Design and analysis of 360 Degree Steering system

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Abstract— This project deals with the design and fabrication of 360-degree wheel rotation vehicle using DC motor and steering is done to reduce time to turn from one direction to other direction. This vehicle can move in all direction at a same position by using of steering, sprocket, DC motor, bearing and chain drive. Foremost function of this vehicle is easy to move from one direction to other direction. Modern development and economical progression of Indian society resulted in increase of people on railway platform, increase of vehicle on the road, due to space constraints, in hospital is major problem of the country. Present-day study aims for development of a system to reduce the turning radius of vehicle. In this system at first vehicle is stopped and wheels are then turned in the required direction with help of steering system and DC motor. This prototype has turning radius nearly equal to negligible of length of the vehicle itself.

I.INTRODUCTION

This scheme is about design of 360-degree wheel rotating vehicle. This vehicle travels in all directions and this design provides better comfort and saves the time of customers, most of the people using this vehicle to carry goods, patient etc. But most of the time, they must face the problem like taking U turn etc. So, must design a 360-degree wheel rotating vehicle to reduce and eliminate problems in the industry and at the railway platform.

Zero degree turning radius of a vehicle indicates the vehicle rotating about an axis passing through the center of gravity of vehicle i.e. the vehicle rotating at the same place, where it is standing. No additional space is required to turn the vehicle. Therefore, vehicle is to be turned in the space equal to the length of the vehicle itself. In this system, control system is connected to sprocket via motor and this sprocket is connected to sprocket of front wheel by chain drive. Control system is used to provide the direction of front wheel.

The DC motor is coupled to sprocket bolt at above of frame. When power is supplied from battery to DC motor then rotary motion transfer from DC motor to the wheel. The bearings are providing below sprocket which allow to wheel rotate 360 degree about vertical axis. Then this same rotary motion is transferred to the rear wheels by sprockets and chain drive arrangement. So as a result, this arrangement of the vehicle wheels to turn 90 degrees left and 90 degree right from original position, then front wheels of this vehicle rotate 360 degree by control system, sprocket and chain drive arrangement. Deprived of moving from the spot, i.e. the vehicle has zero turning radius. This aids in turning the vehicle in tight spaces such as parking lots and within small compounds. The many functions of the steering is to control the angular motion the wheels, direction of motion of the vehicle, to provide directional stability of the vehicle while travelling straight ahead, to enable straight ahead condition of the vehicle after completing a turn, the road irregularities must be damped to the maximum possible extent. This should co-exist with the road feel for the driver so that he can feel the road condition without facing the effects of moving over it.

Types of wheel steering:

There are four types of wheel steering as follows

1. Front wheel steering.
2. Shorter radius turning.
3. Parallel parking.
4. Zero-degree rotation.

II. DC MOTORS

Almost every mechanical movement that we see around us is talented by an electric motor. Electric machines are a means of converting energy. Motors take electrical energy and produce mechanical energy. Electric motors are used to power many of devices we use in everyday life. Motors come in various sizes. Huge motors that can take loads of 1000's of Horsepower is typically used in the industry. Few examples of large motor applications include elevators, electric trains, hoists, and heavy metal rolling mills. Examples of small motor applications comprise motors used in automobiles, robots, hand power tools and food blenders. Micro-machines are electric machineries with parts the size of red blood cells and find many bids in medicine.

Electric motors are generally classified into two different categories: DC (Direct Current) and AC (Alternating Current). Within these groups are numerous types, each offering unique abilities that suit them well for specific applications. In many cases, irrespective of type, electric motors consist of a stator (stationary field) and a rotor (the rotating field or armature) and operate through the interaction of magnetic flux and electric current to produce rotating speed and torque. DC motors are distinguished by their capacity to operate from direct current.

TherearedifferentkindsofD.C.motors,buttheyallworkonthesame values.Inthis,wewillstudy their basic principle of operation and their characteristics. It's important to understand motor characteristics so we can choose the right one for our application requirement.

Principle ofoperation:

Consider a coil in a magnetic field of flux density When the two ends of the coil are connected across a DC voltage source, current I flow through it. A force is exerted on the coil as a result of the contactofmagneticfieldandelectriccurrent.Theforceonthetwosidesofthecoilissuchthatthecoilstarts to move in the path offorce.

In an actual DC motor, several such coils are wound on the rotor, all which experience force, resulting in rotation. The larger the current in the wire, or the greater the magnetic field, the faster the wire moves because of the greater force created.

At the same time this torque is being produced, the conductors are affecting in a magnetic field. At differentpositions,thefluxlinkedwithitchanges,whichmakesanemftobeinduced(e=dφ/dt). This voltage is in obstruction to the voltage that causes current flow through the conductor and is referred to as a counter-voltage or backemf.

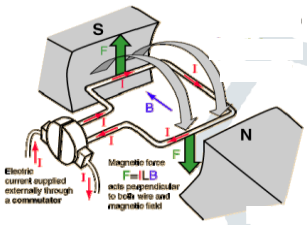

Fig 1: Principle of Motor

III. WELDING:

Welding is a fabrication process that joints materials usually metals or thermoplastics, by causing coalescence. The most general of the welding machines [09]uses the arc welding methods. Arc welding is a process that is used to join metals by using electricity to create enough heat to melt metal, and the melted metals when cool result in a binding of the metals. It is a type of welding uses a welding power supply to create an electric arc between an electrode and the base material to melt the metals at the welding point. Arc welding processes may be physical, semi-automatic, or fully automated.

Basic Principle of Electric Welding Machine:

Power source is given to electrode and the work. An appropriate gap is kept between the work and the electrode. A high current is passed through the circuit. An arc is produced about the area to be welded. The electric energy is changed into heat energy, producing a temperature of 3000 to 4000 C. This heat melts the edges to be welded and the molten pond is formed. On solidification the welding joint is obtained

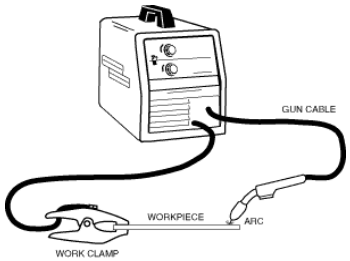

Fig 2: Electric welding machine

Welding transformer set:

The major component of the electric arc welding machine is the transformer. The unit consists of the following main components single phase transformer (with tap changing secondary). The transformer is a step-down transformer with different tapping at H, M and L; welding Tung cables.

The transformer is a conventional phase transformer which has shell type of lamination core and insulated windings of copper cols. In addition, the windings are given double insulation with the use of varnish so prevent short-circuiting in the windings. With the help of Angle iron and lamination core, the core loss, iron loss in the machine is reduced to minimum. They also help to reduce humming in the machine. Hence, efficiency of the machine is greatly improved.

It is used to step down the voltage source. It consists of primary and secondary circuits. The input is given to primary windings. By electromagnetic induction the current flows over the secondary coil. The transformer output can be controlled as per requirement. A combination of primary and/or secondary taps on the welding transformer commonly used to deliver a macro adjustment of the welding current, as well as adjustment of secondary voltage. Transformer ratings for AC machines are expressed in KVA (kilovolt for a specified duty cycle.

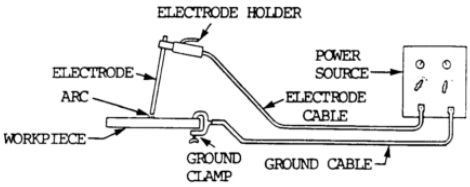

Fig 3: Welding Transformer Set

IV. COMPONENTS:

(i) Sprocket:

A sprocket is a profiled wheel with teeth, cogs, or even sprockets that net with a chain. The sprockets are used for the power transmission between the wheels through the roller chain drive. A sprocket is a profiled wheel with teeth that meshes with a chain, track or other perforated or indented material. Chain sprocket is a part this vehicle. Chain sprocket are used to deliver the clockwise or anticlockwise direction to front wheel and rear wheel through the chain drive. Sprockets are used in bicycles, motorcycles, cars, followed vehicles, and other machinery also to convey rotary motion between two shafts where gears are unsuitable or to impart linear motion to a track, tape etc.

Fig 4: Sprocket

(ii) Roller chain:

A roller chain is the type of chain driven most usually used for transmission of mechanical power between two sprockets. It consists of a sequence of short cylindrical rollers held together by side links. It is driven by a toothed wheel called a sprocket. 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 also vehicles. In this vehicle first chain drive connected with sprocket of front wheel and second chain drive relates to sprocket of rear wheel.

Fig 5: Roller Chain

(iii) Wheel:

In this automobile wheels are made of plastic material. Wheels relate to DC motor and four wheels rotate 360 degree by help of controlling, chain sprocket, chain drive and bearing arrangement. The back wheels rotate 90 degree left and 90 degree right from original position by help of DC motor, sprocket and chain driver arrangement, DC motor has given to each wheel to provide forward and backward movement of wheel.

Fig 6: Wheel

(iv) Iron pipe:

Iron pipe is a one of vital parts of 360-degree wheel rotation vehicle. It is made of mild steel. This is used to connect bearing and DC motor of each wheel.

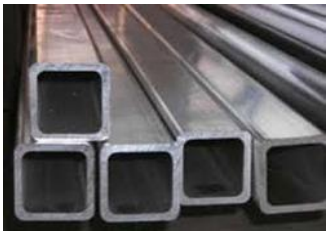

Fig 7: Iron Pipes

(v) DC motor:

In this vehicle one DC motor are provide in each of 2 wheels to move forward and backward direction. The description of motor used is 12 V, with 60 rpm.When power supply from battery to DC motor then DC motor rotate in clockwise direction and when reverse current supply from battery to DC motor then DC motor will rotate in anticlockwise direction. Which will give forward and backward movement of vehicle. In any electric motor, operation is founded on simple electromagnetism. A current-carrying conductor produces a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the asset of the external magnetic field. As you are aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities repel. The internal arrangement of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion.

Fig 8: DC Motor

(vi)Bearing:

In this vehicle bearing is used to make easy to move wheel from one direction to other direction[10], each bearing is connected with each wheel with the help of sprocket and iron pipe. A bearing is a machine part that constrains relative motion to only the desired motion and reduces friction between moving parts. The design of the bearing may, for example, deliver for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by regulatory the vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction.

Fig 9: Bearing

(vii) Fixed frame:

The static or fixed frame forms the base of the 360-degree wheel rotation vehicle. This frame is made of Mild Steel (MS). It has four wheels attached to its two sides by sprocket bolt and iron pipe.

(viii) DPDT Switch:

A Double Pole Double Throw (DPDT) switch is a switch that has 2 inputs and 4 outputs; each input has 2 corresponding outputs that it can connect to. Individually the terminals of a double pole double switch can either be in 1 of 2 positions. This makes the double pole double switch a very adaptable switch. With 2 inputs, it can connect to 4 different outputs or redirect a circuit into 4 different modes of operation.

Fig 10: DPDT Switch

V. WORKING

This project consists of steering, chain sprocket, DC motor, wheel, bearing, iron pipe, battery and chain drive. In this system first the vehicle is stopped, and wheels are then turned in the required direction with help of control system and DC motor. Teeth of sprocket are totally mesh with chain drive which has used to provide rotary motion to rear wheels by help of DC motor. Direction control system is used to provide direction of rotation to front wheels by help of sprocket and chain drive arrangement. DC motors are used in each of 2 wheels to provide forward and backward drive of this vehicle, also a battery is used to provide electrical energy of each DC motor. It has turning radius closely equal to negligible of length of the vehicle itself. This system is to be useful in hospitals, small industries and on railway platforms.

- 360-degree wheel rotation vehicle consist of control system, chain sprocket, chain drive, iron pipe, battery, DC motor and wheel.[1]In this vehicle sprocket of front wheel and control system are connected by first chain drive and sprocket of rear wheel connected to second chain drive and DC motor has is given to each wheel to provide forward and backward movement of vehicle.

- Once power is supplied from the battery to DC motor then DC motor starts to rotate in clockwise direction and also sprocket will rotate in clockwise direction because sprocket bolt is coupled to DC motor, the same rotating force is transferred to other rear wheels by chain drive because sprocket of rear wheel are connected by chain drive and bearing has deliver with sprocket which allow to wheel rotate. So as an outcome, rear wheels also rotate 90 degree left from original position and reverse current flow from battery to DC motor then rear wheels rotate 90 degree right from original position.

- When power supply from battery to DC motors of each wheels then each DC motor starts rotating then wheels also rotate with DC motor because wheels and DC motors are connected by bolts and nuts. As a result, vehicle moves in forward direction and when opposite current flow from battery to DC motors, then DC motors start rotating in opposite direction. As a result, vehicle is move in backward direction.

VI. FABRICATION OF PARTS:

(i) Frame Construction:

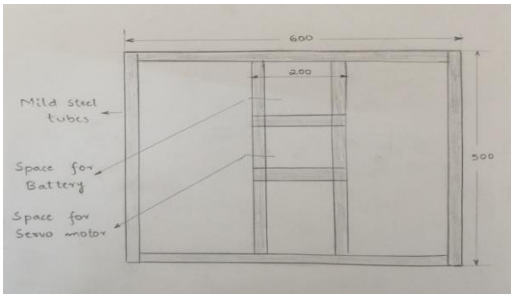

Fig 11: Frame Construction

Procedure:

- Mild Steel tubes of 600- and 500-mm lengths are joined together by welding to form a rectangle structure
- Another two tubes are welded at the middle for a length of 200mm between them for Battery and Motor placing
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(ii) Chain Mechanism:

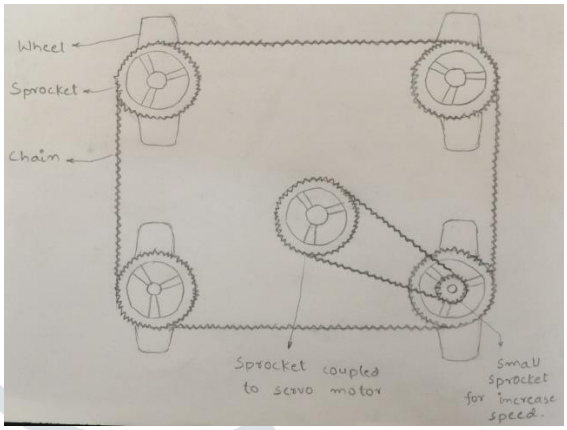

Fig 12: Chain Mechanism

procedure:

- Four sprockets with chain arrangement are places at the four corners of chassis
- Another Sprocket is placed at the middle which is coupled with a Servo motor
- One small sprocket of speed reduction 1:3 is placed at one corner above the big sprocket
- A chain is meshed between this smaller sprocket and sprocket of Servo motor, as shown in the fig. above

(iii)U & L Clamps Construction:

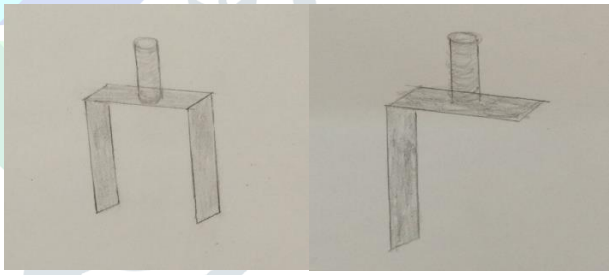

Fig 13: U-Clamp**Fig 14:** L-Clamp

Procedure for making Clamps:

- MS Bars of 5mm Thickness and 20mm width is taken
- Cut the Bars to a length of 17mm and 12mm by using Cutting Machine
- A shaft/rod of 9mm is taken and cut it to required Lengths
- Weld the Bars and shaft by using Welding Machine in order to get U-Clamp and L-Clamps each of 2no.s

(iv) Design of Hubs:

Hub which is attached to Frame:

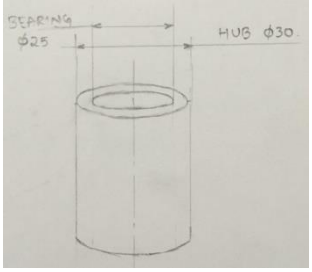

Fig 15: Hub attached to frame

Procedure:

- MS Rod of diameter 40mm is taken and placed on the Lathes Chuck
- Decreased the Dia to 30mm by Facing Operation by using Single point Cutting Tool
- By using Turning Operation make the length of the Bush to 55mm
- A hole is Drilled to a Diameter of 25mm throughout the Hub by use of Drilling Operation
- Chamfer the edges of Hub

Hub which is attached to Sprocket:

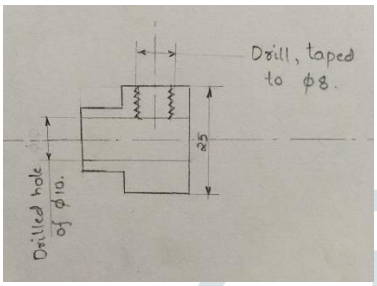

Fig 16: Hub attached to Sprocket

Procedure:

- MS Rod of Diameter30mm is taken
- Make it to a Diameter of 25mm by using Turning Operation with a single point Cutting Tool
- Decrease the diameter at one end to 15mm to place the Sprocket onto it
- Drill a Hole of 10mm Diameter to make a hub
- Another hole is drilled and tapped it to 8mm diameter by using Drilling and Tapping operation to place Grub Screw which acts as Locking nut

(v) Design of Bush:

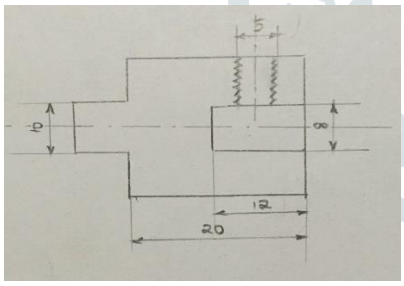

Fig 17: Bush

Procedure:

- MS Rod of Diameter 30mm is taken
- Make it to a Diameter of 25mm by using Facing Operation with a Single point cutting tool
- Decrease it to 10mm diameter at one end of the Bush to place it inside the Circular plate
- Drill a hole of 8mm diameter to a length of 12mm at another end of the Bush
- Another hole of 5mm is Drilled and tapping operation is done for making internal Threads to place the Grub Screw inside it which acts as Locking nut

(vi) Sprockets

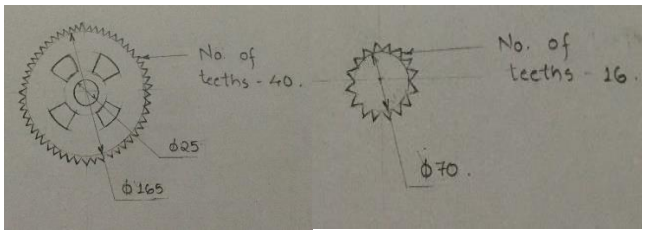

Fig 18: Sprockets

Procedure:

- A Cycle Sprocket of diameter 165mm is taken
- A hole of 25mm diameter id drilled at the center of the Sprocket to place it on the Hub
- Another small sprocket of diameter 70mm is taken and made the suitable inside diameter to place it onto the hub

VII. Results and Discussion

Fabrication of 360 Degree Steering System is Successfully CompletedA low-cost vehicle which power from DC motor has been made will rotate vehicle in 360 Degrees. It will be helpful in many industries. Also, Vehicle will be able to rotate in tight spaces easily & parallel parking & U-turn problem will be solved.

This project work has provided us an excellent chance and experience, to use our limited knowledge. We gained a lot of practical knowledge about, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is a good key to bridge the gates between the institution and the industries.

We are satisfied that we have completed the work with the limited time successfully. The "360 DEGREE STEERING SYSTEM" is working with acceptable conditions. We can able to understand the difficulties in maintaining the tolerances and the quality. We have done to our ability and skill making maximum use of available services. Thus, we can guide in parallel direction. In recent time the development is made in automobiles. So, we have modified in such a way that it can save time and easily work with many problems. This can give immediate response and less space is required. The developed model is recommended for presence in the cars.

A prototype for the proposed approach was developed by lifting plate and DC motor to rotate 360 degree. This prototype was found to be able to turn very easily in tight spaces, and after manufacture of 360-degree steering system, vehicle consumed very less space to turn from one direction to another direction and it consumes less time to turn.

Thus, we have developed a "360 DEGREE STEERING SYSTEM" which helps to achieve the parking of the vehicles easily using the parking machines or fittings. By using more techniques, they can be altered and developed according to the applications.

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