STAEDTLER® No. 937 811E Engineer's Computation Pad

68 George Washington Gale Ferris, Jr., a civil engineering graduate from Rensselaer Polytechnic Institute, built the original Ferris wheel for the 1893 World's Columbian Exposition in Chicago. The wheel, an astounding engineering construction at the time, carried 36 wooden cars, each holding up to 60 passengers, around a circle 76 m in diameter. The cars were loaded 6 at a time, and once all 36 cars were full, the wheel made a complete rotation at constant angular speed in about 2 min. Estimate the amount of work that was required of the machinery to rotate the passengers alone.

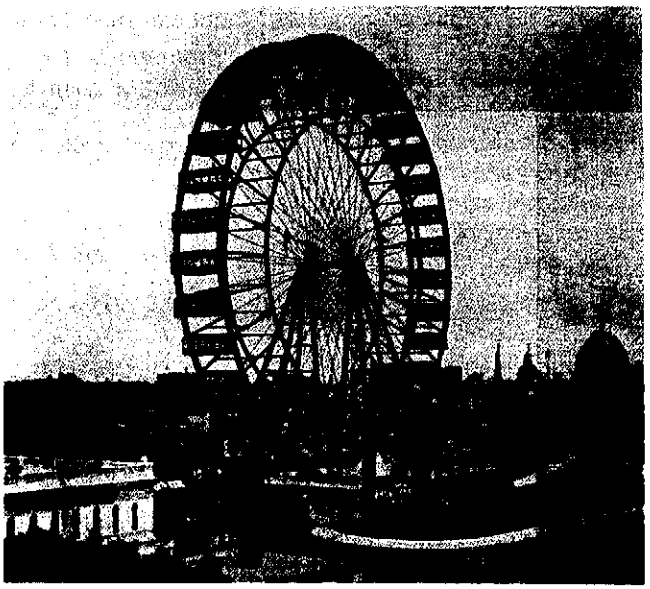


FIG. 11-16 The original Ferris wheel. *(From "Shepp's World's Fair Photographed" by James W. Shepp and Daniel P. Shepp, Globe Publishing Co., Chicago and Philadelphia, 1893)*

IT TAKES WORK TO GET THE FERRIS WHEEL ALONG WITH ITS PASSENGERS UP TO ITS ROTATIONAL SPEED

$\omega = \frac{\text{TOTAL ANGLE}}{\text{TOTAL TIME}} \sim \frac{\text{RADIANS}}{\text{SEC}}$

$\omega = \frac{2\pi}{T = 2\text{min} = 120\text{s}} = 0.0524$

WHEN THIS IS DONE THE TOTAL KINETIC ENERGY GIVEN TO THE SYSTEM $= \frac{1}{2} I_{\text{wheel}} \omega^2 + \frac{1}{2} I_{\text{PASSENGERS}} \omega^2$

$W^{\text{TOTAL}} = \Delta K$ WORK-ENERGY THEOREM

THE WORK DONE JUST TO GET THE PASSENGERS UP TO SPEED $= \frac{1}{2} I_p \omega^2 = \frac{1}{2} \left(N m_p R^2 \right) \omega^2$

$N = 36 \text{ CARS} \times 60 \text{ PASSENGERS/CAR} = 2,160 \text{ PASSENGERS}!$

$m_{\text{PASSENGER}} \sim 60 \text{ kg}$ on AVERAGE WITH KIDS?

$W = \Delta K = K_f - K_i = \frac{1}{2} I_p \omega^2 - 0 = \frac{1}{2}(2,160)(60) 38^2 0.052^2$

$= 2.5 \times 10^5 \text{ Joules} = \frac{1}{4} \text{ M Joule}$

ONCE THEY ARE MOVING — IF THERE IS NO FRICTION — NO MORE WORK NEEDS TO BE DONE TO KEEP THEM MOVING

$\frac{dK}{dt} = \frac{dW}{dt} = \tau_{NET} \left(\omega = \frac{d\theta}{dt} \right) \Rightarrow \Delta K = W_{TOT} = \tau \Delta\theta$ (IF τ CONSTANT)

COULD BE USED TO ESTIMATE THE TORQUE GIVEN $\Delta\theta$ NECESSARY TO ANGULARLY ACCELERATE UP TO ω_f.

$\Rightarrow$ IT must have had 6 passengers/car

$\Rightarrow$ 10 times less WORK = ENERGY