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HELICOPTERS

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There are many possible configurations.

Only 5 of these configurations have been important and 2 of them are very rare.

- Monorotor Helicopter.
- Birotor in tandem (*twin tandem*).
- Birotor side by side (*twin side-by-side*).
- Birotor with two crossing axes (*twin intermeshing*).
- Birotor coaxial (*twin coaxial*).
The monorotor helicopter, in which the reaction torque generated in the fuselage, by the main rotor, is offset by the tail rotor or by another device.
Birotor in tandem (*twin tandem*): The rotors are positioned symmetrically about the transversal axis of the vehicle. The rotors intersecting blades and rotating in opposite directions. Both rotors inclined axis to cancel out any torque transmitted to the fuselage.
The birotor side by side helicopter (twin side-by-side) has never been popular, even though it was used in one of the largest helicopters built, the Mil V-12.
The type of birotor (*twin intermeshing*) is made of two rotors rotating in opposite directions on two inclined axis and are located close together.
• The last mentioned configuration is the birotor coaxial helicopter (*twin coaxial*) in which the rotors are on top of each other rotating in opposite directions. It is quite a compact layout.
• Gearboxes, transmission shafts/drive shafts and control systems (cap 10).
• There will be one or more gearboxes that connect the engine/s whose output shaft is rotating at an angular velocity between 6000 and 50000 R.P.M.
• The main rotor rotates about 300 R.P.M.
• The design is fundamental, not only for its function of transmitting power and reducing angular speed, but because it can seriously penalise the total weight of the vehicle.
System is made of:

- Assembly of shafts and reduction boxes of R.P.M.
- Set of elements, components, and systems are moved due to the engine.
• **Power Transmission of the Agusta AB412.**
  - The power from the engine/s is transmitted through a shaft/s, to the main gearbox and hence the main rotor and to the tail rotor through one or two gearboxes (42° and 90°).
  - Also, a set of accessories that are mounted on it.
• Other transmission systems.

1. Mast assembly
2. Transmission
3. Input quill
4. Engine to transmission driveshaft
5. Tail rotor driveshaft
6. Tail rotor driveshaft (short section)
7. Tail rotor driveshaft
8. Tail rotor driveshaft
9. Tail rotor driveshaft
10. Tail rotor driveshaft
11. Tail rotor gearbox
12. Intermediate gearbox
13. Hanger assembly
14. Hanger assembly
15. Hanger assembly
16. Hanger assembly
17. Tail rotor drive quill
18. Hydraulic pump and tachometer (system 1)
19. Cover
20. Hydraulic pump drive quill (system 2)
- Power transmission CH-47.
Engine

Combustion chamber
Power turbine (to transmissions and rotors)
Compressor (axial)
Intake
Exhaust

GAS GENERATOR SECTION
- axial compressor
- accessory gearbox
- inlet screen
- power turbine
- combustion chamber
- compressor turbine
- centrifugal compressor
- reduction gearbox

POWER SECTION
- exhaust duct
- output shaft
- reduction gearbox
- compressor turbine
- axial compressor
- accessory gearbox
- power turbine
- inlet screen
- combustion chamber
- exhaust duct

POWER TRANSMISSION
Engine
Reasons to use turbines are:

- Smoother operation with a significant reduction in vibrations.
- The helicopter is quieter, or at least has a different kind of noise.
- Lighter for the same power output.
- The rotation velocities are typically between 6000-50000 R.P.M. in the majority of engines.
• Figure 9-18 (Bell 230). Accessories and engine controls
Engine

1. Reduction gearbox
2. Bracket
3. Electrical connector
4. Gasket
5. Power turbine tachometer generator
6. Bracket
7. Washer
8. Nut
Within the power plant, the gearboxes are generally installed at the output shaft.

- Provide a first reduction of the R.P.M. (around 5:1).
- Supply power to the auxiliary systems and accessories: torque wrench, oil pump, start up system (input/output), fuel control system.
• The gearbox of the Agusta AB412.
Engine

- They also can have the function of combining the power output when the helicopter has two engines.
- In recent decades: new generation of gearboxes with significant reductions in the weight of the transmission.
- Numerous improvements: gearboxes of light material with 3 steps of reduction with a ratio velocity of 12:1 and even greater improvements which:
  - reduce the forces on the teeth/grooves of the boxes,
  - reduce the number of parts,
  - reduce the noise,
  - facilitate the installation of MMS devices (*mast-mounted sight*) and,
  - other minor advantages.
Engine
- Firewall.
Engine

- Bell 407.

1. Mast assembly
2. Transmission assembly
3. Engine to transmission driveshaft assembly
4. Rotor brake kit (optional)
5. Spacer
6. Freewheeling assembly
7. Transmission/engine oil cooler
8. Pylon beam assembly

NOTES:
- Helicopter configuration using flywheel 407-040-316-101 must have spacer if rotor brake kit is not installed.
- Helicopter configuration with no flywheel 407-040-316-101 must have rotor brake disc 407-340-319-101 installed at all times.
● Bell 407.
- Bell 407.
For both piston and turbine helicopters. A gear is necessary to disengage the rotor engine in case of engine failure or in case of functioning in idle. This mechanism is called freewheel.
The *freewheel* is composed of 2 tracks, the inner track and the outer one, plus a screen in which a series of links is mounted.
• Each link has 2 diametres, one of them being longer than the other.
  – If the movement comes from the outer track (engine side), it tilts the link with the greatest diametre making it jam through the tracks, turning jointed, as a whole.
Freewheel

- If the movement comes from the interior track (rotor side), it tilts the links with the smallest diametre, thus disengaging both tracks, rotating the interior track and leaving the exterior track free (stopped, or rotating at lower R.P.M./revolutions than the interior).
• Another freewheel design.
• Main gearbox. MGB.
Main Transmission

- **Main Gearbox**: The universal type is usually situated in front of the engine and suspended by struts on structural supports on the roof of the cockpit.
- Engage the engine or engines by the driving shaft or shafts.
- The function of the main transmission is twofold:
  - To reduce the movement of the rotor,
  - To change the direction of the shaft of rotation (by) 90°.
Main Transmission

- It generally consists of 3 sections:
  - *Intermediate section*: a casing on which the following are mounted
    - the engine input pinion gear at the rear,
    - the gearbox of the main generator on the front
    - an optional power output on the left side
  - *Upper section* is composed of a casing which is mounted on the intermediate section and screwed in.
    - Inside there will be one (or more) toothed ring/s that form the planetary system that produce one of the reductions of R.P.M.
- **Lower section** consists of a casing that serves as an oil sump of the main transmission.
  
  - A series of motion output shafts for accessories are mounted on this section.
  - The lower section takes its movement from the intermediate section through a shaft.
Main Transmission

- Main Transmission Bell 412
Main Transmission Bell 412

1. Flexible coupling (forward)
2. Bolt
3. Steel washer
4. Driveshaft
5. Bolt
6. Steel washer
7. Flexible coupling (aft)
8. Nut
9. Steel washer
10. Engine-to-driveshaft curve coupling adapter
11. Main input quill curve coupling adapter
12. Steel washer
13. Nut
Example (twin engine helicopter, Bell 230).
The movement is transmitted from each power shaft to the first reduction gear with its corresponding freewheel.

From the gear, on one side comes the movement for the hydraulic system, and from the other to the main collector gear that combines the outputs of both turbines.
Through the vertical shafts, it is transmitted to the sun gear of the planetary gear sets, which rotate constrained in a translation motion because they are geared in a fixed ring.

The planetary gears are joined by a support box that rotates around them, and gives motion to the main rotor mast. The tail rotor obtain the movement from the lower output gear.
In this way three reductions can be achieved for the main rotor:

- The first one is achieved in the exterior gear (turboshaft – freewheel),
- The second in the main collector gear, and
- The third in the planetary gear set.
• Main Gearbox (Bell 230).
• In other helicopter configurations the combination of the 2 engine outputs produces an additional gearbox.

• There are other cases where there are two systems of sun-planetary gears which produce a necessary reduction: in these cases there is usually no exterior gear system.
• Rear rotor transmission details CH-47.
Detail of the rear rotor transmission, birotor helicopter in tandem.
MGB OPERATION

- Main Gearbox SH60.
- Main Gearbox Super Puma.
MGB OPERATION
MGB OPERATION

- New epicyclic & rotor mast modules
- Back-up lubrication spray system
- New oil filter acc. JAR 29
- New servo actuator fitting
- Reinforced main casing

- Reinforced Main gear drive
- Chip detectors acc. JAR 29
Figure 1. General Description - Main Gearbox
Sheet 1.

Figure 2. Detailed Description - MGB Lubrication
Sheet 1.

Figure 1. Detailed Description - Main Gearbox
Sheet 1.
Generally, a tubular steel shaft (Bell 230), is aligned with the transmission by a series of bearings.

It presents a series of grooved and threaded zones.

In the grooved parts linked together we find: the main rotor, the assembly of controls and the swashplate, the planetary gear sets of the main transmission, which produce the movement.
(On) the threaded zones there are:

- The retaining nut of the main rotor,
- The retaining nut of the upper mast bearing,
- The retaining nut of the lower mast bearing.
The assembly of elements transmit the movement from the main gearbox to the tail rotor.
Movement through the shaft is divided into a series of sections, 1 or 2 gearboxes and links, designed to absorb the system’s vibrations (hangers) and mismatches in the alignment of the shafts.
Bell 407.

1. Forward short shaft
2. Oil cooler blower assembly
3. Aft short shaft
4. Tail rotor driveshaft segment assembly
5. Tail rotor gearbox
6. Splined flywheel adapter (S/N 53000 thru 53442 pre BHT-407-II-30), splined adapter (S/N 53443 and sub. or S/N 53000 thru 53442 post BHT-407-II-30)
7. Weights (qty–2) (S/N 53443 and sub. or S/N 53000 thru 53442 post BHT-407-II-30)
8. Bearing hanger
9. Coupling disc pack
- Bell 407.
TAIL ROTOR TRANSMISSION
Bibliography