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Research Article

Installation of Off Delay Timer Unit in Earthmoving Machineries

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Abstract

The project is about installation off-delay timer unit in earthmoving turbocharger machine. In this type of live project we use off-delay timer as medium to increasing the efficiency of engine as well as turbocharger. Basically, our project had been done on excavator XYZ 450 Z-AXIS. As we had find out the problem in excavator that when the operator start the machine for performing some kind of work as the excavator as widely used to perform for heavy digging jobs in mining industries so it consist of turbocharger as a main mechanical component because of it the high torque as well as large amount of power output is generated. So, after the work done the operator turn off the machine immediately without keeping the engine idle running for certain minute (2 to 3 min) as engine get shut down but still the turbocharger get rotating at high rpm approx.. 2,50,000 rpm and due to that the highly back pressure of turbocharger get strike on engine and thus the efficiency and life span of the same get hampered. Thus by introducing off-delay timer unit in earthmoving machine i.e. excavator we decreasing the maintenance cost as well as increasing the efficiency of engine and turbocharger. According to the industry calculation the cost for maintenance without timer is going to be very high which is around 1,50000 and it going to decrease by introducing this timer in excavator.

Keywords: *Gasoline Engine, Exhaust Manifold, Intake Manifold, Turbocharger, Volumetric Efficiency.*

Introduction

When people talk about high performance engine, the Topic of turbocharger usually comes up. Turbocharger also appears on large diesel engine. A turbo can significantly, Boost an engine's horsepower without significantly increasing its weight, which is the huge benefit that makes turbo so popular. Turbocharger is a type of force induction system. They compress the air flowing into the engine. The advantage of compressing the air is that it lets the engine squeeze more air into a cylinder, and more air means that more fuel can be added. Therefore, you get more power from each explosion in each cylinder. A turbocharged engine produces more power overall than the same engine without the charging. This can significantly improve the power-to-weight ratio for the engine.

In order to achieve this boost, the turbocharger uses the exhaust flow from the engine to spin a turbine, which in turns spins an air pump (Impeller). The turbine in the turbocharger spins at speeds up to 1,50,000 RPM(Rotation Per Minute) that's about 30 times faster than most car engine can go and since it is hooked up to the exhaust, the temperatures in the turbine are also very high. Our project will aim on avoiding premature failure of turbocharger due to lack of lubrication cause by sudden stop of engine.

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Consequentially we can avoid damages to engine and other components of hydraulic excavator. It is very essential to stop the engine by following procedure:

After making engine speed to Low Idle Speed and run it for minimum 2 minutes, then turn Key Switch to 'OFF' position to stop the engine.

In usual practices nobody follows this. Just consider an examples of car - many people come running the car at high speed and apply the brake. Immediately turn Key Switch to OFF position to stop the engine. Due to this engine oil pump will not supply engine oil to turbocharger for lubrication as engine got shut off, but turbocharger will still continue to rotate at very high speed. It will not stop immediately (Running RPM up to 150000). This can cause failure of turbocharger due to lack of lubrication and consequentially failure of engine.

We have introduced Off Delay Timer Unit to avoid sudden stopping of engine even key switch turn to 'OFF' position.

Excavators are heavy construction equipment consisting of a boom, dipper (or stick), bucket and cab on a rotating platform known as the house. The house sits atop an undercarriage with tracks or wheels. They are a natural progression from the steam shovels and often mistakenly called power shovels. All movement and functions of a hydraulic excavator are

accomplished through the use of hydraulic fluid, with hydraulic cylinders and hydraulic motors. Due to the linear actuation of hydraulic cylinders, their mode of operation is fundamentally different from cable-operated excavators which use winches and steel ropes to accomplish the movements.

Excavators are also called diggers, JCBs (a proprietary name, in an example of a generic trademark), mechanical shovels, or 360-degree excavators (sometimes abbreviated simply to 360). Tracked excavators are sometimes called track hoes by analogy to the backhoe. In the UK, wheeled excavators are sometimes known as rubber ducks.

Applications

- Dashboard and controls of a 3.8 tons excavator
- Excavators are used in many ways:
- Digging of trenches, holes, foundations
- Material handling
- Brush cutting with hydraulic attachments
- Forestry work
- Forestry mulching
- Demolition
- General grading/landscaping
- Mining, especially, but not only open-pit mining
- River dredging
- Driving piles, in conjunction with a pile driver
- Drilling shafts for footings and rock blasting, by use of an auger or hydraulic drill attachment
- Snow removal with snowplow and snow blower attachments

Configuration

Modern, hydraulic excavators come in a wide variety of sizes. The smaller ones are called mini or compact excavators. For example, Caterpillar's smallest mini-excavator weighs 2,060 pounds (930 kg) and has 13 hp; their largest model is the largest excavator available (a record previously held by the Orenstein & Koppel RH400) the CAT 6090, it weighs in excess of 2,160,510 pounds (979,990 kg), has 4500 hp and has a bucket size of around 52.0 m^3 depending on bucket fitted.

Engines in hydraulic excavators usually just drive hydraulic pumps; there are usually 3 pumps: the two main pumps are for supplying oil at high pressure (up to 5000 psi) for the arms, swing motor, track motors, and accessories, and the third is a lower pressure (~700 psi) pump for Pilot Control, this circuit used for the control of the spool valves, this allows for a reduced effort required when operating the controls. Generally, the 3 pumps used in excavators consist of 2 Variable displacement piston pumps and a Gear pump. The alignment of the pumps in the excavator unit changes with different manufacturers using different formats.

Fig.1: Excavator (Earthmoving machine)

The two main sections of an excavator are the undercarriage and the house. The undercarriage includes the blade (if fitted), tracks, track frame, and final drives, which have a hydraulic motor and gearing providing the drive to the individual tracks, and the house includes the operator cab, counterweight, engine, fuel and hydraulic oil tanks. The house attaches to the undercarriage by way of a center pin. High pressure oil is supplied to the tracks' hydraulic motors through a hydraulic swivel at the axis of the pin, allowing the machine to slew 360° unhindered.

The main boom attaches to the house, and can be one of several different configurations:

Most are mono booms: these have no movement apart from straight up and down.

Some others have a knuckle boom which can also move left and right in line with the machine.

Another option is a hinge at the base of the boom allowing it to hydraulically pivot up to 180° independent to the house; however, this is generally available only to compact excavators.

There are also triple-articulated booms (TAB).

Attached to the end of the boom is the stick (or dipper arm). The stick provides the digging force needed to pull the bucket through the ground. The stick length is optional depending whether reach (longer stick) or break-out power (shorter stick) is required.

On the end of the stick is usually a bucket. A wide, large capacity (mud) bucket with a straight cutting edge is used for cleanup and leveling or where the material to be dug is soft, and teeth are not required. A general purpose (GP) bucket is generally smaller, stronger, and has hardened side cutters and teeth used to break through hard ground and rocks. Buckets have numerous shapes and sizes for various applications. There are also many other attachments which are available to be attached to the excavator for boring, ripping, crushing, cutting, lifting, etc.

Before the 1990s, all excavators had a long or conventional counterweight that hung off the rear of the machine to provide more digging force and lifting capacity. This became a nuisance when working in confined areas. In 1993 Yanmar launched the world's

first Zero Tail Swing excavator which allows the counterweight to stay inside the width of the tracks as it slews, thus being safer and more user friendly when used in a confined space. This type of machine is now widely used throughout the world.

There are two main types of Control configuration generally use in excavators to control the boom and bucket, both of which spread the four main digging controls between two x-y joysticks. This allows a skilled operator to control all four functions simultaneously. The most popular configuration in the US is the SAE controls configuration while in other parts of the world, the ISO control configuration is more common. Some manufacturers such as Takeuchi have switches that allow the operator to select which control configuration to use.

Excavator attachments

Hydraulic excavator capabilities have expanded far beyond excavation tasks with buckets. With the advent of hydraulic-powered attachments such as a breaker, a grapple or an auger, the excavator is frequently used in many applications other than excavation. Many excavators feature a quick coupler for simplified attachment mounting, increasing the machine's utilization on the jobsite. Excavators are usually employed together with loaders and bulldozers. Most wheeled, compact and some medium-sized (11 to 18-tonne) excavators have a backfill (or dozer) blade. This is a horizontal bulldozer-like blade attached to the undercarriage and is used for leveling and pushing removed material back into a hole.

Noble manufacturers

- Bobcat Company
- Bucyrus International
- Case CE
- Caterpillar Inc.
- CNH Global
- Doosan Infracore (formerly Daewoo Heavy Industries & Machinery) - including Solar brand
- ENMTP
- Hitachi Construction Machinery
- Hydrema
- Hyundai Heavy Industries
- John Deere
- J. C. Bamford (JCB)
- Kanga Loaders
- Komatsu Limited
- LBX (Link-Belt) Excavators
- ThyssenKrupp
- Kobelco
- Kubota
- Liebherr
- LiuGong
- L&T
- Mitsubishi Heavy Industries
- New Holland
- Orenstein & Koppel (O&K)
- Poclain

Problem Statement

Why we want to choose this topic

In last summer holiday we had visited toXYZ coal mines. Here we have seen the problems of excavator machine that was when the operator suddenly stop the machine then the turbocharger get hampered by the speed and itslife span reduces and efficiencies decreases.

By installation of this circuit unit these causes reduction in maintenance cost and increase in efficiency.

Problem Identification

Before we went to XYZ coal mine we had read the procedure to run the excavator we have find that excavator should run at ideal speed for 2 to 3 minutes before switch off but when we see that the operator suddenly switch off without dealing the machine and thus we get reduction in efficiency and life span in this way we have find out the problem.

Development of Project

Installation of off delay timer unit in earth moving excavator machine increasing the efficiency, life span & reduces maintenance cost.

Material Used

- 4 Terminal relay (qty 2)
- 5 Terminal relay (qty 1)
- Off delay timer unit
- Emergency stop switch
- Wire cables for making wiring harness
- Insulation use for protecting wires
- Clips used for connecting wires.

Working

It works on the principle of relay circuit .a relay is an electromagnetic switch operated by relatively small electric current that can turn on or turn off a much larger electric current. The heart of a relay is electromagnetic coil becomes a temporary when electricity flows through it. You can think of a relay as a kind of electric lever.

Condition no 1:- when key switch is at off position

The battery ground terminal is connected to vehicle frame. Current from battery positive terminal flows as shown above when key switch is OFF.

Condition no 2:- when key switch is turned to on position and engine started by cranking

Current from battery positive terminal flows as shown above when key switch is ON and engine is started by cranking. Machine is operated by the machine operator for doing earthmoving work.

Condition no 3:- when key switch is turned to off position to shut down the engine

Current from battery positive terminal flows as shown above when key switch turned to 'OFF' to shut down the engine, but we have installed OFF DELAY TIMER UNIT which will continue to hold and connect terminal-15 and terminal-16 of Off Delay Timer Unit for a set time. i.e. current from terminal-15 flows to terminal-16 and from terminal-16 to terminal-M of key switch for a set time and engine will continue to run for specific time as set in 'Off Delay Timer' After a specific time, terminal-15 will connect to terminal-18
Note: - Key switch 'M terminal' supply current to all electric components of excavator.

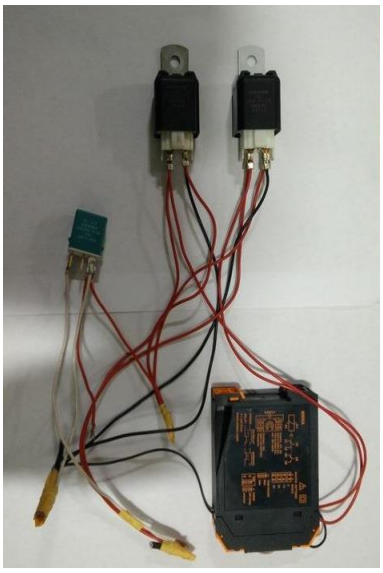
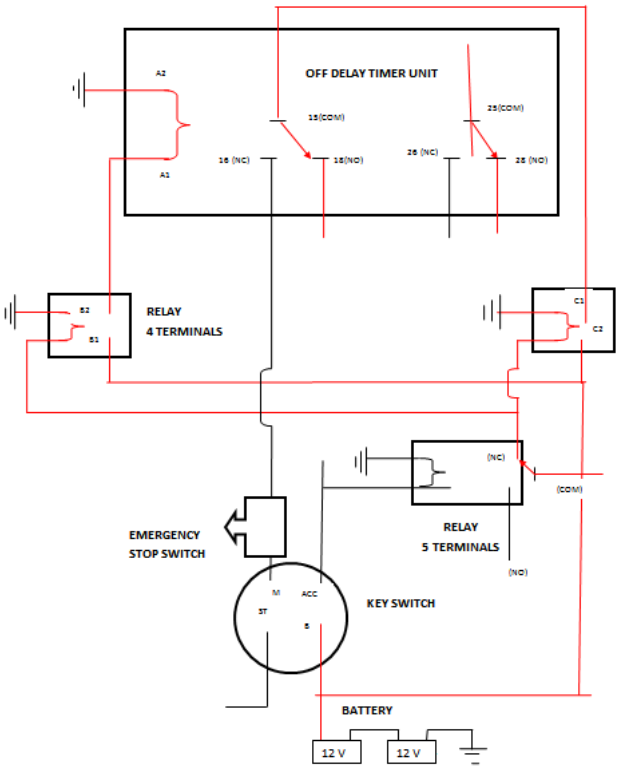


Fig.2: Off delay timer unit connected with relay

Fig.3: Key Switch

Modification done in key switch connector

Made another wiring harness consisting of three wires and further these three wires connected to 'Key Switch'



Calculation

ZX-450 Engine Model: - 6WG1 ISUZU

Engine high idle rpm – 1750
Engine low idle rpm – 750

When engine is running at high idle rpm at that time turbocharger rotates approx. 3, 00,000 rpm
When engine is running at low idle rpm at that time turbocharger rotates approx. 1, 28,571 rpm as per below calculation

Calculation

1750 → 3, 00,000
750 → x (Denotes turbocharger speed at low idle)

By installing this project we are stabilizing speed of turbocharger at 1, 28,571 rpm for 3 min, it will avoid premature failure of turbocharger due to lack of lubrication

The Advantages of the project are:

- The efficiency of engine and turbocharger get increased
- The maintenance cost of excavator regarding engine get low down
- Fuel cost comes to low

- The life-span of engine get increased and turbocharger also
- Hoses of excavator get maximum efficiency due to less generation of

Heats as backpressure on engine get eliminated, etc.

The applications are as follows:

- Its use in excavators
- Sports racing car
- Flying jets
- Fighter jets
- Diggers
- Sports bikes
- Hydraulic lifting cranes

Cost Estimation

Sr.No	Description	Qty	Unit Price	Amount
1	OFF Delay Timer Unit	1	7600	8600
2	Relay 4 Terminal	2	1750	4500
3	Relay 5 Terminal	1	1690	2690
4	Emergency Stop Switch	1	600	600
5	Wires	4 (Bundle)	430	1720
6	Insulation	1(Bundle)	320	320
7	Tools Kit Purchased	1	800	800
8	Other Miscellaneous Items	NA	500	500
		Total Amount		19730

Future scope

- There is a great scope of this project as it is not so costly and the materials required for the project are available in the market.
- The prototype system is only a single module for testing and analysis of project. If the project shows positive response then it can be converted into a large system and we can implement in all excavators and various applications.

As by implementing this fabulous timer unit in all vehicles and bigger machineries where turbocharger takes place results in low maintenance cost of the same. This helps in future very well and the cost estimation of any machine get rigidly low down.

Conclusion

- Due to OFF Delay Timer Unit engine will stop after 2 min when key switch is turn to OFF position. This will help to improve the life of turbocharger also avoid the premature failure of turbocharger and engine.
- Consequently engine life increases.
- We can adjust delay time by using 'timing selector switch' on timer. This project is very much useful and helpful for engines having very high HP like earthmoving machinery, generators etc. as most of turbocharger failure is due to lack of lubrication cause by sudden stopping of engine by careless behavior of operators.

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