AC Motor Speed Control

AC Induction Motor Speed Control

► So what can we do to control the speed of an AC induction motor?

- Change the number of poles (in discrete increments - inefficient & rarely done)
- Change the frequency of the AC signal
- Change the slip

Change AC Frequency

► Variable speed AC Motor adjustable speed drives are known as

- inverters,
- variable frequency drives (VFD) , or
- adjustable speed drives (ASD).

► Common ways to vary AC frequency:

- Six-step inverter
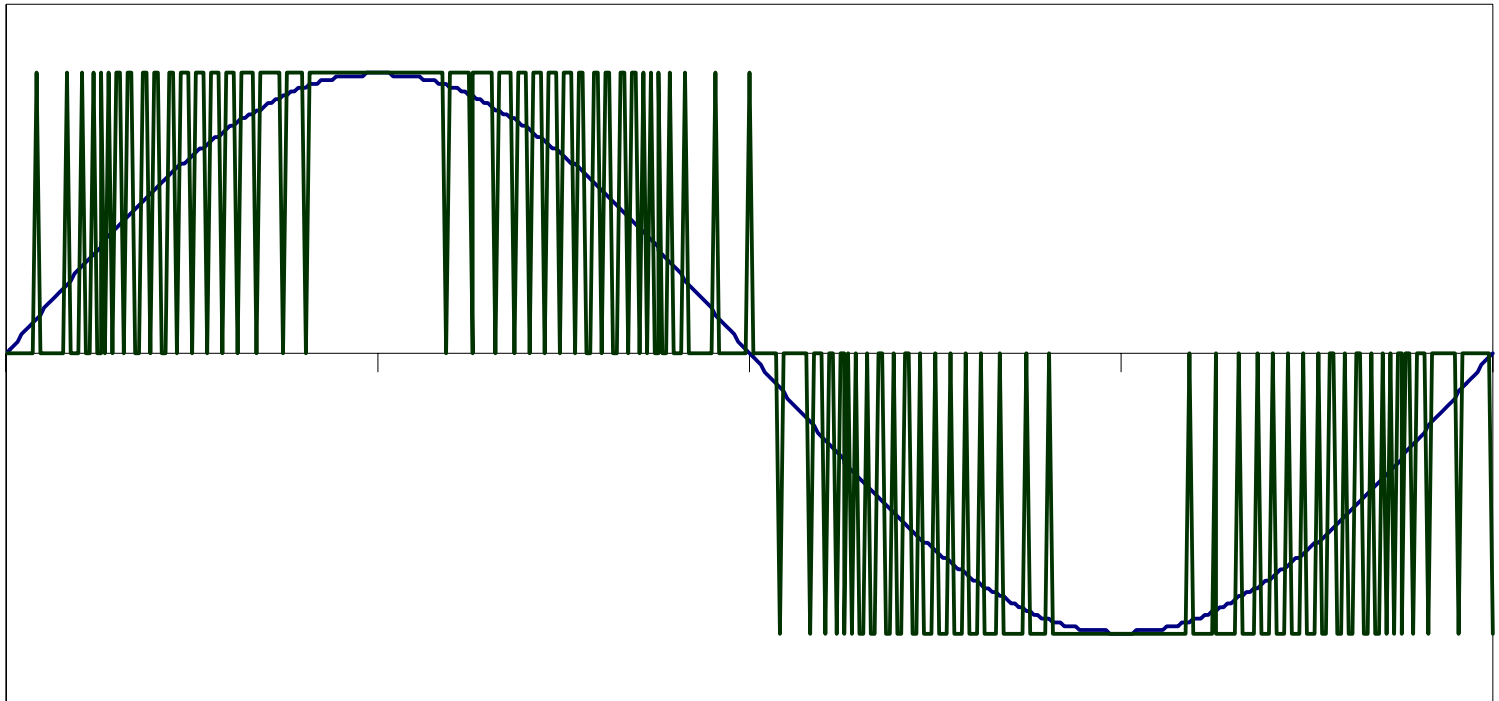- Pulse-Width-Modulation
- Vector Flux

Six-step Inverter

► AC rectified to DC, then switched to imitate a sine wave
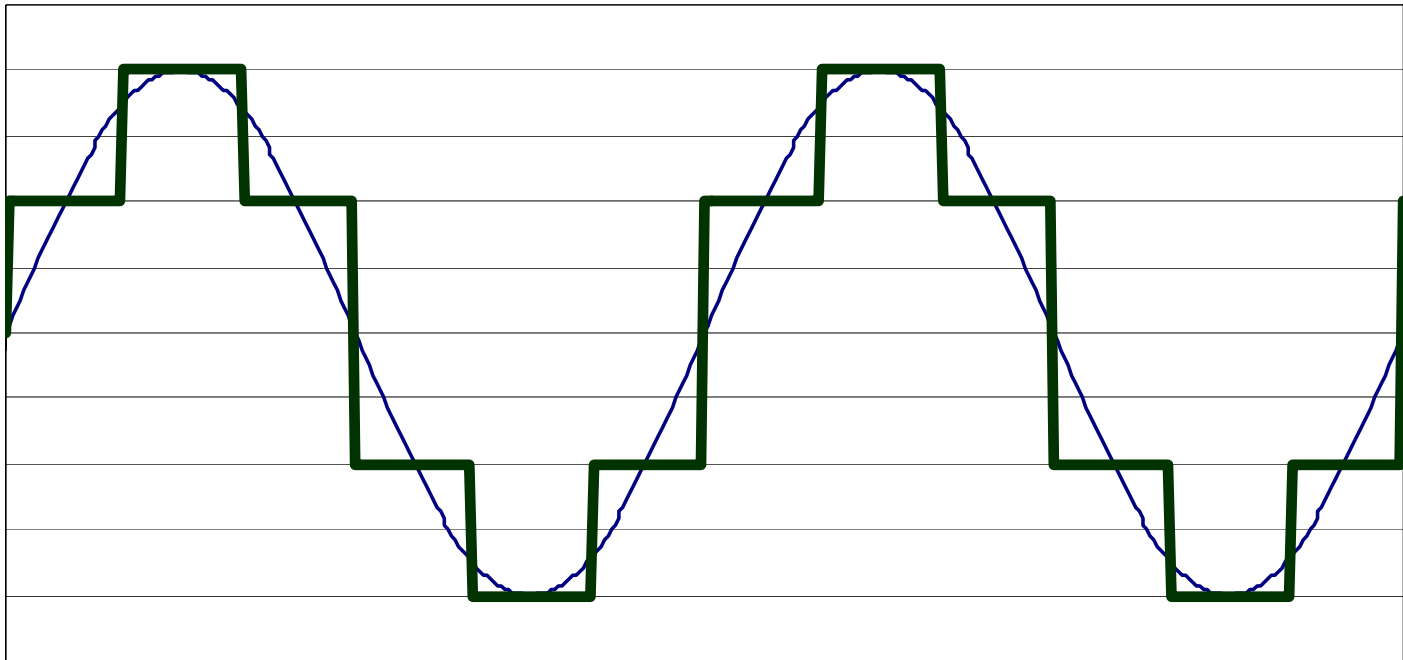
also called a Variable Voltage Inverter or VVI

Pulse-Width-Modulation

► DC voltage (rectified AC) rapidly switched to match "area under curve"

also called Pulse-Density-Modulation

Changing Rotor Slip

► Important to match the motor to the load

 ▪ ensure that a change in motor power gives a desired change in load speed

► Load should have a substantial inertial components

 ▪ inertial torque can "carry" the load through brief periods when motor torque cannot

► Best used with motors designed for high slip

Variable Series Resistance

►Additional series resistance reduces voltage across main windings

Variable Resistor

AC

Rotor

Main winding
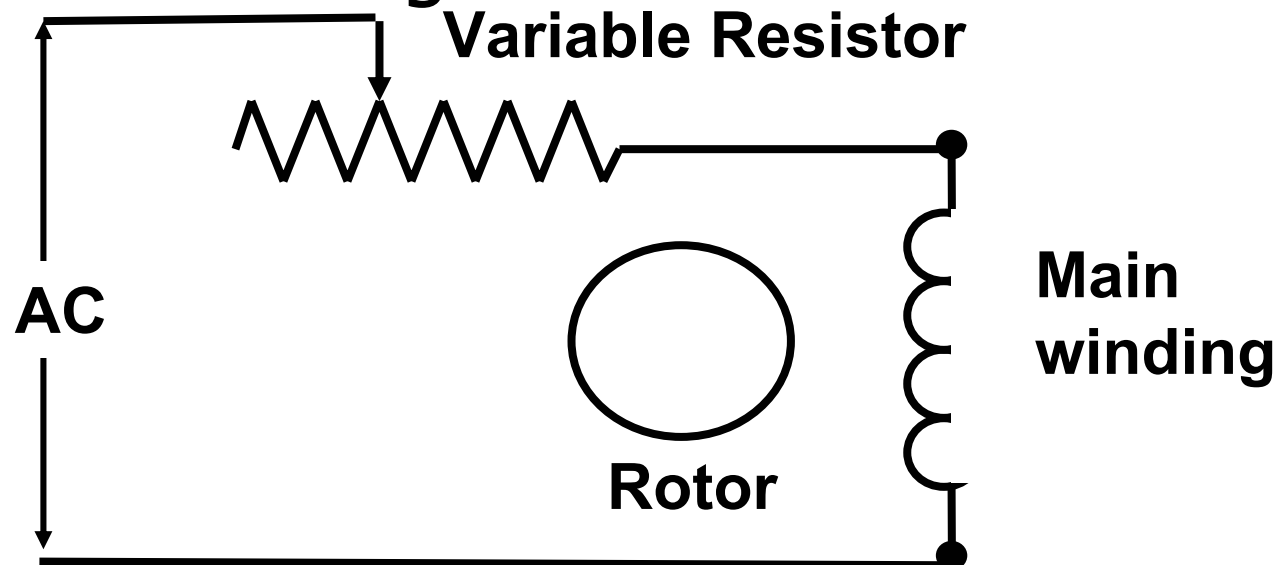
"The traditional way to control the speed of a wound rotor induction motor is to increase the slip by adding resistance in the rotor circuit. "
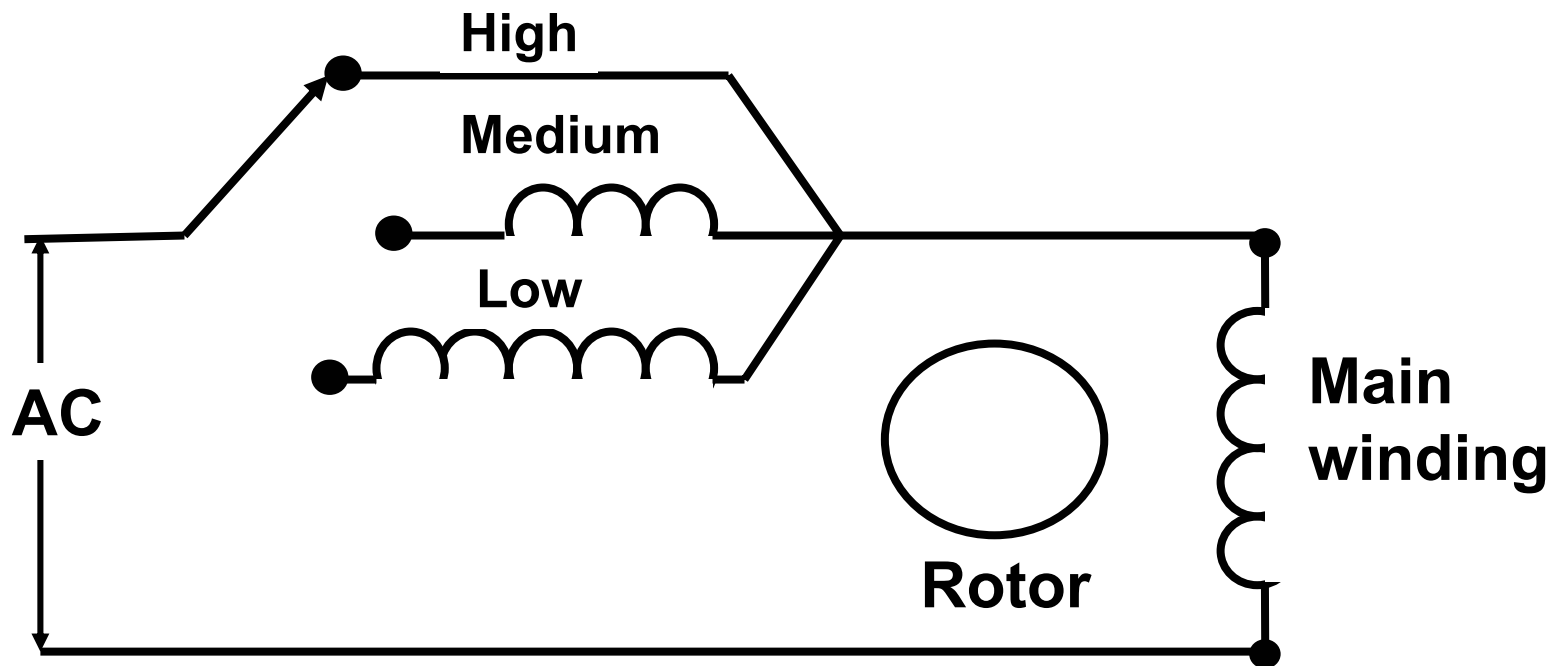http://www.findarticles.com/p/articles/mi_m3541/is_3_77/ai_98551731

Variable Voltage Transformer

► More efficient than previous method, no power wasted in the series resistance

Variable Transformer

AC

Main winding

Rotor
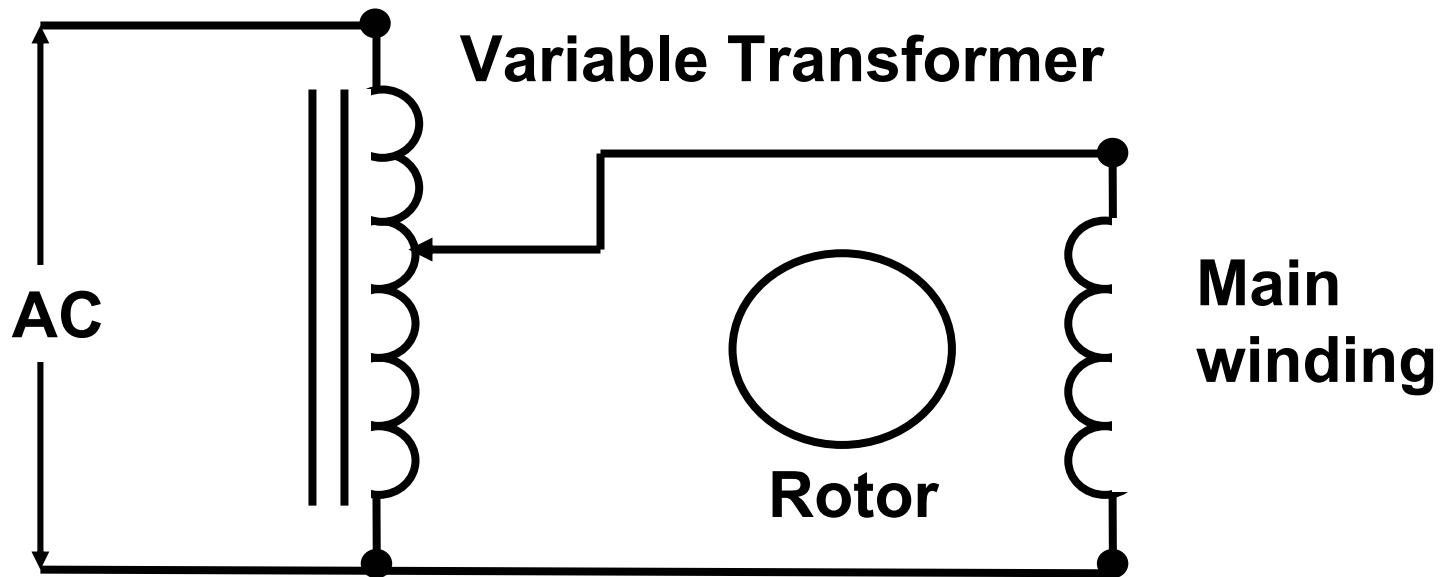
Tapped Winding

► Commonly used with 3-speed fan motors (like the one in AC Motor Lab)

High
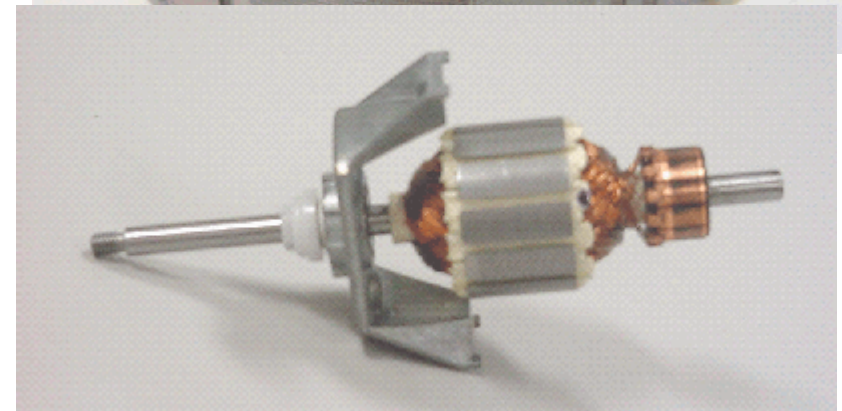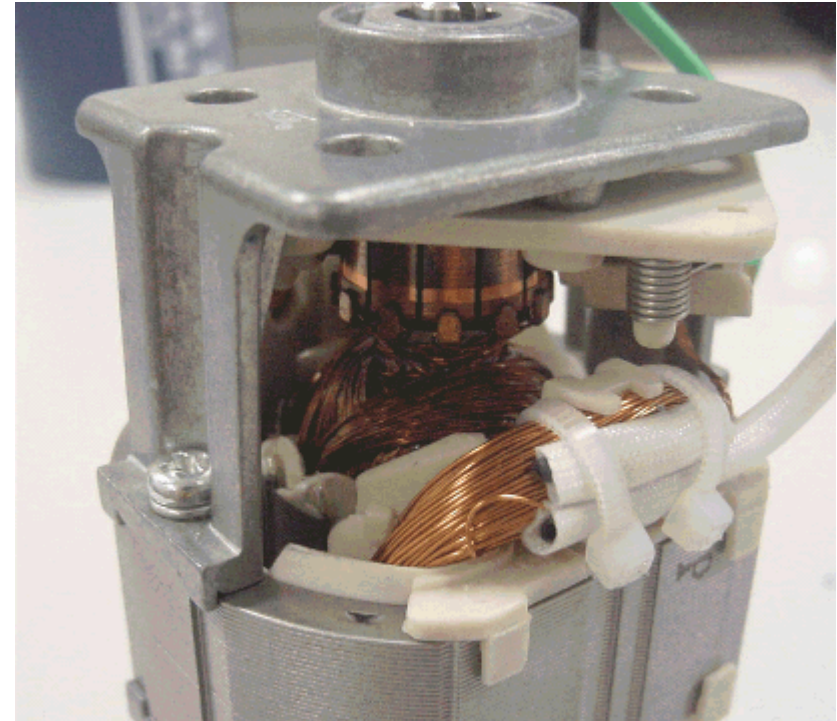
Medium

Low

AC

Rotor

Main winding

Other Motors

►Series, Shunt, Compound Wound DC Motors

►AC/DC Universal Motors

►Gear Motors

Universal Motor
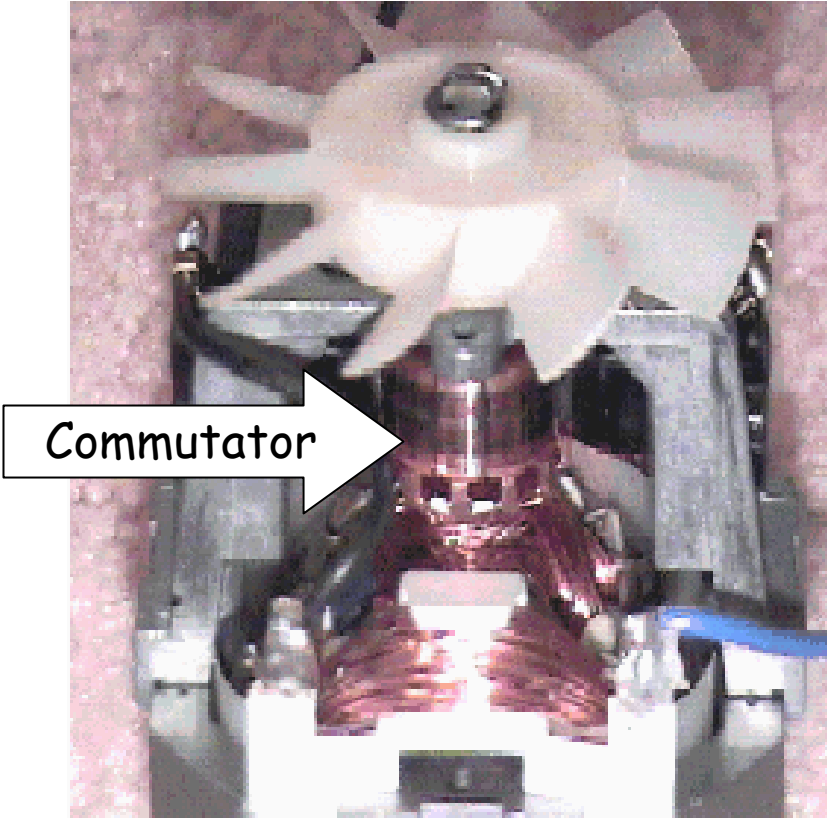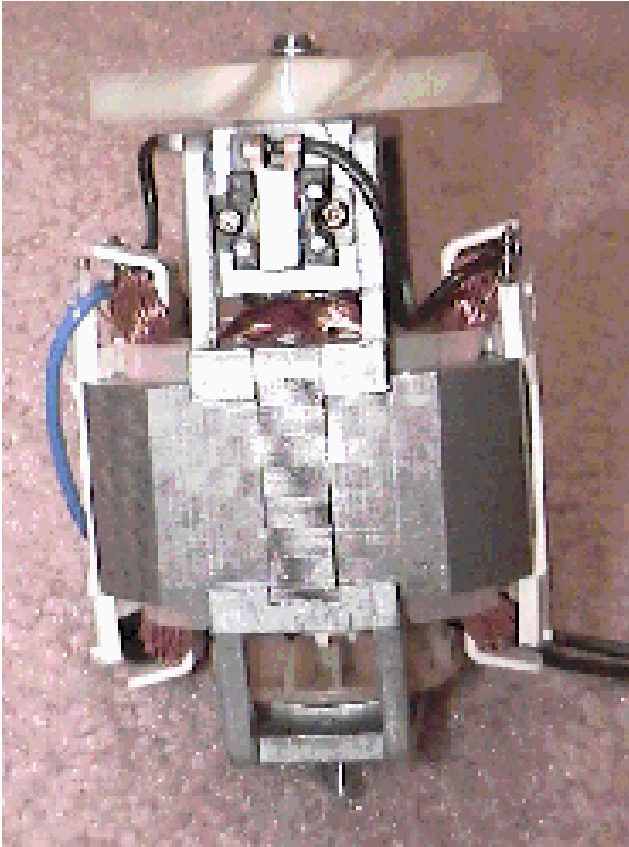
► Runs off ___ or ___ power

► Commonly found in _____ appliances

► Wound like a DC _____ motor

- windings on both stator and rotor

- brushes like a DC motor

Universal Motor

► Nearly equivalent performance on DC or AC up to 60 Hz

► Highest horsepower-per-pound ratio of any AC motor

- speeds many times higher than that of any other 60-Hz motor

Universal Motor from a Blender

Commutator

Gearmotors

► Motors are inherently high-speed, low torque devices

► Applications frequently require low-speed, high torque

► Manufacturers provide motors with integral gear sets - called "gearmotors"

  - both AC and DC versions
  - increased torque - lower speed available
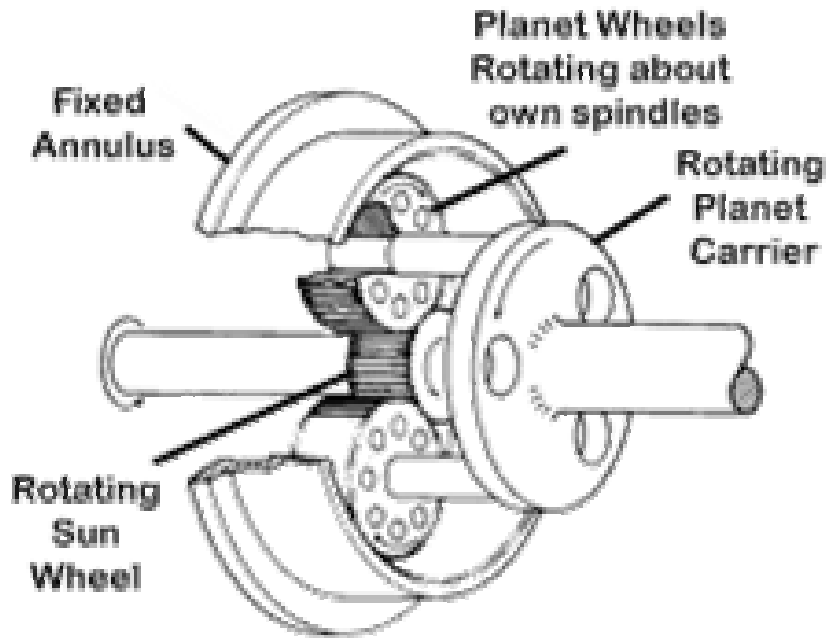
Parallel Shaft Gearboxes

Pinion gears

Output shaft
speed, ω_{out}

Spur gears

Input motor
speed, ω_{in}
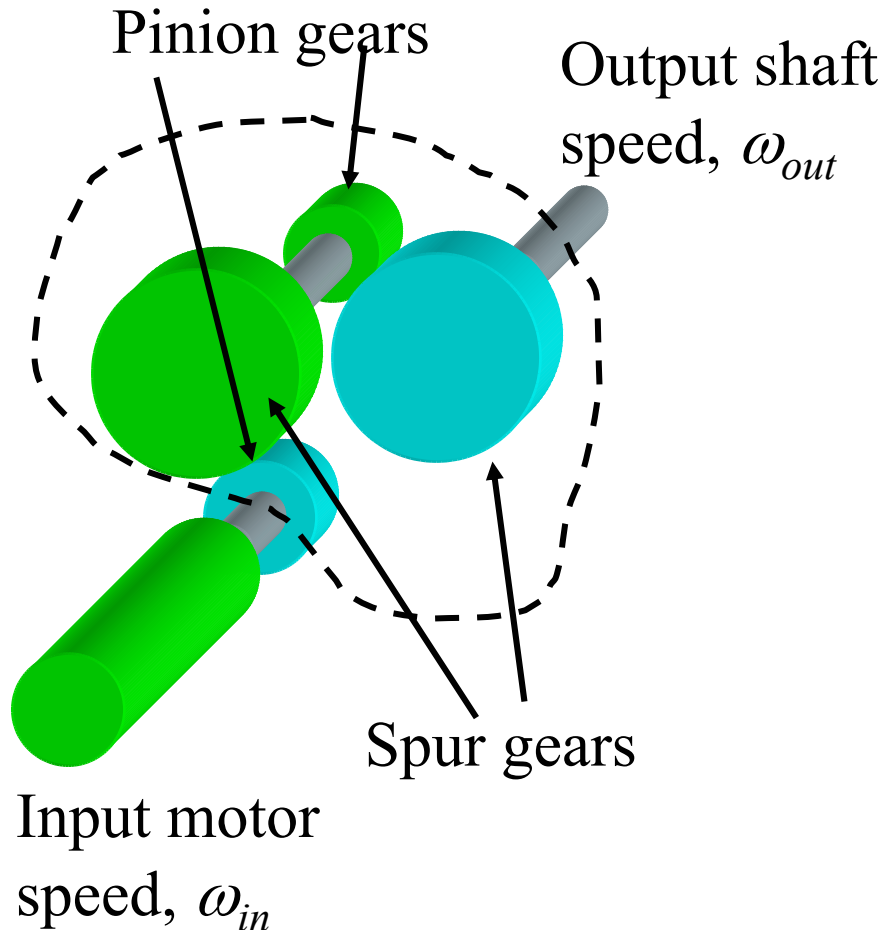
▶ Gear reductions ratio typically given as

▶ Each gear pair reduces the overall efficiency of gearmotor

Worm and Planetary Gearboxes

www.qei-motion.com

Input axis

Output axis

www.gearman.com

Planet Wheels Rotating about own spindles

Fixed Annulus

Rotating Planet Carrier

Rotating Sun Wheel
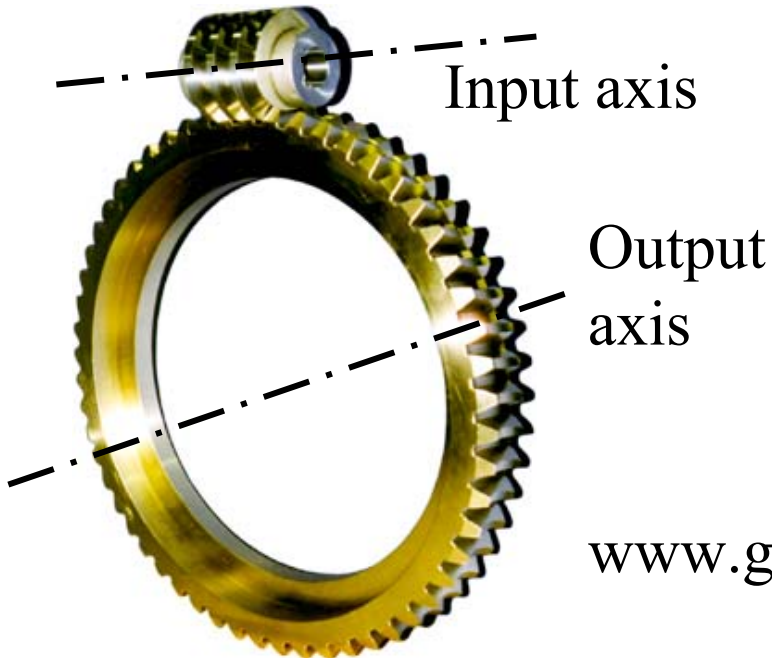
www.magtorq.com

Electric Screwdriver Gearbox

Sun

Planets

Ring

24 teeth

48 teeth

8 teeth

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