Servo valves and proportional control valves

![Servo valve diagram]

**Figure 9-27.** Automotive example of mechanical-hydraulic servo system.

Driver initiates a right turn. Steering wheel goes clockwise from driver’s perspective.

The movement of the steering wheel pushes the sliding sleeve to the right, from our perspective.

This links pump discharge (P) to right-hand outlet to the left side of cylinder (A). This connects the B port of the cylinder to tank (T).

Flow into the cylinder pushes the piston rod to the right. It is unclear how the mechanism between the piston rod and the wheel works, but this rotates the wheel clockwise, and this seems to make the car turn LEFT. So this drawing is a bit flawed, in that turning the wheel right makes the car go left. This, however, does not affect how the mechanism works. Another linkage could be devised that reverses the rotation of the wheel.

The left-hand side of the piston is connected to the spool. Recall that the sliding spool has been pushed right. The piston moves to the right, but this also pulls the spool to the right. This movement continues until the lands on the spool again cover the sliding sleeve ports P-A-B-T. Thus a displacement of the sliding sleeve produces a displacement—not a velocity—of the piston, the connected linkage, and the wheel. Also, a small displacement of the sliding sleeve produces a small displacement of the steering linkage to the right (and a gentle right-hand turn), while a large displacement of the sliding sleeve—produced by a large turn of the steering wheel—produces a large motion of the piston and steering linkage and a sharp right-hand turn.
This is a two-stage servo valve. The top stage is an electromechanical stage. It shifts and moves the valve spool seen at the middle of the valve. The movement of the spool ports P to A or B and the other port to T. Let’s see how this works.

The top part is a *torque motor*. A current is sent to it, and this makes the armature rotate. Let’s say a current is sent to the torque motor that makes the armature rotate clockwise. The flapper is rigidly connected to the armature and rotates clockwise too.

The rotation of the armature/flapper closes the gap between the left-hand nozzle and the flapper. It opens the gap on the right side of the flapper between it and the nozzle.

This causes the pressure in the chamber on the left side of the spool to build and that on the right side of the piston to drop. This shifts the spool to the right.

As the spool moves to the right, it pulls the flapper off of the left-hand nozzle by means of the feedback wire. It continues to do this until the flapper is again centered between the nozzles and the pressure on either end of the spool is equal. At this stage, the torque on the flapper imposed by the current and the opposite torque imposed by the feedback wire are in equilibrium. The spool is shifted and stays shifted.

Thus a current input to the torque motor produces a displacement of the spool. A large current produces a large rotation of the flapper and a greater travel of the spool before the feedback wire’s
torque counteracts that of the torque motor’s current. A small current to the torque motor produces a smaller displacement of the spool before the feedback wire’s torque counteracts the current torque. Of course the amount of displacement of the spool governs the amount of flow that goes from P to A and from B to T.

Parker DY3H and DY6H flapper servo valve

This is the flapper servo valve used on the hydraulic and pneumatic servos in the Controls lab.
This valve seems to be in a velocity-control application. It has no feedback mechanism, which makes it a proportional control valve rather than a servo valve. There also seems to be missing a spring, needed to hold the spool plunger up against the armature.
Figure 7-17  Schematic of a two-stage electrohydraulic servovalve with force feedback controlling a motor with inertia load.
This is a flapper valve with the nozzles supplied via internal passageways in the spool itself. It also has no feedback mechanism, so technically it is a proportional control valve, not a servo valve.
These two are mechanical servos. Both have mechanical feedback mechanisms.