Windmill for wind machines with pneumatic power transmission

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Preliminary

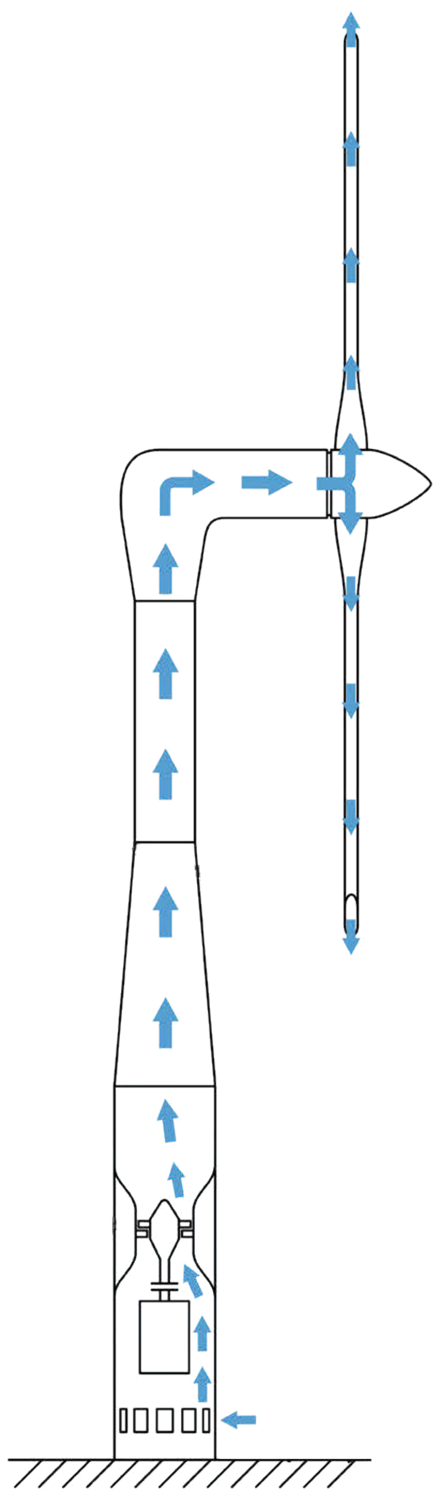


Figure 1

More than sixty years ago, based on the patent of M. Andreau, a 100 kW test wind-machine was built in Southern England. An article published in Engineering in March 1955 describes the machine and the experience gained therefrom.

In conventional wind-machines used to generate power the wind turbine turns a generator through a mechanical coupling. In wind-machines with pneumatic power transmission the turbine rotates freely. Turbine blades, head and column form a continuous duct. The duct starts from the air intake openings located at the bottom of the column and ends in the air outlets rearward facing the end of the blades. An air turbine is located in the duct and a generator is connected thereto. When the wind turns the turbine, the air flowing beside the outlets sucks the air out of them. This suction moves the air in the duct and the air flowing inside turns the turbine and the turbine drives the generator.

The velocity of the wind and power output were measured during operation of the machine. It was found that the power factor of the wind-machine was 14.5%, i.e. the machine utilized such proportion of the capacity of the wind. In those days the power factor of conventional machines that have been developed for decades reached approx. 30%. By this token, the pneumatic system was rejected.

After getting acquainted with Andreau-type pneumatic wind-machines, many decades ago, I decided to try to improve it. My first assumption was that one of the causes of poor performance was the rearward facing outlet at the end of the blade which was a low performance suction device (Figure 5).

I illustrate changes in losses in mechanical and pneumatic power transmission systems in Figure 2.

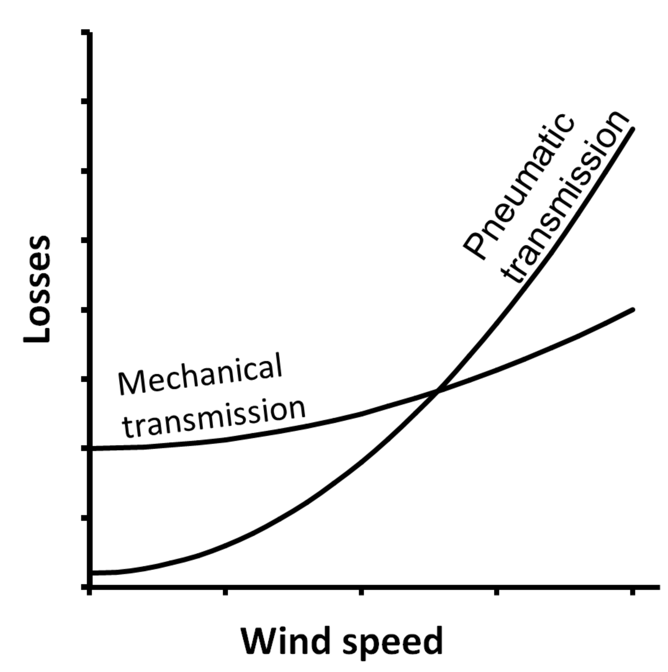


Figure 2

Works that we have done so far

Figure 3: Examination of the efficiency of suction elements in a closed wind tunnel

Figure 4: Pilot wind machine

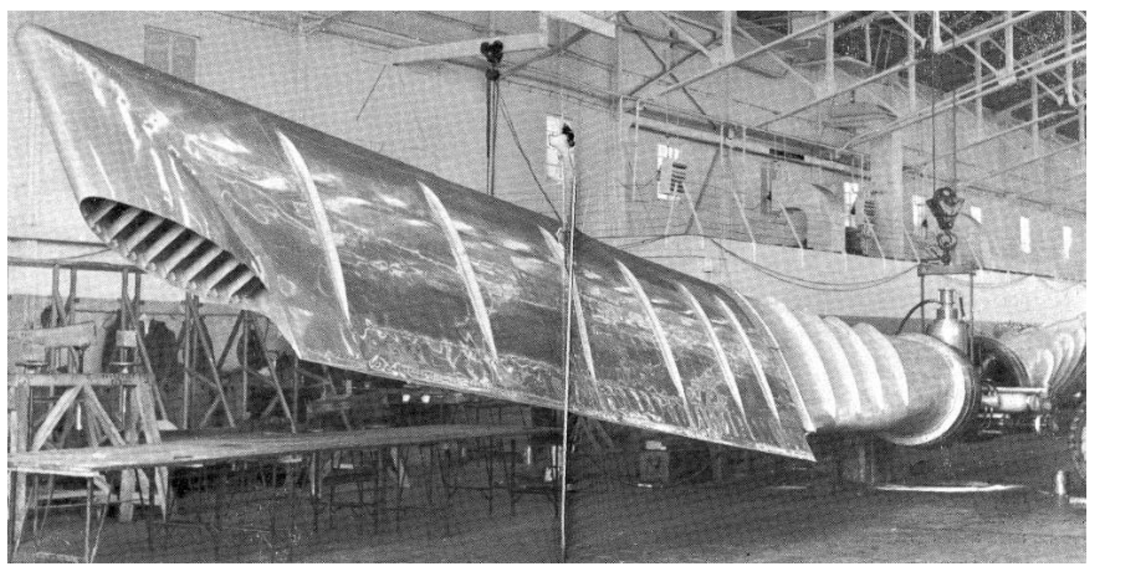
I have built a pilot wind-machine having a diameter of two meters (Figure 4) and elaborated inventions to improve the pneumatic wind-machine.

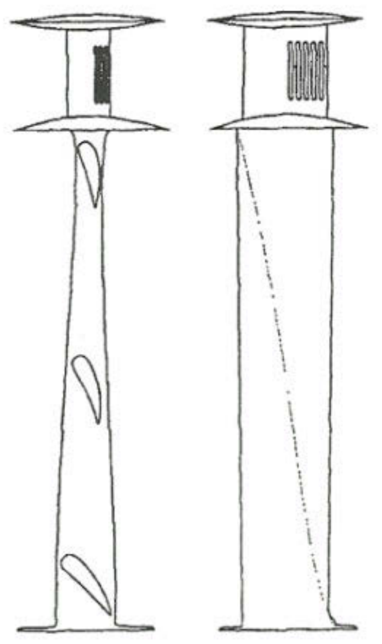
In the patent with reference number HU/P 0103756 I presented mechanisms to improve suction capacity.

The blade described in the patent with reference number HU/P 1200736 (Figure 9) reduces loss of flow on inner and outer surfaces of the blade.

Different types of blades

Figure 5: Blade of the Andreau-type wind-machine: the rearward facing outlet





Figures 6, 7: Blade of the wind-machine realized: The suction element has an aerofoil cross-section

Figure 8: Blade of the planned next machine: the suction element is turned to fan blade position

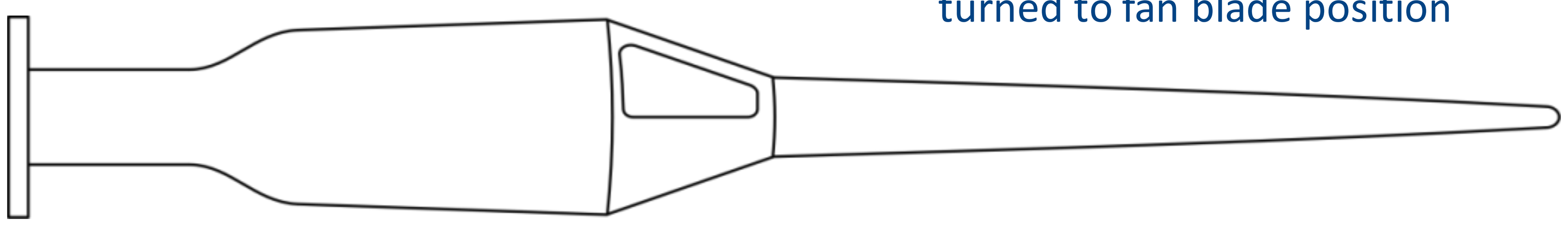


Figure 9: The blade is divided into three sections. The first section is a hollow blade of large cross-section connected to the hub of the wind turbine. The second section is the suction element equipped with air outlet. The third section is the external end of a conventional fast-spinning wind turbine blade having a small cross-section.

Expected effects of blades to be tested

More than ninety years ago Betz demonstrated with calculations that maximum 16/27 or approximately 59% of kinetic energy of the wind can be extracted. 11/27 of the energy is needed to pass the decelerated air.

I am assuming that the conventional wind turbine makes use of only one half of the useable 16/27 to rotate the turbine, and with the other half it spins the air in the direction opposite to the wind turbine. The latter 8/27 is part of the rotating mechanism of the wind turbine, i.e. it is a loss resulting from the action-reaction principle.

In the wind-machine with pneumatic power transmission a large part of the blade is similar to the conventional one, these parts rotate the air that moves away from the wind turbine in the same way as in the conventional one, but here we can exert influence on the rotation of the air by altering the direction of the air jet moving away from the suction element.

My next idea was to turn the suction element into the position shown in Figure 8, and with this modification I transform it to a fan blade. I expect this modification to increase the speed of the air passing in front of the outlet and to further intensify suction.

However, the suction element that has a shape of and is located as a fan blade not only increases suction capacity but gives a new direction to the air jet moving away from the suction orifice and is positioned, leading, in a way not initially expected, to a significant loss reduction since the fan blade drives the air in the wind direction and rotates it in the same direction as the turbine. This air jet moving away from the suction element is mixed with an air mass moving away from the other part of the blade and rotating in the opposite direction. This air jet decelerates the rotation and accelerates the movement of the air mass to utilize some part of the losses arising in the rotational movement.

Accordingly, the reason why the wind-machine with pneumatic power transmission is better than the mechanical one is that one of the losses of the turbine, i.e. rotation of the air, is balanced or compensated by a similar loss of pneumatic power transmission.

The fan blade rotates a small mass of air at high speed in the same direction as the wind turbine rotates. The other two sections of the blade rotate a larger mass of air in the opposite direction. With the size of the blade sections and the angle between these sections and the plane of rotation can and should be approached, or reached maybe, that the tangential components of the kinetic energy of the two rotations are equal and the rotation of the air moving away from the wind turbine is prevented.

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