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DESIGN AND FABRICATION OF AUTONOMOUS LUBRICATION OF CHAIN

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ABSTRACT: Automated chain lubrication systems provide an exact metered quantity of lubricant and apply it reliably to the chain where it is required.

Despite new types of material and advanced technology, many chains still require lubrication. Optimum lubrication reduces friction and subsequent wear on chains. The largest relative movement of all chains occurs between the link plate and the chain stud, and it is here where considerable forces are present. Insufficient lubrication of this area will result in premature wear and chain failure. The consequence is expensive production downtime. Precise and efficient lubrication is a prerequisite for trouble-free operation and long life of the chain. Modern automated chain lubrication systems apply precisely metered quantities of lubricant to the chain, exactly where it is needed – while the chain is in operation. Proper metering keeps the lubricant quantity to a minimum, yet ensures sufficient amounts, thus reducing the impact on your budget and, of course, the environment! minimizes chain wear and noise levels. The life span of chains can often be increased by ten times and more.

Keywords: Auto lube system, Chain mechanism, D.C motor, Digital time, Microcontroller, Solenoid valve.

I. INTRODUCTION

In many plants, maintenance departments are downsizing, yet there are still the same number of productions machines and lubrication points that require manual lubrication. Due to competitive demands, most industries are under increased pressure to be more efficient and improve "uptime". Increased regulations that focus on the environment and safety (lock-out and tag-out requirements) require plant maintenance managers and personnel to follow time-consuming procedures. With more than 100years experience in lubrication equipment and systems, Lincoln has the unique capability and system solutions to address these important issues. These universal challenges will not go away. Manual lubrication is not consistent with "pro-active" maintenance strategies and lowering overall cost. Grease is semi solid lubricant. It generally consists of a soap emulsified with mineral or vegetable oil. The characteristic feature of greases is that they possess a high initial viscosity, which upon the application of shear, drops to give the effect of an oil lubricated bearing of approximately the same viscosity as the base oil used in the grease. This change in viscosity is called 'Thixotropy'. Grease is sometimes used to describe lubricating materials that are simply soft solids or high viscosity liquids, but these materials do not exhibit the shear-thinning (Thixotrophic) properties characteristics of the classical grease. For example petroleum jellies such as Vaseline are not generally classified as greases.

comparison of manual and automatic greasing: There are certainly advantages to automatic application when compared to manual application. Theoretically, it is preferable to apply small amounts of oil at short intervals rather than large amounts of oil at long intervals. With manual application, the trick is to apply as much oil as possible without causing harm due to over-oiling, thereby maximizing the re-lubrication interval. While this is fine for most oil and grease-lubricated components, there are many applications that may benefit from more frequent application or could be harmed by large application volumes. Machine lubrication systems are a very important portion of manufacturing and production workshop maintenance. Automatic lubrication systems eliminate the need for often careless manual lubrication, providing a safer, more frequent, and opportune monitored approach to machine lubrication. However, traditional automated lubrication systems have inherent environmental and technical–economic problems. With the goal of higher machining precision, cost effectiveness, greater reduction in oil consumption, and more flexible performance, an automated lubrication control system is introduced in this research work. The new automated lubrication control system in bike chains provide self lubrication on chain based on the RPM of chain; Even though these systems are usually fully automated, a system that requires a manual pump or button activation is still identified as a centralized lubrication system. A typical automated system (grease or oil) includes a pump, controller/timer, lubricant

supply line, metering devices and lubricant feed lines. Many auto lube systems integrate the reservoir, controller and fault monitor capability in one unit for design simplicity and installation cost reduction. During a lubrication cycle, the pump delivers lubricant through a supply line to the metering devices (typically injectors or divider valves).

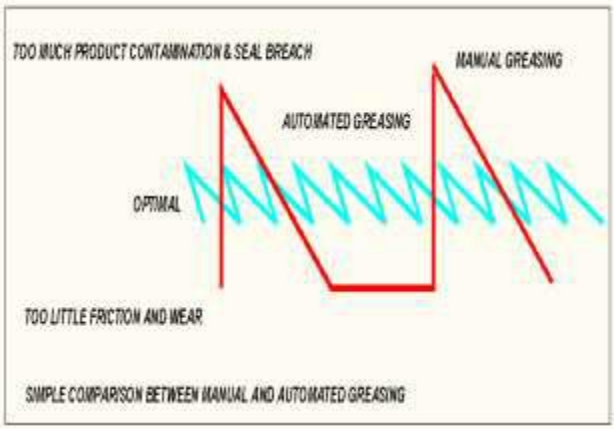

Fig.1.1Comparison of manual and automatic lubrication

There are lots of problems with manual greasing such as
1) There is excessive loss of grease.
2) Equipment getting harmed due to over greasing.
3) Excess time lost in lubrication.
4) Requiring variable labours

1.1 MOTIVATION

The failures due to non lubrication have been increased significantly. More than 20 percent of the world automobiles have chain failures and fractures occurring due to careless lubrication or non lubrication which happens due to non observance of the user or the process not being automatically controlled. Due to non lubrication of chains in bikes and different machineries used in agricultural and constructional industries the maintenance time of the machineries and the production downtime is increasing day by day. The comparative study of manual and automatic lubrication system by T.Elakkiya and A Anitta of jeppiar engineering college,chennai motivated the main concept of the project in turn giving an idea to innovate the process and hence automate it so as to do the lubricate the machineries and avoid their failures. Due to that absence of lubrication of chain and mechanical links the components of the machine and the machine life is getting depleted and due to lack of it the system cannot respond or perform correctly. The progression of mechanical and mechatronics is presenting auto lube system to be an alternate lubrication device, which also increases life expectancy of the machine.

1.2 OBJECTIVE

1.2.1 PRIMARY OBJECTIVE

- To design and develop a portable auto chain lubrication system for assistance in lubrication and to provide ample amount of lubricant in bike chains when needed and automate the process of lubrication by sensing the number of RPM of chain and hence quantity of oil on chains using microcontrollers installed in the machine tool guide ways.

1.2.2SECONDARY OBJECTIVE

- The device we set out to build should be light weight, portable and user friendly.
- The device should be flexible to changes with respect to future developments to be made.

II. LITERATURE SURVEY

There are many surveys done on lubrication systems but this AUTONOMOUS SELF LUBRICATION SYSTEM holds its own importance as the idea of lubrication on the intricate parts which cannot be lubricated manually are made to lubricate through this system. There are many surveys done under the topic of lubrication out of which some of them are:-

A COMPARATIVE STUDY OF MANUAL LUBRICATION AND AUTOMATIC LUBRICATION done by Elakkiya /Asst. Prof A. Anita/ Asst.Prof Dept. of Electronics and instrumentation Engineering Dept. of Electronics and instrumentation Engineering Jeppiar Engineering College, Chennai, Tamil Nadu Jeppiaar Engineering College, Chennai, Tamil Nadu in which a comparison of the automatic and manual lubrication was done and the survey concluded as Frequent lubrication run time is eliminated and pump motor energy consumption is considerably reduced by appropriate material of stator core material winding. Motor overloading is reduced by using thermal relay which has high sensitivity. A complete literature survey on DESIGNING AND MANUFACTURING AN AUTOMATED LUBRICATION CONTROL SYSTEM IN CNC MACHINE TOOL GUIDEWAYS FOR MORE PRECISE MACHINING AND LESS OIL CONSUMPTION by Mahdi Sparham & Ahmed A. D. Sarhan & N. A. Mardi & the conclusion was made as In this research work, a newly designed automated lubrication control system for CNC machine tool guideways was introduced for more precise machining and less oil consumption. It
is a novel approach in machining technology in that the ideal lubrication condition during machining could be identified via temperature signals from sensitive sensors installed in the machine tool's guideways. Temperature signals reflect the friction, wear, and loading conditions. Nevertheless, the temperature sensor signals are found to be implicated in periodic fluctuations such that once the temperature reaches a preset critical value, the temperature sensor signals fluctuate around that critical temperature up and down repeatedly in a very short time, misleading the controller. In each fluctuation cycle, the controller sends a wrong command signal for oil injection which leads to higher, unnecessary oil consumption.

III .DESIGN PROCEDURAL OF AUTONOMOUS CHAIN LUBRICATION SYSTEM

The auto chain lubrication system was designed and modeled virtually on the basis of lubricating the components of a roller chain and the machine components and to come up with a new proposed system to eliminate the manual process so used till date.

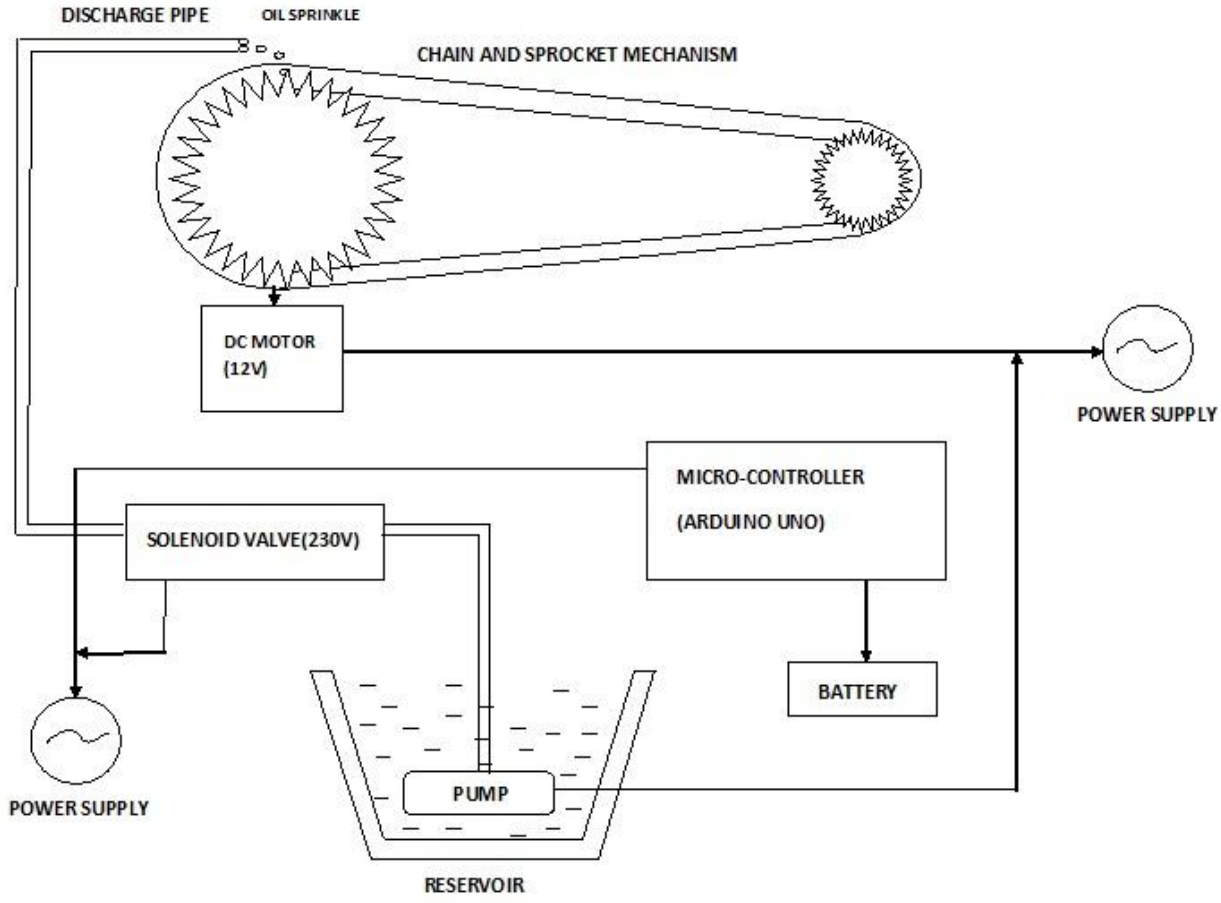

Fig 3.1 Line diagram of autonomous lubrication system

3.1 FRAME SELECTION

The Frame of the system was selected by keeping the following parameters:-

- Frame has to be low in weight.
- Design should be easy yet portable.
- Design should not create problem in normal operation of the machine or the movement of the chain.

Keeping these parameters in mind the bicycle chain was selected for the system. Chain maintenance is one of the most controversial aspects of bicycle mechanics. Chain durability is affected by riding style, gear choice, whether the bicycle is ridden in rain or snow, type of soil in the local terrain, type of lubricant, lubrication techniques, and the sizes and condition of the bicycle's sprockets. Because there are so many variables, it has not been possible to do controlled experiments under real-world conditions. As a result, everybody's advice about chain maintenance is based on anecdotal "evidence" and experience. Experts disagree on this subject, sometimes bitterly. This is sometimes considered a "religious" matter in the bicycle community, and much vituperative invective has been uttered in this regard between different schismatic cults.

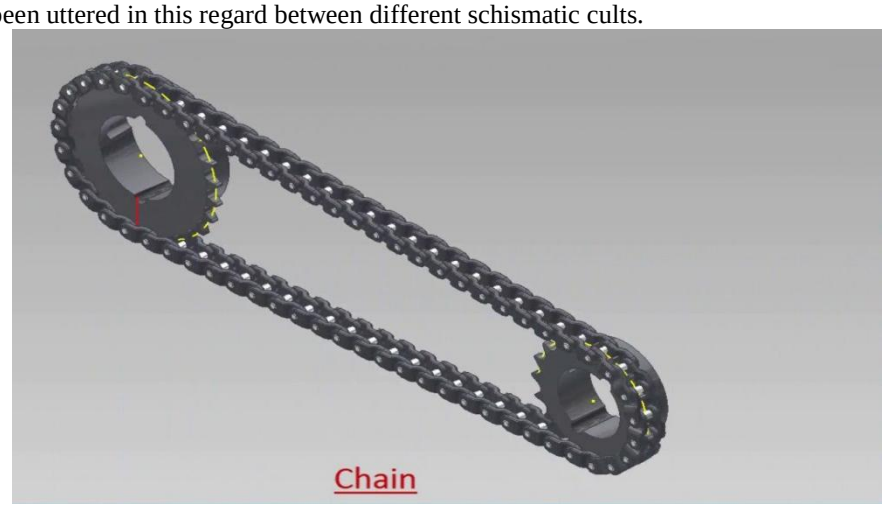

Fig-3.2 bicycle chain frame

SIZE OF THE CHAIN The chain in use on modern bicycles has a 1/2" (=12.7 mm) Pitch, which is ANSI STANDARD #40, where the 4 in "#40" indicates the pitch of the chain in eighths of an inch, and metric #8, where the 8 indicates the pitch in sixteenths of an inch.
WIDTH OF THE CHAIN Chains come in either 3/32", 1/8", 5/32", or 3/16" roller widths, the internal width between the inner plates. 1/8" chains are used on bikes with a single rear sprocket: those with coaster brakes, hub gears, fixed gears such as track bicycles, or BMX bikes. Chains with 3/32" wide rollers are used on bikes with derailleurs such as racing, touring, and mountain bikes. Fixed sprockets and freewheels are also available in 3/32" widths so fixed-gear and single-speed bikes can be set up to use narrow and lighter 3/32" chains. Finally, chains with 5/32" wide rollers are used on freight bicycles and tricycles**.**

3.2 MICROCONTROLLER

- The microcontroller is used for controlling the amount of oil to be sprayed on the chain while the chain is in motion.
- The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.
- The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.
- "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions.

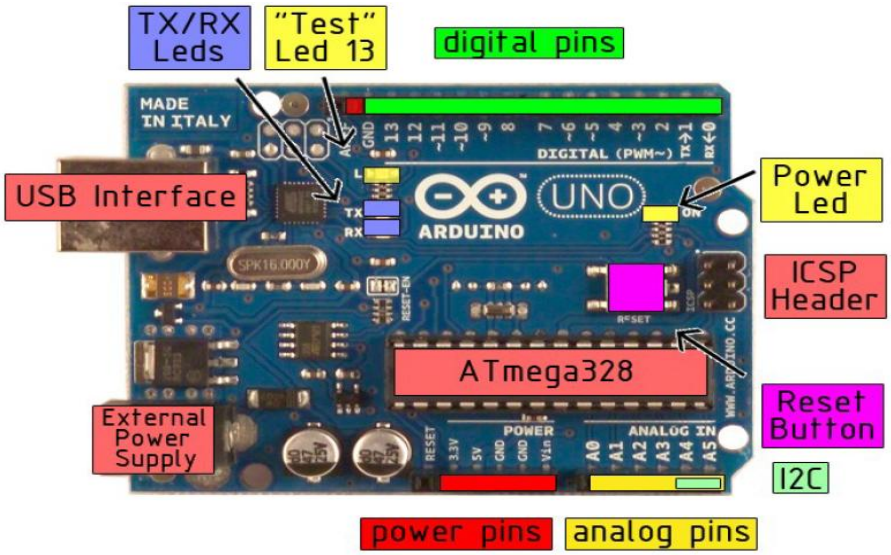

Fig-3.3 Arduino Microcontroller

TECHNICAL SPECIFICATION

Microcontroller	ATmega328
Operating Voltage	5v
Input Voltage (recommended)	7-12v
Input Voltage (limits)	6-20v
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40mA
DC Current for 3.3V Pin	50mA
Flash Memory	32 KB of which 0.5 KB used by bootloader
SRAM	2KB
EEPROM	1KB
Clock Speed	16MHz

3.3 SOLENOID VALVE

2-Way solenoid valves have one inlet and one outlet, and are used to permit and shut off fluid flow. The two types of operations are Normally Closed (NC) and Normally Open (NO). Two types of constructions apply to 2-way solenoid valves, which are direct acting and internally piloted. With Direct acting constructions, the solenoid is energized, the core directly opens the orifice of a Normally Closed valve or closes the orifice in a Normally Open Valve. The valve will operate at pressures from 0 psi to its rated maximum. Internally piloted constructions use line pressure to assist operation. When the coil is de-energized (on a Normally Closed Valve), the pilot orifice is closed and line pressure is applied to the top of the piston or diaphragm through the bleed orifice, closing the valve.

Fig-3.4 2/2 way solenoid valve

TECHNICAL SPECIFICATIONS

Solenoid:

Inlet Connection :	4 x 6mm Hose
Outlet Connection :	4 x 6mm Hose
Pressure Range :	0 – 10 kg/cm2 Max
Ambient Temperature :	–10oC to +60oC
Fluid Temperature :	–10oC to +60oC
Seal Material :	NBR
Exterior Material :	Polyester
Valve Body Material :	Brass or Aluminium
Cable Plug :	DIN 43650B
Power Consumption :	40VA in 10ms (Power-On) at AC 220V 1VA (Holding) at AC 220V
Working Voltage :	AC 100V to AC 230V
Insulation Resistance :	Higher than 100MΩ/DC 500V

3.4 DC MOTOR

- The wiper motor is a permanent-magnet direct current (DC) one. It is equipped on the front windscreen glass with the mechanical parts of the worm gear. The worm gear functions to slow down and increase torque. Its output shafts spur four-bar linkage, by which the movement is changed from rotary to swinging.
- Three-brush structure is adopted to make speed change more convenient. The intermittent relay, by which the interval is controlled, utilizing the return of switch contacts and the charge-discharge function of the resistor-capacitor in the relay, drives the wiper to wipe in a certain cycle.
- The wiper blade tape, the tool to clean the rainwater and the filth on the glass, presses the surface of the glass with springs. Only when the tip of the blade is in a certain angle with the glass, can the required function be realized.
- The wiper motor is used in this project to power the rotation of the chain mechanism so as to show the lubricatio on an automated moving chain system.

Fig 3.5: DC motor

Specifications

Rating voltage : 12v
No load current : <2.5 A
No load speed : <200 rpm
Rated current : <8 A
Rated speed : <100 rpm
Stall current : <25 A
Stall torque : >20 N.m

IV.WORKING

4.1 WORKING MODEL

The working principle of autonomous lubrication of chain system is based up on RPM so rotated by the chain . the whole system consists of components which are D.C. motor, microcontroller ,solenoid valve, water pump, battery, chain and sprocket mechanism, discharge pipe and adapter.

The D.C Motor and water pump is given the power supply through the same connection, the solenoid valve and microcontroller are connected to power supply through same connection.

The chain mechanism is powered by D.C motor of 100RPM ,when the system is switched on the microcontroller is assigned value by user which is nothing but the number of RPM which is a virtual value assumed by the user that the chain is rotating at the same RPM to observe the lubrication by the system at different time interval.

The microcontroller is given a virtual value as the D.C motor always have a fixed RPM at which it is rotated and the system can only be made according to the actual RPM when the system is integrated with an engine powered by a gear mechanism. The microcontroller is programmed as such it interprets the need of lubrication according to the number of revolutions done by the chain mechanism. In simple words if the RPM so rotated by the chain mechanism is more the lubrication needed to the chain will be more and hence the microcontroller is assigned a time value in seconds which increases as the value of RPM decreases and thus it is concluded that the time of lubrication assigned behind a particular RPM value is inversely proportional to the number of rotation so done by the chain mechanism. So when the RPM value is more lubrication is done in short time intervals and gradually as the value of RPM decreases, the lubrication is done after long time interval. The oil sprayed by the discharge pipe is 3.5seconds which is the time taken for one revolution of chain.

The microcontroller is connected to the solenoid value through which the microcontroller sends the data by which actuation and deactuation of solenoid value takes place at the right time intervals based on the programming done in the microcontroller. The water pump is used to suck the oil from the reservoir and this oil is made to flow through the solenoid value towards the point of discharge through which required quantity of oil gets lubricated on the chain. The application of autonomous lubrication in large scale industries helps in continuous production without the consequence of production breakdown. If automatic lubrication system is not installed there will manual inspection and needs human interference ,sometimes the physical location on machine often makes it impractical to manually lubricate at certain parts of machine.

V. TABLES AND FIGURES

The graph and figures as obtained per the result are given and tabulated below :

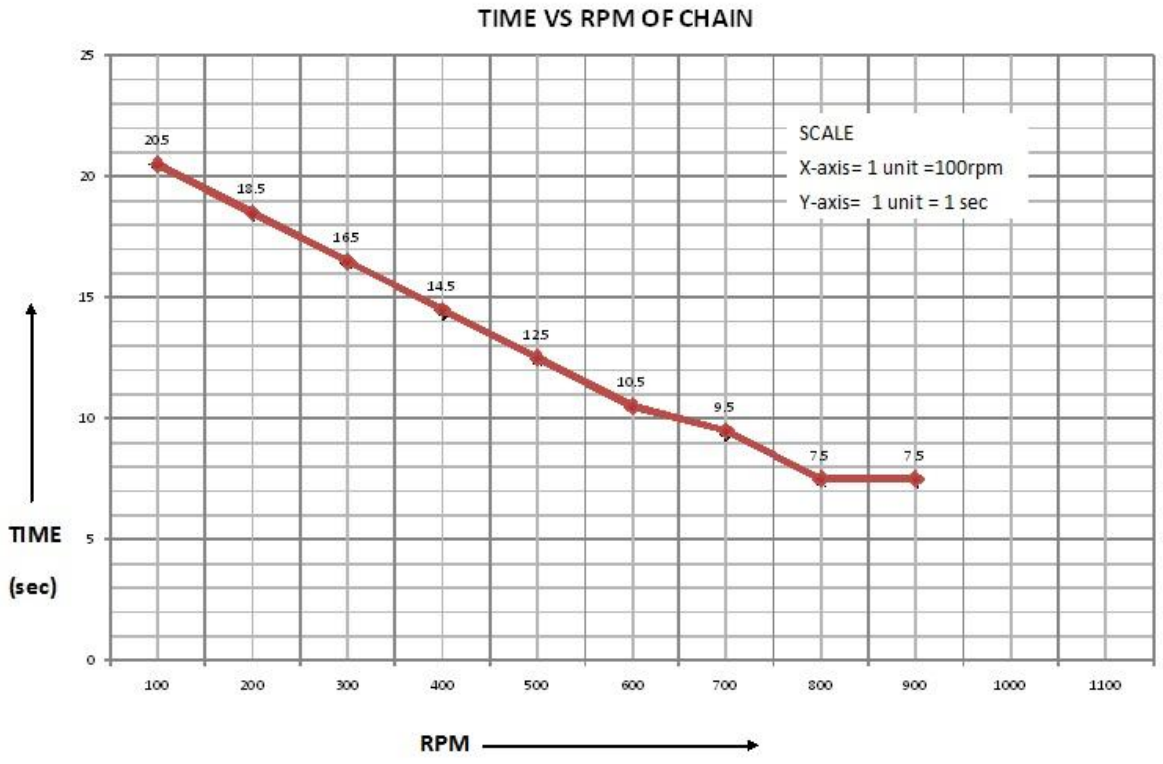

Table 5.1 Table showing discharge at different time intervals

NUMBER OF TRAILS	RPM ($x10^2$)	TIME OF DISCHARGE
1	9	7.5
2	8	7.5
3	7	9.5
4	6	10.5
5	5	12.5
6	4	14.5
7	3	16.5
8	2	18.5
9	1	20.5

VI. FUTURE SCOPE

- Design is compact, can be installed on bikes for automatic lubrication of chains which reduces the careless manual lubrication and hence increases the life of the chain .
- Autonomous lubrication system can be incorporated in large scale industries at intricate parts which need lubrication and where manual lubrication is not possible.

VII. DESIGN AND FABRICATION

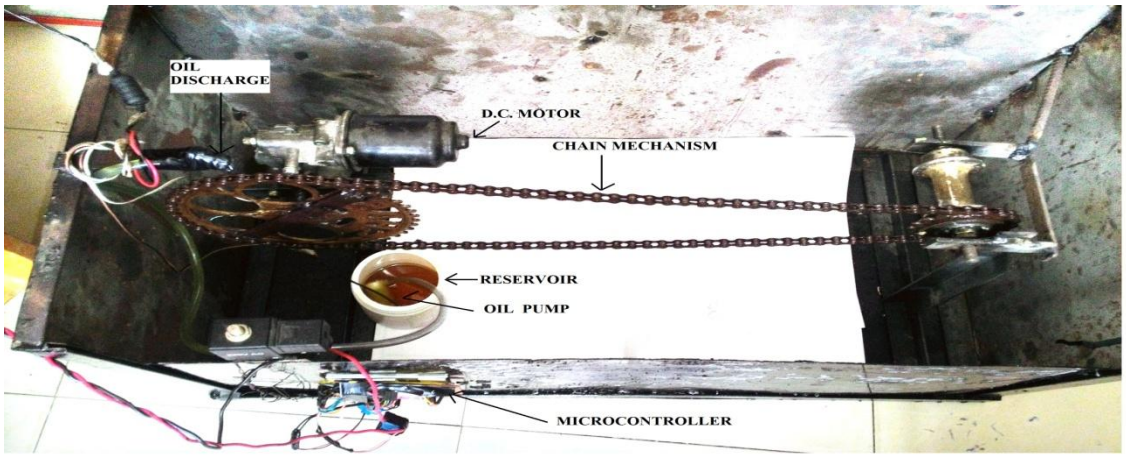

Fig:7.1 Top View Of Autonomous Lubrication System

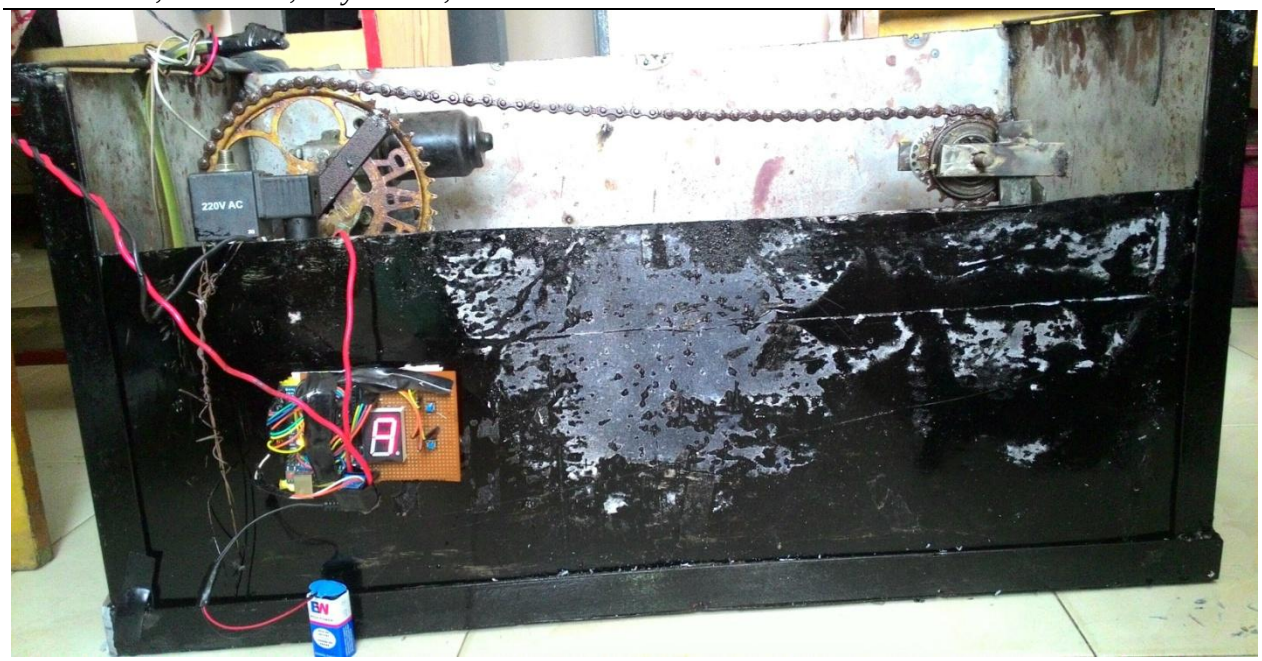

fig 7.2 Side view of autonomous self lubrication of chain

VIII.CONCLUSION

From the Automatic Lubrication system it is concluded that the cost and man power require for the lubricating the various oil points can be eliminated. The loss of oil during greasing reduces as compared with the manual lubrication. The system provides safety to the lubricating component and the operator. This system enables the oiling to the points which are not reachable to operator and down time also reduces. The lubricant consumption will considerably reduced by control system optimization that is right quantity of lubricant at right part. Failure of bearings and chains due to lack of lubrication is considerably reduced. Frequent lubrication run time is eliminated as the lubrication now gets automated. The autonomous self lubrication holds many advantages of which are like all critical components are lubricated regardless or location or ease of access. proper lubrication of critical components ensures safe operation of the machinery. less wear on component means extended component life, fewer breakdowns, reduced downtime, reduced replacement costs and reduced maintenance costs.

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