BI-DIRECTIONAL GEARBOX

Deltic Engines Type T18-37K use a gearbox incorporating twin clutches and this is secured to the phasing gear case. The drive from the output gear in the phasing gear case is passed to the clutch assembly by a quill-shaft as described in the previous chapter. The clutch assembly is driven in a clockwise direction when viewed from the free end of the engine, the twin hydraulically operated clutches enable the engine to idle in neutral or drive the gearbox output flange in a clockwise or anti-clockwise direction. Spur gears in constant mesh are employed throughout, the required direction of of drive being engaged by either clutch.

Lubrication and cooling of the gear trains is provided for by the use of spray jets, the oil being directed into the mesh of each mating pair of gears; the oil is returned to the 'CA' crankcase by means of an external pipe and through transfer ports in the base of the gearbox. An auxiliary pump, driven from the gearbox, continues to supply oil when the engine has stopped and the gears are rotated by the action of the trailing propeller. This pump is referred to as the "trailing pump".

Attachment faces for mounting feet are machined on extensions cast integrally with the free end casing.

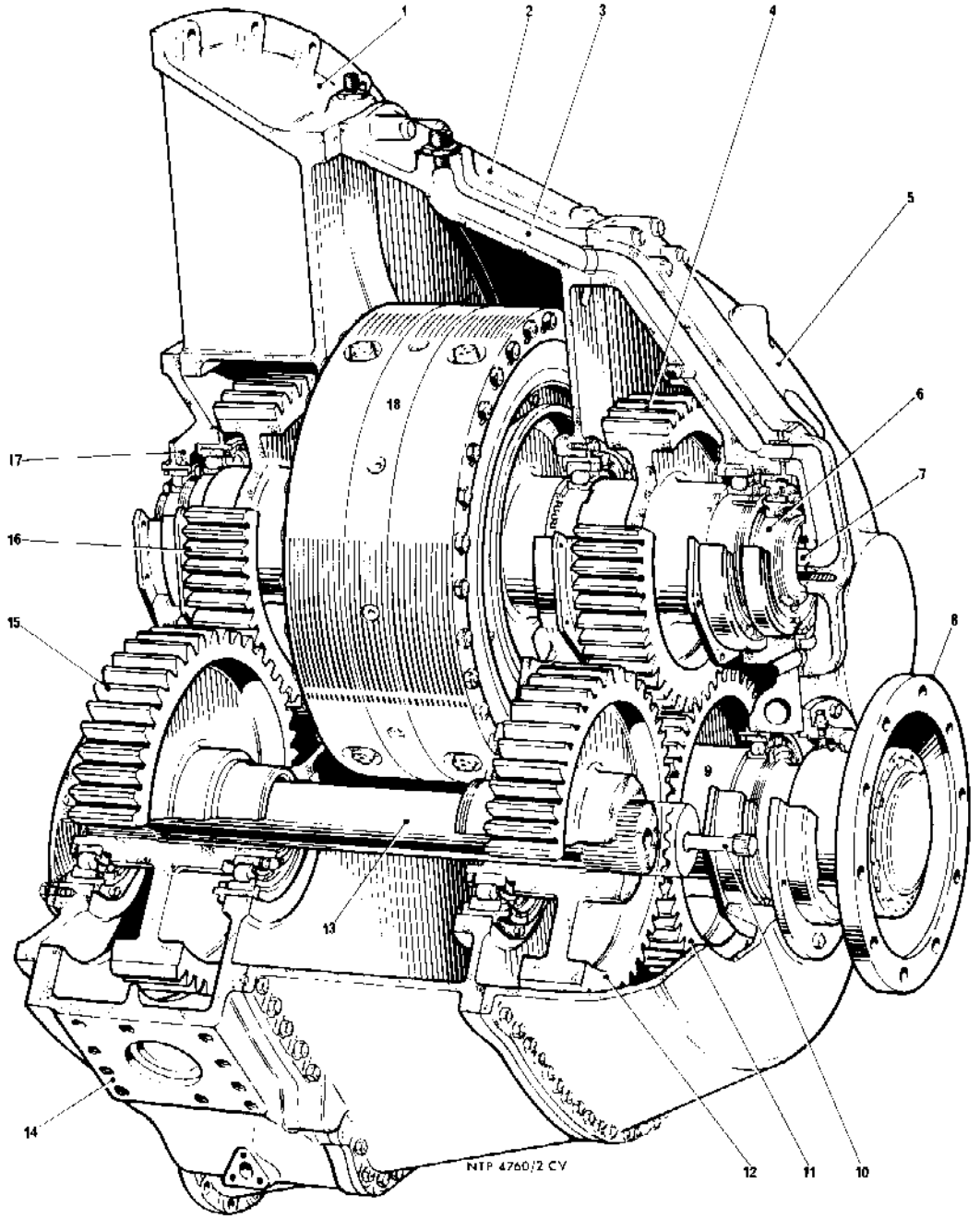
Casings

The gearbox comprises four casings, the free end case, centre case, drive end case and a gear carrier plate; a fifth casting, in the form of a cover plate secured to the drive end case, performs the task of directing engine lubricating oil through passageways and ports to the clutch assembly. The casings have face to face joints which are coated by a thin film of jointing compound, correct location of each case is provided for by dowels. Jacking points are sited in each mating face to enable the joint to be 'broken' when dismantling the gearbox.

Ducts and drillings for conveying lubricating oil to the spray jets are provided in the castings, as are ducts to convey oil in its passage from the hydraulic control units to the clutch assembly. Leakage of oil from duct to case where these ducts join is prevented by transfer tubes and synthetic rubber 'O' rings.

Gears and Shafts

The clutch assembly is supported on two shafts which are flange mounted on either side of the central driving member of the clutch, the three components being bolted together by fitted bolts. The shafts are supported by a roller bearing housed in the gear carrier plate at the free end and a ball bearing housed in the drive end casing at the driving end. An oil tube is fitted into the drive end shaft and mates with the cover plate referred to in the first paragraph. Pressure oil from the hydraulic control unit can be passed either through the tube or the annular space formed between the oil tube and the hollow clutch shaft.



1. Free-end casing
2. Centre casing
3. Oil duct
4. Reverse rotation drive gear
5. Drive-end casing
6. Clutch shaft
7. Oil tube
8. Output coupling
9. Output shaft
10. Drive shaft for trailing pump
11. Output gear
12. Idler gear
13. Layshaft
14. Engine mounting foot attachment face
15. Idler gear
16. Direct rotation drive gear
17. Gear-carrier plate
18. Hydraulic clutch

BI-DIRECTIONAL GEARBOX

The driving gears of the twin clutches are in connection with the respective friction discs by splined couplings and are supported by roller bearings which are housed in the casings. Reference to the illustration "Bi-directional Gearbox" will show the gear trains. It should be remembered that the clutch assembly is rotating in a clockwise direction at all times thus, when the drive end clutch is engaged, gear (4) which is in direct mesh with the output gear (11) will turn that gear and the output shaft and flange (8) in an anti-clockwise direction (viewed from the free end of the engine). Conversely, when the free end clutch is engaged, gear (16) which is in mesh with pinion (15) on layshaft (13), will turn the layshaft and gear (12) in an anti-clockwise direction. As gear (12) is in mesh with the output gear, the output gear, shaft and flange will now turn in a clockwise direction (viewed from the free end of the engine).

Provision is made to drive a trailing pump and shaft tachometer generator from the drive end of the layshaft (13) if required.

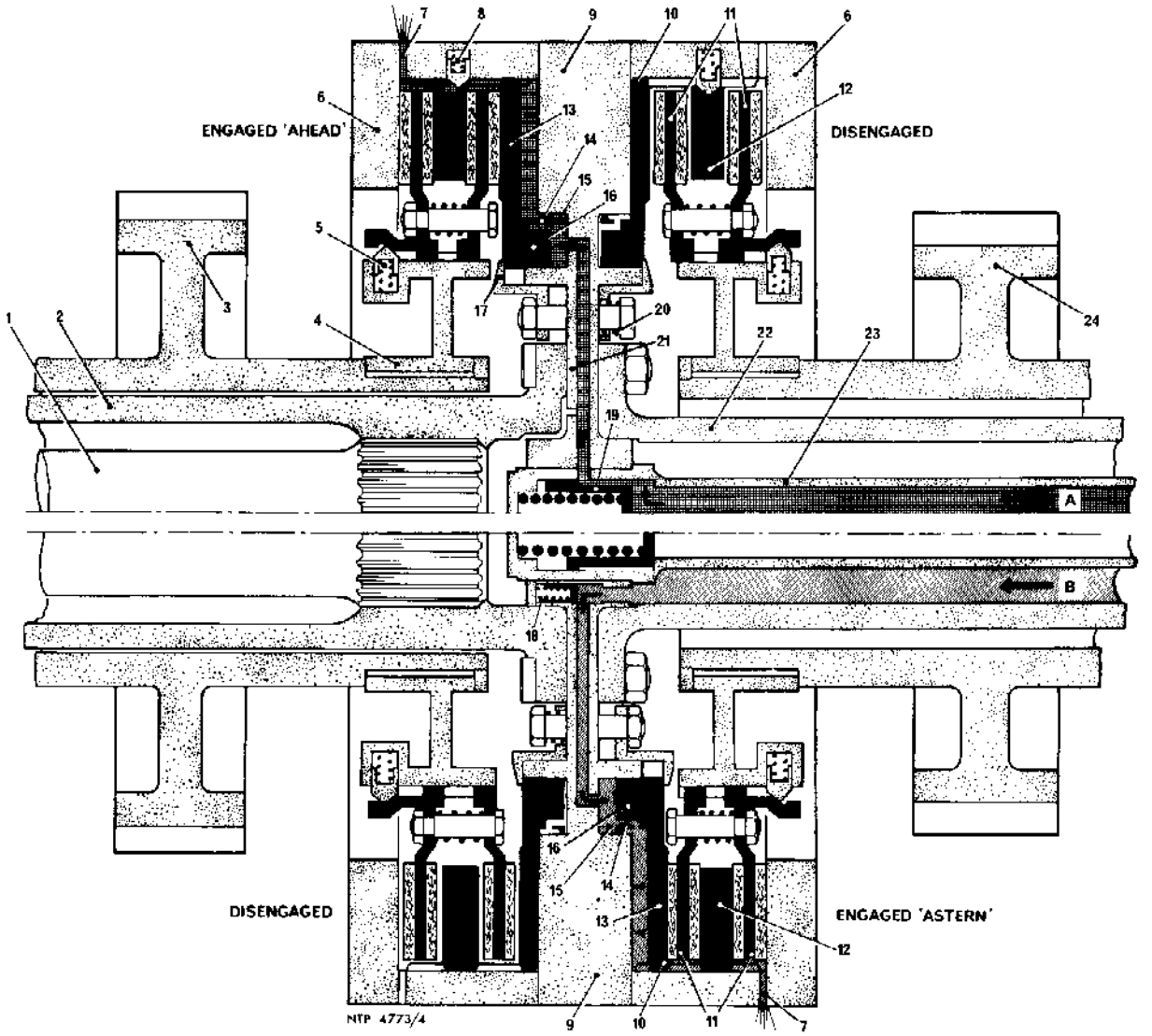
Hydraulic Clutch Assembly

The hydraulically operated clutch assembly consists of two separate clutches arranged one on either side of a common driving member, one clutch being used for the engagement of the drive which rotates the output shaft and flange in a clockwise direction and the other for the engagement of the drive in the reverse direction. The two clutches are similar in design and operation and each has two friction discs interposed between three steel plates.

From the accompanying diagrammatic illustration it can be seen that each clutch is assembled in a housing formed between the driving plate (9) and a reaction plate (6) bolted to each side of the driving plate. Adjacent to the driving plate in each clutch is a pressure plate (10), the outer edge of which carries machined teeth. These teeth engage with splines cut on the inside of the reaction plate, thus the pressure plate is positively driven and at the same time can move axially in the splines of the reaction plate. One side of the pressure plate is subjected to hydraulic pressure and has a primary (16) and a secondary (13) loading face.

Between the pressure plate (10) and the reaction plate (6) are the friction discs with a centre pressure plate (12) sandwiched between them. The outer edge of the centre pressure plate carries teeth and also engages with the splines of the reaction plate. The friction discs are secured to toothed plates, the teeth of which engage with a splined coupling, attached to the driving gear thus a positive drive can take place between the friction discs and the driving gear through the toothed plates and coupling while allowing an axial movement of the friction discs with their toothed plates.

When the clutch is in the free or neutral position the pressure plate (10) is held against the driving plate and away from the adjacent friction discs by a spring loaded return plate (17). The central pressure plate is held in its neutral position by plungers (8) which always seek the lowest



1. Quill-shaft
2. Clutch shaft
3. Ahead drive gear
4. Clutch coupling
5. Clutch coupling detent plunger
6. Reaction plate
7. Peripheral bleed orifice
8. Intermediate pressure plate detent plunger
9. Centre driving plate
10. Piston pressure plate
11. Friction discs
12. Intermediate pressure plate
13. Secondary loading face
14. Orifice
15. Primary oil chamber
16. Primary loading face
17. Spring loaded return plate
18. Anti-drain valve
19. Oil tube anti-drain valve
20. Return spring
21. Oil supply clutch quill-shaft splines
22. Clutch shaft
23. Oil tube
24. Astern drive gear

A. Oil supply for ahead clutch operation
B. Oil supply for astern clutch operation

HYDRAULIC CLUTCH - FUNCTIONING

point of vee-section grooves machined on the outer toothed edge of the plate. Compression return springs hold the two friction discs apart at a predetermined distance while further detent plungers arranged around the driving coupling centralise the friction discs, in their neutral position, between the pressure plates and reaction plates.

Operating Oil Flow

Pressure oil from the clutch pump housed in the hydraulic control unit flows through one of two galleries in the gearbox casings, and along either the oil tube or the annular space between the tube and the shaft to operate the clutch. The oil passes through anti-drain valves (18) positioned in the driving plate or through the oil tube and valve (19), and is conveyed through separate sets of radial and transverse drillings in the clutch driving plate to the oil chamber (15) where it exerts a pressure on the primary loading face of the pressure plate. The oil continues to flow through a restricted orifice (14) in the pressure plate primary loading face and exerts an increasing pressure on the secondary loading face. A bleed orifice (7) is provided at the periphery of each clutch this ensures a flow of oil through the clutch and obviates any possible build up of sludge in the splines and teeth of the reaction plate and pressure plates which might lead to sluggish operation.

Clutch Functioning

Movement of the clutch control to engage either ahead or astern will cause the hydraulic control unit to direct pressure oil from the clutch pump into the duct in the gearbox casings leading to the appropriate side of the clutch. Oil pressure builds up in the primary loading chamber (15) to a valve approaching the pressure drop through the transfer orifices. This pressure is sufficient to move the pressure plate away from the driving plate and sandwich together all the plates of the selected clutch. No further axial movement of the pressure plate can now take place, and the clutch is sealed against the escape of pressure oil except from the peripheral bleed orifice. Pressure in the primary loading chamber increases and, as a greater amount of oil can pass through the transfer orifices than can escape through the bleed orifice, pressure also rises across the secondary face of the pressure plate, thus completing the engagement of the clutch plates. Sudden shock engagements are eliminated with this two stage system and the useful life of the gear teeth and clutch surfaces is considerably increased. Centrifugal force acting on the oil is small at idling speed but large at full speed, and is supplementary to the clutch pump pressure.

The clutch is released from engagement when movement of the clutch control causes the hydraulic control unit to cut off the oil supply to the clutch. Centrifugal force displaces the oil through the bleed orifices and the clutch discs and pressure plates return to their neutral positions under the conbined action of the return springs and detent plungers.

The anti-frain valves in the oil tube and driving plates retain the oil, in the passages and pipes leading to the clutch, against the action of the centrifugal pressure. As soon as the oil supply is cut off by the hydraulic control unit these valves close and they can not be opened by a depression on the outlet side. As the oil feed passages and pipes to the clutch are always full of oil, immediate operation of the clutch is assured, the small leak through the oil tube spigots being compensated by a bleed in the hydraulic control unit.

A description of the hydraulic control unit and its operation will be found in Chapter II on Controls.

Trailing Pump

An auxiliary pump is fitted on the bi-directional gearbox to ensure that the gears are adequately lubricated when rotated by a trailing propeller. The pump draws oil from the bottom of 'CA' Crankcase and delivers it to the auxiliary spray jets within the gearbox; this system also operates when the engine is running and provides additional lubrication.

The trailing pump is mounted on the drive end casing of the gearbox and is driven through a quill-shaft from the layshaft. Each side of the pump is connected to both the inlet and outlet passages through double ball valves, thus ensuring that oil flows in the same direction, regardless of changes in the direction of the pump drive.