GAS EQUATIONS WITH ANALYSIS OF INTERNAL COMBUSTION ENGINE OPERATION AND ITS IMPROVEMENTS

Author:	Dipl.-Ing. Andrija Radović
Tel:	+381 64 1404075
E-mail:	andrijaradovic@hotmail.com
Address:	Spasovdanska 13a
	11030 Belgrade, Serbia

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ABSTRACT

The objective of this paper is to analyze physical and constructional limitations of the contemporary combustion engines. There will be demonstrated that the increase of efficiency can be achieved on three possible ways: conventional, semi-conventional and unconventional ones.

The conventional method is based on the full derivation of classical Gas Kinetic Model with profound clarification of all equations with especial attention to the formula for adiabatic expansion. Conventional concept deals with the mechanical energy extraction by the expansion of the gas chamber and general conclusion is that motion of the piston should be adjusted to the gas equation in the way to keep force momentum as constant as possible which requires elliptical gears. The consequential conclusion is that compression ratio should be adjusted according adiabatic equation and fuel property and that operating volume should vary too by both piston displacement variation and varying volume of the residual area to keep fuel-volume ratio in optimal range for particular power and rpm. The ratio of volume-surface should be kept as low as possible to minimize thermal loss through the cylinder’s wall and there thermal insulation can help a lot. The compression-decompression ratio should be asymmetric and there is also a way for utilization of much more effective Stirling like cycle. These recommendations for improvements can bring additional 20% of efficiency only by the slight modification of the current design of reciprocal engine.

Semi-conventional method is based on the side result of the analysis of the classical concept indicating that constant of adiabatic expansion can be significantly augmented by the limitation of freedom’s degree of molecules during expansion which can be achieved preferably via magnetic collimation or even with the electrostatic field. This is intuitively conceivable because molecules collimated in one direction will better pound the piston then ones running in all directions. There is also indication that acceptance of energy from the molecules may be achieved by the physical fields and not only by the expansion of the combustion and in the rest of the text are given even a few possible methods for that – MHD extraction or induction pump-generator, one of them even include method for generation of artificial gravitational field utilized as the brake field for energy extraction of the motional non-conductive fluid.

The unconventional method is based on the theory of Schauberger and it greatly impacts the possibility of realization

of thermal cycle based on the entirely liquid coolant in the entire cycle. This theory has great repercussion to the concept of ionic thermal pump and even to the explanation of the seemingly overunity machines whose, in fact, drain Zero Point Energy. It seems that plasma is just a coolant with excellent properties and therefore plasma arc is absolutely ideal coolant for the heat pump. The Fermi-Dirac distribution claims that even on absolute zero conductive electrons should have kinetic energy caused by the quantum fluctuation of the space itself, which is the same sort of fluctuation as the one causing the laser’s beam to slightly spread on the distance in vacuum. The source of these fluctuations is the same one causing the uncertainty, which is so common to our apprehension of the time implying that the concept of the time itself is connected to those fluctuations – time is rather related to the uncertainty of the future than being a true fourth spatial dimension.

GAS KINETIC MODEL

Objective of this chapter is derivation of the classical concept and profound clarification of all formulas especially vague ones which should betoken possible improvements of the classic thermodynamic machines based on the mechanical energy extraction by the gas chamber volume expansion.

Let us start from the volume populated with the molecules cheerfully running everywhere representing the most classical concept of the ideal gas. Force of those molecules acting to the wall of the chamber is given by the following equation:

$$F = \frac{dP}{dt} = \frac{dm}{dt} \cdot v \tag{1}$$

Whereas F is force, P is pulse or linear momentum, m is mass of the gas, v is average velocity of the molecule and t is time. While the velocity is changing double after bouncing from the wall and while there are three dimensions and also while there are two directions for possible motion of the molecule we have:

$$F = \frac{dm}{dt} \cdot v = \frac{1}{2 \cdot 3} \cdot 2 \cdot \frac{dm}{d\ell} \cdot \left(\frac{d\ell}{dt} \cdot v \right) = \frac{2}{6} \cdot \frac{dm}{d\ell} \cdot v^2 \tag{2}$$

As aforesaid, six is number of possible directions in E^3 space and number two denotes the total change of linear momentum (i.e. pulse) during repulsion. The volume of the chamber is given by the following formula:

$$V = S \cdot \ell \tag{3}$$

Thereby we have that force acting to the walls of the chamber filled with homogenous gas is:

$$F = \frac{2}{6} \cdot \frac{m}{\ell} \cdot v^2 = \frac{2}{6} \cdot \frac{m}{V} \cdot v^2 \cdot S \tag{4}$$

$\Rightarrow$

$$\frac{F}{S} = \frac{2}{3 \cdot V} \cdot \frac{m \cdot v^2}{2} = \frac{2}{3 \cdot V} \cdot \frac{N \cdot m_m \cdot v^2}{2} = P \tag{5}$$

$\Rightarrow$

$$P = \frac{2}{3 \cdot V} \cdot \frac{m \cdot v^2}{2} = \frac{m \cdot v^2}{3 \cdot V} = \frac{\rho \cdot v^2}{3} \tag{6}$$

$\Rightarrow$

$$v = \sqrt{\frac{3 \cdot P}{\rho}} = \sqrt{\frac{3 \cdot P \cdot V}{m}} \tag{7}$$

Whereas m_m is the mass of a single molecule and ρ is the density of the gas in the chamber.

From (5) we have:

$$P \cdot V = \frac{2}{3} \cdot N \cdot E_m \tag{8}$$

Formula for average energy E_m of a single molecule on absolute temperature T is borrowed from the similar theory without further examination of its validity:

$$E_m = \frac{3}{2} \cdot k_B \cdot T \tag{9}$$

As mentioned, above equation is the alien one borrowed from appropriate theory and its validity will not be queried. Further we have:

$$\frac{m_m \cdot v^2}{2} = \frac{3}{2} \cdot k_B \cdot T \tag{10}$$

$\Rightarrow$

$$\frac{m_m \cdot N_m \cdot N_A \cdot v^2}{2} = \frac{3}{2} \cdot N_m \cdot N_A \cdot k_B \cdot T \tag{11}$$

Whereas N_A is Avogadro[1] number and N_m is number of gas' moles. While gas constant is equal to the product of Boltzmann[2] constant and Avogadro number we have:

$$\frac{m \cdot v^2}{2} = \frac{3}{2} \cdot N_m \cdot R \cdot T \tag{12}$$

[1] Lorenzo Romano Amedeo Carlo Avogadro di Quaregna e di Cerreto, 1776 – 1856
[2] Ludwig Eduard Boltzmann, 1844 – 1906

$\Rightarrow$

$$E_U = \frac{3}{2} \cdot N_m \cdot R \cdot T = C_V \cdot R \cdot T \tag{13}$$

Whereas k_B is Boltzmann constant, E_U is internal heat energy of the gas and C_V is the isochoric constant of the gas. And the number of molecules is:

$$N = N_A \cdot N_m \tag{14}$$

After (9) and (14) have been inserted into (8) it is obtained:

$$P \cdot V = N_A \cdot k_B \cdot N_m \cdot T \tag{15}$$

$\Rightarrow$

$$P \cdot V = R \cdot N_m \cdot T \tag{16}$$

This brevity derivation allegedly offers one insurmountable explanation of all thermodynamic processes, but this will be challenged in the text below.

Equation (16) does not count speed of the piston. The equation that pays attention to that speed of the barrier, i.e. piston V_b is:

$$P \cdot V = N_m \cdot R \cdot T \cdot \left(1 \pm 2 \cdot v_b \cdot \sqrt{\frac{M_r}{3 \cdot R \cdot T}} + v_b^{\ 2} \cdot \frac{M_r}{3 \cdot R \cdot T} \right) \tag{17}$$

This equation resembles to Peng-Robinson equation [4] very much:

$$P = \frac{R \cdot T}{V_m - b} - \frac{a \cdot \alpha}{V_m^{\ 2} + 2 \cdot b \cdot V_m - b^2} \tag{18}$$

According above equation the pressure is higher on the surface of the piston that compresses the gas than on the rest of walls of the cylinder. The extra pressure on the cylinder can be treated also as jet pressure:

$$\left(P + P_{jet}\right) \cdot V = R \cdot N_m \cdot T \tag{19}$$

$\Rightarrow$

$$\left(1 \pm 2 \cdot \frac{M_r \cdot v_b^{\ 2}}{R \cdot T} \right) \cdot P \cdot V = R \cdot N_m \cdot T \tag{20}$$

Above equation resembles to Van der Waals[3] one derived in year of 1873:

$$\left(P + \frac{a}{V_m} \right) \cdot \left(V_m - b\right) = R \cdot T \tag{21}$$

[3] Johannes Diderik van der Waals, 1837 – 1923

Most of modern gas equations only modify the volume of void space of cylinder in the basic gas equation (16) excluding the space populated by the molecules themselves without noticing the dynamic influence of the compression and decompression process at all! They failed to notice that forces of compression and decompression are slightly different and thereby periodical compression and decompression of the gas would increase its temperature and this effect was treated as frictional heating although it was not that simple! They also failed to notice that the mass of the gas, i.e. inertial property of the operational fluid also plays role in the cycle especially in the fast engines and that this gas mass also confronts to the compression and decompression too congesting the molecules in the vicinity of the piston's head. The attempt of putting all these modifications in a single variable usually brings only partial results embodied in many various gas equations no one fitting well.

Equation (13) deal with the internal thermal capacity of the gas and equation (16) deals with the mechanical property of the gas, and this apparent duality of the gas properties will be analyzed in the text below.

DERIVATION OF THE FORMULA OF ADIABATIC CYCLE ENTIRELY BASED ON THE GAS KINETIC MODEL

As aforesaid, major objective of this paper is proper derivation of equation of the adiabatic expansion because this is the formula of utmost importance for thermodynamics used in practical energetic applications – this formula defines operation and efficiency of almost any internal combustion motor in common usage today.

Let us try first to derive polytrophic formula of adiabatic expansion solely from the kinetic theory starting from the equation (6):

$$P = \frac{2}{3 \cdot V} \cdot \frac{m \cdot v^2}{2} = \frac{2}{3 \cdot V} \cdot \frac{m}{2} \cdot \left(\frac{2 \cdot E}{m} \right) = \frac{2 \cdot E}{3 \cdot V} \tag{22}$$

We also have that is:

$$P = -\frac{dE}{dV} \tag{23}$$

Increase of the volume causes decrease of the internal energy of the gas because the gas performs mechanical work – thereby the minus sign exists in above equation. Combining (22) and (23) we have:

$$\frac{dE}{dV} = -\frac{2 \cdot E}{3 \cdot V} \tag{24}$$

This simple differential equation has following solution:

$$\frac{E}{E_0} \cdot \left(\frac{V}{V_0} \right)^{\frac{2}{3}} = 1 \tag{25}$$

Variable E will be replaced by P and V via (22):

$$E = \frac{3 \cdot P \cdot V}{2} \tag{26}$$

When (26) is inserted into (25) it becomes:

$$\frac{P \cdot V}{P_0 \cdot V_0} \cdot \left(\frac{V}{V_0} \right)^{\frac{2}{3}} = 1 \tag{27}$$

$\Rightarrow$

$$\frac{P}{P_0} \cdot \left(\frac{V}{V_0} \right)^{\frac{5}{3}} = 1 \tag{28}$$

$\Rightarrow$

$$P \cdot V^{\frac{5}{3}} = Const \tag{29}$$

Above formula has exponentiation coefficient that is not that close to the experimentally determined coefficient for the air that is 1.4 mismatching the value of 1.6666 a lot. This value is theoretically derived from Gas Kinetic Theory and it is completely valid for the ideal gas only.

DERIVATION OF THE FORMULA OF ADIABATIC CYCLE ENTIRELY BASED ON THE EXTENDED KINETIC MODEL – PHLOGISTON MODEL

There were few attempts to correct above formula and to make it closer to the real situation occurring in cylinders by additional Degrees of Freedom coefficients, although those coefficients can only increase the exponentiation coefficient, not to decrease it. Allegedly gas is able to absorb part of the kinetic energy into the rotational motion which is treated by those Degree of Freedom coefficients. This mechanism of transfer of linear kinetic energy into mechanic one is not quite clear because piston performs only linear compression and decompression whose then should lead to increase or decrease of the spins in the atoms in molecules precisely oppositely directed to preserve Angular Momentum's Conservation Law – the one of the very few physical laws whose correctness we take for granted. This is not just a minute error because various gases have different polytrophic coefficients and this abundance of coefficient's values cannot be explained simply by the Degree of Freedom correction coefficient for the particular gas and even not with the introduction of the new force like Van der Waals one. We believe that exchange of impulses between gas particles in the collision is happening only under the control of Energy and Momentum Conservation Laws that also rule Gas Kinetic Theory too. Therefore failure of the Gas Kinetic Theory which is entirely based on the atomistic model would rather challenge the laws of energy and momentum conservations than the nature of force fields that surround the molecules themselves or putatively the volume occupied by the molecules. The essence of the problem becomes obvious on the Crookes[4] photometer whose rotor rotates by repealing on the gas in perfectly symmetric spherical chamber although this should not be possible according the fact that closed circular constant force's integral over the spherical surface is always equal to zero indicating that something is wrong with the repealing force itself! If this force is not conservative one, then this indisputably means that action-reaction law does not act in total here and that some sort of Doppler's effect rules here too perceivable in equation (17) and (20). The essence of the rotors rotation cannot be solely the light's linear momentum because generated force exceeds few orders of magnitude the value expected from the Einstein[5] linear momentum formula P=h·f/c… unless somehow it can, just as it obviously can! Operation of this device may imply that Act at Distance Theory based on the Classical String Theory might be correct.

Therefore it is pertinent place to be noticed that most of researchers have been locating the crux of the problem in the gas state, in the domain of potential energy instead in the exchange of the energy between the molecules themselves simply because the force fields cannot affect kinetic energy exchange as far as they are conservative and symmetric in both spatial and speed's meanings. They were obtaining those corrections usually by involvement of a new kind of exotic force acting to the molecules embodied in a new coefficient in the gas equation and by extruding the volume populated by the molecules.

The classical textbooks usually tried to overcome this unpleasant situation in which is less or more obvious that atomistic theory is stumbling here by introduction of one totally empiric equation for thermal capacity initially derived by Newton[6] and which seemingly does have approval in equation (9). The usual name for this method is Extended Kinetic Theory which is actually in its essence a Phlogiston Model. The empirically obtained formula for gas thermal capacity is:

$$E_U = Q \cdot m \cdot T \tag{30}$$

Or:

$$E_U = C_V \cdot N_m \cdot T \tag{31}$$

Whereas Q is mass thermal capacity of the gas, m is mass of the gas, C_V is molar thermal capacity of the gas or isochoric constant, T is its absolute temperature and E_U is thermal energy inserted by heat into gas with mass m or number of moles N_m on the absolute temperature T. Extended Gas Kinetic

[4] William Crookes, 1832 – 1919
[5] Albert Einstein, 1879 – 1955
[6] Isaac Newton, 1642 – 1727

Model is entirely based on the above empirical equation and theoretical equation (16).

Instead to take equation (9) for granted this concept simply involves another equation with extra coefficient C_V obtained experimentally for each gas particularly.

Directly from gas equation (13) follows that thermal capacity of the gas Q is:

$$Q = \frac{3}{2} \cdot \frac{R}{m_r} \tag{32}$$

And:

$$C_V = \frac{3}{2} \cdot R \tag{33}$$

According Gas Kinetic Model it is:

$$C_V = M_r \cdot Q \tag{34}$$

Whereas m_r denotes molar mass of the particular gas. Formulas (32) and (33) are not utterly true for any real gas and therefore their right sides are replaced with the coefficients Q or C_V respectively whose are experimentally obtained for the each particular gas apart.

These equations seemingly look like aliens in this concept and this is the point where this derivation starts being more contrived than derived mainly due to introduction of an extra equation (30) apparently not required by the Gas Kinetic Model that is theoretically able to yield equation (33) entirely by itself only. After derivation of (30) we have:

$$dE_U = C_V \cdot N_m \cdot dT \tag{35}$$

Mechanical work of the piston done by the gas's internal heat is:

$$dE_A = F \cdot d\ell = P \cdot S \cdot d\ell = P \cdot dV \tag{36}$$

In the adiabatic cycle energy transfers from the internal energy E_U into mechanical work E_A implying that increase of the volume causes drop of internal energy and consequently temperature, and therefore by equalizing (35) and (36) the resulting equation should contain a minus sign:

$$P \cdot dV = -C_V \cdot N_m \cdot dT \tag{37}$$

$\Rightarrow$

$$dT = -\frac{P}{C_V \cdot N_m} \cdot dV \tag{38}$$

Differentiation of the initial gas equation (16) only dedicated to the mechanical properties of the gas yields following formula consisted of the sum of isochoric and isobaric processes:

$$dP \cdot V + P \cdot dV = R \cdot N_m \cdot dT \tag{39}$$

After (38) is inserted into (39) we have obtained:

$$dP \cdot V + P \cdot dV = -R \cdot N_m \cdot \frac{P}{C_V \cdot N_m} \cdot dV \tag{40}$$

⇒

$$dP \cdot V + P \cdot dV = -\frac{R}{C_V} \cdot P \cdot dV \tag{41}$$

⇒

$$dP \cdot V = -\frac{R \cdot P}{C_V} \cdot dV - P \cdot dV \tag{42}$$

⇒

$$dP \cdot V = -\left(\frac{R}{C_V} + 1\right) \cdot P \cdot dV \tag{43}$$

⇒

$$\frac{dP}{P} = -\left(\frac{R}{m_r \cdot Q} + 1\right) \cdot \frac{dV}{V} \tag{44}$$

⇒

$$LOG\left(\frac{P_1}{P_0}\right) = -\left(\frac{R}{C_V} + 1\right) \cdot LOG\left(\frac{V_1}{V_0}\right) \tag{45}$$

Now we have equation for the adiabatic work of the piston entirely relied on the gas internal heat energy:

$$\frac{P_1}{P_0} = \left(\frac{V_1}{V_0}\right)^{-\left(\frac{R}{C_V}+1\right)} \tag{46}$$

⇒

$$\frac{P_1}{P_0} = \frac{V_1^{-\left(\frac{R}{C_V}+1\right)}}{V_0^{-\left(\frac{R}{C_V}+1\right)}} \tag{47}$$

⇒

$$P_0 \cdot V_0^{\frac{R}{m_r \cdot Q}+1} = P_1 \cdot V_1^{\frac{R}{m_r \cdot Q}+1} \tag{48}$$

Or:

$$P_0 \cdot V_0^{\frac{R}{C_V}+1} = P_1 \cdot V_1^{\frac{R}{C_V}+1} \tag{49}$$

This equation is practically only useful equation for engineering of cylinders and pistons in adiabatic motors obtained from the Gas Kinetic Model. This equation is usually rather given in the following form also known as Polytrophic formula:

$$P \cdot V^{\frac{R}{m_r \cdot Q}+1} = P \cdot V^{\frac{R}{C_V}+1} = P \cdot V^{\chi} = k_A \tag{50}$$

Implying that adiabatic coefficient is:

$$\chi = 1 + \frac{R}{m_r \cdot Q} = 1 + \frac{R}{C_V} \tag{51}$$

Whereas P is pressure, V is volume and χ is adiabatic coefficient also known as Heat Capacity Ratio constant. χ is rather variable than constant because it slightly depends on the temperature and characteristics of the particular gas. Above equation has better form than equation (48) because equation (48) contains some sort of mutual dependency between variables because, as aforesaid, thermal capacity Q should be able to be expressed by the function of the molecule mass and velocity only and this is not the case in the real world.

We can proceed further with the derivation to obtain the gas equation:

$$dE_A = P \cdot dV = k_A \cdot V^{-\chi} \cdot dV \tag{52}$$

$\Rightarrow$

$$E_A = k_A \cdot \frac{V_1^{1-\chi} - V_0^{1-\chi}}{1-\chi} = -E_U = -m \cdot Q \cdot (T_1 - T_0) \tag{53}$$

$\Rightarrow$

$$P_1 \cdot V_1 - P_0 \cdot V_0 = m \cdot (\chi - 1) \cdot Q \cdot (T_1 - T_0) \tag{54}$$

$\Rightarrow$

$$P \cdot V = m \cdot (\chi - 1) \cdot Q \cdot T \tag{55}$$

According formula (51) above equation leads directly to equation (16) proving that Extended Gas Kinetic Model does not modify gas equation and that it affects adiabatic formula only.

Allegedly it is also:

$$\chi = \frac{C_P}{C_V} = \frac{Q_P}{Q_V} = 1 + \frac{dE_A}{dE_V} = 1 + \frac{P \cdot dV}{N_m \cdot C_V \cdot dT} \tag{56}$$

Whereas χ is adiabatic constant, Q_P is isobaric specific heat and Q_V is isochoric specific heat. It will be shown by equation (82) that above equation is correct.

Let us continue derivation of the energy that gas's internal heat transfers to the piston from classical equation (48). We will start from this equation simply because equation (30) yields some connection between internal energy and the temperature:

$$dE = P \cdot dV = \left(P_0 \cdot V_0^{\frac{R}{C_V}+1} \right) \cdot V^{-\left(\frac{R}{C_V}+1\right)} \cdot dV \tag{57}$$

⇒

$$E = \int_{V_0}^{V_1} \left(P_0 \cdot V_0^{\frac{R}{C_V}+1} \right) \cdot V^{-\frac{R}{C_V}-1} \cdot dV = \left(P_0 \cdot V_0^{\frac{R}{C_V}+1} \right) \cdot \frac{C_V}{R} \cdot \left(V_0^{-\frac{R}{C_V}} - V_1^{-\frac{R}{C_V}} \right) \quad (58)$$

Finally we have the amount of the mechanical energy transferred to the piston by the internal heat of the gas:

$$E = P_0 \cdot V_0 \cdot \frac{C_V}{R} \cdot \left(1 - \left(\frac{V_0}{V_1} \right)^{\frac{R}{C_V}} \right) \quad (59)$$

Or for the initial temperature before the decompression has started, it is:

$$E = m \cdot T_0 \cdot Q \cdot \left(1 - \left(\frac{V_0}{V_1} \right)^{\frac{R}{C_V}} \right) \quad (60)$$

Ratio $\frac{V_0}{V_1}$ is constant and it is defined by the motor's construction denoting the degree of the compression in the particular cylinder. It is about 1:10 for gasoline engines and 1:16 for diesel engines.

Initial temperature in the cylinder right after the explosion is:

$$T_0 = \frac{E_h}{Q \cdot m} \quad (61)$$

Pressure right after the explosion is:

$$P_0 = \frac{R \cdot E_h}{m_n \cdot Q \cdot V_0} \quad (62)$$

Whereas E_h denotes chemical energy released by the explosion by inserting (62) into (59):

$$E = \frac{R \cdot E_h}{m_n \cdot Q \cdot V_0} \cdot V_0 \cdot \frac{m_n \cdot Q}{R} \cdot \left(1 - \left(\frac{V_0}{V_1} \right)^{\frac{R}{C_V}} \right) \quad (63)$$

Finally:

$$E = E_h \cdot \left(1 - \left(\frac{V_0}{V_1} \right)^{\frac{R}{C_V}} \right) \quad (64)$$

Efficiency is:

$$\eta = \frac{E}{E_h} = 1 - \left(\frac{V_0}{V_1}\right)^{\frac{R}{C_V}} = 1 - \left(\frac{V_0}{V_1}\right)^{\chi - 1} \tag{65}$$

Above equation tells us that the efficiency of the adiabatic internal combustion engine does not depend on the heat energy of the gas and its amount and that it is only determined by the characteristic of the gas (which is usually air) and the degree of the compression's ratio which is constructional characteristic of the particular motor's design. Above formula is the one cited in the most of automotive encyclopedias showing full ingenuity of the internal combustion engine in respect to steam engine (adiabatic vs. isobaric cycle).

For the air we have:

$$\chi - 1 = \frac{R}{C_V} = 0.4 \tag{66}$$

Theoretical top efficiency of the gasoline engine is 60% and for the diesel engine is 67%, but for the modern gas turbine (top models has 1:40 to 1:42 decompression) it is astonishing 77%. The advancement of the ordinary symmetric cycle of internal combustion engine is asymmetric compression and decompression in Atkinson[7] or Split Cycle, i.e. situation in which compression is smaller then decompression preventing wastage of energy to usually unnecessary compression to such rate. Disadvantage of Split Cycle engine (e.g. Scuderi[8] engine) is its fixed ratio of compression and decompression that diminish efficiency outside the adequate speed and power making it very inelastic although this motor seemingly has zero residual compression bringing total ventilation of the pistons area. Residual volume certainly is not zero because it would indicate infinite compression. Both Atkinson and Split cycles are markedly better solutions than Otto[9] cycle with symmetric compression and decompression although those cycles are functionally equal only bringing reduction of compression loss via asymmetric compression and decompression. The better solution is replacement of extra cylinder with variable turbo compressor bringing variable compression and decompression ratio in Split Cycle engines and high efficiency over the whole range of speeds. The variable operating volume adjusted to the amount of air and fuel would be significant ecological and efficiency improvements of the concept. The asymmetric cycle is especially suitable for water injection to boost the power with decrease of efficiency by partial transition to the Rankine[10] Cycle.

It is questionable why the compression at all should be performed by the pistons themselves instead of the external turbo compressor capable to accurately adjust amount of air to the corresponding amount of fuel required

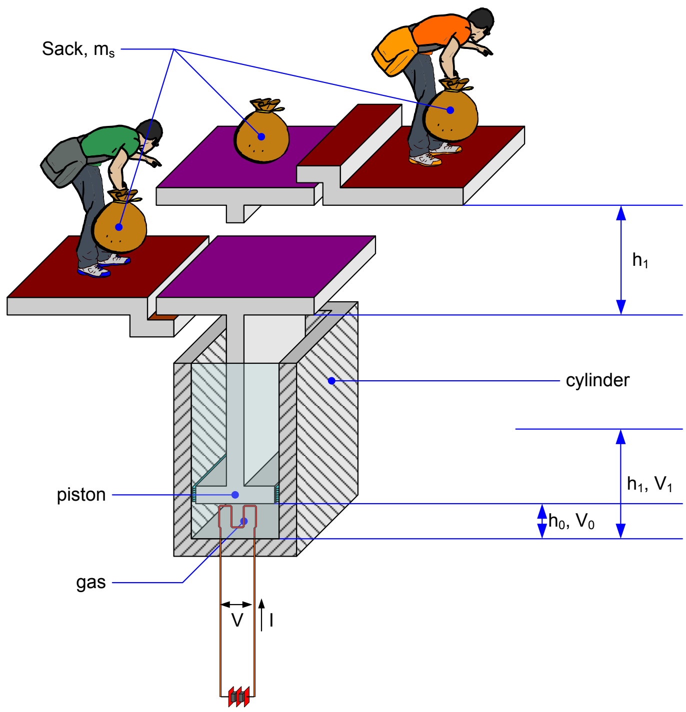
[7] James Atkinson, 1846 – 1914
[8] Carmelo J. Scuderi, 1925 – 2002
[9] Nikolaus August Otto, 1832 – 1891
[10] William John Macquorn Rankine, 1820 – 1872

by the needed power which is a sort of highly advanced Miller[11] cycle released without the compression phase at all.

ADIABATIC CYCLE AS MIXTURE OF ISOCHORIC AND ISOBARIC CYCLES

The modern concept of the gas deals with two empiric constants C_P and C_V and they true meaning is usually misunderstood in most of the textbooks if not all ones. First at all C_P and C_V do not deal with any sort of volume or pressure parameters at all which makes the whole concept a bit tricky for understanding. The concept behind those constants is depicted on the following figure:

Fig. 1



In this fabled situation is a buddy carrying a sack e.g. with the flour into the depot and the sack should be lifted to the appropriate floor by the gas piston. The platform that lifts the sack is limited beneath the lower side and above the upper side. And let the platform only barely touches the lower limiter settled beneath the platform. After the first buddy put the sack to the platform the platform starts pressing the lower limiter much higher. At the moment the electric heater settled in the residual volume of the cylinder starts heating the gas in the cylinder. Until the pressure reaches the value that lifts the platform we have pure isochoric heating cycle on the spot, and after the lifting is started there is a pure isobaric heating cycle in action. The electric heater inserts the thermal energy E_Q into the gas internal energy E_U in both cases, but in the case of isobaric cycle the gas also performs the mechanical work E_A while in the case of isochoric cycle the gas absorbs heater's energy

[11] Ralph Miller, ? - ?, invention discovered in 1957…

E_U only. The above picture also represents the rudimental case of Stirling[12] engine and only difference is that in Stirling engine the gas is pumped from the hot into the cold chamber via piston and in this case the whole cylinder is periodically cooling and heating. It is also obvious that Stirling engines of both kinds suffer from serious flaw related to unadjusted ratio of pumping cold and hot gas which should fit the temperature and the pressure in the hot and cold zone. The contemporary α and β designs of Stirling engines blear the whole concept hiding the theoretical essence of the cycle itself and both type of proposed mechanisms are faraway of any useful and efficient concept at all although it should not be so. Stirling engine is an excellent concept based on the entirely gaseous cycle, but without the insight of the basic principle the rest of the operation remains blurry.

Even more, even in the textbooks the sizes of the hot and cold pistons are usually drawn equally which is false. Stoddard[13] engine is much better and more conceivable concept than Stirling one, but although the compression piston is smaller than the decompression one their volumes ratio remains constant which ruins efficiency that significantly varies with the operational point. The Stoddard engine advanced with the variable compression via Atkinson cycle is going to be very good realization.

For the case of isochoric cycle (V = Const.) we have that is:

$$dE_Q = dE_V = dE_U = N_m \cdot C_V \cdot dT \tag{67}$$

Whereas dE_Q is the infinitesimal heat energy inserted into the gas from the external source, i.e. electric heater, N_m is number of moles, C_V is molar constant of specific heat for the isochoric cycle and dT is infinitesimal variation of gas's absolute temperature.

Above equation only yields connections between the amount of thermal energy that is inserted into the gas and the corresponding gas temperature variation via constant C_V.

The isobaric constant is defined as the increase of energy during the isobaric expansion and the increase of the gas's temperature during the lifting of the sack in the above example:

$$dE_Q = dE_P = N_m \cdot C_P \cdot dT \tag{68}$$

As it can be noticed there is no single variable denoting either volume or the pressure in any of the above two equations and therefore the explanation of C_V and C_P constants in the most of modern textbooks are utterly wrong.

In the case of isobaric expansion related to the isochoric one we need more energy for the same increase of the temperature because the gas splits incoming thermal energy into the chunk of internal energy that remains in the gas and the chunk that is transferred into the mechanical work.

The following equation is valid for the case of isobaric cycle:

$$dE_Q = dE_A + dE_U \tag{69}$$

[12] Robert Stirling, 1790 – 1878, motor invented in 1816,
[13] Elliott Joseph Stoddard, 1859 – ?, motor invented in 1919

I.e.:

$$dE_P = dE_A + dE_V \tag{70}$$

It is interesting to be noticed that the gas stubbornly splits incoming thermal energy into internal heat and mechanical work during the isobaric expansion in quite persistent and pretty constant ratio. According (67) and (68) we have:

$$N_m \cdot C_P \cdot dT = dE_A + N_m \cdot C_V \cdot dT \tag{71}$$

$\Rightarrow$

$$dE_A = N_m \cdot (C_P - C_V) \cdot dT \tag{72}$$

Above equation says that the mechanical work is difference between isobaric energy and isochoric energy while isobaric energy is consisted of mechanical energy and isochoric energy, i.e. heat energy. For the case of isobaric expansion it is:

$$P \cdot dV = N_m \cdot (C_P - C_V) \cdot dT \tag{73}$$

And, now, we have just derived Classical Gas Equation (16):

$$P \cdot V = N_m \cdot (C_P - C_V) \cdot T \tag{74}$$

Above equation defines connection between mechanical properties of the gas and its thermal capacity coefficients. It seems according (74) that is $R = C_P - C_V$. For ideal gas are $C_P = 5/2 \cdot R$, $C_V = 3/2 \cdot R$ and $\chi = 5/3$.

The efficiency of the isobaric engine also known as pneumatic motor is given by the following formula:

$$\eta = \frac{dE_{usefull}}{dE_{total}} = \frac{dE_A}{dE_P} = \frac{C_P - C_V}{C_P} = 1 - \frac{C_V}{C_P} = 1 - \frac{1}{\chi} \tag{75}$$

For isobaric motor based on ideal gas efficiency is 40% only, for air driven isobaric motor efficiency is 31% which is not pretty much at all. Although the efficiency of the isobaric motor is much smaller than the efficiency of adiabatic motor, the energy density of the isobaric motor is immensely higher than the adiabatic one because the pressure drops exponentially in the adiabatic cylinder while it remains pretty constant in entire isobaric cycle of pneumatic motor. Stirling engine can be either isobaric or adiabatic one. If the cylinder has constant income of the high pressure gas from the hot chamber then this is the case isobaric Stirling engine and if the valve is opened shortly just to pressurize the residual volume of the piston then this is isobaric type of Striling engine. There is the same classification of steam engines too. Supremacy of the isobaric cycle over the adiabatic one becomes obviously in the comparison of the pneumatic tools used by professionals on one side and both electric and gasoline ones on another where the power of pneumatic tools extensively outperform gasoline ones only due to usage of the isobaric cycle instead of the adiabatic one that is utilized in gasoline tools. Energy density and efficiency are mutually confronted and therefore the adiabatic cycle has better efficiency and lower energy density than isobaric one.

Mechanical energy released or absorbed by the gas via piston is:

$$dE_A = P \cdot dV \tag{76}$$

For the case of adiabatic cycle the energy used for the piston's motion is entirely stored in the gas already available in the piston's residual volume and therefore we have:

$$dE_A = -dE_Q \tag{77}$$

⇒

$$P \cdot dV = -N_m \cdot C_V \cdot dT \tag{78}$$

Above equation claims that entire energy of mechanical work is obtained from the internal thermal energy of the gas as we have assumed that adiabatic cycle is consisted of the isobaric and isochoric cycles combined.

Now, there is a tricky part, we would rely on the differentiated equation (74):

$$P \cdot dV + V \cdot dP = N_m \cdot \left(C_P - C_V\right) \cdot dT \tag{79}$$

By combining (78) and (79) it is obtained:

$$P \cdot dV + V \cdot dP = -N_m \cdot \left(C_P - C_V\right) \cdot \frac{P \cdot dV}{N_m \cdot C_V} \tag{80}$$

⇒

$$\frac{C_P}{C_V} \cdot \frac{dV}{V} = -\frac{dP}{P} \tag{81}$$

⇒

$$P_0 \cdot V_0^{\frac{C_P}{C_V}} = P_1 \cdot V_1^{\frac{C_P}{C_V}} = \mathrm{Const} = k \tag{82}$$

We have just derived formula for adiabatic compression via constant of C_P and C_V both initially unrelated to the volume and pressure with only assumption that Law of Energy Conservation is valid for this particular case too, i.e. that gas does not store energy into some form of chemical or some other sort of energy other than kinetic one. By derivation of equation (82) we have just proved equation (56).

The efficiency of the adiabatic motor is:

$$\eta = \frac{E_A}{E_Q} \tag{83}$$

Wereas E_A is released mechanical work and E_Q is inserted thermal energy. E_Q is:

$$E_Q = N_m \cdot C_V \cdot T_0 \tag{84}$$

$\Rightarrow$

$$T_0 = \frac{E_Q}{N_m \cdot C_V} \tag{85}$$

With the aid of (74) it is derived:

$$P_0 \cdot V_0 = \left(\frac{C_P}{C_V} - 1 \right) \cdot E_Q \tag{86}$$

While mechanical work per cycle is:

$$E_A = \int P \cdot dV = k \cdot \int_{V_0}^{V_1} V^{-\frac{C_P}{C_V}} \cdot dv = k \cdot \frac{V_1^{1-\frac{C_P}{C_V}} - V_0^{1-\frac{C_P}{C_V}}}{1 - \frac{C_P}{C_V}} \tag{87}$$

$\Rightarrow$

$$E_A = P_0 \cdot V_0 \cdot \frac{\left(\frac{V_1}{V_0} \right)^{1-\frac{C_P}{C_V}} - 1}{1 - \frac{C_P}{C_V}} = \left(\frac{C_P}{C_V} - 1 \right) \cdot E_Q \cdot \frac{1 - \left(\frac{V_1}{V_0} \right)^{1-\frac{C_P}{C_V}}}{\frac{C_P}{C_V} - 1} \tag{88}$$

$\Rightarrow$

$$E_A = E_Q \cdot \left(1 - \left(\frac{V_0}{V_1} \right)^{\frac{C_P}{C_V} - 1} \right) \tag{89}$$

According (83) efficiency is:

$$\eta = 1 - \left(\frac{V_0}{V_1} \right)^{\frac{C_P}{C_V} - 1} \tag{90}$$

As aforementioned, efficiency of the adiabatic motor (90) can significantly exceed the efficiency of the isobaric motor (75) at the cost of the diminished power density [W/kg]. Ratio V_0/V_1 is compression ratio, i.e. this is the ratio between maximal volume and residual volume at maximal and minimal displacements of the piston respectively.

In the case of the adiabatic Stirling engine the situation is not that clear and the integration of the pressure should be something between pressure of the hot and cold chamber, but similar efficiency can be achieved if the pure adiabatic cycle is utilized and therefore Stoddard engine is much better concept offering clear separation of hot and cold areas with improved efficiency.

This was a duly correct way of derivation of the adiabatic process, but in contemporary textbooks usually is cited following pathological method for the derivation based on duly incorrect premises that isobaric and isochoric constants can be generally defined as:

$$V \cdot dP = C_P \cdot N_m \cdot dT \tag{91}$$

And:

$$P \cdot dV = -C_V \cdot N_m \cdot dT \tag{92}$$

Although authors usually correctly name these constants as isobaric and isochoric ones, the equations (91) and (92) tell us a completely different story – that Q_P is an isochoric and Q_V is an isobaric constant. But, this particular moment requires from the reader to be derailed and then deluded just for accepting that and these authors then usually start to spray blurry terms like entropy, enthalpy, First Law of Thermodynamics, etc., just to distract reader and to compel they to take these two equations for granted. It seems that committee of first ever locomotives competition of the steam locomotives “Rainhill Trials” was completely aware of the true meaning of constants Q_P and Q_V (i.e. C_P and C_V) – it is astonishing that this knowledge was somehow lost in time and there is chance that this was done deliberately. It is interesting that equation (91) is directly derived from equations (78) and (79), and (92) is equal to (78) making both (91) and (92) perfectly legible equations except that their explanation is utterly incorrect because those equations are circumstantial ones valid in this particular adiabatic case only and therefore they are not definitional equations at all. In the case of the adiabatic cycle the equations containing C_P and C_V constants are so nasty crisscrossed bringing unaware reader into the complete confusion and delusion about true meaning of the constant C_P and C_V.

So, we have a very noxious combination here – correct equations shrouded by the incorrect explanations and the scale of engineers logic devastation becomes obvious after reading just a few papers dedicated to Stirling motor’s operation analysis.

By adding (91) and (92) following equation is obtained proving (74):

$$P \cdot dV + V \cdot dP = (C_P - C_V) \cdot N_m \cdot dT \tag{93}$$

$\Rightarrow$

$$P \cdot V = (C_P - C_V) \cdot N_m \cdot T \tag{94}$$

We will proceed with derivation based on the false assumption that C_P and C_V are defined by (91) and (92) just to clarify that the method of the derivation available in the most of the modern books are utterly false: we should modified equations (91) and (92) to obtain friendly form of gas equation:

$$\frac{V \cdot dP}{C_P} = N_m \cdot dT \tag{95}$$

And:

$$\frac{P \cdot dV}{C_V} = -N_m \cdot dT \quad (96)$$

These two equations resembles very much to the pair of Maxwell[14] equations whose are producing the same ambiguity in the treatment of the electric transformer – they coupled claim that voltage on the secondary coil should be proportional to the second time derivative of the amperage in the primary coil which does not fit the reality while the voltage on the secondary coil is directly proportional to the voltage on the primary coil within the bandwidth of the transformer. This further implies that the solitary usage of first Maxwell equation is in action here – once in direct and once in reversal direction which also mathematically explains the inability to transfer DC current. Despite the fact that the first Maxwell equation can be directly derived from the Faraday[15] law with the aid of Green[16] theorem and that second one is derived from the Biot[17]-Savart[18] law and that operation of the current clamp seemingly proves conversion of amperage into the voltage in accordance with Maxwell's equation the operation of an ordinary electric transformer challenges their correctness a lot – the electric transformer is the key device of the contemporary technical civilization making the whole situation more embarrassing. This type of ambiguity is obviously identical to one pertained to C_P and C_V definitions implicitly proving that both blunders share the same origin.

By naïve combining (95) and (96) "more accurate" gas equation is obtained:

$$\frac{V \cdot \dot{P}}{C_P} - \frac{P \cdot \dot{V}}{C_V} = N_m \cdot \dot{T} \quad (97)$$

Above equation differs very much from the originating equation (39). In reality such definitional connection between equations (95) and (96) does not exist in any case because true meaning of the constant C_P and C_V is defined on the completely different way via equations (67) and (68) as depicted on the fig. 1. The unit for C_P and C_V is joule/(mol·K) and according equation (91) constant C_P does not denote any sort of energy at all and thereby the constants C_P and C_V are defined by the equation (67) and (68) and not by (91) and (92) as explained in the most of the modern textbooks – furthermore, equations (91) and (92) are circumstantial ones essentially derived by differentiation of the gas equation (94) which does not deal with the thermal energy at all! It is interesting that contemporary science contains such parts with deliberately inserted deceptions in perfectly accurately chosen place in the theory and proper historical circumstances bringing full mind crippling of new engineers and inventors just by misleading of their logic facilitating them to make wrong conclusions and thus efficiently preventing significant and

[14] James Maxwell, 1831 – 1879
[15] Michael Faraday, 1791-1867
[16] George Green, 1793 – 1841
[17] Jean-Baptiste Biot, 1774 – 1862
[18] Felix Savart, 1791 – 1841

rapid technological progress of humankind. There are many technical theories crippled on the same way and there are always people that persistently and radically defend a lot of those blunders with the facts mostly based on the cute game of vanity – if the reader does not understand such blurry part of the theory then this indisputably means that he or she is just an idiot! It is difficult to be seen anything human able to manage so persistently such actions exposing vast technological and psychological knowledge far beyond our own ones, which raise some questions related to either theological or UFOlogical controversies. Most of the inventors that contributed to the development of internal combustion engines were murdered; some of them were deliberately infected by the contagious diseases followed by the incineration of all their papers and this is rater rule than an exception. Many such inventions are effectively suppressed trough history e.g. irrigational pump driven by the vegetable oil motor (precursor of the diesel engine) in the Versailles palace succeeding one driven by the gunpowder. Furthermore is seems that Ancient Romans has industrial era that remained till 13th century (many tool-marks on the buildings, polished marble tiles, huge mines and quarries, stone fortresses, etc.) and if this is true than it means that mass education that started in the early 19th century was preceded with the mass deception of history modifications. There are clear evidences that Ancient Egyptians were using perfectly forged forks, spoons and knifes made from gold and silver (allegedly they were going to use cooper tools only in ordinary crafting except they were using golden plated steel for kitchen accessories), many paintings of medieval artists depict machine treated tails, chandeliers, poles on shores, telescopes, etc.! There are clear tool-marks saved in the Roman mines in the Spain and in the Danube basin. And, if that is not the case, then this indisputably means that there is much more sinister explanation for these misinterpretations and improper derivations of many correct formulas. The history of combustion engines is especially strange: Huygens invented in 1678 gunpowder piston engine and the concept so advance for his time seemingly came out of nowhere and furthermore, this motor was quickly replaced by the vegetable oil driven model and then both faded into the oblivion, especially second one. Then, the same destiny stroked the inventor of the first Steam boat, Diesel engine, etc. Inventor of Otto motor was working only nightly due to strange impact of informers according his own conclusion about the people that were trying to spy him simultaneously ruining his creditability. It appears not to be his paranoia – probably these were spies of Rockefeller, the owner of Standard Oil, who desperately needed motor able to utilize rest of the petroleum fractions and not only the kerosene as the unique petrochemical product of this time.

The violent deaths or serious deterioration and ruining of the works of most of those inventors and scientists indicates that something is able to anticipate ensuing inventions and then to prevent occurrences of these initial inventions at all or to significantly defer them. It seems that they act instantly to suppress any significant invention. And they are not triggered by all kind of inventions – they react only on some particular inventions, which is quite intriguing.

Simply, according exposed wrong concept we have determined that C_P is proportional to the increase of the pressure and C_V is proportional to the released mechanical work which leads to direct confrontation with the gas equation that deals only with mechanical and not thermal properties of the gas at all.

Now, we should expect that there is unique Equation of State that is able to yield correct values for the following isochoric and isobaric constants:

$$C_P = \frac{V}{n \cdot \frac{dT}{dP}} \tag{98}$$

And:

$$C_V = -\frac{P}{n \cdot \frac{dT}{dV}} \tag{99}$$

In reality it is quite difficult to find analytical function able to fulfill both equations simultaneously. The absurdity becomes obvious by the following conditions that should be fulfilled:

$$\frac{dE_A}{dV} = P \tag{100}$$

And:

$$\frac{dE_A}{dP} = 0 \tag{101}$$

The true solution of this controversy is that C_P and C_V is not defined by the (98) and (99) respectively but only by (67) and (68) and therefore there should be enough elements already collected to quit this charade right now.

ANALYSIS OF THE MOTORS' MECHANICAL DESIGN

We have just analyzed equation that rule gas physics and then there are enough elements collected to raise the concept of efficiency improvement to the level of realization via theoretical analysis of the geometry of the reciprocal motor itself.

After focusing on extraction of mechanical energy right after the explosive combustion we can notice that there are eight ways on which we may improve the efficiency of the combustion engine:

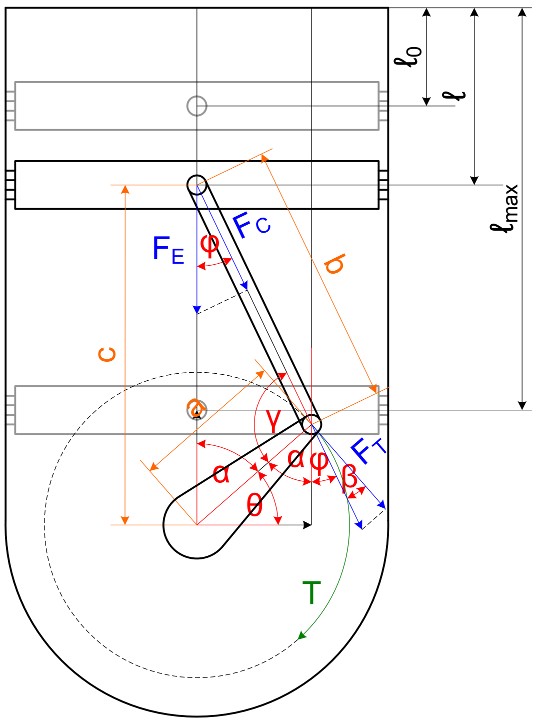
1. to switch to external combustion engine with some much more suitable gas than air (i.e. with bigger Heat Capacity Ratio χ),
2. to thermally insulate cylinder,
3. to increase compression ratio,
4. to make asymmetric compression and decompression,
5. to make adjustable compression with variable operating and residual volumes,
6. to achieve non-trigonometric transmission of force from piston to crankshaft adjusted to the gas equation,

7. to find more accurate gas equation and then to adjust design to this equation according semi-conventional method of efficiency improvement,
8. Shifting from adiabatic cycle to a new one with much higher efficiency based on this unconventional approach.

The sixth way is promising and it is an attempt to figure out what is wrong with the basic design of reciprocal motor. Again, let us recapitulate the objective: we want to extract kinetic energy from the particular molecules and then to convert it into rotational motion of the crankshaft. The best commonly used solution contrived so far is energy extraction trough expansion of the gas chamber embodied in a piston pushed by the gas which trigonometrically transfers force to the crankshaft. The concept might not to be as good as it might resemble at glance.

Following figure depicts the piston connected to the crankshaft in the classical reciprocal internal combustion engine also known as Trigonometric Combustion Engine:

Fig. 2



It is pretty much remarkable that right after the explosion the transfer of force is negligible and therefore a lot of heat is wasted by convection to the metallic wall of the cylinder in the almost isochoric state that lasts until the piston occupies better position for force transfer to the crankshaft. This heat transfer is occasionally restrained either by thermal insulation or by keeping ratio surface/volume as low as possible that was already done in Chrysler Hemi engine. This parameter is not negligible at all because a sphere has 21% less surface than the same volume cylinder and 24% less surface than the same volume cube implying that it would reduced thermal loss in the same ratio, which can be considerable reduction of thermal loss caused by the heat transfer into the engine's block.

Connection between F_E and F_T is:

$$F_C = F_E \cdot COS(\varphi) \tag{102}$$

And:

$$F_T = F_C \cdot COS(\beta) \tag{103}$$

For the force momentum we have:

$$T = F_T \cdot a \tag{104}$$

⇒

$$F_T = F_E \cdot COS(\varphi) \cdot COS(\beta) \tag{105}$$

For the angle β it is:

$$\beta = \theta - \varphi \tag{106}$$

Anent:

$$F_T = F_E \cdot COS(\varphi) \cdot COS(\theta - \varphi) \tag{107}$$

⇒

$$F_T = F_E \cdot COS(\varphi) \cdot (COS(\theta) \cdot COS(\varphi) + SIN(\theta) \cdot SIN(\varphi)) \tag{108}$$

We can also apply sinus theorem here:

$$\frac{a}{SIN(\varphi)} = \frac{b}{SIN(\alpha)} = \frac{b}{COS(\theta)} \tag{109}$$

⇒

$$SIN(\varphi) = \frac{a}{b} \cdot COS(\theta) \tag{110}$$

And:

$$COS(\varphi) = \sqrt{1 - \left(\frac{a}{b}\right)^2 \cdot COS(\theta)^2} \tag{111}$$

In regards to (111) equation (108) becomes:

$$F_T = F_E \cdot COS(\theta) \cdot \sqrt{1 - \left(\frac{a}{b}\right)^2 \cdot COS(\theta)^2} \cdot \left(\frac{a}{b} \cdot SIN(\theta) + \sqrt{1 - \left(\frac{a}{b}\right)^2 \cdot COS(\theta)^2}\right) \tag{112}$$

We can derive the equation of the force momentum now:

$$c = \sqrt{a^2 + b^2 - 2 \cdot a \cdot b \cdot COS(\gamma)} \tag{113}$$

And it is too:

$$COS(\gamma) = COS\left(\frac{\pi}{2} - (\varphi - \theta)\right) = SIN(\varphi - \theta) \tag{114}$$

⇒

$$\mathrm{COS}(\gamma) = \mathrm{SIN}(\varphi)\cdot\mathrm{COS}(\theta) - \mathrm{COS}(\varphi)\cdot\mathrm{SIN}(\theta) \tag{115}$$

In respect to (110) and (111) we have that (115) becomes:

$$\mathrm{COS}(\gamma) = \frac{a}{b}\cdot\mathrm{COS}(\theta)^2 - \mathrm{SIN}(\theta)\cdot\sqrt{1-\left(\frac{a}{b}\right)^2\cdot\mathrm{COS}(\theta)^2} \tag{116}$$

Equation (113) becomes now:

$$c = \sqrt{a^2 + b^2 - 2\cdot a\cdot b\cdot\left(\frac{a}{b}\cdot\mathrm{COS}(\theta)^2 - \mathrm{SIN}(\theta)\cdot\sqrt{1-\left(\frac{a}{b}\right)^2\cdot\mathrm{COS}(\theta)^2}\right)} \tag{117}$$

Displacement of the piston is:

$$\ell = \ell_0 - (a+b) - c \tag{118}$$

⇒

$$\ell = \ell_0 - (a+b) - \sqrt{a^2 + b^2 - 2\cdot a\cdot b\cdot\left(\frac{a}{b}\cdot\mathrm{COS}(\theta)^2 - \mathrm{SIN}(\theta)\cdot\sqrt{1-\left(\frac{a}{b}\right)^2\cdot\mathrm{COS}(\theta)^2}\right)} \tag{119}$$

Therefore we have:

$$F = P\cdot S = \frac{R\cdot E_h}{m_n\cdot Q\cdot\ell_0}\cdot\left(\frac{\ell_0}{\ell}\right)^{\chi} \tag{120}$$

⇒

$$F_E = \frac{R\cdot E_h}{m_n\cdot Q\cdot\ell_0}\cdot\left(\frac{\ell_0}{\ell_0 - (a+b) - \sqrt{a^2 + b^2 - 2\cdot a\cdot b\cdot\left(\frac{a}{b}\cdot\mathrm{COS}(\theta)^2 - \mathrm{SIN}(\theta)\cdot\sqrt{1-\left(\frac{a}{b}\right)^2\cdot\mathrm{COS}(\theta)^2}\right)}}\right)^{\chi} \tag{121}$$

It is finally:

$$F_T = \frac{R\cdot E_h}{m_n\cdot Q\cdot\ell_0}\cdot\frac{\mathrm{COS}(\theta)\cdot\sqrt{1-\left(\frac{a}{b}\right)^2\cdot\mathrm{COS}(\theta)^2}\cdot\left(\frac{a}{b}\cdot\mathrm{SIN}(\theta)+\sqrt{1-\left(\frac{a}{b}\right)^2\cdot\mathrm{COS}(\theta)^2}\right)}{\left(1-\frac{b}{\ell_0}\cdot\left(\left(1+\frac{a}{b}\right)+\sqrt{1+\left(\frac{a}{b}\right)^2-2\cdot\frac{a}{b}\cdot\left(\frac{a}{b}\cdot\mathrm{COS}(\theta)^2-\mathrm{SIN}(\theta)\cdot\sqrt{1-\left(\frac{a}{b}\right)^2\cdot\mathrm{COS}(\theta)^2}\right)}\right)\right)^{\chi}} \tag{122}$$

Force momentum acting to the crankshaft is:

$$T=\frac{R\cdot E_h}{m_n\cdot Q}\cdot\frac{\frac{a}{\ell_0}\cdot COS(\theta)\cdot\sqrt{1-\left(\frac{a}{b}\right)^2\cdot COS(\theta)^2}\cdot\left(\frac{a}{b}\cdot SIN(\theta)+\sqrt{1-\left(\frac{a}{b}\right)^2\cdot COS(\theta)^2}\right)}{\left(1-\frac{b}{\ell_0}\cdot\left(\left(1+\frac{a}{b}\right)+\sqrt{1+\left(\frac{a}{b}\right)^2-2\cdot\frac{a}{b}\cdot\left(\frac{a}{b}\cdot COS(\theta)^2-SIN(\theta)\cdot\sqrt{1-\left(\frac{a}{b}\right)^2\cdot COS(\theta)^2}\right)}\right)\right)^{\chi}} \tag{123}$$

From (120) we have:

$$P_0\cdot V_0=P_0\cdot S\cdot\ell_0=\frac{R\cdot E_h}{m_n\cdot Q} \tag{124}$$

Whereas V_0 is residual volume and P_0 is pressure occurred in residual volume right after the explosion of fuel. Equation (120) becomes now:

$$T=P_0\cdot V_0\cdot\frac{\frac{a}{\ell_0}\cdot COS(\theta)\cdot\sqrt{1-\left(\frac{a}{b}\right)^2\cdot COS(\theta)^2}\cdot\left(\frac{a}{b}\cdot SIN(\theta)+\sqrt{1-\left(\frac{a}{b}\right)^2\cdot COS(\theta)^2}\right)}{\left(1-\frac{b}{\ell_0}\cdot\left(\left(1+\frac{a}{b}\right)+\sqrt{1+\left(\frac{a}{b}\right)^2-2\cdot\frac{a}{b}\cdot\left(\frac{a}{b}\cdot COS(\theta)^2-SIN(\theta)\cdot\sqrt{1-\left(\frac{a}{b}\right)^2\cdot COS(\theta)^2}\right)}\right)\right)^{\chi}} \tag{125}$$

Equation (120) and (125) clearly shows that there is no torque at zero angle of angular displacement regardless the pressure in the residual volume. Formula (125) rules adiabatic pneumatic motors too and then P_0 is the pressure after impulsive injection of air into the residual volume V_0 of the piston.

For the classical reciprocal motor we can see that the ratio of a and b should be kept as close as possible to enable rapid increase of the force momentum M in respect to angle θ to reduce thermal transfer trough the wall of the cylinder as much as possible. Above equation is only seldom cited in the literature and even more rarely derived although it has utmost importance for understanding of process that converts force F into the torque M in reciprocal engines.

There are two solutions to surpass this thermal loss: the first one is to put some kind of thermal insulator like boron in the wall of the cylinder, or to construct motor in which force momentum should remain constant as much as possible during the angle θ of the crankshaft angular displacement with appropriate hemispherical shapes of residual volume and piston's head. All these strategies combined together might bring additional improvement in efficiency of almost 20%.

FORTH SOLUTION: ADJUSTMENT OF THE BOTH AIR AND GASOLINE AMOUNTHS WITH ASYMETRIC COMPRESSION AND DECOMPRESSION FOLLOWED BY THE THERMAL INSULATION OF THE CYLINDER

Significant improvement of the efficiency of the classical reciprocal engine could be achieved trough adjustment of air amount to the amount of fuel which requires usage of turbo charger altogether with asymmetric compression, or even without piston's compression at all which further requires external air compressor, as it has been already mentioned in above text. The adjustable residual volume is also highly appreciable for keeping ratio fuel-air optimal. This improvement is embodied in the usage of two stroke turbo motors without piston's compression cycle at all. The lubrication prevents wide usage of two stroke engines but the solution for the lubrication is so simple that is astonishing why it has not been already devised because the solution is consisted of the rearrangement of cylinders orientation only, almost without any additional complicate lubricating system at all! Absence of turbo charger in most contemporary engines limits efficiency allowing them to rich top full efficiency in only a narrow range of angular velocities defined by the cylinder's volume and the amount of the injected fuel. The thermal insulation of the cylinder via the boron or some other suitable material may help a lot by reducing the transition of the thermal energy through cylinders' walls. However, the efficiency of the motor cannot surpass the limitation given by the equation (65) determined by the decompression ratio and the physical property of the gas itself embodied in χ constant.

ADIABATIC VERSUS ISOBARIC CYCLE

This adiabatic cycle in steam engines was abandoned at the beginning of 20th century when the operation of steam engines was shifted from the adiabatic to the isobaric cycle to increase the power density of the locomotives especially needed by the mountain railways. By the reason of the power density augmentation they transferred from the adiabatic cycle with pulse steam injection into the residual volume to the isobaric cycle with continual injection of steam into the piston to maintain constant pressure during whole pushing cycle. The isobaric cycle requires huge boiler ($V_{boiler} >> V_{cylinder}$) to maintain pressure as constant as possible during the entire cycle and also heating the whole amount of water available in the isobaric locomotive instead of just a fraction of water in the adiabatic steam locomotive, which requires a lot of time for initialization of an isobaric locomotive. The adiabatic steam engine constantly injects fresh water from the reservoir into relatively small boiler by the high pressure gear pump. Thereby the isobaric steam locomotives required all-night initialization to heat whole amount of water before daily exploitation. It seems that it was not a disadvantage at those times as it may resemble today due to very intensive diurnal railroad traffic which were exploiting locomotives almost permanently just with exceptionally rear nocturnal maintenance pauses. During the WW2 it appeared that this deferred start was huge disadvantage which eventually led to their entire replacement mostly by the diesel ones, albeit those steam engines had slightly better efficiency than the similar Diesel locomotives of those times utilizing even a chipper fuel especially due to war's shortage of petroleum. The usage of the liquid phase combined with the gaseous one in the steam engine might be strange to the astute reader: this is done only to increase the power density of the engine while volume ratio of liquid phase and gaseous phase of the same amount of the fluid is enormous and thereby the energy phase loss can be neglected in the respect to increase of energy density. The usage of the liquid phase in the Rankine cycle decreases the energy consumption of the compressor but it increases the energy loss in the phase transfer of water and this can be diminished by the usage of some better fluid then water or super heated water in the novel steam engines' designs. By this vast expansion ratio steam engines were able to achieve relatively huge power on very law rpm leaving steam locomotives completely without a gearbox. Without the liquid phase Rankine cycle will be quite similar to Stirling one.

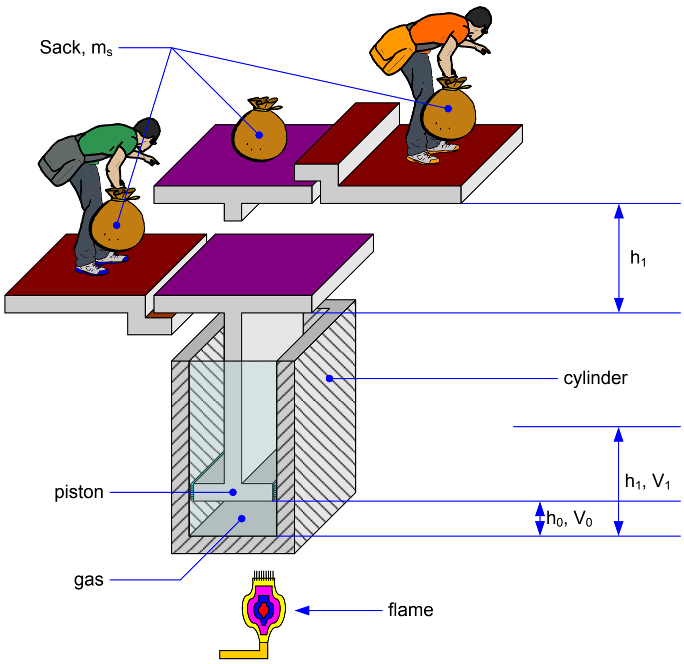
However there was a single attempt to replace isobaric steam engine with the adiabatic steam turbine but this steam-electric locomotive failed due to the imperfection of regulation circuit based on the rudimental electronics available in those times (year: 1938). This locomotive was outperforming similar diesel ones by both power and initialization time of only 15 minutes, but the concept was soon abandoned due to the frequent malfunctions cause by inadequate quality of steel available in the early 20th century used for turbine production.

The echo of those steam engines still exists in modern thermal power plants retaining the same liquid phase of Rankine cycle whose existence should be reconsidered from the standpoint of these new facts.

For a better understanding of the motor's thermodynamic cycle we should analyze following fabled situation with more realistic scenario than one depicted on the figure 1: there is a buddy carrying a sack with the flour into the depot and the sack should be lifted to the appropriate floor. The lifting of the sack is performed by the gas piston. The platform that lifts the sack is limited beneath the lower side and above the upper side. And let the platform only barely touches the lower limiter settled beneath the platform. After the first buddy put the sack to the platform the platform starts pressing the lower limiter much higher. At the moment the flame below the cylinder is ignited and starts heating the gas in the cylinder – instead the electric heater on the figure 1. Till the pressure reaches the value that lifts the platform we have an isochoric heating cycle here, and after the lifting is started there is a pure isobaric cycle on the stage. For reversing of the piston to the initial position the gas should be firstly isochoric cooled and then isobaric cooled till the piston touches the lower limiter. The piston is sealed and the amount of the gas in the cylinder is constant. Contemporary reciprocal gasoline engine is consisted of the isochoric heating during explosion of fuel in residual volume and ensuing adiabatic decompression.

This situation is depicted on the following figure:

Fig. 3



Let ask us the following question again: how much energy inserted by the flame into the gas is stored into the internal energy of the gas and how much is spent to the mechanical work in the isobaric process and why this ratio is so persistent? There was an explanation based on Energy Conservation Law and Gas Kinetic Theory in above text.

For clarification let us consider adiabatic decompression depicted on the above figure: flame inserts thermal energy into the gas and this energy is split to two parts – mechanical work and internal heat energy embodied in the temperature increase of the gas. This ratio is quantified by χ constant that defines the efficiency of the thermal machines and apparently this is cemented by the property of physical gas and cannot be modified. Simply by switching from the isobaric cycle to the adiabatic one we can increase efficiency seemingly impossible by the equation (75). The niftiness of the adiabatic cycle in regards to the isobaric one remains unnoticed due the fact that the adiabatic cycle is the first choice due to the operation of the reciprocal internal combustion engine. The main difference between isobaric and adiabatic cycles is that in the adiabatic cycle gas also carries the thermal energy internally stored while in the isobaric cycle gas only utilizes its own mechanical properties released by the constant entering of energy embodied in the gas equation only.

According all aforementioned thermodynamic equations there is a gloomy prospective for the further huge and simple improvements of the contemporary concept of combustion engine, although there is a room for further improvements and the easiest way is conceptual decomposition of those motors to the basic easy conceivable steps. The further improvement of classical adiabatic motor with retained construction requires both increase of the compression and the RPM to achieve better power density and this lead to the increase of the friction loss ruining initial attempt to improve efficiency of the basic thermodynamic cycle and thermal insulation. Friction loss could be reduced by the utilization of special lubricant and the proper gases like hydrogen but such concept is going to be too complicate for the reliable regular utilization.

Briefly, we are not able to extract energy from gas molecules by the expansion of the gas chamber quite efficiently and we can mitigate this problem either by further accommodation of the mechanical transfer of the thermal energy to the piston or by the utilization of some other non-thermodynamic cycle.

SIXTH SOLUTION: GAS EQUATION'S FRIENDLY MOTOR

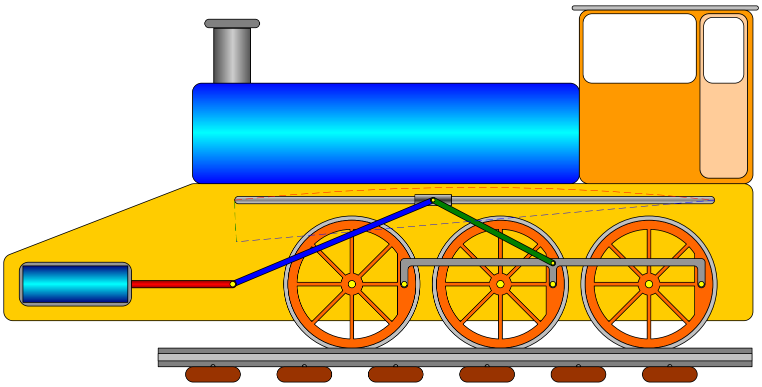
Gas equation friendly motor is type of reciprocal engine which does not have trigonometric functional connection between piston and the crankshaft and therefore its mechanical realization is a bit more complicated, but its efficiency is remarkably higher due to reduced thermal loss during the isochoric gas heating befalling almost entirely in residual volume. There is also significant reduction of the pressure loss caused by the imperfection of the sealing between the piston and the cylinder wall especially evidential in the Wankel[19] engine prolonging the lubricant durability. My initial idea with this concept was fast collection of the abundance of energy right after explosion because significant increase of temperature in the residual volume causes incomplete combustion and pollution by various nitrogen oxides and also to reduce the pressure loss on the piston's sealing. Thereby such motor could operate without exhaust platinum catalyst which may significantly reduce the price of the vehicle supplied with such motor. Reduced pressure in the cylinder by the retarded and deferred combustion also makes motor more durable and sturdy which is especially important in combat applications – this protraction of the combustion must be fairly limited to prevent transition to inefficient isobaric cycle, but to last long enough to make piston able to occupy position able to start with linear transfer of force to crankshaft. Utilization of such motor altogether with the increase of blade numbers and decrease of rotational speed of main fans may elongate combat radius of transport helicopter several times. The increase of blades in he main propeller should be done in accordance with my theory dedicated to the jet propulsion available on my website http://www.andrijar.com/thrusters/index.html with main conclusion that the force of thruster has linear connection with the speed of the jet while the energy has square connection with the speed and therefore propeller should blow more air with lower speed to increase efficiency which may be achieved to the certain extent by the increase of the blades in the main propeller and the decrease of the propeller's rpm. The usage of the electrostatic lifter concept offers the ultimate increase of the efficiency either by the increase power density by heating of the cathode or its ultrasound stimulation.

It is interesting that ancient Antikythera mechanism contained one such nonlinear mechanism to calculate tiny swinging of the Moon on nocturnal sky and this realization may be used in modern motors to compensate trigonometric force transmission of the pistons according the objective to maintain the force momentum as constant as possible facilitating acceptance

[19] Felix Heinrich Wankel, 1902 – 1988, invention discovered in 1957

of mechanical energy right after the explosion without waiting for the piston to occupy better position for the heat energy transfer. There had been many attempts to design motor able to accept abundance of energy available right after ignition of fuel but all of them failed due to strong stress caused by fuel explosion acting to crankshaft which leads premature fatigue defects of gears in the gearbox. Moreover inappropriately designed flywheel is able to greatly limit the capability of mechanical energy acceptance by its inflexibility, except if there is existing system of springs in the flywheel as its existence is common today. Several exceptionally promising designs are one by Tverskoy[20] in 19th century and its improvement done by Baylin[21] in 20th century, then their linear variants offered by Tabag[22] and RKM engines from 21st century. They are all allegedly able to continuously accept energy during cycle but they failed to be used in ordinary application due to its severity to gearbox transmission as abovementioned. This can be mitigated by the usage of multi-stage circular shock absorbers in the flywheel itself. Bourke[23] engine from early 20th century is settled somewhere between linear and trigonometric transmission and this may help to the certain extent in crankshaft shock absorption. Mountain steam engines during late 19th century had one quite interesting mechanism to make them more compact by involving linearity into strictly trigonometric transfer of force from the piston to the traction gear – they did it via horizontal shaft with the slider attached to both the piston and the traction wheel instead of their direct connection:

Fig. 4



It is interesting that they never tried to make sliding shaft slant (blue dashed line on the above picture) or curved (red dashed line ion the above picture) which could significantly accommodate thermodynamic cycle to the adiabatic equation in the manner explained in above text. This omission to better adjust the shape of slider to the thermodynamic process implies that they did not entirely conceive the essence of the thermodynamic process that propels the steam locomotive. It seems that they used this slider just for better packing of mechanical elements in relatively small space available in the mountain locomotives because this enables lateral overlapping of wheel and piston that shortens the length of locomotive a lot casually brought the gain in efficiency and this misunderstanding is presumably the reason why so

[20] N. N. Tverskoy (Russian: Н. Н. Тверского), ? – ?, invention discovered in 1885
[21] Samuel Baylin, 1922 – 1984
[22] Genaro Tabag, ? –
[23] Russell Bourke, ? – ?

advance concept was used so sporadically. The same method could be used for efficiency improvement in marine slow speed diesel engines and in all internal combustion ones with pistons' retarded motion.

In the gas equation's friendly motor extraction of energy must be steadily adjusted to the available energy. This entails usage of non-circular gears for achievement of nearly constant torque. Craft of such logarithmic gear could be a bit tricky task for mass production presently.

NON-TRIGONOMETRIC MOTOR WITH CONSTANT TORQUE DURING THE CYCLE – GAS EQUATION FRIENDLY MOTOR

Non-trigonometric motor attempts to maintain torque as constant as possible during the cycle. Such motor is able to accept chemical energy right after the ignition and to reduce the temperature by draining of the energy which causes reduction of nitrogen oxides together with the efficiency improvement and great reduction of thermal loss. This concept also greatly reduces the pressure drop caused by the imperfection of the sealing between the piston and the cylinder's wall. Although motor's top efficiency is limited by the equation (65), the parasitic losses caused by the thermal, pressurize and frictional losses is going to be significantly reduced and their reduction brings astonishing 20% more efficiency.

Force acting to the piston in the internal combustion engine is:

$$F_E = \frac{R \cdot E_h}{m_n \cdot Q \cdot \ell_0} \cdot \left(\frac{\ell_0}{\ell} \right)^{\chi} \tag{126}$$

It is interesting to be noticed that for compression of 1:8 ratio of maximal and minimal force acting to the piston is 18.3, for compression 1:15 it is 44.3 and for the gas turbine the front line of blades endures 175 higher force than the rear line of blades.

In the proposed non-trigonometric cycle we aspire to maintain force momentum acting to the crankshaft as constant as possible:

$$F_E \cdot r = \mathrm{Const} \tag{127}$$

$\Rightarrow$

$$dF_E \cdot r + F_E \cdot dr = 0 \tag{128}$$

$\Rightarrow$

$$dF_E \cdot r = -F_E \cdot dr \tag{129}$$

$\Rightarrow$

$$\frac{dF_E}{F_E} = -\frac{dr}{r} \tag{130}$$

$\Rightarrow$

$$\frac{F_E}{F_0} = \frac{r_0}{r} \tag{131}$$

⇒

$$\left(\frac{\ell_0}{\ell}\right)^{\chi} = \frac{r_0}{r} \tag{132}$$

According (126) we have:

$$\ell = \ell_0 \cdot \left(\frac{r_0}{r}\right)^{\frac{1}{\chi}} \tag{133}$$

⇒

$$\ell = \ell_0 \cdot \left(\frac{r_0}{r}\right)^{\frac{1}{\chi}} \tag{134}$$

In polar coordinates the length of the curve is:

$$d\ell^2 = dr^2 + r^2 \cdot d\theta^2 \tag{135}$$

⇒

$$\left(\frac{d\ell}{dr}\right)^2 = 1 + r^2 \cdot \left(\frac{d\theta}{dr}\right)^2 \tag{136}$$

⇒

$$d\theta = \frac{1}{r} \cdot \sqrt{\left(\frac{d\ell}{dr}\right)^2 - 1} \cdot dr \tag{137}$$

Derivative of (134) on radius should be found:

$$\frac{d\ell}{dr} = \frac{\ell_0}{r \cdot \chi} \cdot \left(\frac{r_0}{r}\right)^{\frac{1}{\chi}} \tag{138}$$

This is going to be inserted into (137) and then it is obtained:

$$d\theta = \frac{1}{r} \cdot \sqrt{\left(\frac{\ell_0}{r \cdot \chi} \cdot \left(\frac{r_0}{r}\right)^{\frac{1}{\chi}}\right)^2 - 1} \cdot dr \tag{139}$$

⇒

$$d\theta = \frac{1}{r} \cdot \sqrt{\frac{{\ell_0}^2}{r^2 \cdot \chi^2} \cdot \left(\frac{r_0}{r}\right)^{\frac{2}{\chi}} - 1} \cdot dr \tag{140}$$

⇒

$$\theta = \int_{r_0}^{r} \frac{1}{r} \cdot \sqrt{\left(\frac{\ell_0 \cdot \sqrt[\chi]{r_0}}{\chi}\right)^2 \cdot \frac{1}{r^{2 \cdot \left(\frac{1}{\chi}+1\right)}} - 1} \cdot dr \tag{141}$$

Above integral does not have an explicit symbolic solution. However, it can be solved numerically and then it should be used for adjustment of the variable transmission of the piston to the crankshaft that requires specially shaped gears which may be pretty problematic for serial production at the moment. Another solution is to properly shape triangular rotor in Wankel motor to obey to the equation (141). Although Wankel motor suffers from a several deficiencies like huge seal areas both frontal and lateral ones whose limit compression and increase friction making apposite lubricating mechanism quite complicate. However, ability of curving the shape of the triangular rotor mitigates the seal's deficiency because by this adjustment the Wankel motor should became quite durable, efficient and reliable engine. At the moment the designing the new piston engine from the scratch seems to be more reliable and durable solution than an accommodation of Wankel engine, though Wankel based solution is simpler for the instant realization. Although the efficiency of such motor still cannot surpass the limitation given by the equation (65), its utilization does require neither usage of special materials like boron nor involvement of some extraordinary production processes like shaping of logarithmic gears, usage of magnets for the plasma molecules' motional collimation, etc. The gains of the concept are miscellaneous – it brings steadier work with almost constant torque which is very gentle to gears in gearbox, combustion is equable during the whole cycle and therefore the seals last longer and the escape of heat trough cylinder walls are greatly reduced trough extraction of energy that starts right after the fuel's ignition.

However, the significant improvement can be achieved trough adaptation of the mechanical cycle to the gas equation; any further development cannot lead to the significant increase of the efficiency because it is limited by the physics of the gas itself and the piston's mechanics. So, there is a need for some other type of extraction of thermal energy, either by thermo-voltaic elements, thermo-magnetic elements in Curie[24] motor, the MHD generators or via Schauberger[25] cycle.

THE SEVENTH SOLUTION: MORE ACURATE GAS EQATION

The seventh solution for efficiency enchantment of thermal engines is derivation of more accurate form of gas equation based on the fact that contemporary gas equation (16) does not pay attention to the speed of the piston at all. There are several devices that clearly demonstrate the weakness of contemporary impulse transfer theory embodied in the Gas Kinetic Model (most notable is Crookes photometer) and the equations of the gas state, and therefore a more accurate gas equation may eventually betoken same new way of efficiency improvement. The lack of this notification also explains why inventors did not try to figure out the main question here: what is the reason for the thermal energy to be split into the mechanical work and the potential energy of gas pressure in so persistent ratio as defined by the equation (56)? This question instantly triggers another one: what is the microscopic mechanism that transfers kinetic energy of the molecules to the piston's head? We simply lack microscopic explanation for this ratio while the

[24] Pierre Curie, 1859 – 1906
[25] Viktor Schauberger, 1885 – 1958

derivation in the Gas Kinetic Theory is based entirely on the Energy Conservation Law without any further analysis of the phenomenon although this particular ratio plays the major role in the thermodynamic efficiency. We must also consider here that infinitesimal calculus is just mental proteases helping us to deal with continual variables so extraneous to human Boolean like logic. Although this calculus may resemble almightily, actually, it is applicable only to the set of analytical functions, i.e. to all ones for whose we already poses symbolic derivatives. Thereby we cannot find derivative of the hand driven curve in the single point because it might mean that the whole function is defined by this particular point within the radius of convergence of the Taylor series which is not the general case at all – as aforesaid this is valid for the analytical functions only. This unique ability to be found whole segment of the curve putatively from a single point only via Taylor series implies that different curves have different points which defies the essential point definition, but actually this only means that different curves have different derivatives and this blunder is originated in the inept philosophical explanation of the infinitesimal calculus at all… The essence of this notification is the fact that infinitesimal quantization of the continual space via infinitesimal calculus may not be as much correct as we usually like to believe. We can make a comparison with the Telegraphic Theorem which claims that data bandwidth of the telecommunication line in bauds is half of the upper frequency of the line – this statement is obviously false while the ordinary analog modems are able to transfer up to 54000 bits per second trough the telephone line with audio bandwidth of 3.6 KHz up to 4 KHz only. The mathematical proof itself is very convincing but it simply does not pay attention to the information that may be sent via angle variations in multiple amplitudes too. So, all this theoretical limitations of the various methods for efficiency improvement may not be as correct as we currently use to believe.

DISCRETE MODEL

A better insight into the phenomenon might be offered by the mechanical model of small super elastic ideal ball running between two barriers from which one is at rest and the opposite one is moveable. We additionally expect that the following relation is applicable both to the Gas Kinetic Model and the single ball running between these two barriers:

$$\frac{\ell_0}{\ell_1} = \frac{V_0}{V_1} \tag{142}$$

Whereas ℓ_0 and ℓ_1 are the lengths between the barriers of cylinder's chamber for positions 1 and 2 respectively and the V_0 and V_1 are volumes for those positions.

Following ratio should be maintained too:

$$\frac{F_0}{F_1} = \frac{P_0}{P_1} \tag{143}$$

Whereas F_0 and F_1 are forces acting to the moveable barriers of the cylinder's chamber and P_0 and P_1 are the pressures in the cylinder for those two positions.

Therefore we should also expect that something similar to the following equation is going to be offered by this model:

$$\frac{F_1}{F_0} = \left(\frac{\ell_0}{\ell_1}\right)^{\chi} \tag{144}$$

Or:

$$F \cdot \ell^{\chi} = \text{const} \tag{145}$$

The following connection between velocity and the temperature should be valid too:

$$\frac{v_0^{\,2}}{v_1^{\,2}} = \frac{T_0}{T_1} \tag{146}$$

$\Rightarrow$

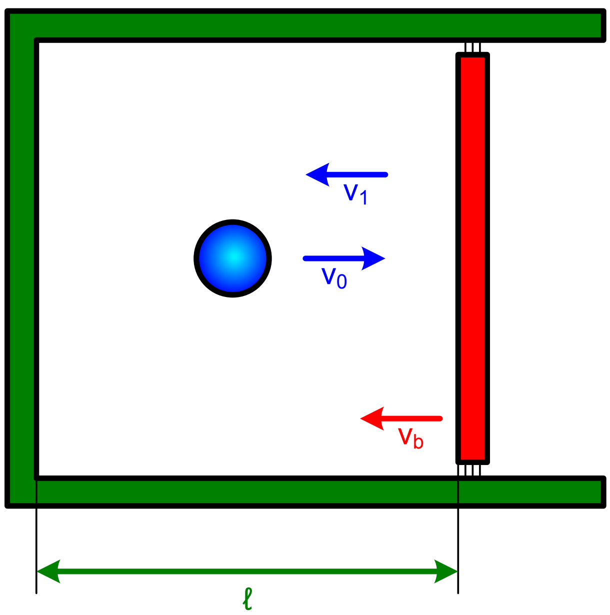
$$\frac{v_1}{v_0} = \left(\frac{\ell_0}{\ell_1}\right)^{\frac{\chi-1}{2}} \tag{147}$$

$\Rightarrow$

$$v \cdot \ell^{\frac{\chi-1}{2}} = \text{const} \tag{148}$$

We intuitively feel that there must be some similarity between tennis player's racket and his ball and the gas molecule moving inside cylinder and therefore such improvement of kinetic model seems to be very promising especially because the Gas Kinetic model does not pay attention to the speed of compression at all. Only mechanical way for the gas molecule to decrease its own velocity is to transfer its kinetic energy by the repulsion to the motional barrier, i.e. to the piston's head as depicted on the following figure:

Fig. 5



Whereas v_b is the speed of the piston (i.e. barrier), v_0 is incoming speed of the ball and v_1 is outgoing speed of the same ball.

When the tennis player hits the tennis ball which is running with speed v_0 then ball's repulsed velocity v_1 is:

$$v_{k+1} = -v_k + 2 \cdot v_b \tag{149}$$

Whereas v_b is the speed of the racket or movable barrier. Above equation is obtained by translation of the inertial frame of the ball to the speed of the rocket and vice versa. In this case we may consider that the barrier is at rest and that only the ball is running. The velocity of the ball is:

$$v_k' = v_k - v_b \tag{150}$$

The ball changes the sign of its velocity after the repulsion and then we must add the speed of the barrier again to retrieve initial inertial frame:

$$v_{k+1} = -v_k' + v_b = -v_k + 2 \cdot v_b \tag{151}$$

If the v_b is negative and v_0 is positive then we have compression on the stage because this means that the barrier approaches to the incoming ball. According concept of Gas Kinetic Model above equation is going to be essential for the explanation of the persistency of χ ratio.

There are two possible theoretical methods to handle this phenomenon – the one is the discrete model based on individual balls and recurrence equations and another one which is based on continuous jet treated with the infinitesimal calculus.

Let us start first with the discrete model just to check validity of the hypothesis. Discrete model also offers correct explanation for energy exchange between movable barrier and bouncing ball which is essential mechanism for transformation of thermal energy into mechanical one via gas chamber's expansion whereas the bouncing ball represents gas molecule and the moveable barrier represent the motional piston in the cylinder.

Gain of the ball's speed right after the repulsion from the barrier is:

$$\delta v = v_{k+1} - v_k = 2 \cdot v_b - 2 \cdot v_k \tag{152}$$

Force acting to the barrier is:

$$F_k = \frac{dP}{dt} = \frac{dm}{dt} \cdot \delta v = 2 \cdot \frac{dm}{dt} \cdot \left(v_b - v_k\right) \tag{153}$$

Time derivative of the mass running between the barriers (one at rest and another one at motion) is:

$$\frac{dm}{dt} = \frac{dN}{dt} \cdot m = f_k \cdot m = \frac{m}{t_k} \tag{154}$$

Whereas v is speed of the ball hitting the barrier and ℓ is distance between barriers, thus we have:

$$F = \frac{m \cdot (v_{k+1} - v_k)}{\delta t_k} \tag{155}$$

Work performed by the moveable barrier is:

$$\delta A = F_k \cdot (\ell_k - \ell_{k-1}) \tag{156}$$

Differential length δℓ is the length passed by the barrier between two ball's hits:

$$\delta\ell = v_b \cdot \delta t = v_b \cdot \frac{\ell}{v_0 - v_b} \tag{157}$$

Work done by the moveable barrier is:

$$\delta A = \frac{2 \cdot m \cdot (v_b - v_0)^2}{\ell} \cdot v_b \cdot \frac{\ell}{v_0 - v_b} = 2 \cdot m \cdot v_b \cdot (v_b - v_0) \tag{158}$$

We could also find this work via the difference of kinetic energy of the ball itself because it is the only object able to exchange energy with the movable barrier:

$$\delta E = \frac{m \cdot v_1^{\,2}}{2} - \frac{m \cdot v_0^{\,2}}{2} = \frac{m}{2} \cdot \left((2 \cdot v_b - v_0)^2 - v_0^{\,2}\right) \tag{159}$$

$\Rightarrow$

$$\delta E = 2 \cdot m \cdot v_b \cdot (v_b - v_0) \tag{160}$$

We have just got the same result in both cases because equations (158) and (160) are identical ones proving that the concept is basically correct by preservation of Energy Conservation Law.

Equation (149) can be transferred into recurrence one for speed (i.e. absolute velocity) for the case of barrier that approaches the ball (i.e. shrinking of area cases increase of the ball's speed):

$$v_{k+1} = v_k + 2 \cdot v_b \tag{161}$$

Solution of above recurrence equation is:

$$v_k = v_0 + 2 \cdot v_b \cdot k \tag{162}$$

We can find the connection between v_k and ℓ_k via following relations. After the ball is repulsed from the right moveable barrier and then collided again with the left wall of the chamber length ℓ_c is:

$$\ell_c = \ell_k - \ell_k \cdot \frac{v_b}{v_k} = \ell_k \cdot \left(1 - \frac{v_b}{v_k}\right) \tag{163}$$

After the ball is repulsed from the left wall of the chamber it approaches the movable barrier and the contact is going to happen after the time t_c:

$$v_k \cdot t_c + v_b \cdot t_c = \ell_c \tag{164}$$

The time that the ball spends passing between stationary barrier and movable one is:

$$t_c = \frac{\ell_c}{v_k + v_b} \tag{165}$$

The distance between moveable barrier and stationary one (i.e. left wall on the above figure) is:

$$\ell_{k+1} = v_k \cdot t_c = \ell_k \cdot \frac{(v_k - v_b)}{v_k + v_b} \tag{166}$$

After the v_k is replaced with (162) in above recursive equation, its solution becomes:

$$\ell_k = \frac{v_0 - v_b}{v_0 + v_b \cdot (2 \cdot k - 1)} \cdot \ell_0 \tag{167}$$

Index k can be expressed via ℓ_k:

$$k = \frac{v_0 - v_b}{2 \cdot v_b} \cdot \left(\frac{\ell_0}{\ell_k} - 1\right) \tag{168}$$

Time of ball's motion between two contacts with moveable barrier is:

$$\delta t_k = \frac{\ell_k}{v_k} + t_c = \frac{2 \cdot \ell_k}{v_k + v_b} = \frac{2 \cdot (v_0 - v_b) \cdot \ell_0}{(v_0 + 2 \cdot k \cdot v_b)^2 - v_b{}^2} \tag{169}$$

For approaching movable barrier that shrinks the volume formula (155) becomes:

$$F_k = \frac{m \cdot (v_{k+1} + v_k)}{\delta t_k} = m \cdot \frac{(v_0 + 2 \cdot k \cdot v_b + v_b) \cdot \left((v_0 + 2 \cdot k \cdot v_b)^2 - v_b{}^2\right)}{(v_0 - v_b) \cdot \ell_0} \tag{170}$$

Above formula represents discrete Netwon 2nd Law although the concept of force in discrete space is ambiguous due to absence of the differentiation.

According (168) we have:

$$F_k = m \cdot \frac{\left(v_0 + \frac{v_0 - v_b}{2} \cdot \left(\frac{\ell_0}{\ell_k} - 1\right) + v_b\right) \cdot \left(\left(v_0 + (v_0 - v_b) \cdot \left(\frac{\ell_0}{\ell_k} - 1\right)\right)^2 - {v_b}^2\right)}{(v_0 - v_b) \cdot \ell_0} \quad (171)$$

And:

$$A_k = F_k \cdot \ell_k \quad (172)$$

If we assume that $v_b << v_0$ then we have:

$$\lim_{vb \to 0} F_k = \frac{{\ell_0}^2}{{\ell_k}^3} \cdot m \cdot {v_0}^2 \quad (173)$$

We have just derived that whenever the pistons speed is relatively small in respect to the molecules' speed of the gas then the equation (144) is going to be valid for χ = 3 which is excellent result in regards to the theoretical value given by equation (29). This difference of 55% is caused by the fact that in the Gas Kinetic Model molecules deals with molecules running in all directions while in this particular case a molecule is collimated in the single direction and the closest comparison is between laser photons and the ones of the incandescent lamp. So, by the collimation of the molecules we can raise χ constant from the theoretical 5/3 up to 3 which brings outstanding efficiency improvement according equation (65). Therefore the reduction of degree of freedom directly leads to increase of efficiency and this is the pivotal moment in this quest of efficiency improvement.

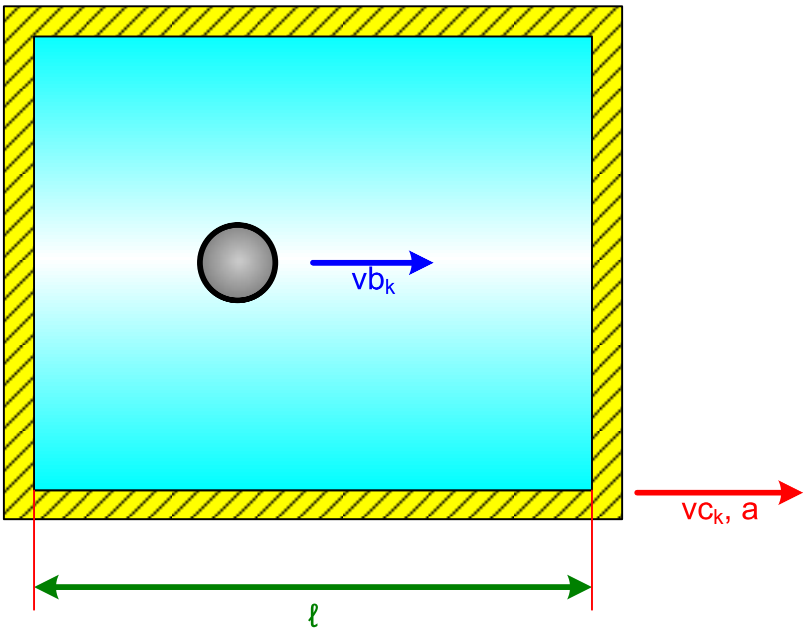
This improvement can be achieved by the magnetic collimation, or by the usage of the operating gas containing ferromagnetic molecules which requires external combustion engine's concept. The piezoelectric sound collimation of operating gas molecules can also help a lot or even strong electric field with excellent transmission in ionized mixtures. Magnetically collimated rocket nozzle may increase rocket range a lot. The effect of collimation may be augmented by enrichment of the rocket fuel by the ferromagnetic atoms although the burning temperature is much higher than the Curie temperature. Such fuel should have vivid orange color of the combustion's flame. It seems that equation (171) also affects the effect of friction because the compression accumulate more energy than the amount released by the decompression implicating that this is the essence of the effect of friction and if this is a frictional mechanism then it should obey to the equation (171).

It is more interesting that equation (171) resembles to modern gas state equations very much and therefore even model based on a single super-elastic ball is able to yield much more refined insight to the subject than the genuine Gas Kinetic Model – thus we have the theoretical model of the microscopic energy exchange between gas molecules and the piston's head itself.

We saw that the official kinetic model does not pay attention to the speed of the compression at all although it is essential ingredient that causes increase the speed of the ball and consequently the increase of temperature. Therefore we must extend our quest for the right theoretical solution for the improvement of combustion engines efficiency, and we are going to analyze the work of Schauberger further in the text. It is obvious that in the process of the adiabatic expansion there is no much more space for the significant conceptual improvement of the thermodynamic cycles based on the adiabatic decompression simply because it is limited by the formula (65) for the theoretical efficiency of the adiabatic process and as it is the most efficient classical thermodynamic cycle known to us this implies that we need to discover a more advanced cycle.

This is a pertinent place to be analyzed a bouncing ball between two barriers in acceleration. As it can be assumed that interaction between barriers is almost instantaneous and that average velocity of the ball should follow the velocity of the barriers and yet the ball must know to discretely accelerate and also discretely decelerate in accordance to the acceleration or deceleration of the barriers of the cage and then there is a strange situation in which the ball somehow knows that the acceleration is on stage and not the deceleration and all that should be happening by simple repulsions from the opposite barriers as depicted on the following picture which firmly implies that we are missing to notice something essential here:

Fig. 6



It is important to be made a clear distinction between the bouncing ball inside the cage in gravitational field and the bouncing ball inside the cage in acceleration because in the first case gravitational acceleration affects the ball itself while in the second case it affects the cage remaining the ball without the continual acceleration at all and therefore these two situations are completely different ones. We may assume that the cage itself does not have mass or that it just has negligible mass – in that case all the inertial properties of the cage is caused by the bouncing ball only and it reflects the inertial property of the solid body with the mass of the ball.

The following set of equations describes situation depicted on the above picture and consisted of a accelerating frame with a super-elastic ball trapped inside it, and the beginning equation is the following one:

$$v_{b_{k+1}} = -v_{b_k} + 2 \cdot v_{c_{k+1}} \tag{174}$$

Above equation is derived according Galilean[26] relativity and it is essentially identical to equation (149) which has been already derived within Galilean relativity.

The length that frame passes between two repulsions whenever the frame accelerates in the direction of the ball's motion is:

$$\ell = -\frac{a \cdot \delta t^2}{2} + v \cdot \delta t \tag{175}$$

There must be chosen a solution that yields positive time for the infinitesimally small acceleration due to ability of time to be always positive:

$$\lim_{a \to 0} \delta t > 0 \tag{176}$$

Therefore the following solution of the quadratic equation is chosen:

$$\underset{\rightarrow}{\delta t} = \frac{v - \sqrt{v^2 - 2 \cdot a \cdot \ell}}{a} \tag{177}$$

Above equation deals with the ball that runs in the same direction as the acceleration of the frame and therefore there is a limit of the acceleration that does not have to be surpassed for preservation of the ball's ability to reach opposite barrier that flees from the ball. This situation is depicted the fig. 6 whereas the ball runs in the right direction at the moment.

In that case there is a critical initial velocity required by the ball to reach another wall of the cage and if the velocity is less than critical then the ball is bouncing on one side of the cage only:

$$v_{critical} = \sqrt{2 \cdot a \cdot \ell} \tag{178}$$

When ball runs in the opposite direction of the acceleration it is:

$$\ell = \frac{a \cdot \delta t^2}{2} + v \cdot \delta t \tag{179}$$

[26] Galileo Galilei, 1564 – 1642

There also must be chosen a solution able to yield positive time for the infinitesimally small acceleration:

$$\underset{\leftarrow}{\delta t} = \frac{\sqrt{v^2 + 2 \cdot a \cdot \ell} - v}{a} \tag{180}$$

Above equation deals with the ball that runs in the opposite direction of the cage's acceleration and in this example the opposite barrier approaches to the ball with negative velocity and thereby the correct equation for the particular case is:

$$\underset{\leftarrow}{\delta t} = \frac{\sqrt{v^2 + 2 \cdot a \cdot \ell} + v}{a} \tag{181}$$

On the fig. 6 this is the situation whereas the ball runs in the left direction approaching the left barrier of the cage.

Equations (177) and (181) can be joined together:

$$\delta t = \frac{v - \mathrm{SGN}(v) \cdot \sqrt{v^2 - 2 \cdot a \cdot \mathrm{SGN}(v) \cdot \ell}}{a} \tag{182}$$

We also have that is:

$$v = v_{b_k} - v_{c_k} \tag{183}$$

By combining (181), (182) and (183) we have got:

$$\delta t = \frac{\left(v_{b_k} - v_{c_k}\right) - \mathrm{SGN}\left(v_{b_k} - v_{c_k}\right) \cdot \sqrt{\left(v_{b_k} - v_{c_k}\right)^2 - 2 \cdot a \cdot \ell \cdot \mathrm{SGN}\left(v_{b_k} - v_{c_k}\right)}}{a} \tag{184}$$

Whereas a is acceleration of the frame, ℓ is length passed by the barrier between two hits, δt is time between two hits, and v is effective velocity of the ball in respect to the cage, $v = \left|v_{b_k} - v_{c_k}\right|$, thus we have:

$$v_{c_{k+1}} = v_{c_k} + a \cdot \delta t \tag{185}$$

There is a following recursive pair of equations:

$$v_{c_{k+1}} = v_{b_k} - \mathrm{SGN}\left(v_{b_k} - v_{c_k}\right) \cdot \sqrt{\left(v_{b_k} - v_{c_k}\right)^2 + 2 \cdot a \cdot \ell \cdot \mathrm{SGN}\left(v_{b_k} - v_{c_k}\right)} \tag{186}$$

Directly from the equation (174) it is derived:

$$v_{c_k} = \frac{v_{b_k} + v_{b_{k-1}}}{2} \tag{187}$$

Above equation clearly shows that the average value of the ball must be equal to the velocity of the frame. After (187) is inserted into (186) the clear recursive equation depending only on the ball's velocities is obtained:

$$v_{b_{k+2}} = v_{b_{k+1}} - SGN\left(v_{b_{k+1}} - v_{b_k}\right) \cdot \sqrt{\left(v_{b_{k+1}} - v_{b_k}\right)^2 - 8 \cdot a \cdot \ell \cdot SGN\left(v_{b_{k+1}} - v_{b_k}\right)} \quad (188)$$

We need to find augmentation of the velocity after two successive repulsions for the profound analysis of the phenomenon:

$$v_{b_{k+2}} = v_{b_{k+1}} - \sqrt{\left(v_{b_{k+1}} - v_{b_k}\right)^2 - 8 \cdot a \cdot \ell} \quad (189)$$

Above equation deals with the ball that travels in the same direction as the cage's acceleration.

$$\delta v_{b_{k+1}} = -\sqrt{\delta v_{b_k}{}^2 - 8 \cdot a \cdot \ell} \quad (190)$$

Collision with the right barrier reduces speed while collision with the left barrier increases speed. Opposite case is under control of the following equation:

$$v_{b_{k+3}} = v_{b_{k+2}} + \sqrt{\left(v_{b_{k+2}} - v_{b_{k+1}}\right)^2 + 8 \cdot a \cdot \ell} \quad (191)$$

Above equation deals with the ball that runs in the opposite direction of the cage's acceleration.

The difference between two velocities in the opposite case, i.e. during the balls motion in the left direction according (189) and (191) is:

$$\delta^2 v_b = \sqrt{\delta v_b{}^2 + 8 \cdot a \cdot \ell} \quad (192)$$

Formulas (190) and (192) show that increment of the velocity during motion in the left direction is equal to the decrement of the motion in the right direction.

Now it is possible to make numerical simulation based on the equations (174), (182), (183) and (185) showing that bouncing ball perfectly follows the velocity of the cage despite the fact that interaction with the cage is happening only in infinitesimally small intervals of time during the collisions. It is interesting fact that equation (174) is adjusted to the Energy Conservation Law and linear acceleration and not to the acceleration with the higher degree like following one:

$$\ell = \frac{da}{dt} \cdot \frac{\delta t^3}{6} + \frac{a \cdot \delta t^2}{2} + v \cdot \delta t \quad (193)$$

Trigonometric version of Cardano[27] formula yields solution of the above 3rd degree polynomial and this formula mismatches the formulas (149), (174) and (183). Profound analysis of this mismatch shows that (149) is perfectly adjusted to the Law of Energy Conservation implying that Galilean relativity sustains Energy Conservation Law:

$$\delta t_1 = \frac{2\cdot\sqrt{a^2-2\cdot\dot{a}\cdot v}\cdot COS\left(\frac{1}{3}\cdot ACOS\left(-\frac{a^3-3\cdot a\cdot\dot{a}\cdot v-3\cdot\dot{a}^2\cdot\ell}{\left(a^2-2\cdot\dot{a}\cdot v\right)^{\frac{3}{2}}}\cdot SGN(\dot{a})\right)\right)}{|\dot{a}|}-\frac{a}{\dot{a}} \tag{194}$$

To show that Energy Conservation law is in concordance with degree of first order we are going to derive formula (149) from formulas for momentum and energy conservations:

$$m_c\cdot v_{c_0}+m_b\cdot v_{b_0}=m_c\cdot v_{c_1}+m_b\cdot v_{b_1} \tag{195}$$

And:

$$\frac{m_c\cdot {v_{c_0}}^2}{2}+\frac{m_b\cdot {v_{b_0}}^2}{2}=\frac{m_c\cdot {v_{c_1}}^2}{2}+\frac{m_b\cdot {v_{b_1}}^2}{2} \tag{196}$$

Solution of above system is:

$$v_{b_1}=\frac{m_b\cdot v_{b_0}+m_c\cdot\left(v_{b_0}-2\cdot v_{c_1}\right)}{m_b-m_c} \tag{197}$$

If we assume that m_c is infinitely larger than m_b, we have:

$$v_{b_1}=\lim_{m_c\to\infty}\frac{m_b\cdot v_{b_0}+m_c\cdot\left(v_{b_0}-2\cdot v_{c_1}\right)}{m_b-m_c}=-v_{b_0}+2\cdot v_{c_1} \tag{198}$$

Above equation is equal to equations (149) and (174) proving that it supports dynamics with acceleration up to second time's derivation. This notification opens very interesting prospective pertained to the exploitation of the second degree oscillators, fluids running trough spiral pipes and similar apparatus which should be affected by this model of temperature embodied in the speed of the balls trapped between two barriers as it was initially noticed by Shcauberger.

CONTINUAL INFINITESIMAL MODEL

The essence of the Continual Model derived from the discrete one is embodied in the force of the nozzle that sprays small balls directed to the

[27] Gerolamo Cardano, 1501 – 1576

approaching barrier. Actually, we need here two forces – the force that acts to the nozzle and the force that acts to the barrier.

We shell split the problem to two parts – the one is the force that acts to the barrier created by the jet of small balls bouncing between barriers and another one is the work done by the barrier during its compressing motion. While there is no anything else except balls capable to absorb the energy performed by the moveable barrier they must store it in the augmentation of their own kinetic energies and therefore the increase of the balls' kinetic energy must be equal to the work performed by the barrier. We saw that in the equation (158) we lost the width between barriers and the question is whether we can lose the variable of compression's speed on the same way because compression's speed does not exist in the classical model and yet we also know that the only mechanism of the balls energy increase is repulsions from the moveable barrier and therefore we do need for the speed of barrier to coexist in our equations too and yet faster barrier implies more energy transfer during the shorter period of time and slower barrier implies slower energy during longer period of time implying that barrier's velocity variable should exist in the appropriate equation.

So, let us assume that there is a continuous jet between running barriers:

$$F = 2 \cdot \frac{d}{dt}(m \cdot v) \tag{199}$$

$\Rightarrow$

$$F = 2 \cdot m \cdot \frac{dv}{dt} = 2 \cdot m \cdot \frac{dv}{d\ell} \cdot \frac{d\ell}{dt} = 2 \cdot m \cdot \frac{v}{\ell} \cdot v = \frac{2 \cdot m \cdot v^2}{\ell} \tag{200}$$

$\Rightarrow$

$$F = \frac{2 \cdot m \cdot (v + v_b)^2}{\ell} \tag{201}$$

Work of the barrier is:

$$dA = F \cdot d\ell = \frac{2 \cdot m \cdot (v + v_b)^2}{\ell} \cdot d\ell \tag{202}$$

$\Rightarrow$

$$dA = \frac{2 \cdot m \cdot (v + v_b)^2}{\ell} \cdot d\ell \tag{203}$$

Then infinitesimal energy of the ball is:

$$dE = m \cdot v \cdot dv \tag{204}$$

Now we have:

$$dA = -dE \tag{205}$$

$\Rightarrow$

$$-\frac{d\ell}{\ell} = \frac{v \cdot dv}{2 \cdot (v + v_b)^2} \tag{206}$$

⇒

$$LN\left(\left(\frac{\ell_1}{\ell_2}\right)^2\right) = \frac{v_b \cdot (v_1 - v_2)}{(v_b + v_1)\cdot(v_b + v_2)} + LN\left(\frac{v_b + v_2}{v_b + v_1}\right) \tag{207}$$

Whenever the v_b is close to zero (slow compression) we have:

$$\left(\frac{\ell_2}{\ell_1}\right)^2 = \frac{v_1}{v_2} \tag{208}$$

According (201) we have:

$$\frac{F_1}{F_2} = \frac{v_1^{\,2} \cdot \ell_2}{v_2^{\,2} \cdot \ell_1} \tag{209}$$

⇒

$$\frac{F_1}{F_2} = \left(\frac{\ell_2}{\ell_1}\right)^5 \tag{210}$$

⇒

$$\frac{P_1}{P_2} = \left(\frac{V_2}{V_1}\right)^5 \tag{211}$$

⇒

$$P \cdot V^5 = const \tag{212}$$

Exponentiation of above equation is quite distant from the average experimentally obtained value of 1.4 for air although this is pretty good result indicating that collimation of the molecules' motional directions may pretty much increase thermal efficiency according (65) just as already concluded by the Discrete Model. As aforesaid, this efficiency improvement can be achieved trough reduction of Degree of Freedom.

There are some indications that according equation (160) infinitesimal variation of the energy of the ball after its energy acceptance from the barrier may not be (204) and that it should be:

$$dE = 2 \cdot m \cdot v_b \cdot dv \tag{213}$$

⇒

$$-\frac{2 \cdot m \cdot (v + v_b)^2}{\ell} \cdot d\ell = 2 \cdot m \cdot v_b \cdot dv \tag{214}$$

⇒

$$-\frac{d\ell}{\ell} = \frac{v_b \cdot dv}{(v + v_b)^2} \tag{215}$$

⇒

$$-\frac{d\ell}{\ell}=\frac{v_b\cdot dv}{(v+v_b)^2} \tag{216}$$

⇒

$$LN\left(\frac{\ell_1}{\ell_2}\right)=\frac{v_b\cdot(v_2-v_1)}{(v_b+v_1)\cdot(v_b+v_2)} \tag{217}$$

Above equation does have explicit solution on v_2:

$$v_2=\frac{v_b\cdot\left((v_1+v_b)\cdot LN\left(\frac{\ell_1}{\ell_2}\right)+v_1\right)}{v_b-(v_1+v_b)\cdot LN\left(\frac{\ell_1}{\ell_2}\right)} \tag{218}$$

⇒

$$\frac{F_1}{F_2}=\frac{{v_1}^2\cdot\ell_2}{\left(\frac{v_b\cdot\left((v_1+v_b)\cdot LN\left(\frac{\ell_1}{\ell_2}\right)+v_1\right)}{v_b-(v_1+v_b)\cdot LN\left(\frac{\ell_1}{\ell_2}\right)}\right)^2\cdot\ell_1} \tag{219}$$

⇒

$$\frac{V_1}{V_2}=\frac{{v_1}^2}{\left(\frac{v_b\cdot\left((v_1+v_b)\cdot LN\left(\frac{V_1}{V_2}\right)+v_1\right)}{v_b-(v_1+v_b)\cdot LN\left(\frac{V_1}{V_2}\right)}\right)^2}\cdot\frac{V_2}{V_1} \tag{220}$$

This approach also indicates that even partially collimated molecules' motional directions may significantly raise the efficiency of the both adiabatic and isobaric processes.

As with both continual and discrete models have been shown that Gas Kinetic Model is plausible and applicable enough to betoken the direction of further optimization of the internal combustion engine's efficiency by their derivation in a single spatial dimension only: the collimation of the molecules' motional directions should be achieved by proper **magnetization** or electrification of the piston either by magnets or by strong electric field and this should significantly improve the piston's efficiency according equation (65) trough increase of polytrophic coefficient for air from 1.3 to more than 4. This improvement is achievable in both internal combustion engines and rocket motors by magnetic collimated nozzle. Efficiency improvement by reduction of the degree of freedom is already proven by the lifter device. The reduction of molecules degree of freedom is able to reduce temperature of blowing jet in the lifter device and though contrary to the thermodynamics laws lifter thruster converts thermal energy into the motional one of the jet. As the lifter thruster certainly reduces temperature of the jet, it is obvious that this energy fed from the temperature drop must be transferred into the kinetic energy of the jet because there is anything else in which this energy can be stored – this rather challenges Thermodynamics Laws than making lifter device impossible simply because its operation is experimentally duly proven. The burdensome fact is that theoretical impossibility of the phenomenon does not prevent its existence at all – this rather prevents the theory itself. Correct theory should be able to anticipate existence of some new and very useful physical phenomenon and it is going to be dominant way of the progress because all accidental discoveries seems to be already discovered by the army of researches with lack of any good idea who traced all available options in their quest for glorious discoveries.

Practical realizations of the magnetic and electrostatic collimators are beyond the scopes of the paper. It is also perceivable that there is possibility for partial transmission of the explosion or the flame directly into electricity trough magnetic separation of flame's ions as it is already happening in the lifter thruster with the proposed electromagnetic field which may bring significant additional benefit in efficiency.

EIGHTH SOLUTION – NON THERMODYNAMIC CYCLE

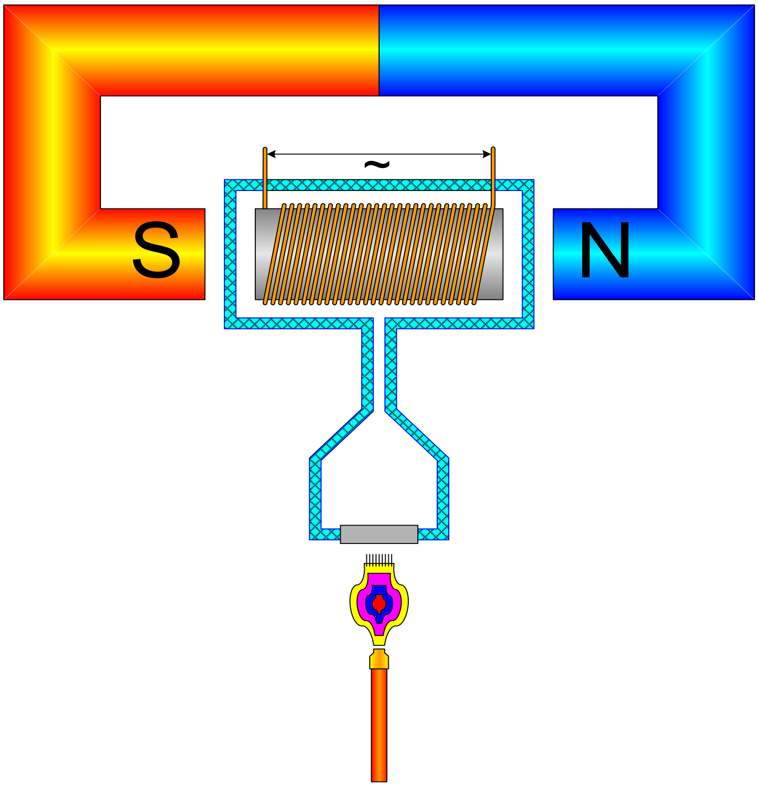
Machines based on thermodynamic cycle always have explicit or implicit hot and cold ends and the gas that propel either piston or turbine. If there is at least one motor that assuredly has only hot end or it is not based on the gaseous cycle then we can prove that the thermodynamic thermal machine is not the only possible way of operation.

The forth solution is any solution which is not based on mechanical energy extraction by the expansion of the gas chamber. There are several methods that can be used for that – electrochemical elements made of doped diamond, thermo-magnetic pumps, eddy current extraction based on the functioning of synchronous generators, piezoelectric thermo-sonic pumps, MHD ionic separation directly from flame, etc.

CURIE MOTOR WITH SOLID STATE CYCLE

Circumstantial evidence that Curie motor is possible is available on the http://www.youtube.com which is consisted of the acetylene torch, external permanent magnet and the lump of the ferromagnetic material hanged to make pendulum. Magnetic attraction is stopped by heating to the Curie temperature and then cooling reestablish making pendulum to swing. Instead of pendulum the lump could be wrapped by coil and sealed in the thermos: by reaching the Curie temperature the magnetic circuit is broken changing the magnetic flux trough the coil which then induces energy impulse via Faraday's induction. The released energy is transferred out of thermos trough wires as electric energy which creates the drop of temperature in the ferromagnetic lump and the reestablishment of the magnetic circuit which again changes the magnetic pulse inducing current in the opposite direction. Such motor is depicted on the following picture:

Fig. 7



This motor obviously has only one thermal end while another cold end is virtual one somehow always on the Curie temperature. This motor directly converts heat into the AC electric current with only one condition that the heat must be greater than the Curie temperature. Its theoretical efficiency is much higher than the one of any thermodynamic engine.

Such motor is possible, but with the limited power density. With the utilization of the diamond heat pipe its power density can be significantly improved. Curie motor is solid proof that the motors that are not based on the classical thermodynamics do exist, so we can proceed further with the text.

SCHAUBERGER EQUATION OF LIQUID CYCLE

The almost unknown and very promising approach is based on the legacy of Schauberger's work. Schauberger's work is quite interesting because it yields a profound explanation of the heat's essence and it also disproves contemporary form of Navier[28]-Stokes[29] equation revealing the true nature of turbulent processes whose revelation is going to be awarded by Clay Mathematics Institute that offered 1000000$ prize established in May of 2000. Extended Schauberger equation (231) also explains the essence of the overunity processes in the plasma previously wrongly attributed entirely to the Cold Fusion Effect. Equation (231) which is junction of the Shcauberger and Bernoulli[30] theories thoroughly handles the turbulence as the way of the

[28] Claude-Louis Navier, 1785 – 1836
[29] George Gabriel Stokes, 1819 – 1903
[30] Daniel Bernoulli, 1700 – 1782

spatial conversion of internal heat into the motion, which is clearly visible on the infra-red images of the turbulent fluid in motion. It appears that all sorts of fluid equations are less or more mutated Bernoulli equation with none of them containing the temperature.

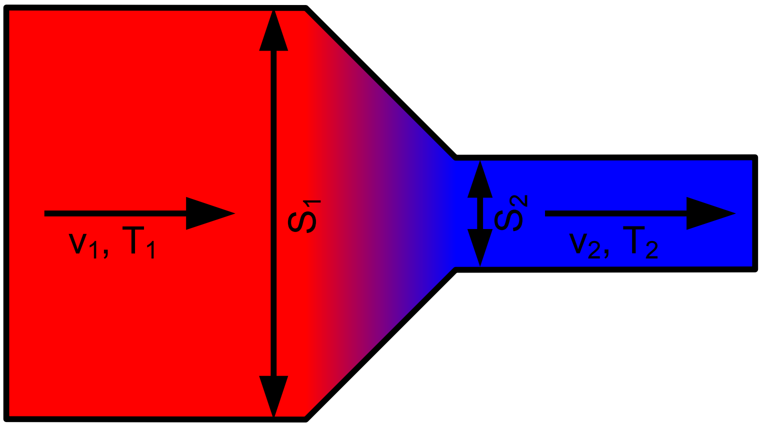
It is pertinent place to be noticed that cold fusion was at least ones awarded by Nobel prize (muon catalyzed cold fusion of Alvarez[31]), there are plenty of allegedly workable devices (Migma cell by Maglić[32], Patterson[33] cell, Fleischmann[34]-Pons[35] cell, etc.) and at least one theoretical explanation [1] experimentally proven. Moray[36] did one exceptionally clever design based on the radioactive PN junction and here radioactivity is interesting because essentially it is augmented uncertainty which is the main ingredient of our perception of time – utilization of unpredictability indicates that some sort of temporal energy extraction was utilized by the Moray's device.

Equation (231) is universal one and it rules gases and liquids too. Basically, Schauberger's approach is similar to Bernoulli's one and it is quite strange that none of them derived the complete equation (231). Even more, Shcauberger missed to derive differential form of his equation too.

Schauberger as genuine hydraulic engineer noticed that any pipe with the variable cross section filled with running fluid seemingly violates Law of Energy Conservation just because the flow is running faster in the narrower part of the pipe than in the wider one, implying that its kinetic energy must be higher as described in [2] and [3]. According to the Schauberger's assumption this increase of kinetic energy is borrowed right from the internal thermal energy of the fluid itself just to preserve validity of Energy Conservation Law. It is important to be noticed that this equation does not explain anything except that Energy Conservation Law should be taken for granted and that this equation then directly follows from this assumption. He also assumed that any thermodynamic process instantly obeys to the Energy Conservation Law.

The essence of this concept is depicted on the following picture:

Fig. 8



[31] Luis W. Alvarez, 1911 – 1988
[32] Bogdan Maglić, 1928-
[33] James A. Patterson, ? – ?
[34] Martin Fleischmann, 1927 – 2012
[35] Bobby Stanley Pons, 1943 –
[36] Thomas Henry Moray, 1892 - 1974

Following line of equations could be established according above picture with general assumption that is $v_2 > v_1$ and $T_1 > T_2$:

$$dE_{K1} + dE_{T1} = dE_{K2} + dE_{T2} \tag{221}$$

$\Rightarrow$

$$\frac{dm_1 \cdot \vec{v}_1^{\,2}}{2} + Q \cdot dm_1 \cdot T_1 = \frac{dm_2 \cdot \vec{v}_2^{\,2}}{2} + Q \cdot dm_2 \cdot T_2 \tag{222}$$

Whereas v_1 is speed in the wider section of the pipe, T_1 is absolute temperature in the wider section, Q is thermal capacity of the fluid and v_2 and T_2 are velocity and temperature in the narrower section respectively. Above equation is known as the genuine Schaumberg equation. While the mass cannot vanish in the pipe, the dm must be unique for all cross sections of the non-leaking pipe. Thereby this can be further simplified:

$$\frac{dm \cdot \vec{v}_1^{\,2}}{2} + Q \cdot dm \cdot (T_1 - T_2) = \frac{dm \cdot \vec{v}_2^{\,2}}{2} \tag{223}$$

$\Rightarrow$

$$\vec{v}_2^{\,2} = \vec{v}_1^{\,2} - 2 \cdot Q \cdot (T_2 - T_1) \tag{224}$$

Now, we will derive generalized equation of the Schauberger principle:

$$(\vec{v} + d\vec{v})^2 = \vec{v}^2 - 2 \cdot Q \cdot dT \tag{225}$$

$\Rightarrow$

$$\vec{v}^2 + 2 \cdot \vec{v} \cdot d\vec{v} + d\vec{v}^2 = \vec{v}^2 - 2 \cdot Q \cdot dT \tag{226}$$

$\Rightarrow$

$$\vec{v} \cdot d\vec{v} = -Q \cdot dT \tag{227}$$

Time derivative of above equation yields:

$$\vec{v} \cdot \vec{a} = -Q \cdot \frac{dT}{dt} \tag{228}$$

$\Rightarrow$

$$\vec{v} \cdot \vec{a} = -Q \cdot \frac{dT}{d\vec{\ell}} \cdot \frac{d\vec{\ell}}{dt} = -Q \cdot \frac{dT}{d\vec{\ell}} \cdot \vec{v} \tag{229}$$

$\Rightarrow$

$$\vec{v} \cdot \vec{a} = -Q \cdot \vec{v} \cdot \vec{\nabla} T \tag{230}$$

We can improve above equation with the essence of the Bernoulli formula:

$$\vec{v} \cdot \vec{a} = -\left(\vec{g} + Q \cdot \vec{\nabla} T\right) \cdot \vec{v} \tag{231}$$

Whereas $\vec{g}$ is gravitational acceleration of the Earth, $\vec{\nabla} T$ is the gradient of the fluid's temperature, $\vec{v}$ is the fluid's velocity and $\vec{a}$ is the acceleration of the fluid. It is significant to be noticed that neither Bernoulli principle nor the Navier-Stokes equation does count the temperature at all and therefore they both are not duly correct formulas. So, there is pertinent question here how is it possible that such omission could remain unnoticed till now!? The answer is very simple: classical fluid mechanics assumes that fluid on fig. 8 drains energy from the pressure obtained by external pump that generates the flow. The situation recently became obvious with development of computer games that started to utilize Navier-Stokes equation mainly for smoke modeling and surface streaming of liquids in real-time and there is shown that this equation usually cannot be used without being constrained and supplemented with at least two additional equations: the first one usually adds the temperature and another one the inertial properties. Although the smoke visualization obtained by the Navier-Stokes equation is satisfactory for computer games it does not entirely matches the real smoking situation which finally led to the Millennium Award. Thereby the correct unique equation must contain temperature, volume, density, viscosity and to be able to solely handle all fluids conditions. It is important to be noticed that Schauberger effect occurs only when the fluid drains energy from its own kinetic energy! The propellant energy of the fluid will be primarily drained from the pump's motor if there is a pump creating gradient of pressure and the thermal energy is the last resort for the fluid to utilize. Here we may notice that there is fractional ratio of conversion between internal thermal energy and external pump energy that corresponds to the C_P/C_V ratio in the adiabatic expansion.

We will stay focused on the effect of the temperature variation and therefore the influence of the gravitational field will be neglected in the following derivations. The experimental proof of the above equation is obtained by the lifter's thruster whose jet has lover temperature on the blowing hole then on the sucking hole which perfectly fits equation (231).

We can also make following innocent simplification and then we have obtained following incomplete generalized form of equation (230):

$$\vec{a} = -Q \cdot \vec{\nabla} T \tag{232}$$

Although the correct solution of equation (120) is:

$$\hat{v} \cdot (\vec{a} \cdot \hat{v}) = -Q \cdot \vec{\nabla} T \tag{233}$$

Above equation yields correlation between temperature and acceleration and it can explain even explosions of rock meteors just as the explosion of super heated liquid rock suddenly exposed to strong deceleration that instantly causes explosion of superheated water in melted meteor or comet just like happened in Tunguska event in 1908, or recently Chelyabinsk event of 2013-02-15. It is almost sure that the Chelyabinsk comet was hit by the ABM rocket from the rear side (forbidden by S.T.A.R.T.) which penetrated the super heated bulb of comet's water causing massive explosion on the sky.

Starting from (228) we have:

$$\frac{d}{dt}\left(\frac{\vec{v}^2}{2} - \frac{\vec{v}_0^{\,2}}{2}\right) = Q \cdot \frac{dT}{dt} \tag{234}$$

Velocity of the single molecule is:

$$v = \sqrt{{v_0}^2 + 2 \cdot Q \cdot T} \tag{235}$$

We also believe that v_0 is zero:

$$v = \sqrt{2 \cdot Q \cdot T} \tag{236}$$

Whereas v is the velocity of the molecules in the fluid, Q is specific heat of the fluid and T is absolute temperature of the fluid. Above equation does not clarify whether Q is dedicated for the isochoric or isobaric gas expansion.

According (34) it is also:

$$v = \sqrt{\frac{2 \cdot C_V \cdot T}{M_r}} \tag{237}$$

It denotes that Q in (233) denotes mass isochoric specific heat.

It is interesting to be noticed that Schauberger hypothesis is so mighty that classical form of the gas equation can be derived from above formula with aid of the Second Newton Law and the definition of pressure, i.e.:

$$\vec{F} = -m \cdot \vec{a} \tag{238}$$

And:

$$\vec{F} = P \cdot d\vec{S} \tag{239}$$

With help of Gauss[37]-Ostrogradsky[38] theorem we have:

$$\vec{F} = P \cdot d\vec{S} = \vec{\nabla} P \cdot dV \tag{240}$$

By combining of (232), (238) and (240) we have:

$$\vec{\nabla} P \cdot dV = dm \cdot Q \cdot \vec{\nabla} T \tag{241}$$

Finally we have:

$$P \cdot V = m \cdot Q \cdot T \tag{242}$$

Above equation corresponds to the equation (16) of kinetic statistical model. It is phlogiston's version of the classical gas equation (16).

What we need here is the equation (50) for adiabatic compression because this equation is the keystone of the all heat machines in contemporary engineering usage.

After (242) is differentiated we have:

$$Q \cdot T \cdot dm = V \cdot dP + P \cdot dV \tag{243}$$

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[37] Johann Carl Friedrich Gauss (Gauß), 1777 – 1855
[38] Mikhail Ostrogradsky, 1801 – 1862

I.e.:

$$dE_T = dE_P + dA \tag{244}$$

Whereas $dE_T = m \cdot Q \cdot dT$, $dE_P = V \cdot dP$ and $dA = P \cdot dV$.

Above equation tells us that thermal energy is spreading into mechanical work of the piston and into the energy required for internal pressure maintenance according fig. 3. And, now, there is a tricky part: there is no variation in volume in the heating of the blocked piston and therefore there is only steady increase in both pressure and temperature:

$$Q \cdot dT \cdot m = k \cdot V \cdot dP \tag{245}$$

Now, we will contrive that the thermal energy of the gas is used for mechanical work of the piston and for the maintenance of the gas pressure are in constant ratio:

$$dA = -k \cdot dE_T \tag{246}$$

This speculation has the following form:

$$Q \cdot m \cdot dT = -\frac{P \cdot dV}{k} \tag{247}$$

And:

$$dE_P = (1-k) \cdot dE_T \tag{248}$$

Equation (246) has the negative sign when the gas has decompression because it utilizes its internal energy to push the piston which consequently causes drop in both temperature and pressure, but equation (248) preserves its sign because drop in pressure follows drop in temperature.

If we involve (247) into (243) we have:

$$-\frac{P \cdot dV}{k} = V \cdot dP + P \cdot dV \tag{249}$$

$\Rightarrow$

$$-P \cdot dV \cdot \left(\frac{1}{k} + 1\right) = V \cdot dP \tag{250}$$

$\Rightarrow$

$$-\left(\frac{1+k}{k}\right) \cdot \frac{dV}{V} = \frac{dP}{P} \tag{251}$$

And we have finally derived the classical formula for adiabatic compression:

$$\frac{P_2}{P_1} = \left(\frac{V_1}{V_2}\right)^{\frac{k+1}{k}} \tag{252}$$

Directly from (242) we have:

$$\frac{P_2}{P_1} \cdot \frac{V_2}{V_1} = \frac{T_2}{T_1} \tag{253}$$

According above equation and (252) we have:

$$\left(\frac{V_1}{V_2}\right)^{\frac{k+1}{k}} \cdot \frac{V_2}{V_1} = \frac{T_2}{T_1} \tag{254}$$

$\Rightarrow$

$$\left(\frac{V_1}{V_2}\right)^{\frac{1}{k}} = \frac{T_2}{T_1} \tag{255}$$

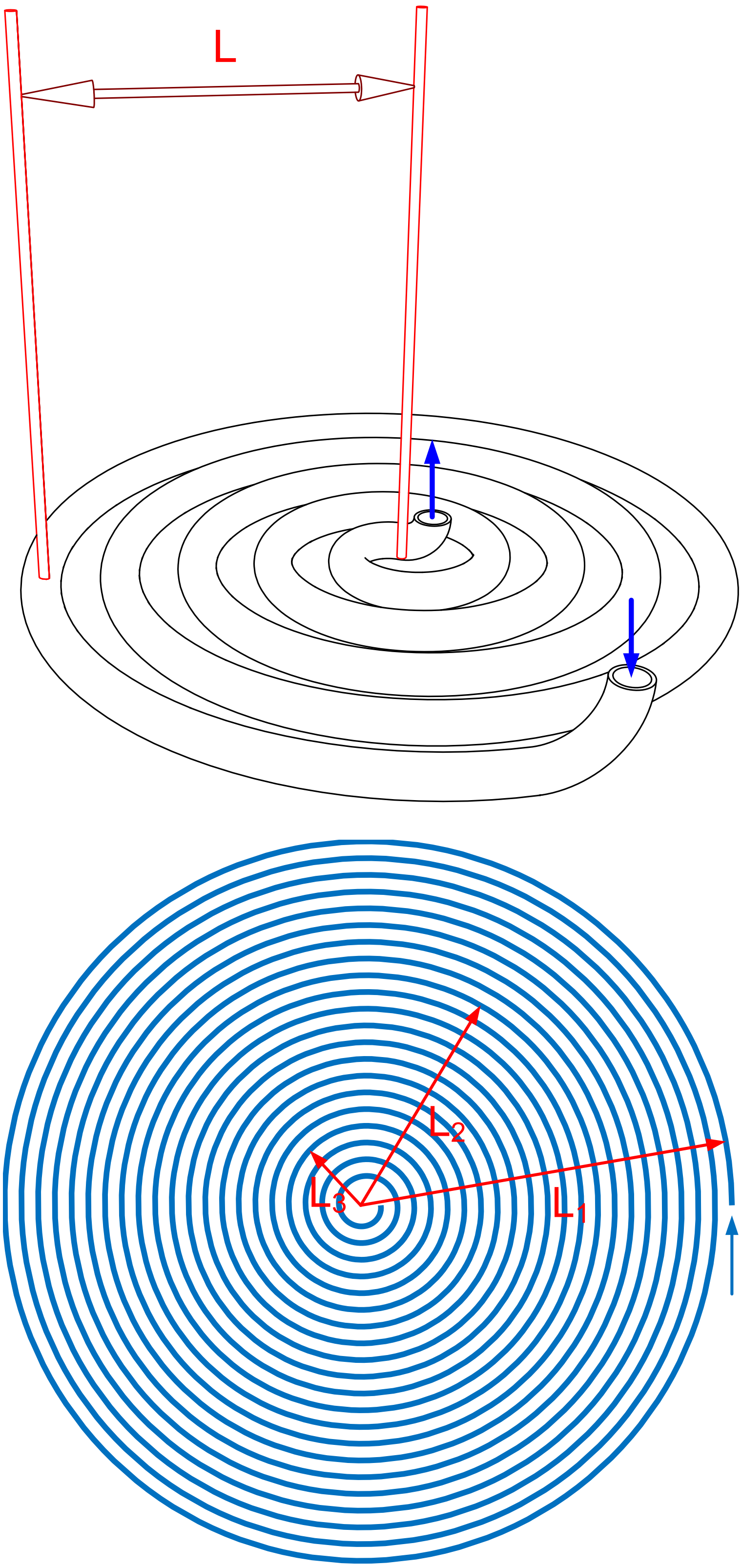
This approach is the clearest derivation of the polytrophic formula of the adiabatic process. The constant k clearly determines the adiabatic constant χ and it also defines ratio in which incoming thermal energy will be shared between isobaric and isochoric processes as aforesaid.

The exceptionally good book pertained to the operation of internal combustion engines [4] uses an excellent excuse why this ratio occurs – cute but also false explanation.

Schauberger's conversion of heat into mechanical work occurs in hurricanes and tornados as it is proved by the satellite images depicting that the temperature of air is directly converted into the speed of the wind. Usage of the Schauberger's equation could improve the weather forecast a lot, especially in the case of the most devastating atmospheric events like hurricanes and tornados are.

Schauberger also noticed that Law of Angular Momentum Conservation is heavily violated in the spiral pipe with running uncompressible fluid:

Fig. 9



The non-compressible fluid that runs through the spiral pipes violates Law of Angular Momentum’s Conservation because infinitesimal element of mass has variable angular momentum due to its constant speed on the variable radius. According the Schauberger there are strange manifestations that affect speed of time passing and also the drop of temperature should be experienced in the vicinity of such vortex. Anyway, the notification that there is a real world situation that obviously violates Law of Conservation of Angular momentum really challenges our entire concept of physics and physical laws. The idea that the local speed of time varies to preserve Angular Momentum Conservation Law even in the case of spiral pipe too is quite interesting and it is basically an extension of his previous hypothesis that the temperature would vary to preserve Linear Momentum Conservation Law which is going to be true and therefore the whole concept is going to be quite intriguing now. The possible variation of time flow may explain the Bermuda triangle effect because this area is rich with hot oceanic water streaming in currents and therefore there are all possible circumstances gathered together for the Schauberger effect to take the stage.

The hurricane utilizes the same sort of motion like the one depicted on the following picture of Hurricane Isabel (2003):

Fig. 10

IMPROVEMENT OF THE NAVIER-STOKES EQUATION BASED ON THE SCHABERGER EQUATION

Compact form of the Navier-Stokes is:

$$(\vec{a}-\vec{g})\cdot\rho = \vec{\nabla}P + \eta\cdot\Delta\vec{v} \qquad (256)$$

Above equation is just a skewers with all force's terms stabbed on. There is following operator's equation that yields connection between total and partial time derivatives:

$$\frac{d}{dt} = \frac{\partial}{\partial t} + (\vec{v}\cdot\vec{\nabla}) \qquad (257)$$

Thus we came to the more familiar form of the Navier-Stokes equation:

$$\left(\frac{\partial\vec{v}}{\partial t} + (\vec{v}\cdot\vec{\nabla})\vec{v} - \vec{g}\right)\cdot\rho = \vec{\nabla}P + \eta\cdot\Delta\vec{v} \qquad (258)$$

Here will be made an attempt to enrich the Navier-Stokes equation (256) with the term that reflects the Schaberger's hypothesis and it comes directly from (232) that connects acceleration and temperature:

$$(\vec{a}-\vec{g})\cdot\rho=\vec{\nabla}P+\eta\cdot\Delta\vec{v}+Q\cdot\vec{\nabla}T \tag{259}$$

Whereas $\vec{a}$ denotes acceleration of the fluid itself, $\vec{g}$ is gravitational acceleration that acts to the fluid, ρ is density of the fluid, P is pressure which gradient is created by the external pump driven by a motor, η is viscosity of the fluid that creates frictional loss, Q is thermal capacity of the gas and it pertains to C_V and T is temperature of the fluid which gradient is able to create this acceleration.

There is also one extra process that stubbornly defies to the Newtonian mechanics – diffusion. The diffusion term can be inserted into the Navier-Stokes equation too. Although this term has negligible influence to the vigorous motions in operating fluids in engines, it is important for the smoke modeling. Fick[39] equation of the diffusion does not contain the temperature too, which is not true according Einstein! Furthermore, detail analysis of diffusion's equation shows that it does not obey entirely to the Newtonian Second Law too! Any process driven by the non-Newtonian mechanics instantly implies that it comes from the outer world that gently touches our world trough the tiny space-time fabric fluctuations. We have only vague concept of Zero Point Energy mainly based on the Fermi[40]-Dirac[41] distribution that claims existence of the motion even on the temperature of absolute zero by those fluctuations. Allegedly the Casimir[42]-Polder[43] effect [8] is caused by the ZPE too. Most notable manifestation of the ZPE is Petro-voltaic effect usually embodied in self charging of the older pyralene[44] electrolytic capacitors.

The basic Fick equation is:

$$\vec{J}=-D\cdot\vec{\nabla}n \tag{260}$$

Whereas $\vec{J}$ is the surface density of the particles involved into the effect, D is the coefficient of the diffusion, and n is spatial concentration of the particles.

Einstein formula for diffusion coefficient D does contain temperature:

$$D=\frac{k_B}{6\cdot\pi}\cdot\frac{1}{\eta\cdot r_m}\cdot T \tag{261}$$

Whereas r_m is radius of molecules, the one that also exists in various gas state equations implicitly representing the volume already occupied by the

[39] Adolf Eugen Fick, 1829 – 1901
[40] Enrico Fermi,1901 – 1954
[41] Paul Adrien Maurice Dirac, 1902 – 1984
[42] Hendrik Brugt Gerhard Casimir, 1909 – 2000
[43] Dirk Polder, 1919 — 2001
[44] polychlorinated biphenyl

gas molecules, D is diffusion coefficient and η is viscosity coefficient. It is perceivable that η depends on temperature, but the influence of temperature to r_m is not quite clear. Above equation predicts that D constant of diffusion will be negligible on low temperature which is utterly false statement and thereupon the accuracy of above formula exacerbates on low temperatures. It should be noticed that at the time of the derivation of above formula Fermi-Dirac distribution was not known.

Better empirical connection between diffusion coefficient and temperature is:

$$D = D_0 \cdot e^{-\frac{T_0}{T}} \qquad (262)$$

Above formula is modified in the manner to cope with the absolute zero temperature:

$$D = D_z + D_0 \cdot e^{-\frac{T_0}{T}} \qquad (263)$$

Whereas D_0 is diffusion coefficient on temperature T_0, D_z is diffusion constant on absolute zero temperature T = 0 and D is diffusion coefficient on temperature T. Above equation that is accurate only in the proximity of T_0 claims that diffusion coefficient D is nil at absolute zero temperature which is false because there are fluctuations even on absolute zero with the condition that the substance is still gaseous on the temperature of absolute zero.
Directly from equation (260) the second Fick equation is derived:

$$\frac{dn}{dt} = \dot{n} = D \cdot \Delta n \qquad (264)$$

Just for the record there is HHC upgrade of Fick equation that is allegedly better version which will not be treated here:

$$\frac{\ddot{n}}{v_{s2}} + \frac{\dot{n}}{D} = \Delta n \qquad (265)$$

From (260) we have:

$$\vec{v} = -D \cdot \frac{\vec{\nabla} n}{n} \qquad (266)$$

Acceleration is going to be derived from (266):

$$\vec{a} = \dot{\vec{v}} = -\frac{d}{dt}\left(\frac{D \cdot \vec{\nabla} n}{n}\right) = -D \cdot \frac{n \cdot \vec{\nabla}\dot{n} - \dot{n} \cdot \vec{\nabla} n}{n^2} \qquad (267)$$

With the aid of (264) is obtained:

$$\vec{a} = D^2 \cdot \frac{\Delta n \cdot \vec{\nabla} n - n \cdot \Delta \vec{\nabla} n}{n^2} \qquad (268)$$

Density ρ is proportional to the concentration n:

$$\vec{a} = D^2 \cdot \frac{\Delta\rho \cdot \vec{\nabla}\rho - \rho \cdot \Delta\vec{\nabla}\rho}{\rho^2} \tag{269}$$

Above equation can be added into equation (259) and then the full version of the Navier-Stokes equation:

$$\vec{a} + D^2 \cdot \frac{\Delta\rho \cdot \vec{\nabla}\rho - \rho \cdot \Delta\vec{\nabla}\rho}{\rho^2} = \vec{g} + \frac{\vec{\nabla}P + \eta \cdot \Delta\vec{v} + Q \cdot \vec{\nabla}T}{\rho} \tag{270}$$

E.e.:

$$\vec{a} + {D_0}^2 \cdot e^{-2 \cdot \frac{T_0}{T}} \cdot \frac{\Delta\rho \cdot \vec{\nabla}\rho - \rho \cdot \Delta\vec{\nabla}\rho}{\rho^2} = \vec{g} + \frac{\vec{\nabla}P + \eta \cdot \Delta\vec{v} + Q \cdot \vec{\nabla}T}{\rho} \tag{271}$$

Above equation is improved Naiver-Stokes equation in compact form with two extra terms: the first one is the Schauberger term and the second one is diffusion one. The diffusion term has negligible influence in the simulation of combustion engines, rocket motors or any other device with vigorous combustion, but it can be used for simulation of smoke spreading trough air. Above equation does contain temperature and it is able to yield full gas equation, diffusion spreading, viscose effects, turbulence and much more, maybe event to be used for determination of the aerodynamic coefficient on ultrasonic speeds where the thermal effects become dominant ones.

Usage of above equation in meteorology can greatly improve the weather forecast of hurricanes and anticipation of tornados trajectories.

It is important to be noticed that equation (268) is derived completely without relying on Second Newton Law. The derivation relied on the Second Newton Law starts:

$$\vec{F} = \frac{d\vec{P}}{dt} = \dot{m} \cdot \vec{v} \tag{272}$$

Whereas $\vec{F}$ is the force, $\vec{P}$ is linear momentum, $\dot{m}$ is time derivative of mass and $\vec{v}$ is velocity.

Pressure is:

$$P = \frac{d\vec{P}}{dt} = \vec{J} \cdot \vec{v} \tag{273}$$

⇒

$$P = \left(-D \cdot \vec{\nabla}\rho\right) \cdot \left(-\frac{D \cdot \vec{\nabla}\rho}{\rho}\right) = \frac{D^2 \cdot \left(\vec{\nabla}\rho\right)^2}{\rho} \tag{274}$$

There is also following connection between gradient of pressure, density and acceleration entirely based on the Second Newton Law:

$$\vec{\nabla}P = \rho \cdot \vec{a} \tag{275}$$

By combining two previous equations it is obtained:

$$\vec{a} = \frac{\vec{\nabla}P}{\rho} = \frac{\vec{\nabla}\left(\frac{D^2 \cdot \left(\vec{\nabla}\rho\right)^2}{\rho}\right)}{\rho} = D^2 \cdot \frac{\rho \cdot \vec{\nabla}\left(\left(\vec{\nabla}\rho\right)^2\right) - \left(\vec{\nabla}\rho\right)^2 \vec{\nabla}\rho}{\rho^3} \tag{276}$$

$\Rightarrow$

$$\vec{a} = D^2 \cdot \frac{2 \cdot \rho \cdot \Delta\rho - \left(\vec{\nabla}\rho\right)^2}{\rho^3} \cdot \vec{\nabla}\rho \tag{277}$$

Above equation of acceleration caused by diffusion is entirely based on the Second Newton Law and it is quite different than equation (269) proving that diffusion does not obey to the Newtonian mechanics further implying that its cause is settled in the small fluctuation of the space-time fabric rather than usual explanation that it is caused by permanent thermal fluctuation of the molecules of the gas. There is a way for derivation of the diffusion equation based on the Gas Kinetic Model and this equation is quite different than one of the diffusion also containing the temperature and while classical diffusion equation is experimentally proven we may expect that Quantum Mechanical explanation is correct. It is interesting that this explanation claims that diffusion will occur even on absolute zero and that it is rather affected by the intrinsic property of the space-time fabric embodied in the D constnat than on the temperature parameter. Therefore the diffusion really challenge the Gas Kinetic Model of the gas implying that there is some mechanism for particles perturbation that is more dominant than one caused by the particles thermal fluctuation which is extremely odd.

VARIABLE WIDTH PIPE AS HEAT MOTOR AND VELOCITY SENSOR BASED ON THE SHCAUBERGER PRINCIPLE

For the non-compressible fluid according (232) and (238) we have:

$$\vec{\nabla}P = \rho \cdot Q \cdot \vec{\nabla}T \tag{278}$$

Above equation implies that pipe depicted on the fig. 8 can be used either for the sensor for velocity of the fluid by measuring the temperature variation or even as the heat engine with fluid only in liquid phase, and the power of the such engine is:

$$W = \frac{dm}{dt} \cdot Q \cdot \vec{\nabla}T \tag{279}$$

The device on the fig. 8 can be also used as the speed sensor based on the difference of temperatures on sections 1 and 2. We also have following continuum equation as constrain of <u>non-compressible</u> fluid:

$$\frac{dV_1}{dt} = \frac{dV_2}{dt} \tag{280}$$

⇒

$$\frac{d(S_1 \cdot \ell)}{dt} = \frac{d(S_2 \cdot \ell)}{dt} \tag{281}$$

Finally it is obtained:

$$S_1 \cdot v_1 = S_2 \cdot v_2 \tag{282}$$

⇒

$$v_1 = v_2 \cdot \left(\frac{S_2}{S_1}\right) \tag{283}$$

By combining (224) and (282) is obtained:

$$v_2{}^2 = v_2{}^2 \cdot \left(\frac{S_2}{S_1}\right)^2 + 2 \cdot Q \cdot (T_1 - T_2) \tag{284}$$

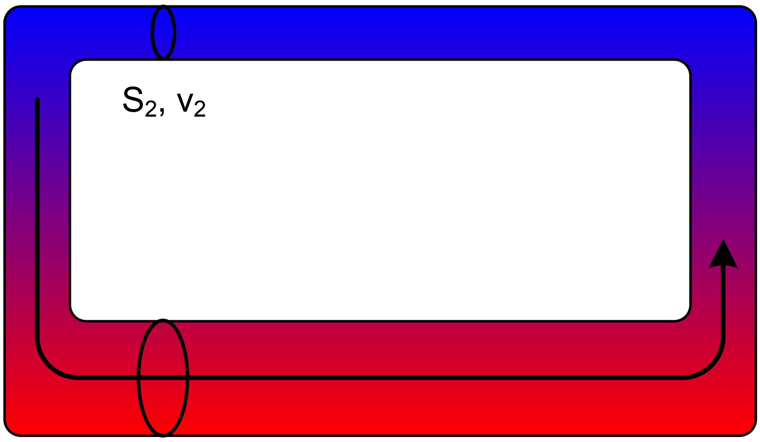
We can derive formula for the speed of the fluid in the narrower part of the pipe now:

$$v_2 = \sqrt{\frac{2 \cdot Q \cdot (T_1 - T_2)}{1 - \left(\frac{S_2}{S_1}\right)^2}} \tag{285}$$

The effect is barely noticeable for the liquids with the high thermal capacity, but for the liquids with small Q the effect can be quite applicable in thermal engine with liquid operating fluid and one extremely suitable fluid is mercury as the conductive and metallic fluid.

Our goal is to find connection between the thermal energy and the mechanical work obtained by such engine depicted on fig. 8. The legacy of the Schauberger work is the ability to be built the thermal machine with entirely liquid coolant completely without the gas phase at all. Such motor is expected to be significantly more efficient then one based on the gas just because the degree of efficiency is determined by the aforementioned equation (247) that splits the internal energy into the persistent ratio between work done for expansion and the pressure drop. We can imagine for the moment following machine:

Fig. 11



The equation of the above engine is:

$$\frac{v_1^2}{2} + Q \cdot T_1 + \frac{P_1}{\rho} = \frac{v_2^2}{2} + Q \cdot T_2 + \frac{P_2}{\rho} \tag{286}$$

Practically we have just come to the situation identical to one we had with gas coolant in which we needed an additional equation to split internal heat energy into the mechanical work and the increase of pressure. So we need here some additional equation to balance T and P in proper ratio.

This situation is much better now because very high efficiency can be achieved with metallic mercury coolant.

Power of the heat pump is:

$$W = \rho \cdot Q^{\frac{3}{2}} \cdot \frac{S_1 \cdot S_2}{\sqrt{S_2^2 - S_1^2}} \cdot \delta T^{\frac{3}{2}} \tag{287}$$

The flow of coolant is:

$$\dot{V} = \frac{S_1 \cdot S_2}{\sqrt{S_2^2 - S_1^2}} \cdot \sqrt{2 \cdot Q \cdot \delta T} \tag{288}$$

Force of the fluid is:

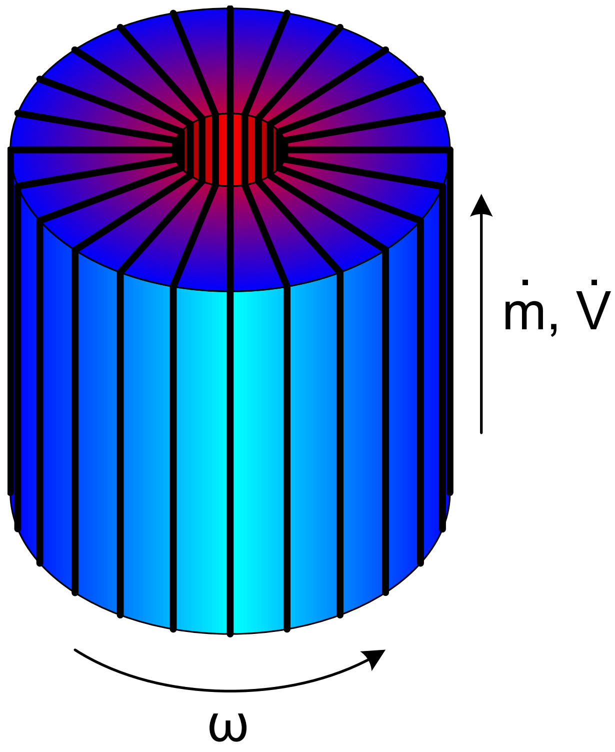
$$F_1 = S_1 \cdot \frac{\rho \cdot Q}{\sqrt{2}} \cdot \delta T \tag{289}$$

CENTRIFUGAL AMPLIFICATION

This effect can be augmented by the centrifugal force when the additional acceleration helps heat transfer. The external acceleration can be involved instead of the variable pipe's width. This approach minimizes the turbulence in flow of the coolant and friction heat loss, but mechanical realization is significantly more complicate then the case variable width pipe.

The design contains equilibrium of centrifugal forces leaving only the thermal effects in action:

Fig. 12



Above picture depicts a pipe winded on the torus that rotates.
According (232) we have:

$$\omega^2 \cdot r = -Q \cdot \frac{\partial T}{\partial r} \tag{290}$$

⇒

$$\frac{\omega^2 \cdot \left(r_2^{\ 2} - r_1^{\ 2}\right)}{2} = -Q \cdot \left(T_2 - T_1\right) \tag{291}$$

⇒

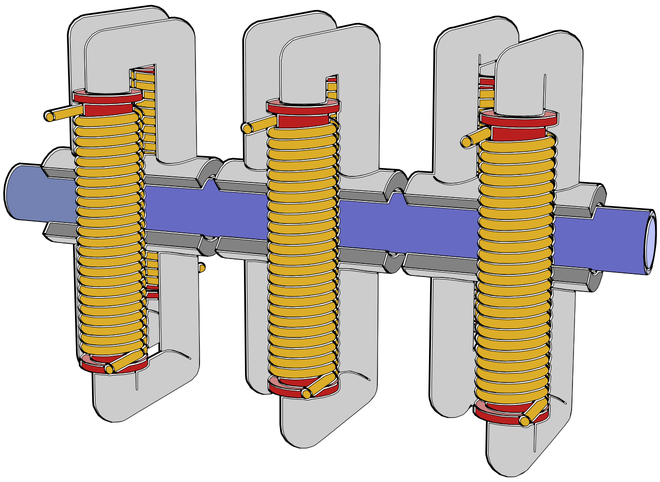
$$\delta T = \frac{\omega^2 \cdot \left(r_1^{\ 2} - r_2^{\ 2}\right)}{2 \cdot Q} \tag{292}$$

Thermal power of the heat pump is:

$$W_T = \frac{\omega^2 \cdot \left(r_1^{\ 2} - r_2^{\ 2}\right)}{2} \cdot \rho \cdot \dot{V} \tag{293}$$

By this constructional solution we have avoided variable pipe width and influence of the thermal capacity of the coolant. The mercury still remains as a good coolant while it can be propelled with the linearly pulsating magnetic field remaining the huge mass density and leaving whole construction without moving mechanical parts, except coolant – of course:

Fig. 13

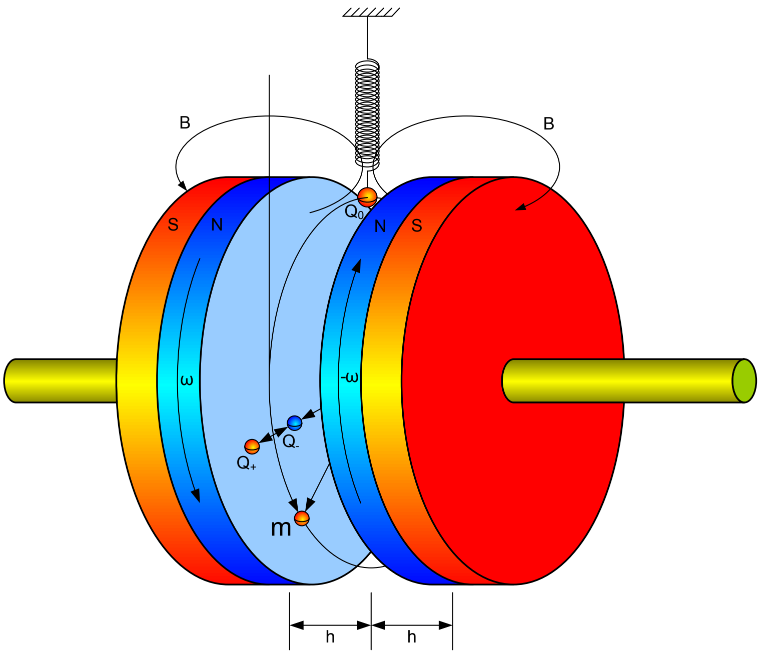


The operation of above pump is based of eddy current propulsion created by the three-phase electrical load on those electromagnets. This pump I had invented does not have turbulent motion while only linear force acts to the fluid making it quite efficient either as motor or generator.

I had invented this pump for extremely hot and corrosive liquid metal and molted salt pumping and it can be used either as motor or generator. The usage as generator in junction with the Schauberger motor is extremely promising offering extremely high degree of efficiency. This pump can be also used for the noiseless ship and submarine propulsion.

The pump is able even to pump non-conductive fluids trough genuine artificial gravitational effect based on my theory of gravity in which the gravitational field is just a torsion magnetic field of an atom:

Fig. 14

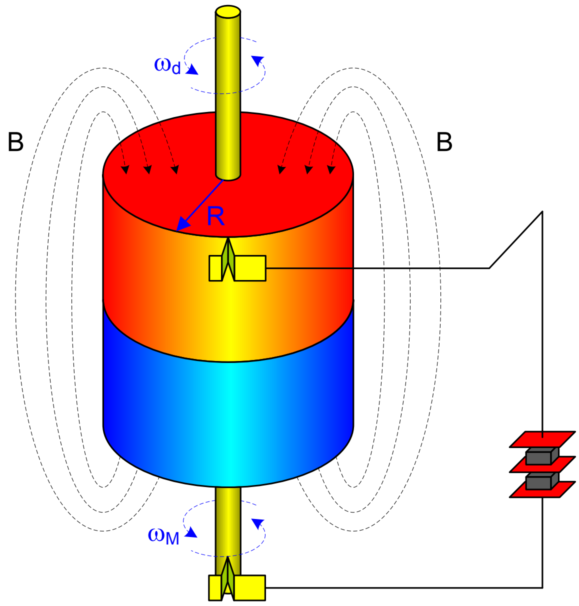


Above picture depicts a dipole representing a neutral molecule between to contra-rotated homopolar magnets oppositely aimed. According my electromagnetic theory M hypothesis is valid one and therefore the field has its own speed that is equal to the speed of the field's source and in this case the speed of the mangets. However, the force acting to the dipole is:

$$\vec{F} = (Q \cdot d) \cdot \left(\hat{d} \cdot \left(\vec{B} \cdot \vec{\omega}\right) - \vec{\omega} \cdot \left(\vec{B} \cdot \hat{d}\right)\right) \tag{294}$$

Simple analysis shows that a force acting to the dipole does not depend on radius and that it is proportional to the mass of the body. It is pertinent place to be noticed that in the atomic nucleuses the spinning magnetic fields of subatomic particles are packed at the very same way as depicted on above picture implying that the gravitation is nothing more than coupled torsion magnetic field. Just a minor modification of the eddy current pump brings ability to pump any kind of mater depending on density instead of conductivity as it is the case in the basic realization. I must stress here that I have invented simplest electric motor ever in 1998 to disprove Second Postulate and to prove validity of M hypothesis as depicted on fig. 15. I also must complain here that "free" Wikipedia rejected to notice this invention of mine although it is regularly published in the Spacetime & Substance scientific magazine [6]:

Fig. 15



Above motor proves M hypothesis showing that magnetic field does rotate with its sort, i.e. homopolar magnet that then intersects the outer par of electric circuit creating the Lorentz[45] force that then spins the homopolar magnet. This ability of the physical field to move together with its source is the key fact for understanding of the essence of gravitational field. There is a very simple fact that electromagnetic radiation on lower frequencies is affected by the electromagnetic properties of the medium while on the higher frequencies it is affected mainly by the mass density of the medium it passes trough which firmly indicates that gravitational field is some sort of microscopic electromagnetic fields.

[45] Hendrik Antoon Lorentz, 1853-1928

Therefore the invention of artificial gravitation is not an accidental discovery and there is complete theoretical background. I spent at least two decades of contemplating to join all these together in a functional theory.

Equation (294) is full theoretical proof of Blackett[46] formula and also of my magnetic theory in which magnetic field is compound of two electric fields moving with slightly mutually different velocities creating via Doppler[47] effect the force known to us as magnetic force. My theory of magnetic field in the cylindrical coordinates is available on http://www.andrijar.com/magdop/index.html and it is obsolete because there is a new one derived in spherical coordinates which is more realistic scenario. However, this is just a tiny excerpt from my gravitational theory. A small fraction of my theory is published in the [5] where is mainly revealed that inertia is caused by the external field and that gravitation is torsion magnetic field in its essence as depicted on fig. 14.

The modification of the electromagnetic pump generates force that is not strong enough to deal with explosion simply because we do not have materials analogous to the ferromagnetic ones in electromagnetism. Without ferromagnetic materials magnetic field probably would remain unnoticed and this is the main handicap of the practical utilization of the gravitational field. However, there are a few tricks that may be used for the achievement of usable artificial gravitational field. The positive aspect of whole situation is that explosions are consisted of ionized gases that could be well treated with electromagnetic field:

$$\ddot{V} + \vec{\nabla}\left(V \cdot \vec{G}\right) = 0 \tag{295}$$

Whereas V is electrical potential and G is gravitational field. According fig.14 and above equation the operation of Nazi Bell seems not to be fabled at all – it seems that they had just extended the d parameter in (294) which is very rudimental way of creation of artificial gravitational interaction.

My theory is profound one offering theoretical connection between electromagnetism and gravitation, explanation of different signs of Hall[48] constant for various metals and it also gives some extraordinary formulas for connection between electron's charge and basic physical values:

$$Q_e = \frac{\pi}{2} \cdot \frac{\sqrt{h \cdot c \cdot \varepsilon}}{\left(2 \cdot \left(2 \cdot 3\right) + 1\right)} = \frac{\pi \cdot \sqrt{h \cdot c \cdot \varepsilon}}{26} \tag{296}$$

The above formula yields amazingly accurate value for electrons charge:

$$\frac{Q_e}{e} = 1.00018157 \tag{297}$$

There is extremely good connection between theoretical derivation of the electron's charge and experimentally determined value. It pertinent place

[46] Patrick Maynard Stuart Blackett, 1897 – 1974
[47] Johann Christian Andreas Doppler, 1803 – 1853
[48] Edwin Herbert Hall, 1855 – 1938, effect discovered in 1879

to be noticed that spin's magnetic fields in atomic cores are actually created by contra-rotating particles making pairs of two overlapping torsion electromagnetic fields that causes the effect of gravitational attraction. The situation becomes clear after adoption of the fact that neutron is hydrogen atom in zero quantum state [10]:

$$m_n = m_p + m_e \cdot \left(2 - \frac{\alpha^2}{2} \right) \tag{298}$$

Whereas m_n is mass of neutron, m_p is mass of proton, m_e is mass of electron and α is constant of fine structure. It seems that hydrogen has two stable quantum levels, level 0 and level 1.

This was just a short excerpt of my gravitational theory which is much more refined and evolved proffering several possibly functional methods for utilization of the artificial gravitational field, inertia effect diminishing and probably even the control of passing of time to certain extent. My gravitational theory also gives one profound analysis of the photon's mechanics, bending of light beams nearby masses, Shwarzschild[49] radius and mutual interaction between electromagnetism, optics and gravitation.

There had been many authors that were very close to the qualitative explanation of the gravitational field (not the quantitative one), but they all failed in this task due to their stubbornly relying on the concept of N hypothesis.

Even with the modification of the pump on fig. 13 to work as generator improved to extract kinetic energy from the non-conductive fluids still there is remaining dreadful efficiency limitation given by (65) albeit greatly diminished.

Above equation claims that there could be a new type of neutron fission in which a neutron decayed into hydrogen atom and a photon realizing tremendous amount of energy exciding many times the energy released in classical fission process and it seems that this could be the missing chain of the explanation of heat excess in many seemingly overunity electrochemical reactions. This mechanism may explain appearance of hydrogen atoms in free space allegedly out of nowhere.

SOLAR ENERGY

A brief analysis of the availability of the solar energy in terrestrial conditions near the equator yields that maximum power density of solar radiation is about 1000W/m^2. Simple analysis shows that average diurnal power including nocturnal period is 1000/π W/m^2, i.e. 318 W/m^2. The desert zone of 50km^2 is able to yield 800GW of energy. With efficiency of 30% which easily can be achieved this is still 240GW of energy, i.e. 60% more than power of the contemporary energetic grid of USA. If we would easily expand this area to 100km^2 we will quadruple the previous power and this is astonishing 1TW of energy!

[49] Karl Schwarzschild, 1873 – 1916

Let us imagine thousands of mirrors casting lights to the numerous towers supplied with the external combustion engines of either Stoddard or Schauberger likes cycle with the liquid salt (NaCl) as coolant supplying whole continents with the electrical energy. For utilization of the Schaberger motor above electromagnetic pump utilized as generator becomes extremely suitable for the application. By the applying suggestions exposed in the above text the efficiency can be even doubled and easily raised to the level of the 60%, i.e. 2TW of available clean and renewable energy. Further increase of solar energy extraction will cause increase of cloudy days which is noxious for the concept of the solar power plant, but their forming may be prevented. However there is a proposition of probably a pretty successful method for the weather control described in [9] that may help very much in this situation. However, two fields of 100km^2 should be enough to stabilize climate in both Sahara and Mojave deserts and also to supply with energy both Americas and Africa & Europe together simultaneously bringing thousand of acres of new arable land seized from a desert. In that situation the famine should be rather a matter of bad demeanor of the global economists than a true reality of the global economy. This abundance of energy could be also used for the creation of clean petrochemical fuel directly from the electricity, water and carbon-dioxide extracted from air which is going to be some sort of artificial photosynthesis.

SCHAUBERGER EQUATION AND ZPE

Although the some phenomena related to the independent events circumstantially indicate that there should be some sort of internal clock affecting synchronization of all events in universe which may mean that the nature of the world is truly digital. This phenomenon is manifesting with the simple experiment: by hitting upward a palm full of coins, the fallen coins will create the leopard leather like texture on the ground showing the existence of some sort of segregation of random events, which really challenges the mathematical concept of independent random events.

But, according Fermi-Dirac distribution the motion of conductive electrons exists even on absolute zero temperature and this fact is the keystone for the **Z**ero **P**oint **E**nergy researchers. Although the amount of the zero point energy that could be collected today is barely sufficient to drive a digital clock, its undoubted existence (petro-voltaic effect, Casmir effect, etc.) gives us hope that we would be able to extract this ubiquitous energy maybe even in the near future, as it will be shown further in the text. During my research in this domain my initial assumption was that the electric arc in water creates Cherenkov proton particles whose are able to penetrate into the cores without electrostatic repulsion, while those particles essentially must be magnetons carrying only magnetic charges without electrostatic ones at all [1]. It was so persuasive hypothesis also because the wavelength of spectral lines of electric arc during electric welding perfectly matches the ones of blue light of Cherenkov's radiation. But, later research showed that plasma has one unique hydrodynamic property to drain **Z**ero **P**oint **E**nergy from the vacuum in the cases in which the neck of plasma is shrinking that is the exact situation treated by Schauberger's equation. Actually, every single beam of the subatomic particles will perform self collimation due to the magnetic shrinking of the beam cause by the magnetic spin polarization of those particles magnetizing the beam itself. Simply, according equation (233) the ability of this beam to drain the heat from the environment becomes especially interesting when it requires to drain negative energy and it seems that in this particular case it drains the energy of the temporal particles whose bring uncertainty to our universe making clear distinction between the time and the forth dimension caused by these fine quantum fluctuations of vacuum embodied in the h constant. At the glance my assumption that the gravitation is acceleration in which instead of the variation in distance there is variation in time might be naïve and according this assumption and by definition of differentiation we may assume that gravitation is a type of acceleration caused by the gradient of the time which does not create displacement of the body and thereby it resembles to reactive centrifugal force, which is very close to the Einstein conclusion. This approach directly leads to the equation for the gravitational force that is identical to the equation for the curvature of the space and then we are very close to the concept of temporal (i.e. time) virtual particles which was evolved by Tesla[50] in his Dynamic Theory of Gravitation. My theory of gravitation confronts Tesla's one in many aspects, and my theory is common to the Schuster[51] and Blackett theories while Tesla's theory is just an extension of Le Sage[52] theory.

It is also interesting that most of the ZPE units in science fiction movies and series precisely resembles to the design I have just proposed, whose are essentially consisted of sealed bulb with water, electrodes and fuel cells able to transfer hydrogen and oxygen into electricity and high voltage electronics. The exact calculation of such device is far beyond the scope of this article, but it is also interesting that Schauberger work has been neglected for so long time as well as my article [1] in which I had precisely proved that Cherenkov particles are indeed magnetons (it was experimentally approved)!!!

ZPE is firstly notices as petro-voltaic effect by Prof. Fernando Sanford in 1892 and it is later theoretically described by the derivation of Fermi-Dirac distribution where it is shown that motion of valence electrons exists even on the absolute zero and that this fluctuation is caused by some sort of the field which pervades our space, which is also responsible for the Casimir[53] effect and our perception of time causing uncertainty to everyday common events too. The detailed analysis of the "Plasma Jet with Variable Thickness operating as Heat Pump" is beyond the scope of this article and therefore it will be not studied in this particular paper.

The experimental proof is quite simple: every single electric-arc welding set is able to bring more energy than the involved one, i.e. an average electric-arc welding set has power of about 300W and it is able to melts half of kilograms of steel for 6 minutes and during this time half a kilogram of water even not start boiling with 300W heater! Ultra-violet image of the welding process clearly reveals the areas with excess of energy brought from the some-extra dimensional source while negative temperature is impossible by

[50] Nikola Tesla, 1856 – 1943
[51] Arthur Schuster, 1851-1934
[52] Georges-Louis Le Sage, 1724 – 1803
[53] Hendrik Brugt Gerhard Casimir, 1909 - 2000

the plasma jet established between the electrode and the conductive welding surface. After the applying relativistic Schauberger equation to the plasma jet the whole situation becomes quite clear offering an abundance of new inventions for a quite bride future for the humankind released of any sort of energy shortage.

I must stress here that during strange events that stroke me I had to negate my own work and to state that there is only a burning of carbonic electrodes instead of true energy excess occurrence and that this research was precursor of more evil events that had hit me later and practically retarded my research in this area significantly.

CONCLUSION

The efficiency of the current heat motors is limited by the nature of the adiabatic decompression of the gas fluid and the efficiency could be augmented for at least 10% by the involvement of the thermal insulators into the cylinders, camshaft should not push the valves by scratching them and the ratio volume surface should be kept as high as possible, but the major improvement is going to be achieved by the adjustment of the piston motion to the nature of the gas equation eventually with collimated molecules or with even more efficient cycle achieved by replacement of the gas cycle with the much more efficient completely liquid or solid state cycle. The external combustion motor with the completely liquid coolant and extremely huge efficiency seems to be possible and we already have similar motor known as electric motor propeled by the uncompressible fluid of electrons' current. The lifter's thruster confirms validity of the equation (231) and eventually it proves HHC equation correctness too. In my previous paper that deals with the operation of thrusters (the digest version is freely available on my personal website on http://www.andrijar.com/thrusters/index.html due to the lack of interest for full non-free version of the study) it is shown that operating radius of helicopters can be augmented several times by decrease or rpm of main propeller and increase the number of blades to diminish the jet speed and increase the amount of blown air according conclusions obtained from that paper – that the thruster's force is linearly proportional to the speed of the blown air and that the energy transferred to the blown air is quadratic proportional to speed of blown air. The elongation of the helicopter's radius can be further extended by usage of internal combustion engines with efficiency improvements suggested in this text or by jet engines improved by the strategies analyzed in this text.

Plasma fluid utilization can further increase the efficiency, especially cold plasma arc induced by high voltage. However, the major cause for small efficiency of the contemporary heat engines is settled in our misunderstanding of the basic gas equations, especially the ones that determine the constant of the adiabatic compression which implicitly defines the efficiency. The explanation trough degree of freedom is just patch, but not a true explanation because this constant is different for different gasses and it depends to the gas molar mass, number of atoms in molecule and valence, but there is missing exact relation which connects all those parameters together and without that we do not have trough insight into the solutions for ultimate efficiency of the heat engines that, as it seems, might be even higher than 100% by avoiding of the gas thermodynamically adiabatic process by plasma cycle. It is interesting that such motors had been already described in ancient paper Vimanika Shastra when ancient author claimed that the motor utilizes liquid mercury, even more the operating fluid is also determined as mercury MHD propelled and there is circumstantial evidences that Moray maybe utilize some sort of plasma heat pump in his devices.

All that requires more experimental and theoretical researches, but properly directed it would not require a lot of time for achievement of great discoveries.

END OF PART 1

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JAA -SERBIAN AUTHORS AGENCY
Head of the Department

Jasmina Jocić - Samokovlija, LL.B.

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