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Aircraft Production Technology
STUDY CASE 1 (LAB work 1)

Contents

1 Aircraft Part Study

In this part, **the tire of the landing gear on a Boeing 737** will be studied.

1.1 Part Location

The tire of the landing gear is located on each of the aircraft's main landing gear assemblies. The main landing gear is located underneath the wings and consists of two assemblies, one on each side of the fuselage. The tire is mounted on a wheel, which is part of the landing gear strut assembly. Fig. (1) and (2) show the location of the tire (pointed by the red arrow) on the main landing gear and the location of the main landing gear (enclosed by the yellow ellipses) on a B737.

Figure 1: The location of the tire on the main landing gear

1.2 Level Analysis

1.2.1 Part level

Location: The landing gear tire is located at the bottom of the landing gear assembly on the aircraft. The tire is mounted on a wheel rim, which is then bolted onto the landing gear axle.

From Fig. (3), the position of the tire (the only part that is white in the figure) can be found.

Interconnected Part List:

- Rubber Compound: The tire is made of synthetic rubber compounds that are designed to provide durability, flexibility, and resistance to wear and tear.
- Steel Bead Bundle: This is a bundle of steel wires that are embedded into the rubber to provide the tire with stability and strength.

Figure 2: The location of the main landing gear on a B737

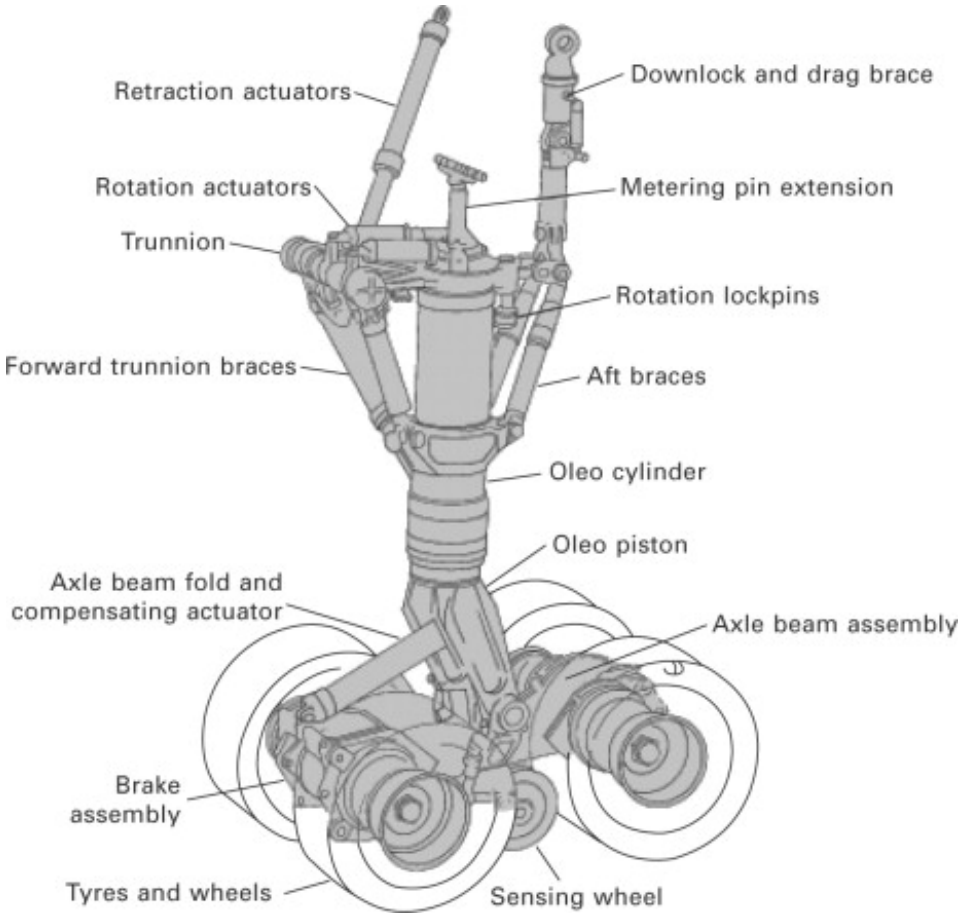

Figure 3: Detail drawing

- Belt Package: A layer of fabric or steel cords is wrapped around the steel bead bundle to distribute the weight of the aircraft evenly across the tire.
- Tread: The tread is the outermost layer of the tire that comes into contact with the runway surface. It is designed to provide good traction and grip on the runway, and is made of a special rubber compound that is resistant to wear and tear.
- Sidewall: The sidewall is the part of the tire that connects the tread to the bead bundle, and provides lateral stability to the tire. It is also made of a rubber compound that is designed to withstand the stresses and strains of landing and takeoff.
- Valve Stem: The valve stem is a small component that is located on the sidewall of the tire, and allows air to be added or removed from the tire as needed. It is typically made of metal, and is attached to the tire through a small hole in the sidewall.

The main purpose of the landing gear tire as a part is to support the weight of the aircraft during landing and takeoff, and to absorb the shocks and vibrations that are generated during these phases of flight.

1.2.2 Node level

Node: Landing Gear Assembly

Location: The landing gear assembly is located on the bottom of the aircraft fuselage and consists of several components, including the landing gear strut, wheel assembly, and tire. The landing gear strut attaches to the fuselage and supports the weight of the aircraft during landing and takeoff. The wheel assembly is attached to the strut and includes the tire, wheel rim, brakes, and other components.

In Fig. (3), the interconnect parts are marked.

Interconnected Part List:

- Landing Gear Strut: The landing gear strut is the primary component of the landing gear assembly and provides support and stability to the aircraft during landing and takeoff. It is typically made of steel or aluminum and includes hydraulic systems for deploying and retracting the landing gear.
- Wheel Assembly: The wheel assembly includes the landing gear tire, wheel rim, brakes, and other components. The wheel rim is typically made of aluminum and provides a mounting point for the tire. The brakes are used to slow down the aircraft during landing and are typically hydraulic or pneumatic.

At the level of the node, the main purpose of the landing gear tire as part of the landing gear assembly is to support the weight of the aircraft during landing and takeoff, absorb shocks and vibrations, and provide traction and stability on the runway.

1.2.3 Panel level

Panel: Landing Gear Wheel Panel

Location: The landing gear wheel panel is located on the bottom of the aircraft fuselage and covers the wheel assembly and landing gear strut. It is typically made of lightweight composite materials and is designed to provide aerodynamic efficiency while protecting the landing gear assembly from debris and other hazards.

Interconnected Part List:

- Hydraulic Systems: The landing gear assembly includes hydraulic systems for deploying and retracting the landing gear and controlling the brakes. The hydraulic systems are typically located within the landing gear strut and wheel assembly.

The main purpose of the landing gear wheel panel is to provide aerodynamic efficiency and protect the landing gear assembly from debris and other hazards during flight. The panel is designed to be lightweight and streamlined, which helps to reduce drag and improve the overall performance of the aircraft.

1.2.4 Section level

Section: Landing Gear Wheel Section

Location: The landing gear wheel section is located on the bottom of the aircraft fuselage and includes the landing gear wheel panel, landing gear strut, and other components. It is responsible for supporting the weight of the aircraft during landing and takeoff and providing a stable platform for the aircraft during ground operations.

Interconnected Part List:

- Wheel Axle: The wheel axle is a critical component of the landing gear wheel section, as it connects the wheel assembly to the landing gear strut. It is responsible for transmitting the weight of the aircraft to the landing gear strut and providing stability during ground operations.
- Braking System: The braking system is an interconnected part of the landing gear wheel section that includes the brake disc, brake caliper, and other components. It is responsible for controlling the speed and direction of the aircraft during landing and taxiing.

The main purpose of the landing gear wheel section is to support the weight of the aircraft during landing and takeoff and provide a stable platform for the aircraft during ground operations. The landing gear strut is the primary load-bearing component, while the wheel axle transmits the weight of the aircraft to the landing gear strut.

1.2.5 Compartment level

Compartment: Landing Gear Compartment

Location: The landing gear compartment is located on the underside of the aircraft fuselage, typically towards the front of the aircraft. It houses the landing gear assembly, including the landing gear tire, and provides a protective enclosure for the landing gear assembly.

Interconnected Part List:

- Wheel Well: The wheel well is an integral part of the landing gear compartment and is designed to protect the landing gear assembly from debris and other hazards. It also provides structural support to the landing gear assembly and helps to distribute the weight of the aircraft during landing and takeoff.
- Electrical System: The electrical system is another interconnected part of the landing gear compartment and includes the landing gear control panel, wiring harness, and other components. It is responsible for controlling the operation of the landing gear assembly, including the landing gear tire.

The main purpose of the landing gear compartment is to provide a protective enclosure for the landing gear assembly, including the landing gear tire. The landing gear strut and wheel well provide support and stability to the aircraft during landing and takeoff, while the hydraulic and electrical systems control the operation of the landing gear assembly.

1.2.6 Unit level

Unit: Landing Gear System

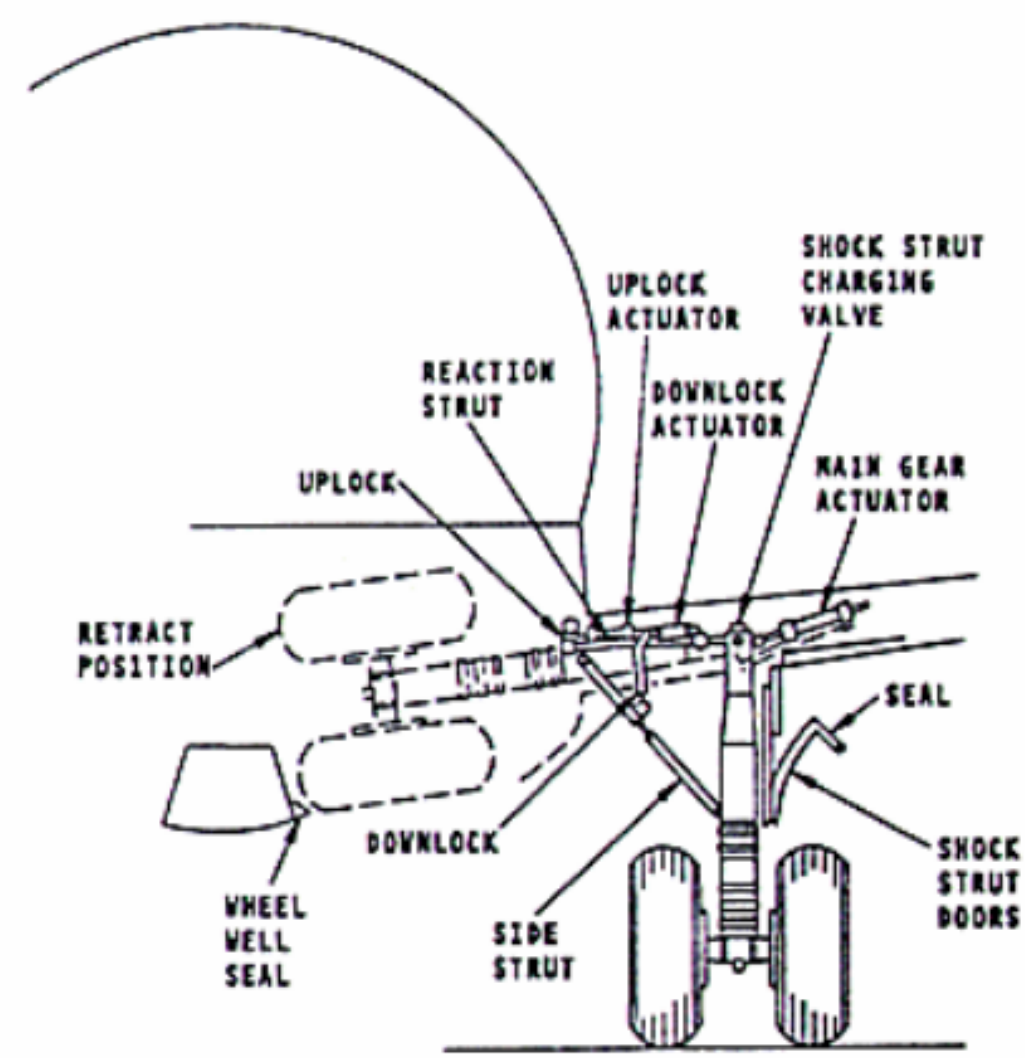

Figure 4: The location of the landing gear system in the aircraft

Location: The landing gear system is located on the underside of the aircraft and includes the main landing gear, nose landing gear, and associated components such as the tires, wheels, and brakes, as shown in Fig. (4).

Interconnected Part List:

- Flight Control System: The flight control system is connected to the Landing Gear System and includes various components such as the flight control surfaces, cockpit controls, and computers that manage the flight of the aircraft.

The main purpose of the landing gear system, including the tire, is to support and cushion the aircraft during landing and takeoff. The landing gear system absorbs the shock of landing and provides a smooth ride during takeoff. The hydraulic system provides the necessary pressure and fluid to operate the landing gear and brake assembly, while the brake assembly works to slow down and stop the aircraft during landing. Together, these interconnected parts ensure that the aircraft operates safely and reliably, and that the landing gear system can extend and retract smoothly.

2 Electronic Part Study (Mechanical Construction Separation version)

In this part, **the cable for the throttle valve on a Boeing 737** will be studied.

2.1 Part Location

The cable for the throttle valve, shown in Fig. (5), is located in the cockpit of the aircraft, specifically in the throttle quadrant, shown in Fig. (6). The throttle quadrant is a mechanical device that is used to control the aircraft's throttle, which in turn controls the amount of power being delivered to the engines. The cable is connected to the throttle lever in the cockpit and runs through the aircraft's control system to the engine. The position of the cockpit in the aircraft is shown in Fig. (7).

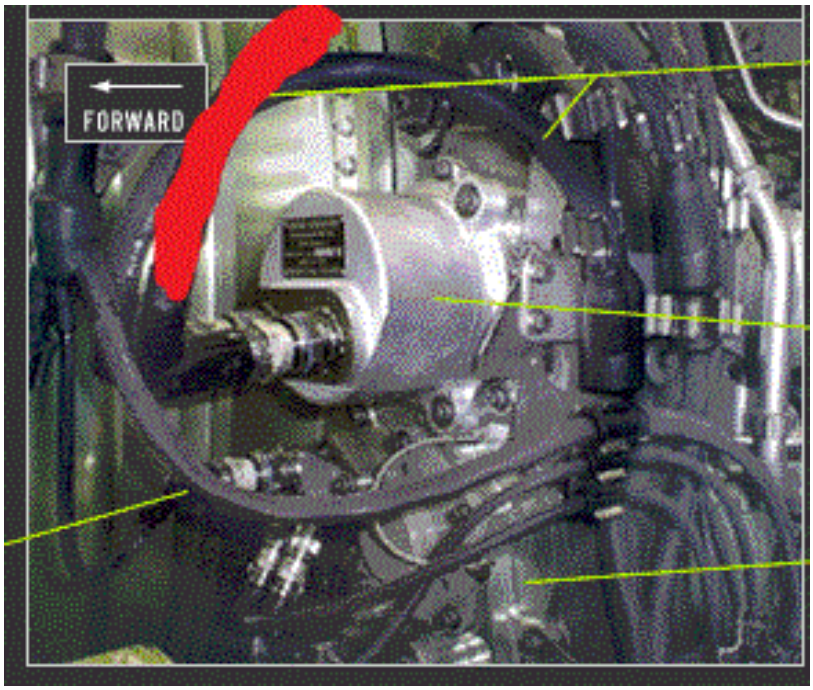

Figure 5: The cable for the throttle valve on a Boeing 737 (colored with red)

Figure 6: Throttle Quadrant (the cable is embedded inside the quadrant) in a B737 cockpit

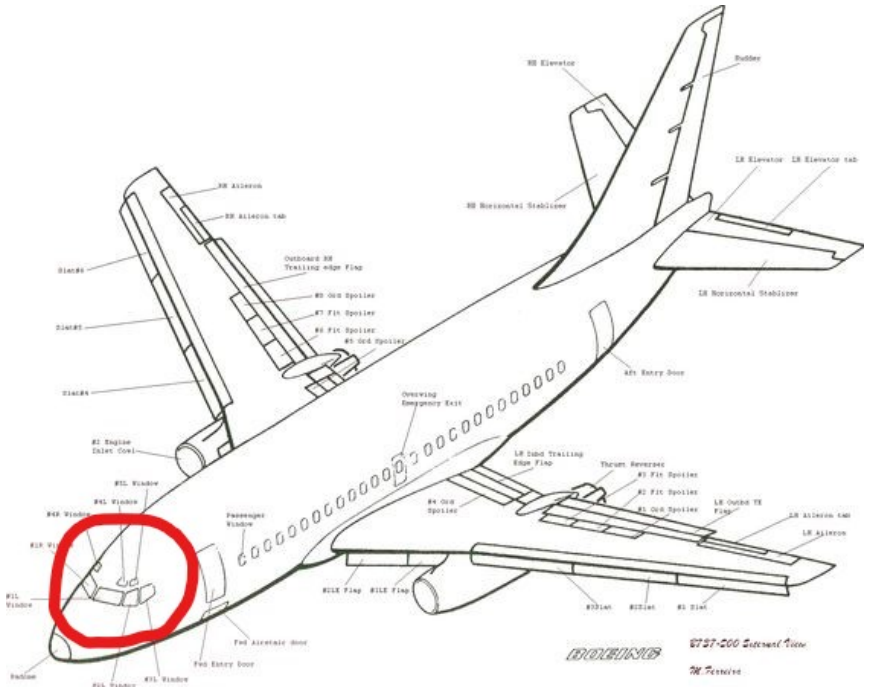

Figure 7: The position of the cockpit in the aircraft, enclosed by the red line

2.2 Level Analysis

2.2.1 Part level

Part location: The cable is a flexible, slender part that runs from the throttle control in the cockpit to the throttle valve located in the engine compartment.

Interconnected parts: The cable is connected to the throttle control in the cockpit on one end and to the throttle valve in the engine compartment on the other end.

The main purpose of the cable is to transmit the pilot's control inputs from the cockpit to the throttle valve, which adjusts the amount of fuel and air that is delivered to the engine. The cable provides a physical link between the throttle control in the cockpit and the throttle valve, allowing the pilot to precisely control the engine's thrust.

2.2.2 Node level

Location: The cable is part of the throttle control system, which is a sub-system of the engine control system.

Interconnected parts:

- Throttle quadrant assembly: The throttle quadrant assembly is a control panel located in the cockpit that allows the pilot to control the throttle valve, along with other engine control systems, as shown in Fig.(6).
- Throttle body: The throttle body is a component located in the engine that regulates the flow of air into the engine. The cable is responsible for transmitting the pilot's commands from the cockpit to the throttle body, allowing for precise control of engine performance.
- Throttle position sensor: Throttle position sensor provides feedback to the pilot about the status and performance of the engine.

The main purpose of the throttle control system, which includes the cable, is to regulate the engine's thrust in response to the pilot's control inputs. The throttle control system receives inputs from the cockpit, processes them using information from engine sensors, and adjusts the amount of fuel and air delivered to the engine via the throttle valve. The cable is a critical component of the throttle control system, as it provides a physical link between the cockpit and the engine compartment.

2.2.3 Panel level

Location: The cable is routed through various panels and conduits within the aircraft, including the cockpit panel and engine compartment panels, as shown in Fig. (8)

Interconnected parts:

- Throttle control panel: This panel is typically located on the center console of the cockpit, and allows the pilot to control various engine functions, including the throttle valve.

The main purpose of the panels and conduits is to provide a protective housing and routing for the cable, ensuring that it is properly secured and shielded from environmental factors such as temperature, vibration, and electromagnetic interference.

2.2.4 Section level

Location: The cable is part of the engine control section, which is a sub-section of the powerplant section of the aircraft.

Interconnected parts:

Figure 8: B737 panel in the cockpit, which the cable is connected and interacted with

- Throttle control unit, which is responsible for converting the pilot's input into a signal that adjusts the engine's throttle setting.
- Engine control system, such as the electronic engine control unit (EECU), which receives the signal from the throttle control unit and uses it to adjust the engine's performance.
- Fuel control unit, which regulates the flow of fuel to the engine, and the engine ignition system, which provides the spark needed to ignite the fuel in the engine. These interconnected parts work together to ensure precise control and safe operation of the aircraft's engine.

The main purpose of the engine control section, which includes the cable, is to regulate the operation of the aircraft's engines. The engine control section receives inputs from the cockpit and engine sensors, and adjusts the engine's thrust by controlling the amount of fuel and air delivered to the engine via the throttle valve. The cable is a critical component of the engine control section, as it provides a physical link between the cockpit and the engine compartment.

2.2.5 Compartment level

Location: The cable is located in the engine compartment, which is a sub-compartment of the powerplant compartment of the aircraft.

- Cockpit compartment: The cockpit compartment houses the throttle quadrant, which is the cockpit control for the throttle valve cable.
- Avionics compartment: The avionics compartment houses the engine control unit, which receives signals from the throttle quadrant and controls the position of the throttle valve.
- Engine compartment: The engine compartment contains the throttle control assembly, which is connected to the throttle valve cable and adjusts the position of the valve based on input from the engine control unit. The cable runs from the cockpit compartment, through the avionics compartment, and into the engine compartment where it connects to the throttle control assembly.

The main purpose of the powerplant compartment, which includes the engine compartment and the cable for the throttle valve, is to provide a housing for the aircraft's engines and related components. The powerplant compartment is designed to provide adequate ventilation, cooling, and access for maintenance and repairs. The cable for the throttle valve is an integral part of the powerplant compartment

2.2.6 Unit level

- Flight Control Computer (FCC): The flight control computer provides the TCU with input on the current flight conditions and pilot commands.
- Hydraulic System: The throttle control assembly is responsible for controlling the flow of fuel and air to the engine, and it is connected to the hydraulic system via hydraulic lines that are responsible for actuating the assembly. The cable is connected to the throttle control assembly and is responsible for transmitting the control input from the cockpit to the throttle valve.
- Airframe: The cable is connected to the airframe through cable guides and pulleys that help to route the cable through the aircraft. The cable guides and pulleys are mounted to the airframe and allow the cable to move freely without getting tangled or obstructed.

The main purpose of the cable for the throttle valve at the level of the unit is to manage the performance and operation of the aircraft's engines, including monitoring engine parameters, controlling fuel flow, and adjusting engine power output. The system is responsible for ensuring that the engines operate safely, efficiently, and in accordance with the pilot's commands. This is acieved by interacting with multiple systems such as the avionics, hydraulic system, throttle control unit (TCU), and engine control Unit (ECU). It plays a critical role in the safe operation of the aircraft and its ability to perform its intended functions.

3 Electronic Part Study (Electrical Construction Separation version)

In this part, **the cable for the throttle valve on a Boeing 737** will be re-studied but in an electrical system hierarchy way.

3.1 Part Location

The overall part location explanation will be similar to that in Section (2.1).

3.2 Level Analysis

3.2.1 Commutation block level

Part location: The throttle valve cable is a basic part and does not have a specific location within the commutation block. The commutation block refers to the electrical connections and switching components that support the operation of the larger electronic systems within the aircraft.

Interconnected parts:

1. Electrical contacts and connectors
2. Switching components (e.g., relays, contactors)
3. Engine sensors
4. Engine throttle valve

The purpose of the commutation block is to convert electrical power from one form to another, such as converting DC voltage to AC voltage or changing the frequency of an electrical signal. The cable for the throttle valve in this context serves as a basic electrical component that connects to other components in the aircraft's electrical system.

3.2.2 Panel level

Location: The throttle control system panel is located in the cockpit area, typically between the pilot and co-pilot seats, as shown in Fig. (6) and (8). This panel contains the controls and indicators for the throttle control system, including the throttle lever and associated instruments.

Interconnected parts:

1. Throttle lever, the lever or the handle in Fig. (6)
2. Instrumentation (e.g., engine RPM gauge, fuel flow meter)
3. Wiring harnesses and cables

The purpose of the throttle control panel in the cockpit is to allow the pilot to control the engine's speed and power output by adjusting the position of the throttle lever. The cable for the throttle valve in this context serves as a means of transmitting the pilot's inputs to the engine control system.

3.2.3 Zone level

Location: The cockpit area, where the throttle control system panel is located, falls under the zone of the flight deck, as shown in Fig. (7). This zone encompasses the area where the pilots sit and operate the aircraft's controls.

Interconnected parts:

1. Cockpit instruments and controls (e.g., flight instruments, communication systems, that can be seen in Fig. (8))
2. Environmental control systems (e.g., air conditioning, ventilation)
3. Cockpit lighting and power distribution systems

The main purpose of the cockpit area as a zone is to provide an environment in which the pilot can safely and effectively operate the aircraft. The cable for the throttle valve in this context must be properly integrated with other systems in the cockpit, such as environmental controls and communication systems.

3.2.4 Area level

Location: The throttle control system circuit includes the engine instrumentation and control systems. Within this circuit, the throttle valve cable connects the throttle lever to the engine's throttle valve, which regulates the flow of fuel and air into the engine.

Interconnected parts:

1. Fuel control system (e.g., fuel pump, fuel injector)
2. Air intake system (e.g., air filter, inlet scoop)

The main purpose of the circuit that includes the cable for the throttle valve is to regulate the flow of electrical power to various components of the engine control system. The cable for the throttle valve in this context serves as a means of transmitting electrical signals to the engine control unit (ECU), which regulates the position of the throttle valve accordingly.

3.2.5 System level

Location: The throttle control system is a sub-system of the aircraft's engine control system. This system includes various sensors, actuators, and other components that work together to regulate the engine's speed and power output.

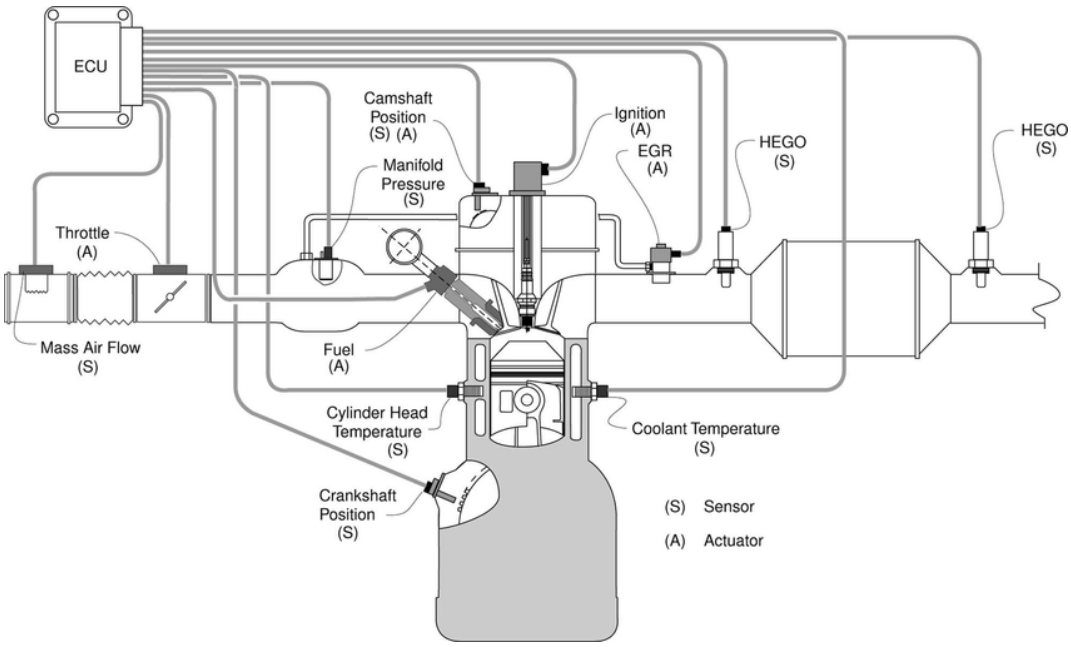

Figure 9: A typical diagram of the engine control system

Interconnected parts list:

1. Engine control unit (ECU)
2. Throttle position sensor
3. Actuators (e.g., fuel injector solenoids, throttle position motor)

The main purpose of the throttle control system is to regulate the flow of fuel and air into the engine in order to maintain the desired speed and power output. The cable for the throttle valve in this context plays a crucial role in transmitting the pilot's inputs to the ECU, which adjusts the position of the throttle valve accordingly.

3.2.6 System complexed level

Location: The engine control system is part of a larger complex of systems that make up the aircraft's propulsion and power generation capabilities. This complex includes the engines themselves, as well as the fuel system, electrical power generation and distribution systems, and other related components.

Interconnected parts list:

1. Engines (and associated components such as the turbine, compressor, and exhaust system)
2. Fuel system (including tanks, pumps, and filters)
3. Electrical power generation and distribution system (including generators, batteries, and wiring). The electricity system of a B737 is shown in Fig. (10), where our study subject connects the electrical loads and equipment bay at the front of the aircraft with the generators and other appliances in the two engines.

4. Hydraulic system (including pumps, reservoirs, and actuators)

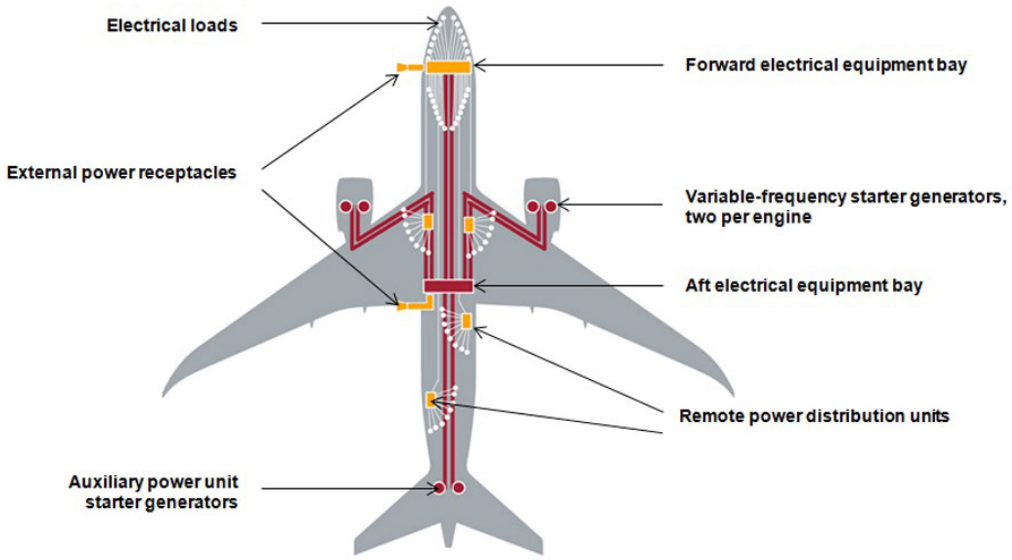

Figure 10: The electricity system of a B737

The main purpose of the engine control system as part of a larger complex of systems is to provide propulsion and power generation capabilities for the aircraft. The cable for the throttle valve in this context is one of many components that work together to ensure safe and efficient flight operations.

4 Discussion

In the last version of the lab report, I mistakenly analyzed the electronic part in the mechanical construction separation way.

Dividing the mechanical system into six levels—part, node, panel, section, compartment, and unit—is another way to categorize the components of an aircraft's mechanical system. This approach emphasizes the physical location and arrangement of the components, and provides a framework for understanding how different parts of the system are interconnected.

Both the electronic and mechanical system hierarchy approaches have their own benefits and drawbacks. The electronic system hierarchy focuses on the electrical connections and logic that govern the operation of various systems, while the mechanical system hierarchy emphasizes the physical layout and structure of the components.

Studying an electrical part like the cable for the throttle valve through the mechanical system hierarchy may not be as effective as using the electronic system hierarchy, which is focused on the electrical connections and logic that govern the operation of various systems. This may lead to some potential consequences or drawbacks. These could include:

1. Confusion: It could be confusing to use a system that is primarily designed for mechanical systems to study electrical components, as there may be a lack of clarity or detail about how the electrical components interact with the other mechanical components.

2. Incomplete understanding: Studying an electrical part through the mechanical system hierarchy may result in an incomplete understanding of the part's function and role within the overall system, since the electrical aspects of the part may not be fully accounted for.

3. Error-prone: There may be a risk of errors or misunderstandings in using a framework that is not specifically designed for studying electrical components. This could lead to mistakes in maintenance, repair, or troubleshooting of the component.

Overall, while it is possible to use the mechanical system hierarchy to study an electrical part like the cable for the throttle valve, it may not be the most effective or efficient approach. Using the electronic system hierarchy would likely provide a more detailed and accurate understanding of the electrical connections and logic that govern the operation of the component, and may reduce the risk of confusion or error.