EXPRESSION OF INTEREST

MASLEN ENGINE™

INDUSTRY DEVELOPMENT CENTRE - HUNTER (IDC)

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Executive Summary

Recognised as an Innovation Centre of Excellence the Industry Development Centre - Hunter Limited (IDC) delivers the NSW Department of State & Regional Development's Innovation Advisory Service, assisting over 1500 inventors and innovative small businesses annually to evaluate, develop and commercialise new products.

The aim of the innovation advisory service is to assist small to medium enterprises to identify, qualify, develop and protect commercially significant inventions in order to facilitate technology transfer through licensing or sale of the intellectual property rights.

The IDC Technology Transfer program is a selective program designed to aid the commercialisation of innovations like the Maslen Engine™ – a novel method of converting reciprocating motion into rotation, providing better balance, minimising frictional losses and delivering twice the power strokes per revolution compared with equivalent conventional engines.

Developed by Formula 1 Power Boat champion and mechanic Des Maslen, the Maslen Engine™ also represents a break-through in emission control technology, capable of being powered by both conventional fossil fuels and/or hydrogen fuel sources.

IDC is flexible in its approach and will consider a range of different proposals including outright sale or licensing of the intellectual property in Australia and international territories.

Further Information on the Maslen Engine™ can be obtained by contacting:

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The Innovation - Maslen Engine™

OVERVIEW

Internal combustion engines play a pivotal role in the world economy particularly in the automotive industry – a major barometer of the world economy. Global production of internal combustion engines in 2000 represented over 90 million units.

Government regulation and consumer awareness are driving innovation in the automotive industry, particularly in the areas of fuel efficiency and low or zero emission policy.

The Maslen Engine™ provides an opportunity for engine manufacturers to position themselves at the leading edge of engine technology offering the unique ability to operate on available fossil fuels, as well as, hydrogen fuel.

PRODUCT DESCRIPTION

The Maslen Engine™ is a novel method for converting reciprocating motion into rotation. Applied to multi-cylinder internal combustion engines, particularly two and four cylinder configurations, it provides improved balance characteristics over conventional crankshaft arrangements.

The key component of the Maslen Engine™ is a cam that converts the reciprocating motion of the piston into shaft rotation, resulting in twice the number of piston strokes per output shaft revolution when compared to a conventional crank configuration.

FEATURES

The Maslen Engine™ is suitable for, but not limited to, multicylinder internal combustion engines in the automotive, marine and aviation industries.

Independent testing by WBM Pty Ltd of Broadmeadow has confirmed that the Maslen Engine™ offers inherently better balance characteristics than conventional crankshaft arrangements.

Other benefits of the system include:

1. Unique ability to operate under fossil or hydrogen fuel sources;
2. Elimination of the 2:1 speed reduction gearing used to drive the camshaft in conventional four stroke engines;
3. Minimisation of frictional losses due to the piston side forces inherent in conventional crankshaft engines;
4. Twice the number of power strokes per revolution compared with a conventional engine with the same number of cylinders;
5. Low tooling costs; and
6. Low vehicle installation costs.

PERFORMANCE

Independent testing[1] of the Maslen Engine™ provides a slight improvement in mechanical efficiency, however the overall engine efficiency and power to weight ratio is considered similar to existing conventional crankshaft engines (on the basis of maximum power).

A two cylinder Maslen Engine™ should produce similar output torque to a conventional four cylinder engine with the same individual cylinder capacity (i.e. twice the overall volumetric capacity). Insofar as maximum torque is probably a more critical factor in automotive applications than maximum power, two cylinder Maslen Engines™ may be a feasible substitute for conventional four cylinder engines. As such they would offer significant weight saving and smaller envelope dimensions. Overall vehicle power to weight ratio therefore could go some way towards compensating for the lower peak power output of the smaller capacity Maslen Engine™ .

[1] Independent testing by WBM Pty Ltd of Broadmeadow

Alternatively, substituting a four (4) cylinder Maslen Engine™ for a conventional four (4) cylinder engine would result in similar peak power availability, but the Maslen Engine™ would be delivering this power at half the speed and twice the torque of the conventional engine.

Theoretically the engine offers ideal balance without the use of balance shafts as required in some conventional engines. This characteristic reduces noise and vibration, as well as loads at high engine speed.

Sinusoidal cam lift characteristics offer benefits similar to those offered by the scotch-yoke engine already being produced in Australia.

In addition, a combination of the above may accumulate a small (estimated 5%) improvement in mechanical efficiency but the net impact on overall engine efficiency may be less dramatic.

INTELLECTUAL PROPERTY RIGHTS

International patent applications have been filed under the Patent Cooperation Treaty by patent and trademark attorney firm, Shelston IP.

Details of the patent application are:

Patent Title:	Radial Engine
Patent Application:	2002249002
PCT Number:	PCT/AU02/00513
WIPO Number:	WO2002/088524
Inventor:	Mr Desmond Jay Maslen
Priority Date/ Country:	24 April 2002, Australia
Status:	Patent Pending

MARKET OVERVIEW

The Motor Vehicle Manufacturing industry in Australia, including both vehicle and engine manufacturing, is in a mature phase of its life cycle, generally growing at a similar rate as the economy. Industry turnover in 2003 was in excess of $14,284 million dollars, valuing it as one of Australia's top fifty industries.

Uptake of new technology is high inline with high globalisation, import and export activity.

The production of Internal Combustion Engines is especially important for the world economy due to their central role in the automotive industry – one of the major economic drivers and barometers of the world economy.

The economic potential of the automotive industry can be appreciated if it is considered that more than 3.7% of the United States total GDP (US$10,171,400, million in 2001) is generated by the production and sale of new light vehicles[2] alone.

In addition to their use in the automotive industry, internal combustion engines are also used in a wide range of other applications: recreational marine equipment, lawn and garden equipment, light industrial equipment, light aircraft, snowmobiles, all-terrain vehicles and others.

While the figures described in this report are a reasonable estimate of the annual global production of internal combustion engines, it is necessary to point out that estimates provided do not include the production of internal combustion engine for applications other than the use in the automotive and motorcycle industries outside the US.

[2] According to Alliance of Automobile Manufacturers (www.autoalliance.org)

The most current estimate of internal combustion engine production available relates to US production where petrol engines dominate, accounting for 84% of all internal combustion engines produced. This fact is relevant considering that non-automotive engines were not counted.

According to the “Internal Combustion Engines: 2001” report, the total number of internal combustion engines produced fell 14% from 2000 to 2001, with diesel engines – both non-automotive and automotive – representing a decrease of 25%, while petrol non-automotive engine production decreased by 13%. It is however worth noting that production of LPG and natural gas engines increased during this period.

As the bulk of the internal combustion engines produced are, however, used in the automotive sector, the numbers above represent just a part of the total production of engines. To account for the internal combustion engines used in the automotive industry in the US, a close approximation may be made by considering the numbers of cars and other vehicles produced. Auto Industry Statistics for the NAFTA region – comprising USA, Canada and Mexico – produced 8,377 million cars and 9,432 million commercial vehicles in the year 2000.

According to Ward’s AutoInfoBank the Light Truck sector of the vehicle industry in the US has the greater share of the industry production and increased 12% compared with the same period a year ago. This trend may be explained by the increasing preference of American consumers for pickup trucks and 4x4 utility vehicles that although classified as commercial vehicles, are used as passenger cars. Demand has also been stimulated by tight environmental regulations on fuel consumption and emissions over passenger cars.

Statistics also reveal that the US vehicle industry accounts for 74% of the total production of vehicles in the NAFTA region. Using this percentage over the NAFTA car production of 8,377 million of cars for the year 2000, the US production was 6,198,980 of cars for the same

year. From this number and the total number of internal combustion engines (24,620,800) from the table above, the total production of internal combustion engine for the US market in 2000 was approximately 30,819,780 for the United States market.

The production of vehicles worldwide also provides a good estimate of the volume of production of internal combustion engines. Of particular note is the fact that Western Europe is the world's leader in passenger car production[3], followed by NAFTA and Japan[4]. According to Auto Industry (www.autoindustry.co.uk), the decreasing Japanese share of the world's car production is due to the Japanese companies' decision to establish production plants closer to their target market, as well as the weak performance of the Japanese economy throughout the last decade[5].

Another notable characteristic is the increased participation of Asian and other markets (mainly Latin America) in the production of vehicles worldwide. This evolution may be more easily seen if the production numbers since 1990 are considered. However, it is worth noting the impact of the Asian economic crises of 1997-98 over the production of passenger cars for all regions, and over the production of all vehicles in the emerging markets.

Regarding the production of commercial vehicles, NAFTA, and in particular the United States, is the world leader in production, followed by Japan and Western Europe. The dominance of the United States in the production of commercial vehicles is due, partially, to the already mentioned consumer preference for pickup trucks and utility vehicles that receive commercial vehicle classification, but are used as passenger cars.

[3] European Union Motor Industry Economic Report

[4] Statistics and information from Japan Automobile Manufacturers Association (JAMA)

[5] Trend still present in Japanese economy

To estimate the number of internal combustion engines produced worldwide, it is necessary to consider the number of motorcycles produced in addition to the number of cars and trucks. Preliminary research estimates the approximate total number of internal combustion engines produced for the motor vehicle and motorbike industry in 2000 as being over 62,425,563 units. A broader estimate of the total number of internal combustion engines produced in the world may be made adding the total number of motorcycles and motor vehicles and the US total engine production without the US car production and the US internal combustion engines imports (minus the US import of automotive diesel engines).

This sum represents over 90 million internal combustion engines produced worldwide in 2000.

Summary of Estimates for Internal Combustion Engines in 2000	
US internal combustion engine production	30,819,780
Total of motor vehicles and motorcycles produced world wide	62,425,563
Total of world vehicles and US productions	90,831,203

Again, these estimates are conservative and do not take into consideration the number of engines produced by non-automotive uses outside the United States market, with snowmobiles being one example. According to the International Snowmobile Manufacturers Association (ISMA), it is estimated that there were 203,153 snowmobile units sold worldwide in 2002. The US market is the biggest market for this product, accounting for 134,082 of the total of units sold worldwide in 2002, with a total sales value of US$817,331,445. According to ISMA, there are four major manufacturers of snowmobiles: Artic Cat, Bombardier Inc, Polaris Industries and Yamaha Motor Corporation.

INDUSTRY TRENDS

The Automotive Industry is a major player on the internal combustion engines industry, accounting for an important share of its demand and production. It is also the driving force on technology advancements and innovation. In this instance, the most important technological trends for internal combustion engines derive from automotive use.

The automotive industry has been, in the past years, investing in research and development of more advanced vehicle and fuel technologies in order to comply with government emissions regulations and attend the demand for more efficient, environmentally-friendly fuels.

This trend will play an important role in the performance of the automotive industry in coming years, with the adoption of tougher emissions regulations by different countries[6], greater awareness of consumers to environment issues and competition between manufacturer companies for better technologies and market opportunities.

One example of tougher emission policy is the California Air Resources Board that has implemented a “zero-emission vehicle program” that requires the motor companies to provide a certain number of “zero-emission” vehicles per year.

The main trends in terms of technologies and fuels used by the automotive industry are the following:

- Diesel Engines
- Hybrid Cars
- Fuel Cell Technology
- Hydrogen Fuelled Vehicles

[6] Especially in Europe, Japan, the US and Canada

Diesel engines account for more than 40% of all cars sold in Europe and the European market presents a growing demand for the cleaner, more efficient diesel engines. This encouraged automotive companies like PSA Peugeot Citroen, Ford and Honda to invest in the development and manufacture of this kind of engine for that specific market. PSA Peugeot Citroen invested US$ 1.08 billion to make new 1.6 litre and two litre diesel engines, expecting to produce 1.6 million engines a year by 2005. The Japanese company Honda, to compete in the European market, developed and is about the launch its 2.2 litre i-CTDi diesel engine that fully complies with Euro 4 emission standards. Also in the launch stage is the 6.0L Power Stroke Diesel developed by Ford to be used in full-size pickups and the SUV Excursion.

Hybrid cars combine improved petrol performance and low emissions, and may represent the next step in the evolution of the internal combustion engine. Automotive companies have been increasingly interested in this technology with Honda and Toyota already offering hybrid cars, with Toyota's hybrid Pirus selling over 150,000 since its launch in 2000. Following the trend, Ford Motor intends to launch a hybrid SUV by 2005, Chrysler announced the launch of a hybrid pick-up by 2005 and GM announced that it would offer hybrid-powered cars by 2005.

With the manufacture of hybrid vehicles, automotive industry analysts expect that hybrid car sales will represent 500,000 units by 2006. An additional incentive for the car manufacturers regarding hybrid technology is the fiscal incentives offered by governments for vehicles that use alternative fuel or electrical power.

Fuel cell technology is, according to some industry analysts, the vehicle technology with best long-term potential for high efficiency and low emissions. It works by generating electricity from chemical reactions between hydrogen and air. However, fuel cell technology needs further development regarding cost of production, availability of fuel and consumer satisfaction if it is to face the competition of hybrid cars and

the continuous improvements of internal combustion engines.

It is worth noting that the US government proposed US$1.2 billion to finance research and development of fuel cell technology. Furthermore in the US, California and Washington DC established programs to test the viability of fuel cell vehicles and hydrogen as an alternative fuel. In this instance, GM Motors will provide six hydrogen-powered vehicles to Washington, Honda will deliver five fuel cell vehicles to California and Ford is developing its Focus Fuel Cell Vehicle.

While the fuel cell technology has great potential there are many challenges to be overcome before it can be considered a legitimate alternative fuel source. For this reason many companies are investing in the more immediate, cheaper solution of internal combustion engines that burn hydrogen instead of petrol. The hydrogen option has numerous advantages, among them that it is 20 to 25% more efficient than petrol and generates almost no CO2 emissions inline with tougher emission regulations. However, hydrogen technology still faces some obstacles as fuel storage, fuel handling and fuel and storage costs.

While these problems are currently being addressed, it is possible that this technology will be available in large-scale production in the near future, with motor companies already developing and testing hydrogen fueled internal combustion engine vehicles. BMW, GM and Ford Motor are currently leading development in this area. GM has gained approval from the Japanese government to operate hydrogen-fueled vehicles in the roads of that country and is investigating more efficient ways of storing that fuel. Ford has been testing hydrogen internal combustion engines and recently the “Model U concept vehicle” that has a hydrogen internal combustion engine and a hybrid-electric transmission.

Of particular interest is the BMW experience. The company has been testing hydrogen internal combustion engines for twenty years and its most recent prototype has a dual fuel capability, running on hydrogen or petrol. The Maslen Engine™ may be the final piece of the puzzle in

perfecting the Hydrogen engine system.

While the big motor companies are investing in the development of new technologies, new designs are also being researched and explored by smaller engineering companies and inventors such as Des Maslen.

Combining the performance capabilities of the Maslen Engine™ and the trends toward efficient and cleaner technologies the Maslen Engine™ is uniquely positioned to take advantage of current and future market opportunities.

The internal combustion engine remains the cornerstone of the automotive industry worldwide and with the development of the Maslen Engine™, is expected to remain that way for many years to come.