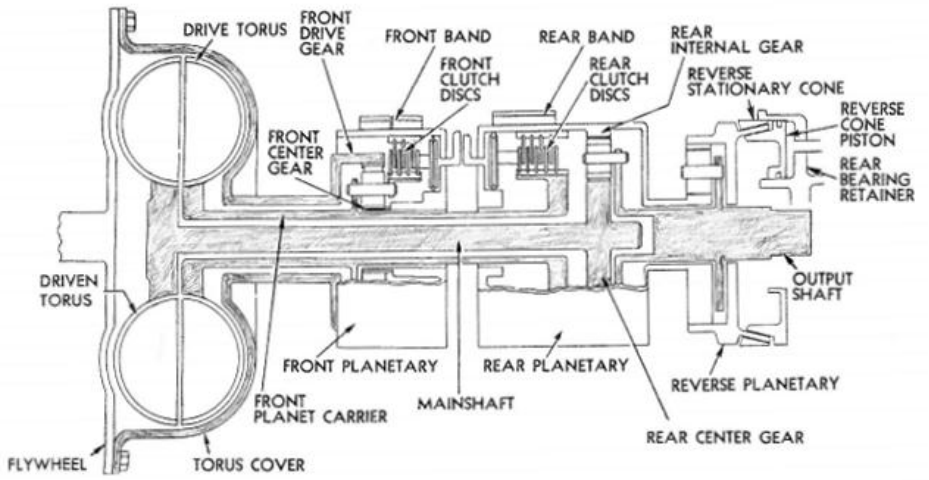


Elements of a Planetary Gearset (Source: Reference 1)

3. Power Flow in Forward Gears.

The front planetary gearset operates in reduction in first and third gears. It operates in direct drive in second and fourth gears. When the transmission is in gear, the front planetary gearset drives the drive torus and drives the rear planetary Internal Gear when rear clutches are engaged.

This is a diagram of the dual range Hydramatic. Refer to it as you read this discussion.



Dual Range Hydramatic (source Reference 1, Fig. 12)

The rear Planet Carrier is attached to the Output Shaft. The rear Center Gear is connected directly to the driven torus via the Mainshaft. The rear Center Gear is driven through the fluid coupling only. In forward gears the rear Internal Gear is either (1) connected to the Front Planet Carrier through rear clutches with rear band released or (2) held stationary by the rear band with rear clutches released. (1) is first/second gears and (2) is third/fourth gears.

This is description of the power flow in third gear from Reference 1.

POWER FLOW IN THIRD SPEED

Power travels from the flywheel to the torus cover, then through the front unit in reduction. Power coming from the front unit is split in two directions. Part of it goes forward, driving the fluid coupling and the mainshaft which is splined to the driven torus. The other part goes back the intermediate shaft to the rear unit.

With the rear unit clutch applied, the rear unit internal gear is locked to the intermediate shaft. Thus, since both the rear unit internal gear and the rear unit center gear are being driven by the front unit at the same speed they are in effect locked together. Therefore, the rear unit is in direct drive and the rear planetary and output shaft turn at the same speed as the planetary of the front unit, which is an integral part of the intermediate shaft (Fig. 12).

Note that in this description, "intermediate shaft" is the same as "FRONT PLANET CARRIER" in the diagram. The description says

"*Thus, since both the rear unit internal gear and the rear unit center gear are being driven at the same speed they are in effect locked together.*"

That seems correct but a bit misleading (to me). The rear unit internal gear is mechanically connected and driven though the rear clutches. However the center gear is connected through the fluid coupling so it is not mechanically connected and slippage in the fluid coupling is possible and would result in gear reduction in the rear unit. The "locked together" effect is accomplished through the fluid coupling.

Here's description of fourth gear.

POWER FLOW IN FOURTH SPEED

The path of power is exactly the same as in third speed except that it passes through the front planetary in direct drive instead of reduction. The same division of power applies in fourth speed as in third. Thus the fluid coupling is relieved of engine power which results in a more efficient drive (Fig. 12).

The same operating principles work in fourth as in third for the rear planetary gearset (rear unit). Power transmission to the center gear is through the fluid coupling thus allowing for slippage and resulting gear reduction. The primary difference in third and fourth is that the front planetary gearset is in reduction in third and in direct drive in fourth.

The confusing and misleading part here is:

"*Thus the fluid coupling is relieved of engine power which results in a more efficient drive.*"

I believe that is incorrect and led me to an incorrect assumption that the fluid coupling was not involved in fourth gear power transfer. However the fluid coupling is not relieved of engine power. It would be correct to say that the fluid coupling is more efficient in fourth because it is driven in reduction in third and in direct drive in fourth. That is, the fluid coupling is being driven at reduced engine speed in third and at engine speed in fourth. The fluid coupling is more efficient at higher speeds so at any given engine speed it is more efficient in fourth than in third.

In third and fourth, power always flows though the fluid coupling to drive the rear unit Center Gear. However, not all power (torque) flows through the fluid coupling, power flows mechanically though the clutches to turn the internal gear and power flows through the fluid coupling to turn the center gear. If there is no slippage in the fluid coupling then the rear unit will operate in direct drive without reduction.

The fluid coupling always transmits power when the transmission is in gear.

4. Division of Power in Third and Fourth

Reference 3 states

"Upon shifting to third, the forward gear assembly went back into reduction and the rear gear assembly locked. Due to the manner in which the rear gear assembly was arranged, the coupling went from handling 100 percent of the engine torque to about 40 percent, with the balance being handled solely by the gear train."

I believe that is wrong. In first/second 100 percent of power does flow through the fluid coupling. However the coupling goes from handling 100 percent of power to handling 50% of power in third and fourth. The Internal Gear and the Inner must be driven at the same rpm for direct drive in the rear unit. That means the same torque (power) must be applied to each the Internal Gear and the Center Gear. So the power would be split 50/50 assuming no slippage in the fluid coupling.

Then Reference 3 states

> *"The shift from third to fourth gear locked the forward gear assembly, producing 1.00:1 transmission. The fluid coupling now only handled about 25 percent of the engine torque, reducing slippage to a negligible amount."*

There is no change in how the rear unit is driven in fourth gear. The Inner Gear (mechanically driven) and the Center Gear (driven by fluid coupling) must continue to share the input torque 50/50 or 50% each.

In third/fourth gears, if the fluid coupling is 100% efficient without any slippage, then the rear unit Inner Gear and Center Gear will be driven at the same speed, thus achieving 1:1 drive through the rear unit. If there is slippage in the fluid coupling, then the Center Gear will rotate slower than the Inner Gear. That would result in gear reduction in the rear unit.

5. Conclusion.

Contrary to some claims (including by me in the past), the fluid coupling is always a component of power flow through the transmission. 100% of power transfers through the fluid coupling in first/second gears. 50% (or less if there is slippage in the fluid coupling) flows through the fluid coupling in third/fourth gears.

The Wikipedia Hydramatic article (Reference 3) claims that 40% of power flows through the fluid coupling in fourth gear and 25% in fourth gear. I find no mechanism in the transmission which would cause such a power division.

Even though power does flow through the fluid coupling, the division of power between the mechanical component and the fluid coupling in third/fourth makes it quite efficient in those gears, likely approaching the efficiency of a manual transmission, especially in fourth gear. Higher engine speeds will make for higher efficiency (less power loss) of the fluid coupling.

The dual range transmission is a strong and efficient transmission and the parent of later designs. In my opinion, it is an engineering work of art, an amazing development for the time period, over 80 years ago.

Comments, corrections, and clarifications welcomed!