Study Notes

Modes of Power Transmission, Tractor and its components
Power transmission system

- Transmission is a speed varying mechanism, equipped with several gears.
- It may be called a sequence of gears and shafts, through which the engine power is transmitted to the tractor wheels.
- The system consists of various devices, which cause forward and backward movement of tractor to suit different field condition. The complete path of power from the engine to the wheels is called Power train.

Modes of Power Transmission

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<thead>
<tr>
<th>Power Transmission Component</th>
<th>Description</th>
<th>Common Uses</th>
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<tr>
<td>Belts</td>
<td>Loops of flexible material used to link two or more rotating shafts mechanically. Can transmit power and track relative movement.</td>
<td>Drive systems, conveyor belts, linking pulleys.</td>
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<tr>
<td>Ropes</td>
<td>Used as belts for power transmission before belts became common. Multiple loops were used for increased traction and backup if one fails.</td>
<td>Transferring power in early systems.</td>
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<tr>
<td>Chains</td>
<td>Consists of interconnected links used for transmitting mechanical power.</td>
<td>Chain drives in bicycles, motorcycles, and vehicles.</td>
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<tr>
<td>Gears</td>
<td>Rotating machine parts with cut teeth (cogs) that mesh with another toothed part to transmit torque. Can produce a mechanical advantage through gear ratios.</td>
<td>Transmission systems, mechanical advantage, speed changes.</td>
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<tr>
<td>Couplings</td>
<td>Devices used to connect two shafts together at their ends to transmit power. Do not allow disconnection of shafts during operation.</td>
<td>Power transmission between shafts.</td>
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Shafts:

- A shaft is a **rotating machine** element which is used to transmit power from one place to another.
The power is delivered to the shafts by some **tangential force** and the resultant torque (or twisting moment) set up within the shaft permits the power to be transferred to various machines linked up to the shaft.

In order to transfer the power one shaft to another, the various members such as pulleys, gears etc. are mounted on it.

These members along with the forces exerted upon them causes the shaft is used for the transmission of torque and bending moment.

The various members are mounted on the shaft by means of keys or splines.

### Types of shafts

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<tr>
<th>Transmission Shafts</th>
<th>Machine Shafts</th>
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<tbody>
<tr>
<td>Transmit power between the source (prime mover) and the machine absorbing power.</td>
<td>Integral part of the machine itself.</td>
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<tr>
<td>Found in counter shafts, line shafts, overhead shafts, and other factory shafts.</td>
<td>Examples include crankshafts.</td>
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<tr>
<td>Subjected to both bending and twisting forces since they carry machine parts like pulleys and gears.</td>
<td>Primarily subjected to twisting forces.</td>
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**Flexible Drive Elements**

- Used for larger center distances between shafts.

**Non-Flexible Drive Elements**

- Used for shorter center distances and within the machine.

### Tractor

- Tractor is a self-propelled machine used for pulling or pushing and stationary work.
- The word "tractor" is derived from "traction" and "motor," indicating its purpose for traction.
- Tractors are used for various jobs by attaching different implements and tools.
- They serve as a farmer's movable power house, providing power for agricultural operations.
- Tractors can have wheels or tracks for operating agricultural implements and machines, including trailers.
- The tractor engine acts as a prime mover for active tools and stationary farm operations through power take-off shaft or belt pulley.

- Power tiller is a walking type tractor controlled by the operator walking behind it. It is also known as a hand tractor.
- The concept of power tiller emerged in the world in 1920, and Japan was the first country to use it in 1947. It was introduced in India in 1963.
Classification of Tractors

The tractors are classified into three classes on the basis of type of construction, type of drive and purpose.

Based on type of construction:

1. **Riding type tractors** – Tractors in which a driver can sit and drive e.g., General purpose four wheel tractors.
2. **Walking type tractors** – Tractors with which the operator walks along e.g., garden tractors, power tillers.

Based on type of drive:

1. **Track type tractors (also called crawler tractor or chain type tractor)** - In this type of tractors, instead of wheels; one track is fitted on either side. This track gets drive from the sprocket run by rear axle shaft. To steer the tractor, there is not steering gear fitted. The tractor is steered by applying brakes to one side of the track with the other track moving. These are used for bulldozing or land clearing work.
2. **Wheel type of tractors** – These are most commonly used agricultural tractors. They can run fast and wheel tyres absorb a certain amount of field shocks also. These can be further divided as:
   A. **Two-wheel tractors** – These tractors are used for small farms, hilly area and gardening purposes and are called power tillers.
   B. **Three-wheel tractors** – These tractors were very popular 15 years back but now its place has been taken by four wheel tractors. These tractors had single or dual wheel fitted at the front end in the centre and were considered good for negotiable shorter turns.

- 1890: Tractor engine invented by George Harris of Chicago.
- 1906: First gasoline tractor developed by Charles Hart from Iowa.
- 1936-37: Diesel engine and pneumatic tires used in tractors.
- 1937-41: Hydraulic system and three-point linkage developed for tractors.
- 1962-70: Manufacturers like TAFE, Hindustan Tractors, Escorts Tractors, and International Harvesters started production during this period.
- 1973: Manufacturing of HMT tractors started.
- 1983-08: GTCL Tractors, Bajaj, Mahindra, Swaraj, Sonalika, John Deere, PTL, VST, and many other companies started manufacturing tractors in India.
C. **Four-wheel tractors** – These are most commonly used tractors in the country. These are also known as all purpose tractors.

**On the basis of available power**

3. Large tractors – more than 45 hp.

**Based on purpose:**

1. **Utility tractors** – It is a specific purpose field tractor and is designed for ploughing driving any other equipment through its P.T.O. drive. It is not being manufactured at present in the country.
2. **All purpose tractor** – It is designed in such a way that it can meet practically all the demands for agricultural purposes such as ploughing, harrowing, leveling, pulling, seed drill, operating thresher, and pumps through its P.T.O. These are provided with three point linkages.
3. **Orchard type tractors** - These are special types of tractors used in orchards. These are made very high in height so that driver while sitting on the seat, the operations on the trees could be performed. No part of the tractor is protruded outside so that tractor can go easily in between trees safely.
4. **Garden tractors** - These tractors are in the range of 1 to 10 hp and are very small in construction. These are mostly used for kitchen or vegetable gardens.
5. **Rotary Tillers** - These are walking type of tractors and are used in small fields or on hills where fields are very small and are at different levels where ordinary tractors cannot work efficiently. Tined blades are fitted to the tillers to prepare the seedbeds quite effectively by pulverizing the soil. These are also used in rice fields for puddling and other operations.
6. **Earth Moving tractors** - These tractors are heavy in weight and strongly built available both is tract and tyre type. These are used for earth moving work on dams, quarries and other constructional works.

**Components of Tractor:**

- Internal combustion engine
- Clutch
- Transmission gears
- Differential unit
- Final drive
- Rear wheels
- Front wheels
- Steering system
- Hydraulic control and hitch system
- Brakes
- Power take off unit
Every tractor is fitted with an I. C. engine, the engine may be carburettor type or diesel type but nowadays almost all the tractors are diesel tractors.

**CONTROL BOARD OR DASH BOARD OF A TRACTOR**

The control board of a tractor generally consists of:

1. Main switch
2. Throttle lever
3. Decompression lever
4. Hour meter
5. Light switch
6. Horn button
7. Battery charging indicator
8. Oil pressure indicator and

**TRACTOR TYRES AND FRONT AXLE**

**TYRES:**
- The tyres are available in many sizes with the ply ratings as 4, 6 or 8. The ply rating of tyres indicates the comparative strength of tyres.
- **The higher the rating, the stronger are the tyres.**
- The tyres size 12—38 means, that the sectional diameter of tyres is 12" and it is mounted on a rim of 38" diameter.
- The inflation pressure in the rear wheels of the tractor varies between 0.8 to 1.5 kg/cm². The inflation pressure of the front wheel varies from 1.5 to 2.5kg/ cm².
Useful life of the pneumatic tyres under normal operating condition may be about 6000 working hours for drawbar work.

**FRONT AXLE:**
- Front axle is the unit on which front wheel is mounted. This wheel is an idler wheel by which tractor is steered in various directions.
- The axle is a rigid tubular or I-section steel construction pivoted at the centre.
- There are various adjustments of front wheel.

**HITCHING SYSTEM OF TRACTOR DRAWN IMPLEMENTS:**
- Tractor drawn implements possess higher working capacity and are operated at higher speeds. These implements need more technical knowledge for operations and maintenance work. Tractor drawn implements may be:

<table>
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<tr>
<th>Trailing Type Implement</th>
<th>Semi-Mounted Type Implement</th>
<th>Mounted Type Implement</th>
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<tbody>
<tr>
<td>Pulled and guided from a single hitch point. Weight not supported by the tractor. Implements are not directly controlled by the tractor steering unit.</td>
<td>Attached to the tractor along a hinge axis, not at a single hitch point. Part of the weight is supported by the tractor. Controlled directly by the tractor steering unit.</td>
<td>Attached to the tractor, controlled directly by the tractor steering unit. Carried fully by the tractor when out of work. Implements are fully supported by the tractor.</td>
</tr>
</tbody>
</table>

- **Wheelbase:** Wheel base is the horizontal distance between the front and rear wheels of a tractor, measured at the ground contact.
- **Ground clearance:** It is the height of the lowest point of die tractor from the ground surface, the tractor being loaded to its maximum permissible weight.
- **Track:** Track is the distance between the two wheels of the tractor on the same axle, measured at the point of ground contact.
- **Turning space:** It is the diameter of the smallest circle, described by the outermost point of the tractor, while moving at a speed, not exceeding 2 km/hr with the steering wheels in full lock.
- **Cage wheel:** It is a wheel or an attachment to a wheel with spaced cross bars for improving the traction of the tractor in a wet field. It is generally used in paddy fields.

**Clutch:**
- Clutch is a device used to connect and disconnect the tractor engine from the transmission gears and drive wheels.
- It transmits power through friction between driving members and driven members.
The need for a clutch:

1. For easy cranking, the engine is disconnected from the transmission unit by the clutch.
2. Clutch disengages the engine power when changing gears to avoid gear teeth damage.
3. Clutch allows stopping the belt pulley in the field without stopping the engine.

Essential features of a good clutch include:

- Good load-carrying ability.
- High capacity to transmit maximum power without slipping.
- Friction surface resistant to heat.
- Easy control by hand or pedal lever.
- There are three types of clutches used in engines:
  - Friction clutch (most popular in four-wheel tractors).
  - Dog clutch (commonly used in power tillers).
  - Fluid coupling (used in some tractors nowadays).

Gear and Gear box

- A tractor engine runs at high speed, but the rear wheel of the tractor requires power at low speed with high torque. Hence it is very much essential to reduce the engine speed and increase the torque available at the rear wheels of the tractor.

Differential Unit:

- Special arrangement of gears to allow one rear wheel of the tractor to rotate slower or faster than the other during turning.
- Consists of differential casing, differential pinion, crown wheel, half shaft, and bevel gears.
- Crown wheel assembly transmits power at a right angle to suit the tractor wheels and reduces rotation speed.
- Differential lock is a device that joins both half axles, ensuring equal traction for both wheels.

Final Drive:

- Gear reduction unit between the differential and drive wheels.
- Transmits power to the rear axle and wheels through spur gears and bull gear.
- Provides final speed reduction for tractor rear wheels.

Steering System:

- Controls the direction of motion of the tractor.
- Converts rotation of the steering wheel into the change of angle of the steering wheels.
- Ensures directional stability and minimum tire wear.
- Classified into front wheel steering, rear wheel steering, or all-wheel steering.