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Research Paper

ANALYSIS OF NANO SIZE IC ENGINE

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Nanotechnology is much discussed these days as a emerging frontier - a realm in which machines operate at scales of billionth a metre. It is actually a multitude of rapidly emerging technologies based upon the scaling down of existing technologies to the next level of precision and miniaturization. Researchers are enthusiastic about its potential applications in the field of nanotechnology such as energy, medicine, electronics, computing and materials. Of late, one of the emerging aspects dealing nanotechnology in mechanical field is the internal combustion engine on a nano scale, which we have chosen as our area of interest. Heat engines have evolved from external combustion engines to internal combustion engines and the hot off the block is the nano internal combustion engine. This picture gives an idea of the size of the nano internal combustion engine. If you observe, the length from the back plate to washer is less than an inch. There are no exotic materials required It has high precision, cost effective, high speed [up to 40000rpm].The various applications can be spotted from race cars to space crafts. It can also be applied to various fields like agricultural pump sets, industrial applications, Hospitals, constructions civil engineering equipments etc., This paper further deals with the history, construction of a nano IC engine, their merits and their future prospects. This paper discuss about Nano IC engine at length.

Keywords: Nanotechnology, IC engine, Nano spanner, Backplate Potential applications

INTRODUCTION

Nanotechnology has become very popular and is used to describe many types of research where the characteristic dimension are less than about thousand nano meter If we are to continue these trends we will have to develop a new manufacturing technology which will let us inexpensively build nano system with mole quantities that are molecular in both size and precision and are inter connected in complex patterns .

Heat engines work on the principle of converting chemical energy into mechanical work and evolve from external combustion engine to internal combustion engine. External combustion engine is the heat engine in which fuel combustion takes place external to cylinder. Due to this it is bulky and consumes

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Figure 1: Nano Size IC Engine

lot of place. Second revolution of heat engines are ICE in which fuel combustion takes internally and consumes less place and became compact, cost effective. Of late third revolution is NANO Internal Combustion Engine. It is difficult to thread- in a needle. Imagine working with an instrument with one billionth of metre.

CONSTRUCTION OF "NANO" - A 0.1CC COMPRESSION IGNITION ENGINE

The ***Nano*** is a 0.1cc (that's less than 0.01 cuin) compression ignition engine - most frequently, if somewhat inaccurately, referred to as a "diesel". It was designed by Richard Gordon and the plans were included as a supplement with the British Magazine *Model Engineer* in the early 1990's

An idea of the size of the *Nano* is given by this picture. From backplate to drive washer is less than 1 inch. There are no exotic materials required. The crankcase is hacked from a solid cube of aluminium 3/4" on a side. The piston and contra piston are cast iron. The crankshaft and liner are any old steel from the scrap box.

Figure 4: Different Parts of Nano Size IC Enigne

Here is an exploded view of the engine. The odd looking thing in the foreground is a special Nano-Spanner required to tighten the backplate. It also fits the fuel nipple. The construction is extremely conventional - only the scale is unusual.

Figure 5: Nano Spanner

Like all model IC projects, there are a few special jigs and tools required to construct the Nano. All are fully detailed in the plan, which includes step by step instructions with photos.

The cutter is made from water hardening drill rod (called “silver steel” in the UK because of its appearance - it contains no silver).the teeth are formed of Dremal-type cut-off wheel.

The cutter is used to form the exhaust ports in the cylinder. There are three of these, spaced at 120 degrees with sufficient space between them for the angled transfer ports to slightly overlap the timing. The crown of the piston is conical to assist transfer. The contra piston has a matching concave conical depression.

As mentioned previously, the crankcase is formed from a cube of aluminum. The venturi is machined separately and secured with Lok-Tite before the final reaming of the crankshaft journal. Notice the three transfer passages in the photo. These terminate in a transfer belt below the cylinder seat that matches with the cylinder transfer ports. If you look very closely, you’ll also see the stuff-up that turned away part of the venturi opening. Always happens on the last operation!

Figure 7: Cutter

There’s nothing special in the crankshaft components. Another jig (not shown) is made to hold the shaft in the 3-jaw chuck, offset by half the throw for forming the crank pin. Even at these sizes, final lapping to size is no different from larger engines in terms of the amount of metal that must be LEFT for removal. Only the microscopic size makes things difficult. The prop driver knurls were formed with a thread form tool, set on edge and used as a shaper. The prop nut is anodized in the usual way.

Figure 8: Needle Valve and Spring

Again, apart from their size, there’s nothing special about the needle valve components the needle itself was made from steel and “blued” it by a quick heat in a gas flame followed by water quenching. No big deal, but the amazing thing is the attention it draws with people who examine the engine. ***This costs just US$10 only.***

When it was fired, it run briefly, oscillating back and forth about TDC like over compressed diesels with small mass fly wheels are wont to do. running! .but spring starters are the only way to start ultra small diesels - hand propping just won't work. Also, the fuel for mini diesels needs a lot of ether - as high as 50% by volume. With high ether fuel and a spring starter, the little Nano will burst into life. Richard Gordon claims it will turn 40,000 rpm - yes, that's no typo, *forty thousand revolutions per minute*. American engine builder Ron Colona used to demo his at model engineering shows and turning at better than 20,000 rpm.

THE COMPONENTS USED

- Crank Case
- Back Plate
- Cylinder And Head
- Venturi And Needle Valve Assembly
- Conrods And Crank Shafts
- Piston And Contra Piston
- Final Assembly And Test Report

Figure 9: Nano Size IC Engine With all Components Attached

Crankcase and Cylinder Rough-out

The crankcase starts off as a chunk of aluminum bar of about 1-1/2" diameter, sawn to length, plus a little bit. The first step is to finish turn the front section with a 1/4" radius where the journal blends into the body. The photo shows the roughing out process. Note that the tool is raked back sharply while "hoggin' great cuts" are made so that if it digs in, the cut will be forced shallower, not deeper as it would be if the tool were set raked forward like a regular knife tool.

Next we need to remove all the excess aluminum that does not look like a crankcase. This can easily be done with a band saw, or less easily done with a hacksaw! In either case, marking out is simplified by preparing a full size profile on paper, centred in a circle the same size as the bar stock. Mine was done from the CAD drawings, but pencil and compass could achieve the same result with about the same effort.

The paper template has a hole cut roughly in the middle to accomodate the journal and the blended radius where it meets the front face. It is attached to the face with a standard glue stick. If you're carefull, this will last long enough to complete the butchery. Saw to within about 1/32" (1mm) of the outline. Take care because heat buildup will melt the glue. The next photo shows the four basic stages in crankcase manufacture:

- Bar stock blank
- Journal turned and sawing template glued in place
- Crankcase rough sawn to within 1mm of the template outline
- The finished crankcase

BACKPLATE

The backplate is simple turning with only some aspects of work holding posing any problems. In this first shot, the backplate profile has been turned on a piece of bar stock with the interior face oriented towards the tailstock. This means we will be screwcutting towards the sholder formed by the backplate rim, so a thin (0.020") runout groove is first cut at the thread/rim junction to the depth of the thread form. This also assures the backplate will form a tight seal against the rear of the crank case.

The thread cutting tool is a piece of 1/4" diameter HSS steel, ground to a 60 degree point with seven degrees of side rake, mounted in a tracting tool holder. This magnificant gadget takes a while to make but is absolutely invaluable to thread cutting. The little ball lever actuates a spring loaded, over center cam - just requiring a flick to retract the tool bit by about 3/16". This allows the saddle to be repositioned for the next cutting pass without having to twiddle dials and remember settings.

The cylinder blank has now been replaced in the 3 jaw chuck with the top of flange against the jaws and some thin aluminum shim (beer can material) arount the outside to protect the finish and thread. The bore will be drilled so as to leave 8 to 10 thou to be removed by the reamer. It is pilot drilled first. I'm told it's good practice to select a pilot size no grater than half the next drilling size to prevent the next size wandering. Here we see the reamer being floated into the bore using the tailstock (larger hand reamers will have a dimple in the end which assists this operation. For this operation, the headstock is turned by hand. Keep up plenty of suds and never rotate the chuck backwards. The reamer is prevented from rotating by resting the tap handle on the compound slide. A piece of shim material protects the slide from damage by the handle

The transfer ports of the weaver are unusual. They comprise 5 vertical channels, spaced equidistantly arount the forward 180 degrees of the cylinder. They terminate in a "transfer belt" below the exhaust ports. This arrangement avoids the induction port at the cylinder rear. These ports cannot be cut before reaming (or boring) as their presence would make it impossible to cut the bore accurately. This flash-failure shot shows how they are drilled. A short aluminum (or brass) plug is turned to be an interference fit up the bore. The holes are then drilled at the intersection of the cylinder and plug. The cylinder wall will be quite thin adjacent the transfer passages, but by using a slightly softer material for the plug, the drill will incline towards the softer material, preventing any danger or a ruined part.

VENTURI AND NEEDLE VALVE ASSEMBLY

In the previous section, the cylinder had progressed to a nearly finished state, still requiring internal lapping. Lapping should always be the last operation on a cylinder of this type. This means the boss for attaching the side port venturi must be fitted before lapping can be done. In this session, the boss is made and the associated parts for the venturi and needle valve.

The boss will be soft soldered to the cylinder (diesels don't get hot enough to melt soft solder). ".solder does not make the joint, it only keeps the air out" and schooled me to make a good fit of parts to be soldered. The boss will butt to the cylinder, which has an outside diameter of 0.500". So, a good fit can be achieved by profiling the boss with a 1/2" end mill. In this photo, we see the boss blank (enough for four) which has been finished outside, drilled ready for tapping and transferred still in the 3 jaw chuck to the mill for end profiling.

APPLICATIONS

Nanoic engine has various applications ranging from race cars to space crafts.

- In race cars this IC Nano Engine was used. The engine was fully fabricated, that is, no castings were employed.

Figure 13: Nano IC Engine

CONCLUSION

With the application of Nano in every sphere of life the ‘big’ may not find its place in engineering dictionary in future. If we are to continue these trends we will have to develop a new manufacturing technology, which will let us inexpensively build nano system with mole quantities that are molecular in both size and precision and are, inter connected in complex patterns. Nano technology with all its challenges and opportunities is an avoidable part of our future. It can be rightly said that nano technology slowly and steadily assuring in the next Industrial Revolution.

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I would also like to dedicate this research work to my father Late R.S Mishra and mother KL Mishra**.**

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