CITS - the NEW two-stroke engine for ALL petrol vehicles of the future.

CITS = Crankcase Independent Two Stroke

See http://citsengine.webs.com/ for a simplified animation of the engine.

(PCT and Patent application details: see Pg 4.)

Although the media has been hyping the advent of electric vehicles (EV's), most industry commentators agree that the piston engine will still be powering our cars for some 2 decades yet. The high cost and weight of batteries, recycling issues, polluting coal-fired power generation, on the one hand, vs more efficient piston engines in lighter smaller cars, using under 3 L/100km on the other, makes EV's a medium term commercial reality only as hybrids (HV's) with a piston engine. The touted Tesla sports EV carries 250 kgs of batteries, and the Audi E8 over 500 kgs. Even forgetting their high cost, and assuming a doubling in the energy density in future batteries, just ***half*** this weight of batteries in each of the world's 40 million cars produced pa, will total about 15 million ***tons*** of batteries pa.!!

Every engineer knows the tantalising ***advantages*** of the normally-aspirated two-stroke over the 4-stroke engine: About 90% fewer basic engine parts; lower maintenance; simplicity; reliability; reduced friction; and twice the firing strokes. Many of us remember their ***disadvantages***: smoky, polluting, uneconomical, petrol mixed with oil. Yet today, great strides in direct fuel injection and electronic engine management have enabled leading outboard two-stroke engines, such as the superb Evinrude Etecs*, and Mercury Optimaxes*, and the stunning snowmobile Rotax 800H's*, to dominate their markets, being ***proven*** to be lighter, and ***cleaner*** on NOx emissions and ***more economical*** than 4 stroke competitors. Why then have 2-stroke engines not yet entered today's markets for motorcars and motor-bikes?

1. These sophisticated two-stroke motors*, ***still*** burn oil mixed with the fuel, being dependent on ***total-loss lubrication***. Although their toxic NOx emissions levels are excellent, this burnt oil increases their *carbon* emissions. Acceptable for recreational emission regulations – but not for the stricter auto ones.

2. Being dependent on timed crankcase compression, each two-stroke cylinder must have its crankcase-void sealed from any others - complex and expensive. Importantly, this also ***precludes*** two-strokes from exploiting the efficiency and smoother running of the most compact V- twin cylinder layout.

3. This crankcase-pressure dependency requires the crankcase void be as small as feasible, to maximise the primary compression ratio for efficient pumping. Practicalities limit this to less than 1.5: 1, ***lower than ideal***. And even to achieve this, the void is usually filled with the flywheel, making the crankshaft expensive and heavy.

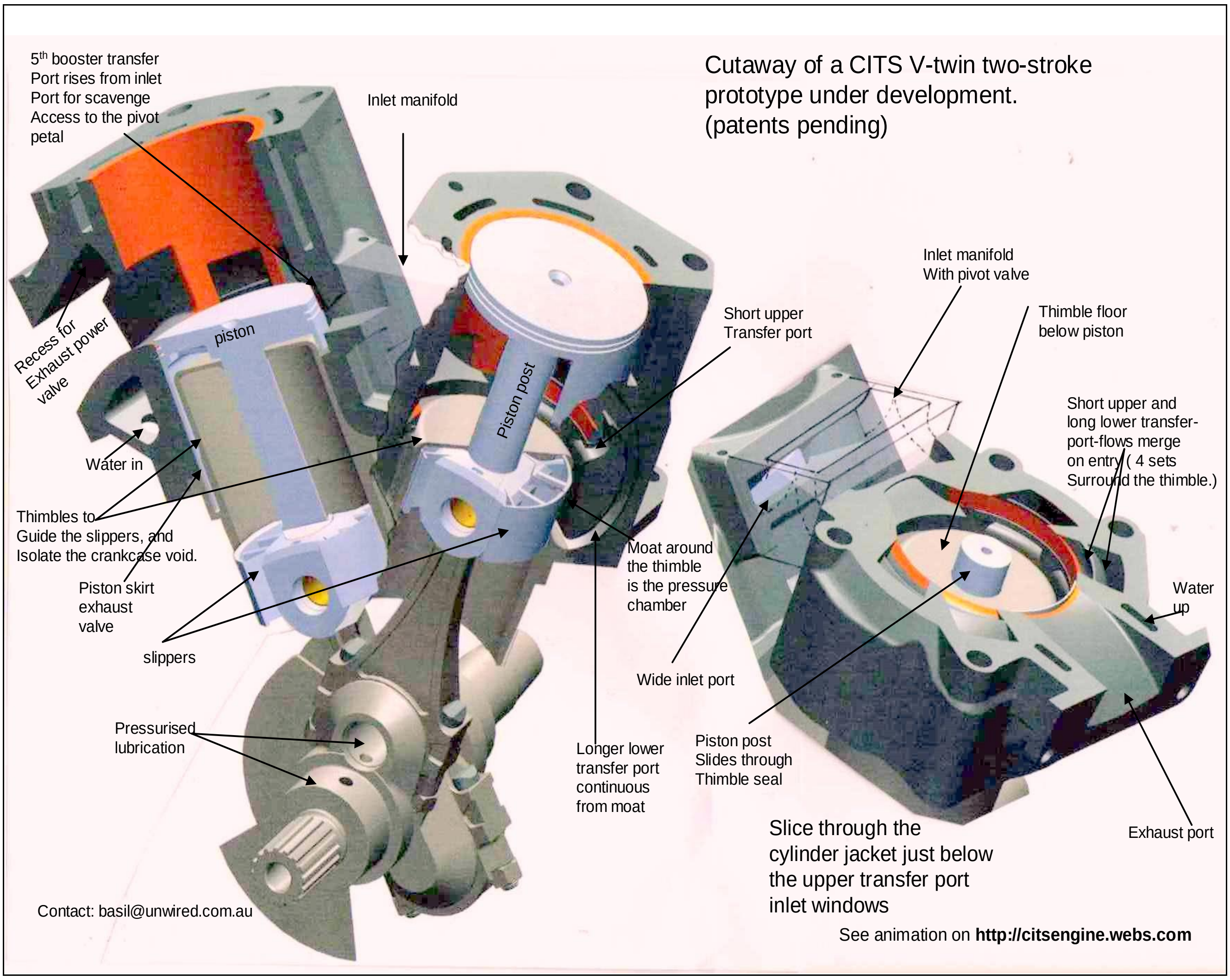
4. The petrol-oil mix provides only marginal lubrication, demanding ball or roller bearings for main, big-end and small-end bearings. Again, heavy, complex and expensive.

Our CITS engine ***absolutely overcomes*** these 4 limitations, and has been successfully tested in a single cylinder prototype in independent dynamometer tests. Even greater results are expected from the synergy of the later patent applied developments, which became apparent and possible with a ***V-twin prototype***, now under development.

For the ***first time ever*** for a two-stroke, the CITS engine will now incorporate the advantages of a compact V-twin cylinder layout, by overcoming the hurdle high-lighted in point 2 above. V-twin advantages are that the twin cylinders ***doubles*** the capacity of a single cylinder, but with ***significantly less*** than double the friction, weight, size, vibration and cost, ***guaranteeing*** more specific power, smoothness and economy. **NB**: Whilst a ***4 stroke*** V-twin has severe vibration challenges, with its pistons travelling to TDC and BDC simultaneously or close thereto, the ***two-stroke*** pistons travelling ***opposingly***, ameliorates this problem.

This "V" breakthrough, led to the discovery of the ***pivoting inlet valve*****,** to replace the common reed valve, and its inherent flow-restrictions. This was due to the fortuitous convergence of 3 simultaneous requisites: ***a)*** an ideal proximity between the opposing inlet ports, ***b)*** an optimal angle between them, and ***c)*** the *opposing* action of the pistons on a two-stoke V twin. The outcome is a lightweight composite petal valve, *interconnected* between each cylinder's inlet tract, such that the alternating opening and closing pressures in each, drive the petals in concert, thus disposing of the need for any ***tension*** to close the petal. Because it is under no tension, there is none to impede the induction. Furthermore, as the pivoting petals demand negligible flex, they can be small enough to fit within the inlet tract, without the interference of a bulky reed block. On reed valves, to minimise flow-resistance and flexing so as to improve durability, several petals are arranged on a block, with their total area perhaps 6 times that of the inlet tract. This interrupts the velocity and flow of the induction charge, further reducing efficiency, ram effect, and primary compression ratio. These inefficiencies are hidden by scavenge from a tuned exhaust system to achieve what is called *stuffing* and *trapping* – but as is well documented – the greater the extent to which this is exploited in seeking power, the ***narrower*** is the power band. To see the valve in simplified animation on the CITS engine, see the animation website http://citsengine.webs.com/ or for more detail, see the cut-away of a proposed prototype below. Adobe Flash10 (standard in most computers) is needed to view the animation, or is a free download on Google if needed. A full Solidworks 3D Cad/Cam of the engine assembly, from which this cut-away is extracted, is available on request. Note that the ***by-pass valve,*** also shown in the animation, is a ***separate*** patent-applied development, to reduce pumping losses by eliminating the throttle, for greater cruise fuel efficiency.

Some might ask how we can claim these great outputs and emissions and economy for the CITS engine, when the synergy as all the parts become part of a greater whole, has yet to be tested. The answer is simple, clear, and free of conjecture. ***ABOVE*** the piston, the CITS engine is mechanically ***unchanged*** from a normal two-stroke – and can adopt the architecture of any of the latest generation of super two-strokes – this includes combustion, stratified injection, scavenge and porting. So one can justifiably expect the same proven emissions, economy and outputs. From that lofty platform, the CITS technology, which is all ***BELOW*** the piston at BDC, takes off. ***That*** is where the simple but subtle patent-applied changes lurk, being: ***a)*** The pivot valve. ***b)*** The by-pass valve ***c)*** The high primary compression ratio ***d)*** The pressure accumulator moat ***e)*** the squish boosted ports. ***f)*** The pressure-lubrication system and reduced oil burning and carbon emission. ***g)*** The efficiencies of the V-twin layout. These advances, will allow the two-stroke to be less dependent on exhaust tuning, to have a broader power band, to be as emission-clean as any four stroke, and to give greater specific outputs by almost any measure, including displacement, package, weight, production cost, and fuel economy. There is much further convincing and compelling technical detail to back up all of these issues, such as surprising advantages of the piston design.



Cutaway of a CITS V-twin two-stroke prototype under development. (patents pending)

Slice through the cylinder jacket just below the upper transfer port inlet windows

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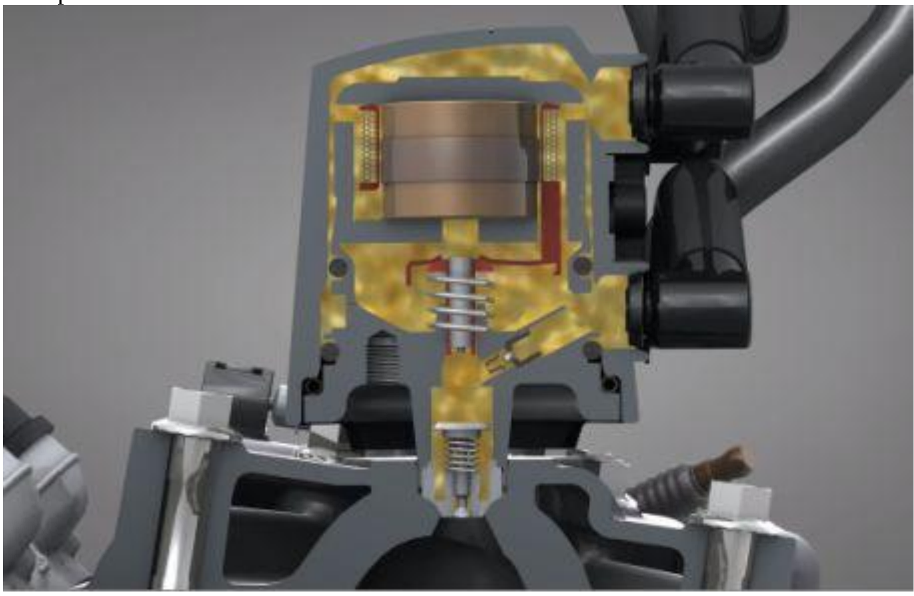
See animation on **http://citsengine.webs.com**

In a normal two-stroke, the source of each fresh charge to be pumped/scavenged through the transfer ports, is spinning in a N/S axis, driven by the windage of the crankshaft within the crankcase. It has to be ***diverted*** through transfer ports, with consequent kinetic energy losses. Compare this with the CITS patent-applied annular pressure accumulator, or moat, elegantly surrounding the lower "thimble" cylinder guide. This allows primary compression ratio as much as 25 % higher than is possible on normal two strokes. Moreover, the moat's void becomes an extension of the transfer port, nearly ***doubling*** its length, so that a longer charge moves ***as one***, down, around and up through the continuum, for reduced inertial losses, and increased ram effect. The moving charge is then further boosted by exploiting the well documented "squish" lateral forces created between the descending piston as it nears the *thimble* floor at BDC, which are redirected via unique patent-applied upper transfer ports to merge with, and boost the long transfer port's charge. 4 of these pairs can be seen as they merge, entering into the cylinder, in the "slice' of the cylinder in the cutaway above.

Copied below from the online **SAE International**, is an article on the remarkable normally aspirated ROTAX 800 H. Note its benchmark-setting output of 155 BHP for snowmobile general usage, ***from just 800 ccs***. This is over ***triple*** the specific output of the latest 2.2 litre 4 stroke car engines. Add our CITS technology allowing even greater efficiency, with lower carbon emissions, production cost, weight and vibration, and it is clear that new benchmarks will be set, and allow the CITS two stroke to find its place in motor cars, as hybrid or stand-alone engines, as well as in motor cycles. V twins from 250 cc, right up to 1300 cc with 160 BHP (120 KW) or over 200 BHP (150 KW) as a hybrid, can power any thing right up to the medium sized family car. Of course V twins *sandwiched* into V4 or V6 configurations could satisfy the most powerful sports car arenas as well, the latter hybrid promising 600BHP (450-KW)

Direct injection keeps two-stroke alive for Bombardier in 2012
26-Apr-2010 17:42 GMT



Electromagnetic injectors mount vertically on the liquid-cooled 800R twin's cylinder head. In this cutaway view, note the internal coolant passages; the engine circulates fuel to help cool the injector.

The last major bastion of the two-stroke engine appears to be in snowmobiles. Thanks to liquid cooling, electronic controls, fuel injection, sophisticated combustion techniques, and variable-exhaust-port technology, the latest avalanche of two-stroke "sled" powerplants aims to comply with the new U.S. EPA Phase 3 emissions regulations slated for the 2012 model year.

Can the two-strokes, with their impressive specific output, high power-to-mass ratio, and package benefits, hold their own against the four-stroke assault? Bombardier Recreational Products (BRP) engineers believe they can. BRP's evidence is the recently unveiled Rotax E-TEC 800R, newly equipped with direct fuel injection (DI) and slated for 2011 Ski-Doo sleds. (BRP owns Rotax, Ski-Doo, as well as Evinrude marine engines and Sea-Doo watercraft.)

The injected 800R is the latest iteration of Rotax's Type 797 series, an 800-cm^3 liquid-cooled parallel twin rated at 155 hp (115 kW).

The Phase 3 standard mandates a nominal 50% reduction in carbon monoxide (CO) and hydrocarbon (HC) emissions compared with uncontrolled levels (150 g/kW•h for HC and 400 g/kW•h for CO). The straight HC limit is 75 g/kW•h, and the corporate average CO limit is 275 g/kW•h.

For two-stroke engineers, the main HC emissions challenge is achieving a complete burn in the combustion chamber. With its DI system, Rotax's development team employs the company's voice-coil electromagnetic injectors to further compress the fuel from the relatively low initial pressure provided by the fuel pump and simultaneously inject it into the 800R's cylinders at 500 psi (34 bar).At this pressure the fuel stream vaporizes almost instantly and is then ignited by the spark plug. This creates a more complete burn as well as better throttle response when compared with the previous carburetted two-stroke, BRP engineers claim. As part of their cleaner emissions profile, the DI E-TEC engines also have greatly reduced exhaust odour during start-up.

The DI system is used in conjunction with BRP's reed-valve induction, 3-D RAVE (Rotax Adjustable Variable Exhaust) electromechanical exhaust valve, and a powerful ECU that processes inputs from a variety of sensors—crank angle, throttle position, knock, coolant temperature, and ambient air pressure and temperature. The open-loop fuel system also cools the injectors as well as the ECU.The 3-D name refers to three-dimensional mapping used to determine exhaust valve operation, as well as three exhaust port openings per cylinder. The new injected 800R achieves a claimed 19 mpg (12.3 l/100 km) in Ski-Doo sleds—up to 37% better fuel efficiency than competitive units, BRP claims.

Other benefits of DI include easier starting, improved idle quality, and greater oil efficiency—264 mi/qt (450 km/L), a 15% improvement over the 2010 carburetted 800R, according to the company.

The addition of DI to its 800-cm^3 engines (the 600-cm^3 units are similarly equipped) proves the two-stroke is alive and, for the time being, still very well indeed. Lindsay Brooke

This sensational performance and convinces us that with CITS technology, the two-stroke engine can reveal its true measure to the world. Our strategy is as follows:

Plan A. is to licence the CITS technology to a major manufacturer for royalties *if it reaches production.* They have infinitely superior facilities and knowledge, and thus a far greater chance of optimising its development. We are endeavouring to arrange a meeting with their top engine team, for them to study the technology, and allow us to answer any questions and doubts. Until that is arranged, we proceed with

Plan B. A Cits Engineering PL shareholder has made possible the design and manufacture of the V-twin 800cc CITS prototype, built on the crankcase of the respected 4-stroke Suzuki 800 V-twin. This provides all ancillaries in place, lowering cost and greatly speeding up development. In addition, it provides a benchmark for before-and-after comparisons between a state-of-the-art 4 valve fuel-injected four stroke and our CITS two-stroke ***of identical bore and stroke***. We hope to be testing this prototype by March 2011. The full cad-cam drawings of the engine are now complete, and production of the prototype is underway. It is of course an ambitious attempt for a privateer.

The patent details are as follows:

Wallington-Dummer Ref.	102029	105007
Australian Application No.	2010241402	PCT/AU2010/001524
Invention title	Two-Stroke Engine Porting Arrangement	Improvements in two-stroke engines
Patent application type	Australian Complete	International PCT
Application status	Filed	Filed
Paid to date	2015-11-12	N/A
Currently under opposition	No	No
Inventor(s)	Basil van Rooyen	Basil van Rooyen
Filing date	2010-11-12	2010-11-16
Effective date of patent	2010-11-12	2009-11-16 (PCT applications do not technically have an 'effective date'; this is the date from which all national phase deadlines will be calculated)
Expiry date	2020-11-12	N/A

The following is for the more technical readers:

The CITS piston- post and slipper is a manageable 10% heavier than a regular piston, and although it increases the engine's height, this is well accommodated by the two-stroke head being much shorter than a 4 stroke, having no camshafts and valves in the head. Moreover, the CITS piston has some surprising advantages:

1. Normal piston "tumble" at TDC/BDC creates high loads at the pressure points of the modern short piston. The distance between these points on the CITS piston are over double those of the normal piston, thus reducing the tumble angularity and the loads commensurately.
2. Although using pressurised engine lubrication, the two-stroke advantage of requiring no oil scraper ring is retained in the CITS two-stroke, thus avoiding the friction of this oil-ring required by four-strokes.
3. The CITS piston-post reduces the nominal induction displacement by some 10% - but two-stroke students will recognise that in any event, the two-stroke displacement is limited to entrapment at exhaust port closure, plus any "stuffing" from exhaust tuning. As this never reaches 90% nominal two-stroke induction, it can be ignored.
4. The lubrication of the isolated upper cylinder and rings is elegantly catered for, via a seal allowing a requisite by-pass of oil-laden air from the crankcase, between the post and the thimble through which it passes. This migrates to the cylinder walls both under the piston on its up-stroke, and then again when the pressure chamber's charge flows via the transfer ports in the loop-scavenge route, around the cylinder walls above the piston. The exhaust skirt causes a shielded area on the up-stroke, and to overcome this, strategically placed bleed holes in the thimble spray oil mist on the cylinder wall which is traversed and picked up and distributed by the skirt.
5. It will be understood that the nominal clearance between the slipper and piston in their cylinders, and between the post and thimble, will ensure no guidance between the post and thimble seal, other than as a lip-seal elastic contact.
6. The hottest part of the two-stroke piston is conveniently cooled by the post, which in turn is cooled by the crankcase oil-laden air, and fresh induction charge, on its travel through the crankcase and pressure chamber voids.
7. The design of underside of the piston-head is determined by a) A need for it to be balanced around its centre, and thus eliminate any bending moment on the post under the G forces involved. b) A need to direct the squish forces laterally, towards the transfer ports. c) The need to shield the fragile petal from any destructive squish pressure waves. d) A desire to keep the primary compression ratio as high as possible.

All these considerations seem to be elegantly resolved in the prototype design.

The by-pass valve is a ***separate*** novelty, also patent applied, and is intended as a replacement for the throttle, to eliminate the down-stream partial vacuum, which increases fuel consumption at part-throttle. It can be applied with either the reed or the pivot valve, on suitable pairs two-stroke of cylinders. Although yet to be tested, it is not critical to the success of the CITS engine, as the throttle is a ready back-stop option.. The by-pass valve is well described in the animation, and is a valve controlling a by-pass circuit between the inlet tracts of a V-twin two-stroke. As the maximum pressure differential between these tracts is greater than between either and atmospheric, when the by-pass passage is open, the high pressure tract air will short circuit into the low pressure tract, reducing the induction from atmospheric fresh charge. Thus the engine output will be reduced, without requiring any throttling.

The Pivot-valve.

This is a petal type check or one-way valve, for application on pairs of cylinders, on two-stroke engines, with the pistons disposed at the preferred 180 degrees, and patent applied.

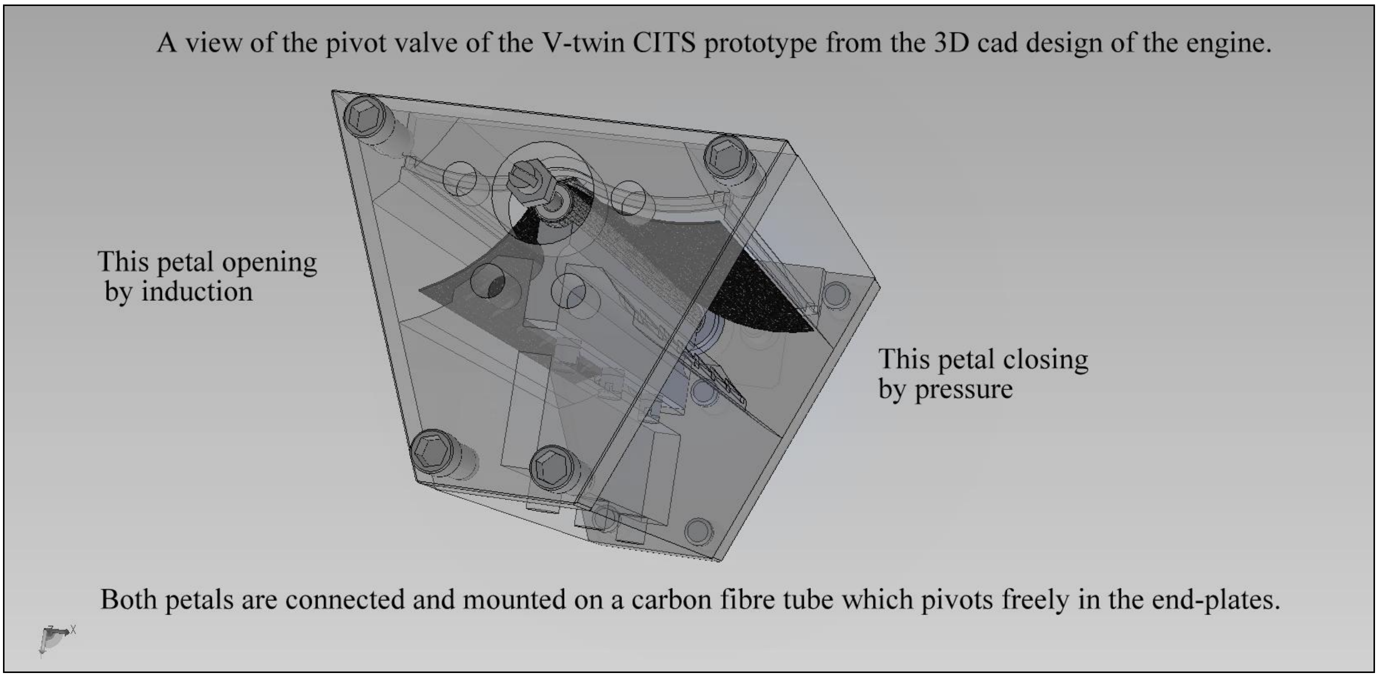
The pivot valve's action is similar in ways to the popular **REED** valve, it differs fundamentally in others. Reeds are steel or carbon fibre petals, ***sprung*** closed, which need to be ***flexed*** to open. This tension, which closes the valve after the induction phase, demands induction pressure to overcome, thus restricting the inflow. This costs energy, and hence power, and fuel. The stress of repeated flexing is the cause of the eventual failure of the petal, which snaps off, often with disastrous results when steel is the material of choice, and less often if of a composite. The tract voids around the valve are bulky, to allow a large petal area, so as to minimise the degree the petals need to flex open, and thus reduce the tension and stress and resistance. The trade-off, however, is a drastic cross sectional change to the inlet tract, with a resultant velocity changes to the incoming charge, and thus to the desired ram effect. Also, the large void down-stream of the valve reduces crankcase compression, affecting induction and transfer pumping efficiency.

The Pivot Valve can utilise the same proven reed petal material selection, even though the durability demands on the pivot petal are significantly lower, in terms of the major factor - flexing. Because the Pivot petals are ***rigidly inter-connected*** on a spindled hub, they are free to pivot about an axis, almost eliminating flex. The Pivot valve is ***self-driven*** by ***alternating*** air-flow directions. Because the petal has ***no tension*** resisting opening, it will open earlier, and faster, than the reed valve. It will be opened by the exhaust scavenge, at or close to BDC, elegantly anticipating and assisting the start of the opposing petal's closure. Moreover, an asymmetric fluid dynamic in the actions of the petal being opened, vs that being closed, presents intriguing opportunities for optimisation. Those opening the valve are recessive, in that the opening forces recede as the valve approaches its fully open position. Conversely, the forces operating on the valve as it closes are steadily *increasing*. The landing forces will be damped by the residual inflowing charge, and by the light-weight petal and elastic seats. So an entire area rich for R&D opens up, where the ideal angle between the petals, and their stiffness vs minimum weight, can be selected to optimise the performance of the pivot valve. The envisaged pivot valve petal is about 5 times longer along its axis, than its width, thus requiring a very short travel, and the perceptive observer will notice that the inlet port is ***below*** the area of ring traverse – thus the inlet port can be almost as wide as the bore. Then a booster, or 5th transfer port of usual proportions, "periscopes" up from the wider inlet port, to above the piston top at BDC, allowing a direct route from the exhaust scavenge to the petal, to minimise response times.

The most controversial aspect considered by those studying this valve, is the initial instinctive doubt as to whether the pivot petal can travel through its arc (about 13mm on our 800 cc prototype), at up to say 6500 rpm intended on the V-twin project. Here are some convincing facts:

- Each petal weighs about 0.30 Gms. This is under 1% the weight of an F1 valve assy. And of this feather-weight, only the outside tip travels the full 13mm arc, weighing say 0.10 Gms. The hub weighs 1.0 gm and works counter-rotationally, travelling a 3 mm arc. Thus the inertial loads involve feather-weights.
- The remarkable humming-bird's wings flap at up to 4000 rpm, working *against* the air to obtain thrust - rather than moving in concert with it, as does the ***air-driven*** pivot valve. This makes the pivot petal, going *with* the flow, "flapping" at even twice the rate, far less remarkable.
- With the pivot valve, the inlet tract maintains a very consistent in cross section. This ensures that the inlet charge velocity is maintained throughout, and exploits the kinetic energy, and ram effect, reducing pumping losses. By contrast, the reed valve block creates cross sectional and route change interruptions within the inlet tract. This all means greater efficiency, economy and power from the pivot valve.
- There is a need to minimise any leakage between the pivot valve hub and the manifold, creating the divide between the cylinders. In a preferred design shown on page 6, this is a seal of UHMPE polymer, cradling the carbon-fibre hub supported on a thin neck. The alternating pressures on either side will create a typical lip-seal to the pivot hub. Thus there is little friction or wear during pivoting movement when pressures are low. With the excellent friction and wear properties of the polymer, and the low speed and loads involved, the valve will be durable, as well as cheap and accessible to replace if necessary. Detail design concepts to make this practical in manufacture and assembly are complete.

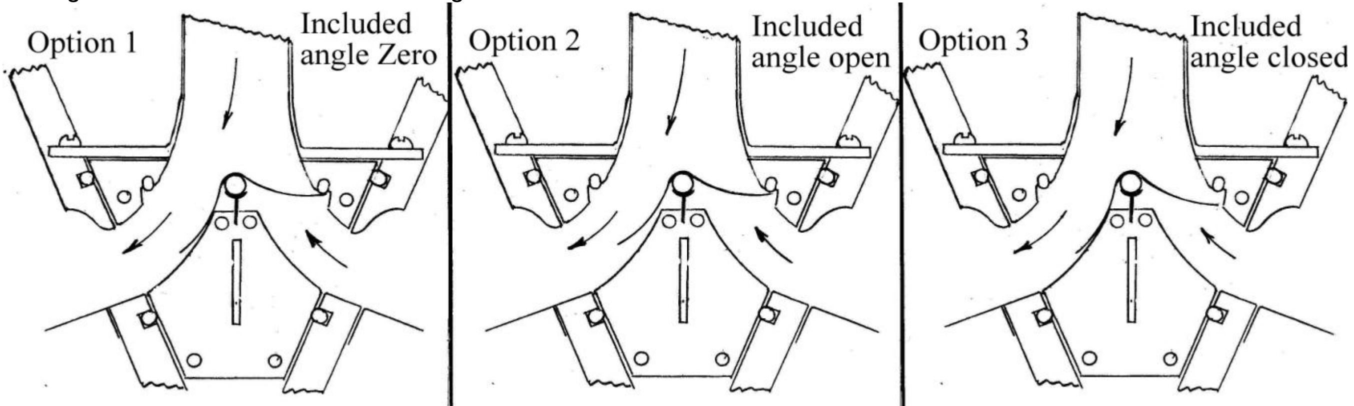
Like the by-pass valve, CITS technology does not ***depend*** on the success of the pivot valve, as the reed valve is a back-stop. But every instinct indicates these valves may add further efficiency to the CITS two-stroke evolution. These are patent-applied options, and will simply add further to the destiny of the technology package, if they prove successful as expected. It is intriguing to consider whether the incoming charge from a certain RPM, has sufficient inertia become a self-activating valve, and hence the any closure of the pressure chamber could become unnecessary to the engine operating. Should this be the case, the pivot petal may just quiver whilst the engine purrs away…….



A view of the pivot valve of the V-twin CITS prototype from the 3D cad design of the engine.

Both petals are connected and mounted on a carbon fibre tube which pivots freely in the end-plates.

In the 3D CAD drawing above, the RH petal is under pressure from the descending piston, and about to seal against Teflon O-cord seats, whilst the LH petal is almost open, from the suction of the rising piston on its side. This is called the zero angle, shown in option 1 below. In this new area of exploration, due to the asymmetry of the closing vs opening dynamics, there may be further optimisation by varying the “zero” nominal angle between the petals – so that as can be seen in option 2 below, with a more “open” angle, the closing petal will be “home” before the closing one. Conversely, shown in option 3, with a more “closed” angle, the opening petal will be “home” before the closing petal. Empirical testing will indicate where the ideal angle lies.



Note both petals are “home”

Here the angle between the petals is such that when one closes, the other is wide open, called Zero. One has to grasp the differing effects of the assymetry of the opening and closing dynamics involved. The closing petal is under incremental force and speed at impact due to an ever decreasing passage but increasing flow, related to piston speed. By contrast, the force on the opening petal is decreasing due to it opening a passage synchronous with flow demand. We will now consider what might happen with this included angle more closed, or more open. Note that in either of these next 2 options, the travel to intial impact is reduced.

Note the LH petal is not yet “home”

In this case, note that the fast closing petal impacts first, driven by ever-increasing force. It can be assumed the opening petal will be lagging due to decreasing forces opening it.However, being interconnected, it is also being mechanically driven by the closing petal. Its lag will be taken up by the flex of the carbon fibre, and this will flick it onward, and by rebound will go beyond its nominal “not quite open” position. There will also be a force from the inducted flow inducing it towards fully open. This may occur conveniently just when flow through the port is at maximum, some time after piston speed is at maximum. This is only reached after mid-stroke on a rising piston.
It does seem safe to assume that due to the two forces described, the petal will open more than the “not quite open” nominal position shown above, and at a propitious time in the cycle.

Note the RH petal is not “home”

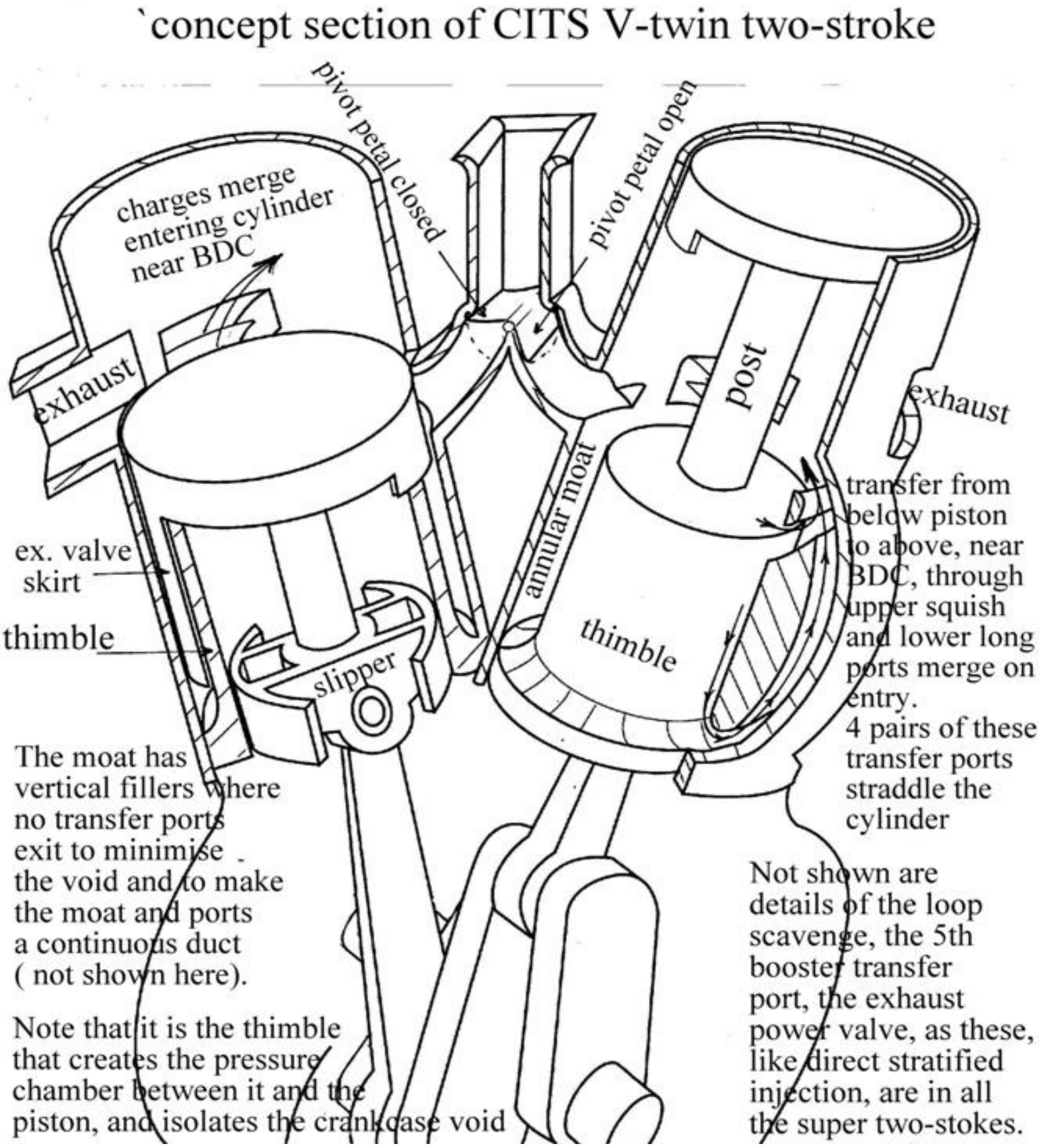
We now see a situation, where the opening petal impacts first, with certainty of reaching the fully open position, and reaching it earlier. The closing petal will be accelerating due to the ever-increasing forces described, and whilst we need it to close as soon as possible to retain transfer pressure, it seems self evident that it will continue toward full closure on inertia, and will be overwhelmed by the increasing forces to fully closed. The high landing impact will be reduced somewhat by this situation. These angles of flex are minimal compared to those reached by the popular reed valves, and should be comfortably accommodated.

With the complex calculations in non-steady state fluid dynamics, it would be a brave man to predict with certainty which will prove optimal. Empirical testing will show us the way forward.

Drwg 139

CITS FLUID DYNAMICS AND PORTING SYNOPSIS. (Patent applied)

The pressure accumulator chamber between the piston underside and the “floor” below it extends into an annular “moat” which elegantly surrounds the lower cylinder, or ***thimble***, as we call it due to its appearance, with the addition of the piston-post hole in its centre. The compressed fresh charge flows down the annular moat, and up through the 4 transfer ports that surround the cylinder, for the full period of their opening, starting from when the descending piston exposes these ports, until it closes them on its ascent. For a brief period in the middle of this event, as the piston approaches BDC and the thimble-floor beneath it, the well-researched ***squish*** effects between two rapidly approaching proximate flat surfaces, are directed laterally into ***squish ports***, boosting the flow of the major transfer ports. This can be readily seen studying the cutaway above, and in this simplified concept cutaway drawing below. (Or in the “4 events” illustrations available on request)



This porting is unique from several standpoints. A subtle one worth identifying is that the major portion of the fresh charge under primary compression moves ***as one,*** down, around and up the transfer port network, giving greater tract length and desired *ram* effect. Thus as the rising piston closes the transfer ports, the ***interrupted*** inflow retains some residual pressure at the start of the next opening of the port. The outrush of exhaust scavenges everything behind it, and the 5th transfer port, “periscoping” up from the inlet port, ensures that this dynamic is directed straight to the pivot valve, starting its opening for induction under the rising piston, and reducing any propensity for draw-back of the charge flowing through the transfer ports. Compare this with the normal two-stroke porting, where the ***source*** of the charge into the transfer ports is spinning with the crankshaft, and must be diverted into a far shorter transfer tract. Despite them being ***poor air pumps***, for the reasons just covered, two-strokes have shown prodigious power in motor-sport and recreational use, by clever exploitation of exhaust-tuning to scavenge and trap a larger charge – but the greater the extent to which this is applied, the narrower is the effective rev-band, which is less suited to every-day use. The CITS engine because of its improved pumping, porting and flows, addresses not only these fluid dynamic issues, but also ***eliminates*** the carbon emissions associated with total-loss lubrication of two-strokes.

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