# Down wind faster than the wind

With all the theories over DWFTTW, I decided to build a wind-powered car, see photo, and put an end to the debate. I have just finished building the car, and it does indeed go faster than the wind. It is a three-wheeled model about 6 feet long and 3 feet wide. The frame is made of wood and aluminum. The propeller is wood, forty inches in diameter, has a 16.5 inch pitch (theoretical distance per revolution) and is facing and blowing aft, up wind in this case. The wheels, one up front for steering and two in the rear, are inline skate wheels. The gearing is a single timing belt running from the rear wheels to the fan shaft, and twisted ninety degrees. All bearings are high-grade ball bearings. The current gearing for down wind produces a car to propeller speed of 1.75 to 1. For every 17.5 feet the wheels roll the propeller moves a theoretical distance of 10 feet. At 10 mph the fan is blowing the air towards the rear at 5.7 mph.

It is difficult finding a flat place with a steady wind, especially at ground level, to do a decent test. The first trial run showed that the car would easily accelerate to wind speed, and would need to have steering, brakes, and a method of determining apparent wind direction. A radio control was added, along with a mast and flag well off to one side and away from the influence of the propeller. Unfortunately we live in a heavily wooded area with few flat parking lots and variable wind, so the results on land are at this time are unreliable. The flag often flies rearward to indicate DWFTTW, however until I see it fly back steadily for a hundred yards or so, I will not be happy. Fortunately we found an excellent motorized treadmill to do our testing on. For those who missed the July issue, No. 21, a vehicle on a treadmill in still air, with the wheels going eight miles per hour is the same as a vehicle going eight mph down wind, in an eight mph following wind. If a car moves forward on a treadmill with no assistance, it is going faster than the wind.

After leveling the track, putting a backstop on to get the car up to speed, and tying the car to a tension gauge, we started the treadmill and increased the speed in one mile per hour increments. At four mph the car leaves the backstop and rolls forwards, but with no measurable force. At five miles per hour the car generates 25 grams of pull. At six mph 45 grams of pull, at seven mph 70 grams, at eight mph 100 grams, at nine mph 125 grams, and at the ten-mph top speed of our treadmill, it is pulling with 150 grams of force.

By reversing the fan direction and taking force measurements, the total lift to drag of the system can be calculated. Subtracting the forward pulling force from the reversed pulling force, and dividing the
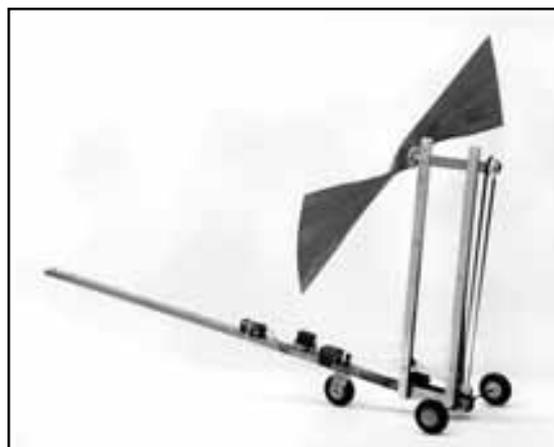
The wind car in its' short and narrow 'treadmill' configuration. Note the radio control for steering and brakes. The mast with apparent wind flag is not shown.

remainder, results in the total force (drag) required to turn the propeller and overcome friction. Adding the forward pulling force to this gives the pulling force (lift) of the propeller.

At 4 mph the measured lift of the propeller is 92 grams and the force required to turn the wheels at that speed is 92 grams, for a L/D of 1 to 1. By ten mph the lift of the propeller is 552 grams and the force to turn the wheels at that speed is 402 grams, for a L/D of 1.37 to 1. With a steady wind over 4-mph, the car will exceed wind speed down wind.

The key to understanding DWFTTW, is that the wheels are turning the propeller and that the propeller need only produce enough lift in still air to overcome the forces required to turn it.

A few notes on car performance on a parking lot;

It is self-starting down wind, and once moving, accelerates rapidly.

It prefers to go straight down wind, not at an angle as on a broad reach.

When the gear ratio is reversed to allow the propeller to act as a windmill and turn the wheels, it goes up wind very well, even though the fan is being used in reverse and not shaped properly.

With the proper ratio, and good conditions, I believe the car will go close to wind speed up wind, and 1.5 times wind speed down wind. At this point I have not tried any other ratios either up or down wind, so further improvements are possible.

For a short video of the car on the treadmill or more information regarding the car or to make suggestions, especially regarding testing, or if anyone wants to come to sunny Florida to watch first hand this winter, let me know via EMAIL.

Jack Goodman,
imaginationltd@aol.com