Low resources Bi-PAP
Initial sketch

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For VentilAid.com

Relying heavily on conversations with Dexter
First listener: Janek

Disclaimer

- This Initial sketch is not DIY instruction for certified medical equipment
- This is collection of initial thoughts on how simple BiPAP machine could be build with limited resources
- It does not describe already existing prototype, but it is based on experience with building several simpler prototypes.
- Numerical values in this paper are ballpark value coming from conversations with experts. They need to be verified, and referenced to official papers and specifications.

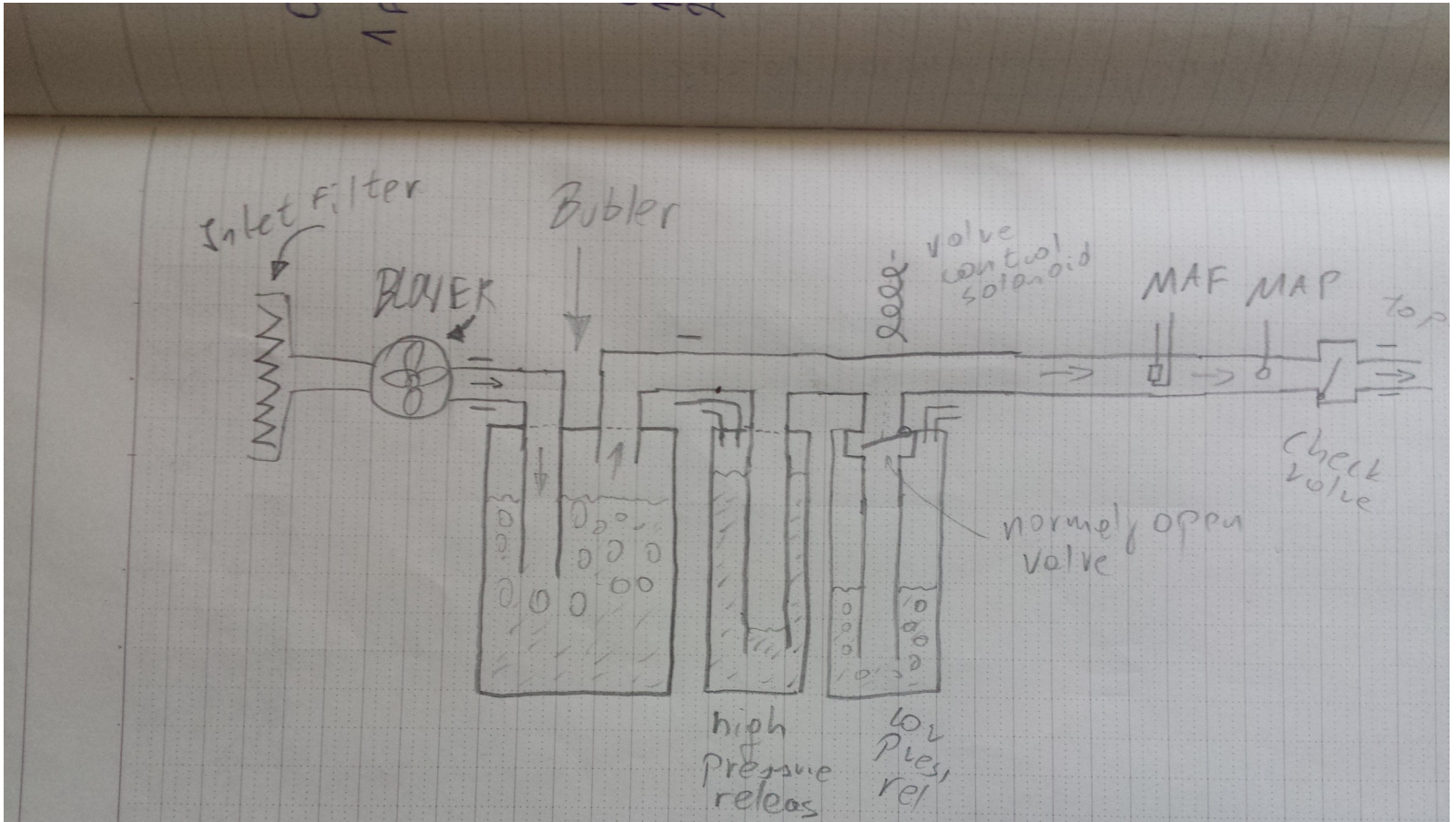
What is BiPAP

- In certain respiratory situations BiPAP mode of ventilation can be used to provide help to patients.
- Using predefined intervals, or detecting user’s rhythms two different positive pressures are delivered to facial mask. High pressure (up to 40cmH20?) on inhale, and low (5 to 20 chH2O) on exhale
- Quick change between operational pressures is needed, with little overshot.
- Significant overpressure can cause damage to user’s lungs

Initial Aim, in order of urgency (numbers to be crosschecked)

1) Reliable source of humidified air
2) Independent setting of pressures P_High and P_Low, from 5 to 30 cmH2O
3) Breath rate setting range of about 10-40 Breaths Per Minute (BPM)
4) Measurement of pressure on user's mask
5) Measurement of Tidal volume (possibly on both, inlet and outlet of mask, to account for leakage)
6) Tidal volume control 200-600 ml.
7) Operating not only with predefined breath rate, but also detecting if user is trying to inhale earlier. Calculating real breath rate, and lung compliance.
8) Control of time ratio between breath in, and breath out (ballpark: 1:3)
9) Plotting all those values on screen
10) Managing exhale (contaminated) air

Draft of simplest design of input side



Building blocs: Air source

- While some facilities already have air source, providing build instructions for it is necessary. PartizanCPAP (temporary name) can be one of options.
- Water bubbler is simplest way to humidify air. Inlet tube is submerged in water, in air tight container. Outlet tube sits well above water surface, and collects humid air. Water could be heated. Water needs to be topped-up, as it will evaporate.

Building Blocks: pressure setting

- Similar bubblers, but open to atmospheric pressure on outlet, can be used to release air if pressure exceeds limit set by water level.
- High pressure bubbler is connected constantly.
- Low pressure bubbler is connected via (ideally: Normally Open, to allow for exhale in case of apparatus failure) valve, and is closed for inhale.
- Valve is still an open issue.
  - It needs to be rather quick: if we are to accommodate for 40 BPM, inhale will take less than 0.5s, and we need to close in fraction of that time.
  - Initial design of a solenoid operated, 3d printed valve is ongoing. Present version requires winding coil, and this is taking manpower.
  - (how about washing machine valves?)
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Building Blocs: Monitoring

- Air pressure, and Air flow sensors should be situated as close to the user as reasonable.
- Final solution still unknown.
  - Professional sensors are on short supply and expensive (at first glance ~50-250 PLN in tme, no more than 100 pcs of nice ones in stock)
  - Automotive sensors are easily available, but meant for different ranges (is there easy way to adapt?)
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Building Blocs: Alarm system

- It is necessary, to have independent alarm system, to alert personnel in case of apparatus or user malfunction.
  - Simple fail-proof, full-proof logic.
  - Valve operation watchdog (like this ne555 thing Maciej proposed for Dexter’s pneumatic respirator?)
  - Over/Under pressure alarm
  - Air leak alarm
- Alarms in monitoring: sudden lung compliance change?

Constrains

- As many ready made parts as possible
- Reliable-by-design parts, that are used in popular machines (automotive and house appliances parts seem to be in stock in large quantities)

Part choices so far

- Tubing that fits well together:
  - Polypropylene plumbing tubes size 32mm, with tiny bit of Teflon tape fits into
  - Standard 40/33 Peshel cable routing elastic hos
  - Fitting from “Oxygen Mask with Nebulizer) matches inside of said Peshel, and has a conversion to standard medical tubing.
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