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E - PREVENTIVE MAINTENANCE WARNING SYSTEM

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E - PREVENTIVE MAINTENANCE WARNING SYSTEM

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ABSTRAK

Laporan ini membentangkan kajian mengenai alat/peranti untuk mengira bilangan putaran/pusingan sesuatu objek dalam sesebuah sistem. Terrdapat pelbagai kaedah penyelenggaraan seperti penyelenggaraan secara penyaman, sistem pemantauan penyelenggaraan, penjadualan penyelenggaraan, dan ramalan penyelenggaraan telah dilaksanakan dalam industri, namun begitu, masalah sukar untuk menentukan dalam mana-mana tahap ketepatan masih menjadi. Satu contoh seperti kegagalan peranti berputar dan menyebabkan ketangguhan masa yang lama di bahagian pengeluaran. Sebelum melaksanakan kajian sistem kawalan, laporan ini menerangkan reka bentuk perkakasan peranti pengira putaran. Selepas membina prototaip, pengantaramukaan perkakasan perlu dilaksanakan. Sebuah reka bentuk pengawal yang merupakan sistem pembilang dibangunkan untuk mengkaji prestasi sistem. Sistem kawalan ini direka berdasarkan perisian CCS C Compiler. Kajian dijalankan untuk memastikan peranti pengira putaran ini tepat, sekiranya terdapat pengiraan yang tidak tepat, cara penyelesaian dikaji sehingga berjaya.

ABSTRACT

This report presents the study on a device for counting the number of rotations of an object in a system, in which a storage means carries counting data designed to represent the number of rotations counted. In recent years, a lot of maintenance method such as maintenance conditioning, maintenance monitoring system, maintenance scheduling, and predictive maintenance are implemented in the industry, and has been difficult to determine within any degree of accuracy. An example such as the rotating device failure and causes long downtime in production line. Prior to the study of control system, this report describes the hardware design of the rotation counting device. Subsequent to the completion of constructing the prototype, hardware interfacing needs to be performed. A controller design which is counter system is developed in order to study on the system's performance. The embedded control system is designed based on CCS C Compiler software.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

SMS	-	Short Message Service
RPM	-	Revolution per minute
GSM	-	Global System for Mobile
PIC	-	Peripheral Interface Controller
LCD	-	Liquid Crystal Display
D1	-	Diameter 1 of pulley size
D2	-	Diameter 2 of pulley size
V1	-	Rotation speed 1
V2	-	Rotation speed 2
DC	-	Direct Current

CHAPTER 1

INTRODUCTION

1.1 Project Background

The maximization, automation, high precision, high efficiency, and electromechanical integration development tendency of equipment have made enterprise improve production efficiency. However, the enhancement of performance and complexity of equipment and the high correlation between components have led to problems, including frequent paroxysmal failure of machinery, high maintenance expense and long maintenance cycle. A condition monitoring programs offer an innovative mean for modern rotating equipment to implement and schedule predictive maintenance, as opposed to relying on conventional preventive maintenance techniques, vibration, wear and temperature are the three important condition monitoring techniques to predict the health of the rotating machinery.

Sohre(1972) has presented the prediction and identification of faults in the trubomachinery. Renwick(1984) has presented a condition monitoring program for plant maintenance and diagnosis of heavy machinery problems in which he discussed the importance of machinery dynamics in the design of a rotating machinery. M.Sarath Kumar and B.S. Prabhu(1998) has presented a work using vibration characteristics of a rotor-bearing system, the condition of a rotating machinery(electrical rotor) is predicted using an off-line expert system. Shaohong Wang, Tao Chen Jianhong Sun(2010) has designed a realization of a remote monitoring diagnosis and prediction system for large rotating machinery. Frank Vial, Marc Beranger(2011) invented an electronic device for counting and storing the number of rotations of an object and the number of counter resets. This device is used to count the rotations of an object mobile about an axis, for example, such as a vehicle wheel to track wear of the tire on that wheel.

The development of the programmable rotation counting devices relates generally to counter circuit and more specifically, it relates to a programmable rotation counting system for generating an output signal at the expiration of a preselected number of operating rotation of industrial equipment. Machinery malfunctioning problems are often sources of increased maintenance costs and disturbances in production activity across the industry. Reliable preventive methodologies are needed to enable cost effective condition based maintenance. This development can be applied in the monitoring of the total amount of operating bearing life cycle in rotating machinery system and generating an output signal after a predetermined number of operating rotation on the rotating machinery system has elapsed.

1.2 Problem Statement

At the operation of various types of bearing in a rotating machinery systems, the number of rotation in which any specific systems are actually running during the course of a day may vary significantly due to weather conditions, energy conservation systems, and shutdown of the equipment due to certain malfunctions. Thus, the normal service or scheduled maintenance interval has been very difficult to determine within any reasonable degree of accuracy. For example, if a periodic maintenance interval of 6 months was selected for a given bearing in a rotating machinery system, this may or may not be frequent enough dependent upon its operating condition. If the case where a bearing in a rotating machinery system has been subjected to a high level stress, the maintenance interval for servicing should be required after a lesser number of operating rotations.

1.3 Objective of Project

i. To investigate the practical preventive solutions available suiting local manufacturing industries.
ii. To develop a cost effective Programmable E- Preventive Maintenance Warning System
iii. To validate the performance of the wireless notifying system

1.4 Scope

This project is focused on a programmable rotation counting system with GSM to provide an alert system to service personnel that the industrial equipment is due for a scheduled maintenance. This is because the difficulty to detect when will the rotating machinery breakdown and causes the production to stop. In addition, we are able to understand the microcontroller. This programmable rotation counting system able to operate at moderate speed at 400-6000 RPM.

1.5 Maintenance Tools

This section presents some of the maintenance tools that directly or indirectly used in engineering.

1.5.1 Revolution counter

A revolution counter known as a device that tracks revolutions of a rotating shaft, disc, or similar rotation object. It is able to return data about the about the speed of rotation as well as simple recording the number of rotations. Some are analog, requiring a mechanical connection with the device they measure, while others may use techniques like laser sighting to collect information. An example of a revolution counter is the tachometer which is commonly use in a vehicle, with a display providing information about the engine's number of revolution per minute (RPM).

The revolution counter can return data in the form of revolutions per minute, often with a needle sliding along a graduated scale. The scale may have shaded zones indicating safe operating speeds. High speed may endanger the equipment and the scale could include green, yellow and red zones or indicating system to alert the operator to make adjustment on slow down the revolutions per minute to reduce risks of damage or injury.

1.5.2 Maintenance

Maintenance recommendations are based on industry standards and experience in reclamation facilities. However, equipment and situations vary greatly, and sound engineering and management judgment must be exercised when applying these recommendations. Other sources of information must be consulted (e.g. manufacturer's recommendations, unusual operating conditions, personal experience with the equipment, etc.) in conjunction with these maintenance recommendations.

Maintenance activities fall into three categories:

- Routine Maintenance - Activities that are conducted while equipment and systems are in service. These activities are predictable and can be scheduled and budgeted. Generally, these are the activities scheduled on a time-based or meter-based schedule derived from preventive or predictive maintenance strategies. Some examples are visual inspections, cleaning, functional tests, measurement of operating quantities, lubrication, oil tests, and governor maintenance.
- Maintenance Testing - Activities that involve using test equipment to assess condition in an offline state. These activities are predictable and can be scheduled and budgeted. They may be scheduled on a time or meter basis but may be planned to coincide with scheduled equipment outages. Since these activities are predictable, some offices consider them "routine maintenance" or "preventive maintenance." Some examples are governor alignments and balanced and unbalanced gate testing.
- Diagnostic Testing – Activities that involve using test equipment to assess the condition of equipment after unusual events, such as equipment failure/

repair/replacement or when equipment deterioration is suspected. These activities are not predictable and cannot be scheduled because they are required after a forced outage. Each office must budget for these events. Some examples are governor troubleshooting, unit balancing, and vibration testing.

1.5.3 Preventive maintenance

Preventive maintenance is meant equipment is maintained before breakdown occurs or also known as maintenance performed in an attempt to avoid failures, unnecessary production loss and safety violations. This type of maintenance has many different variations and is subject of various researches to determine best and most efficient way to maintain equipment. Recent studies have shown that Preventive maintenance is effective in preventing age related failures of the equipment. For random failure patterns which amount to 80% of the failure patterns, condition monitoring proves to be effective. The effectiveness of a preventive maintenance schedule depends on the reliability centered maintenance (RCM) analysis which it was based on, and the ground rules used for cost-effective.

Some advantages of PM are:

- It is predictable, making budgeting, planning, and resource leveling possible.
- When properly practiced, it generally prevents most major problems, thus reducing forced outages, "reactive maintenance," and maintenance costs in general.
- It assures managers that equipment is being maintained.
- It is easily understood and justified.

Preventive Maintenance does have some drawbacks:

- It is time consuming and resource intensive.
- It does not consider the actual equipment condition when scheduling or performing the maintenance.

- It can cause problems in equipment in addition to solving them (e.g., damaging seals, stripping threads).

1.5.4 Condition-Based Maintenance

This maintenance activity relies on knowing the condition of individual pieces of equipment.

Some features of CBM include:

- Monitoring equipment parameters such as temperatures, pressures, vibrations, leakage current, dissolved gas analysis, etc.
- Testing on a periodic basis and/or when problems are suspected such as vibration testing, and infrared scanning.
- Monitoring carefully operator-gathered data.
- Securing results in knowledgeable maintenance decisions which would reduce overall costs by focusing only on equipment that really needs attention.

1.5.5 Combination of Condition-Based and Preventive Maintenance

A combination of CBM and PM is perhaps the most practical approach. Monitoring, testing, and using historical data and PM schedules may provide the best information on when equipment should be maintained. By keeping accurate records of the "as found" condition of the equipment when it is torn down for maintenance, one can determine what maintenance was really necessary. In this manner, maintenance schedules can be lengthened or perhaps shortened, based on experience and monitoring.

CHAPTER 2

LITERATURE REVIEW

In this chapter, an overall finding of revolution counter device on rotational machinery, bearing, belting from 1944-2011 are included. Predictive maintenance schedules and preventive maintenance method since 1993-2008 are also presented. Bearing, belt fault detection and motor failure using neural network based model ranging from year 2004-2011 are included. Vibration protection becomes desirable for rotating machinery when it is operated with certain defects. Thus, to prevent fault on the rotating device by using a vibration analyzer is also covered here from the year 1944 to 2009.

2.1 Revolution Counter

Toshio Lino, Kenji Fujino and Takashi Tsukada (1999) implemented the magnetic bubble device (MBD) for revolution counters on servo motors. The key device of the sensor is a magnetic bubble device (MBD) that was based on the magnetic bubble memory technology. The MBD allows the maintaining and updating of the revolution number without any backup battery or by gearing-down mechanism where, maintenance free and small sized revolution counters were realized. The designed

MBD sensor with 152 bit memory was able to count 32,487 revolutions without any problem.

Toshio Lino and Hiroshi Nakayama (1999) constructed a full absolute encoder consists of an absolute angle sensor using the diffused light optical system and magnetic bubble device revolution counter. A high resolution compact angle sensor was realized by using this optical system. Real time data output was also realized by using digital signal processor. By using precision compact magnetic circuits and electrical circuits, the feature of backup battery free revolution counting was brought out. On the other hand, Nino Stojkovic, Zoran Stare and Neven Mijat (2001) portrayed that the measurement of rotational speed can be done in several ways. Three different measurement methods are presented and appropriate resolutions and relative errors are calculated. The method which measures the time between two pulses gives the best results for slow rotation speeds. Meanwhile, the method which counts the number of pulses in time window gives better results for high rotation speeds. Measurement optimization is done by measuring in two modes corresponding to previous methods and relative error is significantly decreased, revolution counter is realized for measuring rotation speeds in range 10-9999 RPM with a sensor which gives one pulse per revolution. A microcontroller is used for switching between the measurement modes as well as for the rotation speed calculation and displaying.

A programmable maintenance timer system was invented and patented by John C. Hansen, Spring Grove, Lioyd A. Johnson, Dover (1985). This programmable maintenance timer system with a telemetry system including a microprocessor-based is suitable for use with industrial equipment such as centrifugal chilling system. This system is a device for presenting selective a maintenance time interval representing a number of hours before a maintenance service is performed. It is counting down the time interval to zero, and for generating an output signal after the time interval has reached zero to the telemetry system so as to alert service personnel to service the industrial equipment is due for a scheduled maintenance. This timer system also includes a non-volatile memory device to record permanently the total elapsed operating hours in the preset maintenance time interval so as to avoid loss of information upon a power failure.

Figure 2.1 shows an overall block diagram of a programmable maintenance timer system of the present invention interconnected to a centrifugal water chilling system and a telemetry system. This programmable maintenance timer system is generally designed by reference numeral 3 and receives an input signal from centrifugal water chilling system 1 and line 2. An output signal is then generated on line 4 for delivering it to a telemetry system 5. A power source 6 has its output applied to the timer system via the line 7 and to the telemetry system 5 via line 8. Its input is 120 VAC.

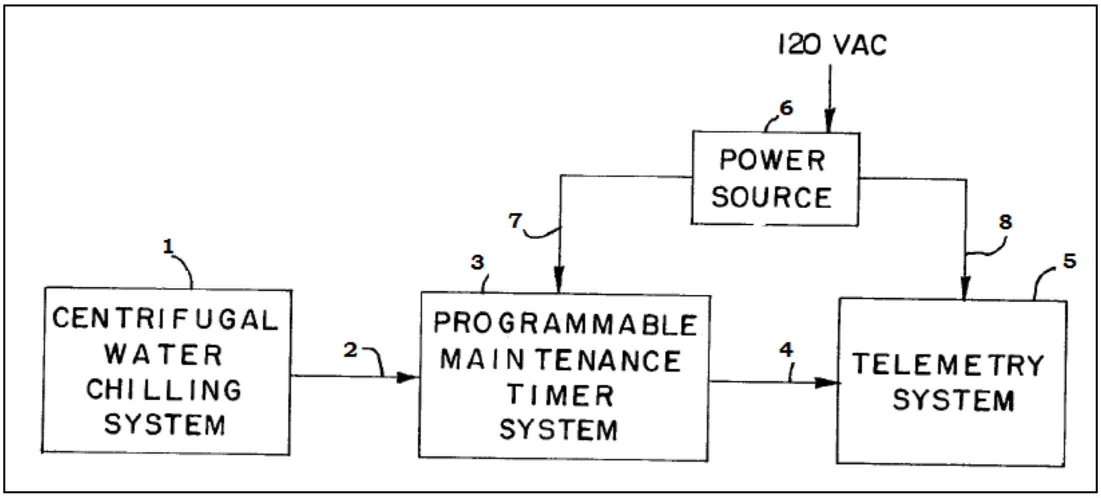

Figure 2.1: Overall block diagram of a programmable maintenance timer system
(John C. Hansen, Spring Grove, Lioyd A. Johnson, Dover, 1985)

Figure 2.2 shows a block diagram showing in more detail the power source 6 illustrated in Fig. 2.1. The power source 13 receives a 120 VAC potential on the lead line 9 and includes an isolation transformer 10, a voltage regulator/battery charger 11, and a rechargeable battery 12. The battery 12 is constantly rechargeable by the battery charger 11 to provide a backup operating power supple to the programmable maintenance timer system 3 when there is a power failure in the 120 VAC potential. The power source 13 delivers a +6.9 VDC regulated voltage on its output lines 7 and 8.

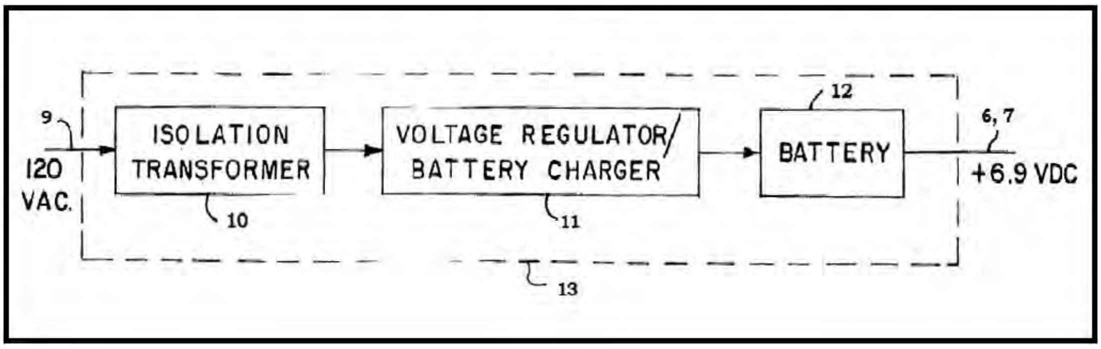

Figure 2.2: A block diagram showing in more detail the power source 6 illustrated in Figure 2.1 (John C. Hansen, Spring Grove, Lioyd A. Johnson, Dover, 1985)

Scott R. Wheeler, Dominic Baulier (2010) invented a revolution counter for turning assemblies. This revolution counter generally relates to a tool and associated method for keeping accurate count of the number of turns that a driving part, example: a wrench is used to drive or turn a driven part such as a shaft or gear. Particularly, it is directed to a mechanical revolution counter for keeping track of the number of turns a driven part is driven for adjustment to a target or optimal position. A memory counter circuit maintains a count of turns and increments of the driven part by the driving part, and a reference setting circuit sets a reference setting of the memory counter circuit when a count is to be taken. The device body has a first portion mounting the adapter shaft with the rotary encoder, an intermediate housing containing the memory counter circuit, and a second portion at a distance from the first portion and of a sufficient mass that acts to orient the device body to a gravity-determined position as a reference position. The memory counter circuit receives output signals from the rotary encoder circuit and maintains a count relative to a reference position of the device body.

Figure 2.3 is a diagram of a preferred embodiment of a Revolution Counter Tool having a splinted shaft having input and output ends connected in-line between a driving part and a driven part of a turning assembly.

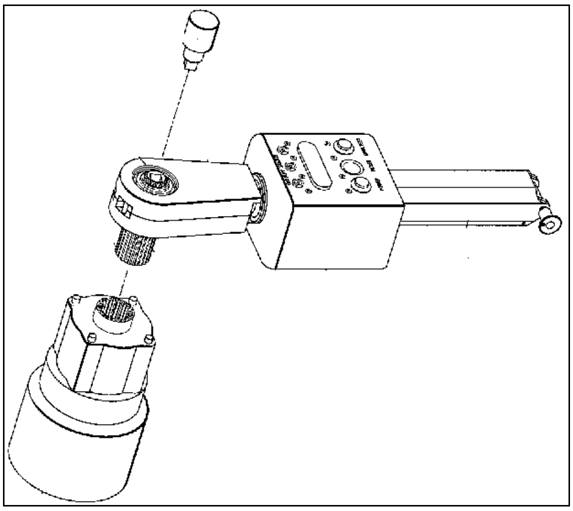

Figure 2.3: Diagram of a preferred embodiment of a Revolution Counter Tool
(Scott R. Wheeler, Dominic Baulier, 2010)

Figure 2.4 shows a transparent isometric view of the tool width counter components in its housing. Mounted on the proximal end 7a of the tool are an optical rotation sensor 1, having a pair of sensor units side-by-side which provides quadrature detection output signals, in combination with a rotary encoder disc 2 having a number of slot apertures at equidistant intervals around its periphery for demarcating corresponding angular increments (count resolution with quadrature signals: 25x4=100 increments). Arranged in the intermediate housing 5b is an incremental up/down pulse counter 4 which counts two pulse input signals (in quadrature) from the pair of optical rotation sensors 1. The counter 4 has a nonvolatile memory for retaining a count in process, and a digital LCD display 3 for providing a digital counter readout. Reset intermittent contact push button 5a enabling resetting of the counter for new count which is active only when the auxiliary Reset intermittent contact push button 5b is activated too, and a power ON/OFF contact push button 6.

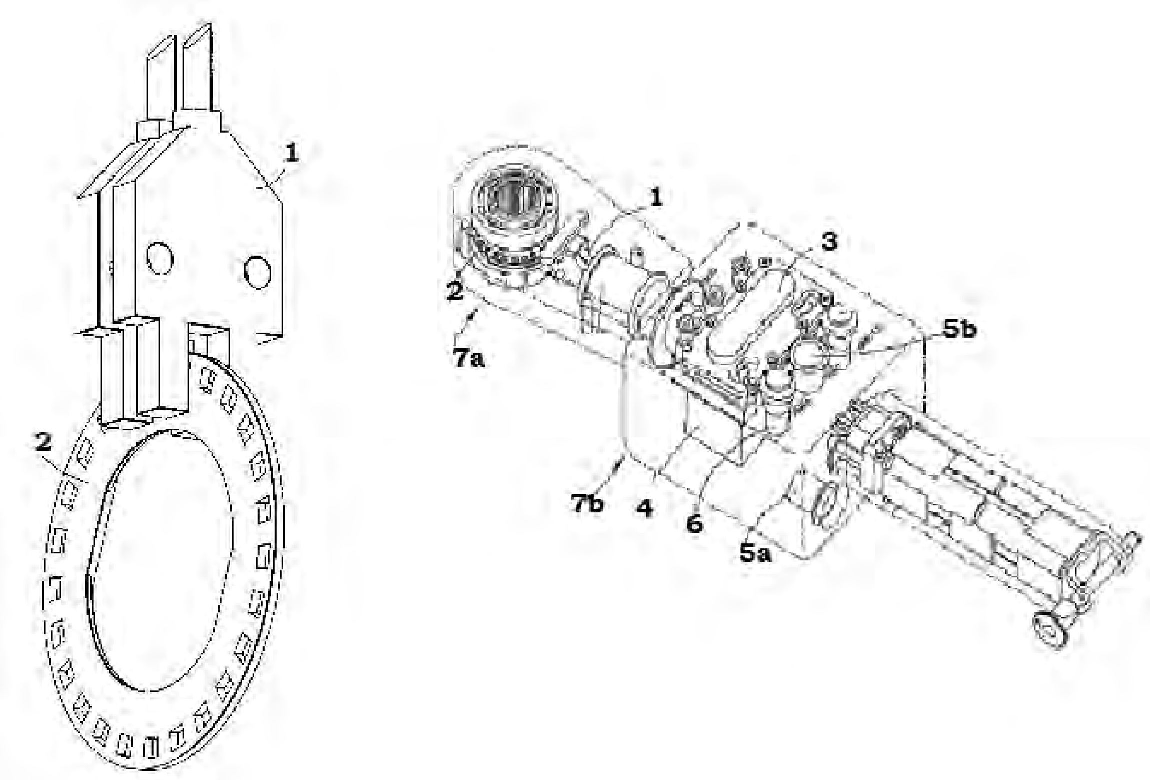

Figure 2.4: Isometric view of the Tool width counter components in its housing
(Scott R. Wheeler, Dominic Baulier, 2010)

2.2 Predictive Maintenance

Kyung Park. S (1993) presented Condition-based predictive maintenance method by using multiple logistic functions. For complex systems, the system failures exhibit an exponential nature, negating the benefit of traditional, time based preventive maintenance. Under this circumstance, the condition-based predictive maintenance (CbPM) is more appropriate as the system condition can be monitored from the surface by running machinery, and maintenance is performed only when needed as the failure prognosis dictates. A cost optimal prognostic criterion for CbPM using a multiple logistic function of risk variables to be monitored, which fluctuate randomly according to a certain probability distribution, was also discussed. A numerical example demonstrates the procedure and the utility of the method. In addition, Chen. M, Wang. M, Chen.Y. H (2008) proposed an efficient algorithm to obtain the optimal maintenance policy. The optimal preventive maintenance policy is investigated with incorporating the costs of minimal repair, imperfect preventive