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# Fabrication of Solenoid Gear Changer

[1] Harish babu.L, [2] Devendra Tarun Murugan, [3] Dada Hayath Ali, [4] Jithin Anthony, [5] Kiran R
[1] Assistant professor, [2] [3] [4] [5] UG Scholars
8th Semester, Department Of Mechanical Engineering
Sri Sai Ram College of Engineering, Anekal, Bengaluru

***Abstract:*** **-- In this study, a gear shifting mechanism was designed and applied to make the shifting process faster and less destructible for the driver. The new device must be reliable, has a small dimensions, low construction and maintenance cost. This paper aims to improve gear shifting process using devices as: a manual four stroke engine bike, two solenoid actuator, Programmable Logic Controller (PLC), limit switches, push buttons, indicators, and power supply. According to suggested gear_ shifting method the control unit chooses optimum gear shifting ratio for an automobile without operating it manually (using relays). Using this method leaves to the driver the excitement of choosing the shifting moment. A solenoid actuated transmission shifting apparatus is provided for temporary or permanent installation in automobiles with conventional, H-pattern-type manual transmissions or automatic transmissions and for use with motorcycle transmissions. The shifting apparatus allows for both upshifting and downshifting through the transmission gears by pressing pushbuttons mounted on the Steering wheel, "handlebar" or dashboard. A solenoid shift actuator for a transmission, which actuates, in a direction of shift, a shift lever for operating a synchronizing device of the transmission, the shift actuator comprising a first electromagnetic solenoid and a second electromagnetic solenoid for actuating an operation member coupled to the shift lever in the directions opposite to each other. Each of the first electromagnetic solenoid and the second electromagnetic solenoid comprises a casing, a fixed iron core disposed in the casing, a moving iron core arranged to be allowed to approach, and separate away from, the fixed iron core, an operation rod mounted on the moving iron core to engage with the operation member, and an electromagnetic coil arranged between the casing and the fixed iron core as well as the moving iron core**

***Keywords*****: Control unit (relays) - programmable, pneumatic cylinders, Solenoid valves, gear box, and gear shifting Mechanism, proximity sensor.**

## I. INTRODUCTION

At present due to the extended difficulties in manual operations, the technology has shifted from manual to automatic; few of them include ABS system, active steering system etc., in order to increase passenger safety and comfort. Increasing demands on performance, quality and cost are the main challenge for today's automotive industry, in an environment where movement, component and every assembly operation must be immediately and automatically recorded, checked and documented for maximum efficiency. One of the automatic applications includes pneumatic gear changer. This study describes in detail in an understandable way to how to convert the traditional manually gear shifting mechanism by using microcontroller (control unit relays).

A method of controlling a gear change of an automobile, said automobile comprising an internal combustion engine; an automatic transmission connected to an output rotation shaft of said engine so as to transmit the rotational output of said engine to drive wheels of said automobile through any selected one of a plurality of gear ratios; a load device selectively connectable to said output rotation shaft of said engine via selectively-connecting means; and means for generating a gear change control signal for selecting one of said gear ratios of said automatic transmission in accordance with one of operational conditions of said automobile and said engine said method comprising the steps of controlling said selectively-connecting means when said gear change signal-generating means generates the control signal for shifting up the gear in said automatic transmission, in such a manner that said selectively-connecting means connects said load device to said output rotation shaft of said engine. For some drivers, the gear shifting can cause some confusing at driving especially at critical situations.

A crowded road on a hill or a sudden detour makes a lot of tension on the driver. One of the difficulties in this situation is to choose right reduction ratio and engaging it at the right time. This design helps the driver to increase his focusing on the road. Also reduces the time needed to engage the required reduction ratio, which increases the vehicles' response.

The present invention relates generally to shifting devices for automatic and manual transmissions used in automobiles, motorcycles and the like, and more specifically to solenoid actuated shifting systems that allow for shifting the transmission by pressing pushbuttons located on the steering wheel or handlebars.

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The present invention is an add-on, pushbutton actuated, electrical solenoid driven mechanism that is used to upshift and downshift a manual motorcycle or automobile transmission or automatic automobile transmission. The shifter is actuated by a two pushbutton controller, one used to upshift and one used to downshift. The solenoids are wired into and powered by the vehicle's electrical system. An electro-mechanical or solid state relay, triggered by the pushbuttons, is used to switch the power to the solenoids. In the motorcycle version, two solenoids are mounted in a linearly opposing fashion such that, when actuated, they operate the transmission shifter lever arm in the appropriate direction, either up or down, in order to switch through the transmission gears.

Depending upon the particular type of transmission, the automobile configuration is somewhat more complex requiring a plurality of solenoids to operate due to the typical H-pattern shifting and the presence of a reverse direction gear. For example, a three-speed transmission requires at least three solenoids, a four-speed transmission requires at least four solenoids, etc. The solenoids are arranged, linearly aligned and in an opposing manner, such that When operated in sequence, the required H-pattern shifting is achieved. The control system for the automobile version is also more complex. In this case, several electro-mechanical or solid state relays are required to switch power to the increased number of solenoids. Furthermore, either hard-wired logic or the use of a microprocessor must be incorporated in order to determine the proper shifting pattern by memorizing the current gear position. In either installation, a configuration is available wherein the operator can maintain the option of manually shifting the transmission using the motorcycle foot lever or the automobile shifting handle.

## II. SUMMARY

Over the years a Wide variety of devices have been developed to modify the controls used in the operation of motor vehicles. These motivation behind these devices also varies and includes purposes such as enhancing the performance of racing vehicles to motor vehicle performance testing apparatuses to allowing those with physical handicaps or other disabilities to operate a vehicle without requiring the use of their feet or legs. In racing circuits, these devices are typically used to shift the gears of a manual transmission, usually providing only upshifting capabilities and often involving complex installations and control systems that incorporate the use of sophisticated data acquisition and automated controls electronics. In the performance testing arena, these devices are equally if not more complex, typically bulky, and usually prohibit the vehicle from being used for transportation purposes while in use. Vehicle control adaptations for handicapped drivers are also complex, expensive, are installed permanently and are typically incorporated in vehicles with an automatic rather than a manual transmission.

The present invention addresses situations that would benefit from the adaptation of a manual transmission to automate gear shifting, but until now has been prohibited by the inherent problems associated with each of the aforementioned classes of vehicle control modifications. The motivation behind the present invention lies basically in two areas. First, in the racing arena as Well as in everyday usage, many people enjoy the vehicular control and response provided by a manual transmission. However, especially in the racing scenario, they risk their safety and well-being due to the fact that manual transmissions require the use of a free hand to operate which negatively affects the amount of control they have over their vehicle. Second, in the commonly occurring situation where the owner of a vehicle has been injured and temporarily loses availability or has limited use of an arm or hand, it is extremely dangerous to drive their vehicle, if not impossible altogether. Accordingly, it is an object of the present invention to provide a pushbutton solenoid shifter that incorporates the use of electronic solenoids to actuate the shifting of gears in the manual transmission of an automobile, motorcycle or the like as Well as automatic automobile transmissions.

It is another object of the present invention to provide a pushbutton solenoid shifter that both upshifts and down shifts through the gear pattern of a manual transmission. It is another object of the present invention to provide a pushbutton solenoid shifter that is controlled by a steering Wheel or handlebar mounted pushbutton assembly. It is another object of the present invention to provide a pushbutton solenoid shifter that can be adapted to a variety of manual transmission configurations, including 3, 4, 5, and 6 speed transmissions, including a reverse gear. It is another object of the present invention to provide a pushbutton solenoid shifter that is adjustable or fine-tunable so as to accommodate the action of varying transmission linkages. It is another object of the present invention to provide a pushbutton solenoid shifter that

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attaches directly to the transmission linkage in a permanent configuration. It is another object of the present invention to provide a pushbutton solenoid shifter that attaches to the manual shifting lever in a temporary fashion in order to accommodate individuals with temporary loss of the use of their hand or arm. It is another object of the present invention to provide a pushbutton solenoid shifter that attaches to the manual shifting lever in a manner that allows the user to use the manual shifting lever if desired. It is another object of the present invention to provide a pushbutton solenoid shifter for use with a manual automobile transmission that allows for the manual actuation of the transmission via a conventional shifting lever or the like. It is another object of the present invention to provide a pushbutton solenoid shifter that attaches to a motorcycle frame, actuating the foot lever to upshift/downshift the transmission while allowing the user to manually actuate the shift lever with his/her foot.

## III. OBJECTIVE

The main objective of this system is to minimize the human errors in operating the gears with the help of automatic technology. Other objectives include optimum gear ratios, reducing wear and tear of the gears, shifting the gear effectively, optimum performance of the gear box, optimum force exerted by the cylinders to move the shifting levers (pedals).

## IV. MODEL COMPONENTS

1) 4-Stroke Engine Bike
2) Solenoid actuators
3) Micro controller
4) 12 Volt DC power supply
5) Proximity sensor
6) Liquid Crystal Display
7) Relay switch
8) 12v to 220v Inverter

### *1. 4-Stroke Engine Bike*

A four-stroke engine (also known as four cycle) is an internal combustion (IC) engine in which the piston completes four separate strokes while turning a crankshaft. A stroke refers to the full travel of the piston along the cylinder, in either direction. The four separate strokes are termed:

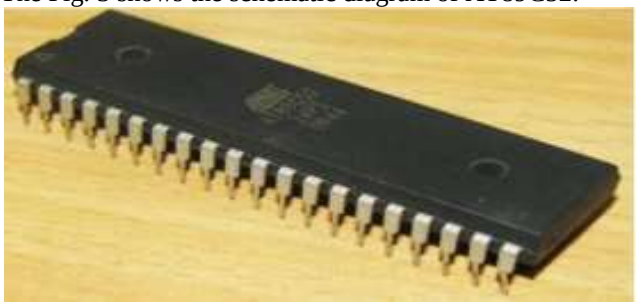
1. Intake
2. Compression
3. Combustion
4. Exhaust

### *2. Solenoid actuators*

### *3. Microcontroller*

A microcontroller (sometimes abbreviated µC, uC or MCU) is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications. In this document the type of microcontroller incorporated is AT89C52. AT89C52 is an 8-bit microcontroller and belongs to Atmel's 8051 family. AT89C52 has 8KB of Flash programmable and erasable read only memory (PEROM) and 256 bytes of RAM. AT89C52 has an endurance of 1000 Write/Erase cycles which means that it can be erased and programmed to a maximum of 1000 times.

The Fig. 3 shows the schematic diagram of AT89C52.



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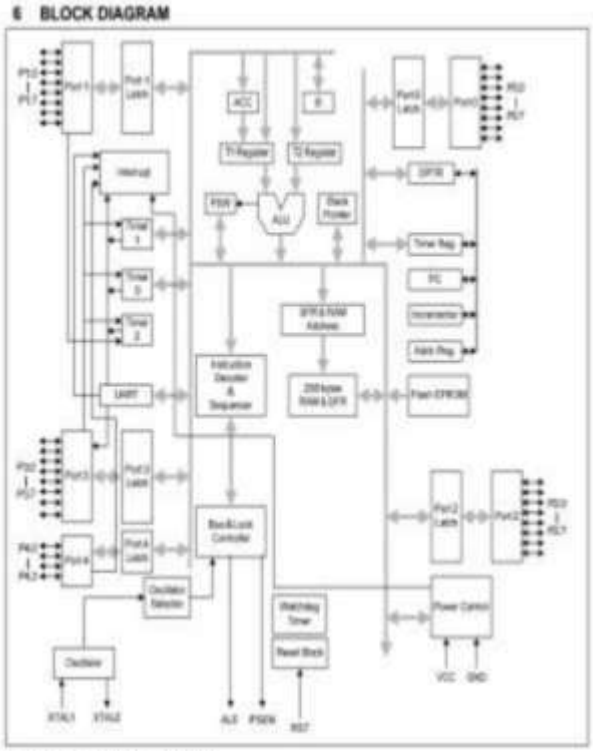


1 GENERAL DESCRIPTION

The W78E054D/W78E052D/W78E051D series is an 8-bit microcontroller which can accommodate a wider frequency range with low power consumption. The instruction set for the W78E054D/ W78E052D/ W78E051D series is fully compatible with the standard 8052.

The W78E054D/W78E052D/W78E051D series contains 16K/8K/4K bytes Flash EPROM programmable by hardware writer; a 256 bytes RAM; four 8-bit bi-directional (P0, P1, P2, P3) and bit-addressable I/O ports; an additional 4-bit I/O port P4; three 16-bit timer/counters; a hardware watchdog timer and a serial port. These peripherals are supported by 8 sources 4-level interrupt capability. To facilitate programming and verification, the Flash EPROM inside the W78E054D/W78E052D/W78E051D series allows the program memory to be programmed and read electronically. Once the code is confirmed, the user can protect the code for security.

The W78E054D/W78E052D/W78E051D series microcontroller has two power reduction modes, idle mode and power-down mode, both of which are software selectable. The idle mode turns off the processor clock but allows for continued peripheral operation. The power-down mode stops the crystal oscillator for minimum power consumption. The external clock can be stopped at any time and in any state without affecting the processor. The W78E054D/W78E052D/W78E051D series contains In-System Programmable (ISP) 2KB LD Flash EPROM for loader program, operating voltage from 3.3V to 5.5V.

***4. 12 V DC power supply:***

The power supply which is incorporated in the system is Lead- acid battery (12V). Rechargeable lead acid batteries are the same type used in automobiles. As with your car battery, how you use this battery has a significant impact on its lifespan. For example, if you forget to turn off your car's lights and drain the battery, a jump start might work a few times. But after a few full discharges, even a jump won't help and the battery will need to be replaced. With proper use and treatment, a lead-acid battery can last for years. Here are some recommendations for getting the longest life from the internal battery.

***Fig.4: 12 V battery***

***5. Proximity Sensor***

A proximity sensor can detect metal targets approaching the sensor, a proximity sensor is a type of sensor which detects the presence of nearby objects called target without any physical contact. Depending on the type of technology used proximity sensor emits an electromagnetic or electrostatic field, or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal when target comes closer to the face of sensor. A proximity sensor is used in many applications such as in mobile phones and for level sensing. In I phone proximity sensor is used to deactivate the touch screen when the phone comes near to the face.

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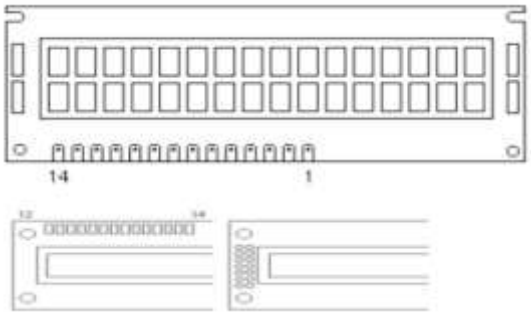
*Fig.5: Ir sensor*

***6. Liquid Crystal Display***

Liquid crystal display, a type of display used in digital watches and many portable computers. LCD displays utilize two sheets of polarizing material with a liquid crystal solution between them. An electric current passed through the liquid causes the crystals to align so that light cannot pass through them. Each crystal, therefore, is like a shutter, either allowing light to pass through or blocking the light. The following Fig.6 shows the representation of a LCD.


*Fig.6: Liquid Crystal Display*

***LCD OPERATION***




*Sample LCD Display*

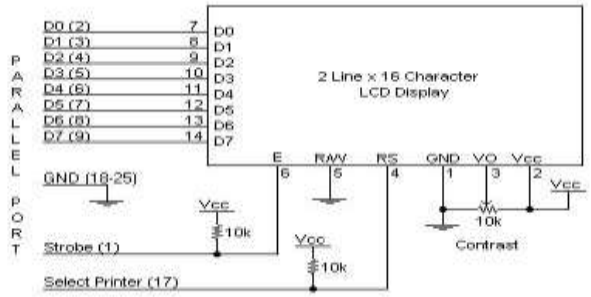
In recent years the LCD is finding widespread use replacing LEDs (seven segment LEDs or other multi segment LEDs). This is due to the following reasons:

1. The declining prices of LDCs.
2. The ability to display numbers, characters, and graphics. This is in contrast to LEDs, Which are limited to numbers and a few characters.

Incorporation of a refreshing controller into the LDC, thereby relieving the CPU of the task of refreshing the LCD. In contrast, the LED must be refreshed by the CPU (or in some other way) to keep displaying the data.

1. 4. Ease of programming for characters and graphics

***LCD pin descriptions***




***Pin Description for LCD***

The LCD discussed in this section has 14 pins. The function of each pin is given in Table

**VCC, VSS, and VEE:**

While $V_{CC}$ and $V_{SS}$ provide +5V and ground, respectively, $V_{EE}$ is used for controlling
LCD contrast. RS, register select. There are two very important registers

Inside the LCD. The RS pin is used for their selection as follows. If RS=0, the instruction command code register is selected, allowing the user to send a command such as clear display, cursor at home, etc. IF RS=1 the data register is selected, allowing the user to send data to be displayed on the LCD.

**R/W (read/write):**

R/W input allows the user to write information to the LCD or read information from it. R/W=1 when reading; R/W=0 when writing.

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**E(enable):**

The enable pin is used by the LCD to latch information presented to its data pins. When data is supplied to data pins, a high-to-low pulse must be applied to this pin in order for the LCD to latch in the data present at the data pins. This pulse must be a minimum of 450 ns wide.

**D0 - D7:**

The 8-bit data pins, D0 - D7, are used to send information to the LCD or read the contents of the LCD's internal registers.

To display letters and numbers, we send ASCII codes for the letters A - Z, a - z, and numbers 0 - 9 to these pins while making RS=1.

There are also instruction command codes that can be sent to the LCD to clear the display or force the cursor to the home position or blink the cursor. Table 11.2 lists the instruction command codes.

We also use RS = 0 to check the busy flag bit to see if the LCD is ready to receive information. The busy flag is D7 and can be read when R/W=1 and RS = 0, as follows: if R/W = 1, RS = 0. When D7 = 1 (busy flag = 1), the LCD is busy taking care of internal operations and will not accept any new information. When D7 = 0, the LCD is ready to receive new information. Note: It is recommended to check the busy flag before writing any data to the LCD.

| Pin | Symbol | I/O | Description |
|---|---|---|---|
| 1 | VSS | -- | Ground |
| 2 | VCC | -- | +5V power supply |
| 3 | VEE | -- | Power supply to control contrast |
| 4 | RS | I | -- RS=0 to select command register, RS=1 to select data register |
| 5 | R/W | I | R/w-0 for write, R/W=1 for read |
| 6 | E | I/O | Enable |
| 7 | DB0 | I/O | The 8-bit data bus |
| 8 | DB1 | I/O | The 8-bit data bus |
| 9 | DB2 | I/O | The 8-bit data bus |
| 10 | DB3 | I/O | The 8-bit data bus |
| 11 | DB4 | I/O | The 8-bit data bus |
| 12 | DB5 | I/O | The 8-bit data bus |
| 13 | DB6 | I/O | The 8-bit data bus |
| 14 | DB7 | I/O | The 8-bit data bus |

***Table: Pin Descriptions for LCD***

***Table: LCD Command Codes***

| Code [5] (Hex) | Command to LCD Instruction Register |
|---|---|
| 1 | Clear display screen |
| 2 | Return home |
| 4 | Decrement cursor (shift cursor to left) |
| 6 | Increment cursor (shift cursor to right) |
| 5 | Shift display right |
| 7 | Shift display left |
| 8 | Display off, cursor off |
| A | Display off, cursor on |
| C | Display on, cursor off |
| E | Display on, cursor blinking |
| F | Display on, cursor blinking |
| 10 | Shift cursor position to left |
| 14 | Shift cursor position to right |
| 18 | Shift the entire display to the left |
| 1C | Shift the entire display to the right |
| 80 | Force cursor to beginning of 1st line |
| C0 | Force cursor to beginning of 1st line |
| 38 | 2 lines and 5x7 matrix |

***Table : LCD Command Codes***

***7.Relay switch:***

A relay is an electrically operated switch. Relays are used where it is necessary to control a circuit by a low power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The following Fig.7 shows the schematic diagram of a relay.

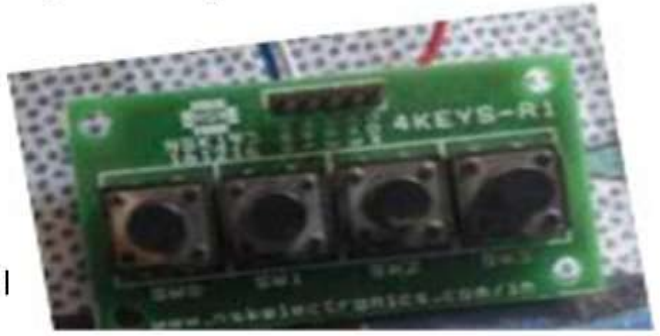


***Fig. 7: Relay Switch***

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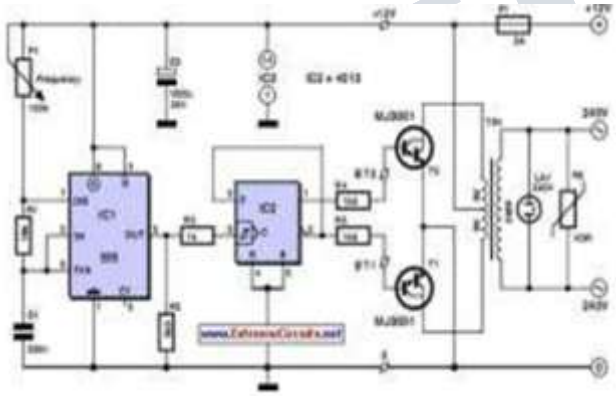
This Board can be used to Control Solenoids, Motors etc.

- Input Logic -5v level from MUC.
- Interfaced with Transistor 547.
- Input Pin connected to Burg stick

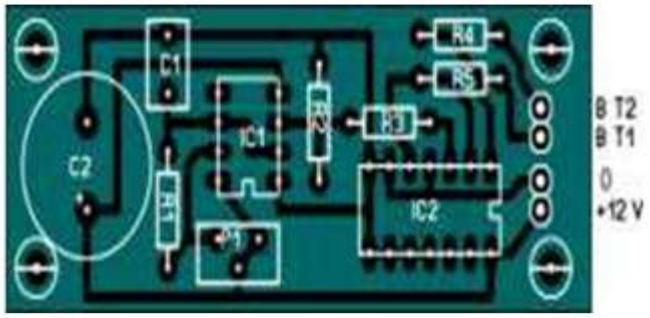
***8. 12V TO 220V INVERTER***



As the mark/space ratio (duty factor) of the 555 output is a long way from being 1:1 (50%), it is used to drive a D-type flip-flop produced using a CMOS type 4013 IC. This produces perfect complementary square-wave signals (i.e. in anti-phase) on its Q and Q outputs suitable for driving the output power transistors. As the output current available from the CMOS 4013 is very small, Darlington power transistors are used to arrive at the necessary output current. We have chosen MJ3001s from the now defunct Motorola (only as a semi-conductor manufacturer, of course!) which are cheap and readily available, but any equivalent power Darlington could be used.

These drive a 230 V to 2 × 9 V center-tapped transformer used 'backwards' to produce the 230 V output. The presence of the 230 VAC voltage is indicated by a neon light, while a VDR (voltage dependent resistor) type S10K250 or S07K250 clips off the spikes and surges that may appear at the transistor switching points. The output signal this circuit produces is approximately a square wave; only approximately, since it is somewhat distorted by passing through the transformer. Fortunately, it is suitable for the majority of electrical devices it is capable of supplying, whether they be light bulbs, small motors, or power supplies for electronic devices.

***PCB layout:***




***COMPONENTS LIST***

Resistors
R1 = 18k?
R2 = 3k3
R3 = 1k
R4,R5 = 1k?5
R6 = VDR S10K250 (or S07K250)
P1 = 100 k potentiometer
Capacitors
C1 = 330nF
C2 = 1000 µF 25V
Semiconductor
T1,T2 = MJ3001 IC1 = 555
IC2 = 4013
Miscellaneous
LA1 = neon light 230 V F1 = fuse, 5A
TR1 = mains transformer, 2x9V 40VA (see text) 4 solder pins

## V. WORKING PRINCIPLE:

In this construction there are two pneumatic cylinders consisting of pistons on either side of the vehicle pedal for engaging the gear. It is controlled by a control unit (micro

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controller). This microcontroller (chip) is preprogrammed for working of the system. The role of two pneumatic cylinders is one for increasing the gear speed and for decreasing the gear speed. For the forward motion one cylinder is actuated & for the reverse motion second cylinder is actuated.

CONSTRUCTION

***WORKING PROCEDURE:***

The two solenoid coils are fixed to the gear shaft of the two ends. One is used to shift the gear in upward direction. Another one is used to shift the gear in downward direction. These two coil is operated depends upon the speed of the vehicle this is manually button operated solenoid gear changer for two wheeler.

To perform a manual gear change control apparatus for an automobile and a method of controlling such apparatus. A rotational output of an internal combustion engine is connected to drive wheels of the automobile and a load device. When a gear shifting-up of a manual transmission is to be effected, the load applied by the load device is increased, or the load is connected to an output rotation shaft of the engine via a selectively-connecting device, thereby reducing the rotational speed of the output rotation shaft of the engine to a required level. In this work, two solenoid coils are coupled to the gear rod of the two ends.

## VI. CONCLUSION

This project is made with pre-planning, that provides a lot of practical knowledge regarding, planning, purchasing, assembling and machining. The application of solenoid gear produces smooth operation. Even though the initial cost of button operated solenoid gear shifting system is very high, but it is very much useful for two wheelers, car owners & auto-garages. By using more techniques, this design can be modified and developed according to the applications. This project also helped us to know the periodic steps in completing a project work. And let to know the strength of team work

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[2] J-O Hahn1, J-W Hur, G-W Choi, Y M Cho and K I Lee. Department of Mechanical Engineering, Korea Airforce

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