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07.03. Suction-Cylinder-Engine

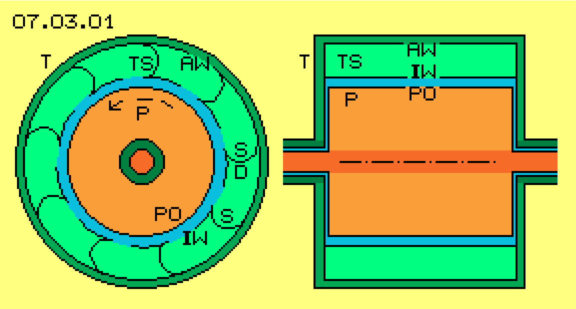
Objectives and Basics

Considerations of that chapter 07.03. are based on effects described at great length by earlier chapters, so if necessary details are to study there. At previous chapter 07.01. ´Cellar-Windmill´ air-driven engine was presented suitable for energy-supply of houses. That machine however is too voluminous and not strong enough for drive of vehicles. So object of that chapter now is conception of autonomous working ´windmill´ most compact and producing performance suitable as engine for vehicles.

Machines with only one turning element might have been working (Schauberger, Mazenauer, Clem), however are hard to control. If two turning elements are used, machine won´t be self-accelerating directly and thus controlled easier. Constructional element at the one hand is a pump (here all times marked by P and red colours) for generating flows and at the other hand a turbine (here all times marked by T and green colours) for generating mechanic torque (here all times assumed left turning).

Several types of pumps are usable, however flows are generated most effective when using suction-effects and/or flows are accelerated at its best by application of (Laval-) nozzles. Diverse of these pumps are described at previous chapters. Here however at first, most simple pump is used generating flow only by friction at cylinder-surface.

At picture 07.03.01 that cylinder-shaped pump P with its outer surface PO schematic is shown left side by cross-sectional view and right side by longitudinal cross-sectional view. Drive of pump is done via its shaft (dark red) which is turning within hollow-shaft (dark green) of turbine. That hollow-shaft is beard within housing (here not drawn) and via that hollow-shaft torque is put off system.



Turbine T in principle is hollow-cylinder with disks (green) at both sides, including pump in total. Inside at outer-wall AW of that hollow turbine-cylinder, turbine-blades TS are installed and their area here is marked light-green. These blades reach form left to right disk of turbine and are solid fixed there.

Turning momentum is not produced by redirection respective deceleration of flows within these blades (like at common turbines), but exclusively by suction-effect. Corresponding these blades are installed ´wrong way´ showing concave side ahead in turnings sense of system.

Any turbine-blade has a suction-side S (frontside in turning sense) and a pressure-side D (backside in turning sense). Between each two blades a canal is build. Here distance between blades is rather long. From each inside-edge of blades towards backward is attached a surface resp. sheet which here is called ´inner-wall´ IW.

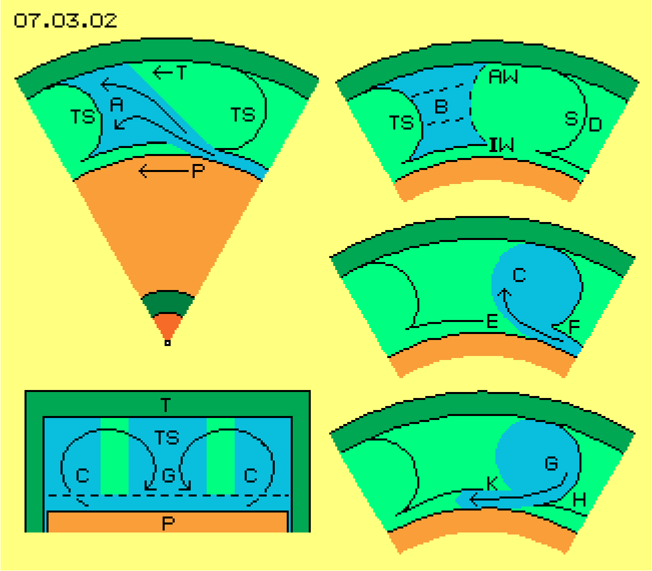
That inner-wall protects pressure-side from flows, air is standing within that ´dead-end-street´ resp. is turning like turbine around system axis. Just normal atmospheric resp. static pressure is weighting at pressure-sides. Opposite, alongside suction-sides exists relative flow and thus reduced static pressures weights onto suction-sides. Exclusively by that difference of static pressures, that turbine produces torque (stronger than pump needs drive).

All spaces between surfaces of pump and turbine are filled up by air (and parts of these areas are marked blue). Between pump-surface PO and inner-wall IW is some distance, so there is space for ring-shaped layer of air (at this picture marked blue).

No Flow at Suction-Side

Picture 07.03.02 shows previous cross-section by larger scale however only sector or parts of. Principle of movement processes are sketched. Generally, pump turns about twice as fast than turbine, like marked by arrows P and T. Also air thus moves by different speeds within space and at different surfaces thus exist different relative-speeds.

Air at pump-surface is dragged by friction into turning sense. Air layers further outside are some slower, at inner-wall however still faster than turbine moves ahead. Part of that fast air pushes inside of turbine and flows ahead, like upside-left marked by blue area and arrows A. However, there won´t come up real flow, because borders of turbine-disks aside, pressure-side of turbine-blade, inner- and outer-wall builds ´dead-end-street´. Thus at pressure-side weight normal atmospheric pressure plus permanent dam-up-pressure of that ´hindered flow´.



Air by friction is accelerated by pump and at the other hand, air is decelerated at surfaces of turbine or air affects previous dam-up-pressure. Resulting turning momentum at turbine however is about five to ten percent weaker than pump demands drive-forces. So at first, that combination of pump and turbine demands energy-input for balancing diverse friction-losses.

It´s decisive for generating positive torques, strong static pressure weights onto pressure-sides. So at this area B (marked blue upside-right of picture) should exist no flow. This is achieved when dead-end-street is long enough. Pressure-surface should be rather coarse or e.g. covered by porous material. Also grids or holy-sheets could be installed there (see dotted lines). However surfaces there should show into turning sense, so building no (contrary) pressure-sides.

Flow at Suction-Side

At this picture middle-right, wanted flow C alongside suction-surface is marked blue. Coming from pump, air moves faster ahead than turbine is turning ahead. This air is guided outward if backside-edge E of inner-wall reaches some further inward. Same time, edge F of turbine-blade ends some further outside, so opening towards turbine is build. Layer of fast air-flow gets ´scraped-off´ and guided outward into turbine.

That air turns cylindrical within rounding of turbine-blade and thus flow exists alongside suction-side with its corresponding reduced static pressure onto that surface. Real throughput with faster speeds however comes up only when air can exit turbine same time, like marked blue at flow G downside-right at picture.

That outlet-flow is achieved when edge H of turbine-blade reaches some more inward to pump-surface and same time backside-edge K of inner-wall is positioned some further outward. So relative wide outlet-opening is build. Same time is formed a nozzle between pump-surface and inner-wall, starting with relative wide distance at backside-edge of inner-wall and ending rather narrow at frontside edge of turbine-blade.

Within that nozzle come up very fast speeds and air might move there even faster than pump is turning. Like known by any water-jet-pump, air is ´dragged-off´ inlet aside, thus off air-cylinder turning around turbine suction-side. This process shows no deceleration, but air-particles fly off turbine ´by own drive´ into that neighbouring faster flow. Without input of energy results increased mass-throughput by well structured flow (all details of that process are described multiple at earlier chapters).

Distance between pump-surface and that inner-wall may not be too narrow, because ´incredible´ strong suction forces come up. That inner-wall must be rather solid and well founded within turbine-disks, otherwise that sheet will be pulled towards pump (like experienced by diverse experiments).

Diagonal Circulation

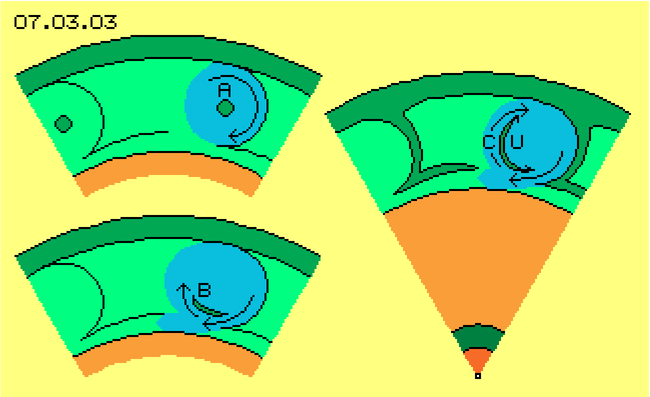
Previous edges E resp. K and F resp. H naturally can not be positioned further inward and outward same time, but only at different positions in axial direction. Concerned part of longitudinal cross-sectional view is sketched at previous picture downside-left. Normal resp. average position of these edges is marked by dotted line.

These edges must reach some more outward or inward only few millimetres for building previous openings for inlet-flow C or outlet-flow G. So these edges are curved lines, resulting inlet to turbine e.g. at both sides near turbine-disks and mutual outlet at the middle of turbine-blade. These areas of inlet and outlet can be decidedly or by gradual transmission offering fluid space for optimum movement pattern by itself.

At any case will result diagonal flow, where previous cylindrical movement within rounding of turbine-blades is overlaid by sideward movements. Again relative speed alongside suction-surface thus is increased, at the other hand danger of ´sticking-suction´ between pump-surface and inner-wall is reduced. All air is involved within that diagonal-cylinder-movement, so air within ´dead-end-street´ towards pressure-side is merely affected.

Optimised Circulation

That diagonal-turning air-cylinder however may rotate not only at area of inlet and outlet but must reach out to outer-wall, so flow affects alongside total suction-side. At picture 07.03.03 are shown optimising measurements by analogue drawings.



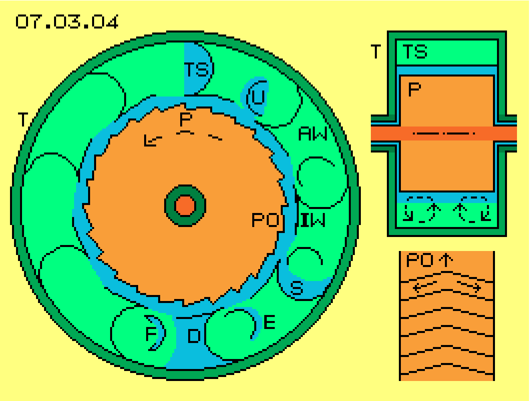
For example, air-vortex has dedicated centre if round pipe A is installed from left to right turbine-disks, so flow at area marked blue all around that pipe comes up.

Even more effective would be bended fin B at area of inlet and outlet. At the one hand additional nozzle is build and thus flow out off turbine is enforced. Suction of accelerated flow reaches back, so alongside total surface of suction-side air is dragged outward (and particles again will follow fast flow by own drive). At the other hand, air follows bending of frontside edge of that fin and thus inlet flow is guided outward.

This picture right side shows cross-sectional view of a sector and contours of blades and inner-wall are drawn more detailed. Previous fin B well could reach further outward, so building real ´circulation-blade´ U. Flow C moves alongside bended frontside surface of circulation-blade quite outward and thus back again alongside total surface of suction-side of turbine-blade.

Between turbine-blade and circulation-blade will come up vortex-core. That flow should be kept off backside surface of circulation-blade and/or that backside should be rather coarse, so air won´t flow fast along that surface. Circulation-blade thus also has a frontside suction-surface and a backside pressure-surface and thus will contribute positive to torque of turbine.

Suction-Pump
Up to now, pump does not contribute to positive torque. Pump only accelerates air or keeps air rotating by friction. Positive effect of acceleration can only come up if particles by their own move faster ahead within space. That´s only possible by suction resp. if pump produces relative void, e.g. by permanent back-stepping wall. At picture 07.03.04 schematic is shown, how that effect could be achieved by that simple cylinder-shaped pump.



Left side by larger scale, cross-sectional view is shown with previous discussed elements, each marked blue: turbine-blade TS with concave bend at frontside, circulation-blade U with convex bend frontside, outer-wall AW and inner-wall IW, suction-side S at frontside of turbine-blade and analogue suction-side E at circulation-blade, opposite pressure-side D of turbine-blade and also backside surface R of circulation-blade with their relative strong static pressures.

New at this picture is shape of pump-surface PO which now has tooth-like structure. Frontside wall (in turning sense) shows nearby into radial direction while backward reaching side of that notch is flat with smooth transmission into tangential direction. Each engraving should be only few millimetres deep.

Steep frontside-wall permanently runs off air, thus continuously produces area of relative void, which continuously is filled up again by air-particles. These particles must not be dragged by friction-forces, but fly behind wall by own drive based on their normal molecular movement. They come fast ahead within space as they can move some longer distance until next collision and when hitting onto that wall, just push it ahead.

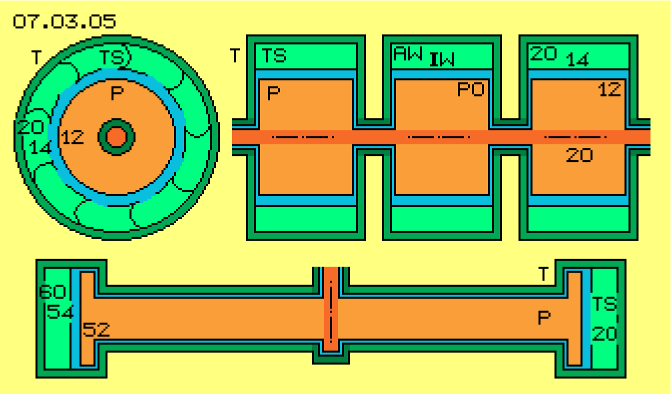
Above of these ´teeth´, air moves some slower than pump, so air glides backward over these notches. Within these engravings come up cylinder-like flows, which ´stationary´ (relative to pump) turn around within space. At this picture downside-right view onto circumference of pump resp. at its surface PO is sketched and edges of notches are arranged arrow-like. These flow-cylinders thus are ´brushed´ diagonal, so air wanders diagonal within notches, here towards left and right side.

That measurement supports previous diagonal circulation within turbine-blades (see arrows upside-right at longitudinal view), because air is guided from middle area of outlet towards both sides into areas of inlets. These simple tooth-shaped notches thus contribute positive to circulation of air within turbine and thus increase torque of engine.

At the other hand that measurement reduces danger of ´sticking-suction´ between pump-surface and inner-wall. This pump with structured surface demands less energy-input for drive. However these engravings may not be too deep, especially at middle area of outlet, so air there exits turbine by most laminar flow.

Diverse measurements exist for optimising circulation movements within turbine like for acceleration and organisation of flows by pump-surface. Which combination for which application is most best could be calculated, however finally must be approved by experiments.

At any case however shape of turbine-surface should be includes. For example these surfaces won´t be straight line from one turbine-side to the other but in total will be bended at axial direction. Air does not move only cylindrical within blades but also diagonal from inlet areas aside towards outlet area at middle of blades and total blade finally must be shaped according to complex movement pattern.


07.03.05

Long or wide

An other questions concerns shape of machine in general. If that engine is used for drive of vehicles, naturally most compact and fast turning unit would be preferred, like for example schematic is shown at picture 07.03.05 upside-left by cross-sectional view. If stronger performance is demanded, engine can be build longer, e.g. by three modules arranged at one axis, like shown upside-right by longitudinal cross-sectional view.

This motor e.g. has outer diameter of about 50 cm, outside-wall AW is positioned at radius of 20 cm, turbine-blades reach inward to radius 14 cm and thus are 6 cm high, pump has radius of about 12 cm. Distance between turbine-disks should not be too wide because strong forces come up and flows should not be too diagonal directed. Here that width is assumed by 20 cm. One blade thus has an effective surface of 6 * 20 = 120 cm^2. Nine blades can be arranged at that circumference, at these three modules thus 27 resp. total effective surface is 120 * 27 = 3240 cm^2 resp. 0.324 m^2. If previous circulation-blades are installed, corresponding wider surface is available, however neglected at following calculations.

Length of effective lever-arm is assumed by 0.17 m corresponding to average radius of turbine. Outside circumference of pump is about 0.75 m. That compact cylinder can drive e.g. 6000 rpm without problems. That´s 100 revolutions each second resp. surface of pump moves by 75 m/s within space. Opposite inner-wall of turbine is positioned at radius of 0.14 m with circumference of about 0.88 m. If for example turbine turns 2400 rpm, that surface moves within space by about 35 m/s.

By that difference of 75 - 35 = 40 m/s air flows into turbine and by that speed air-cylinder will turn around within rounding of turbine-blades. Based on nozzle-effect, air probably will move off turbine even faster. That relative speed within turbine-blades is decisive factor, because contributing by square to performance of machine. All other linear factors like radius, effective surfaces and turbine-revolutions are mutually to change. For example, flat motor of previous picture downside will achieve likely results when using analogue data.

Performance Scale

At the following, scale of performance is calculated for previous compact engine. Dynamic pressure of flow is P = 0.5 times density times speed by square. Density of air here is assumed by 1.2 kg/m^3. At previous relative speed of 40 m/s results flow-pressure of P = 0.5 * 1.2 * 40^2 = 960 kg/ms^2. Corresponding to that flow-pressure, sideward (static) pressure onto suction-surfaces is reduced (details see previous chapter).

That pressure-difference affects onto effective surface of all blades of 0.324 m^2. So force is F = 960 * 0.324 = 311 N. That force affects at lever-arm by average length of 0.17 m. Turning momentum thus is M = 311 * 0.17 = 52.9 Nm. Based on known formula, at previous turbine-revolutions of 2400 rpm results theoretic performance P = 52.9 * 2400 / 9550 = 13.3 kW. Net-performance thus might be about 10 kW. At following table these numbers are listed at column 4.

Like mentioned upside, relative speed of flow alongside turbine-blades is essential factor. If previous revolutions are halve to 3000 resp. 1200 rpm, theoretic performance is lowered to 1.7 kW. By that idle-revolutions probably ´internal needs´ resp. friction losses of machine are balanced (see column 3 of table). If opposite, previous revolutions are put up by half to 9000 resp. 3600 rpm, theoretic performance rises up to about 44.8 kW (see column right side of table).

Revolutions - Pump / Turbine	rpm	3000 / 1200	6000 / 2400	9000 / 3600
V - Pump / Turbine	m/s	37 / 17	75 / 35	112 / 52
V - Suction-Side	m/s	20	40	60
P - Flow-Pressure	kg/ms^2	240	960	2160
Force F = P * 0.342 m^2	N	78	311	700
Momentum M = F * 0.17 m	Nm	13.2	52.9	119.0
Performance theoretic	kW	1.7	13.3	44.8

If flat shape of conception (at previous picture downside) is used, that Suction-Cylinder-Engine is comparable with previous mentioned ´Cellar-Windmill´ concerning constructional volume and performance. For vehicles however that compact engine (at previous picture upside) in shape of cylinder with diameter of about 50 cm and length of some 80 cm preferably will be used. Stronger performance is achieved by faster revolutions or even by additional modules, thus larger volumes.

Factor Density

However one factor contributes to performance, which does not demand larger volume: density of air. Previous data were based on normal density of air by 1.2 kg/m^3 according to atmospheric pressure. If air within that machine is compressed to 2 bar, double performance results. At 5 bar scale of performance goes up to 200 kW and at 20 bar theoretic performance rises up to about 1000 kW.

So if that small engine drives by increased air pressure resp. air-density, performance scales are achieved which merely are achieved by combustion-engines of same volume. In addition that machine is build extremely simple - and consumes no fuel nor produces any pollution.

Simple construction and easy operation is based on working medium air. Even compressed air still shows advantages of gases: centrifugal forces practically are to neglect (total different to liquid medium), there are still areas of different density, so suction-effects occur, allowing usage of kinetic energy of normal molecular movements for external benefits.

Diverse ´windmills´ of previous chapters could also achieve increased performance when using compressed air as working medium. Up to now, that Suction-Cylinder-Engine however represents most compact shape. Naturally motors using much higher density of water as working medium, should achieve comparable performance by smaller constructional volumes, however even previous ´Meander-Wheel´ did hard to manage centrifugal forces. So that compressed-air-mode of Suction-Cylinder-Engine probably will be most easy variation for usage of Free Energy at many applications.

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