TKP3501
Farm Mechanization

Topic 3b:
Power Trains: Mechanical-drive

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Outlines

- Mechanical Drive Power Trains
  - Clutch
  - Transmission
  - Differential
  - Final drive
Learning Outcome

- Understand the different mechanical-drive power trains
- Know the basic components mechanical-drive power trains of a tractor
- Comprehend the principle of speed to torque variations in gear settings
Power from engine of 4 wheeled tractor is supplied through power train for work output.

The power train consists clutch, transmission gear box, PTO shaft, differential gear box, final drives: axles, wheel drive shafts and wheels.

![Diagram showing the relation of engine clutch to power train](image-url)
Clutch
Clutch

- Transmit power from engine to the transmission and provides means of stopping and starting in power flow
- To transmit torque at variable speed (gear system)
- Two kind: wet and dry
THE CLUTCHES

A powerful Belleville spring (coloured red) between the two pressure plates (coloured yellow) presses the PTO clutch plate against the flywheel and presses the transmission clutch plate against the clutch cover.

The controls are:
- a lever for the PTO clutch
- a pedal for the transmission clutch.

Special lever mechanisms (coloured green or blue) release the pressure plates to disconnect one or the other clutch.

Since the two controls are fully independent the PTO can be started or stopped even when the tractor is on the move or, vice-versa, the tractor can be stopped with the PTO running.
Clutch is a mechanism for connecting or disconnecting loads to the engine.

Loads is transmitted by power train. Clutch enables gear change in order to balance up load and engine capacity. Loads include forward speed, tractor weight, drawbar pull and rotary power at PTO.

Clutch disengages the rotating engine output shaft from gear box consisting of a set of gears. In this way the gears in gear box are no longer in motion thus gear selection is possible by shifting the gears to the desired combination that suit the instantaneous load.

In the process of gear shift power to drive wheel is temporarily stopped.
Typical Disk Clutch

- Driven Plate
- Pressure Plate
- Clutch Release Assembly
- Drive Shaft
- Free Travel
- Clearance
- Clutch Release Lever
- Flywheel
- Power Flow

**Engaged**

**Disengaged**

1 - 1.5 mm
While engaged the pressure plate is in full contact with driven disc the other side is also in full contact with flywheel.

At disengaged position pressure plate is released from driven disc. This is as a result of the operator’s foot on the pressing the clutch pedal which cause the throw-out bearing to press on release lever.

The connection and lever arrangement allows clearance and adjustment to the clutch setting to take up wear and tear.
- Clutch care is important. Avoid “clutch riding” which accelerate clutch wear.
- Worn clutch will cause clutch slip at flywheel face, heat is generated which further degenerate the clutch.
- It is a housing contains gear sets and shafts with access for filling and draining gear oil.
- The purpose of transmission box is to control speed and torque transmitted to the output shaft or to the drive wheels.
Torque is shifted from one gear to another and in the process rotation speed and torque vary according to gear combination.

If from smaller gear to larger gear; power will increase but rotation speed will decrease and so is the reverse.

Loads on tractor varies widely, as such gear combination needs to be accurate. In this engine will not be overloaded causing it to stall or increase in fuel consumption.

The number of gears varies with the number of speed on the tractor. An example of 3 forward speed gear combination is as shown.
Gear combinations
Forward gear

Reverse gear

Idler gear

low (first) gear

second gear

high (third) gear

reverse

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On first gear speed selection the moveable large gear is in mesh with fixed smallest gear. The fixed small gear drive the moveable gear. This arrangement result in low speed at output shaft that is connected to the drive wheel.

On second gear, fixed larger gear is in mesh with moveable smaller gear. The speed of drive wheel become much faster than the first gear.

Third speed. The highest gear combination for this gear box, input shaft from clutch is connected directly to the output shaft of the gear box. Resulting in the highest speed.

Reverse motion. An idler pulley is placed between the fixed gear and the moveable

There are many more combinations and speeds, additional gear box in series e.g. from 4 speeds to 8 speeds.

Lubricating oil such as SAE 90 is placed in the gear box for anti friction, heat removal and anti rust. See the manufacturer’s instruction on the time needed to change oil.
Transmission

For forward and reverse

- Two independent clutches combined in a single group connect the engine power to the transmission and to the PTO gently and smoothly. The first, lever-operated, is for the PTO. The second, control pedal, is for the transmission. The PTO clutch may be a separate assembly; in this case it is separate from the transmission clutch and is hydraulically operated.

- The compartment which follows contains the range gearbox: low, medium, reverse (or medium-high) and high. This compartment also contains the Four-Wheel Drive power connection if present.

- Another compartment holds the gear pairs for the speed gearbox: 1st, 2nd, 3rd and 4th speeds or 1st, 2nd, 3rd, 4th and 5th speed and reverse.

- The housings, in modular cast iron, are combined into a single block and make up the load-bearing chassis of the tractor itself. The housings (gearbox, final transmission, final drives and PTO) are secured to one-another by rugged flanged joints.

- A special compartment is available for option such as:
  - reverse
  - creeper
  - creeper + reverse
  - HI-LO
  - Over-Drive etc.
Transmission of 2 wheeled tractor

- Belt and pulley drive Transmission
- Pulley is fixed to crankshaft output shaft and connected by multiple belts to pulley on transmission box.
- An idler pulley may be used as simple clutch on smaller two wheeled tractors
Differential

Transmit power from transmission to final drives

Allow the wheel to turn at different speed during turn
• The oil-immersed disk brakes are hydrostatically or mechanically operated. For longer lifetime and increased efficiency, they are located before the final drives so that they act on much lower torques.

• The final transmission housing contains the PTO gearbox (540-1000 rpm) and the relative exchangeable output shaft end.

• On bends, the rotation speed of the outside wheel increases and that of the inside wheel is reduced; the differential comes into play to adapt the two speeds to the bend correctly. When working in the field along a straight line and at high draft forces, the differential can be locked using special mechanically, mechanically-hydrostatically or hydraulically operated devices.

• Starting from the clutch the rotation speed is gradually reduced by the gearbox, the range box and the bevel gear pair, but to generate the tractive forces required for normal use of the tractor the speed must be further reduced by the epicyclic or cascade type final drives.

• The power has been transmitted straight up to this point but is now directed at 90° towards the driving wheels through the bevel gear pair. The axes of rotation of the pinion and crown wheel are perfectly perpendicular to each other.
The purpose of the differential gear box is to avoid drive shaft breakage as a result of different speed of wheel rotation during turns.

The Pinion Gear from input drive shaft turns the crown gear. The gear arrangements are such that:

- Whenever the tractor moves in straight path all the differential gear sets rotate as one unit.
- When the tractor turns the gear arrangements allows the wheel on the inner side of the turn circle to turn slower than the outside wheel.
Diff Gear Lock is provided to almost all tractors to enable both drive wheels to rotate at similar speeds and similar power.

Otherwise one wheel will rotate freely when the tractor wheel get stuck or one wheel slips freely. As such the tractor will not move. This happens on soft ground or sandy soil.

Diff gear lock is engaged by the operator

Diff gears uses similar lubricating oil as in gear box
Final Drives
Transmit power from differential to PTO and driving wheels
Wheel

A - independent link suspension position sensor
C - Tie rod assembly
E- Lower control arm

B – Upper control arm
D – Drive shaft assembly
F – Suspension cylinder
Used to drive many field equipment's such as rotary tiller, pump, sprayers, rotor slasher.

PTO shafts speed and size had been standardized.

Speed

Former rotational speed standard (before 1959) was 540 rpm with +/- 10 rpm. Shaft size was 1 1/8 in. to 1 3/8 in. (35 mm) having 6 splines. Some are still in use.

New standard (since 1960) is 1000 rpm +/- 25rpm. Shaft size 1 3/4 in. (45 mm). Used mostly large tractor
3 ways PTO are driven

- **Transmission gear box:**
  - moves when the clutch is engaged as that to deliver power to drive wheels.

- **Continuous running**
  - Driven by transmission gear box. Have separate clutch that enable it to operate even when the tractor wheel drive is disengaged. It can be engaged or disengage while the tractor is moving.

- **Independent**
  - Driven by its own gear box and clutch system. Independent of tractor main power train and it can be operated or disengaged while the tractor is moving.
Figure 1. The major components of PTO systems
Fig. 45—Location Of PTO Shaft And Drawbar Hitch
Attach stabilizer bars or check chains to limit sway to 3 cm. Adjust tractor linkage to level the Rotavator laterally and longitudinally (see Fig. 3)
Safety measure working with PTO

- Always place PTO cover especially during operation.
- Always disconnect PTO when not in use.
- Avoid contact with hand, feet and clothing from moving PTO and connected parts.
- Do not connect shafts to PTO at extreme angle of connection.
- Avoid servicing works while the PTO is running and with the engine running.
QUESTIONS

- In mechanical transmissions, power flow is stopped and started by the _____.
- Match each item on the left with the job it performs on the right
  - Clutch: Equalizes load for tuning
  - Transmission: Connects and disconnects power
  - Differential: Selects speeds and direction
Questions

- Two gears are in mesh. Gear A has 12 teeth, while gear B has 24 teeth. When gear A has made one complete revolution, how far has gear B traveled?

- True or False? For speed reduction in low gears, a large gear drives a smaller gear

- True or False? When a machine turns, the outside drive wheel must turn faster
How and where to start tillage in the farm?
Thank you.