International Journal on Applications in Mechanical and Production Engineering
Volume 1 : Issue 2 : February 2015 , pp 27 – 39 www.aetsjournal.com ISSN (Online) : 2395 - 3500

THREE MODE OPERATIONS FOR AUTOMOBILE STEERING

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Abstract— The main aim of this project is to steer the vehicle according to the desire of the driver. The implementation of three steering modes provided in the vehicle can be altered. The most conventional steering arrangement is to turn the front wheels using a hand–operated steering wheel which is positioned in front of the driver. Tiller is rear–wheel steering, where the type of steering is different. Tracked vehicles such as tanks usually employ differential steering that is the tracks are made to move at different speeds or directions to bring about a change of course. This has led to greater comfort for the driver to drive the vehicle whether it comes taking a turn or it comes to changing lane over the highway. In convertible four wheel steering, three mode steering can be changed as needed which assists in parking at heavy traffic conditions. This kind of vehicles can be used in negotiating areas, where short turning radius is needed and on off road driving.

I. INTRODUCTION

Nowadays, the condition of increasing road traffic makes the handling of vehicles more difficult. The present scenario demands an exploration of new vehicle handling mechanism, which in turn forces us to find out an alternative way instead of current system or a modified steering mechanism for better handling. While the vehicle enters a congested or narrow area there would be no one who doesn't wish for, if they would be able to reduce the turning radius of their vehicle or if they could move the whole vehicle sideways without turning the vehicle.

Here, comes the application of three Mode Interchangeable four Wheel Steering, which provides the same by steering the rear wheels too as our requirement. With the help of this system, the rear wheels also can be turned with respect to the direction of front wheels whenever required. Thus, the vehicle can be controlled more effectively especially during cornering, parking. When both the front and rear wheels steer toward the same direction, they are said to be in phase. When the front and rear wheels are steered in opposite direction, this is called anti-phase, counter-phase or opposite phase. Our project concentrates on the advancement in steering in race courts.It's highly unlikely for cars to turn the car across the lane with front wheel steering in high speed.

Steering is the term applied to the collection of components, linkages, etc. which will allow for a vessel (ship, boat) or vehicle (car) to follow the desired course. An exception is the case of rail transport by which rail tracks combined together with railroad switches provide the steering function.

The most conventional steering arrangement is to turn the front wheels using a hand–operated steering wheel which is positioned in front of the driver, via the steering column, which may contain universal joints to allow it to deviate somewhat from a straight line. Other arrangements are sometimes found on different types of vehicles, for example, a tiller or rear–wheel steering. Tracked vehicles such as tanks usually employ differential steering that is, the tracks are made to move at different speeds or even in opposite directions to bring about a change of course.

II. LITERATURE REVIEW

[1] S.Nithyanath,.et al.(March 2014).The most conventional and general steering arrangement is to turn the front wheels using a hand–operated steering wheel which is positioned in front of the driver. The four wheel three mode steering system is a modification for the present steering which is used for the improvement of easiness for vehicle handling. The four wheel three mode steering system assists driver by controlling the steering angle of vehicle's four wheels as the requirement of

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driver, for making the parking and handling at congested areas easier. For meeting the application the rear wheels steer in the opposite direction or in the same direction of the front wheels, allowing reduced turning radius or sliding of vehicle to sideways. .if we are able to transmit the motion that is given on steering wheel to the rear wheels and able to control like front wheels as our requirements, which is the basic idea of our project four wheel three mode. In convertible four wheel steering with three steering modes can be changed as needed which assists in parking at heavy traffic conditions, when negotiating areas where short turning radius is needed and in off road Driving.

[2] Rithvik.M.S,.et al.(March 2018).The most conventional and general steering arrangement is to turn the front wheels using a hand – operated steering wheel which is positioned in front of the Driver. The steering column, which contain an universal joint which is part of the collapsible steering column which is designed to allow it to deviate from a straight line according to the Roadmap. In convertible four wheel steering with three mode operation three steering modes can be changed as needed which assists in parking at heavy traffic conditions, when negotiating areas where short turning radius is needed and in off road driving.

[3] Dr.P.Sathyabalan,.et al. (Dec 2013).Here we have fabricated the four wheel steering with three mode operation. The main aim of this project is to steer the vehicle according to the requirement. The four wheel steering is more required in critical roads and in desert roads. In this project we implement three steering modes in a single vehicle and the modes can be changed as needed.

[4] AtulKumarKaushik,.et al.(March 2017).Work is based on the steering system modification that a new type of steering mechanism can be employed over conventional steering system. This includes steering over all of the 4 wheels instead of 2 wheels as in the present world. This has led to greater comfort for the driver to drive the vehicle whether it comes to taking a turn or it comes to changing lane over the highway. There are three modes for its operation which can be employed as per the requirement.

The main motive of this project is to make three mode steering operation which leads to greater comfort for driver to drive the vehicle. It can be changed as needed which assists in parking at heavy traffic conditions.

III.COMPONENTS

1) RACK AND PINION

A rack is a toothed bar or rod that can be thought of as a sector gear with an infinitely large radius of curvature. Torque can be converted to linear force by meshing a rack with a pinion: the pinion turns; the rack moves in a straight line. Such a mechanism is used in automobiles to convert the rotation of the steering wheel into the left-to-right motion of the tie rod(s). Racks also feature in the theory of gear geometry, where, for instance, the tooth shape of an interchangeable set of gears may be specified for the rack (infinite radius), and the tooth shapes for gears of particular actual radii then derived from that. The rack and pinion gear type is employed in a rack railway.

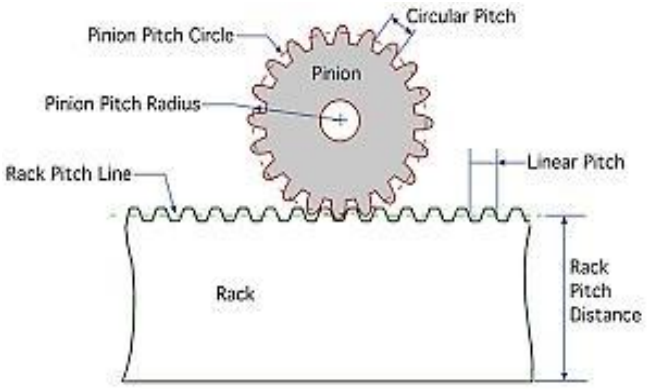


Figure 3.1 rack and pinion

A rack and pinion is a pair of gears which convert rotational motion into linear motion. The circular pinion engages teeth on a flat bar - the rack. Rotational motion applied to the pinion will cause the rack to move to the side, up to the limit of its travel. The pinion is in mesh with a rack. The circular motion of the pinion is transferred into the linear rack movement.

2) BEVEL GEAR

Bevel gears are gears where the axes of the two shafts intersect and the tooth-bearing faces of the gears themselves are conically shaped. Bevel gears

are most often mounted on shafts that are 90 degrees apart, but can be designed to work at other angles as well. The pitch surface of bevel gears is a cone.

Figure 3.2 Bevel gear

A. STRAIGHT BEVEL GEAR

Straight bevel gears are used for transmitting power between intersecting shafts. They can operate under high speeds and high loads. Their precision rating is fair to good. They are suitable for 1:1 and higher velocity ratios and for right-angle meshes to any other angles. Their good choice is for right angle drive of particularly low ratios. However, complicated both form and fabrication limits achievement of precision. They should be located at one of the less critical meshes of the train. Wide applications of the straight bevel drives are in automotive differentials, right angle drives of blenders and conveyors.

Figure 3.3 Straight bevel gear

B. SPIRAL BEVEL GEAR

Spiral bevel gears are also used for transmitting power between intersecting shafts. Because of the spiral tooth, the contact length is more and contact ratio is more. They operate smoother than straight bevel gears and have higher load capacity. But, their efficiency is slightly lower than straight bevel gear. A spiral bevel gear is a bevel gear with helical teeth. The main application of this is in a vehicle differential, where the direction of drive from the drive shaft must be turned 90 degrees to drive the wheels.Functions of a Gear Drive: A gear drive has three main functions: to increase torque from the driving equipment (motor) to the driven equipment, to reduce the speed generated by the motor, and/or to change the direction of the rotating shafts. ... Gears operate in pairs, engaging one another to transmit power.

Figure 3.4 Spiral bevel gear

C. HYPOIDAL BEVEL GEAR

These gears are also used for right angle drive in which the axes do not intersect. This permits the lowering of the pinion axis which is an added advantage in automobile in avoiding hump inside the automobile drive line power transmission. However, the non –intersection introduces a considerable amount of sliding and the drive requires good lubrication to reduce the friction and wear. Their efficiency is lower than other two types of bevel gears. These gears are widely used in current day automobile drive line power transmission.

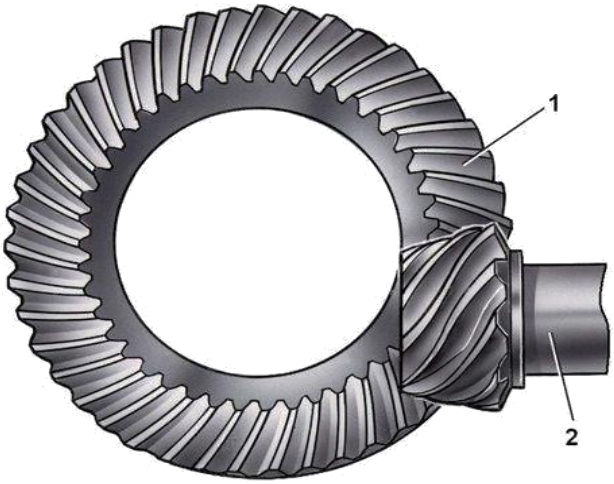


Figure 3.5 Hypoidal bevel gear

A hypoid gear is a style of spiral bevel gear whose main variance is that the mating gears' axes do not intersect. The hypoid gear is offset from the gear centre, allowing unique configurations and a large diameter shaft. The teeth on a hypoid gear are helical, and the pitch surface is best described as a hyperboloid. A hypoid gear can be considered a cross between a bevel gear and a worm drive.

3) CHAIN DRIVE

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles. The power is conveyed by a roller chain, known as the drive chain, passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force.

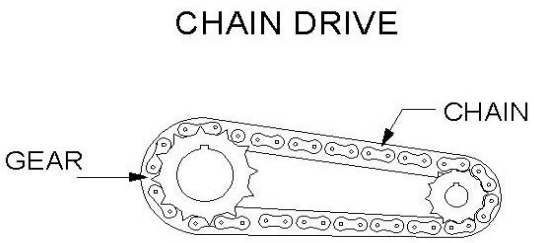


Figure 3.6 chain drive

The oldest known application of a chain drive appears in the Polybolos, a repeating crossbow described by the Greek engineer Philon of Byzantium (3rd century BC). Two flat-linked chains were connected to a windlass, which by winding back and forth would automatically fire the machine's arrows until its magazine was empty. Although the device did not transmit power continuously since the chains "did not transmit power from shaft to shaft, and hence they were not in the direct line of ancestry of the chain-drive proper", the Greek design marks the beginning of the history of the chain drive since "no earlier instance of such a cam is known, and none as complex is known until the 16th century. It is here that the flat-link chain, often attributed to Leonardo da Vinci, actually made its first appearance.

The first continuous and endless power-transmitting chain was depicted in the written horological treatise of the Song Dynasty (960–1279) Chinese engineer Su Song (1020-1101 AD), who used it to operate the armillary sphere of his astronomicalclock tower as well as the clock jack figurines presenting the time of day by mechanically banging gongs and drums. The chain drive itself was given power via the hydraulic works of Su's water clock tank and waterwheel, the latter which acted as a large gear.

4) STEERING SYSTEM

The steering system is to achieve angular motion of the front wheels to negotiate a turn. This is done through linkage and steering gear which convert the rotary motion of the steering wheel into angular motion of the front road wheels.

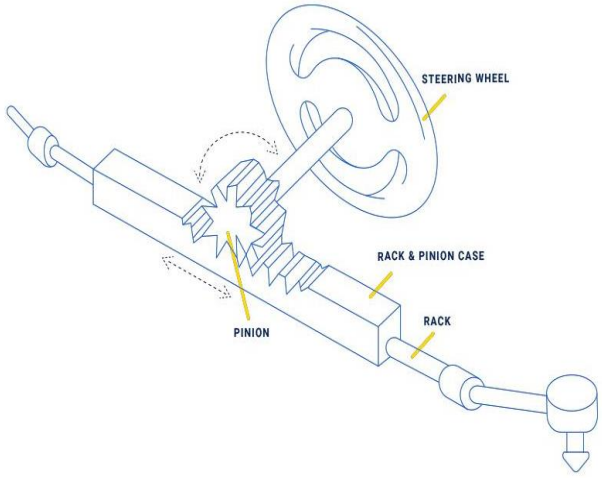


Figure 3.7 steering system

A. Rack and pinion steering system

In most cars, small trucks and SUVs on the road today, there is a rack and pinion steering system. This converts the rotational motion of the steering wheel into the linear motion that turns the wheels and guides your path. The system involves a circular gear (the steering pinion) which locks teeth on a bar (the rack). It also transforms big rotations of the steering wheel into small, accurate turns of the wheels, giving a solid and direct feel to the steering.

Components of the steering system

Whatever a car's make and model, quality auto steering parts support a flawless drive. Premium rack and pinion parts manufactured by MOOG include axial rods, tie rod ends, drag links, centre arms, steering rack gaiter kits, tie rod assemblies and wheel end bearings.These steering parts are robust and hard wearing enough to provide both strength and durability. Choosing parts which meet OE manufacturer specifications means the whole assembly will be responsive and long-lasting.

Return of four-wheel steering

Beyond the swivel of the front wheels, some cars have a steering system which affects all four. This has traditionally been exclusive to sporty or luxury models, but there's a growing trend towards the feature in more affordable cars. A four-wheel steering control unit sits behind the rear axle of the car and affects the rear wheels as needed. Car wheels turn in opposite directions at low speeds, but at high speeds, turning all four wheels in concert helps to maintain stability and prevent fishtailing.

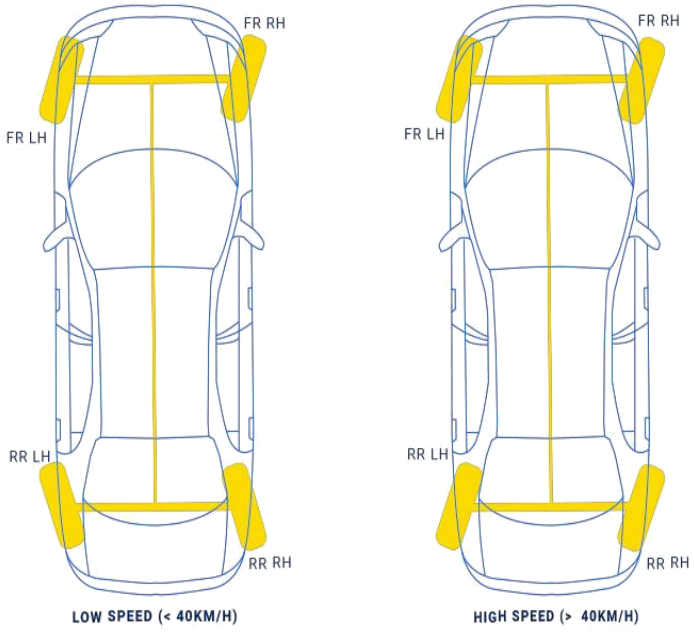


Figure 3.8 Return of four-wheel steering

Having highly technical four-wheel steering means better handling, as the steering is monitored and in emergency situations, the car reacts with the optimum response. This type of steering system is starting to appear on the Infiniti, Renault, Honda, Nissan, Mazda and other marques to give drivers new heights of driveability and responsiveness and keep us safer on the roads.

Secondary functions of the steering system are

1. To provide directional stability of the vehicle when going straight ahead.
2. To provide perfect steering condition, perfect rolling motion of the road wheels at all time.
3. To facilitate straight ahead recovery after completing a turn. To minimize tire wear.
4. Till recently all vehicles were steered by turning the front wheels in the desired direction, with the rear wheels following. However, lately all-wheel-steering has been designed and employed in some selected vehicles.

The requirements of good steering system are

1. The steering mechanism should be very accurate and easy to handle.
2. The effort required to steer should be minimal and must not be tiresome to the driver.
3. The steering mechanism should also provide directional stability. This implies that the vehicle should have a tendency to return to straight ahead position after turning.

B. DESIGN OF THE STEERING SYSTEM

1)TOP VIEW

steering system, in automobiles, steering wheel, gears, linkages, and other components used to control the direction of a vehicle's motion. Because of friction between the front tires and the road, especially in parking, effort is required to turn the steering wheel.

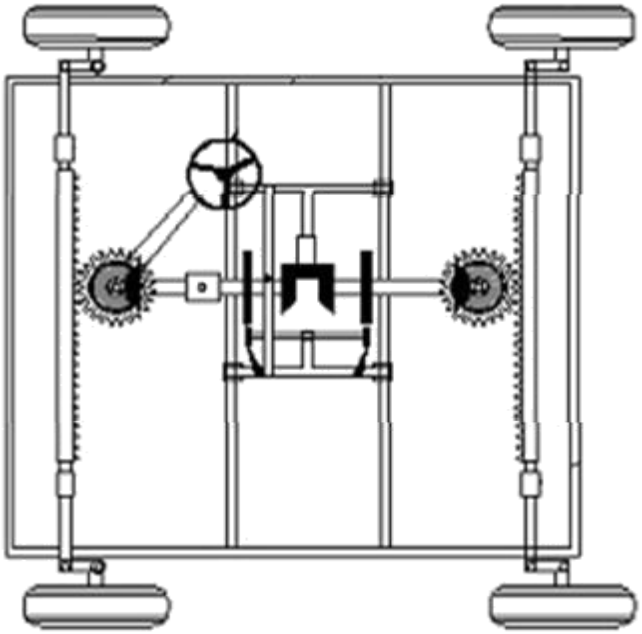


Figure 3.9 Topview

2) SIDE VIEW

Turning" is a basic function of the vehicle born by steering sysytem which changes the direction of the vehicle by turning tires through steering wheel operation. Powersteering is a device providing comfortable operation to the driver though steering wheel operation assistance (lighter feel).

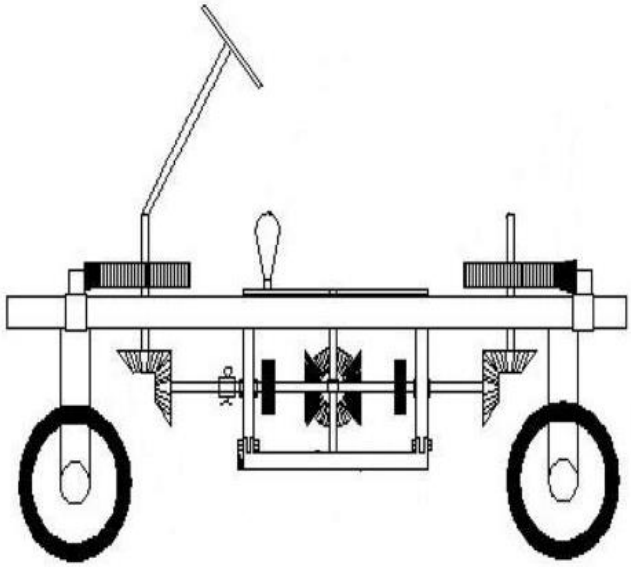


Figure 3.10 Side view

5) WHEEL

A wheel is a circular device that is capable of rotating on its axis, facilitating movement or transportation or performing labor in machines. A wheel together with an axle overcomes friction by facilitating motion by rolling. In order for wheels to rotate a moment needs to be applied to the wheel about its axis, either by way of gravity or by application of another external force. Common examples are found in transport applications. More generally the term is also used for other circular objects that rotate or turn, such as a Ship's wheel and flywheel. The wheel most likely originated in ancient.

The wheel is a device that enables efficient movement of an object across a surface where there is a force pressing the object to the surface. Common examples are a cart drawn by a horse, and the rollers on an aircraft flap mechanism.

The wheel is not a machine, and should not be confused with the wheel and axle, one of the simple machines. A driven wheel is a special case that is a wheel and axle. Wheels are used in conjunction with axles, either the wheel turns on the axle or the axle turns in the object body. The mechanics are the same in either case. The normal force at the sliding interface is the same. The sliding distance is reduced for a given distance of travel. The coefficient of friction at the interface is usually lower.

Figure 3.11 Wheel

6) TYPES OF GEAR

There are three major categories of gears in accordance with the orientation of their axes.

A gear is a kind of machine element in which teeth are cut around cylindrical or cone shaped surfaces with equal spacing. By meshing a pair of

these elements, they are used to transmit rotations and forces from the driving shaft to the driven shaft. Gears can be classified by shape as involute, cycloidal and trochoidal gears. Also, they can be classified by shaft positions as parallel shaft gears, intersecting shaft gears, and non-parallel and non-intersecting shaft gears. The history of gears is old and the use of gears already appears in ancient Greece in B.C. in the writing of Archimedes.

Figure 3.12

A. VARIOUS TYPES OF GEARS

There are many types of gears such as spur gears, helical gears, bevel gears, worm gears, gear rack, etc. These can be broadly classified by looking at the positions of axes such as parallel shafts, intersecting shafts and non-intersecting shafts.

It is necessary to accurately understand the differences among gear types to accomplish necessary force transmission in mechanical designs. Even after choosing the general type, it is important to consider factors such as: dimensions (module, number of teeth, helix angle, face width, etc.), standard of precision grade (ISO, AGMA, DIN), need for teeth grinding and/or heat treating, allowable torque and efficiency, etc.

Besides this page, we present more thorough gear technical information under Gear Knowledge (separate PDF page). In addition to the list below, each section such as worm gear, rack and pinion, bevel gear, etc. has its own additional explanation regarding the respective gear type. If it is difficult to view PDF, please consult these sections.

It is best to start with the general knowledge of the types of gears as shown below. But in addition to these, there are other types such as face gear, herringbone gear (double helical gear), crown gear, hypoid gear, etc.

There are three major categories of gears in accordance with the orientation of their axes

Configuration:

1. Parallel Axes / Spur Gear, Helical Gear, Gear Rack, Internal Gear
2. Intersecting Axes / Miter Gear, Straight Bevel Gear, Spiral Bevel Gear
3. Nonparallel, Nonintersecting Axes / Screw Gear, Worm, Worm Gear (Worm Wheel)
4. Others / Involute Spline Shaft and Bushing, Gear Coupling, Pawl and Ratchet.

The difference between a gear and a sprocket

Simply said, a gear meshes with another gear while a sprocket meshes with a chain and is not a gear. Aside from a sprocket, an item that looks somewhat like a gear is a ratchet, but its motion is limited to one direction.

Classification of types of gears from the point of positional relations of the attached shafts

1. When the gears two shafts are parallel (parallel shafts). Spur gears, rack, internal gear and helical gear, etc. Generally they have high transmission efficiency.
2. When the gear two shafts intersect each other (intersecting shafts).bevel gear is in this category. Generally they have high transmission efficiency.
3. When the gear two shafts are not parallel or intersect (offset shafts).worm gear and screw gear belongs in this group. Because of the sliding contact, the transmission efficiency is relatively low.

7) SPUR GEAR

A gear is a rotating machine part having cut teeth, or cogs, which mesh with another toothed part in order to transmit torque. Two or more gears working in tandem are called a transmission and can produce a mechanical advantage through a gear ratio and thus may be considered a simple machine. Geared devices can change the speed, torque, and

direction of a power source. The most common situation is for a gear to mesh with another gear; however a gear can also mesh a non-rotating toothed part, called a rack, thereby producing translation instead of rotation.

The gears in a transmission are analogous to the wheels in a pulley. An advantage of gears is that the teeth of a gear prevent slipping.

When two gears of unequal number of teeth are combined a mechanical advantage is produced, with both the rotational speeds and the torques of the two gears differing in a simple relationship.

In transmissions which offer multiple gear ratios, such as bicycles and cars, the term gear, as in first gear, refers to a gear ratio rather than an actual physical gear. The term is used to describe similar devices even when gear ratio is continuous rather than discrete, or when the device does not actually contain any gears, as in a continuously variable transmission.

The earliest known reference to gears was circa A.D. 50 by Hero of Alexandria, but they can be traced back to the Greek mechanics of the Alexandrian school in the 3rd century B.C. and were greatly developed by the Greek polymath Archimedes (287–212 B.C.). The Antikythera mechanism is an example of a very early and intricate geared device, designed to calculate astronomical positions. Its time of construction is now estimated between 150 and 100 BC.

DIAGRAM OF SPUR GEAR

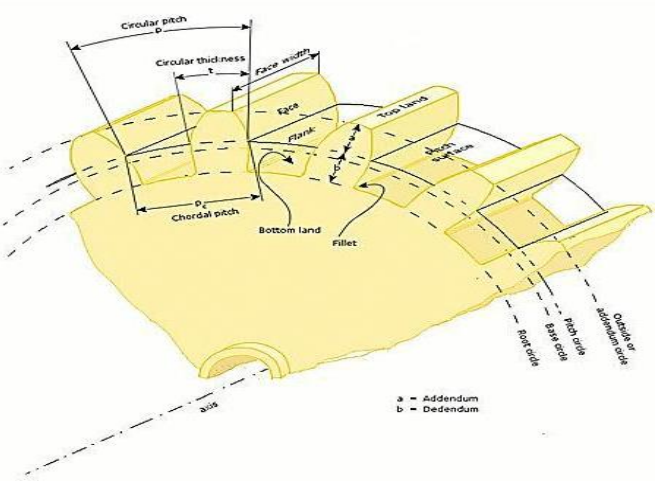
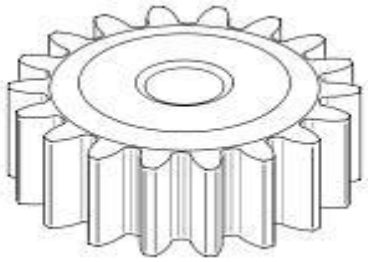


Figure 3.13 Spur gear nomenclature

The definite velocity ratio which results from having teeth gives gears an advantage over other drives (such as traction drives and V-belts) in precision machines such as watches that depend upon an exact velocity ratio. In cases where driver and follower are in close proximity gears also have an advantage over other drives in the reduced number of parts required; the downside is that gears are more expensive to manufacture and their lubrication requirements may impose a higher operating cost.



The automobile transmission allows selection between gears to give various mechanical advantages.

Figure 3.14 Spur gear

An external gear is one with the teeth formed on the outer surface of a cylinder or cone. Conversely, an internal gear is one with the teeth formed on the inner surface of a cylinder or cone. For bevel gears, an internal gear is one with the pitch angle exceeding 90 degrees. Internal gears do not cause direction reversal.

IV. DESIGN OF EQUIPMENT AND DRAWING

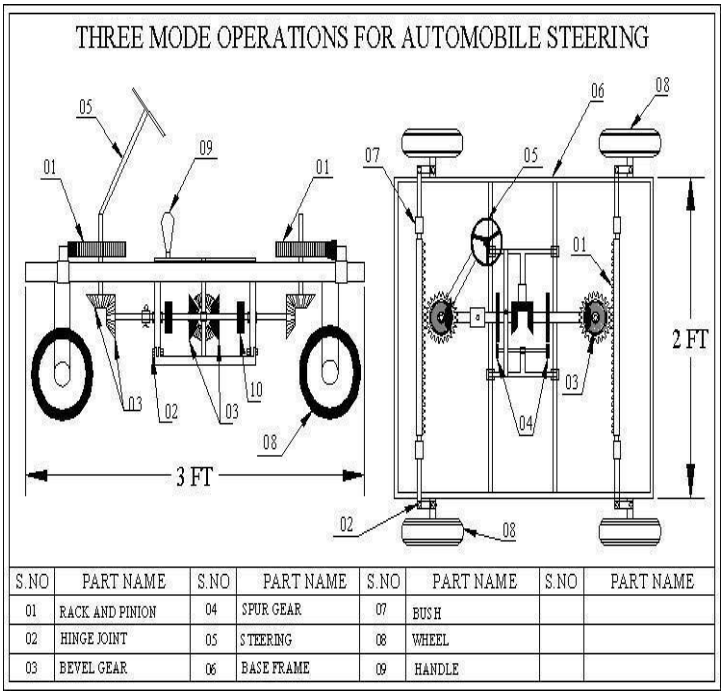
1) COMPONENTS

The four wheels steering with three mode operation consists of the following components to full fill the requirements of complete operation of the machine.

- Rack and pinion
- Bevel gear
- spur gear

- Steering
- Wheel
- Hinge joint
- Chain drive

2)DRAWING FOR THREE MODE OPERATIONS FOR AUTOMOBILE STEERING



S.NO	PART NAME	S.NO	PART NAME	S.NO	PART NAME	S.NO	PART NAME
01	RACK AND PINION	04	SPUR GEAR	07	BUSH		
02	HINGE JOINT	05	STEERING	08	WHEEL		
03	BEVEL GEAR	06	BASE FRAME	09	HANDLE		

Figure 4.1 Drawing for three mode operations for automobile steering

A. DESIGN CALCULATION

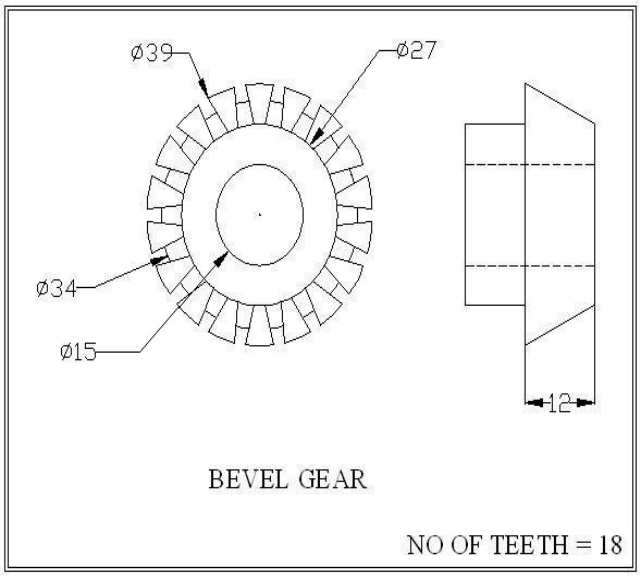


Figure 4.2 Bevel gear

B. CALCULATION FOR BEVEL GEAR- for three gears:

No. of teeth (T) = 18
Inner diameter (d) = 15 mm
Diameter of the pitch circle (D) = 40 mm

Circular pitch, $Pc = \pi D/T$
= 3.14*40/18
= 6.97 mm
= 7 mm
= 18/40
= 0.45 mm
Module,
m = D/T
= 40/18
= 2.2 mm

RACK AND PINION CALCULATION ASSEMPTION

Pressure angle of rack and pinion (p) = 20˚ full depth system
Pitch of the rack and pinion (P) = 10 mm
Diameter of pinion (D) = 105 mm
Number of teeth on rack = 50
Number of teeth on pinion = 20
Addendum (a) = 1 / P
= 1/10
= 0.1 mm Deddundum (d) = 1.25 / P
= 1.25 / 10
= 0.125 mm

$D_p = N_p / P_d$
$D_p = 50 / 10$
= 5.0 mm
$D_p = 20 / 10$
= 2.0 mm
$\sigma = F_t / (b_a . m . Y)$
Y = Lewis form factor = 0.352
Module of gear = m = 1 / $D_{p,}$ = 1 / 5.0, = 0.2 Face width of gear (b_a) = 10 mm Bending stress of gear = 110 Mpa
110 x 10^3 = F_t / 10 x 0.2 x 0.352
F_t= 156 x 10^^{3}N
W = Ft x v / 1000
Velocity of gear = v = π x D x N / 60 x 1000
= π x 90 x 250 / 60 x 1000
= 1.178 m / s
W = F_t x v / 1000
= 156 x 10^^{3} x 1.178 / 1000

= 184 watts

Pressure angle of gear = 20˚

Normal force (Fn) = Ft tanϴ

= 156 x 10^3 x tan 20

= 56780 N

Radial load = Fr =F_t / tanϴ,

= 156 x 10^3 / tan 20

= 429752N

V. DESIGN AND TEST RESULT

Ackerman Steering Mechanism: With perfect Ackermann, at any angle of steering, the centre point of all of the circles traced by all wheels will lie at a common point. But this may be difficult to arrange in practice with simple linkages. Hence, modern cars do not use pure Ackermann steering, partly because it ignores important dynamic and compliant effects, but the principle is sound for low speed manoeuvres the turning circle of a car is the diameter of the circle described by the outside wheels when turning on full lock. There is no hard and fast formula to calculate the turning circle but you can get close by using this:

TURNING CIRCLE RADIUS = (TRACK/2) + (WHEELBASE/SIN (AVERAGE STEER ANGLE))

TURNING RADIUS	FOUR WHEEL STEER	TWO WHEEL STEER
By calculation	2.59m	4.4 m
By calculation	4.4 m	4.4 m

Table. No: 5.1 Test result

VI. RESULT AND DISCUSSION

The various type of steering control mechanisms are used for four wheeler vehicles. This is also one of the steering mechanism and which is utilized for three mode operation based on the condition required. The operation and mechanism of this unit and its function have been studied. At the end, the mechanism is assembled. This mechanism is more advantages of other types of steering mechanism since it has more easily to operate and also less time consumption, easy handling etc. The project carried out by us made an impressing task in the field of automobile industries. It is very usefully for driver while driving the vehicle. This project has also reduced the cost involved in the concern. Project has been designed to perform the entire requirement task which has also been provided.

VII. WORKING PRINCIPLE

Our project consists of a steering setup, spur gears, bevel gears and lock nut. The three modes are,

1. Front wheel steer
2. Both front and rear wheel steer in same direction
3. Both wheels in opposite direction

When the lock nut is removed, the steering operation is carried out in normal condition. That is only front wheels steer. But when the lock nut is inserted, the other two modes can be used. When the gear arrangement is pushed to one position, the spur gears get engaged and the steering of rear wheel is ensured and is in same direction as that of the front wheels. When the gear arrangement is moved to other side, the spur gear disengages and the bevel gear gets engaged. Due to bevel gear arrangement, the rear wheel steers in opposite direction to the front wheel. This results in third mode steering. Here we have used two chain drives for vehicle movement. The universal joint is used in rear wheels for pedaling power transmission between pedal shaft and wheel shaft.

When turning, the driver is putting into motion a complex series of forces. Each of these must be balanced against the others. The tires are subjected to road grip and slip angle. Grip holds the car's wheels to the road, and momentum moves the car straight ahead. Steering input causes the front wheels to turn. The car momentarily resists the turning motion, causing a tire slip angle to form.

Once the vehicle begins to respond to the steering input, cornering forces are generated. The vehicle sways as the rear wheels attempt to keep up with the cornering forces already generated by the front tires. This is referred to as rear-end lag, because there is a time delay between steering input and vehicle reaction. When the front wheels are turned back to a straight -ahead position, the vehicle must again try

to adjust by reversing the same forces developed by the turn. As the steering is turned, the vehicle body sways as the rear wheels again try to keep up with the cornering forces generated by the front wheels.

The idea behind four-wheel steering is that a vehicle requires less driver input for any steering manoeuvre if all four wheels are steering the vehicle. As with two-wheel steer vehicles, tire grip holds the four wheels on the road. However, when the driver turns the wheel slightly, all four wheels react to the steering input, causing slip angles to form at all four wheels. The entire vehicle moves in one direction rather than the rear half attempting to catch up to the front. There is also less sway when the wheels are turned back to a straight-ahead position. The vehicle responds more quickly to steering input because rear wheel lag is eliminated.

1) MODE OF OPERATION

A. Normal Mode
B. Reduced Turning Radius Mode
C. Sliding Mode

A. Normal Mode

While tackling a turn, the condition of perfect rolling motion will be satisfied if all the four wheel axes when projected at one point called the instantaneous centre. When the lock nut is removed, the steering Operation is carried out in normal condition. That is only front wheels steer.

Figure 7.1 Normal Mode

B. Reduced Turning Radius Mode

In 3rd mode of operation when another lock nut is inserted. The gear arrangement is moved to other side, the bevel gear disengages and the spur gear gets engaged. Due to spur gear arrangement, the rear wheel Steers in opposite direction to the front wheel. This results in third mode steering. Fig shows the third mode operation.

Figure 7.2 Reduced Turning Radius Mode

C. Sliding Mode

In 2nd mode operation when the lock nut is inserted, the other two modes can be used. When the gear Arrangement is pushed to one position, the bevel gears get engaged and the steering of rear wheel is ensured and is in same direction as that of the front wheels. Fig shows the second mode operation.

Figure 7.3 Sliding Mode

VIII.LIST OF MATERIALS

The various factors which determine the choice of material are discussed below.

1)Properties:

The material selected must possess the necessary properties for the proposed application. The various requirements to be satisfied can be weight, surface finish, rigidity, ability to withstand environmental attack from chemicals, service life, reliability etc.

The following four types of principle properties of materials decisively affect their selection

a. Physical
b. Mechanical
c. From manufacturing point of view
d. Chemical

The various physical properties concerned are melting point, thermal

Conductivity, specific heat, coefficient of thermal expansion, specific gravity, electrical conductivity, magnetic purposes etc.

The various Mechanical properties Concerned are strength in tensile,

Compressive shear, bending, torsion and buckling load, fatigue resistance, impact resistance, elastic limit, endurance limit, and modulus of elasticity, hardness, wear resistance and sliding properties.

The various properties concerned from the manufacturing point of view are,

- Cast ability
- Weld ability
- Surface properties
- Shrinkage
- Deep drawing etc.

2) Manufacturing case:

Sometimes the demand for lowest possible manufacturing cost or surface qualities obtainable by the application of suitable coating substances may demand the use of special materials.

3) Quality Required:

This generally affects the manufacturing process and ultimately the material. For example, it would never be desirable to go casting of a less number of components which can be fabricated much more economically by welding or hand forging the steel.

4) Availability of Material:

Some materials may be scarce or in short supply. It then becomes obligatory for the designer to use some other material which though may not be a perfect substitute for the material designed. The delivery of materials and the delivery date of product should also be kept in mind.

5) Space consideration:

Sometimes high strength materials have to be selected because the forces involved are high and space limitations are there.

6) Cost:

As in any other problem, in selection of material the cost of material plays an important part and should not be ignored.

Sometimes factors like scrap utilization, appearance, and non-maintenance of the designed part are involved in the selection of proper materials.

The list of materials or components used in three mode operation

Sl. No	PARTS	Qty.
1.	Rack and pinion	02
2.	Bevel Gear	07
3.	Spur Gear	01
4.	Steering system	01
5.	Ball bearing	04
6.	Wheel	04
7.	Hinge joint	02
8.	Base frame	01
9.	Nut &Bolt	As required

Table.No: 8.1 List of Materials

IX.COST ESTIMATION

1. LABOUR COST: Lathe, drilling, welding, power hacksaw, gas cutting cost
2. OVERHEAD CHARGES: The overhead charges are arrived by "manufacturing cost"

Components	Quantity	Unit cost in Rs.	Total cost in Rs.
Rack and pinion	02	800	1600
Bevel gear	07	600	4200
Spur gear	01	500	500
Steering system	01	300	300
Ball bearing	04	100	400
wheel	04	150	600
Hinge joint	02	350	700
Iron	As required	170/kg	935
Nut & Bolts	As required	15Nos.	150
Total cost in Rs.			9385

Table no: 9.1 cost estimation

X. SCOPE OF THE FUTURE WORK

1. Computer-controlled Quadra-steer is possible and it can be switched on and off and has an effective trailer towing mode.
2. Computer determines how much and in which direction the rear wheels should move, and whether the rear wheels should turn the same direction as the front wheels or in the opposite direction.
3. It can be used in all common vehicles.

XI. CONCLUSION

So, we conclude that the project made an effective impact while driving the vehicle. This project has also reduced the cost involved in the ideal manufacturing. Project has been designed to perform the entire task required. It is very usefully for driver while driving the vehicle.. It should not be confused with four-wheel drive in which all four wheels of a vehicle are powered. The four wheel steering system is very much beneficial over the front or rear wheel steering system as it greatly decreases the efforts required for turning of vehicle and also provides steep turning option within a very confined space. With the help of this system, the rear wheels also can be turned with respect to the direction of front wheels whenever required. Thus, the vehicle can be controlled more effectively especially during cornering, parking or when we get into a congested or narrow area.

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