ULTIMATE TRANSMISSIONS

New Business Proposition

Mechanical, Kinetic Energy Recovery Systems (KERS)

Recovering waste energy, reducing CO2 emissions and improving vehicle mileage & performance

Using Patented Mechanical and Control Solution I-KERS

ULTIMATE TRANSMISSIONS

Agenda

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- **KERS and the Automotive Market**
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  - Recycling energy
  - Its value to the Automotive Industry
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Kinetic Energy Recovery – Why?

- **When a vehicle is moved by a power source the energy from that source is used to**
  1) accelerate the vehicle, or move it up hills.
  2) to overcome wind and rolling resistance.
- **The energy consumed in overcoming wind and rolling resistance is lost, while the rest can be recovered.**
  - In a city or suburban environment where a vehicle moves at relatively low speed and is continually changing speed or elevation, as much as 70% is recoverable.
  - On a highway, where the speed is higher and the vehicle runs at a more constant speed less than 20% is typically recoverable.
- **Any recovered energy can be directly used to**
  1) Reduce fuel consumption and CO2 emission.
  2) Improve the performance of the vehicle.
- **Machines that can recover and reuse this energy are called Kinetic Energy Recovery Systems (KERS).**
  - The efficiency with which they can capture store and release this energy, directly affects how much they can improve fuel efficiency and lower CO2 emissions.

KERS & AUTOMOTIVE MARKET

What is KERS?

- **Kinetic Energy Recovery System (KERS) has been developed in F1 motor racing to supply additional power through recovering energy from braking.**
- **Different applications of KERS enable**
  - Power improvements.
  - Efficiency improvements.
  - Engine downsizing.
  - CO_2 savings.
- **Almost all automotive manufacturers will need KERS in the future**
  - To comply with CO_2 emissions standards.
  - To improve fuel efficiencies.
  - To meet targets on both of the above.
- **Customers will require**
  - Improved fuel efficiency.
  - Low CO_2 output (taxation).
  - No loss of performance.
- **KERS is the system that will deliver these benefits.**
- **KERS is therefore a future MUST HAVE.**
- **Ultimate Transmissions have developed an improved KERS system called I-KERS that can potentially double the amount of energy that can be recovered and reused.**

KERS & AUTOMOTIVE MARKET

Opportunity

- **Value of workable KERS to the Global market is over double its cost.**
- **High profits are available to companies satisfying this market need.**
- **Ultimate Transmissions mechanical I-KERS solution**
  - Can be delivered without a high level of technical risk.
  - It is covered by solid patentable IP and substantial know how.
  - Can be delivered in a smaller package and at a lower cost.
  - Significant advantages over other solutions to reduce CO2, comply with regulations.
- **The global production forecast is 60m vehicles+ p.a. for the next 20 years**
  - The majority of these vehicles will require some form of KERS.
- **KERS development has only just commenced both technically and commercially.**
- **The technical and market development costs are low when compared to the size of the opportunity.**

KERS HOW IT WORKS

Reducing Fuel Consumption & Tax

- **The cost of fuel is now around $1.50 per litre** (dependent on local taxation)
  - It is very likely that it will continue to rise.
  - Consumers are now very aware of what this means to the whole of life costs of owning a car.
  - At 100kms per 10 litres, the fuel costs of driving a vehicle 200,000kms. will more than equal the vehicles cost.
- **Burning a litre of fuel produces 2,300gms of CO_2**
  - Most countries are planning to impose taxes on either the CO_2 itself or the Carbon therein.
  - Most are imposing this tax on consumers, as they consume or before they consume it.
  - The EU is imposing an additional tax, on manufacturers, as a penalty, for building cars that produce an amount of CO_2 ,that exceeds legislated limits. The tax is imposed on the manufacturer's entire fleet and must be paid for by the consumer.
  - By 2015 the EU tax will be €95/gms of CO_2 over legislated limits
  - The EU is targeting 95gms./km of CO_2 by 2015 equating to 25km/litre.
  - The USA is said to be demanding a vehicle mileage of 95 mpg. This is even more difficult than the EU targets and would equate to 57gms of CO_2/km.
- **Burning 1 kg of Coal produces over 3,500gms of CO_2**
  - Unless electricity is generated using sustainable "renewable energy" or nuclear power, electric vehicles will indirectly generate CO_2.
  - The need for efficiency will always exist as the cost to the consumer for buying energy will continue to increase.

All Vehicle Manufacturers must find cost effective ways of reducing CO_2 emissions and improving mileage

KERS HOW IT WORKS

Energy Without CO_2 & Without Costs

- **Today we only know of three ways of finding energy without producing CO_2**
  - Renewable energy from Wind, Solar, Hydro etc.
  - Nuclear Power.
  - Energy Recycling.
- **However the equipment itself still costs money and consumes energy to produce and de-commission.**
  - KERS is a method of creating energy within an automobile without generating CO_2.
  - Mechanical KERS is one of the cheapest solutions.
  - Mechanical KERS is one of the most efficient solutions.
  - Mechanical KERS is one of the most durable solutions.
  - Mechanical KERS whole of life CO_2.
  - emission is one of the lowest.
- **Energy recycling reduces CO_2 and improves fuel consumption directly and on top of any other method.**

KERS HOW IT WORKS

Recycling Energy

- **KERS captures the kinetic energy in a vehicle when it slows down**
  - Instead of applying the brakes the wheels are designed to connect to a system of shafts and gears, that drive a mechanical transmission or electrical generator.
  - The resistance torque to the wheels provides sufficient braking for all but panic stops.
  - The system is normally only applied to two of the vehicles four wheels.
  - The returning energy is stored either mechanically in a flywheel or chemically in a battery.
  - When the vehicle is required to accelerate some or all of this energy is released from the batteries or flywheel.
  - The application of the brake or accelerator by the driver is interpreted by a control system. as a request for energy to be stored or released at a rate consistent with the pressure on the brake or accelerator peddle.
- **The captured energy is then free to use and has not been created by burning fuel and releasing CO_2**
  - It reduces fuel consumption and CO_2 emission by 20% - 60% dependant on vehicle type, driving conditions, and efficiency of the KERS.
  - The extra power can also be used to improve the vehicle performance.
  - The extra power can be used to supplement the lower power of a down sized engine.
  - The power is instantaneously available to lessen the negative effects of turbo or supercharger lag.

Perpetual Motion is impossible but this is the next best thing

KERS HOW IT WORKS

Its Value To The Automotive Industry

- **The commercial value of a KERS to a European vehicle manufacturer in 2012.**
  - will be equal to the tax they would pay on around 30gms of CO_2.
  - Currently this tax is set at €95.00/gram.
  - Should a manufacturer's "fleet" be unable to comply with EU standards, by 30gms they will face a tax bill of €2,850.00 per vehicle.
  - KERS would help eliminate such a tax burden.
- **The value of a KERS to a consumer will equal the savings they will enjoy over the time they own the vehicle.**
  - Based on a 5 year fuel bill $150.00/month.
  - A 25% saving will amount to around $2,250.00.
- **In many circumstances an OE will agree that a properly functioning reliable KERS will add bottom line value to his company's profit of over $5,000 per unit**.

An opportunity exists to enjoy super profits while the cost of the KERS remains at less than half its commercial value

CURRENT TECHNOLOGIES

Collect Store & Release

- Current Technologies collect energy from front or back wheels of a slowing automobile using the collection system as a brake.
  - Either the energy is converted to electricity by a motor generator.
  - Or it remains as mechanical shaft power.
- The energy is stored in one of two ways.
  - As electrical energy from the generator is passed to a battery where it is stored chemically.
  - Alternatively it passes to a another motor generator and is converted back to mechanical energy by spinning a flywheel.
  - When the energy remained as mechanical, it passes directly via a transmission without any change of state to spin a flywheel.
- When ready for release.
  - The chemical energy is converted to electrical and then to mechanical by the motor generators on the wheels.
  - When stored as mechanical energy in the flywheel, it is converted to electrical, using the flywheel to spin the motor generator and then back to mechanical by the motor generators on the wheels.
  - When connected mechanically it flows directly out of the flywheel through the transmission to the wheels at a controlled rate.

Three Common Systems

- **Current technologies are dominated by three main systems**
  1) Full electric using electric motor generators for collection and delivery and chemical batteries for storage. These are more commonly called Mild Hybrids.
  2) Part Mechanical in which collection and delivery is carried out by motor generators with the energy stored mechanically in a flywheel.
  3) Full Mechanical with the energy collected and delivered mechanically and stored in a flywheel. These are being referred to as Mechanical Hybrids.

CURRENT TECHNOLOGIES

Efficiencies

- **Two types of efficiency must be combined in order to rate the overall value of a KERS**
  1) The Mechanical Efficiency of the system measures the energy collected to the energy that is returned to the wheels.
  2) The Collection Efficiency measures the deceleration energy that is collected versus the amount available for collection.
- **A KERS may be good at one of these and not good at the other**
  - Energy is lost after collection, because of losses in the steps involved in the round trip, from collection to reuse.
  - Energy can also be lost because it was not collected as it was outside the range of the system.
- **The amount of fuel saved by the system is a function of the total amount of energy recovered and successfully transferred to the wheels, for every kilometer travelled.**
  - Current KERS systems exhibit less than 50% overall efficiency when both Mechanical and Collection efficiencies are taken into account.

CURRENT TECHNOLOGIES

Optomizing a KERS Performance

- **An optimized KERS will Collect.**
  - Immediately it is called on to do so.
  - As efficiently as possible.
  - All available braking energy.
  - Up to a rate equal to all non panic stopping events.
- **An optimized KERS will Store.**
  - Sufficient energy to deliver it back to the system to support normal levels of hill climbing or acceleration.
  - For long enough to have it available between normal stop-start driving cycles.
- **An optimized KERS will Release.**
  - Immediately it is called on to do so.
  - All available energy if called on.
  - At a rate consistent with consumer performance expectations.
  - Any time acceleration is called for.
  - It will do this for the life of the vehicle or around 6 million times for a passenger vehicle and more for a commercial vehicle.

It will be Cheap, Reliable and Safe.

CURRENT TECHNOLOGIES

Optomized Output of a KERS

- **A typical KERS, in a medium sized passenger vehicle of 1.8 tonnes loaded weight will be able to**
  - STORE **780kJ** or **0.2kWh** of energy.
  - OUTPUT that energy at a rate of **70kW.**
  - RETAIN **80%** of the energy storage for over **10** minutes.
- **Customer benefits**
  - This is sufficient energy to accelerate the vehicle vehicle to over 100kph.
  - It is sufficient to accelerate the vehicle to 60kph more than four times.
  - It is sufficient power to accelerate the vehicle to 100kph in under 10 seconds .
  - It is sufficient energy to move the vehicle slowly (<10kph) through heavy traffic for over thirty minutes.
  - It is sufficient to drive the vehicle up a 40 meter incline.
  - The storage time is sufficient to capture all typical, city and most highway driving, braking events.
- **Fuel Consumption and CO2**
  - 780kj released to the wheels is equivalent to burning 50cc of fuel.
  - This will reduce overall fuel consumption by 20%-50%.
  - It will reduce the vehicles CO2 emissions by 115 gms. each time the flywheel cycles the full 780kJ of energy.

CURRENT TECHNOLOGIES

Three Different Concepts

- **Full Mechanical is composed of**
  - An 8 kg. flywheel spinning at around 60,000RPM in a vacuum.
  - A special seal to allow the shaft of the flywheel to pass through the vacuum to the outside.
  - Gears to step down the speed of the flywheel and a clutch to disconnect it from the wheels.
  - A Constantly Variable Transmission (CVT) to control energy flow into and out of the flywheel.
  - Additional gears to bring the speed down further and a modulated wet clutch.
  - Shafts to connect it to the wheels.
- **Part Mechanical is composed of**
  - A Combined flywheel and Radial Flux motor/generator enclosed in a vacuum.
  - An Electrical control system.
  - Another pair of radial Flux motor/generators on either the front or back wheels of the vehicle.
- **Full Electric is composed of**
  - A battery system large enough to deliver the required power output.
  - An Electrical Control system.
  - A pair of radial flux motor/generators on either front or back wheels or a motor/generator driving into the main transmission and another driving into the differential.

CURRENT TECHNOLOGIES

Full Electrical Hybrid Details

- **The Toyota Hybrids are essentially KERS based transmissions**
  - Its improved CO_2 emissions are almost all due to the KERS action within the Hybrid system.
- **The following components make up the hardware in a Toyota Camry Hybrid**
  - A NiMH battery pack weighing 50kg.
  - A pair of motor/generators and controls weighing 50kg. One drives directly into the transmission and one directly into the differential.
  - A weight saving within the geared parts of the transmission of around 20kg.
  - Total extra weight between a standard Camry and a Hybrid is 80kg.
  - The actual weight of the KERS itself is around 100kg.
- **The system delivers the following output**
  - An extra 30kW of power when accelerating.
  - The ability to capture braking energy up to a maximum of 30kW.
  - 30 meters of altitude climbing without the ICE.
  - 15 minutes driving at less than 10kms/hr.
  - Total useable energy collection < 800kJ.
- **Warranty**
  - The entire Hybrid system including batteries is guaranteed for 170,000kms or 8 years.

CURRENT TECHNOLOGIES

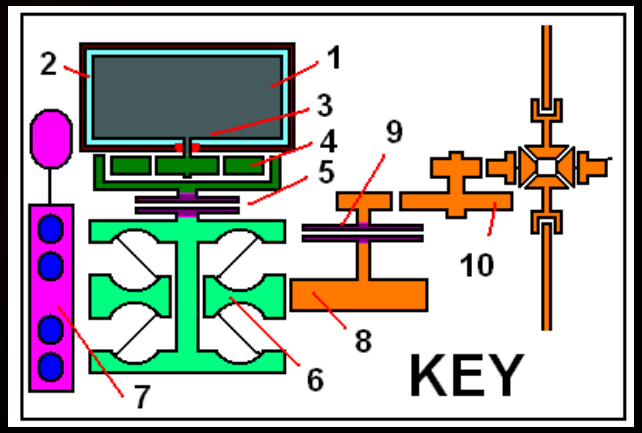
Pros & Cons of Different Concepts

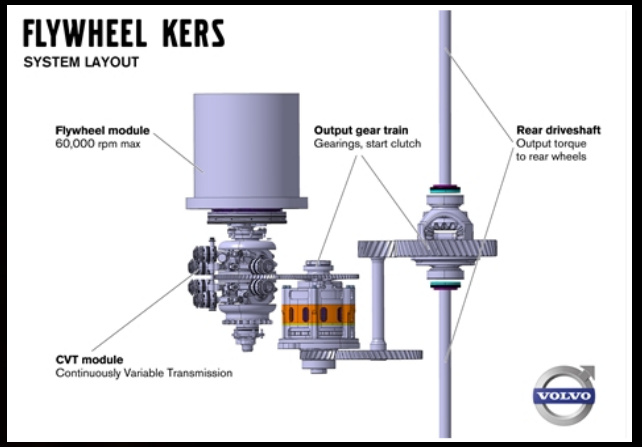
- **The Full Mechanical Concept is characterized by**
  - WEIGHT ≈ 45 kg.
  - COST ≈ $2,500.00
  - MECHANICAL EFFICIENCY ≈ 70%.
  - COLLECTION EFFICIENCY ≈ 60%.
  - DURABILITY capable of tens of millions of full discharge cycles.
  - SAFETY very safe even in an accident.
  - FUEL SAVINGS quoted by Jaguar as being 22.5% with stop start.
- **Part Mechanical Concept is Characterized by**
  - WEIGHT ≈ 75 kg.
  - COST ≈ $4,000.00.
  - MECHANICAL EFFICIENCY ≈ 60%.
  - COLLECTION EFFICIENCY ≈ 95%.
  - DURABILITY capable of millions of full discharge cycles.
  - SAFETY difficult to maintain safety in an accident.
  - FUEL SAVINGS not quoted by Porsche.
- **Full Electric Concept is characterized by**
  - WEIGHT ≈ 100 kg.
  - COST ≈ $6,000.00.
  - MECHANICAL EFFICIENCY ≈ 50%.
  - COLLECTION EFFICIENCY ≈ 90%.
  - DURABILITY not capable of millions of full discharge cycles.
  - SAFETY fire risk.
  - FUEL SAVINGS quoted as 30% by Toyota for Camry.

FULL MECHANICAL KERS

Design Concept

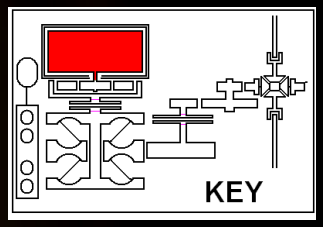
- Full Mechanical KERS being developed by the auto industry are typically based on
  1. A carbon fibre flywheel spinning at around 60,000RPM
  2. The flywheel runs in partial vacuum
  3. A high speed shaft seal to seal the vacuum
  4. An epicyclic gear set to reduce the RPM by around 6:1
  5. A high speed clutch
  6. A Single Roller Full Toroidal Variator (SFTV) – CVT
  7. A hydraulic control system for the CVT
  8. Secondary helical gears
  9. A modulated clutch capable of vehicle launch
  10. Further secondary gears connecting to a differential that connects to the rear wheels.



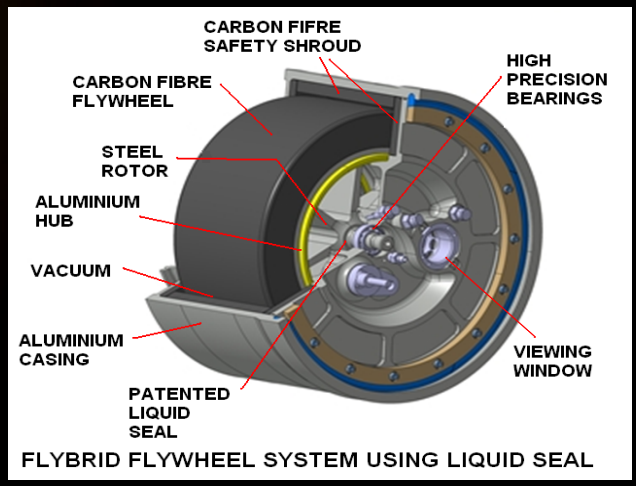


FULL MECHANICAL KERS

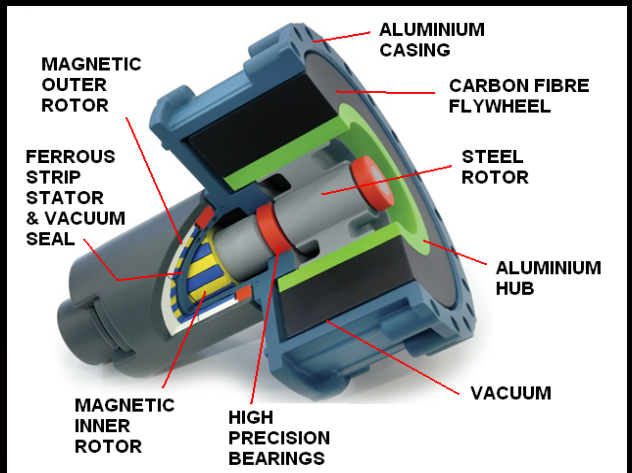
The Flywheel



- All Flywheels are based on Carbon Fibre and Epoxy resin.
- Some use a patented liquid seal to protect the vacuum in which the flywheel spins.
- They require special bearings because there is limited lubricant in the vacuum enclosure.
- Under experimentation: Magnetic gears that also function as a mechanical coupling allowing within a hermetically sealed vacuum enclosure
- They all run at around 60,000RPM are around 200mm. In diameter, weigh 6-10kg. and store around 500kJ - 800kJ of energy.
- The flywheel itself does not make any sound.



FLYBRID FLYWHEEL SYSTEM USING LIQUID SEAL

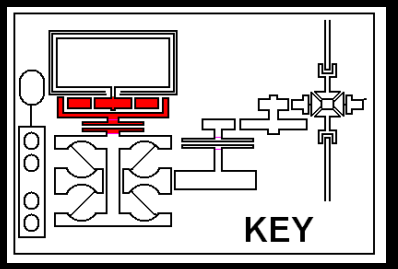


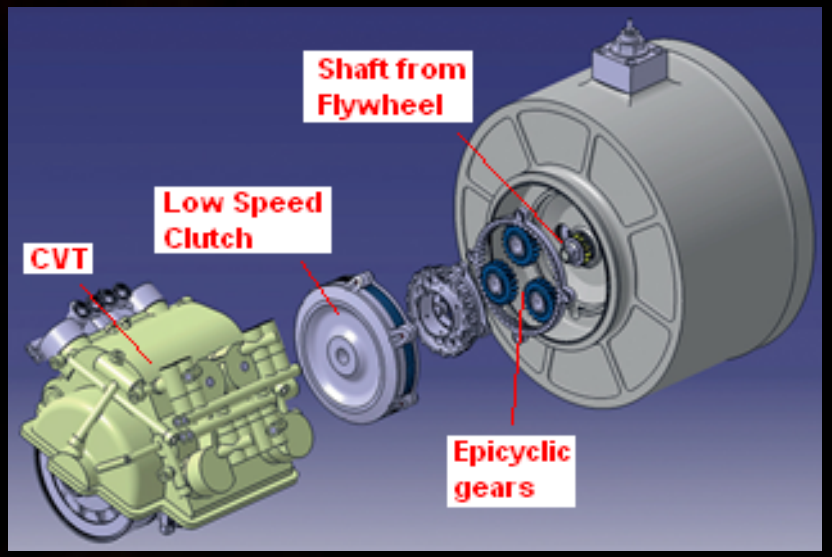
RICARDO FLYWHEEL AND MAGNETIC GEARS

FULL MECHANICAL KERS

Step up Gearing and Clutch

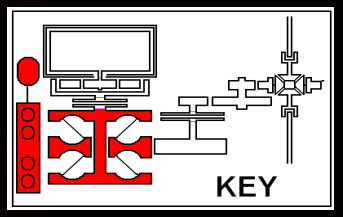
- A step up gear takes the 60,000 RPM to a manageable speed outside the vacuum
- The maximum step up of an epicyclic gear or a magnetic gear is 6:1.
- The gears are placed just outside the vacuum enclosure and spin all the time the flywheel is spinning.
- They emit a continuous high pitched sound.
- The clutch disconnects the CVT from the flywheel when it is not transferring power to reduce free running losses.



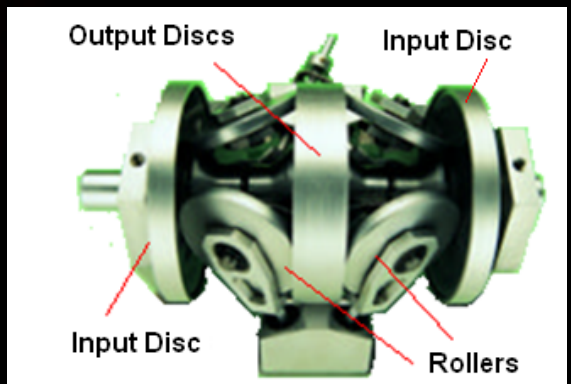


FULL MECHANICAL KERS

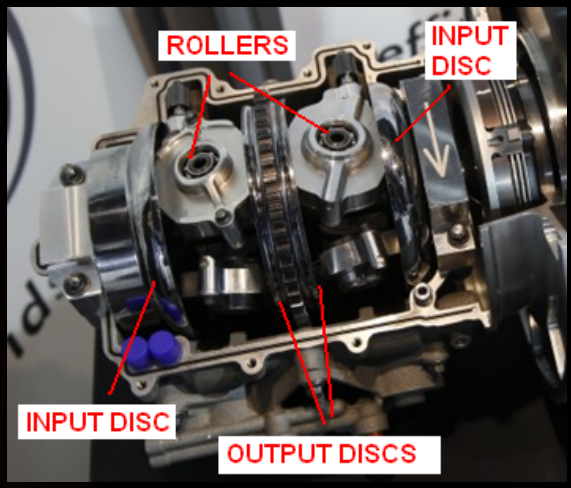
SFTV – CVT & Hydraulics



- Most developers are using a Single Roller Full Toroidal Variator (SFTV).
- The technology is not owned directly by them.
- Rollers are clamped between an input and output disc and by varying their rotational position the gear ratio can be altered in a seamless manner.
- Twin cavities are used with three rollers in each cavity.
- Input power supplies the outer discs and output comes off the side.
- The control mechanism is hydraulic based on torque with a secondary electronic system to convert the torque signals to power.
- The output of the CVT reaches over 20,000RPM.
- Typical ratio spread of the CVT is 6:1

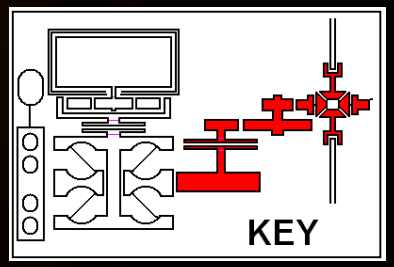


Single Roller Full Toroidal Variator (SFTV) Two cavities Three rollers per cavity

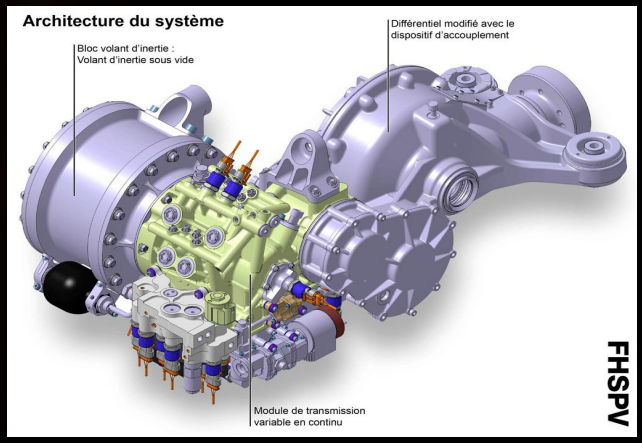


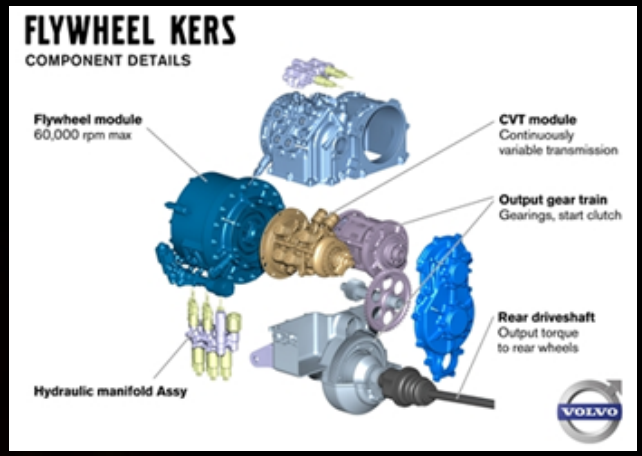
FULL MECHANICAL KERS

Output Gearing and Final Clutch



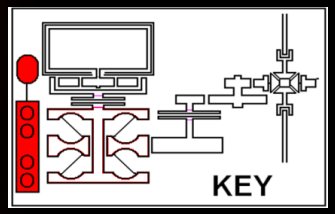
- The 20,000 RPM of the CVT is reduced to an axle speed of around 1,000 RPM using typically a three stage system of heavy helical gears
- A conventional wet clutch placed before the last step down is used for vehicle launch.
- Typical overall ratio spread is 6:1
- This gives an operational match for the KERS speed and the vehicle speed from a maximum of around 120kph to a minimum of 20kph.
- In reality the actual matching speeds are typically much less, as the flywheel is not often at its maximum speed making it difficult to collect braking energy from a vehicle travelling at above 80kph.



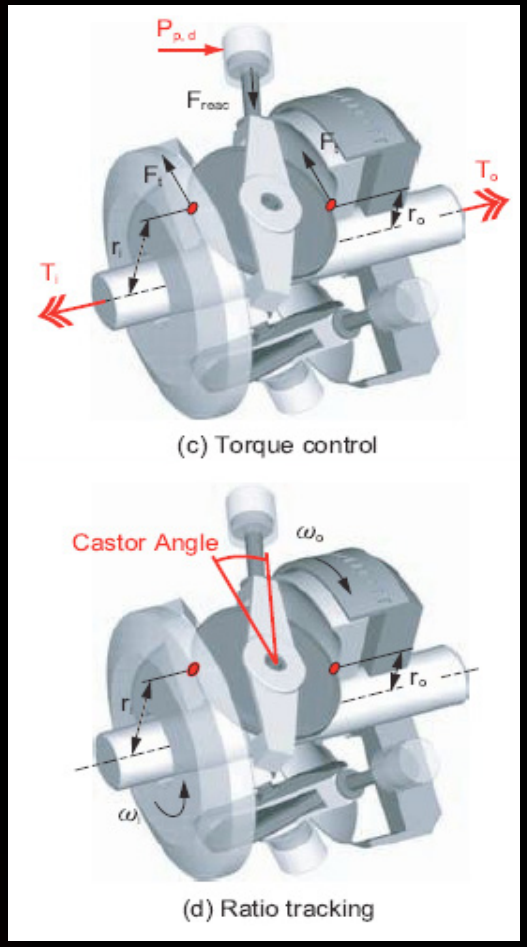


FULL MECHANICAL KERS

Torque Control



- **Changing the ratios in the SFTV – CVT controls the flow of energy or Power in and out of the Flywheel**
  - Most commonly the SFTV uses an hydraulic system to control the torque output of the Variator.
  - Each roller is connected to a piston supplied with high pressure fluid.
  - By varying the pressure of the fluid the roller is moved forward and backward and changes ratio as it does so.
- **This form of ratio control is referred to by the developers of these variators as "Torque Control"**
  - It has the advantage of automatically maintaining a constant torque from or to the flywheel when transferring energy simply by maintaining a constant pressure.
  - However it is an unintelligent response and requires an electronic system to convert this response to a control of power which is what is required by the operator of the vehicle.
  - The elastic nature of the hydraulic system can cause unintended vibrations when moving rapidly from one state to another.
- **Torque control is fundamentally unsuitable for application to an IVT system driven by a flywheel.**
  - The output torque is no longer directly proportional to the fluid pressure.



FULL MECHANICAL KERS

Strength & Weaknesses

STRENGTHS

- The Mechanical efficiency of the system is high.
- Mechanical KERS will be a cheaper than full electric or the semi electric systems
- It will also be lighter and more efficient.

WEAKNESSES

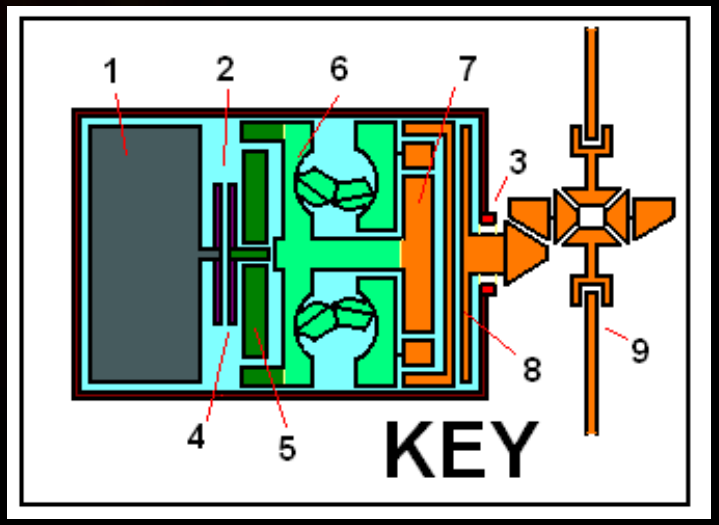
- The Collection efficiency is low because of the narrow ratio spread.
- The lip seals that bear on the shaft are subject to rubbing speeds that are outside the upper limits set by reputable manufacturers. They also must perform at these speeds all of the time the flywheel is running.
- The single stage epicyclic or magnetic gears can not step-up much more than 6:1 leaving the input speed to the CVT very high.
- The step down gears are rotating all the time the flywheel is rotating they will be noisy, and consume energy.
- The CVT and its control system is expensive heavy and inefficient.
- The CVT hydraulic control may exhibit elastically induced vibrations
- The CVT control is not intelligent enough in itself to manage power without another layer of electronics
- The CVT ratio spread is not high enough to capture high or low speed braking energy
- The launching process must use a slipping clutch.
- They are not yet fully developed technically with only prototypes being tested now.

The I-KERS Solution

THE I-KERS SOLUTION

Full Mechanical – Improved Performance

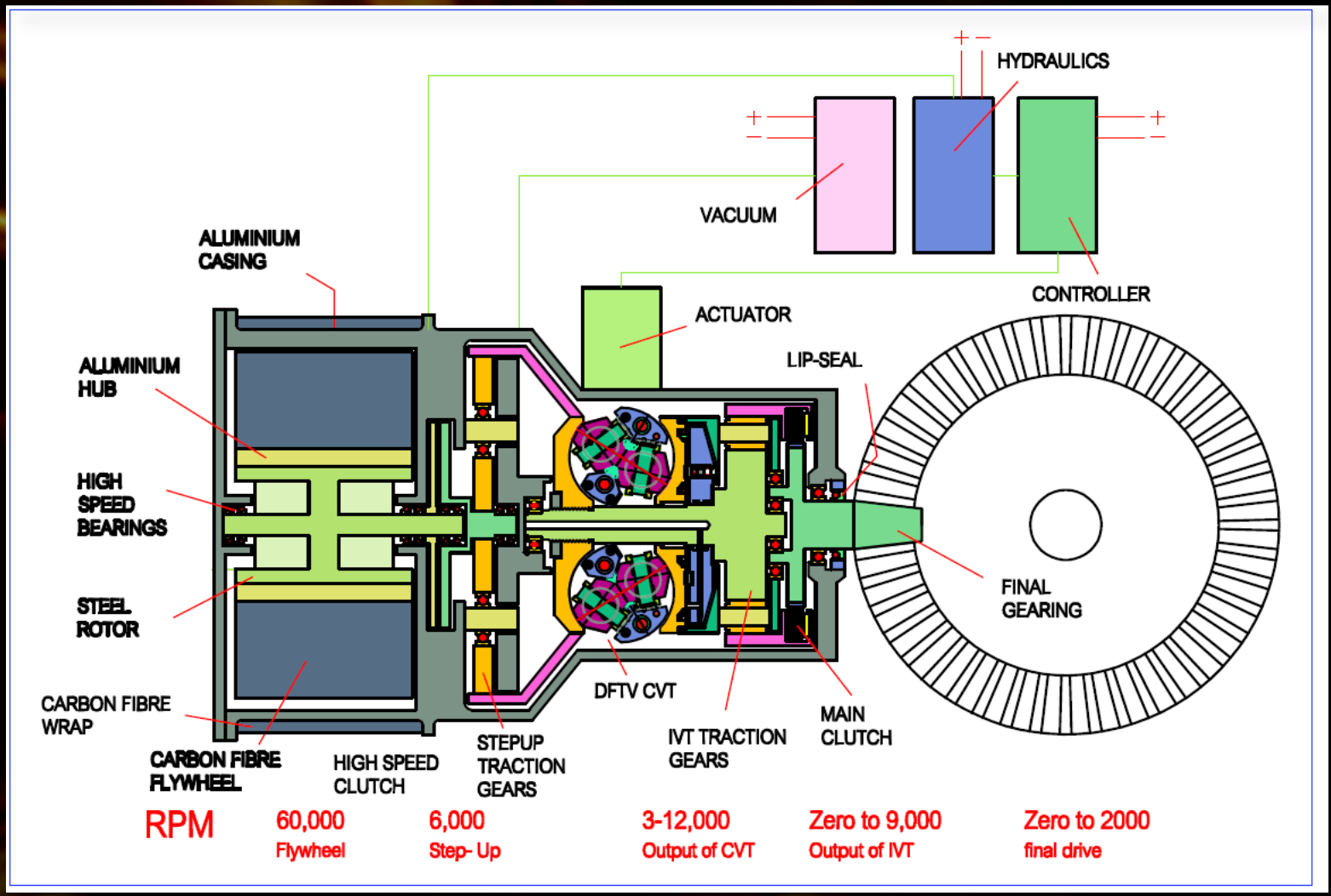
1. 8kg Flywheel rotating at 60,000RPM
2. Entire system enclosed in vacuum
3. Low speed conventional seal
4. Close coupled magnetic clutch placed before step up gears.
5. Noiseless traction step up gears.
6. Improved Double Roller Full Toroidal Variator (DFTV) - CVT
7. Traction IVT final drive
8. Torque control clutch
9. Rear wheel connection on front wheel drive cars



1 < 45kg 2 < $2,000 3 > 80% Mechanical Efficiency 4 > 90% Efficiency

THE I-KERS SOLUTION

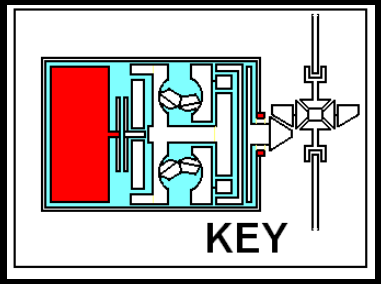
In Detail



THE I-KERS SOLUTION

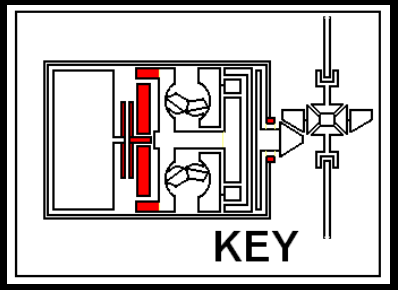
The Flywheel

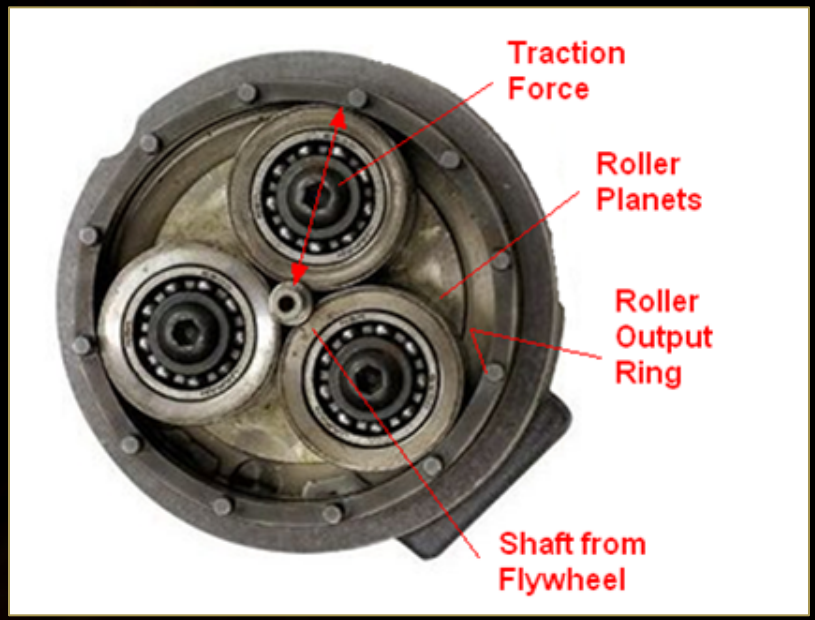
- The flywheel is based on carbon fibre cast into a high temperature resin allowing it to operate in a slightly weaker vacuum .
- The bearings are conventional high precision bearings fed with a small amount of lubricant
- The casing is aluminium wrapped in a layer of carbon fibre reinforced resin as safety shroud.
- It will weigh 10 kg.
- It will run at up to 64,000RPM and store up to 780,000kJ of energy
- The flywheel does not make any sound.
- The entire KERS is encased in a vacuum with a low speed conventional seal on the output shaft



The Step Up Gearing & Clutch

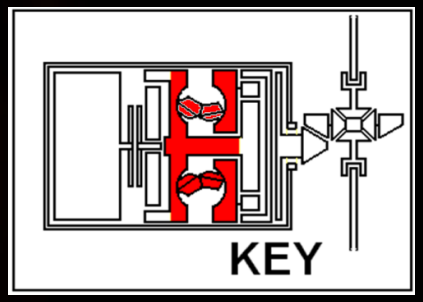
- The flywheel connects directly to the high speed clutch.
- The clutch drives into the step up gears.
- The step up gears are traction based without teeth. They are silent running.
- They reduce the speed of the flywheel from 64,000RPM to 6,000RPM.





THE I-KERS SOLUTION

The DFTV-CVT

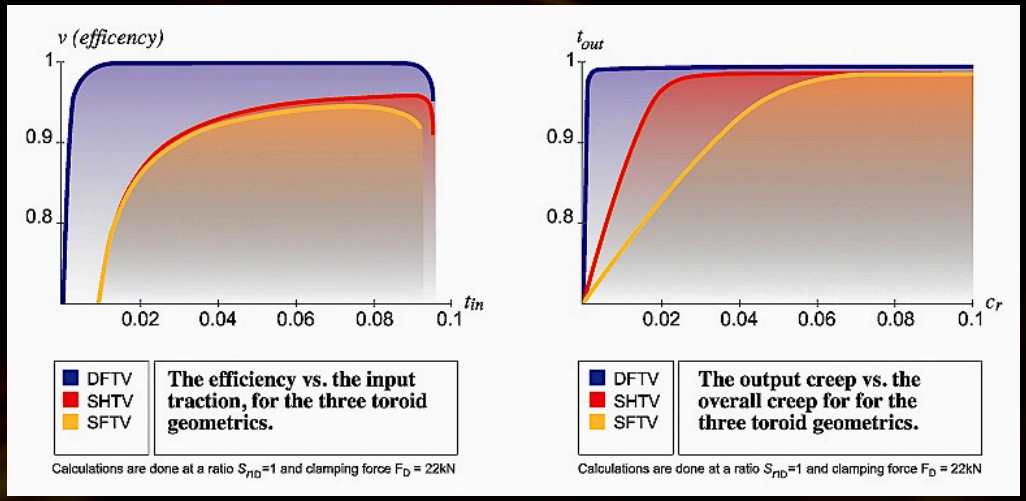


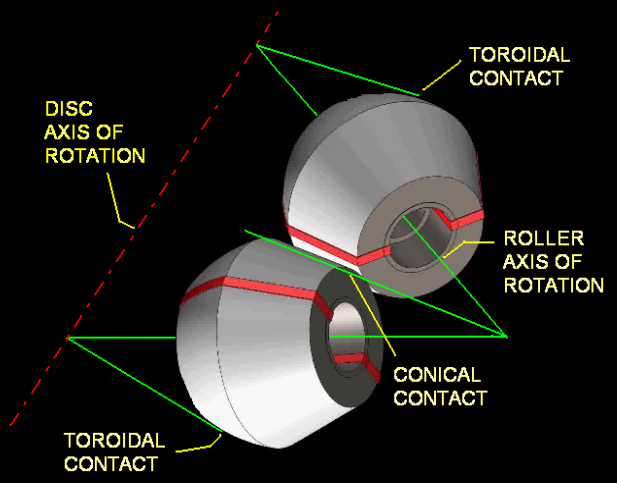
- The Double Roller Full Toroidal Variator (DFTV) is smaller cheaper and more efficient than the SFTV.
- The Single rollers of a SFTV are replaced with Double rollers.
- The Hydraulic controls are replaced with full electronic controls.
- The Double cavity is replaced with a single cavity.
- Both the input and output can be collected at one end, allowing coaxial connection to a single stage IVT gear set.
- Both the input and out put discs rotate in the same direction.

DFTV Design – Improves Efficiency

- The design reduces the mismatched surface velocities that exist in a SFTV.
- At the 1:1 ratio there are no mismatched velocities in any of the power contacts and the CVT mechanical efficiency approaches 100%.
- When contact velocities are mismatched a constant skid exists, which saps energy and produces heat.
- The DFTV reduces these mismatched velocities by such an extent that the overall efficiency is improved by up to 7%.

NOTE … This is explained in greater detail in the Ultimate transmissions website
www.ultimatetransmissions.com





DFTV Design – Improves Power Density

- The matching of the contacts speeds allows the contacts to be Larger
  - They can carry a higher clamping force without over stressing
  - They can transfer more power with less heat.
- The narrow roller profile allows more rollers to be placed in the cavity
  - Typically four are used.
  - A SFTV is restricted to three.
- Power Density and Efficiency tradeoff.
  - In order for the Power Density of a SFTV to match that of a DFTV an even larger efficiency drop off occurs
  - The efficiency loss presents itself as unacceptably high heat generation

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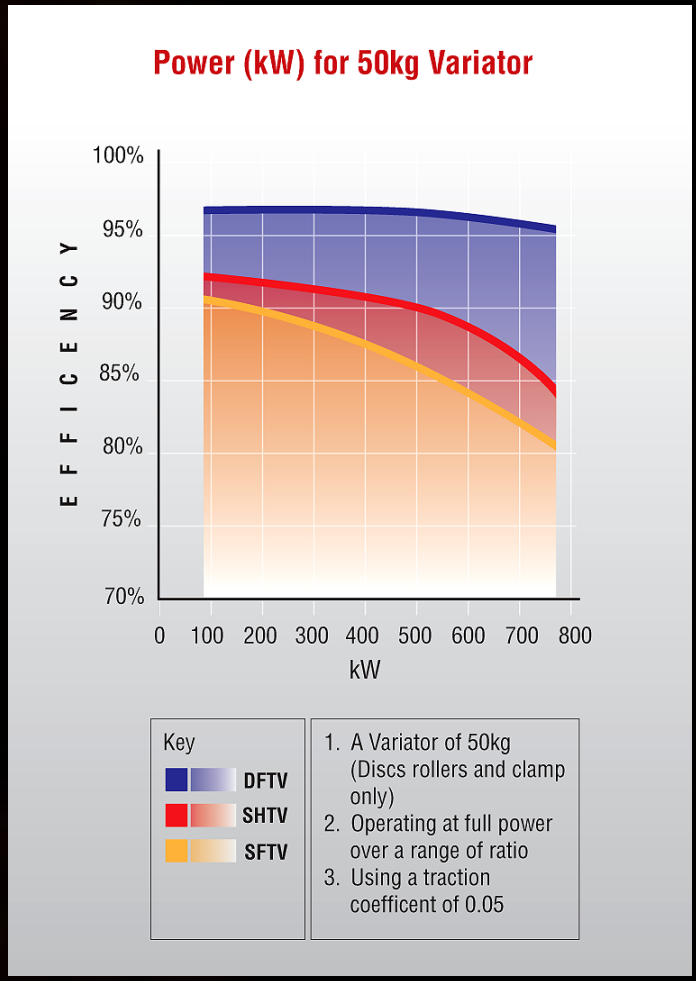
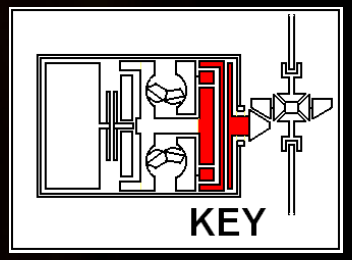
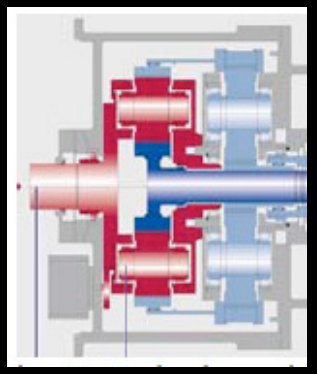


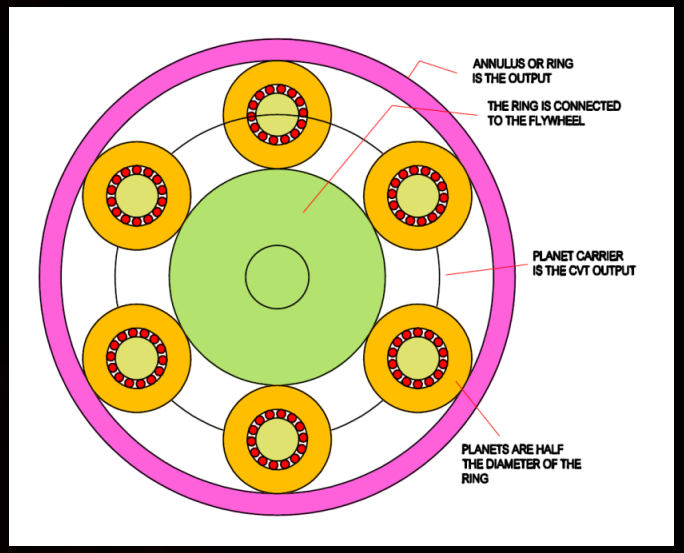
THE I-KERS SOLUTION

Output Gearing & Final Clutch

- Both the input and output from the CVT drives a traction based epicyclic gear-set .
- This arrangement produces what is called an IVT or Infinitely Variable Transmission.
- The output from the gear-set can include a zero ratio and even reverse.
- It is connected to a conventional wet, slow speed, high torque clutch.
- The Clutch protects the down stream drive from very slow speed over torque which is possible with IVT arrangements.
- The gear set is traction based. It uses rollers not gear teeth.







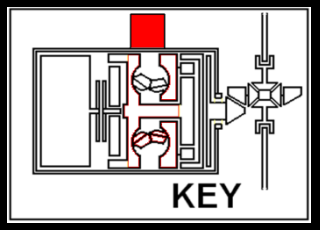
THE I-KERS SOLUTION

IVT system Explained

- **By combining a simple epicyclic gear-set with the Ultimate Transmissions DFTV a gear ratio spread that ranges from zero or neutral, up to a very high overdrive is created.**
  - The resulting I-KERS is capable of collecting and releasing much more energy, more efficiently than a system that has a simple 6:1 ratio spread.
  - The Output shaft speeds supplied to the differential range from 9,000RPM to zero.
  - The flywheel can deliver and collect energy over a very wide band of vehicle speeds and flywheel speeds.
  - Only when the flywheel is almost exhausted (less than 2,000RPM) and the vehicle is travelling above 140kph is the clutch needed to provide slipping re-engagement.
- **Ultimate transmissions can adopt this arrangement because**
  - The CVT operates within its most efficient ratio band where it remains almost 99% efficient. (at 4:1)
  - The traction based epicyclic gear set is also almost 99% efficient.
  - Without such a high level of efficiency the recirculating power losses that exist in this very simple form of IVT becomes excessive.
  - The coaxial and unidirectional arrangement afforded by the DFTV allows this very simple layout.
  - The lower RPM of the CVT allow direct coaxial input into the differential.
  - The DRS control system uses rate of ratio change and flywheel RPM to modulate power, not torque.

THE I-KERS SOLUTION

DRS “Power Control”



- **Direct Roller Steering (DRS) technology developed by Ultimate Transmissions allows Power to be controlled by a simple stepper motor**
- **Other systems must use a hydro/electro/mechanical system that reacts to torque not power.**
  - These systems are subject to elastically induced vibrations.
  - Torque is not a suitable control for an IVT system driven by a flywheel.
- **The DRS system controls the rate of ratio change which directly manages Power.**
  - DRS can be applied to both SFTV and DFTV systems.
  - The stepper motor has a power rating of less than 20 W
- **The rate that energy flows into or out of the flywheel is directly proportional to how fast the stepper motor moves.**
  - This allows a direct control of power in or out of the flywheel in response to a driver request for braking or acceleration.
  - The algorithms that control the rate of ratio change can work equally well with or without the IVT gear reduction system

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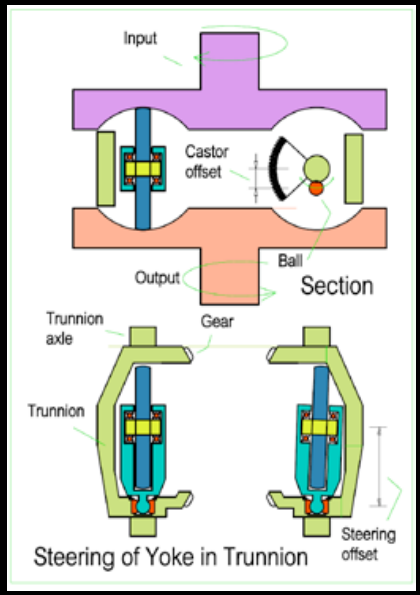
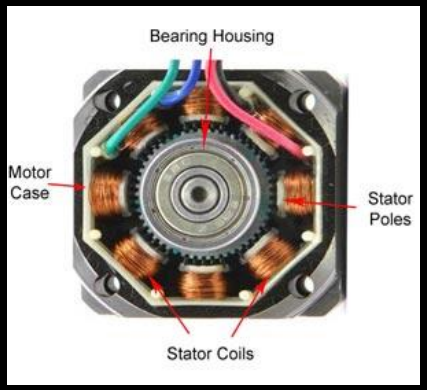




THE I-KERS SOLUTION

What Makes it Better?

- **The improved performance comes from several enabling technologies that have been developed by Ultimate Transmissions.**
  - Ultimate Transmissions has developed a comprehensive solution based on its own technology and know-how without any license agreements with others.
- **The entire KERS unit is enclosed in a vacuum – not just the flywheel.**
  - This eliminates the need for any high speed or hi-tech seal as the power flows in and out of the unit via the output shaft which runs at low speed and only when power is being transferred.
  - A simple magnetic clutch running in the vacuum can disconnect the flywheel immediately it is not transferring energy.
- **Traction power transfer rather than toothed gears are used throughout .**
  - A traction based step down gear set is used to reduce the high speed of the flywheel to a manageable speed of 6,000RPM
  - An improved efficiency CVT called a DFTV or Double Roller Full Toroidal Variator controls the output ratio.
  - A second traction based epicyclic gear set creates what is referred to as a IVT with geared neutral greatly enhancing the ability of the KERS to collect and deliver energy.
  - A high torque low speed clutch controls the high torques that can flow from IVT systems.
- **A fully electronic ratio control system based on what is called DRS or Direct Roller Steering eliminates a bulky hydraulic system. This control can interface with the main vehicle controls without any other interpretative system .**
  - The energy flow or power is controlled directly into and out of the flywheel. This enables vehicle dynamics that closely resemble the operator expectations of accelerator or brake peddle depressions.

THE I-KERS SOLUTION

Strength & Weaknesses

STRENGTHS

- It will deliver an overall fuel saving and CO2 reduction better than all other KERS solutions for both city and highway driving.
- It is supported by several layers of patents.
- It does not rely on technologies or patents supplied by others.
- It has no components that operate outside conventional engineering standards.
- No components require fundamental de-risking.
- The vacuum seal and other components will be highly durable.
- It is cheaper and smaller than its Full Mechanical competitors.
- It is more efficient than all of its competitors .
- The control system is fully electro mechanical eliminating bulky hydraulics.
- Its IVT system guarantees maximum energy collection and delivery at both high and low speed.
- Its IVT system guarantees low speed responsiveness without clutch slip.
- Its rear wheel strategy ensures simple take up for a broad market sector.
- I- KERS saves weight and mass versus alternative solutions
- Development within the industry is at a very early stage and still wide open for new entrants

WEAKNESSES

- It is not fully developed technically and requires prototyping

THE I-KERS SOLUTION

Direct Fuel Savings Comparison

- **The quoted and estimated fuel saving potentials of the various systems can be directly compared**
  - Suburban driving situation
  - Volvo Jaguar (Full Mechanical KERS) 22.5%
  - Toyota (Full electric Hybrid) 30%
  - I-KERS (Improved efficiency KERS) 45%
- **Highway driving**
  - Volvo Jaguar (Full Mechanical KERS) 7%
  - Toyota (Full Electric Hybrid) 4%
  - I-KERS (Improved efficiency KERS) 14%

The Business Opportunity

THE BUSINESS OPPORTUNITY

Defined

- Huge global market > $80 billion per annum.
- OE requirement certain.
- Low initial development cost < $10 Million.
- Low technical risk – no “new” engineering.
- Powerful IP.
- Strong technical and management team.
- Technologically ahead of the competition.
- Opportunity to capitalise on the next major automotive “essential”.
- Opportunity to sell “ownership” to an OE.

Development Strategy

- **Establish development team**
  - Confirm prototype design
  - Design key components
  - Bench test key components
- **Develop Engineering Design**
  - Prepare prototype design
  - Simulate performance
  - Simulate control system
- **Prepare working prototype**
  - Purchase prototype vehicle
  - Install in vehicle
  - Test and report
- **Develop manufacturing methodology for flywheel mass production**
- **Research**
  - Competitor actions
  - OE specific requirements
- **Create OE interest through**
  - PR news releases
  - Trade shows
  - Direct Marketing
  - Web
  - Contacts
- **Identify strategic partner(s)**
  - OE manufacturers
  - “Ownership” opportunity
- **Demonstrate Technology**
  - Operational prototype
  - Vehicle demonstrator

The development time frame is expected to take two years

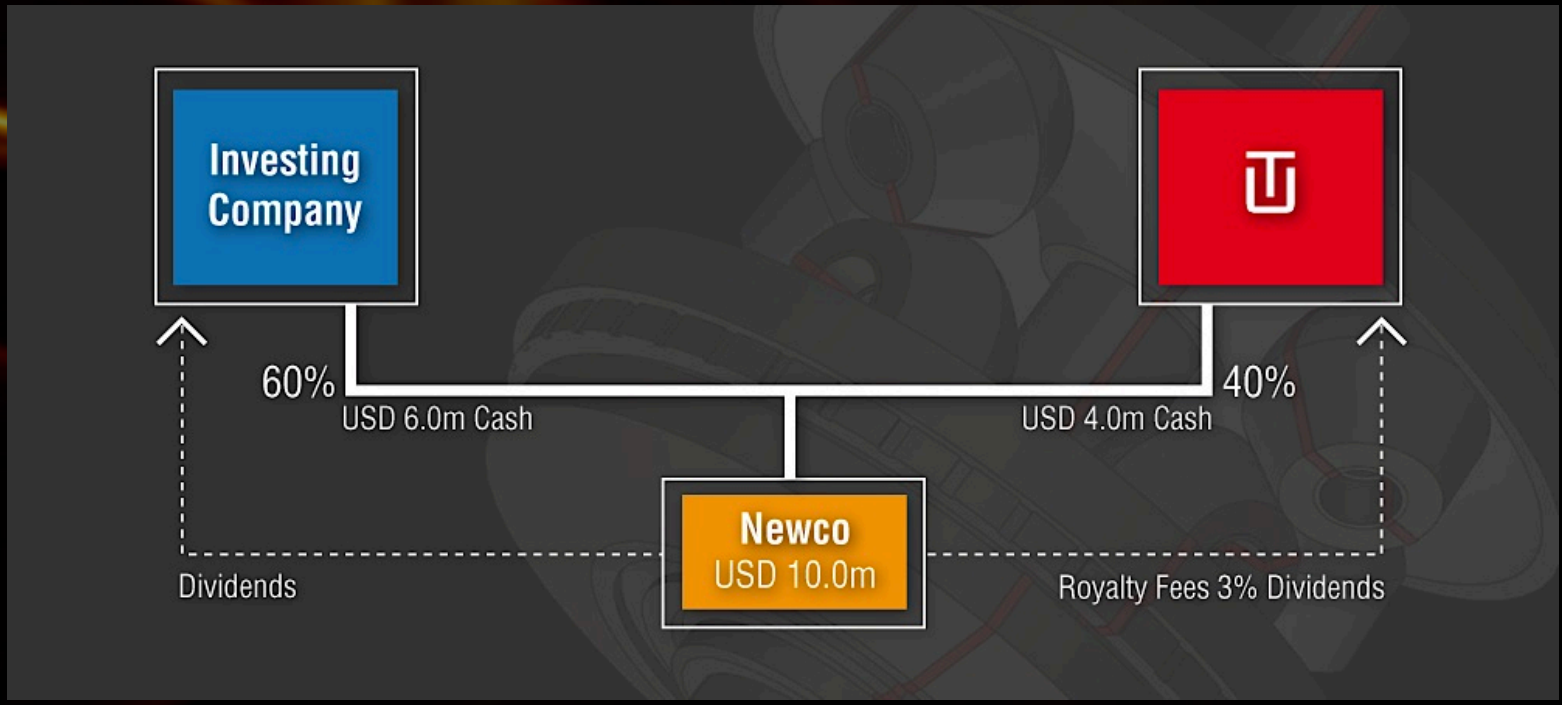
What UT Wants

- **A partner willing to establish a JV with UT**
  - Willing to invest in the business.
  - Fund prototype development (est USD6.0m).
  - OE automotive connections.
  - Access to Developing markets.
  - Access to low cost manufacturing environment.
- **Ultimate Transmissions**
  - Technology License (USD4.0m) as its JV investment.
  - 3% Royalty on manufactured cost of products using the technology.
  - Technology management agreement.
  - JV Board representation.

What UT Gives

- **Exclusive license for 5 product enabling technologies**
  - The DFTV CVT.
  - Fully Enclosed vacuum Concept.
  - The DRS Control system.
  - Traction Epicyclical Gears.
  - Coaxial IVT output.
- **Broad patent protection**
  - Patents are under process for the DFTV, the DRS, and will follow on aspects of the vacuum and traction epicyclic concepts.
- **Powerful associated know how.**
  - UT has researched all aspects of this opportunity.
  - It has developed comprehensive ,software solutions for all of the design issues associated with the KERS concept, the flywheel, the CVT and the IVT.
- **Strong technical and market management team**
  - Technological and application expertise.
  - Access to external technological resources.
  - Fully committed to development of the business.
  - Connections to European automotive industry and consultants.
- **Reinvestment of the full license fee in JV company.**
- **License options on parallel products.**

Simple JV Structure



Summary

- KERS is a new technology that **will** be adopted by OE
- KERS will…..
  - Deliver improved fuel consumption
  - Lower CO2 emissions
  - Help achieve future legislative targets
  - Lower user CO2 tax penalties
  - Offer a significant volume and profit opportunity
- KERS is new but is already being developed by serious automobile players
- **I-KERS**
  - A significantly superior technology
  - Can be used by Internal Combustion Engines and Electric Vehicles
  - Has other automotive applications
  - Has applications in other industries
- UT owns **I-KERS** and offers this for development
- UT wants to minority JV with a partner who can
  - Fund prototype development
  - Become/have access to a manufacturer for the Product
  - Has regional automotive connections

www.ultimatetransmissions.com