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Spark advance angle measurement for the ignition system of automotives

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ABSTRACT

The performance of the automotive vehicle depends upon the efficiency and quality of engine used. For that the ignition system of the engine should be powerful. In order to determine the performance of the ignition system, important parameters are to be measured. In ignition system, the spark takes place some degree before ignition. The time of advance angle is required for mixing the air and fuel during this time the combination takes place so as to get a better performance. This angle is known as spark advance angle. Measurement of spark advance angle is important. The angle varies with vehicles. In this paper spark advance angle measurement system using programmable microcontroller are simulating the engine by using an AC motor which rotates the fly wheel with sufficient speed. The TDC will be recognized with help of some sensor which will be fixed at the top side. The ignition system will be mounted near the motor assembly.It should be done very carefully and robustly so that accidents should be avoided and better performance should be met. The trigger pulses are received from the trigger unit. These pulses are digitized using transistorized switching. From transistor collector, the pulses are given to microcontroller input port. From here onwards the software coding and visual indication part starts.

Keywords— Spark advance angle, Microcontroller, Software coding.

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I. INTRODUCTION

"Angle of advance is the angle that is between the ignition spark and the outer dead centre." Internal Combustion (IC) engines, combustion of air and fuel takes place inside the engine cylinder and the products of combustion expand to produce reciprocating motion of the piston. This reciprocating motion of the piston is in turn converted into rotary motion of the crank shaft through connecting rod and crank.This rotary motion of the crank shaft is in turn used to drive the generators for generating power.Ignition timing is very important, since the charge is to be ignited just before (few degrees before TDC) the end of compression, since when the charge is ignited, it will take some time to come to the required rate of burning.The purpose of spark advance mechanism is to assure that under every condition of engine operation, ignition takes place at the most favourable instant in time i.e. most favourable from a standpoint of engine power, fuel economy and minimum exhaust dilution. By means of these mechanisms the advance angle is accurately set so that ignition occurs before TDC point of the piston. The engine speed and the engine load are the control quantities required for the automatic adjustment of the ignition timing. Most of the engines are fitted with mechanisms which are integral with the distributor and automatically regulate the optimum spark advance to account for change of speed and load.

The development of automotive electronics i.e. Autotronics has been remarkable in now a days. Microcontroller is used to control engine operation to maximize fuel economy, monitor the vehicle performance parameter and diagnosis on-board system malfunction. In these we replace some mechanical components with electronics components to make automobile engines more efficient.

II. SYSTEM DESCRIPTION

In these DC motor is used to in place of the engine. A sensor is used to detect the top dead point of the engine. A timer and a counter in the microcontroller are used to measure the speed of the engine.

2.1. Mechanical Design

The mechanical design for the project consists of a rigid fabricated M.S. Frame i.e. Base Foundation.A V belt assembly, bearing & bearing Housing, 1 phase AC induction motor, a rotating shaft, wheel, position sensors, Rigid base for motor assembly.

2.2 Electrical Design

It is based on electro-mechanical design. The electrical hardware are as follows.

1. Single Phase Induction motor
2. Inductive Proximity Sensors
3. Advance angle measurement Hardware
    a) Opto-Isolator
    b) Micro controller
    c) LCD display
    d) Regulated power supply
    e) AC Voltmeter
    f) AC Current Meter

Inductive Proximately Sensor

It detects the metal target and is highly immune to harsh industrial environment such as dust, humidity, dirt and oil. Namur type switches for installation in Hazardous Area. Two pulses are arriving at the micro controller's input port with some time difference. The signal pulse form sensor before TDC is given to the port 3 i.e. INT1 and the signal pulse from sensor from the TDC is given to INTO pin of the Micro controller. Pin No. 9 of Micro controller is reset pin. At power on, the ping gets a trigger pulses. The program execution starts. The hardware consists of 10 MF / 25v & 10K capacitor & resistor combination respectively. The micro controller is programmed with assembly language. The programming logic is provided later. At port 0 LCD is interfaced in our case. It is 16 X 2 alphanumeric type LCD. It has its own Microcontroller and memory. LCD is interfaced with Micro controller through the 8 bit data bus and 3 control lines. The supply, ground, intensity control and the back light LED supply is controlled independently. After the micro controller receives the two inputs at its two interrupts, it calculates the time delay between these two. This time is converted into angle and it is shown on LCD display. The entire advance angle meter works on +5v dc regulated power supply.

2.3. PCB Development

PCB means the printed circuit board. It is of glass epoxy material or paper phenolic material. There are rules and regulations for designing the PCB. After the PCB network is ready, the transparency is developed. With the help of transparency the screen printing is done on PCB from copper side. The printed PCB is allowed for etching in Fecl3.

The project being developed using the Micro controller based technology, the software plays a vital role in our project. Assembly language programming is used. The program requires the assembly cum simulator, emulator.

Before developing any software code, the algorithm and the flow chart is to be developed first.

III. ALGORITHM

Presentation of the logic in written statements is known as algorithm. It is written in step by step fashion.

1. First of all, when power is ON, the Micro Controller is initialized. All the ports of Micro controller care high.
2. LCD is initialized and message is shown on LCD display.
3. Read input port.
4. Read INTD / INTI
5. If pulse is there then find out the time difference between the two.
6. If the pulse is no there, show the advance angle = 00.
7. If the pulses arrive at the INTO / INTI pins, the time difference is converted into angle as the entire cycle is of 360˚C.
8. The cycle goes on repeating and the angle changes if the speed on the position of TDC is changed.

The above algorithm can be converted into flow chart and then into assembly code.

IV. EXPERIMENTAL SETUP

The trigger wheel rotates as per the motor speed. While rotating, it crosses two different but similar sensors on its path. One of the sensors is located at the top side. Another sensor is located before the top sensor. The location at which the top sensor is located is known as top dead sensor. It is significant in capacitive & inductive type of ignition systems. While starting there is spark before TDC, so that while reaching at TDC, the fuel & air mixture is totally mixed & at TDC the spark voltage is observed. The time difference between the TDC & the before the TDC is known as advance time. It is then converted into angle as the entire revolution of the trigger wheel is 360˚C.

The angle between TDC sensor & Before TDC sensor is known as advance angle. Two inductive pickups are used. The sensors senses the metal object the in its vicinity and accordingly, the pulses are generated at the output.

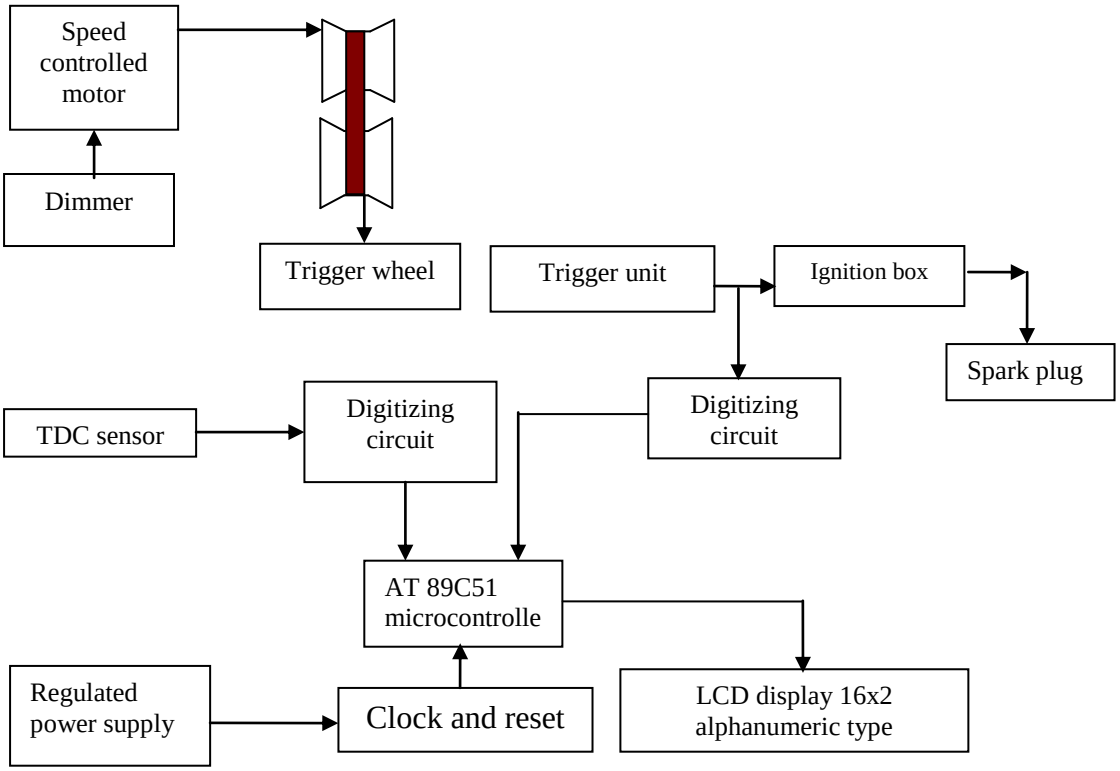

Figure.1 Block diagram of spark advance angle measurement

IV. PART LIST

4.1. Electrical components list

1. Resisters : 1/4th watts, 10 K, 4K7, 100E, etc
2. Capacitors : 1000 µF/25V
   10µF/25V
   0.1µF/25V
   22Kpf/25V
3. Diode : 1N4148
   1N4007
4. Regulator : 7805
5. IC : AT 89C51 Micro Controller
6. Opto-Isolator : MC817
7. IC base : 40 pin Dip
8. Crystal : 12 MHz.
9. LCD Display : 16 X 2 Alpha-numeric type
10. Power transformer : 0-12 V, 0.5 Amp, 230V AC input
11. 16 pin ralimate connectors
12. Inductive Proximity Sensors – 02 Nos
13. PCB development
14. Software Development tools
15. Mains chord
16. Miscellaneous

4.2. Mechanical components list

1. 1 Phase, 0.5 H.P. Induction motor : 01
2. Ball Bearing : 02
3. 3” Pulley : 01
4. 2” Pulley : 01
5. V-belt 57” –A-Type : 01
6. Motor Foundation M-10 bolts : 04
7. Motor Foundation M-10 nuts : 04
8. Sensing Washer : 02
9. Rotating Wheel with Shaft : 01
10. Bearing Housing : 02

4.3. Control Panel

1. AC Voltmeter Analog : 01
2. AC Current meter Analog : 01
3. AC Indicators : 02
4. Toggle S/W : 02
5. Miscellaneous : MS Angle Frame

V. CONCLUSION

Microcontroller based angle measurement system replace electronic components in place of mechanical hardware to make automobile engine more effective and inexpensive. In these DC Motor is used in place of automobile engine and a sensor is used to detect the revolution of motor. Sensor and microcontroller that makes automobiles monitor and control more effective automobile functions. Programmable nature of microcontroller allows one to easily make adjustment for the different requirement of variety of vehicle operating condition in various climate and condition. It shows ability to perform automotive system functions electrically with high degree of accuracy and reliability.

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