Fabrication of Convertible Motorcycle

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Abstract:- Nowadays transport vehicles have become the most necessary and convenient mechanism for people's movement. Motorcycles are used in plenty as well. Commuter and cruiser motorcycles are two styles of motorcycles widely used for transportation purposes. Constructing a single convertible design which can be used as both commuter and cruiser will reduce the need of depending on two individual motorcycles. We intend to fabricate such a convertible motorcycle with minimum possible cost. The peculiarity of this motorcycle is that the motorcycle is convertible as either a commuter or cruiser by the rider himself. Such a conversion is accomplished by several systems incorporated in the motorcycle.

***Keywords**:- Cruiser; Commuter; Rake angle; Wheelbase; Seat height; Miniature relay; DC motor.*

I. INTRODUCTION

Commuter and cruiser motorcycles are two styles of motorcycles widely used for transportation purposes. Cruiser is a style of motorcycle generally equipped with a low seat and pullback handlebar providing an upright seating posture. On the other hand Commuter is another style of motorcycle that one use to get to and from work and to run errands. In the context of the local terrains of the state (Kerala), commuter style motorcycles are characterized with low rake angle, shorter wheelbase, high seat and Clip-on handle bar (hereinafter referred to as commuter motorcycle).

The important structural parameters that distinguish between a commuter style motorcycle and a cruiser motorcycle are rake angle, wheelbase, seat height, handle bar style, foot pedal position which contribute to different seating posture, riding comfort and maneuverability. By fabricating a single motorcycle that can adapt either to have the structural characteristics of a commuter motorcycle or that of a cruiser motorcycle. Providing means to change the parameters such as rake angle, seat height and foot pedal position will bring about changes in wheelbase, trail, seat height, handling, seating posture, riding comfort, maneuverability and so on which will enable the motorcycle to run in either commuter mode or cruiser mode.

II. LITERATURE SURVEY

A. Design of Motorcycle Active Chassis Geometry Change System

Jakub Šmiraus, Michal Richtář carried out an innovative attempt to increase the stability of motorcycle with the use of up-to-now changeless parameters such as trail or wheelbase. An old super sport Kawasaki ZXR 400 L was chosen as the platform for the design. The frame was produced as a 3D model in Autodesk inventor and several feasible options of construction were designed. The most realistic option to change the rake angle of all the feasible results was based on an electric linear actuator [1].

B. Motorcycle Rake and Trail Adjuster - U.S. Patent 20080100028A1

This patent describes a motorcycle fork rake extension kit providing an increased fork rake without welding. The kit simply consist of an upper adapter block and a lower adapter block. The lower adapter block have a greater spacing to increase fork rake. This kit is efficient in changing the rake angle of motorcycle. But the procedure of changing the rake angle is so tedious that to undo the increased rake angle, one has to remove the kit and fit the fork assembly to its default position [2].

C. Adjustable Front Wheel Assembly for Vehicles - U.S. Patent 007111861B2

An apparatus for adjusting front wheel assembly rake angle is disclosed. Even though rake angle could be adjusted without disassembling the front wheel assembly, the demerit with this system is that it is based on hydraulic systems. Hydraulic systems are energy consuming and expensive compared to electrical systems [3].

D. Internship Report – 1/3 Activities developed in the Body Vehicle department - BMW Motorcycle Development Center

The report gave insights on seat ergonomics and seating posture and put forward the design for a height adjustment kit for BMW R 1200 GS. The mechanism consisting of four connectors attached to the frame and the seat required manual adjustment to change the seat position [4].

III. METHODOLOGY AND EXPERIMENTATION

The soul idea is to bring about necessary modifications on a motorcycle so that it can be used as a commuter as well as a cruiser. Justification of this idea rather than building a motorcycle from scratch is based on financial and resource conservation. The specimen selected for the project is 'Pulsar' - a commuter motorcycle manufactured by Bajaj Auto. This choice is very much reliable as the manufacturer itself had launched a cruiser motorcycle namely 'Avenger' with the same engine and power train of 'Pulsar' motorcycle.

The conversion of the specimen between commuter and cruiser modes is carried out by the means provided for transmuting the rake angle, seat height and foot pedal position. As pneumatic and Hydraulic mechanisms are highly space and power demanding and have the disadvantage of excess weight gain it is decided upon electrical systems for changing rake angle, seat position and foot pedal position. Such actuators coupled with certain mechanical members provide required change in those parameters. All of the systems are controllable by switches.

Opting to specific elements in each mechanism is based on the knowledge acquired through the literature survey. The design, fabrication and assembly procedures are so versatile that it includes geometric appraisal, data collection, calculation, designing, fabrication and revision.

IV. CRUISER AND COMMUTER MODES

In cruiser mode the rake angle is made wider, seat position is lowered and foot pedal is forwardly placed. This riding position places the feet forward of the seat and the hands higher, with the upper body almost erect. When switched to commuter mode, the rake angle is reduced, seat is elevated and foot pedal is drawn back such that the riding position places the feet under the seat and the hands below shoulder height.

The changing parameters in commuter and cruiser are given in Fig 1 and Fig 2 respectively.

Fig 1:- Cruiser Mode.

Fig 2:- Commuter Mode.

The below table gives a quick overview of the varying parameters of the motorcycle in different modes.

Specification	Commuter Mode	Cruiser Mode
Rake angle (degree)	27	32
Seat height (mm)	770	710
Wheel base (mm)	1320	1450
Foot pedal position	Below seat	Forwardly placed

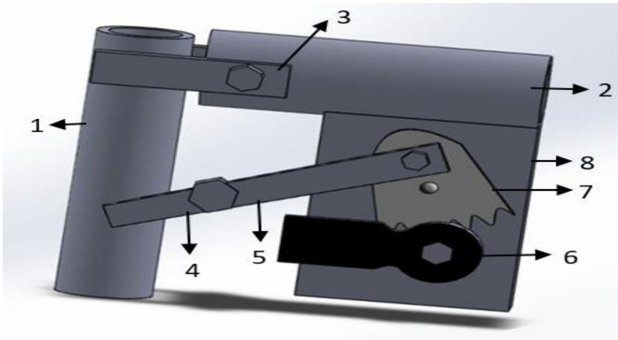
Table 1. Comparison of varying parameters in commuter and cruiser modes

V. DESCRIPTION OF MECHANISMS

A. Variable Rake Angle Mechanism.

Different components of the variable rake angle mechanism are Permanent magnet DC electric motor, Gear drive, Geared arm and Mild steel links.

The permanent magnet DC motor rotates in one direction once electric supply is given. The motor rotates a worm gear attached to the motor armature. This will make the gear drive rotate which is meshed with the worm gear. Gear drive is connected with the toothed end of the geared arm. Thus rotation of the permanent magnet DC motor cause the geared arm to rotate about its pivotal point. A mild steel link is connected to the upper end of the geared arm. The geared arm provide corresponding motion which displaces the permanently fastened link on the steering column to finally bring about therequired change in rake angle. When the permanent magnet DC motor rotates in clockwise direction rake angle is increased. When it is rotating in counterclockwise direction, rake angle is reduced.

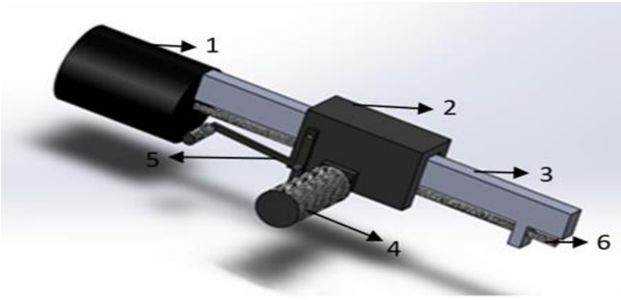


(1) Steering Hub, (2) Frame, (3, 4&5) Mild Steel Links, (6) DC Motor, (7) Geared Arm, (8) Supportive structure

Fig 3:- Variable rake angle mechanism assembled view

B. Adjustable Foot Controls

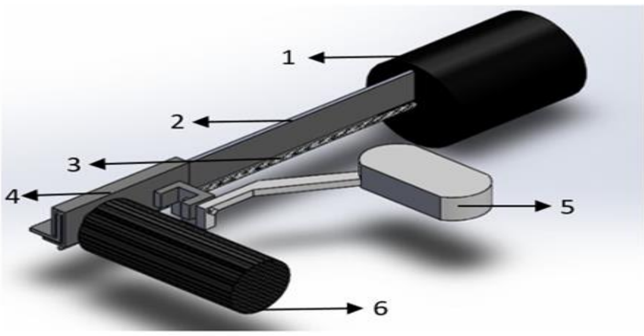
Left side of the foot control comprises of shift lever, shift peg and foot peg. The challenge with providing an adjustable means to move the foot control was in devising a plan to make the gear shift controls work in both the configurations. This is achieved by making the transmission possible via cable drives. The assembled view of the adjustable foot controls on the left side is shown in Fig 4.



(1) DC Motor, (2) Sliding Element, (3) Guide Way, (4) Foot Peg, (5) Gear Shift Lever (6) Lead Bolt

Fig 4:- Adjustable foot controls on left side – assembled view

The right side foot controls also have permanent magnet DC electric motor, lead bolt, guide ways and sliding element as shown in Fig 5. But unlike the push-pull assembly of gear shift cables in the left side, the right side foot control assembly has only one cable connecting the brake pedal and rear wheel brake adjuster nut. The major difference is only in the structural change of the sliding element.

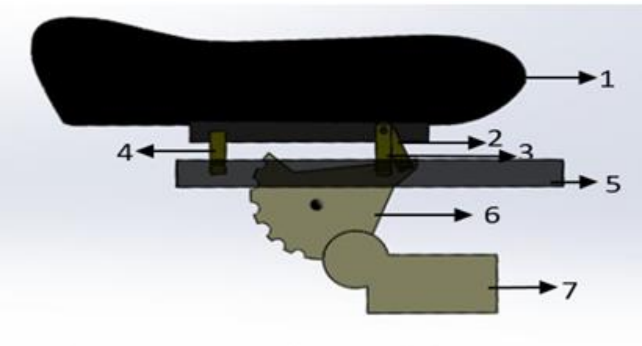


(1) DC Motor, (2) Guide Way, (3) Lead Nut, (4) Sliding Element, (5) Brake Pedal, (6) Foot Peg

Fig 5:- Adjustable foot controls on right side – assembled view

C. Seat Positioning System

The seat positioning system consists of a permanent magnet DC motor, Geared arm and four mild steel linkages made of mild steel. It is with the help of this system the adjustment of seat position is possible as shown in Fig 6.



(1) Seat, (2, 3&4) Mild Steel Links, (5) Frame, (6) Geared Arm, (7) DC Motor

Fig 6:- Seat positioning system assembly – schematic side view

VI. CIRCUIT DIAGRAM

For the three mechanisms to work efficiently, proper electric circuit was designed. It is given in Fig 7. Mainly there are two reasons for using miniature relays in the circuit. First is to keep the operating switches safe during the running of motors and second is to change the polarities of inputs to the motors for back and forth movements of the motors to successfully convert the motorcycle from one configuration to other and vice versa. Once the coils are energized in a miniature relay, the other two terminals are short and electricity flows through it.

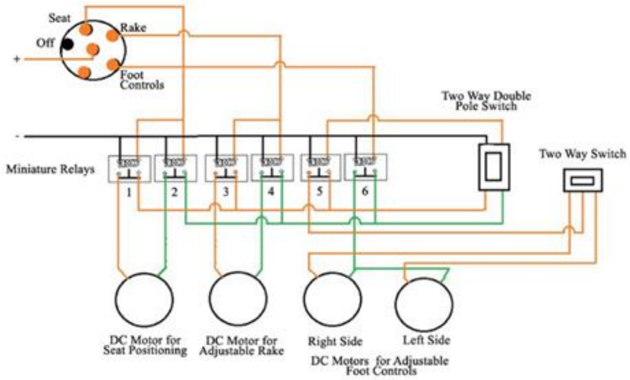


Fig 7:- Circuit Diagram

When the rotary switch is turned to the 1st position (corresponding to seat positioning system), the miniature relays 1 and 2 are energized. Thus by operating the two way double pole switch the DC motor for seat positioning can be operated in the desired rotational direction. Once the rotary switch is turned to the 2nd position (corresponding to variable rake angle mechanism), 3rd and 4th miniature relays are energized. Now for the DC motor of the variable rake angle mechanism to rotate, the two way double pole switch may be operated in the desired direction.

Upon turning the rotary switch to 3rd position (corresponding to adjustable foot controls) 5th and 6th miniature relays are energized. Due to the output limitations of the battery, only one DC motor of the adjustable foot controls is made operable at a time. Thus turning the two way switch to either one of the working positions will make corresponding DC motor of adjustable foot controls live to operate according to the control by the two way double pole switch.

When the motorcycle configuration is set to commuter or cruised mode to embark on a ride, one may turn the rotary switch to off position so that no relays are energized and no power is drawn from the battery by the elements in the given circuit diagram.

VII. CONCLUSION

The convertible motorcycle model is fabricated successfully. Later, real time tests were conducted in on road and off road conditions and satisfactory results were obtained. Implementation of motorcycles of this kind have the potential to reduce the need of depending on two individual motorcycles for different roads and rides. This will in turn economize material required without being highly expensive. With the help of computer aided analysis, optimization and improvement of the design features of the model are still possible. Such systems can be incorporated with suitable existing motorcycles as well.

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