



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**REDESIGN MOTORCYCLE TRANSMISSION WITH REVERSE  
GEAR**

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Mechanical Engineering Technology (Automotive Technology) (Hons.)

by

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## DECLARATION

I hereby, declared this report entitled "Redesign Motorcycle Transmission with Reverse Gear" is the results of my own research except as cited in references.

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Date : 9<sup>th</sup> December 2014

## **APPROVAL**

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor in Mechanical Engineering Technology (Automotive Technology) (Hons). The member of the supervisory is as follow:

.....

(Project Supervisor)

## ABSTRAK

Kejuruteraan terbalik pada transmisi motosikal dengan gear undur adalah suatu konsep pemahaman kejuruteraan automotif yang tidak disediakan dalam bilik kuliah harian memandangkan ianya dipandang ringan oleh sesetengah pihak padahal ianya bukanlah suatu pengetahuan baru dalam bidang kejuruteraan. Sejak pembangunan automotif berkaitan go-kart dan motosikal pelbagai guna semakin membangun permintaan gear undur ini juga turut meningkat. Oleh itu, ilmu asas berkenaan kejuruteraan terbalik adalah suatu pengetahuan yang amat penting dalam penciptaan projek ini. Tujuan projek ini adalah untuk mereka bentuk semula transmisi motosikal dengan aplikasi tambahan iaitu gear undur. Reka bentuk itu adalah konsep idea yang baru walhal idea yang telah dihasilkan oleh lain-lain jenis gear undur yang sedia ada masih melalui proses kejuruteraan terbalik daripada transmisi motosikal sedia ada. Piawaian industri bagi lukisan kejuruteraan dua dimensi dan model tiga dimensi adalah jangkaan keputusan akhir tetapi jika terdapat apa-apa pelanjutan penyelidikan seperti program Master, projek ini boleh diteruskan dengan penghasilan prototaip yang lengkap untuk memperlihatkan aplikasinya. Kemajuan projek ini perlu didokumentasikan kerana ia boleh dijadikan sebagai suatu rujukan yang sah bagi pelajar-pelajar seterusnya yang terlibat dalam projek ini selain untuk tujuan penyelidikan yang berkaitan dengan transmisi motosikal yang dilengkapi gear undur.

## **ABSTRACT**

Redesign motorcycle transmission with reverse gear is a conceptual understanding of automotive engineering which is not provided in daily lectures room due to the fact that this system is not a new knowledge but has been underestimated. Since the automotive development of go-kart and multipurpose motorcycle raised, the demand of this reverse gear also increased. As such, it is vital to attain this basic knowledge through this project. The purpose of this project is to redesign motorcycle transmission with reverse gear. The design is purely new and the idea is generated by other types of reverse gear also it passing through a process of reverse engineering of existing motorcycle transmission. Industrial standard of 2D engineering drawings and 3D models is the expectation for final result but if there is any extension of research such as master programmed, this project could be further with a simple prototype to realize its applications. The progress of this project needs documenting, as it can be a good reference for the next student who involve in this project as well as for a research related to the motorcycle transmission with reverse gear.

## **DEDICATION**

I dedicate my dissertation work to my family and many friends. A special feeling of gratitude to my loving parents, Yahya and Fiana whose words of encouragement and always give fully support in my study. My brother Syazwan, and sister, Hafiza whose guide me in choosing the right path of life and have never left my side.

I also dedicate this dissertation to my beloved supervisor of project, Ir. Mazlan Bin Ahmad Mansor who willing to teach and guide me from beginning until finished where he also struggle teaching us in daily lecture class. Other lecturer who sincerely teach me from diploma until end of bachelor degree would be dedicated as my personal acknowledgement for them

I dedicate this work and give special thanks all teachers who had taught me in MRSM Kuala Krai who always proud me besides my best friends in my hometown and in UTeM. All of you have been my inspiration for my future.

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A special thank goes to my classmates who help me in completing this whole reverse gear system by guiding in producing assembly of whole parts. Besides giving me brilliant ideas and sharing their knowledge, that kind of cooperation hopefully can realize my dream to end up this project successfully.

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## LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

2D	-	Two dimension
3D	-	Three dimension
cc	-	Engine displacement; cubic centimeters
ATV	-	All-terrain vehicle
CAD	-	Computer-aided design
lbs	-	Mass; pound
PCD	-	Pitch circle diameter
$p$	-	Pitch
$r$	-	Ratio
$T$	-	Torque
$MA$	-	Mechanical advantage; torque ratio
$\omega$	-	Angular velocity
$N$	-	No. of teeth

# **CHAPTER 1**

## **INTRODUCTION**

### **1.1 Project Overview**

This project is to redesign motorcycle transmission with reverse gear in split unit and this system will be applied into Modenas Kriss 110cc's transmission. For our information, this motorcycle has four gears forward transmission without reverse gear [1]. The idea to do this project research is generated when looked at three-wheel motorcycle especially used by disabled people and food stall seller behind the road. Besides that, an observation toward All-terrain Vehicle (ATV) has been done by focusing on its transmission system and as the result, this kind of vehicle already have reverse gear but with have deficiency in its operation. There are several techniques and systems used in order to produce reverse gear such as using electric motor and hydraulic pump. However, both systems are not suitable because may drains the vehicle battery besides lack of power. There are a few concepts of reverse gear's operation and each concept has their own advantages and disadvantages. Further research on revolution of motorcycle's reverse gear will be discussed in the literature review.

### **1.2 Research background**

Reverse engineering is the main process used in making this research. As the title of this project which is Redesign Motorcycle Transmission with Reverse Gear in Split Unit, the stock or original components of Modenas Kriss 110cc motorcycle's transmission has been used to get the CAD data and making analysis. The expectation

result is to produce 2D engineering drawing and 3D models in industrial standard which is compatible with reverse engineering process in order to get CAD data. Kriss 110cc's transmission has been built in-unit construction which means the main engine components such as crankshaft are in the same compartment with the transmission. However, this kind of transmission do not provide a reverse gear as its purpose is only for two wheel motorcycle but sometimes as example, may hawkers especially in Malaysia modify this motorcycle to be three-wheel motorcycle for their business purpose. Affect from this modification, the motorcycle will be overweight and the user faced a problem to reverse the motorcycle but hand.

As the innovation to solve their problems, a reverse mechanism must be applied to the vehicle by inspects the original specification of this Modenas Kriss 110cc especially its transmission itself. Developer for this motorcycle, Modenas, actually has developed the motorcycle's structures with conscientiously by observed the uses of Kriss 110cc on the road and its dominant user. There will be a problem to locate an idler gear which functions to reversing a gear because the original engine's space of Kriss 110cc is limited for its original component's size. As the solution, a split gearbox has been designed to solve this problem besides evaluates its advantages in uses of split unit such as easily maintained compared to in-unit transmission.

### **1.3 Problem Statement**

Most of two-wheel motorcycles have no reverse gear and Modenas Kriss 110cc is the one of motorcycle with no reverse gear. As we can see on the road, there are several motorcycles that have been modified to be three-wheel motorcycle for multi-purpose such as for disabled people and trading. This type of motorcycle's structure could increase its weight and harder to move backward by foot. Besides that, this Kriss 110cc's engine sometimes has been used in all-terrain vehicle (ATV) and self-made go-kart. These two vehicles also faced the same problems because it have four wheels and need a reverse gear to move it backward easily.



## **1.4 Objective of Project**

The main objectives to be considered are:

- (a) To study and understand the best concepts and operation of reverse gear toward Modenas Kriss 110cc.
- (b) The sequence is designs in 3D models and generates 2D drawings with industrial standard.

## **1.5 Scope of Project**

The scopes of this study are:

- (a) CATIA V5 software will be used for modeling and simulation testing.
- (b) Modenas Kriss 110cc's transmission will be used for reverse engineered process.
- (c) Dimensions and parameters of this transmission will be produced based on existing transmission through reverse engineering process.
- (d) Best ratio of reverse gear system will be calculated referring to standard of transmission manufacturer.
- (e) The developed transmission with reverse gear will be fit and placed into split-unit gearbox using CATIA V5 software.
- (f) 2D engineering drawings in industrial standard and 3D models would be the expected result for this research.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

This chapter will deal with the overview of the state knowledge about motorcycle's reverse gear. There are several stages in developing reverse gear system that must be understood include its chronology order and related to theoretical studies because the main method in this research is by using conceptual of reverse engineering. As Modenas Kriss 110cc's transmission would be the vehicle used for our research, an understanding to its specification of transmission or gearbox also must be explored before making the development of reverse gear mechanism and several improvements.



Figure 2.1: Image of Modenas Kriss 110.[1]

Project overview and research background sections before has discuss about the significance this reverse gear to the user but not stated in details. There will be a section to discuss the major problem and user, Previous Studies, which require a better reverse mechanism system that appropriate with their uses compared to the other reverse mechanism in the market.

Apart from that, reverse engineering is the main method used in this research because the Kriss 110cc's transmission already exists nowadays but not providing a reverse mechanism. A clearly understanding of reverse engineering also must be discussed in this chapter from the beginning of development of reverse mechanism to get almost the same of original transmission components. Another development and innovation of this research is to design this built-in-reverse transmission in split unit or pre construction transmission. There are several criteria and causes that force in-unit transmission to be converted and built into split unit transmission.

## 2.2 Principle of Motorcycle Gearbox.

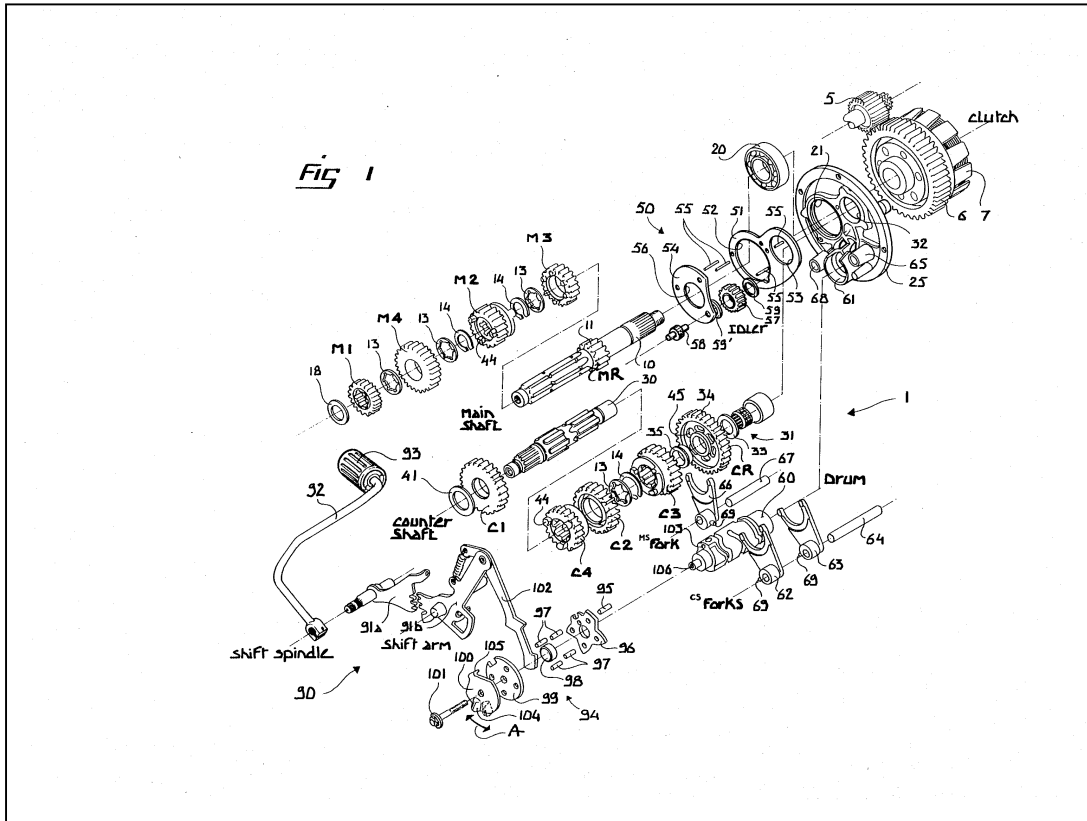


Figure 2.2: Structure of motorcycle gearbox's components.[4]

Most of all modern gearboxes operate on the indirect, constant-mesh principle. The word indirect means that power entering a shaft and exits from the other while the power transmitted always passing through one from five or six pairs. By making the only pair in the box while both of whose gears are locked to their respective shafts, selection of a particular pair to carry the drive can be accomplished because constant mesh contains that all gear pairs remained in mesh. Apart from that, one gear is always free-spinning on the shaft as the pairs not engaged.

Shifting, a terms referred to an action of changing gear in transmission, cannot be accomplished by forcing precisely formed gear-tooth profiles into and out of mesh. However, the end-faced of gear are provided with rings of heavy pegs whose called dogs

or dog clutch. One of a gear will be free-spinning of any given meshing gear pair while the other are splined. A free-spinning must be dogged to the shaft by sliding an adjacent splined gear or dog-ring against it in order to select that pair to transmit power, so that their dog sets engage. Affect from dogging the shaft, the gears that slide could not move out of their teeth to be out of mesh with their mating gear because generally, most of the motion is only 5mm. In this situation, power can be transferred through the gear and shaft properly to the output shaft from clutch shaft because both gears are locked to their individual shaft.

Of course only one pair of gear can be allowed to engage in one time; otherwise it could lock the transmission affected from simultaneous double engagement. Shift drum or plate will managed the engagement and disengagement all of gears available in a gearbox with wiggly slots milled into it. Moreover, it drives shift such by engagement of their guide pins into the wiggly slots as rotation of this drum or plate from one detent position to the next by linkage's engagement. Normally, two gears cannot be selected simultaneously because the slots are cut and to hold the transmission in a selected gear, the shift plate or drum is equipped with a detent device.

In addition, the detent device usually uses the form of a bumps machined-form onto one end of the shift drum or onto a detent ring a connected to the drum where these components engaged by either pivoted arm or a spring-loaded plunger. Linkage of shift from rotating drum or plate to the other and from one detent is caused by shifting. Metal-to-metal in holes of bored rotated by shift drum but to reduce friction of shifting, recent designs always combine rolling bearings. In a situation, selecting neutral in transmission could be harder with engine running as gear lever is dab up and down because the shift drum could jumping between two deep detents and never stopping at the shallow neutral detent between of it if the clutch is dragged such as the plates is been wrapped of lift insufficiently.

## 2.3 Previous Studies

### 2.3.1 Background of Previous Invention

An invention of motorcycle transmission featuring reverse gear were developed by Dittman, Jr. (1985) where this invention of reverse mechanism provides in-unit transmission compared the aftermarket's motorcycle reverse mechanism which manufactured as an independent setup. Basically, a rider are afford to moves backward a two-wheel motorcycles easily by hand although that vehicle do not have reverse gears because most of it are sufficiently light weight. However, there will be a problem for rider to move backward a larger motorcycle where he or she needs to dismount and balance to do that matter especially when moving over a curb.

In European countries or United States of America (USA), there are several police units that used three wheel police-type motorcycles in daily for law enforcement and this kind of motorcycle usually comes in two rear wheels with a box mounted there between. In many situations, a police vehicle particularly requires rapid maneuverability but it is impractical especially for the police officer who rides three-wheel motorcycle to dismount and push the vehicle backwardly.



Figure 2.3: Three wheel police-type Harley Davidson's motorcycle. [10]

Not just that three wheel motorcycle, even a two wheel police-type motorcycle also faced the same problem in the lack of reverse gear and it could be extremely serious in an emergency situation where the officer would be unsafe to protect himself and enforcing law besides would not be enough time. Although three wheel motorcycles are more stable compared to two wheel motorcycles but it could be harder to move backward due to the increasing of the weight resulted from mounted box and the number of wheels itself. Even the older Harley Davidson three-wheel police motorcycle has provided with a reverse gear mechanism but it was not an in-unit-transmission where the Harley engine drove a chain to a separate transmission which in turn drove a chain powering the rear axle. In order to shifting these Harley's transmission, a cam plate should be employed with forks because it was not a constant mesh transmission.

KVV Enterprises, Inc. of Cincinnati, Ohio, recently had launched a three-wheel police motorcycle which featuring a reverse mechanism. "Trident", the name of that motorcycle however, powered snowmobile starter motor as reverse mechanism by a secondary alternator and battery system where the power system is separated from the regular engine alternator and battery. For the specific operation, a flywheel is set up in the differential while the starter motor is mounted under the tricycles seat engages it for reverse movement after been shifted to neutral. When it is left in gear, the starter switch is turned and this operation is quite similar to the motion of an automobile but it moves slowly in a lurching motion. By then, a reverse gear mounted integrally and associated with motorcycle engine is need in order to ensure these systems can be operated with ordinary motorcycle shifting mechanism in mechanical compatibility besides providing rapid shifting with full engine power.

### **2.3.2 The Invention of Prior's Motorcycle Transmission Featuring Reverse Gear**

The invention of Dittman, Jr. (1985) has provides a constant mesh reverse gear which operates fork system and standard rotary shift drum. This constant mesh reverse gear is located within the engine casing along with motorcycle transmission's 3-5 forward gears. Mounted on a countershaft, the reverse gear engages an idler mounted on

its own separate shaft in engagement with a main shift reverse gear. Besides that, an idler pin placed between a pair of plates mounted on the transmission endplate which these plates also have apertures therein to receive the main shaft and countershaft. As any ordinary motorcycle, this system also operates the shift lever by using toe in order to engage a shift arm which one turn engages a pawl and cam plate assembly for rotating the rotary shift drum. The shift forks are operated by pins riding in cam grooves on the rotary shift drum.

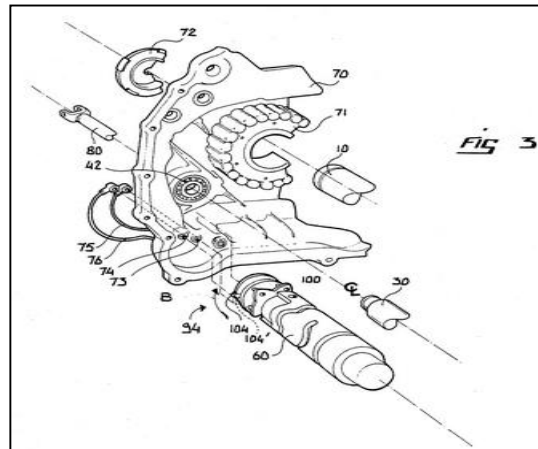


Figure 2.4: Rear engine casing showing the contact assembly, movement to signal reverse gear and back-up warning systems. [4]

A brilliant idea that he designs to beware other road user and pedestrians is by producing a reverse signal. In order to structure this design, a contact boss is placed in an indicator plate on the cam plate assembly. Electrical contacts in the rear of the engine casing engaged by the contact boss which positively indicate the engagement of the transmission in reverse gear. In turn, both the rider and pedestrians will be aware about the reversing process and ready to be backed up when these contacts active both of a back-up beeper and back-up light.