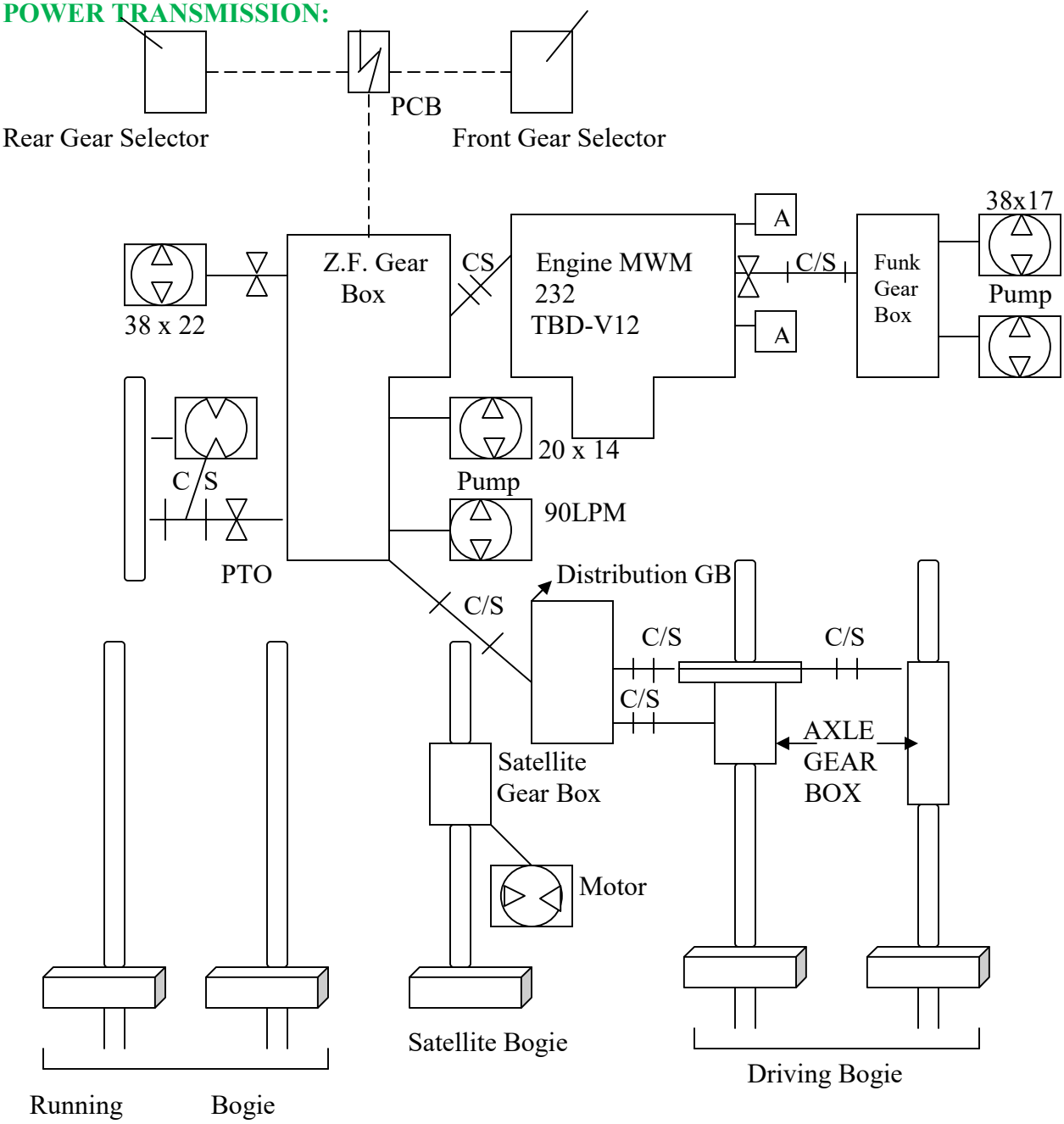
PROMOTIONAL COURSE – PROMOTIONAL JE
Course No.CE 27 Module No. 27.3
SUB: MECHANICAL
Duration: 44 Periods

Sub-discipline	Lesson	Contents	Period	Total Periods
Mechanical	**Power Transmission**	Block Diagram, Types of Power Transmission, Mechanical Transmission, 'V' belt, Chain, Pulley, Cardon Shaft.	1	**1**
	Gear Box and Clutch Assembly in DUO, Driving Axle	Working, Construction and Maintenance practices of Main gear box, Clutch assembly.	1	**2**
		Working, Construction and Maintenance practices of Reversing gear box, Six speed gear box and distributor Gear Box, setting of crown & tail pinion on Driving Axle.	1	
	Z. F. Hydro-dynamic Gear Box	Function and Construction, Precautions during working and Maintenance aspects,	1	**2**
		Failure Analysis and Troubleshooting.	1	
	Funk Gear Box, Reduction Gear Box and Satellite Axle Gear Box.	Working, Construction and Maintenance practices.	2	**2**
	Tamping Unit, Lifting and Lining Unit, Bearings.	Function and Parts, Precautions during working & repairing, Maintenance schedule, Setting of bearings and spacers on vibration shaft	1	**2**
		Failure Analysis and Troubleshooting.	1	
	Lubrication	Oil and Lubricants used in different Gearboxes, Tamping unit, Lifting unit, Screen Drum etc., types and their capacities.	2	**2**
	Maintenance Schedules	Maintenance Schedules and IOH/POH of machines.	2	**2**
		Total	44	**44**

Sub:- Mechanical

Block Diagram, Types of Power Transmission, Mechanical Transmission, 'V' belt, Chain, Pulley, Cardon Shaft.

POWER TRANSMISSION:



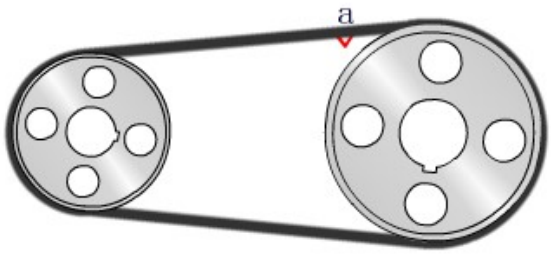
POWER TRANSMISSION:

In mechanical Engineering, the word power transmission is widely used term in all types of transmission involved in mechanical arrangement. The following are the various mechanical power transmissions generally available in day to day working, which are given as under:

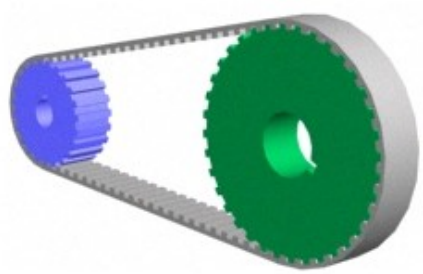
Belt transmission
Chain drive transmission
Pulley drive transmission
Gear drive transmission

Types of transmission:

Belt drives have two types of transmission, friction and meshing. The former transmits power by friction force produced between the belts and the pulleys and the latter by meshing between the teeth in the belt and the grooves cut on the periphery of the pulley.

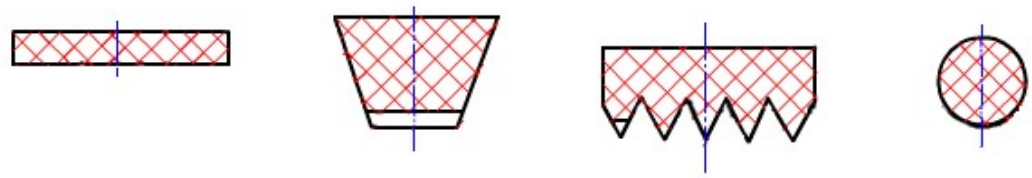


By friction



By meshing

Cross section of belts

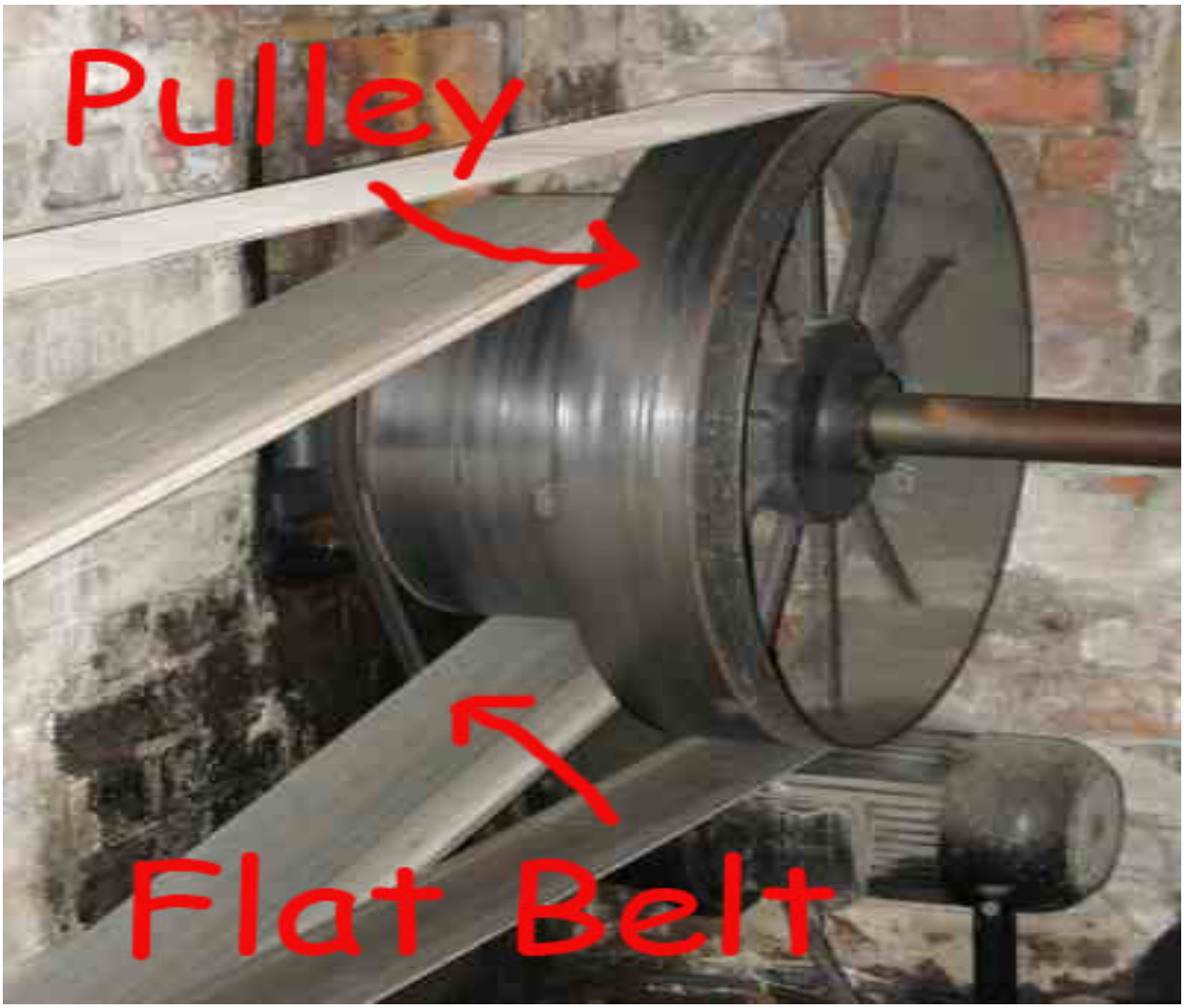


Flat belt V-belt Multiple V-belt Round belt

Types of belt drive:

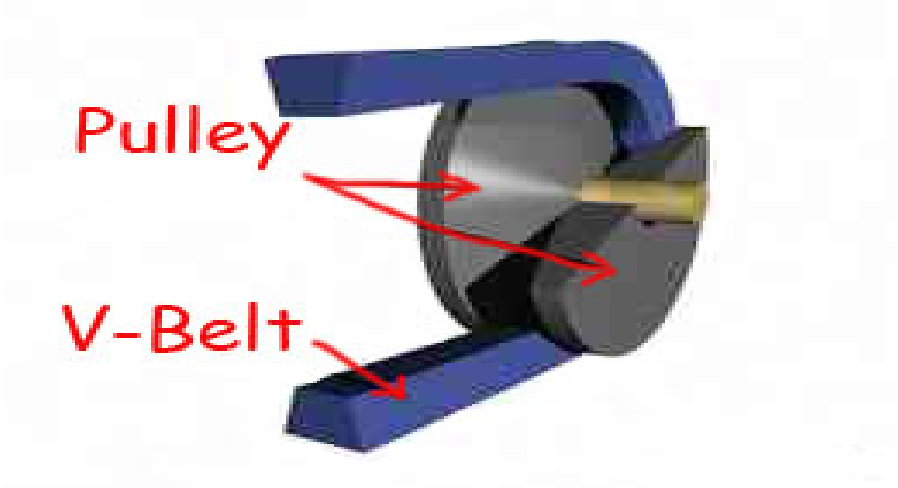
1. Flat belt

Flat belt transfers torque by friction of the belt over a pulley. Flat belt drives are mostly used for low power and high speed applications. These are also used for conveyance applications. Best drives result from belts with high flexibility, low mass, and with a high coefficient of friction.



2. V-Belt

V-belts are also known as wedge rope. This provides the best combination of traction, speed of movement, long of the bearings, and long service life. Better torque transfer possible compared to flat belt. With a flat belt drive only one belt is used, with a v- belt drive a number of belts are used.V- Belt Drives achieve drive efficiencies of about 95%.

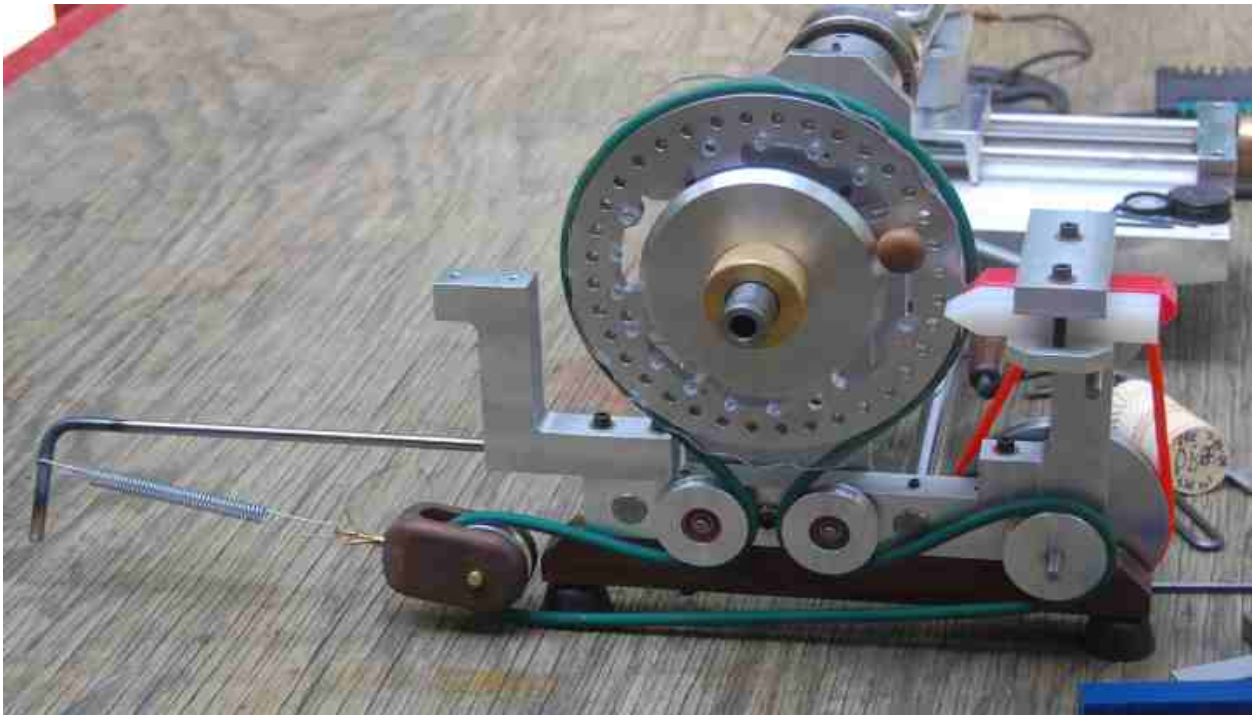


3. Timing belt

These belts are used for power transfer and for synchronized drives to ensure that the driven pulley is always rotating at a fixed speed ratio to the driving pulley. Belt toothed on the inside driving via grooved pulleys. This has limited power capacity compared to chain and V- belt derivatives and does not require lubrication.

4. Round belt

Round belts have circular cross section designed to run in a pulley with a circular (or near circular) groove. They are for use in low torque situations.

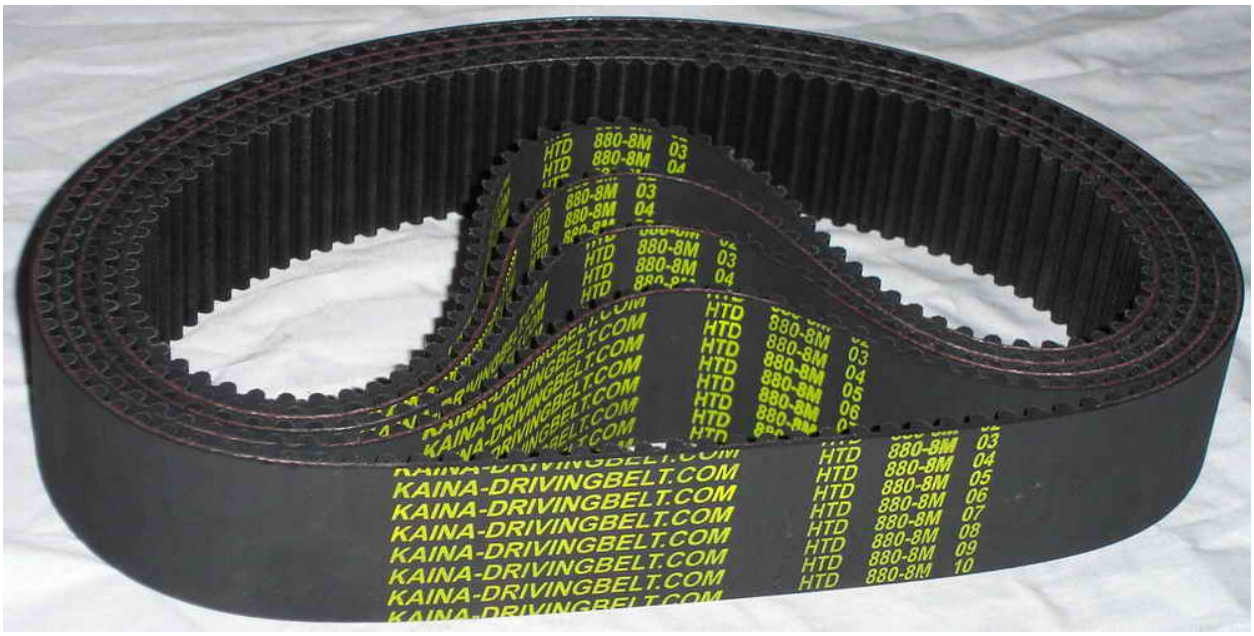


5. Other types

(a) Multi-groove/ Polygroove belts: These are made up of 5 or 6 “V” shape belt alongside each other. The added flexibility offers an improved efficiency.

(b) Ribbed belt

It is a power transmission belt featuring lengthwise grooves.



(c) Speciality belt

This type of belt transmits power on the tension side of the loop, designed for continuously variable transmission.

Of the various belt types, V-belts are the most popular. V-belts are belts of trapezoidal cross section with two sides wording surface and run over pulleys with grooves of the corresponding cross section.

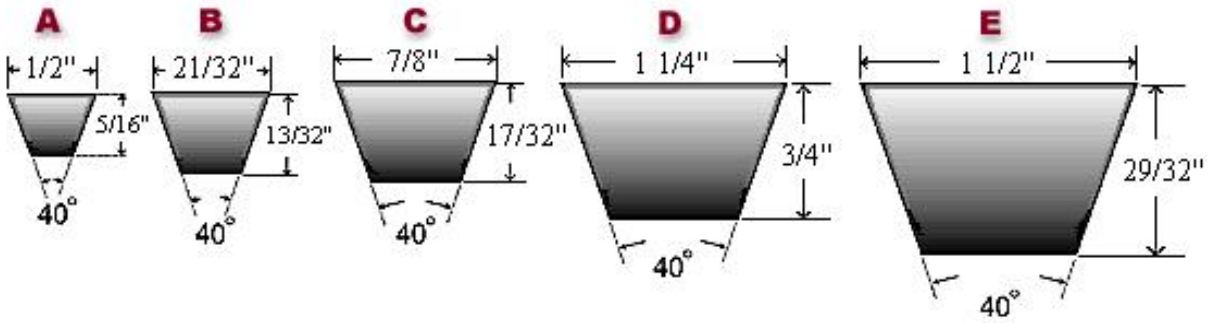
1.VEE BELT DRIVE :

V-belt drives are by far the most widely used of any of the belt drives in an industrial plant. Because of this large usage, V-belts have progressed from the one or two simple types originally furnished to at least a dozen different types. Most types of belts having similar cross-sections are interchangeable, and can be used to operate related pieces of equipment. The particular choice of for using a certain type of belt over others that are almost identical is based on the experience of the equipment manufacturer, plant engineer or the maintenance department.

V-Belt construction

1. Cover
2. Insulating Compound
3. Tension members
4. Compression area

Generally, V-belts are broken down in to three separate groups, identifiable by the size and shape of the belts. In the first group, belt sizes are currently designated by the letters A, B, C, D, and E as shown in the fig. Each of the different lettered belts has specific size limitations indicated by the dimensions. Some manufactures sizes vary slightly from those shown. Belts are made in specific length, although they are occasionally purchased as a single strand and spliced to the desired length. The standard belts are still the most commonly used in industry. Generally following are the different categories of belts used in transmission in machines, A-33, A-34, A-41 & A-42 etc.



The second group of V- Belts is classed as high capacity belts. These are used where standard belts may not perform well because of high horsepower or loading conditions. Also heat, moisture, or other similar conditions may require special belt. Sometimes, there isn't room for a standard drive, and the reduced section of the high capacity belts allows it to fit in to the smaller space.

The standard and high capacity belts, there are a number of smaller belts used for lighter duty and with smaller drive pulleys, the two types commonly used are shown in fig. The 2L through 5L belts are similar in cross-section to standard belts, and are used most often.

2. CHAIN DRIVE:

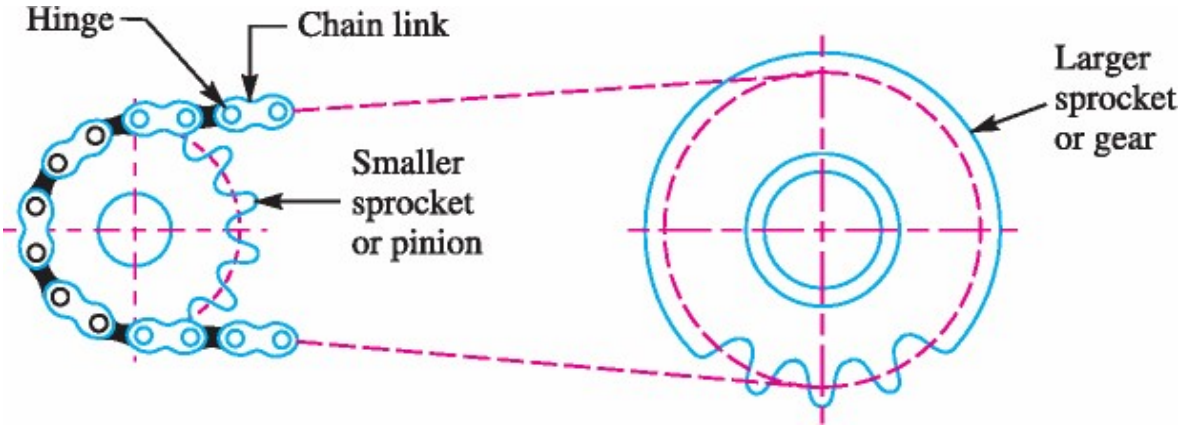
This is the method of power transmission in which chain is used for transmitting power from one end to another. In this method chain is interlinked and power transmission takes place. In track machines, following are the applications of chain drives such as simplex chain, duplex chain of PQRS machines, cutting chain of BCM etc.

Chain drive, unlike V-belts drives; do not use friction to aid in transmitting motion. Their means of transmitting motion is positive and similar to a gear tooth contact. Because of the positive transfer of motion, chain drives are approximately 98 percent efficient. The chain serves as a connection between the driver and the driven sprockets allowing them to be spaced some distance apart,

The chain, while flexible, can only be used to transmit motion in a straight line between the sprockets, it cannot make quarter turns or be reversed like a V- belt can, however chains have several advantages that V- belts do not.

One of these is the driving range of driving power that is available from the compact single strand chains, additional horse power can be accommodated by doubling or tripling the strands of chain as require. Also, the chain can be driven from either side without reversing the chain strand.

Furthermore, the chain weight forms its own take up on the loose or slack side of the drive this eliminates the adjustment that is required in a V- belt drive to maintain the proper friction contact. However, chain drives do stretch, and occasionally the take up has to be adjusted, or a link or two removed from the chain. Another important feature is that a chain drive can be positioned in any part of the driving machinery with only minor assembly or disassembly problems. This is accomplished by the link design which allows you to place the strand of chain in position and then couple it together.



Chain Definitions

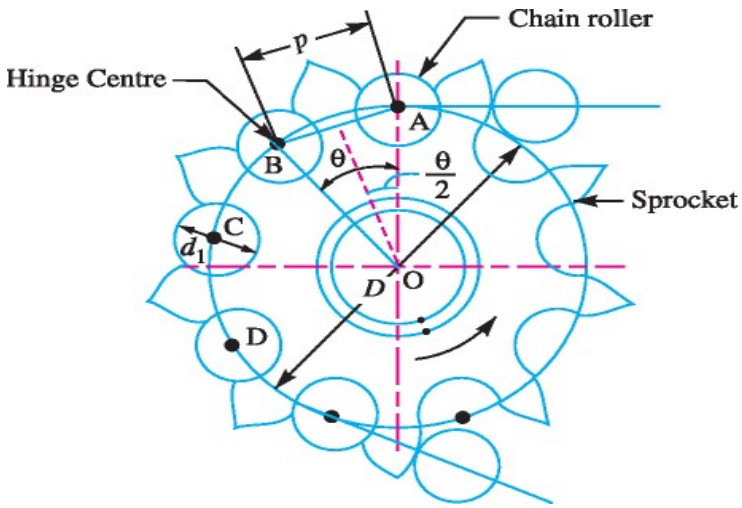
Like V- belts drives, chain drives also have specific terms describing their various components. Some of these are quite similar to the V- belt drives, while others are considerably different. We will only cover a few of the more common terms used.

Drive Sprocket:
Usually the driver sprocket is the smaller of the two sprockets and the one having the highest RPM.

Driven Sprocket:
The driven sprocket is usually the larger of the two sprockets and the one having the slower RPM.

Chain Pitch:
This is the distance from the center of one connecting pin to the center of the next, in chains having a solid block link; the chain pitch is on alternate spacing.

Center Distance:
The center distance is the distance between the centers of driver and driven shafts.



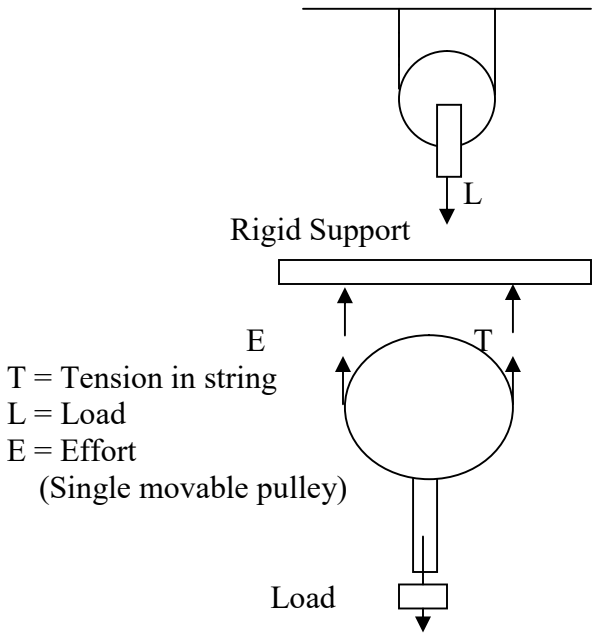
Chain Length:
The chain length is the distance from the center line of the connecting pin at one end of the strand to the empty connecting hole at the opposite end.

Chain Rating:
The chain rating, or recommended working load is the load that the chain will satisfactorily handle over extended periods of time. Most manufacturers rate their chains in maximum or average working load.

Ultimate Strength:
This is the strength of the chain before it will break. This is not a governing factor in the selection of the chain. However, it gives you the shock loading capacity of the chain.

3. PULLEY DRIVE TRANSMISSION:

This is also a method of power transmission in which pulleys are used and we get mechanical advantages by the fixed support as from the following figure:



As per the figure, an inextensible String of negligible mass-passes around the grooved rim of the pulley. One end of the string is tied to a hook ‘H’ at a rigid support and the effect ‘E’ is applied at its free end.
The tension ‘T’ acts on the string on both sides of pulley as shown in the above figure.
Load is balanced L = T+T = 2T and effort E = T.

$$\text{Mechanical advantage} = \frac{\text{Load L}}{\text{Effort E}}$$

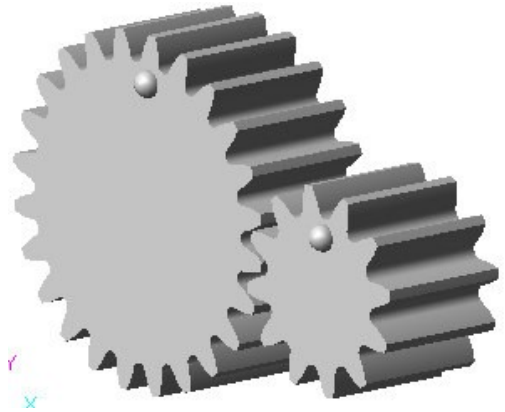
$$\text{Therefore} \quad MA = \frac{2T}{T} = 2$$

So by applying an effort equal to half the load (in ideal situation) i.e. single movable pulley acts as a Force multi pliers) P

4.GEAR DRIVE TRANSMISSION:
In this method of power transmission Gears are used for transfer of power from one point to another. More teeth of Gears are meshed to each other. There are two gears which are connected to each other one is drive gear and the other driven gear. Depending upon no. of teeth, Gear Ratio is decided. The arrangement of gears on drive and driven gear can be such that driven gear can rotate faster or slower.

Gear:

A toothed wheel that engages another toothed mechanism in order to change the speed or direction of transmitted motion.



A gear is a component within a transmission device that transmits rotational force to another gear or device. A gear is different from a pulley in that a gear is a round wheel which has linkages ("teeth" or "cogs") that mesh with other gear teeth, allowing force to be fully transferred without slippage. Depending on their construction and arrangement, geared devices can transmit forces at different speeds, torques, or in a different direction, from the power source. The most common

situation is for a gear to mesh with another gear. Gear's most important feature is that gears of unequal sizes (diameters) can be combined to produce a mechanical advantage, so that the rotational speed and torque of the second gear are different from that of the first. To overcome the problem of slippage as in belt drives, gears are used which produce positive drive with uniform angular velocity.

5. CARDON SHAFT TRANSMISSION

In this method power transmission is achieved through different cardon shafts and accordingly power is transmitted from one end to another. Different sizes of cardon shafts are used on different track machines.

Various cardon shaft used in old Duomatic machine:

1. Engine to main gear box 1 No.
2. Main gear box to system pump 1 No.
3. Main gear box to vibration pump 1 No.
4. Six speed gear box to driving motor 1 No.
5. Six speed gear box to distribution gear box 1 No.
6. Distributor gear box to axle gear box 1 No.
7. Distributor gear box to intermediate axle 1 No.

Clutch assembly:

Clutch plate burn.	1. Withdrawal bearing CT-1310 get jammed. 2. Fingers not working properly. 3. Springs not working properly.	1. Replace withdrawal bearing. 2. Finger (6 no.) & console fit properly & replace if need. 3. Springs should be cleaned& replace the defective one, if required.

Power takes off assembly:

1. Output shaft (1240 310 013) get broken bearing also damage.	Lock of shaft get broken, lock bolt loose.	Tighten the lock bolt and adjust the flange at proper place.

Axle gear box:

1.Bearings (NU231531313) of tail pinion get seized.	1. Plunger pump not operating properly. 2. Hyd pipe may be choked.	1. Spring at pump should be changed if required. 2. Clean the hyd pipe through which gear oil is passed to bearings at tail pinion.
2. Teeth at crown & tail pinion get damaged.	Not match properly.	The teeth matching done properly.

PRECAUTIONS DURING FITMENT OF CARDON SHAFT:

Shaft should be dynamically balanced

Male portion	-	Long
Female portion	-	Short
In road vehicle	-	Male portion in the direction of driving.
In Track Machine	-	Male portion in towards working direction.

To avoid the dropping of cardon shaft cradle is provided.

- Arrow mark on male and female portion should be in line. If there is no arrow mark then yoke should be in same plane for both male & female.

- In female shaft, there is through hole from yoke centre to other end, so that excess grease may come out, other wise this will act as a solid part.
- Bolts should be fit tightly and it should be of proper size.
- Greasing in X (cross) and splines should be done after 50 Hrs.
- Play in splines and yoke should be checked every 50 Hrs.
- Nylon locked type nuts should be use.

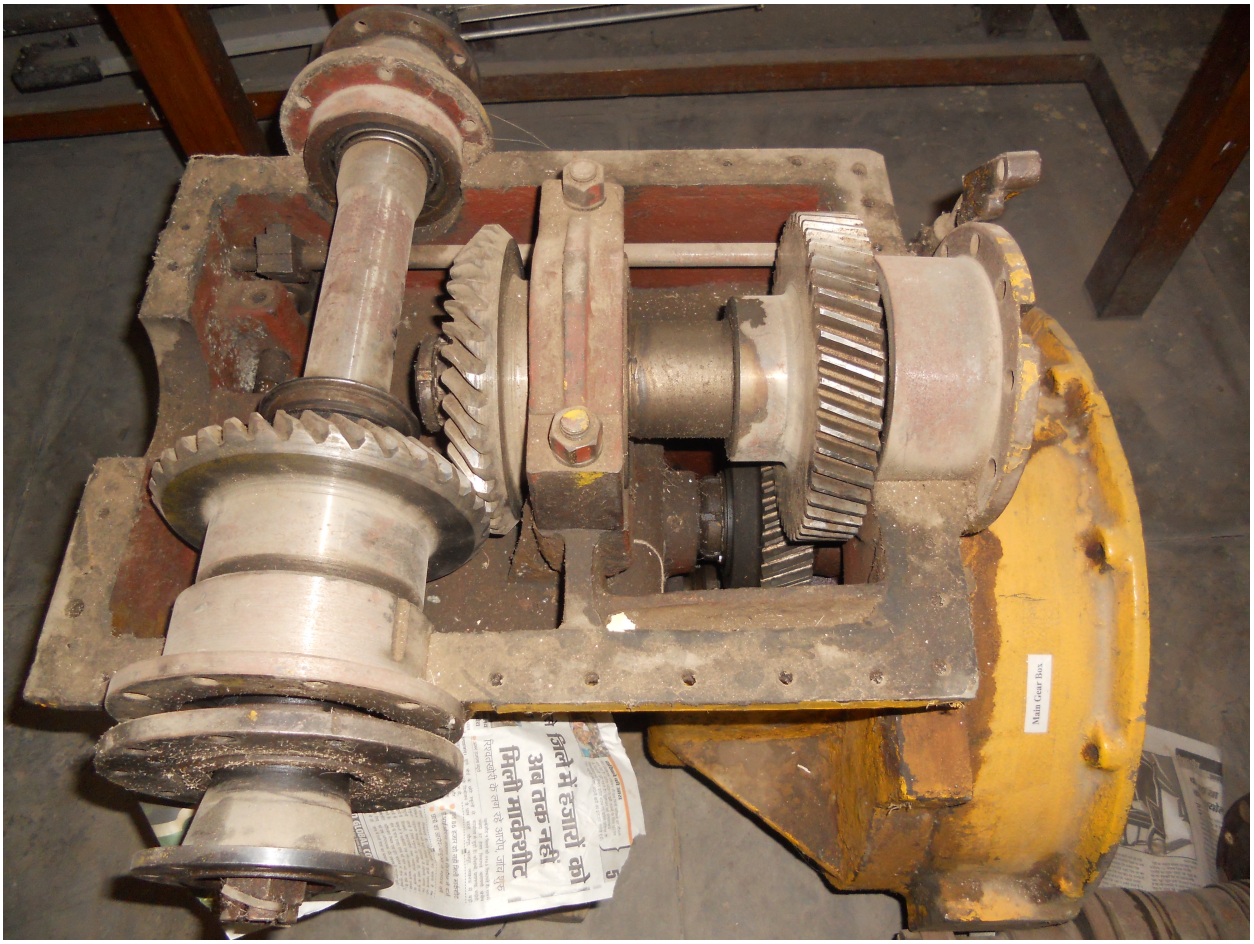
Sub:- Mechanical

Working, Construction and Maintenance practices of Main gear box and Clutch assembly.

GEAR BOX AND CLUTCH ASSEMBLY IN UNO / DUO

MAIN GEAR BOX, SIX SPEED AND REVERSING GEAR BOXES:

The track machines are driven/traveled from one station to another station by means of either hydraulics system or mechanical system. In mechanical system of traveling, Gear Boxes are used. In Duomatic old, Unomatic and other machines various Gear Boxes are used such as main gear box, directional gearbox, reversing gear box, reduction gear boxes and six speed Gear boxes etc.



Following are the Gear Boxes used on 08-Duomatic machine.

1. **Main Gear Box = 1 No.**
   From engine the power comes to this gear box. This gear box distributes the power in three directions:
   Main power to reversing and Six speed gear box.
   RH side for operating Hydraulic pump – 38 x 17 GPM
   38 x 22 GPM
   L.H. side for operating hydraulic pump – 38 x 17 GPM

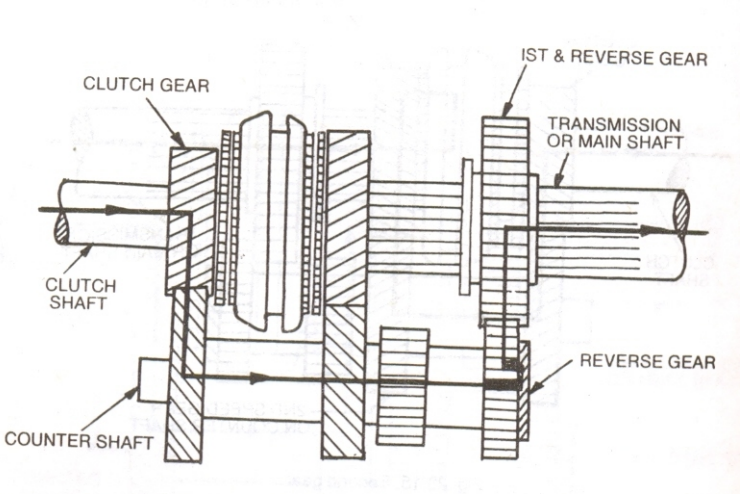
   The following are the main parts of main gear box

   A = Driving shaft
   B = Flange
   C = Washer for bearing housing left
   D = Spacer rings
   E = Spacer ring
   F = Shims
   G = Retaining rings
   H = Crowns nuts
   J = Rings
   K = Splits pins
   L = Seeger rings
   M = Cylindrical roller bearing
   N = Bearing housing left

O = Lid for bearing housing left
P = Bevel gear
R = Bearing housing right
S = Self alignment roller bearing
T = Spacer sleeve
U = Clutch gear
V = Conical roller bearing
W = Washer for bearing housing, right

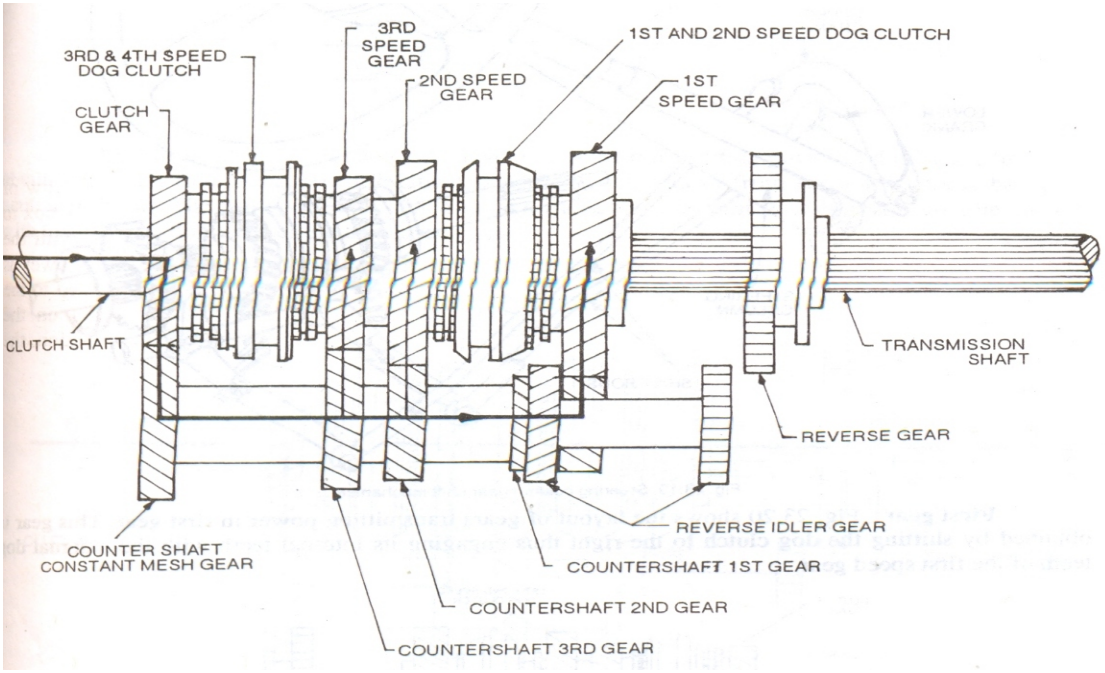
2. Reversing Gear Box 1 No.:

In this gearbox arrangement has been provided to drive the machine in either direction at the same speed. Figure shows the simplified diagram of a gear box showing the flow of power in the reverse gear. Before obtaining this gear the vehicle is brought to rest and the gear box to its neutral position. After this the first and reverse gear is moved to the left, till it meshes with the reverse idler. The second speed gear revolves but not transmits power. In this position the power is transmitted through the reverse idler to the main shaft by the first reverse gear which is splined to the main shaft, gears on the main shaft are in constant mesh with the corresponding gears on the counter shaft. The reverse idler gear and the reverse sliding gears are not in mesh. In this position the gear box is in neutral, since no power is transmitted to the main shaft



3. Six Speed Gear Box 1 No.:

This gear box is used to achieve different gear ratio and speed from 1^{st} to 6^{th} . For better understanding, Figure show the lay out a 4-speed gear box synchronous system in all the four forward speed. It is to be noted from the figure that the clutch shaft drives the counter shaft drive gear through main drive gear. The first, second and third speed gears on the main shaft are in constant mesh with their corresponding gears on the counter shaft. The reverse idle gear and reverse siding are in not in mesh. In this position the gear box is in neutral, since no power is transmitting to the main shaft.



4. **Differential distributor Gear Box 1 No.:**
   (Power is transmitted from different distributor gear to both Axle Gearbox.
5. **Axial Gear Box 2 Nos.:**
   Power transmission to axle by crown tail pinion arrangement is the out come of machine movement.

Gear Box Troubles :

The most common troubles of gear box and there causes are as follows

1. **Grinding noise in neutral :**
   A grinding noise occurs when the engine is running and the vehicle is in neutral. Its causes are gear box not properly alingned with the engine causing the shaft from the fly wheel to the gear box to bind.
2. **Noise in gear:**
   When the vehicle is being driven or rear wheels turning off the ground noise is heard in gear its causes are
   (a) Dry rear bearing on main shaft.
   (b) Damaged speedometer drive gears.
   (c) The noise heard in neutral will also be heard in gear but will be more pronounced.
   (d) Noise occurring in rear end and in the clutch may also be seem to come from the gear box.
3. **A Hum or bowl in neutral:**
   (a) Lack of lubrication
   (b) Worn shaft
   (c) Too much back lash in gear train.
   (d) Too much end play in gears of counter shaft.
   (e) Gear chipped, burred, improperly matched of badly machined.
   (f) Gear shift forks rubbing in grooves causing gear interference
   (g) Worn bearings.
4. **Hard shifting, sticking in gear:**
   (a) Distorted splines of the main shaft
   (b) Too strong shifter locks spring

(c) Improper clutch adjustment
(d) Battered gear tooth
(e) Silent synchromesh shift binding

5. Oil leakage:

(a) Too high oil level in case.
(b) Damaged or improperly installed gaskets or oil seals
(c) Loose cover bolts
(d) Cracked case or cover

(a) Too much clearance between teeth in mesh
(b) Insufficient mesh or gears
(c) Worn gears or bushing of bearing retainers
(d) Weak or broken shifter locks spring
(e) Remote control shifting mechanism out of adjustment
(f) Improper alignment of gear box with the engine

MAINTENANCE PRACTICES OF GEAR BOXES:

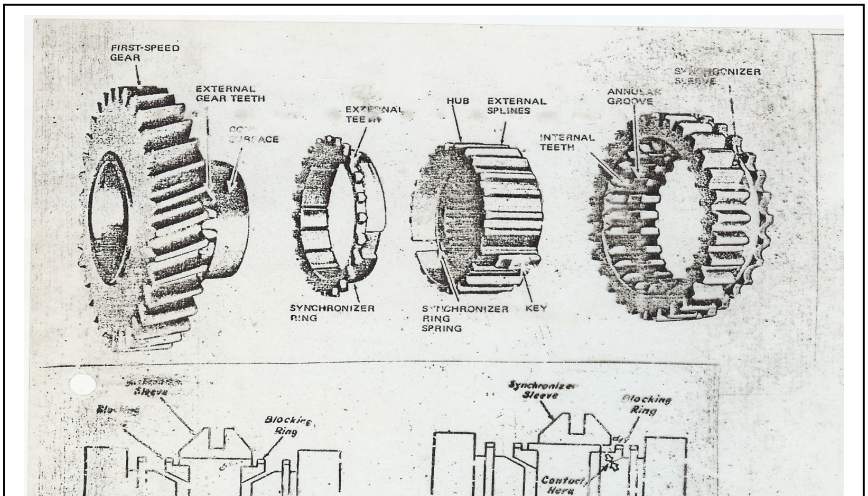
The modern track machines are very complex and costly assets. Even one day down time is very costly. Increased availability of machines results in more output with good quality at cheaper ratio.

As this is a mechanical gear box, lot of wear and tear takes place on account of its movement. The gear box should be filled with the proper graded oil i.e. SAE-C-90 and while working with this machine as mechanical gear boxes are provided, it is to be ensured that when machine is required to be operated, whenever we want to put the machine in working mode i.e. at the time of engagement of hydraulic pump, first of all the engine should be stopped and the lever is to be operated for engagement of working pumps. Similarly when the work is over it is to be ensured that the engine is stopped and the lever is operated to disengage the working pump for travelling mode.

It should also be ensured that no dust or dust is allowed to enter the gear box as it is very much harmful for the smooth functioning of Main Gear Box, directional gear box or Six Speed Gear Box. During assembling this factors should also be taken into consideration.

ENGAGER BODY FOR DUOMATIC MACHINE PART NO. G – 70-11

Engager body shall be manufacture out of EN-353 engager body shall be slide fit with crown gear and drive shaft components found suitable in visual inspection as well as correct from the dimensional characteristics minimum one engager body of each lot should be taken randomly for its chemical testing

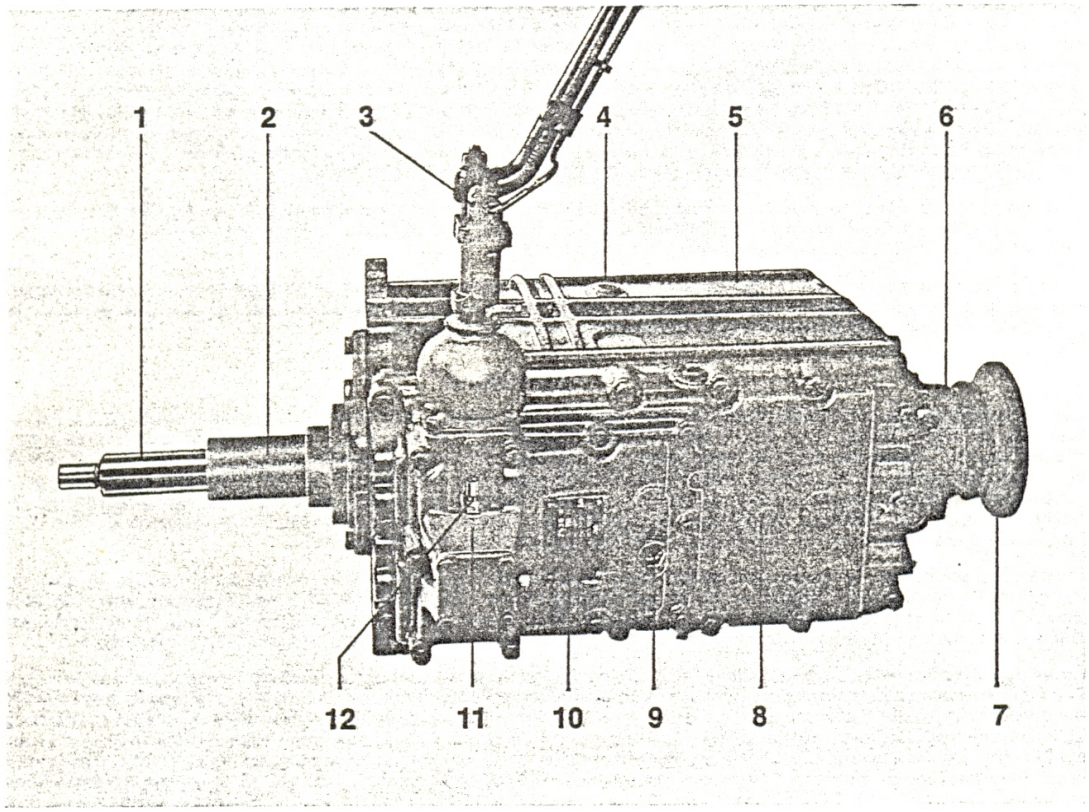


Sub:- Mechanical

Gear Box and Clutch Assembly in UNO/DUO : Clutch Assembly, Working, Construction and Maintenance practices of Reversing gear box and Six speed gear box.

CLUTCH:

The power developed inside the engine cylinder ultimately aimed to turn the wheels so that the actuator can move on the road. The reciprocating motion of the piston turns a crankshaft rotating the fly wheel through the connecting rod. The circular motion of the crank shaft is now to be transmitted to the rear wheel. It is transmitted through the clutch, gear box, universal joints, propeller shaft or drive shaft, differential and axles extending to the wheels.



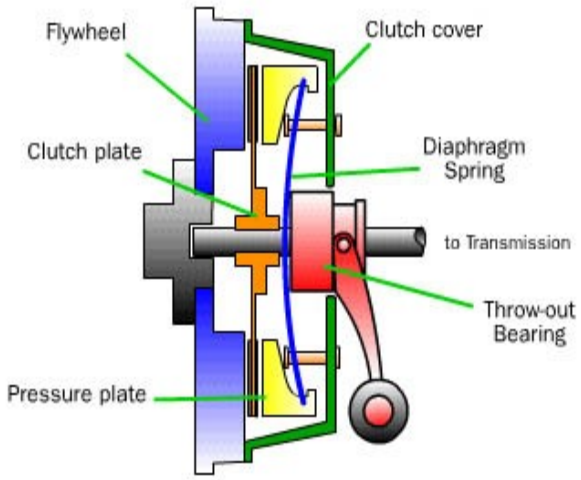
5. Input shaft
6. Input cover plate
7. Selector lever
8. Oil filter and oil over flow plug (vertical)
9. Gear box housing
10. Speedometer cover
11. Output flange
12. Selector cover
13. Oil filter and oil over flow plug (horizontal)
14. Specification plate
15. Housing cover & 12. Breather valve

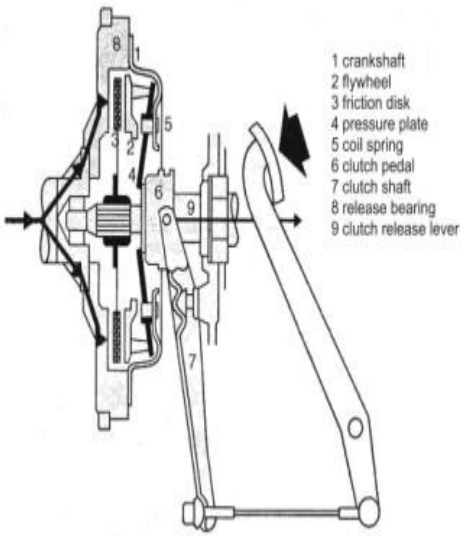
Functions of clutch:

Clutch is a device used in the transmission system of track machine to engage and disengage the engine to the transmission. Thus the clutch is located between the engine and the transmission. When the clutch is engaged, the power flows from the engine to the rear wheels through the transmission system and the vehicle move. When the clutch is disengaged the power is not transmitted to the rear wheels and the vehicle stops while the engine is still running. The clutch also permits the gradual taking of the load. When properly operated, it prevents jerky motion of the machine and thus avoids putting and undue strain on the remaining parts of the power transmission system.

Principles of operation:

The clutch works on the principle of friction. When two friction surfaces are brought in contact with each other and pressed they are united due to the friction between them. If one is revolved, the other will also revolve. The friction between the two surfaces depends upon the area of the surfaces, pressure applied up on them and coefficient of friction of the material. The two surfaces can be separated and brought in to contact when required. One surface is considered as driving member and other is driven member. The driving member is kept rotating. When the driven member is brought in contact with the driving member, it also starts rotating.





Requirements of clutch:

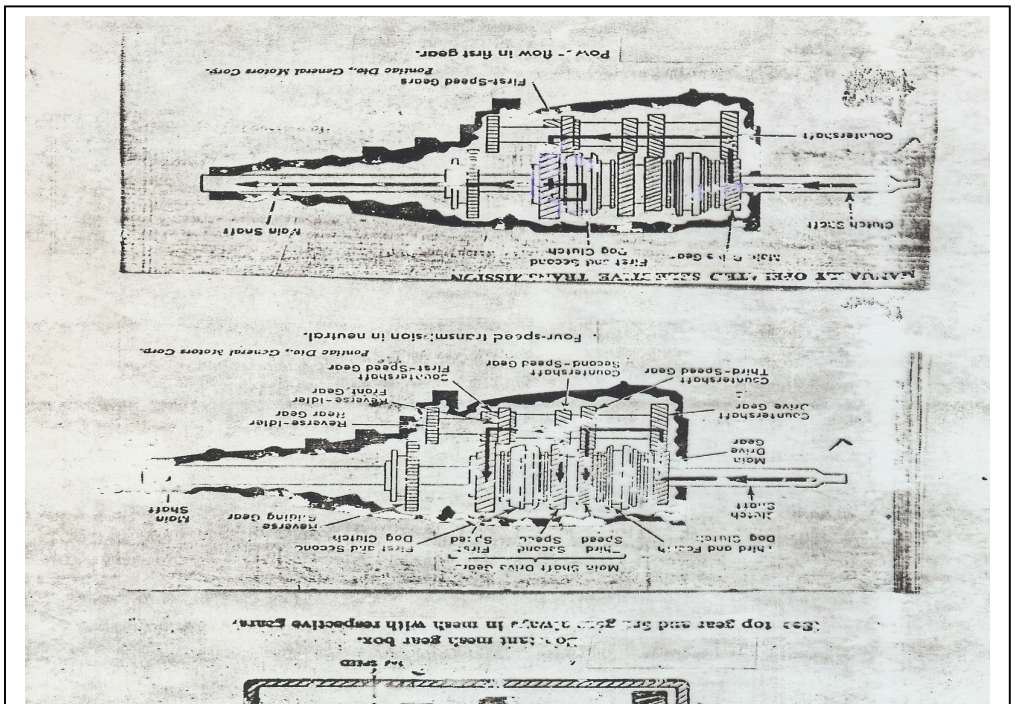
1. **Torque transmission**: The clutch should be able to transmit maximum torque of the engine.
2. **Gradual engagement**: The clutch should engage gradually to avoid sudden jerks.
3. **Heat dissipation**: The clutch should be able to dissipate large amount of heat which is generated during clutch operation due to friction.
4. **Dynamic balancing**: The clutch should be dynamically balanced. This is particularly required in the case of high speed engine clutches.
5. **Vibration damping**: The clutch should have suitable mechanism to damp vibrations and to eliminate noise produced during the power transmission.
6. **Size**: The clutch should be as small as possible in size so that it will occupy minimum space
7. **Free pedal play**: The clutch should have free pedal play in order to reduce effective clamping loads on the carbon thrust bearing and wear on it.
8. **Easy in operation**: The clutch should be easy to operate requiring as little exertion as possible on the part of the driver.
9. **Lightness**: The driven member of the clutch should be made as light as possible so that it will not continue to rotate for any length of time after the clutch has been disengaged.

MAINTENANCE OF REVERSING AND SIX SPEED GEAR BOXES:

The track machines are driven/traveled from one station to another station by means of either hydraulics system or mechanical system. In mechanical system of traveling, Gear Boxes are used. In Duomatic and old Unomatic and other machines various Gear Boxes are used such as main gear box, directional gearbox, reversing gear box, reduction gear boxes and six speed gear boxes etc.

For reversing gear box proper lubrication has to be ensured and proper matching of gears to be provided so that there is no problem with regards to the movement of the machine. Proper maintenance schedule has to be observed as per the manual laid down for this purpose.

For six speed gear box it is also to be ensured that proper clearance of gears are maintained and proper backlash along with the proper matching of gears are in co-operated. As per the laid down procedure for schedule maintenance, six speed gear box maintenance to be done accordingly.

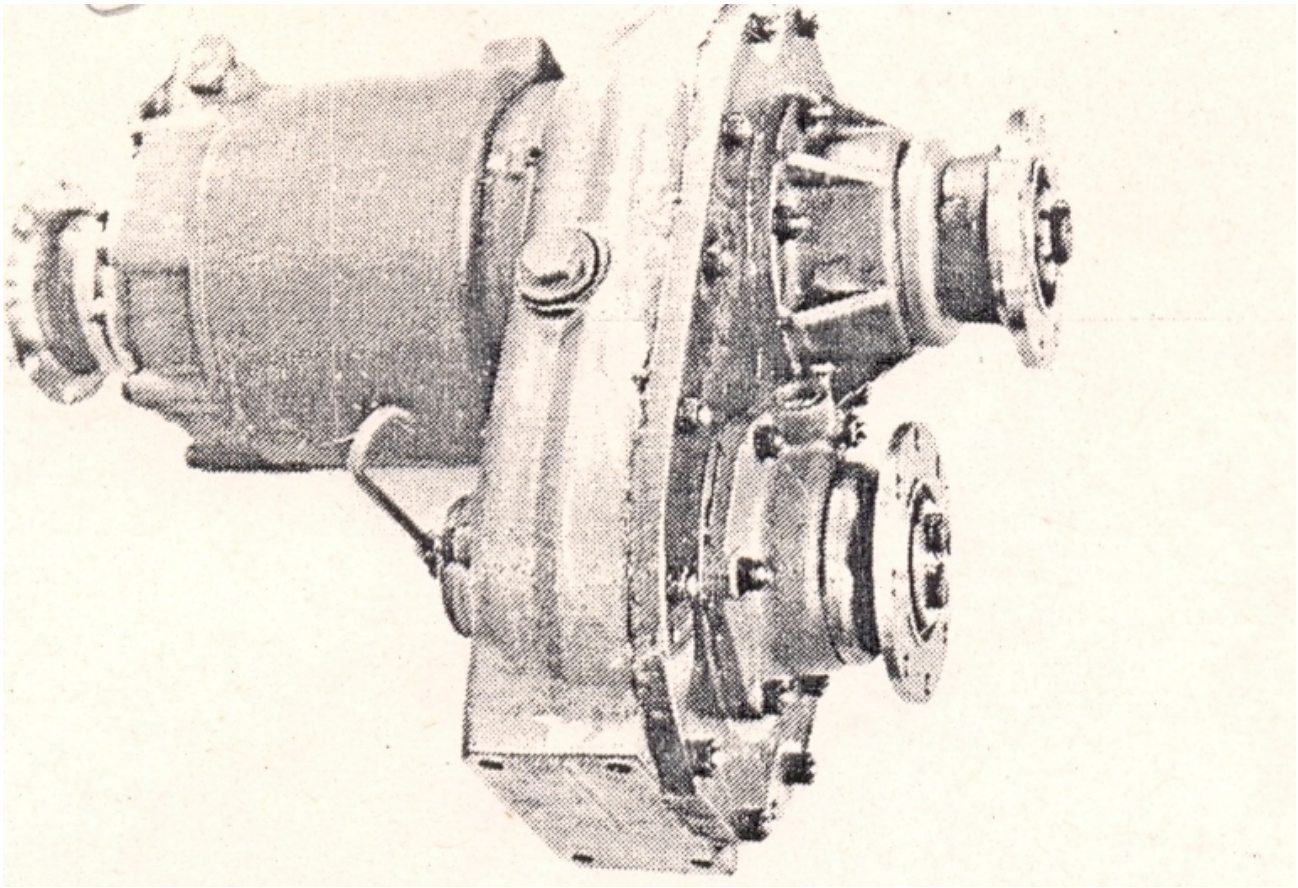


Sub:- Mechanical

Distributor Gear Box : Working, Construction and Maintenance practices.

Distribution Gear Box (Construction and Maintenance Practices):

This is the Gear box used for the purpose of power transmission in different track machines. With the help of this distributor gear box power is directed and distributed to different directions with the help of cardon shaft as per requirement. As this gear box is subjected to maximum wear & tear due to mechanical arrangement of gears, maximum care should be taken with respect to its maintenance as well as changing of the gear oil provided for the gear box. Attention should also be paid with regards to the contamination because if contamination is entrapped in the gear box, it will damage the gear box.



DIFFERENTIAL – DISTRIBUTOR GEAR

Sub-discipline:- Mechanical (Lessons: 14 Sessions: 24)

Lesson-IV: Driving and Running Axle **Session-5:** Function, Parts and Maintenance aspects, setting of crown & tail pinion

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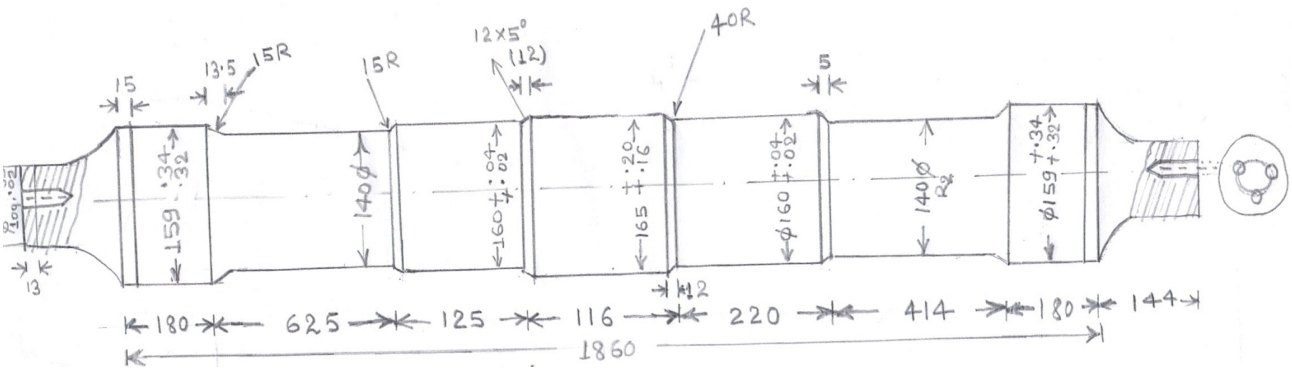
Driving and Running Axle for (Duomatic):

Driving axle is the powered axle which has the arrangement of Crown & Pinion Assembly. Wheel is pressed at 50 Tonne load. There is arrangement of axle gear box assembly. In axle gear box assembly, roller bearing NU-2220 or NU-2224 is provided. The driving axle being powered axle gets power through cardon shaft transferred from engine. Schedule maintenance of the axle is to be carried out by greasing of axle gear box housing as per requirement. All new Track Machines working in Indian Railways are powered axles. They have been provided with the hydraulic motors for power transmission.

Driving Axle



Driving Axle (front bogie) – csm:

(1) Taper roller bearings – 32032x – 02 No. in each axle.
(2) UD 62 - 2610P (plasser) NJP – 2224 outside - 02 No.
(3) UD 62.2618P (plasser) NJ – 2224 inside – 02 No.

NJP 2224 – P is separate round piece which supports the bearing from outside.
NJ 2224- for support, a collar is already provided in both bearing.

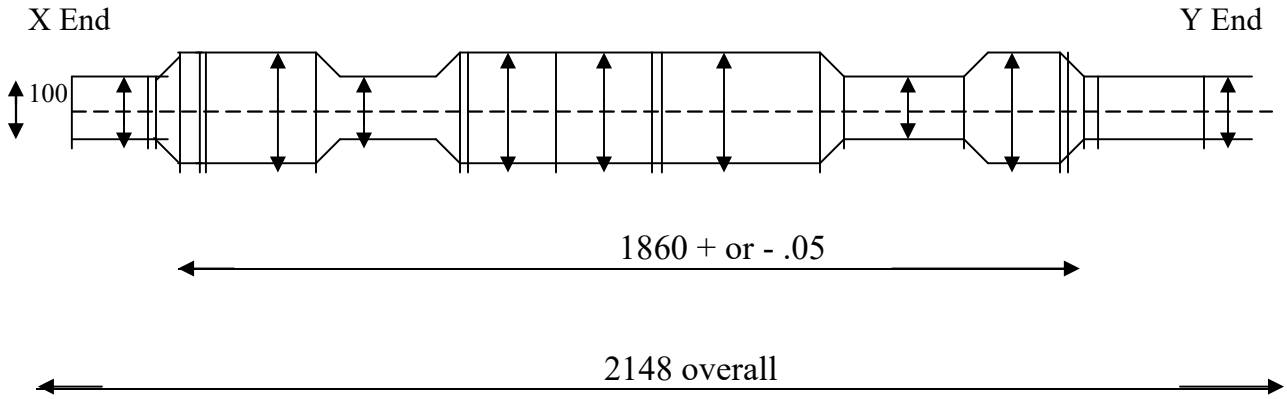
1. Tapper roller bearing 31313 – Q- ec7A - 02 mm.

At tail pinion roller bearing NU2315 - 01 No.

2. Crown Em 163.105.Z31 – 36 teeth.

Tail pinion – 10 teeth

3. Namda is provided is csm & unitmat to prevent leaving of grease.
4. Oil seal (130*160*13) is provided in Duo to prevent leaving of grease.

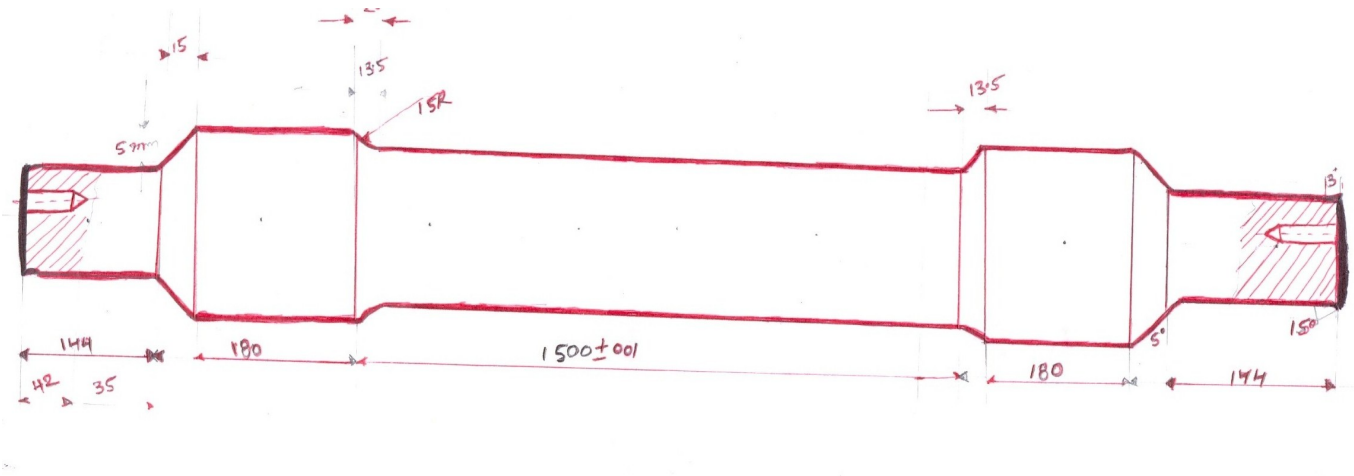


ALL DIMENSIONS ARE IN MM.

Running Axle:

Running axle is normally known as idle axle and it is not a powered axle. Running axle has arrangement of Axle & Wheel only. Wheel pressing is carried out in the axle to complete the whole assembly. Wheel is pressed at 50 tonne load. There is no crown and pinion arrangement in running axle. There is axle box assembly provided on running axle. This consists of roller bearing NU-2220 or NU-2224 along with the distance pieces. Under the maintenance schedule the axle box bearing are greased through bearing grease periodically. As per latest circular of Track Machine Manual the driving axle and running axle of different machines such as BCM, Unimat, CSM & DGS are required to under go Ultrasonic testing for their better performance.

RUNNING AXLE OF DUOMATIC



Sub:-Mechanical

Z.F. Hydro-dynamic Gear Box: Function and Construction

Working Principle of Z.F. Gear Box: (Zahnrad Fabric):

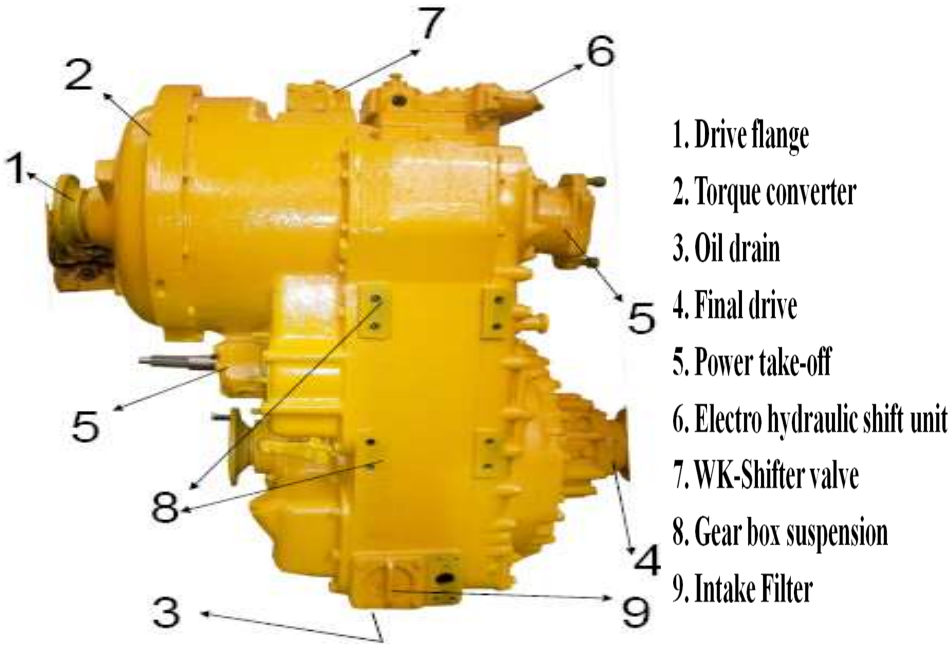
The power transmissions in various tamping machines have been associated with mechanical methods of transmission envisaged by Plasser & Theurer. Gone are the days when we were utilizing mechanical gear boxes such as six speed gear boxes, directional gear boxes etc. but with the past experiences it has been observed that such mechanical gear boxes have typical arrangement of gear-train etc. which were not only subjected to wear and tear but also it tends to more-failure and more maintenance.

So, in order to eliminate all such things new conception for power transmission is the generation of Z.F. Gear Box. ZF is a German Nomenclature and it stands for Zaharaid Fabrick. Original specification of ZF is 4WG.65II WK

Abbreviations are:

4	-	Speed
WG	-	Hydro-dynamic fluid
65	-	Input – Torque
II	-	Electric – Shift
WK	-	with converter clutch
Gear box oil	-	Ultra -10
Capacity	-	Approximately 45 Ltrs.
Manufacturers –		
BP	-	Actuma Super with ultra 10W
10C	-	Servo ultra 10
HP	-	HP auto transmission fluid.

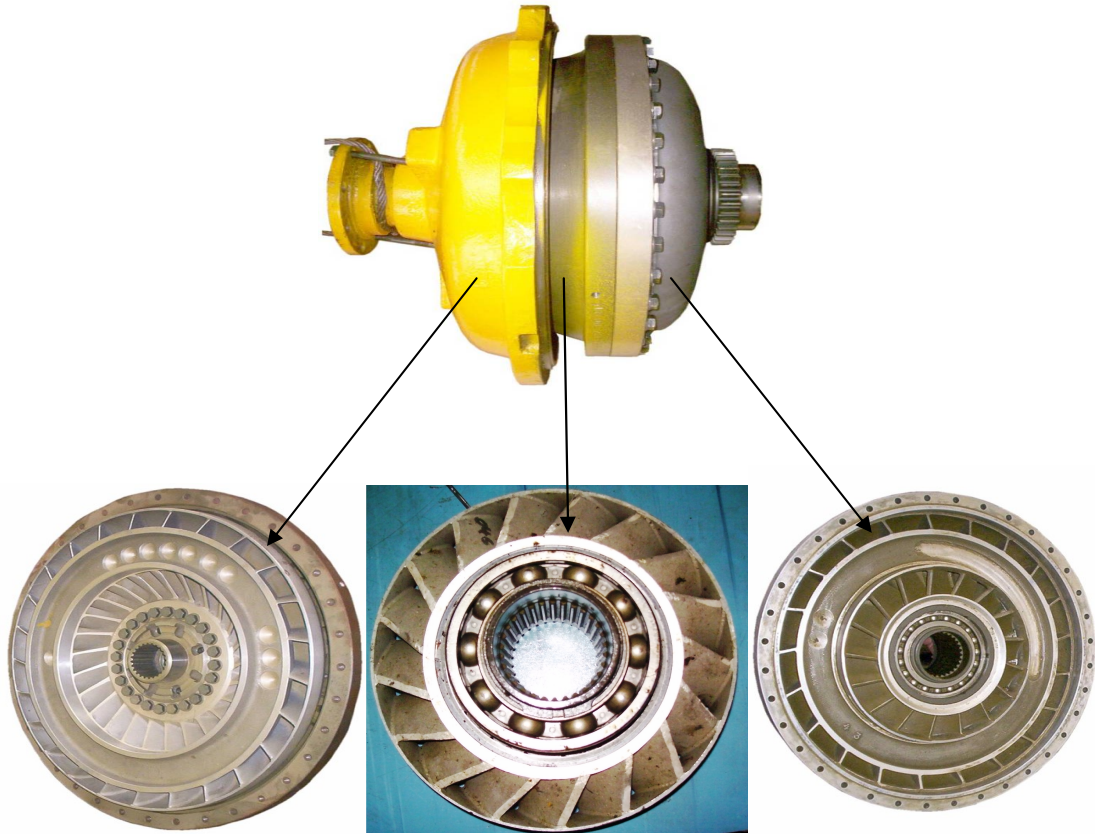
Various Parts of Z.F. Gear Box:



1. Torque Converter:

Torque Converter is a special type of fluid coupling. It is very much effective when the engines speed is increased. At idle speed it does not transmit any power and keeps as slipping. Thus the vehicle is declutched automatically. In manual transmission if the driver does not declutched properly the engine stops. This problem is overcome in automatic power transmission. In this case need is to idle the engine only within the converter the oil is the medium of the power transmission. At about 80% of pump speed i.e. impeller, the turbine becomes one and the turbine movement becomes equal to the pump movement.

Torque Converter



Impellor Stator Turbine

Some of the torque converters are provided with a converter clutch W.K. which locks the turbine with impellor and then prevents the slip and improves the fuel efficiency. The torque converter then acting as a fluid clutch. It consists of three main parts.

1. Impellor
2. Stator
3. Turbine.

1. **Impellor –** It is a device having curved blade to its inner face and attached to engine fly wheel. As the fly wheel turns the impellor also turns and throws the oil with a certain velocity. The velocity and mass being projected which is actually responsible for turning the unit. The oil escaping from the impellor wheel enters to the turbine wheel giving the direction of movement.
2. **Turbine –** Turbine is attached to the driven-unit i.e. input of gear box and faces of impellor on account of which the oiler projected from the pump causes the turbine to run. The turbine shaft runs the gear system.

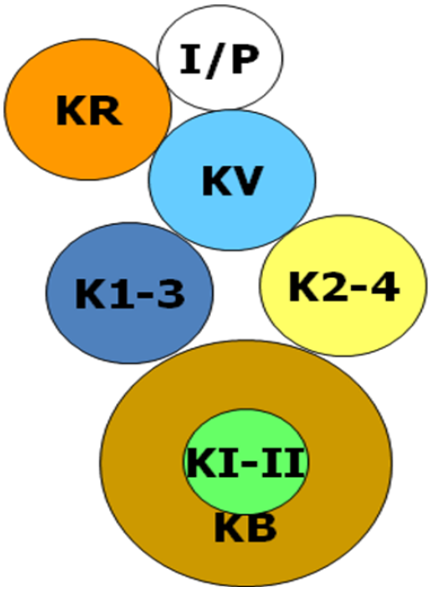
3. **Stator –** It is a curved fine wheel mounted on a free wheeling device between the impellor and turbine. As the fluid leaves the turbine, the fluid would be thrown back to the pump in reverse direction i.e. opposite to that of rotation of pump. Thus, it requires more power to drive it. The oil coming from the turbine is directed by the stator vanes in a direction which is favorable to the directions of moving of pump. The stator (reaction member) following the turbine wheel has the task of redirect against the oil which is streaming out of the turbine and directs it to the correct streaming direction to the pump wheel. The stator receives a reaction movement due to this reversing motion. Thus it improves the efficiency of converter. Also the oil in favorable direction gets added up with the oil which would normally had been projected by the pump and thus multiples the torque. As the turbine speed increase the direction of oil coming from turbo charges. Thus the oil direction does not oppose the impellor movement. Also the direction of oil is such that the stator direction is reversed. The stator stepson free wheel and allowing the oil to flow in the required direction.

   As the conversion is increasing the correspondence with the speed difference between pump wheel and turbine, therefore the maximum conversion takes place when the turbine wheel is not moving with increasing output speed, the torque conversion gets decreased. The out put speed is automatically adopted to required output movement of the torque converter.

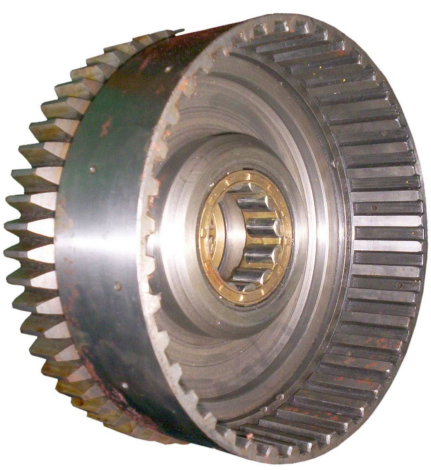
A gear pump is used for the circulations of oil to converter and also used for shifting of gears. Gears pump supplies pressurized oil of pressure (10-12 bars) for actuation of clutches. Feed rate of pump is 40 lit/min. This oil is controlled by electrically operated solenoid valves which get current from PCB and is a function of engine rpm and turbine speed.

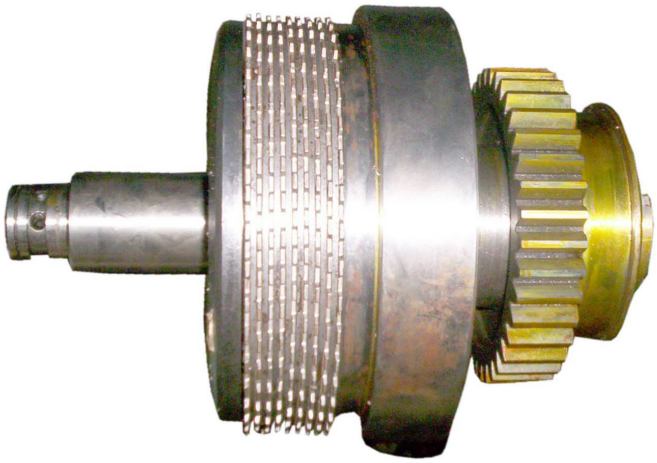
3. Gear Train:

It is provided for multiple speeds of machines. Clutch assemblies are used in power transmission makes the engagement of gear trains. All gears are moving in constant mesh but only actuated clutch is effective. Power is transmitting through multiple disc clutches which receives hydraulic power through solenoid after placement of gear by selector lever.



Gear Train

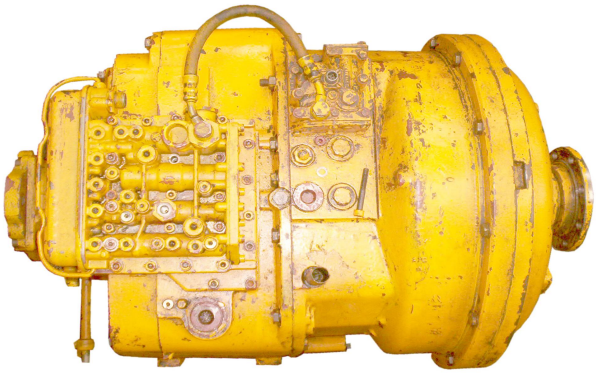




Clutch assembly

4. Shifter Assembly

It is brain of the gearbox. Hydraulic fluid is pressurized & supplied from this unit. Four solenoid valves are provided for various clutch operation (M_1 M_2, M_3 & M_4).The solenoid valve operate thev shifter valve and the shifter valve operates the clutches. Current consuming of each solenoid is equal to 0.25A – 0.5A.



5. Power Take-off unit

Three take off units are provided for pump operation.

Sub:- Mechanical

Z.F. Hydro-dynamic Gear Box: Precautions during working and Maintenance aspects.

PRECAUTIONS DURING WORKING AND MAINTENANCE ASPECTS:

1. Z.F. Hydrodynamic gear box should be handled by a skilled & trained workman only with a special emphasis on cleanliness.
2. It is preferable to keep special tools recommended by OEM for limited maintenance operations to be carried out at field or else similar indigenized tools must always be made available in the machine.
3. Use only recommended brand of Locktites, i.e.:
   270 No. for nuts & bolts
   574 No. for Sealant (Liquid Gasket)
   641 No. for Bearing surface.
4. Replace oil ULTRA-10/SAE 15-W-40 (as the case may be) after every 500 hrs. of working. During oil replacement, strainer should be checked for any accumulation of impurities over magnetic rod. 'O' Ring over strainer must be replaced at the time of oil change.
5. Check the oil level weekly:
   (a) While the machine is in horizontal plain.
   (b) Keep transmission in neutral position.
   Cold level at 40^0C & 1000 RPM – Lower mark.
   Hot level at 80^0C & 1000 RPM – Upper mark
   Where 80^0C is not achieved, checking at 40^0C for lower mark will serve the purpose.
6. Replacement of pressure filter (25 micron) at the interval of 250 hours of working.
7. Replace the filter along with oil in case of buzzer alarm heard for choking of filters.
8. Check external connections at regular interval for their tightness.
9. Operation of gear shifting should not be done below 1200 RPM of the engine.
10. Towing speed restriction of 10 Kmph should be followed; otherwise it may lead to the damage of gearbox. Connecting two machines for block operation should not be done.
11. Shifting of gear should be carried out at the proper time. Any delay or early shifting will reduce the gearbox life in long run.
    Proper Time for Lockup indication
    Indicator is not provided in operating panel, gears are being shifted only based on experience and assumptions. A LED connection may be provided in cabins as has been provided in SPURT car. CPOH can provide circuit diagram if desired.
12. Frequent variation of speed should be avoided.
13. Z. F. key should be put off only after stopping of machine as two clutches out of seven clutches remain engaged even in neutral position and counter speed of the wheel through cardon shaft will affect those clutches which may damage the frictional bearings and slippage of clutch may occur.
14. If for any reason external impurities enter the gearbox, working of machine should be stopped and after rectification of defect complete oil should be replaced. In that case clean the gearbox as much as possible including torque converter.
15. Pressure cut off switch should be checked for its functioning at 2.5 bar. Early or late cut off may reduce the life of the costly Z.F. gearbox.
16. In case of any obstruction while moving, r.p.m. should be reduced and brakes should be applied below the cut off pressure i.e. 2.5 bars. Avoid the excessive application of brake above 2.5 bars.

FAILUES ANALYSIS & TROUBLE SHOOTING:

COMMON FAILURES OCCURED IN Z. F. GEARBOX ALONG WITH THEIR REMEDIAL AND PREVENTIVE MEASURES BASED ON FIELD EXPERIENCE.

MAIN NPRESSURE HAS GONE TO ZERO AND MOVEMENT OF THE MACHINE STOPPED

Case Study:
Earlier it happened on different machines that suddenly during the course of working, main Pressure dropped to'0'. After checking the oil level And functioning of electrical pressure gauge, it was observed that 0.6mm orifice, provided on intermediate plate in shifter assembly was found choked completely.
Due to contamination of oil. After cleaning of plate & orifice, gearbox started functioning with normal pressure.

Remedial Measures
(a) Check the functioning of pressure gauge by providing spare hydraulic gauge (0-25 bar) in place of electrical, if it is ok.
(b) Check of flow of ZF pump by flow meter or any other suitable means (Shaft key of pump may get slipped), if it is ok.
(c) Check the intermediate plate for choking of pressure orifice, clean if choked.
(d) Finally overhaul the shifter assembly or get assistance from CPOH.

Preventive Measures
The machine operator must be attentive for 25-micron pressure filter choking buzzer due to passage of contaminated oil and once it is heard or in case of hydraulic oil entering in ZF gearbox chamber due to bursting of pump oil seal (38-22, 38-17,20-14, variable pump) stop the working of machine and clean the gearbox immediately by flushing out oil as much as possible including torque converter. Under any circumstances safety switches or filters should never be bypassed.

Flickering Movement of Pressure Gauge and Sound Observed from Torque Converter
Case Study
At times this happened in field after replacement of oil. Reason for such failure is, less oil level due to improper topping up or due to external leakage. After checking it has been found that recommended procedure for checking oil level was not followed properly by field staff.

Remedial Measures:
(a) Check the oil level at recommended procedure
And refill the oil as per requirement.

(b) Check & attend the external leakage if any.

Preventive Measures
(a) Check the oil level as under:
At 1000 rpm and 40^{o}C-Lower mark (Cold level).
At 1000 rpm and 80oC-Upper mark (Hot level).

Checking oil level at less than 1000 rpm will generate malfunctioning.

(b) Fill extra oil while travelling on gradients (Ghat section).

3. Machine Movement Stopped but Pressure and Temperature Are OK.

Case Study

This happens due to dislocation of towing lever bolt /splines during process of working. In past it did happen on few machines. On investigation it has been found that field staff normally do not put their attention on this particular subcomponent. For this small failure several times machines had been under break down for 5 to 10 days for want of CPOH staff. After checking it was observed that towing lever bolt /splines were dislocated during the process of working.

Remedial Measures

(a) Towing lever was found dislocated from its locking. Tightened the bolts of the lever.

(b) In case it is spline type, temporary arrangement by welding can also be done over shaft and lever.

Preventive Measures

(a) Check the tightness of nuts regularly.

(b) In case of spline type shaft, replace the shaft and lever.

Engine Taking additional Load or Engine Stopped While Shifting First Gear.

Case Study

In several machines it was observed that machines are under break down for the said problem and help of CPOH is sought for. After going through the failure it was observed that it happens mainly due to failure of electrical circuit. In exceptional cases torque converter clutch also gets damaged. Early actuation of lockup clutch is the reason behind such failure.

Remedial Measures

(a) Check electrical connection of lockup circuit.

(b) Check inductive transmitter resistance 1.5K-Ohm & distance from pulse disc shall be kept 0.7mm to 1mm.

(c) Check the functioning of electronic module. Frequency 650Hz at 14000 rpm for lock in.

4. Preventive Measures

Check the 24-Volt power supply over WK valve by keeping the machine in towing mode and increase the rpm after engaging the gear. Electrical supply of 24 D.C. should reach to WK valve at 1400 rpm and above & should k not beless than said rpm in any case otherwise adjust the gap of inductive transmitter as above at (b).

5. Excessive Temperature

Case Study

In several machines it has been observed by CPOH that improper operation has resulted in rising of temperature of the gearbox. Early late shifting of gear is one of the reasons behind this failure. It is also suggested that working of the machine above 120^{o}C should be prohibited. Safety switches should never be bypassed.

Remedial Measures

Keep the machine in neutral. Increase the RPM from 1200 to 1500, within 2 to 3 minutes temperature should drop quickly to normal. If not, then ask the assistance from CPOH as the overhauling of shifter assembly is required in that case.

Preventive Measures

(a) Don't overload the machine.

(b) Keep the rpm minimum up to 1200 while passing through down grades.

(c) Don't down k shift on higher speed.
(d) Check the oil level regularly; less oil may lead to such failure.

6. Burning Of Clutches:

Case Study

In few machines it has been observed that fume suddenly starts coming out through breather though the pressure and temperature was normal. It happens due to choking of lubrication line resulting in hunger of oil in clutch assemblies. Once this happens, the only solution left is to overhaul the complete gearbox at CPOH.

Remedial Measures:

Complete overhauling is required. Burning of any clutch at normal pressure and temperature is due to choking of lubrication lines (internal tubing's).

Preventive Measures:

Check the lubrication oil pressure, if it reaches to 3.5 bar and above at 1000 rpm, stop the machine and ask CPOH for further check as in case of choking of lubrications lines, complete oil will go to sump by pressing the valves setting. In no case lubeoil pressure should rise above 3.5 bars at 1000 rpm continuous watching of lube oil pressure of the gearbox can save an extensive damage.

7. Main Pressure Is Tool Low:

Case Study

It is observed that many old machines are kept on working for a long time at lesser main pressure. Working at lesser pressure below 10 bars may lead to slippage of clutch and finally can damage the gear box. Initial symptom of this failure oil turning out blackish.

Remedial Measures:

(a) Check pressure gauge for its functioning by providing hydraulic pressure gauge.
(b) Tighten the Allen bolts over shifter assembly upto 50 Nm. Pressure will increase by this process from 1 to 2 bar.
(c) Contact CPOH for further checking, as the overhauling of complete shifter assembly or gearbox is needed in this case.

Preventive Measures:

(a) Nut bolts (external) should be checked during schedule maintenance.
(b) Operating the machine at less pressure can damage the gearbox due to slippage of clutch.

8. Abnormal Sound

Case Study

Abnormal sound may be observed due to damage of any mechanical component inside, damage of bearing, nut & bolts, locks etc in the process of working. In case of any abnormal sound machine working should be stopped immediately to avoid further damage to gearbox.

Remedial Measures

Complete overhauling is required to be carryout in workshop.

Preventive Measures

(a) Don't tow the machine above 10 Km/h.
(b) Skipping speed should be avoided.
(c) Down Shifting should be done at recommended speed.
(d) Acceleration of machine should be avoided after placing the brakes.

9. Oil Becomes Blackish

Case Study

Black colour of oil is the indication of poor health of gearbox. Complete checking of the gearbox including replacement of oil is required to be carried in this case.

Remedial Measures:

(a) Replace oil and 25-micron pressure filter. Keep watch on the colour of replaced oil.

(b) Check the lubrication pressure, if it is 3.5 bars at 1000 r.p.m. stop the machine. Further operation of gearbox may lead to excessive damage. If pressure is within range, replace oil, check strainer, if nothing is found in it, and keep on working by frequent checking of lube oil pressure unit till it reaches to 3.5 bars.

Preventive Measures

(a) Don't keep on working if the main pressure is less than 10 bar.

(b) Filter/oil should be replaced as per prescribed schedule.

Jerks Observed In All Three Speeds

Case Study

Whenever jerks are observed while shifting the gear, itis the indication of poor condition of the gearbox. Clutch gaps are increased resulting longer gear shifting time (recommended gear shifting time is1.17 seconds to 1.7 seconds). Early checking of the gearbox is required after said indication during working.

Remedial Measures

(a) If jerks are felt only while placing the first gear,
Check external connections.

(b) If jerks observed in all three speeds complete gearbox needs checking, may ask CPOH for the same/

Preventive Measures

(a) Shifting of gears should be done at proper time, for that lockup indication may be provided over operating panel.

(b) Down shifting should be avoided.

(c) Check your pressure switch for its functioning replaces if required

good maintenance practices

ZF Hydrodynamic gearbox should be handled by a skilled & trained workman only with a special emphasis on cleanliness. It is preferable to keep special tools recommended by OEM for limited maintenance operations to be carried out at field or else similar indigenized tools must always be made available in the machine.

Use only recommended brand of Locktites, i.e.:-

270 No. For nuts & bolts.

574 No. for Sealant (Liquid Gasket).

641 No. for Bearing surface.

Replace oil ULTRA-10 / SAE 15-W (as the case may be) after every 500 hrs. of working. During oil replacement, strainer should be checked for any accumulation of impurities over magnetic rod. 'O' Ring over strainer must be replaced at the time of oil change.

Check the oil level weekly:

(a) While the machine is in horizontal plain.

(b) Keep transmission in neutral position.

(c) Cold level at 40°C & 1000 RPM - Lower mark
(d) Hot level at 80°C & 1000 PM - Upper mark
Where 80°C is not achieved, checking at 40oC for lower mark will serve the purpose.

Replacement of pressure filter (25 micron) at the interval of 250 hours of working.
Replace the filter along with oil in case of buzzer alarm heard for choking of filters.
Check external connections at regular interval for their tightness.
Operation of gear shifting should not be done below:-

1200 r.p.m. of the engine:
Towing speed restriction of 10 Kmph should be followed: otherwise it may lead to the damage of gearbox. Connecting two machines for block operation should not be done.
Shifting of gear should be carried out at the proper time. Any delay or early shifting will reduce the gearbox life in long run.

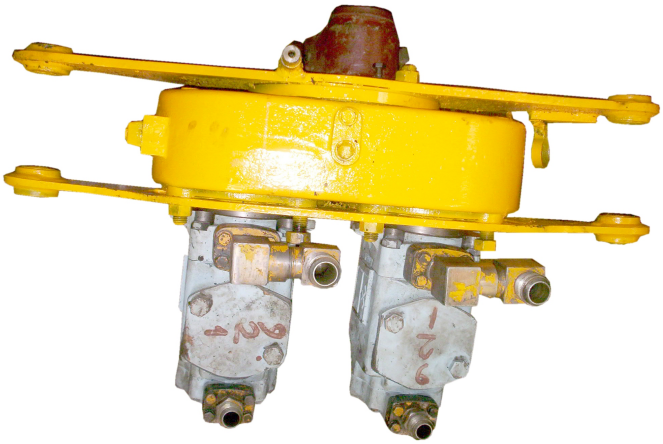
Proper Time for Lockup indication:
Indicator is not provided in operating panel, gears are being shifted only based on experience and assumptions.A LED connection may be provided in cabins as has been provided in SPURT Car. CPOH can provided circuit diagram if desired. Frequent variation of speed should be avoided. ZF key should be put off only after stopping of machine as two clutches out of seven clutches remain engaged even in neutral position and counter speed of the wheel through cardon shaft will affect those clutches which may damage the frictional bearings and slippage of clutch may occur. If for any reason external impurities enter the gearbox, working of machine should be stopped and after rectification of defect complete oil should be replaced. In that case clean the gearbox as much as possible including torque converter.

Pressure cut off switch should be checked for its functioning at 2.5 bars. Early or late cut off may reduce the life of the costly ZF gearbox.
In case of any obstruction while moving, r.p.m. should be reduced and brakes should be applied below the cut off pressure I.e. 2.5 bars.
Avoid the excessive application of brake above 2.5 bars.1-MAIN PRESSURE HAS GONE TO ZERO AND MOVEMENT F THE MACHINE STOPPED

Sub:- Mechanical

Funk Gear Box: Working, Construction and Maintenance practices. .

FUNK GEAR BOX



Funk gear box is a mechanical gear box used for the purpose of power transmission. This has got the gear arrangement in such manner that with the help of a common shaft input power is taken and the power is transmitted in to two opposite directions. For example hydraulic pumps being in two opposite directions get power from one common input and pumps (LHS & RHS) can be driven in to two different directions.

REDUCTION GEAR BOX:

It is a mechanical gear box use for power transmission in Track Machine. This gear box is used whenever we want to run the working unit at lower speed. Gear trains are selected as according to match the speed of the working unit. This gear box is used mainly in the working mode when the machine works during sleeper to sleeper movement.

Maintenance practices for the maintenance of reduction gear box there is a need of oil changing as per the prescribed manual. This should also be ensured that dust and dirt should not entrapped in the gear box as otherwise it will damaged the gear box and their will be no smooth operation of the gear box.

WORKING AND CONSTRUCTION OF SATELLITE AXLE GEAR BOX:

In 09-CSM machine, Plasser and Theurer provide a Continuous machine movement along with tamping for achieving more out put. For this purpose, tamping and lifting unit has been provided on Satellite frame which moves independent of machine movement. While tamping, main Machine moves continuously and the Satellite unit Stops for each tamping cycle and go distantly again and again. For the movement of Satellite frame, we use a satellite gear box which takes mechanical Energy through a hyd. Motor. Satellite gear box is a very sophisticated gear box and engaging of two big and small Spur gear depends upon Pneumatic Pressure. If Pneumatic Pressure is less than 2.5 bar then it will affect gear box as well as out put. In order to avoid long idling and long life of Satellite gear box. Following points are to be help in mind during operation.

Sub:- Mechanical

Satellite Axle Gear Box: Precautionary steps to avoid failure.

PRECAUTIONARY STEPS TO AVOID FAILURE.

i) It is to be ensured that Pneumatic Pressure should not be less then 2.5 bar.
ii) Engaging and disengaging of both Spur Gears should be 100%.
iii) Satellite brake of 5 bars should act properly while tamping.
iv) Longitudinal Transducer limit switch should be in working order, limit switch connection should be in NO Position.
v) 32mm, 25mm pin Rocker Bearing GE-25, link plate, torque plate, Gear Box top housing must not any play.
vi) Proximatic Switch (1422k) should be set properly according to fork Position after ensuring 100% engaging and disengaging of both spur gears.
vii) There should not be any play between fork hole and guide rod. Pneumatic cylinder and shifter rod should be tightened along with the check nut.
viii) Pneumatic cylinder and valve should work properly and get it cleaned periodically.
ix) Rubbing block and brake gap should not be more than 3mm.
x) The seal of satellite brake cylinder should be checked regularly and replaced after every 1000hrs if required.
xi) Booster cylinder should be in working condition and pressure should not be less than 40 bar(40-60 bar)
xii) According to Track condition Machine speed should co-inside with satellite movement.(Machine Speed 1.2km/hr)

Sub:- Mechanical

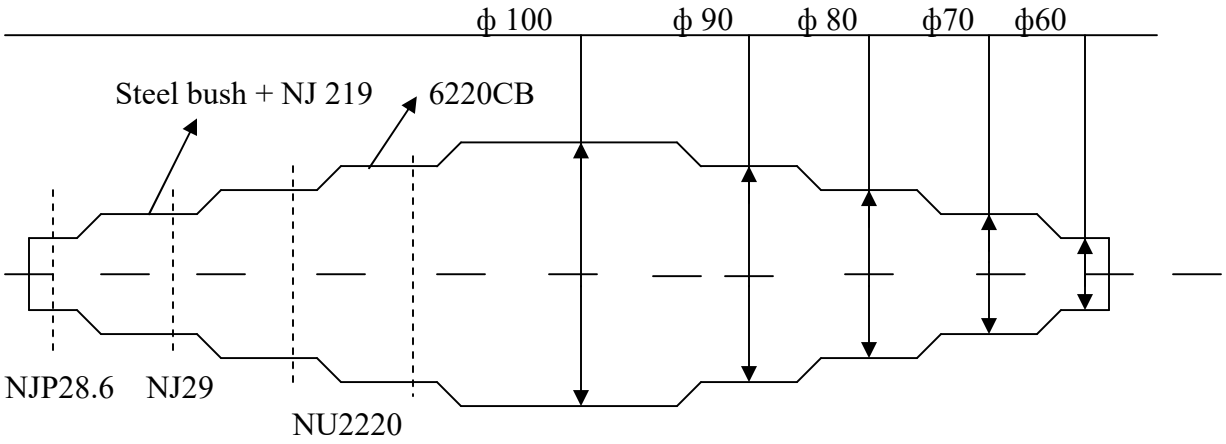
Tamping Unit : Function and Parts.

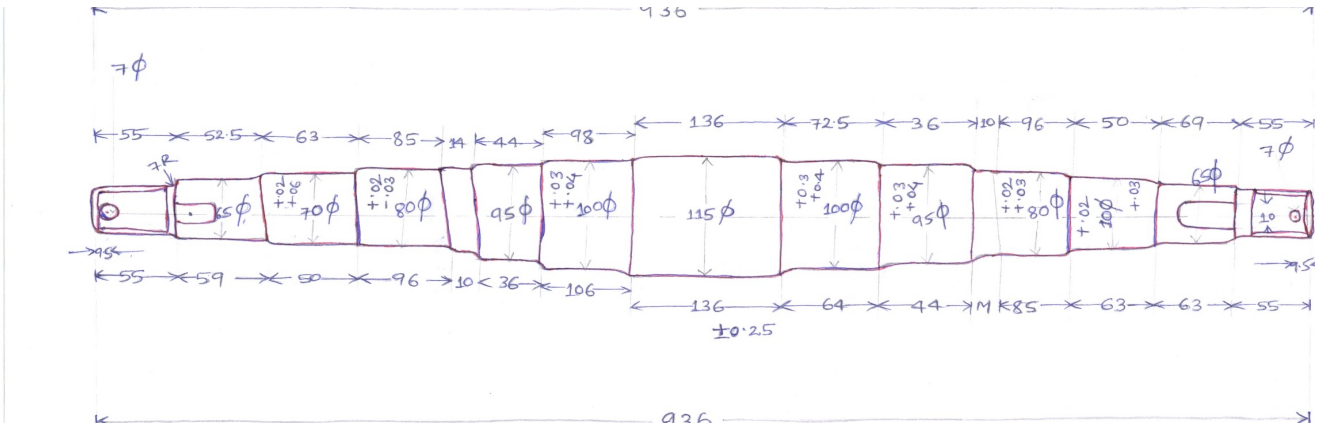
TAMPING UNIT FUNCTIONS & PARTS

Tamping Units/Bank:

The tamping unit is the most important mechanical assembly of the machine in addition to the Diesel Engine (which has been dealt separately). There are various designs of tamping banks suiting different types of machines and track requirements e.g. single sleeper tamping. Double sleeper tamping, switches and crossing etc., whatever type of machine it may be, M/s plasser & Theurer has world wide patent for its non-synchronous design of tamping banks. Which are discussed one by one.

Vibration Shaft:



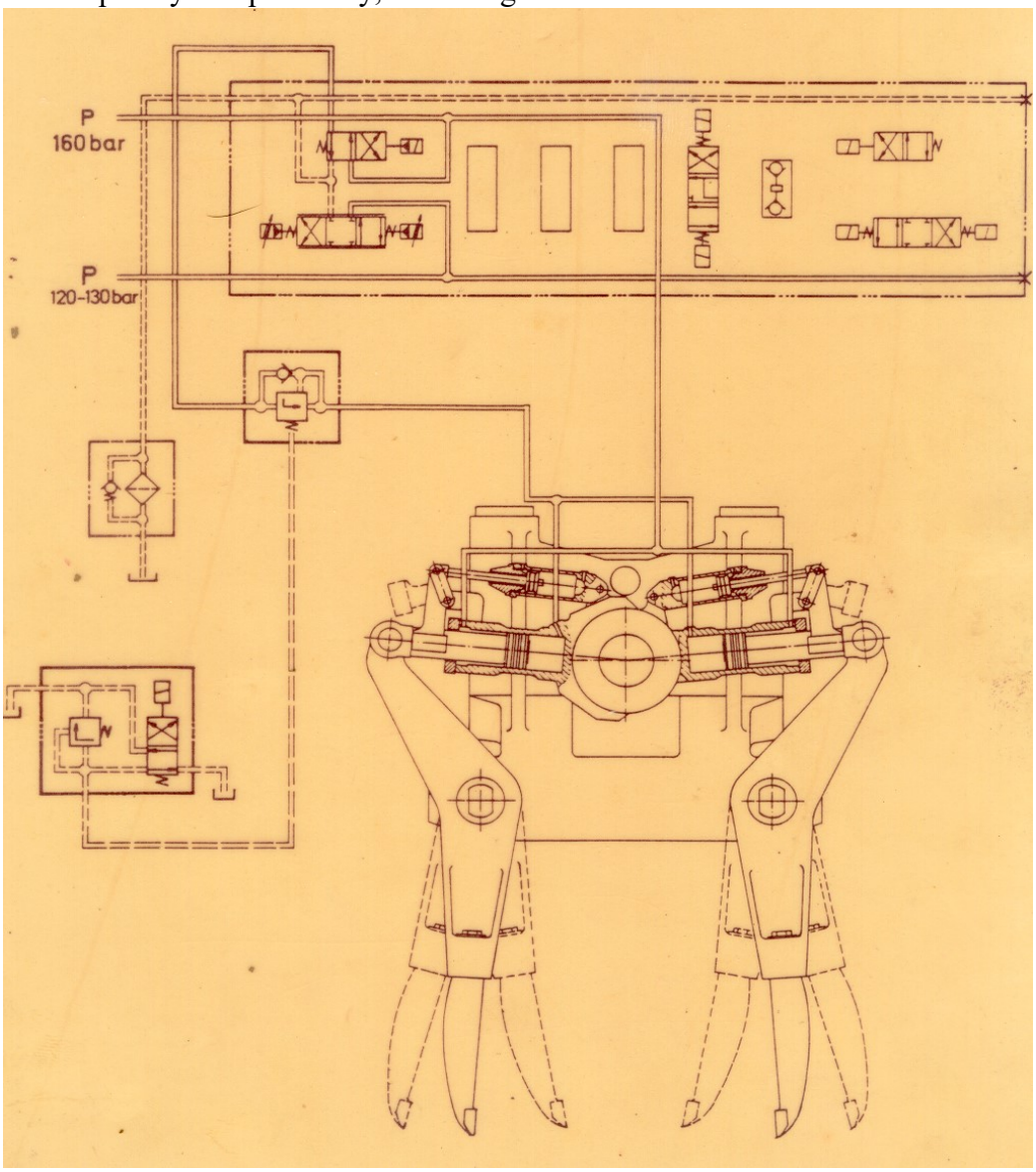


All Dimensions ARE in MM

1.1 Tamping Bank For Tamping Single Sleeper

The mainliner universal machines having this tamping bank are designated 06-16 type. Non-synchronous constant pressure-vibration tamping is achieved by 8 tamping tools on each bank, arranged in pairs, in side and outside the rails, on both sides of the sleepers. The machine operates with a total of 16 tamping tools.

Non-synchronous feed adjustment results in all tamping tools exerting the same pressure on the ballast bed, regardless of the in-feed movement. There is complete force equilibrium between tool pairs, and uniform specific surface pressure on all **tamping tools. The pairs of tamping** tools move completely independently, according to the resistance encountered in the ballast bed.



During the in-feed action of the tamping tools, resistance builds up in front of each individual tool pair. When the resistance has reached the level of the chosed tool in-feed force, the tool pairs concerned come to rest. The other tamping tools continue to work until they too exert the same force on the ballast bed.

The plasser & Theurer non- synchronous constant pressure tamping system therefore guarantees completely uniform tamping of the sleeper bearing surface.

The tool blades are corrugated and have a spade shaped edge. This means that they adapt more more easily to the grain of the ballast, and deal with a wider tamping zone. Due to the spade-shape of the blades the tools encounter less penetration **resistance.**

The vibration is generated by a hydraulically driven eccentric shaft. Connecting rods (hydraulic cylinders) are supported on the shaft conveying the eccentric movement to the swing arms, which in turn vibrate the tamping tools.

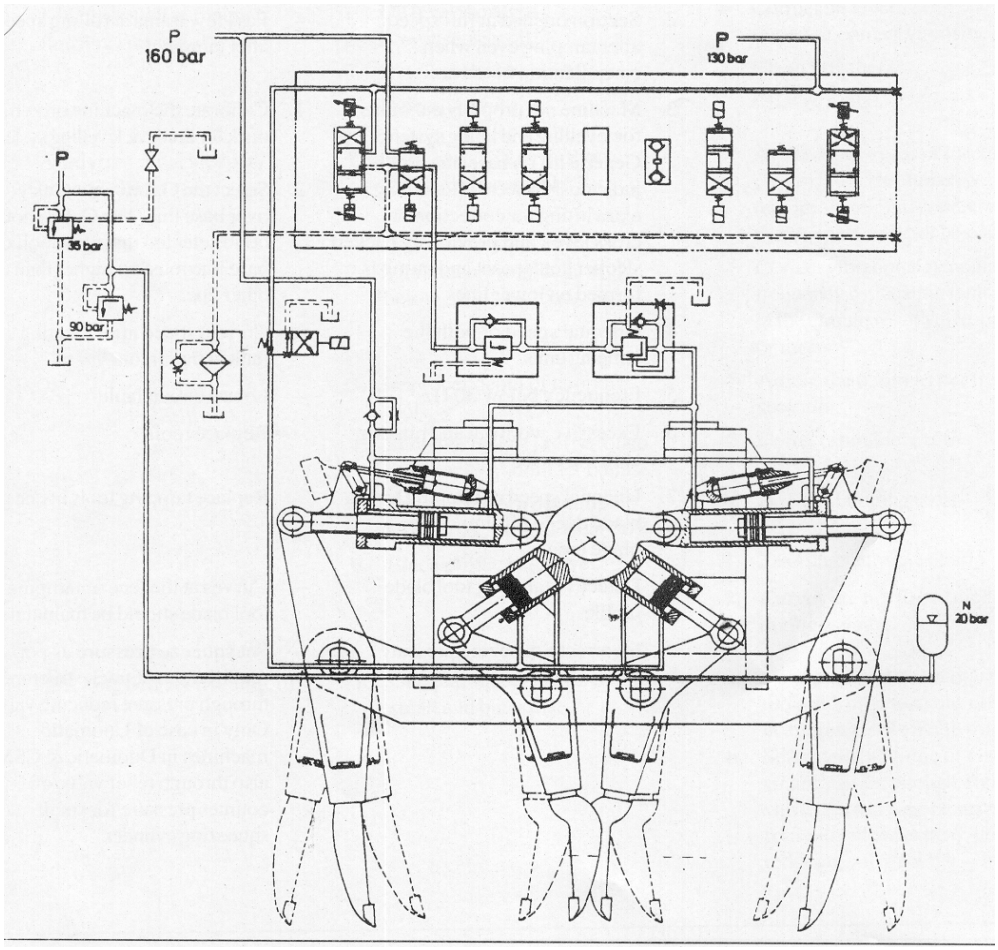
Speed of rotation of	
Vibration shaft approx	: 2,100 rev/min.
Vibration of tamping	
Tools approx	: 35 cycles.
Amplitude of vibration	: 10 mm.

1.2 Tamping Bank For Tamping Two Adjacent Sleepers

The double headed tamping machines are of the type mainliner Duomatic 06-32 series.

Two independent tamping banks are laterally movable on horizontal guide columns for automatic centering above the rails, allowing a perfect tamping even on curves. Each machine has 32 tamping tools arranged in pairs for the simultaneous tamping of two adjacent sleepers.

A uniform compaction of the sleeper bearing surface is achieved by non-synchronous constant pressure vibration tamping. The design of the tool plates vibration frequency, etc., are similar to that of the 06-16 tampers.



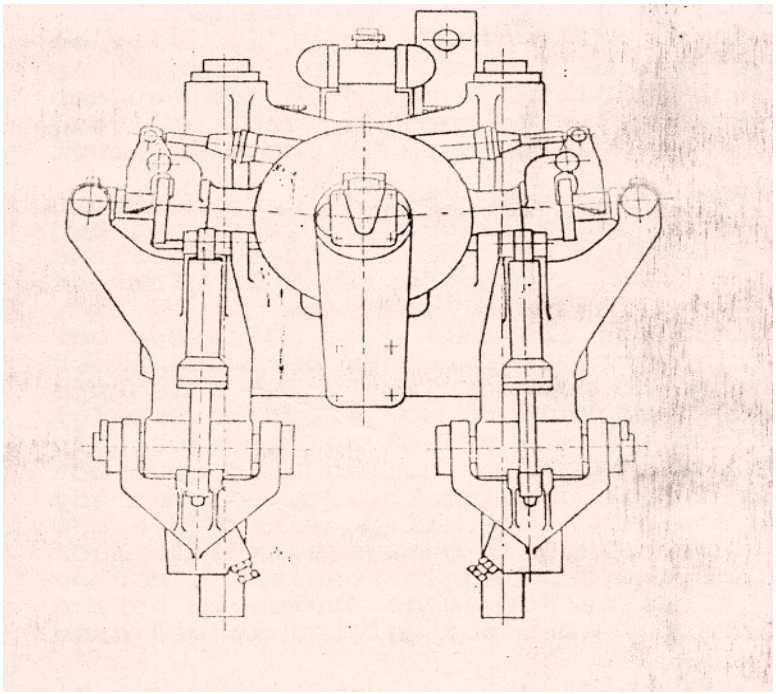
The simultaneous tamping of two adjacent sleepers increases the output., as compared to that of machines with a single tamping bank. Tamping machines with double-sleeper tamping banks are therefore considerably more economic in operation than those with

single tamping banks. The generally track layout achieved with these machines is better than achieved tamping for individual sleepers. The output of double-headed tamping machines being greater, they are preferred by railway administrations even when used by contractors, as traffic restrictions and expenditure on personnel is lower than that which would be used for double the number of single-headed tamping machines.

Speed of rotation of vibration shaft : 2,100 rev/min.
Vibration of vibration : 10 mm.

1.3 Tamping Bank for Switches and Crossing

The tamping machines with these banks have the type designation mainliner unviers al 2 W 75.



One tamping bank per rails is equipped with 4 titable tamping tools. This disposition allow the tamping of all parts of the 5 & C layout. Even such parts as frogs, switch blades, etc. can be under-gripped by swinging in the tools. The non-synchronous feed adjustment of the tamping tools is by hydraulically produced vibrations.

For tamping double sleepers the opening width of the tamping clamps is increased. The tamping tools have a large surface and are manufactured of wear resistant manganese steel. Tamping tools with extra wide plates can be used for tamping plan track. The tamping banks are raised and lowered by hydraulic cylinders. The tamping banks can work independently.

The tamping banks can also be equipped with tool spades to apply on a larger area. The sleeper can then be tamped once with vertical tools and once with tools slightly tited outward so.

Rotations of vibration shaft : Appox 2, 100 rev/mins.
Vibration of tamping tools : Approx 35 cycles.
Amplitude of vibrations : Approx 10 mm.

Sub:- Mechanical

Tamping Unit: Precautions during working & repairing. Maintenance schedule.

Trouble Shooting and Failure Analysis:

Trouble in Tamping Unit	Solution
1. Wear and tear of tamping tools.	1. Repair, welding and replacement of tamping Tools
2. Play developed in the Tamping Arm.	2. Requirement of Replacement of Tamping after certain specified time.
3. Leakage in the radial seal of tamping arm (955mm pin)	3. Replacement of Radial Seal of tamping arm (955m pin)
4. Breakage of Cover bolt 16 x 35 of small squeezing cylinder.	4. Replacement of cover bolt of 16 x 35 of small squeezing cylinder.
5 Shearing of piston screw of squeezing cylinder.	5. Replacement of bearings of Tamping Unit.
6. Seizure of bearings of Tamping unit.	6. Replacement of bearings of Tamping Unit.
7. Breakage of Vibration shaft of Tamping clip.	7. Replacement of vibration shaft of tamping unit.

Sub:- Mechanical

Lifting and Lining Unit: Function, assembly and maintenance aspects. .

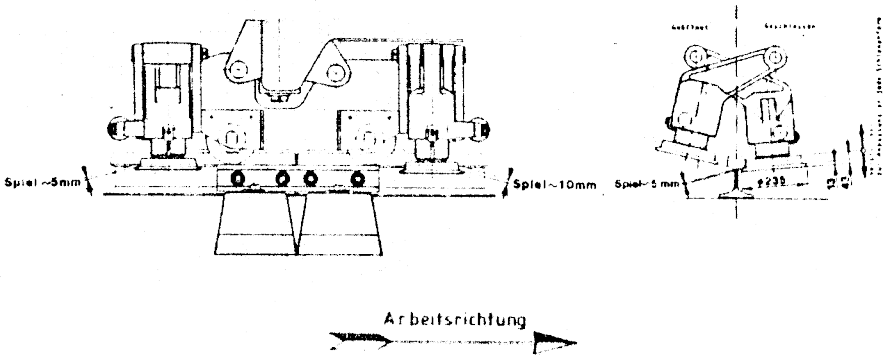
Lifting and Lining Unit

The track lining equipment and the roller lifting unit are complied. Two double-flanged rollers and one horizontal hydraulic cylinder on each unit line the track. When the combined lifting and lining unit have been lowered the 8 lifting rollers as well as the 4 lining rollers roll along holding the rails.

The track is lined by the lining cylinders moving the two tool carriers in the required direction. The lining force acts on the track on four points by the flanges of the ling rollers. The track is moved into the correct piston without impact. As lifting and lining are also carried out simultaneously and the combined unit is arranged immediately in front of the tamping bank, the track is is tamped in its corrected position.

The Leveling, tamping and lining machines of the mainline universal series are equipped with the combined unit for simultaneous lifting and lining of the track.

The lifting force is applied centrally over each rail without support on the ballast. Two pairs of rollers grip each rails under the head from inside and out side. This means that the track is lifted on four points. Because of the clamp like arrangement of the lifting rollers, and of the vertical lifting roller of the vertical lifting roller of the vertical lifting force, no tilting moment is conveyed to the rail and therefore no excessive loads exacted on the rail and therefore no excessive loads exacted on rail fastenings. In moving forward, the clamps remain closed, rolling under the rail top without touching the fastenings. The clamps also over-roll joints, fish-plates, welds, etc., without having to open. For tracks where the closed roller clamps cannot roll clear (e.g. bull head track) a special automatic control device is provided, which opens the clamps when the machine moves forward to close them again when the machines reaches the next tamping spot.



GENERAL INFORMATION

The sequence of dismantling the lifting and lining unit is basically the versed sequence of its assembling.

Utmost cleanliness is to be observed all through out the dismantling, repair and reassembling. Before repair the lifting and lining unit is to be cleaned with an adequate cleansing agent.

When repair is carried out on a unit which is mounted to the machine the site is to be protected against dropping dirt.

Before reassembling thoroughly clean all parts, replace used washers and remove sealing from sealing surfaces trim all burr and similar roughness. Replace by new ones damaged and worn parts.

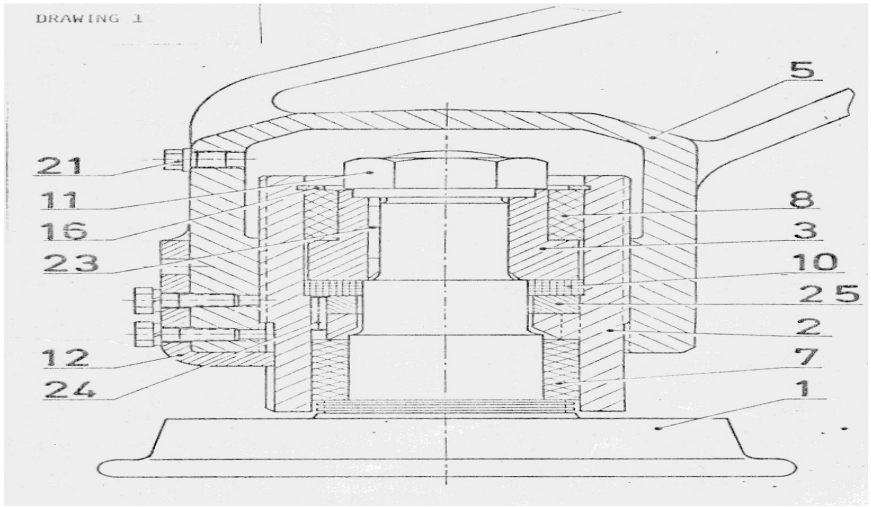
A competent machine is to assess which of the parts submitted to normal wear are to be re-used. Washers, sealing rings, locking plates split pins and the like are to be replaced in case they were damaged during dismounting.
No clips, or splinters or other foreign matters are to be left in the housing.
Observe during reassembling the indicated torque and adjusting date. Screws and nuts for which no torque is indicated are tighghtended according to standard charts.
The numbers indicated in these instructions (e.g. 1/A,B) mean.
1 = number of figure
A,B = position
Numbers not followed by letters refer to the illustration as a whole.
V.B. = Numbers of devices used.

13.0 ASSEMBLING THE LIFTING ROLLER CLAMP ASSEMBLY

Hold lifting disc (1/1) in vice and insert adjusting spring (1/23) into shaft using a hammer of plastic material or of aluminum.
Drive to the bushing of plastic material (1/7) into the clamp sleeve (1/2) by means of device (VB 815) insert the intermediate ring (1/25) and secure against torsion by means of the clamping sleeve (1/24).
Grease the plastic bushing (1/7) and drive pre assembled clamp sleeve (1/2) in the shaft of the lifting disc (1/1)
Subsequently insert the greased axial pressure plate (1/10), the pressure bushing (1/3) and the plastic bushing (1/8), in using device (VB815)
Secure plastic bushing (1/8) by seeger ring (1/16).

Degrease nut (1/11) and thread of lifting disc shaft (1/1) coat them with loctite and tighten the nut.

1.	Lift disc	2.	Clamp sleeve
3.	Pressure bushing	5.	Clamp lever
7.	Bushing of plastic	8.	Material
10.	Axial pressure plate	11.	Nut
12.	Protector	16.	Seeger ring
21.	Plug screw	23.	Adjusting spring
24.	Clamping sleeve	25.	Intermediate ring.



Functions, types, bearing clearances and maintenance aspects

Bearings are required while transmitting rotary power from the source to the points of its usages through various linkages to reduce friction, undue power losses, to give even support to the rotating unit and to avoid setting up of undue vibrations in the rotating member thus increasing life of the unit, by reducing wear.
Various types of bearings have been developed by bearing industries in the world for use on various machines and working units to suit to various loads, RPM, condition of working like vibration, jerks, etc. Various weathering condition like sun, dry wet, hot, cold or chemically contaminating atmosphere. There are generally the following types of bearings available.
Bush bearings.
Ball bearings.
Roller bearings
Needle roller bearings.
Thrust bearings.
Spherical bearings
Tapper roller bearings.
Special bearings (Rocker bearings)

Use of Bearings on Track Machines:
On track machines use of various types of bearings on their working units like tamping units lifting units, scrapping chains, ballast regulating units etc. is made e.g. besides this bearings are used in the following assemblies.
Wheels and axles.
Gear boxes.
Axle gear bogies.
Various bogies.
Pumps & Motors.
Radiator fans.
Engines, etc.

Numbering of Bearings:
Each bearing is given certain No. as per International standardization organizations ISO as per their diameters Plan for ball and roller bearings for other bearings different methods are used.

Bearing Number with series: (Example Of 62 Series)
Bearing up to 17 mm dia, bore the number are given as under:

SEREIS NO.	**DIA**	**SERIES NO.**	**DIA**
3 mm	623	9 mm	629
4 mm	624	10 mm	6200
5 mm	625	12 mm	6201
6 mm	626	15 mm	6202
7 mm	627	17 mm	6203
8 mm	628	20 mm	6204 From 20 mm on wards.

Last Nos. when multiplied by 5 given the bore dia of bearing..

Selection of Bearings:

Many factors have to be considered like.

1. Loads (Radial and axial)
2. RPM
3. Vibration
4. Shocks
5. Reversal of directions.
6. Atmospheric conditions (Clean dusty) full of chemicals.
7. Space to fit bearings.
8. Precision required in running.
9. Lubricating conditions
10. Quite running.
11. Temperatures while running.
12. Ease of mounting and dismounting
13. Clearance required in a bearing.

Bearing Clearance:

Bearing internal clearance is defined as the total clearance through which one bearing ring can be moved relative to the other this is indicated by shelters from C1 to C5.

Mounting and dismounting of bearings:

Before mounting any bearing the shaft or housing should be checked for proper tolerances for fits etc. if this is not observed the bearing may fail prematurely.

For providing bearings on a shaft interference fit the bearing should be heated in a oil bath tub and provided.

For providing bearing in a housing the bearing may be cooled in ice.

The bearing should be mounted square.

Lubrication paths should always be available if not these should be provided.

fixing of bearings should preferably be done in dust free atmosphere.

Axial location of bearings must be done as interference fit alone is generally not adequate for the axial location of bearing. As a rule therefore some suitable means of axially securing the ring is needed.

Bearing Technology

1. History Of Bearing

Bearing is a great invention of mankind. Even primitive man knew the use of balls and rollers for carrying heavy materials since when Egyptian pyramids were constructed . Recorded facts are available that in 1558,a Frenchman applied rollers to well bucket for drawing by reducing water the labour to great extent.

Pre-historic instances reveal that chariot was the most important asset of Assyrian Empire used for carrying weapons and soldiers in the war. The chariot axle used to get damaged by friction and hot axle trouble even with a load of four soldiers and a little weapons. The soldiers had an earnest desire to develop less friction chariots and their wish was granted in the later half of the nineteenth century when bearings were introduced.

In 19^{th} century a huge stone weighing 1000 tones and eight meters high used as a base of Russian czar peter I's statue was carried to its site by use of bronze balls.

Today this industry is so advanced that hundreds of bearings in thousands of sizes are available. Right from the simplest machinery like bicycle using balls for reducing friction to the most complicated rockets and satellites launched so far, utilize bearings for speed and service to the mankind and it is the best way to overcome friction.

2. **Bearing Materials**

The material for race ways and rolling elements have very small contact surface which are repeatedly subjected to stresses, must be such as to withstand wear and high elastic limits and high fatigue limits.

As a rule, high carbon chrome bearing steel Grade SAE 52100 or EN-31 is used for races and rolling material.

2.1 Chemical Composition

Grade	C	Cr	Mn	Si	P	S
SAE 52100	0.95 to 1.10	1.30 to 1.60	0.50	0.15 to 0.35	0.025	0.025

Other bearing steels depending upon the methods of heat treatment involved are as following.

S. No.	Group of Steel	Specification	Bearing Hardness
01.	Tool Steel	EN-31	HRC = 58-64
02.	Case Hardening	EN-32 & EM-207	HRC = 58-64
03.	Flame/Induction Hardening	EN-9K EN-43D EN-42E EN-43	HRC≥ 55

3. Bearing Life

The following relationship exists between the life in terms of millions of revolution and the load on rolling bearing.

$$L = (C/P)^P$$

Where

L = Rated life in millions of revolution
C = Dynamic Load capacity in Kgs.
P = Bearing Load in Kgs.
p = Constant i) For ball bearing = 3
ii) For Roller bearing = 10/3

If the speed n is constant, the life of rolling bearing can be determined in terms of operating hours (Lh) from the following formula.

$$L_h = \frac{16666}{n} (C/P)^P$$

$$= \frac{16666}{n} (Ca/Pa)^P$$

Example :- (Roller Bearing)

Given C = 1740 Kgs.
P = 415 Kgs.
n = 900 r.p.m.
For C/P = 4.2 and n = 900 r.p.m.
Read Nomograph for p = 10/3
L_h = 2200 hrs.

Example: (Ball Bearing)

Given C = 1850 Kgs.
P = 300 Kgs.
n = 2200 r.p.m.

For C/P = 6.16 and n = 2200 r.p.m.
Read Monograph for p = 3
L_h = 1800 Hrs.

4. Selection of Bearing

The bearings are selected keeping in view the equivalent load, desired life and operating speed or r.p.m. as discussed earlier. Tables showing load factor and r.p.m. are available for selection of bearing size for a desired life. The following table can be used as guide for calculating bearing. life of different machine.

5. Recommended Life Value

Type of machine	**Life L_h in Operating hrs.**
Infrequently operated machines Apparatus, devices, Demonstration gear.	500
Machine intended for brief operation lifting gear, Domestic equipment, hand tools.	4,000……8,000
Machines on intermittent operation: conveying Equipment, infrequently operated machine tools, Agricultural machinery.	8,000……15,000
Machines for I-shift operation: Machines tools, ventilators, countershafts, general Production machinery, extruders.	15,000….30,000
Machines on continuous operation: Pumps, compressors.	30,000…60,000
Machines on continuous operation with high production Capacity: Paper machines, textile machinery	100,000

NOTE: It will be seen from above table that the Track Machines fall in the Category of Machines on intermittent operation having life L_h = 8000 – 15000 operating hrs.

6. **Bearing Construction:**

Every Bearing has four main constructional features:
Inner race
Outer race
Balls/Roller/Needle.
Cage

The race (Outer & inner) provide the path for rolling elements for their smooth and frictionless motion that is why the bearings are termed as antifriction bearings also. The rolling elements (Ball/Roller/Needle) are sometimes mounted on the inner race where as in some cases on outer race. The rolling elements are kept intact, equally spaced and in one plane by a cage which can be pressed or fabricated type depending upon the manufacturer's design.

6.1 **Specification Of Cage:**

The cages are specified as follows and find their asses in industry/machinery as per requirement. The cage not only keep the rolling elements in position but also retain grease for their lubrication which if lost, the bearing is damaged and or results in over heating and caesura

S. No.	**Code**	**Cage Material.**
1.	F	Steel cage

2.	L	Light alloy cage
3.	M	Brass cage
4.	TM	Plastic cage
5.	J	Sheet Steel cage.

These days even Aluminum cages are also provided by the manufacturers.

7. RADIAL AND AXIAL CLEARANCES:

The radial or axial clearance ofa bearing is the amount by which the two races may be moved from one end position to the other radialy or axially.

7.1 RUNNING CLEARANCE:

Running clearance may be defined as the clearance of the mounted bearing produced as a result of fitting conditions and operating temperature. In other words:

Radial clearance > Running clearance

Radial clearance - Mounting tolerance = Running clearance

In order that the running clearance of a radial bearing always has the correct value to ensure an efficient function bearings are available with reduced or enlarged radial clearance for special conditions.

7.2 CLEARANCE SYMBOL:

Symbol	Clearance Classification
C2	Radial clearance smaller than normal

Radial clearance normal

C3	Radial clearance larger than normal
C4	Radial clearance larger than C_3
C5	Radial clearance larger than C_4

7.3 Radial Clearance of Deep Groove Ball Bearing With Cylindrical Bore:

Bored (mm)		**Radial clearance (In units of 0.001mm)**							
		C 2		**Normal**		**C 3**		**C 4**	
Over	**Incl**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**
2.5	10	-	7	2	13	8	23	-	-
10	18	-	9	5	18	11	25	18	33
18	24	-	10	5	20	13	28	20	36
24	30	-	11	5	20	13	28	23	41
30	40	-	11	6	20	15	33	28	46
40	50	-	11	6	23	18	36	30	51
50	65	-	15	8	28	23	43	38	61
65	80	-	15	10	30	25	51	46	71
80	100	-	18	12	36	30	58	53	84
100	120	-	20	15	41	36	66	61	97
120	140	-	23	18	48	41	81	71	114
140	160	-	23	18	63	46	91	81	130
160	180	-	25	20	61	53	102	91	147
180	200	-	30	25	71	63	117	107	163

Radial Clearance of Cylindrical Roller Bearings With Cylindrical Bore and Interchangeable Components:

Bored (mm)		Radial clearance									
		C 2		Normal		C 3		C 4		C 5	
Over	Incl	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
18	24	0	30	10	40	25	55	35	65	55	85
24	30	0	30	10	45	30	65	40	70	60	90
30	40	0	35	15	50	35	70	45	80	70	105
40	50	5	40	20	55	40	75	55	90	85	120
50	65	5	45	25	70	45	90	65	105	100	140
65	80	5	55	30	80	55	105	75	125	115	165
80	100	10	60	35	85	65	115	90	140	145	195
100	120	10	65	35	90	80	135	105	160	165	220
120	140	10	75	40	105	90	155	115	180	185	250
140	160	15	80	50	115	100	165	130	195	-	-
160	180	20	85	60	125	110	175	150	215	-	-
180	200	25	95	65	135	125	195	165	235	-	-

7.5 **Radial Clearance Specified for High Temperature:**

Operating temperature	$120\text{-}150^0C$	$150\text{-}180^0C$	Over 180^0C
Radial clearance	C_3	C_4	Greater than C_4

8. **Classification of Bearings:**

There are three main classification of bearings e.g.
Ball bearing
Roller bearing
Needle bearing

They are further classified as follows:

I. **Ball bearings:**
Rigid Ball Bearings
Deep groove ball bearings
Angular contact
Double row-self aligning
Thrust Ball bearings
Single Thrust
Double/Duplex thrust.

II. **<u>Roller Bearing</u>:**
Cylindrical roller bearing
Spherical roller bearing
Taper roller bearing

III. **<u>Needle Bearing</u>:**
Needle cage
Inner Race
Shell type needle bearing
Needle bearing with hard shoulder.
Needle bearing without shoulder
Adjustable needle bearing
Self aligning
Cam follower type needle bearing

Roller follower needle bearing
Thrust Needle roller bearing
Flat cages.

Maintenance Aspects of Bearing:

9. **Lubrication of Bearings:**

Rolling bearing generally require a minimum of lubrication as the load is transferred under rolling friction. Primarily sliding friction occur only on the guide surfaces of the cages, but the quality of lubrication is never-the-less a decisive factor in the life of an antifriction bearing as the main function of lubricant is to prevent corrosion, wear and over heating.

9.1 **Importance of Lubrication:**

The lubrication plays very important role in antifriction bearings and serve various purposes as below:
It reduces friction and wear.
It prevents corrosion
It acts as coolant
It works as noise damper
It acts as dirt remover
It acts as seal/sealent also
It acts as retainer for rolling element.
NOTE: Lack of lubrication is one of the most common reasons for premature bearing death.

9.2 **Type of Lubrications:**

There are three types of lubrications commonly in use for antifriction bearings.

9.3 **Grease Lubrication:**

Properties of various types of greases are reproduced below for guidance of the users.

Type of Grease	**Calcium**	**Sodium**	**Aluminum**	**Barium**	**Lithium**	**Benton**	**Silica gel**
Name of Grease	Cup Grease	Fiber Grease	Mobile Grease	Multi purposes Greases	Non soap base greases.		
Outward appearance	Evenly butter like	Fiber out or butter like	Evenly thread like	Evenly fiber out	Evenly butter like	Evenly butter like	Evenly butter like
Dropping point ^{0}C	85	160-	85	175	175	More than 200	More than 200
Maximum Temp. Recommended ^{0}C	70	125	80	135	135	125	125
Water resistance	Good	Poor	Good	Good	Good	Fair	Poor
Mechanical stability	Fair to good	Fair to good	Poor to fair	Poor to fair	Excellent	Fair	Poor
When heated above 120^{0}C and then cooled	Bleeding	No Change	Jelly like	No Change	No Change	No Change	No Change

9.4 **Dry Lubricants:**

Dry lubricants are recommended for operating temperatures above 250^0C under normal operating conditions there is no advantage in using them even when used in conjunction with grease or oil.

10. **Maintenance of Roller Bearings Axle Boxes:**

Normally we do not require any maintenance except inspection and re-lubrication which is done at 6000-10000 miles (or 96000-160000 Kms). However depending upon the dynamitic conditions, if it is necessary lubricate the bearing earlier. Provision for grease nipple should be kept if possible.

Sub:- Mechanical

Lubrication: Oil and Lubricants used in different gear boxes, Tamping unit, Lifting unit, Screen -drum etc., types and their capacities.

Lubrication:

Oil and lubricants used in different gear boxes, Tamping Unit, Lifting Unit Screen drum and their capacity. Following are the various oil & lubricants used in machines.

Gear Box	-	C90 – 20 lts.	
Tamping Unit	-	SS-100 Hyd. Oil	
Grease for Tamping Unit	-	RR3	
Grease for Axle	-	Bearing grease	
Main gear box of BCM	-	Hyd. Oil HLP68	
Screen drum for BCM	-	Hyd. Oil HLP68	70 lts.
Axle Gear Box	-	Hyd. Oil HLP 68	45 Lts (each axle)
Dredger drum	-	Amola 100	25 lts.
Turn table	-	Hyd, oil	15 lts.
Turn			

Sub:- Mechanical

Maintenance Schedules: Maintenance Schedules of machines.

Maintenance Schedules of Track Machines

Following are the various schedule maintenance of different machines given as under:

Schedules	UNO/DUO	CSM/09-3X Unimat/MPT DSG/BRM	BCM	FRM-80
	Engine Running Hours	Duration	Engine Running Hours	Duration
Schedules- I	Daily	1hr.	Daily	1hr.
Schedules-II	50hrs.	2hrs.	50hrs.	2hrs.
Schedules-III	100hrs.	1 Day	100hrs.	1 Day
Schedules-IV	200, 400, 600, 800hrs.	2 Days	200, 400, 600, 800hrs.	2 Days
Schedules-V	1000, 3000, 5000hrs.	7 Days	1000, 3000, 5000hrs.	7 Days
Schedules-VI	2000, 4000hrs.	45 Days	2000, 4000hrs.	45 Days
Schedules-VII	6000hrs. (POH)	90 Days	6000hrs. (POH)	90 Days
Schedules-VIII	-	-	-	-

	PQRS		TRT		T-28	
Schedules	Engine Running Hours	Duration	Engine Running Hours	Duration	Engine Running Hours	Duration
	Daily	1hrs.	Daily	1hrs.	Daily	-
Schedules- I	50hrs.	2hrs.	50hrs.	5hrs.	50hrs.	-
Schedules-II	100hrs.	1 Day	200hrs.	1 Day	100hrs.	-
Schedules-III	200hrs.	2 Days	500hrs.	7 Days	150hrs.	-
Schedules-IV	1000hrs.	7 Days	1000hrs. (IOH)	7 Days	200hrs.	-
Schedules-V	2000hrs. (IOH)	45 Days	6000hrs. (POH)	-	300hrs.	-
Schedules-VI	4000hrs. ((POH)	60 Days	-	-	500hrs.	-
Schedules-VII	-	-	-	-	1500hrs.	-
Schedules-VIII						

Sub:- Mechanical

Overhauling of Machin: IOH/POH of machines.

OVERHAULING OF MACHINES

This can be said without any fear of contradiction that lot of wear and tear takes place on account of machine working and as machines are subjected to wear and tear, failures are bound to take place, so in order to prevent the failures of machines, schedules have been framed which are followed and then chances of failures are reduced. The various schedules have been incorporated in the track machine manual-2000 depending upon the type of machine which reduces down time of machines and this are known as preventive maintaining but this is not sufficient to meet the requirement of machines and accordingly with the certain passage of time and specified working hours of machines after which, other than schedules, machine are taken to zonal or central periodical overhauling workshop for conveying out IOH/POH of machines which are given as under for good health of machine. Yard stick of IOH/POH of machines.

POH of machines.

Overhauling of tamping Units, Gear Assembly, axle assembly and lifting lining assembly for unit change either at shop floor or field.

Post POH service to zonal railway and performance monitoring of overhauled.

Development of Expertise, Standardization/documentations and dissemination of knowledge with respect to overhauling of assemblies.

Study of Interchangeability of components and subassemblies.

Study of failures, finding out remedial measures, troubleshooting and development of maintenance practices.

Procurement of stores and equipments required for POH and their inspection.

Inspection and testing of machines/assemblies received prior to and after POH.

Study of new imported machines and preparations of inventory list with complete series of machines. (machine wise) and checking for changes with reference to old series of machines.

Development of drawings and material specification for manufacturer of spares.

Providing shop floor training regarding maintenance of machines.