The transmission in a Ferret

In the Ferret transmissive power from the engine is taken through a fluid flywheel to a five speed pre-selector gearbox. At the front of, and forming a single unit with the gearbox, is a transfer box which contains a forward and reverse mechanism and a differential drive: **the H-drive**.

An **H-drive** drivetrain is used for heavy off-road vehicles to supply power to each wheel. H-drives do not use axles but rather individual wheel stations. A transfer case is a part of the drivetrain of four-wheel-drive, in other words: a vehicle with multiply-powered axles. With a permanent 4x4 drive there is no ‘diff' action between the front wheels and rear wheels on either side. Therefore, the only disadvantage of the H-differential configuration is wind-up.

A single differential splits the drive into separate left and right drive shafts. At each wheel station a bevel box drives the half-shaft out to the wheel. Effectively, a longitudinal diff lock is permanently engaged in a vehicle with an H-drive. The advantages of the H-differential are:

- Independent suspension at each wheel station
- Traction is maintained if one wheel loses grip
- Greater ground clearance and lower unsprung mass (no centre diff box on the axle).
- A low unsprung mass (i.e. the suspension, wheels/tracks and other components directly connected to the suspension) leads to better ride & handling and less vibration.

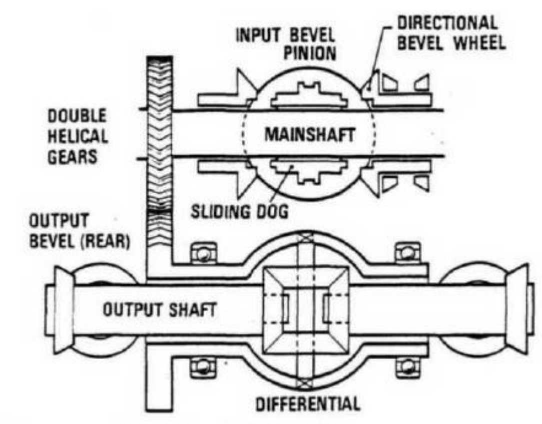
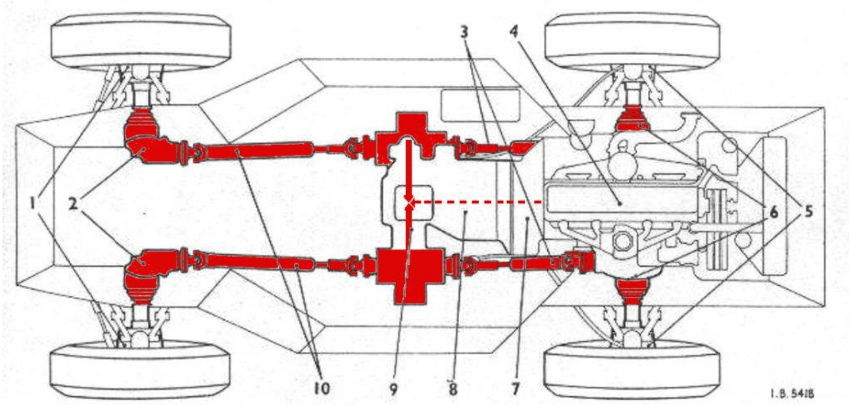


Fig 6.1 TRANSFER BOX

The upper half of the Ferret transfer box contains two spiral bevel directional control gears, in constant mesh with the driving bevel on the output shaft of the gearbox. Positioned coaxially with the directional gears is a sliding dog that permits the driving motion to be taken to one or other of the directional gears to effect forward or reverse motion. A double-helical drop-down pinion gear on the right-hand end of the mainshaft is meshed with a similar double-helical pinion on the differential assembly of the output shaft in the lower half of the transfer box. Half-shafts connect the differential with the output bevels and propeller shafts.

Ferrets use a simplified layout of the H-drive with the gearbox and transfer case within a single housing, was used for the Ferret. A single wide casing houses the differential and transfer box, with four articulated driveshafts running to bevel gear boxes inboard of each wheel.

The propeller shafts are fitted with universal constant-velocity joints. The driveshafts are articulated with Tracta constant-velocity joints and epicyclic reduction gears in the hubs at each wheel-station.



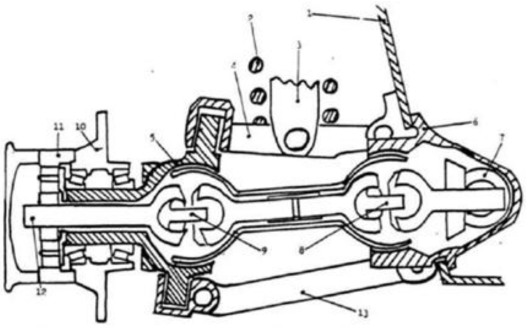
1 Front road wheel hubs
2 Front bevel boxes
3 Rear propeller shafts
4 Engine
5 Rear road wheel hubs
6 Rear bevel boxes
7 Fluid coupling
8 Gearbox
9 Transfer box
10 Front propeller shafts

Transmission layout H-differential

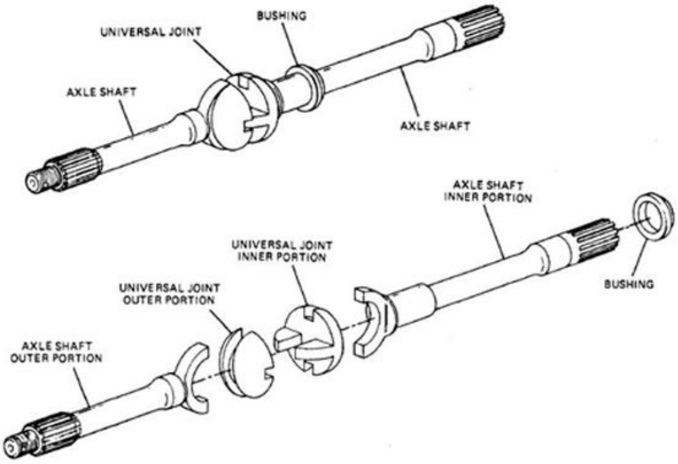
Constant-velocity joints (aka homokinetic or CV joints) allow a drive shaft to transmit power through a variable angle, at constant rotational speed, without an appreciable increase in friction or play. Constant-velocity joints are protected by a rubber boot, a CV gaiter, filled with oil or molybdenum disulphide grease.

[Four bevel gears in the transfer box](#) connect via universal joints with the propeller shafts. Each of these four propeller shafts drives its own bevel box through a second universal joint. At each wheel station a bevel box drives the half shaft out to the wheel. Bevel gears are used in differential drives, which can transmit power to two axles spinning at different speeds, such as those on a cornering vehicle.

Within each [bevel box](#) and associated wheel hub are two constant velocity Tracta joints which form a flexible drive to the epicyclic reduction gears contained within the wheel hub. The Tracta joint works on the principle of the double tongue and groove joint. It comprises only four individual parts: the two forks (a.k.a. yokes, one driving and one driven) and the two semi-spherical sliding pieces (one called male or spigot swivel and another called female or slotted swivel) which interlock in a floating (movable) connection. Each outer Tracta joint is attached to the road wheel hub, forming one enclosed unit. The hub carries the needle roller bearings and epicyclic hub reduction gears.

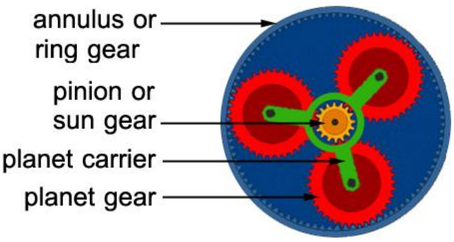


1. Hull.
2. Road spring.
3. Shock absorber.
4. Upper link.
5. Swivel assembly.
6. Bevel box.
7. Prop-shaft bevel.
8. Inner tracta joint.
9. Outer tracta joint.
10. Roadwheel hub.
11. Reduction gear annulus.
12. Outer tracta shaft.
13. Lower link.



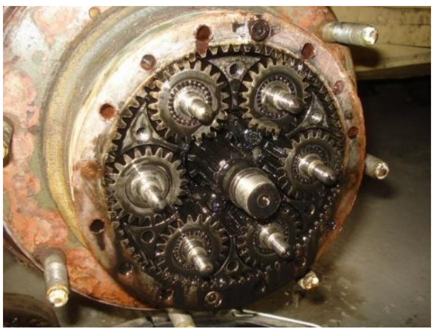
Using bevel boxes to drive the half shaft out to the wheel (rather than DAF's worm gears) requires the final drive reduction to be placed in the hubs, using an epicyclic reduction in each hub. This had the advantage of reducing torque in the driveshafts, allowing their unsprung weight to be made lighter. (Unsprung weight is anything not supported by the suspension. Where the axle assembly (including the differential) moves with the driving wheels it is unsprung. Reducing unsprung weight can aid acceleration through improving traction and making the suspension more effective. The unsprung weight of a wheel controls a trade-off between a wheel's bump-following ability and its vibration isolation.)

An **epicyclic gear train** consists of two gears mounted so that the centre of one gear revolves around the centre of the other. The planet and sun gears mesh so that their pitch circles roll without slip. A point on the pitch circle of the planet gear traces an epicycloid curve.



Epicyclic gearing systems also incorporate the use of an outer ring gear or *annulus*, which meshes with the planet gears. In many epicyclic gearing systems, one of these three basic components is held stationary; one of the two remaining components is an *input*, providing power to the system, while the last component is an *output*, receiving power from the system.

The load in a [planetary gear train](#) is shared among multiple planets, therefore torque capability is greatly increased. The more planets in the system, the greater the load ability and the higher the torque density. Multiple gear surfaces share the instantaneous impact loading evenly which make them more resistant to the impact from higher torque. The housing and bearing parts will not be damaged and crack due to high loading. Epicyclic gear trains are also efficient with only 3% loss per stage, ensuring a high proportion of the energy being input is transmitted through the gearbox.



[Epicyclic reduction hubs]() are essential on the Ferret and other wheeled armoured vehicles to reduce the torque of the transmission driveline and to provide sufficient tractive power for a permanent four-wheel drive. (In this picture the planet carrier and sun gear have been removed)

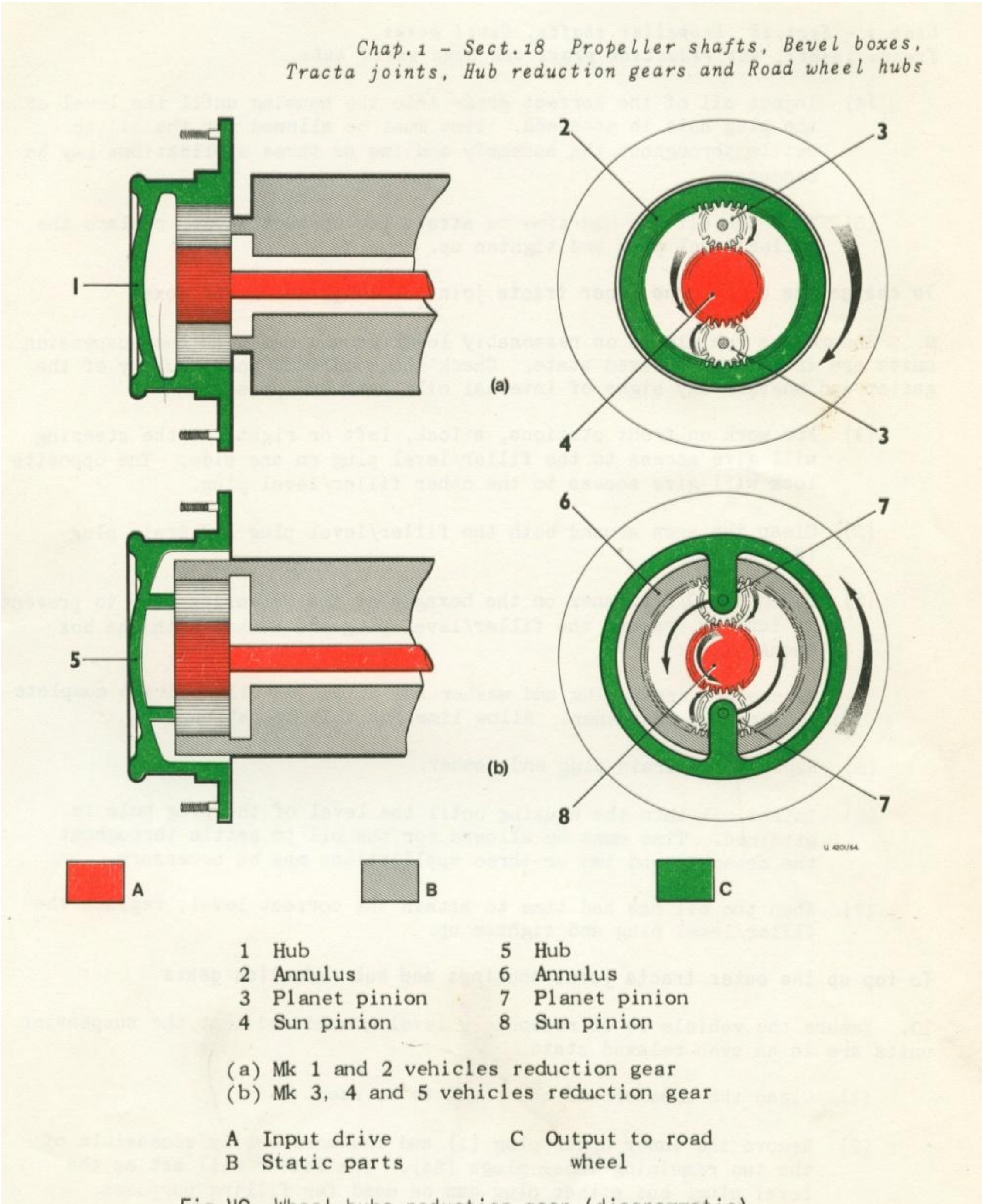


Fig 49 Wheel hubs reduction gear (diagrammatic)

Filling the wheel station with EP90

There are three filling points on each wheel station: the Inner bevel box/inner Tracta; the outer tracta, and the wheel hub. The filler for the outer Tracta is on top of the housing, right behind the brake backing plate. Its easier to get to with the tyre off with a large Allen key fitting. This filler plug is only used when initially filling after changing the wheel station. It takes ages for oil to flow between inner and outer Tracta hubs. The oil in the planetary wheel hub can run all the way through to the inner Tracta. Some people use a grease pump filled with EP90 gear oil, I use a [Sealey oil syringe pump]() with tubing, having straightened the terminating metal tube.

The Allen key fitting on the wheel hub is easy to get to. The rear wheel station inner bevel box/Tracta filling points are likewise easy to get to. In order to fill the inner bevel box/Tractas on the front wheel stations, the steering has to be put on full lock, first one way then the other.