How come all engines pollute & inefficient in XXI century?

Author: Stanislaw Holubowicz
Contact: Email gun-engine@shaw.ca
Tel. +1.778.397.8999

Abstract

This paper explains design flaws and causes of inefficiencies plaguing all engines and also suggests a concept how to make engines efficient and not polluting. Then it explains that the entire trend of engine research violates the second law of thermodynamics by preventing detonations. Also paper defines basics of physics violated by existing engine designs, which have been preventing developments of efficient and environmentally sound engines for more than a century. Then the paper proposes a new thermodynamic cycle, from which all flaws, as seen in the Diesel and Otto cycles, are eliminated and suggests an ideal engine and a design of the ideal engine, which agrees completely with the basics of physics. The ideal engine is cooled by complete conversion of heat into work only, without heat losses as seen in all engines today.

If you quarrel with PHYSICS …guess what… Physics always wins!!!

Introduction

Today thermodynamic cycles, as well engine designs violate basics of physics. The violations results from many design flaws responsible for many causes of inefficiency. The causes have been handed down from generation to generation and those are still penetrating into engines under development for the future. Thus it is obvious that researchers simply do not know what causes inefficient and polluting operation of all engines, because current trend of engine research was inherited from XIX century, when neither the efficiency nor pollution was issues.

Background

There are many faults in all engines which relate to flaws of engine design or even flaws of the thermodynamic cycle on which the design is based. Those relate to violations of basics of physics as well violations of laws of nature such as the second law of thermodynamics

Basics of physics demand that**:**

1. Max force should act onto max distance to produce max torque, which in all engines occurs when crank is horizontal
2. Energy should be released from fuel at max possible rate to maximize power available from used fuel, because power available from consumed fuel id defined as energy release in time
3. Max torque should retain high from starting up to max speed
4. Max efficiency should retain high from starting up to max speed
5. Expansion of exhaust produces work cooling the exhaust, thus expansion should be complete, preferably below atmospheric pressure
6. Torque should remain high from starting up to max speed
7. Efficiency should remain high from starting up to max speed

8. Design of engine should withstand detonations of fuel as detonation creates better thermodynamic conditions for energy conversion and efficiency according to the second law of thermodynamics

Violation of the second law of thermodynamics by current trend of research

Today trend of engine research is based on XIX century idea of preventing detonations in engines introduced by Otto, because the XIX century engine (we inherited) cannot withstand detonation. However detonation creates much better thermodynamic conditions for energy conversion and efficiency. The better conditions result from much higher temperature of energy release from fuel, as well much higher pressure, thus it is the author's conclusion that researchers should find new methods and new designs, which would allow detonations in engines instead of notoriously preventing detonation, because the prevention violates second law of thermodynamics as it lowers the temperature and pressure resulting from the energy releases from fuel. These are important factors limiting efficiency of all engines, because those violate the second law of thermodynamics and logic.

Violations of basics of physics by current engine design

1. In all engines, the max pressure acts on zero distance, which occurs when crank aligns with the centerline of cylinder and that is a design flaw
2. Energy release from fuel is intentionally slow to prevent detonation that destroy all engines and that is another design flaw
3. Ignition is advanced in all engines, which relates to slow rate of energy release and that is definite design flaw, because introduces three distinctive speeds such as:
   3.1. Speed of max torque
   3.2. Speed of max efficiency
   3.3. Speed of max power; wherein it is impossible to drive streets at max efficiency speed due to traffic conditions and traffic restrictions and in addition the advancement also causes torque that counteracts crank move until crank aligns with centerline of cylinder
4. Expansion of exhaust is only partial, thus only a very small part (less than 20%) of heat energy released from fuel converts into useful work and the rest (80%) is wasted.
5. In addition the not converted part of the heat accumulates in the internal parts and must be disposed or the engine melts, thus all engines are rigorously cooled and cooling wastes most of energy released from fuel
6. All engines produce only one power stroke from each energy release from fuel and that is another design flaw
7. Torque almost does not exist during starting or slow speed and it increases slowly with revolutions of engine, but at max it is very low, thus every engine needs torque boosting transmission, which consumes energy and lowers efficiency of vehicles
8. Efficiency during starting up is very low (below 1%) and at max reaches no more than 20% to 30%, thus the average efficiency of vehicle, during routine street driving, does not exceed 3% to 5 % and **that is not acceptable!**

Violations of basics of physics by today engine thermodynamic cycles

Today we know several engine thermodynamic cycles, which we inherited from XIX century and two inherited from the beginning of XX century.

Inheritances from XIX century

1. A four stroke Otto thermodynamic cycle which includes processes:
   1.1. Induction of gaseous fuel and air mixture
   1.2. Compression of the mixture
   1.3. Igniting the mixture by electric spark to initiate energy release from fuel, which led to engine self-destruction due to resulting detonation
   1.4. Incomplete expanding of exhaust which produces incomplete heat into work conversion
   1.5. Evacuation of hot exhaust still possessing plenty of heat
   1.6. Repeating step 1.1 to step 1.5 indefinitely; wherein Otto replaced the gaseous fuel with light fraction of oil and introduced induction of mist of fuel hanging in air which slowed down energy release from fuel and replaced detonation a controlled combustion, so a reliable gasoline engine resulted
2. A two stroke gasoline engine thermodynamic cycle from which a valve-less engine resulted, which is no more due to polluting features. It comprises following processes:
   2.1. at the end of power stroke exhaust evacuates through a port on one side of cylinder and fuel mist with oil enters, from the crank-case, into cylinder through anther port on the other side of cylinder;
   2.2. then compression stroke compresses the fuel mist/oil mist /air mixture which is ignited by a spark causing ;
   2.3. power stroke and the step2.1 repeats at the end of the power stroke; wherein the arrangement does not burn fuel with oil completely thus intense emissions of dangerous carbohydrates result, so this engine is allowed in very little gadgets like lawn movers etc. only
3. A four stroke Diesel thermodynamic cycle which comprises the following processes:
   3.1. Induction of air into cylinder
   3.2. Compressing air so its temperature rises above flash point of fuel
   3.3. Injecting fuel mist into compression heated air; wherein if only one droplet forming fuel mist ignites, the resulting flames ignite nearby droplets and flames propagates from droplet to droplet until all fuel mist is in flames; wherein this process is slow and also creates emissions of black particulates
   3.4. Expanding the resulted exhaust to produce useful work
   3.5. Releasing pretty hot exhaust
   3.6. Repeating process 3.1 to process 5 indefinitely
4. Atkinson & Miller four stroke thermodynamic cycle, which includes the following processes:
   4.1. Delaying induction into cylinder by opening induction valves later than in Otto cycle, which causes smaller volume of cylinder during induction than the volume in which exhaust expands thus from less fuel more power, but this cycle is asleep
   4.2. Inducting fuel with air into cylinder

4.3. Detonating the fuel charge
4.4. Expanding exhaust in larger volume of cylinder than that of induction to produce useful work
4.5. Releasing exhausts
4.6. Repeating steps 4.1 to 4.6 indefinitely; wherein the Atkinson cycle is similar to Otto cycle, but allows entering less fuel into cylinder which improves the efficiency

Inheritances from XX century

We also inherit from XX century:

1. Two stroke diesel engine with elongated crank which improved expansion and doubled the efficiency
2. Wankel rotary engine with poor expansion and poor efficiency
3. A combination of Wankel and reciprocating engine with expansion improved, in which reciprocating piston is placed in the rotary piston pushing on crank geared with shaft of rotary piston, which adds torque produced by piston to torque produced by the rotary piston
4. Turbocharging, which allows more fuel into cylinder with not much improvement of the efficiency, thus wasting more energy

In addition, we inherited from XX century a method of solving problems by browsing publications or surfing the Internet, which boosted careers of many without scientific curiosity or passion to make science and created an army of career oriented junk-scientists not able to create any new knowledge and waste time on known, obvious or unimportant. Indeed those are dishonest methods based on plagiarism, which led us where we are today.

Although these ways are very effective, but also prevent solving real problems such as those related to poor efficiency and pollution emissions from millions of vehicles or the Industry. Therefor a total stagnation of the entire field of engine research is the results.

We have reached almost total destruction of urban environment crowded with vehicles, where many suffer from respiratory problems like Asthma or Chronic Bronchitis or even genetic disorders plus heart attacks and strokes resulted from inhaling black particulates emitted from vehicles.

The most important fault in all engines is very poor expansion of exhausts

All engines expand exhaust not completely and that relates to geometrical dependencies between cylinder bore and the length of crank. Mr. Sultzer- a Swiss engineer- first noticed this fault and elongated crank adding a cross-guide to the piston rod in his invention of a two stroke long crank diesel engine; patent granted in 1923, which doubled efficiency over an engine with normal crank. However the long crank engines are only popular in marine versions to propel ships. In those days Academia, as well the industry resisted use of long crank engines and many of those made life of inventor miserable by accusing him of stealing invention and Mr. Sultzer was exposed to painful legal actions and accused of a robbery of intellectual property, but he won and patent was granted 13 years after filling. In 1926 he proved efficiency of his invention doubled over that of the engine with normal crank and proved the efficiency exceeded 46%

Automotive industry has not tried that technology, due to difficult balancing of not symmetrical rotating mass of long crank at high speeds (dominating engines in vehicles).

Expansion of exhaust is a very important factor that defines energy conversion and efficiency of all engines. Thus researchers should concentrate on developing new ways to extend expansion of exhaust below atmospheric pressure. This paper proposes two such ways resulted from new thermodynamic cycle presented herein.

The need to break engine research stagnation

We still use the XIX century Diesel and Otto thermodynamic cycles, even though both cycles include heat wasting processes: one process is the release of hot exhausts and the other process is the external cooling to prevent melting of internal parts. Both cycles intentionally waste most (80%) of heat energy released from fuel and that reduces efficient operation in all engines today. A new thermodynamic cycle is needed, such one that is free from the intentional wastes of energy and can be practically implemented. This paper proposes such cycles.

New thermodynamic engine cycle and new engine design are needed

The most devastating is that researchers accepted the XIX century thermodynamic cycles and resulting from the cycle engine designs as final proving lack of critical thinking as well lack of imagination or scientific passion to deliver expected solutions.

Although those have worked hard for over a century long history of engine development trying to improve diesel or gasoline engine, their efforts have not produced expected results and it seems that they are involved in some kind of a Sisyphean work leading nowhere, because they concentrate on trifles such as: better parts; prevention of detonation; better control of combustion processes or lowering resistance of fluid flow through valves, while the most destructive to energy conversion and efficiency are the following:

1. Poor expansion of exhausts from which result:
   - 1.1. Conversion of a fraction (hardly exceeding 20%) of heat energy released from fuel into work
   - 1.2. Accumulation of not converted heat in internal parts and thus
   - 1.3. Need for cooling to prevent engine from melting (huge waste of energy in all engines)
   - 1.4. Releasing very hot exhausts (huge waste of energy in all engines)

Overview of publications

Nobody has published a paper defining precisely what causes the inefficiency, only very wrong statements blaming the second law of thermodynamics or thermodynamic cycle, which indicates total misunderstanding of the second law of thermodynamics that is one of many laws of nature we must obey, but the Diesel or Otto thermodynamic cycles are products of human mind and if deficient, those can be changed- if their flaws are precisely defined. This paper defines the flaws and proposes a new thermodynamic cycle and new engine design free from the flaws as seen in today engine cycles and engine designs.

The recent publications glorifying low temperature combustion is another blunder added to many from the past, because it quarrels with the second law of thermodynamics, which instruct that we should rather increase the temperature of energy release from fuel and certainly not decrease it.

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To eliminate mentioned violations of basics of physics, let's define an ideal engine from which all the above violations are removed.

Ideal engine

Ideal engine is an engine, the design of which does not violate basics of physics -as previously described. Therefore in the ideal engine:

1. Max pressure should act upon piston when crank is horizontal, because this increases torque by two orders
2. Energy release from fuel should be by detonation, because this increases the rate and temperature of energy release from fuel and that is necessary- according to the second law of thermodynamics
3. The fuel should be an explosive mixture of fuel vapor, or gaseous fuel like hydrogen and air, because this causes needed detonation and also prevents formation of black particulates emissions
4. Expansion of exhaust should be below atmospheric pressure because this converts more of the heat released from fuel into useful work
5. Cooling should be by conversion of heat into work only, because this eliminates heat losses
6. More than one power stroke resulted from a single energy release from fuel
7. Torque should be high and should retain at max from starting up to max speed because this eliminates need for energy wasting transmission
8. Ignition should not be advanced, because this eliminates the "parasitic" torque as seen in all engines
9. Efficiency should be high in a range of 90% to 95% and retain at max from starting up to max speed
10. Power available from fuel should be maximized by repeating max pressure when crank is horizontal
11. More than one power stroke should result from each energy release from fuel

***To recap*:**

A. *A new thermodynamic cycle is a must or engines will remain inefficient and polluting*
B. *A new engine design based on that new cycle is needed as well*

C. The present day engine technology deserves to be sent to museum and should be prevented from use by legislation to preserve fuel resources and the environment
D. A new engine should be developed according to the new design

Discovering a new thermodynamic cycle
Challenges:
A new thermodynamic cycle would be possible if one can find how to:

1. Expand exhaust below atmospheric pressure in order to convert more heat into work , while cooling cylinder internally without heat losses
2. Recover energy left in expanded exhaust
3. Use the recovered energy to re-compress the exhaust
4. Expand the re-compressed exhaust again to produce additional work
5. Repeat process 1 to process 4 until meaningless heat is left in the exhaust
6. Releasing cool exhaust

Finding answers to these challenges led to the concept of a thermodynamic cycle (patent pending) which includes the following processes:

1. Vaporizing fuel
2. Mixing resulting fuel vapor with air to create an explosive mixture
3. Inducting the explosive mixture into cylinder
4. Compressing the mixture in cylinder
5. Detonating the mixture precisely at TDC (Top Dead Center) to yield a pulse of high pressure and temperature
6. Expanding the resulting exhaust below atmospheric pressure during first power stroke
7. Repeating pressure of detonation over work piston when crank is horizontal
8. Recovering the energy from expanded exhaust
9. Using the recovered energy to re-compress the exhaust
10. Expanding the exhaust again to produce additional power stroke
11. Repeating process 8 to process 10 until the temperature of re-compressed exhaust dropped below dew point
12. Releasing cool exhaust into a water/exhaust separator
13. Commencing next engine cycle indefinitely while
14. Separating water resulting from reactions of fuel carbohydrates and air
15. Releasing cool exhausts
16. Collecting and treating the resulting water for usage

Discovering a new engine design according to the new thermodynamic cycle

Challenges:

A new engine design based on the new thermodynamic cycle is possible if one can find out how to invent:

1. A method to cushion tremendous forces of detonation to prevent mechanical damages?

2. A method to cool exhaust fast internally before the high temperature of detonation melts the internal parts?
3. A method and device that would allow repeating tremendous pressure of detonation over work piston when crank is horizontal to boost torque by two orders?
4. a better graph of pressure building over the work piston, so when crank is aligned with centerline of cylinder the pressure is zero and it raises gradually and then maximizes when crank is horizontal and then drops gradually until is zero upon completion of power stroke?
5. A method to recover heat energy from expanded exhaust?
6. A method to use the recovered energy to re-compress expanded exhaust?
7. A method to re-expand exhaust again so to yield additional power stroke?
8. Repeat the process 5 to process 7 according to the new thermodynamic cycle?

Finding answers to these challenges

Answering these challenges led to an invention of a new engine design (patent pending), described in publication [1&3].

Author describes the new engine in publication [1&3] and also compares the new engine to a long crank long stroke marine propulsion in publication [2]

New engine design

The new engine design comprises mainly four functional blocks:

1. An explosion enforced harmonic oscillator replacing cylinder head, the functions of which are as the following:
   - 1.1. Receiving on its input, which is a primary energy chamber, an explosive charge of fuel and air
   - 1.2. Compressing the mixture
   - 1.3. Detonating the mixture to produce a pulse of high pressure and temperature
   - 1.4. Cushioning tremendous forces of detonation to prevent mechanical damages
   - 1.5. Extending expansion of exhaust to, or below atmospheric pressure to cool exhaust fast which prevents accumulation of heat in parts and thermal damages
   - 1.6. Converting the pressure pulse into cosinusoidal pressure variations during expansion
   - 1.7. Converting the cosinusoidal pressure variation into sinusoidal pressure variations on its output
   - 1.8. Providing the sinusoidal pressure variations over piston of the traditional engine
   - 1.9. Re-compressing expanded exhaust
   - 1.10. Re-expanding exhaust again
   - 1.11. Continue the process 1.8 & process 1.9 until the temperature of exhaust drops below dew point
   - 1.12. Releasing cool exhausts into an exhaust separator
   - 1.13. Commencing next engine cycle indefinitely

2. A prior art engine, the cylinder head of which is replaced by the said harmonic oscillator; wherein the function of the said engine are as the following:
   2.1. Receiving on its input, which is an energy recovery chamber, the output from harmonic oscillator that are sinusoidal pressure variations
   2.2. Converting the pressure variations into torque and rotation
3. A water/exhaust separator the functions of which are as follows:
   3.1. Receiving from the harmonic oscillator the said exhaust with fog that can contain also traces of NOx or SOx pollutants
   3.2. Allowing dissolving the pollutants in the droplets forming fog to clean exhaust; wherein the surface of contact between exhaust and each individual droplet is tiny, but the numerous droplets of water forming the fog create large surface into which pollutants dissolve fast in real time, which clean the exhaust
   3.3. Separating polluted water from exhaust
   3.4. Releasing clean exhaust
   3.5. Directing contaminated water into water treatment
4. Water treatment block, the functions of which are:
   4.1. to treat the recovered water
   4.2. collect the treated water for usage

Mathematical proof of the new cycle and new design

Pressure resulting from detonation of fuel

Ignition advancement and slow energy releases by combustions causes that the max pressure in TDC results from only 7% of energy release from fuel in prior art engines. Thus detonating fuel exactly in TDC yields pressure proportionally higher in the invented engine - see (2)

$$P_{\exp pulse} = \frac{100\%}{7\%} \bullet p_{MAX.DIESEL} = 14.3\, p_{MAX-DIESEL}; \qquad \textbf{(2)}$$

In diesel engine the average pressure over piston is calculated as **(3)**

$$P_{av.disel} = P_{MAX-DIESEL} \int_{0\pi} e^{-\beta t} dt; \qquad \textbf{(3)}$$

Calculation of effective pressure acting on work piston in new engine

Effective pressure of sinusoidal pressure variation that act on piston in the ultimate engine could be calculated as (**4)**

$$P_{eff-invention} = 14.3\, p_{MAX-DIESEL} \bullet \frac{0.707}{2} \bullet \int_0^{\pi} e^{-\beta t} dt = 4.456 \bullet P_{av-diesel}; \qquad \textbf{(4)}$$

The expression (4) proves that energy conversion of new design improves by incredible 445.6%. Therefore the resulting efficiency improves in the same proportion and the efficiency is almost the same as that of Carnot engine.

Also the new design eliminated need to advance ignition and that flatten the efficiency vs. speed characteristics so the resulting efficiency is preserved within whole range of speeds from start up to max speed.

This features of the new design, if properly exploited, preserves good mileage within the whole range of speeds that is: the fuel consumption during port maneuvers is as low as during ocean run.

Torque calculation

Using expression (2) is easy to calculate the pressure that yields torque, as resulting from expression (5), thus torque improves according to the expression (6).

$$P_{cr.hor.-convert} = 14.3 \bullet p_{MAX-DIESEL} \bullet \frac{r}{2} = 101 P_{MAX-DIESEL} \quad ; \qquad \textbf{(5)}$$

$$T_{invention} > 101 T_{diesel}; \qquad \textbf{(6)}$$

Please notice:

1. The improvement of torque is above two orders better from the same fuel than in diesel engine;
2. This indicates a potential to save fuel by 99% without power sacrifices

Exploring aspects of this new engine design

The engine design could be explained using black box design method "borrowed" from system developers. The black box is a functional block that does not provide any information about internal parts or relationship among parts of the block. Instead it defines the inputs and outputs of the block plus its functions. This allows speeding up the designing processes and eliminates what is irrelevant; but it adds design issues not existing in designs of prior art engine such as frequency relationships

Frequency relations between the oscillating mass and work piston

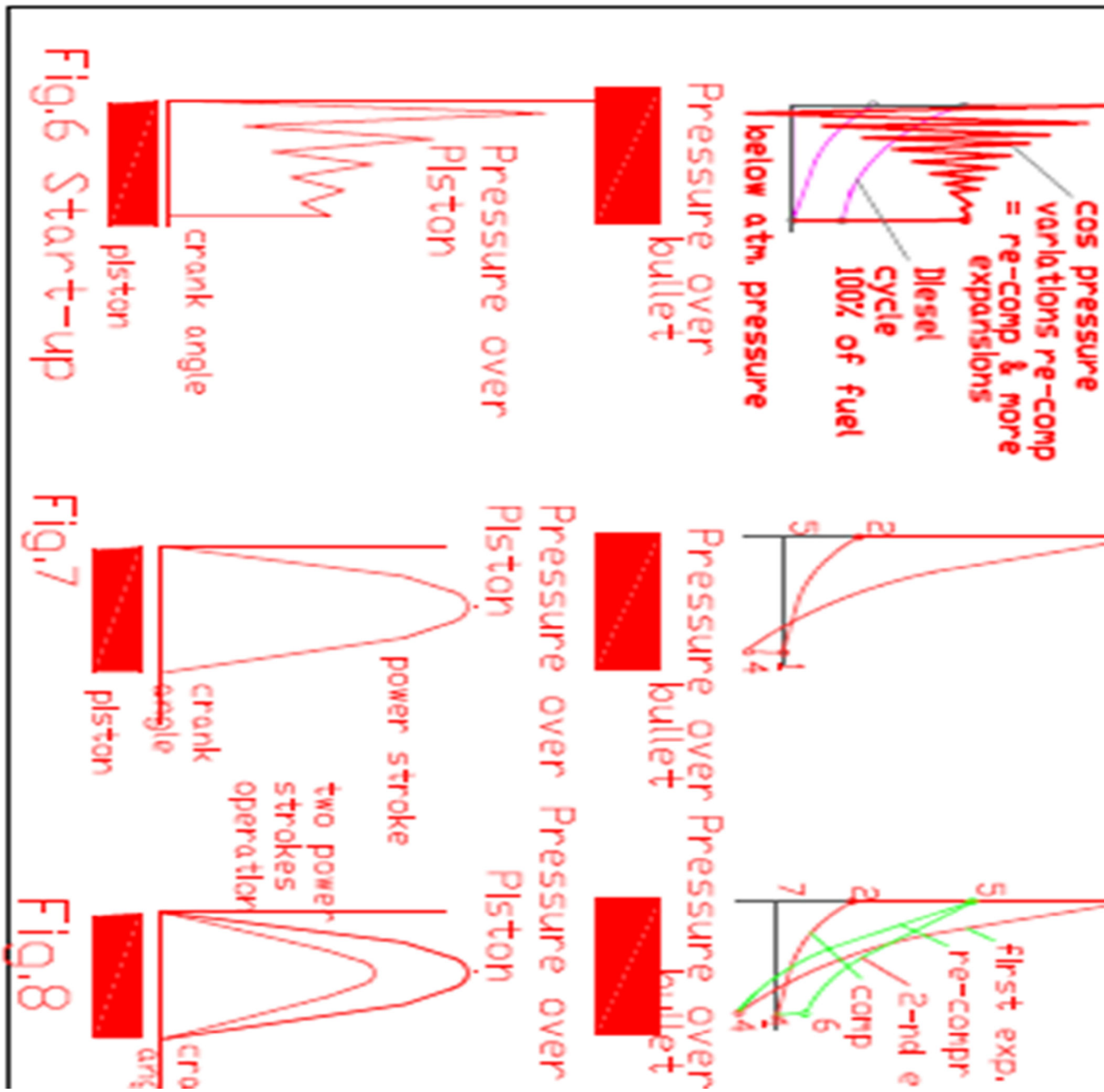
The use of the oscillator adds new design considerations. The new design must address frequency dependence between two oscillating components. These are: 1) oscillating mass of the oscillator 2) the piston of engine that oscillates and is connected to load; wherein both are separated from each other by the energy recovery chamber.

There are three conditions:

1. Frequency of oscillating mas is higher that of work piston
2. Frequency of oscillating mass is equal to that of work piston and phase difference is 180 degree
3. Frequency of oscillating mass is lower than that of work piston; wherein the condition 1) occurs during starting and up to max speed, condition 20 occurs when piston and oscillating mass approach each other bouncing back and condition 3) occurs when car downs the hill and this induces breaking, which prevents over-speeding.

Therefore three variations of the new thermodynamic cycles result related to:

1. Starting and speeding up to the destined speed
2. Destined speed
3. Driving down the hill



<u>Converted Suzuki at test bed (right photo)</u>

<u>Conversion of junk into the most efficient possible engine</u>

For test description refer to publication [1]
For design details refer to publications [1&3]

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Contacts

Address: K. Holubowicz-Independent Inventor; #1208-7272 Kingsway, Burnaby, BC, Canada V5E 4G1;
Tel.: +1.778.397.8999 ;
Email:gun-engine@shaw.ca