FACULTY OF MECHANICAL ENGINEERING
UNIVERSITY OF WEST BOHEMIA

UNIVERSITY OF WEST BOHEMIA IN PILSEN
FACULTY OF MECHANICAL ENGINEERING
DEPARTMENT OF POWER SYSTEM ENGINEERING

Lecture on the subject
KKE/TSM - Boosting combustion engine theory

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esf evropský sociální fond v ČR | EVROPSKÁ UNIE | MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY | OP Vzdělávání pro konkurenceschopnost
INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Podpořeno v rámci projektu CZ.1.07/2.2.00/15.0383
Inovace studijního oboru Dopravní a manipulační technika
s ohledem na potřeby trhu práce

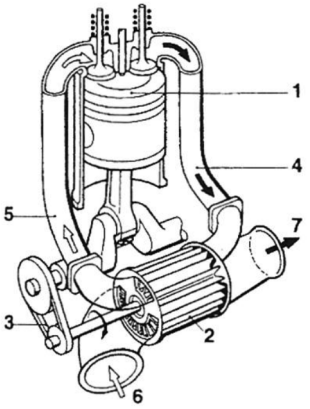
Boosting combustion engine theory

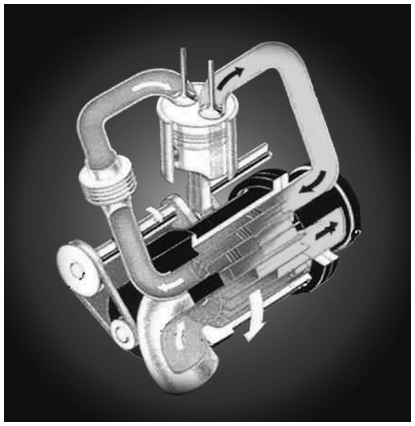
Superchargers

Introduction

- Turbocharging – during this process is transported air with higher mass flow rate and pressure to the combustion chamber.
- Increase of mass flow rate is provided by
  - **Using dynamic effects of gasses in manifolds**
  - **Using proper turbocharger**
    - *Mechanical charging (from crankshaft)*
    - *Drive by exhaust gases*

Supercharging via pressure waves





Basic concept od pressure wave charger [2] [10]

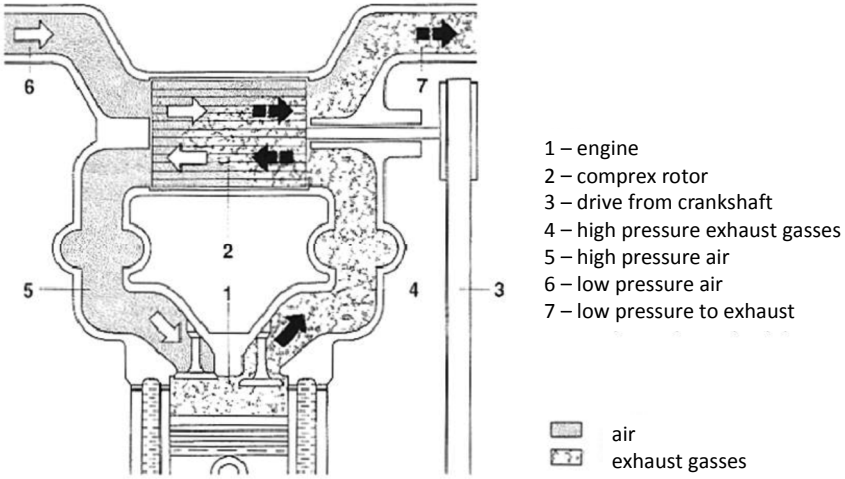
1 – engine; 2 – comprex rotor; 3 – drive from crankshaft; 4 – high pressure exhaust gasses; 5 – high pressure air; 6 – Low pressure air intake; 7 – Low pressure gas to exhaust

Supercharging via pressure waves

Principle of work:

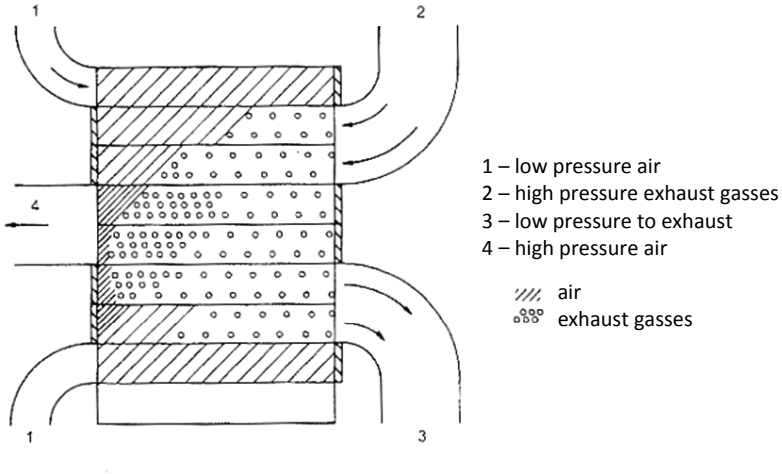
- Device consist by Comprex rotor(2), devided by partition walls and solid case with four holes. Rotor is driven by V-belts (3) from crancshaft.
- High pressure exhaust gasses (4) flow to the Comprex rotor (2) and compress low pressure air (6). Rotor (2) rotates and the hole on solid case reaches same position as charging manifold (5). Exhaust gasses push compressed air toward to charging manifold (5). By rotating of the rotor (2) charging manifold is getting closed and the exhaust gasses changes direction.
- On the opposite side d the rotor (2) another hole reaches same position as exhaust manifold and the exhaust gasses expands to the exhaust manifold (7). Expanding gasses creates an underpressure at the rotor chamber (2). The underpressure causes air suction when the hole at rotor (2) reaches intake manifold (6)
- Opening times of intake and exhaust holes and engine RPM are harmonized with pressure waves, which are created by high pressure exhaust gasses.
- Reaction of the device to RPM change is much better than classic turbocharger

Supercharging via pressure waves



Charging by pressure waves – principle of work [3]

Supercharging via pressure waves

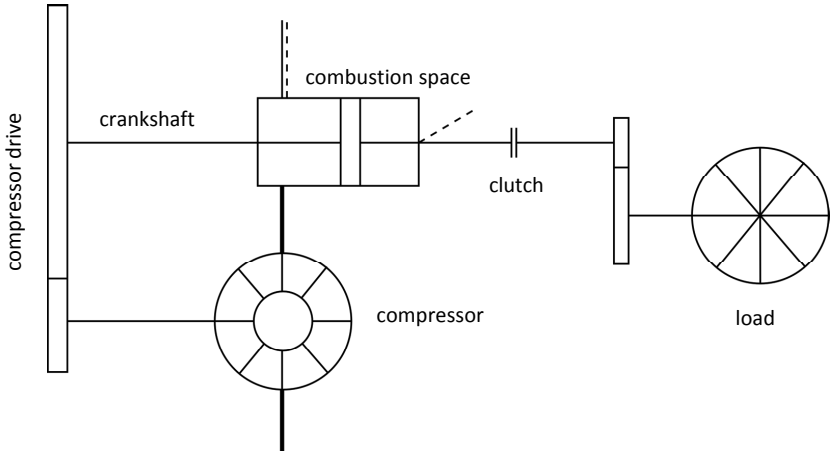


Charging by pressure waves – principle of work [3]

Mechanical supercharging (compressors)

- Mechanical drive turbochargers (compressors)
- Driven by crankshaft of internal combustion chamber
- Advantage is very fast responses to the gas acceleration pedal
- Disantvantage is that it's driven by crankshaft (decrease efficiency of the cycle)
- Drive from crancshaft:
  - gears
  - chains
  - Geared belts
  - V-betls (small chargers)
  - Overload clutch (engines with high RPM)

Mechanical supercharging (compressors)

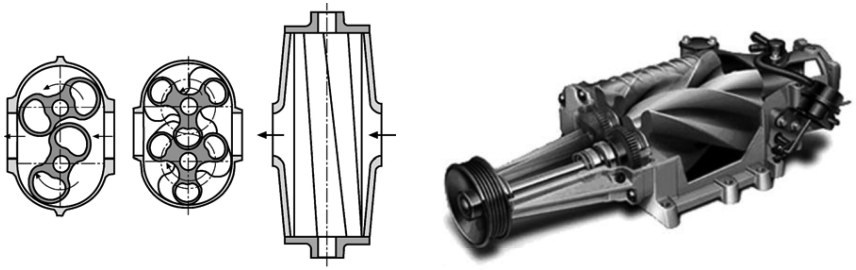


Engine turbocharged by compressor

Mechanical supercharging (compressors)

Roots charger

- Compressor with outer compression (compression behind working space – almost no internal compression)
- Two rotors (tooth 2-3)



Roots charger– cut [5], 3D model [8]

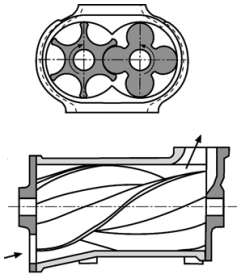
Mechanical supercharging (compressors)

Roots charger – at engine [9]

Mechanical supercharging (compressors)

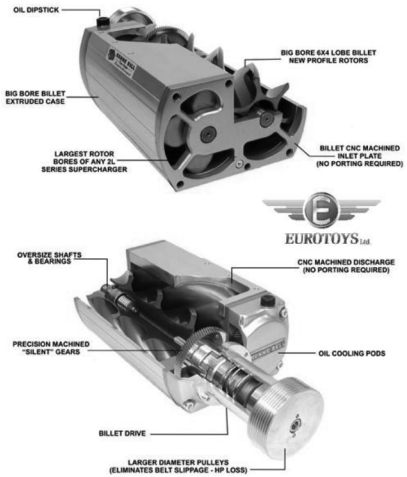
Lysholm's charger

- Compressor with internal compression and with high pressure ration (high losses during lower engine modes)
- Two rotors (primary and secondary)
- Primary rotor have usually 4 gear tooth, secondary usually 6
- Revolutions of primary rotor are higher than secondary rotor (1,5x)



Lysholm's charger – cut [5]

Mechanical supercharging (compressors)

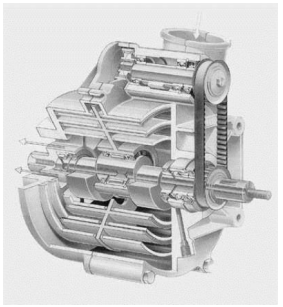


Lysholm's charger – cut [13], at engine[14]

Mechanical supercharging (compressors)

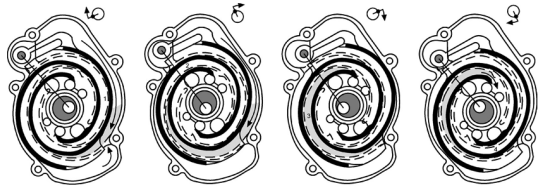
G – charger

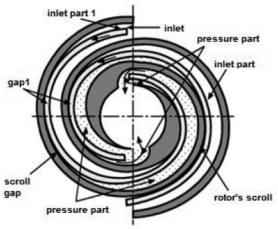
- Excentric (paralelogram) with internal combustion
- Case made by two spiral baffles
- Inside the box is the delivery part two spiral baffles, which fit into the gap between the case's spiral baffles.
- Discharge part makes a circular movement, but does not rotate (formed four working chambers continuously moving to the center of the blower)
- High price, power instability



G-charger – 3d cut [15] , real view [16]

Mechanical supercharging (compressors)

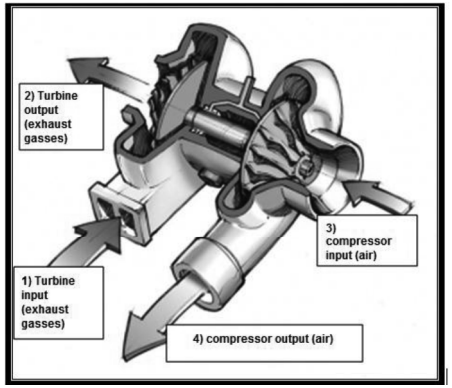


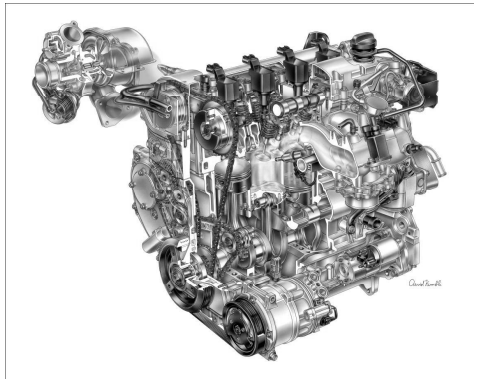


G-charger – principle of work[5]

Turbochargers

- Currently (2013) most used method of engine supercharging
  - Lower fuel consumption
  - Robust construction and higher power





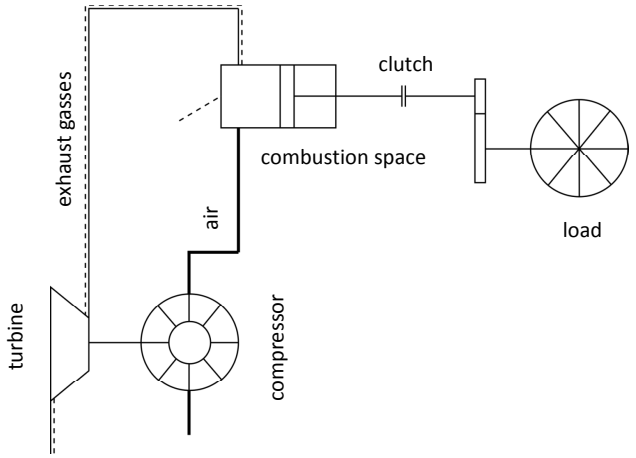
Turbocharger – principle of work [17] [18]

Turbochargers

Principle of work

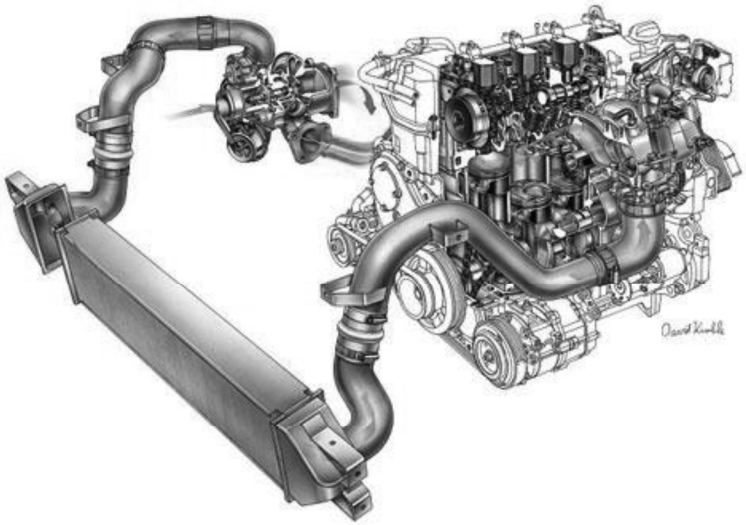
- Exhaust gasses leaving combustion space and moving forward to the turbine section (1). In turbine section exhaust gasses spins turbine impeller and leaving turbine section (2) through the exhaust manifold
- Turbine section is connected with compressor section via shaft
- Turbine section spins the compressor section (compressor's impeller
- According dynamic phenomena created by compressor's impeller, the air flows into compressor (3). After that the compressor compress the air and transport it to the combustion space (4).

Turbochargers



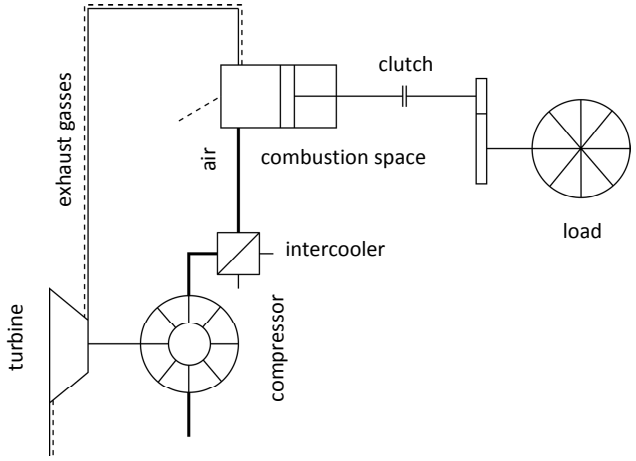
Turbocharger – schematic (without intercooler)

Turbochargers



Turbocharger position in the engine with intercooler [19]

Turbochargers



Turbocharger – schematic (with intercooler)

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[11]http://img.photobucket.com/albums/v251/skrenos/cars/lysholm2.jpg

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[13] http://eurotoysltd.com/catalog/images/cut_a_way.jpg

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[18]http://media.gm.com/content/Pages/news/us/en/2010/Nov/1109_gm_buick/_jcr_content/rightpar/sectioncontainer/par/download/file.res/2011-Powertrain-4-Cylinder-Ecotec-2.0L-I4-VVT-DI-Turbo-LHU-012.jpg

[19]http://image.gmhightechperformance.com/f/9058755/0609htp_12_z+saturn_sky_redline+turbocharger_system.jpg

DISCUSSION...

...QUESTIONS

Poděkování

Tento projekt je spolufinancován
Evropským sociálním fondem a státním rozpočtem České republiky

Projekt CZ.1.07/2.2.00/15.0383
Inovace studijního oboru Dopravní a manipulační technika
s ohledem na potřeby trhu práce