## Index

Adenosine tri-phosphate (ATP), 51 Aerodynamic drag, reducing, 187 Aerodynamics, 173-205 Age, effects of on power, 63-64, 75 Airplanes, human-powered, 420-429 Air resistance, 125–127 All-terrain bicycles, 27, 443–444 Aluminum alloy versus steel for frames, 373-376 American Star, 22, 24 Anaerobic threshold (AT), 55, 61 Anaerobic work, 45 Anaerobic work capacity (AWC), 46 Ariel bicycle, 17 ATP. See Adenosine tri-phosphate Backpedaling brakes, 238–239 Back-to-back tandems, 408 Backward pedaling, 86-88 Balance, how bicycles, 268–270 Balance-gear, Starley's, 21 Balancing. See Steering and balancing Bearings, 17, 210, 212-215 Bicycle-riding skills, 271-272 Blimp, human-powered, 427–429 Blood hematocrit, 68 Boats, human-powered, 4 Body-temperature regulation, 117 Boundary-layer suction, 193–196 Brakes, power absorption, 241–243 Braking, 237-261 rear wheel only, 246-248 rim temperatures reached, 256-261 stability during, 243-246 wet-weather, 247-253 Breathing, 73–77 Brittle behavior of materials, 362–365 Brown's recumbent, 29–30 Bump losses, 132–136 Capstans, 6

Carbohydrate fat, 56 fuels, 53

glucose, 53 lactate, 53 pyruvate, 53 Challand recumbent, 28–29 Cheetah recumbent bicycle, 405-406 Clayton, Nick, 3 Coaster brakes. See Backpedaling brakes Cocktail-party effect, 434 Composite bicycles, lightweight, 436-438 Contraction, 50 Convective cooling, 109 Countersteer to generate lean, 270-271 Coventry tricycle, 20 Crank length, effect of, 89-91 Creatine phospate. See Phosphocreatine (PCr) Critical power (CP), 43 Crosswinds and faired bicycles, 201-203 Da Vinci III helicopter, 424-426 Daedalus aircraft, 422-424 Daedalus flight ergometry, 63-66 Dandy-horse, 11 Decavitator hydrofoil, 416–417 Derailleur gears, history, 26 Design goals for components, setting, 366-368 Differential gear, 21 Diffusion, 173 Disk brakes, 239-241, 440-441 Drafting and side-by-side bicycling, 197 - 201Drag coefficients, 175–181 Drag versus Reynolds number, 184-186 Drais, Karl von, 8-11 Draisienne, 11 Drum, cage, Leonardo's, 6, 8 Dunlop, John Boyd, 26

Dynamic pressure of air, 177 Dynamics of bicycles, 282-285 Eccentric contraction, 50 Electric-assist bicycles, 414-415 Electric transmission, 337–340 Energetics in pedaling, 69 Energy consumption versus distance, 153 Energy expenditure of bicyclists, 77 Energy storage, 167 Equivalent roller to two-roller setup, 211 Ergometers, 38 adaptation, 39 Exercise bicycles, 42 Exposed chains, elimination, 442–443 Facile bicycle, 4 Factors of safety, 354 Fairings, bicycle, 189–193 Fast glycolytic (FG) fibers, 58 Fast oxidative glycolytic (FOG) fibers, 58 Fatigue, low-cycle and high-cycle, 357-360 Fatigue of materials, 356–360 Fat-reducing exercise, 57 Fiber recruitment, 59 Frame design, 381–383 Fuel cells, animals as, 72-73 Future of human-powered vehicles, 431-456 Galleys, oar propelled, 4-5 Gearing and energy efficiency, 165 Gear ratio, effect of, 99–100 Gears derailleur, 319-321 hub, 318–332 Glycolysis, 53 Gompertz, Lewis, 11–12

Gradients and headwinds, 163 Gyroscopic effects, 268

Hand-cycles, 404, 412 Heat-transfer data, 111–118 Helicopters, 424–427 Helios helicopter, 426–427 Herlihy, David, 3 High bicycle, 4, 19 High-power aerobic metabolism, 61, 66 High-power pedaling, 48 Hillman, William, 17 History of bicycle materials, 353– 354 History of bicycles in general, 3–35 History of power transmission, 311-313 Hobby horse, 11 Hot and cold conditions for bicycling, 115 HPV racing, 32 Hub gears, 26 Human factors, feel and control, 301-303 Human power generation, 37–108 Hydraulic actuation, 441-442 Hydrostatic drive, 335-337

IHPVA, 31 Impedance match, gearing, 313–315 Instrumentation for stress, 383–385

Jaray, Paul, recumbent, 31 Johnson, Denis, 11

Kangaroo Dwarf Roadster, 22, 24 Kremer prizes for human-powered aircraft, 420–422 Kyle Edge recumbent bicycle, 406– 407

Lactate threshold (LT), 55, 61 Lallement, Pierre, 14–15 Laminar flow, 179 Land vehicles, human-powered, 404– 414 Lawn mowers, 400–402 Leonardo's bicycle, 3 Lessing, Hans-Erhard, 3 Lever and linear drives, 93–98 Lever-tension wheel, 17, 18 Loading of bicycles, 354–355 Local and mean heat transfer, 110 Macmillan, Kirkpatrick, 12 Materials properties, 370-371 and stresses, 353-395 testing, 365-366 Material strength, relevant, 355–356 McCall velocipede, 12 Meyer, Eugene, 17 Michaux, Pierre, 14 Mitochondria, 54 Monoblade forks, 438-440 Motor neurons, 48 Muscle fast glycolytic (FG) fibers, 58 Muscle fast oxidative glycolytic (FOG) fibers, 58 Muscle fibers, 48 Muscle-fiber types, 57–59 Muscle fuels, six, 51 Muscle functions, 48 Muscle pennation, 49 Muscle slow oxidative (SO) fibers, 57-58 Muscle slow-twitch fibers, 58 Musculair aircraft, 422–423 Negative work, 50. See also Eccentric contraction Noncircular cranking, 96–98 Nonmetallic components, 376-379 Nonround chainwheels, 91-95 Notch sensitivity of materials, 364-365 Nuescheler's record power, 41, 48 Number of gear ratios, optimum number, 344-348 OBLA (onset of blood-lactate accumulation), 55 Omer 3 submarine, human-powered, 420-421 On-bicycle power measurement, 40-42, 47, 99-100 One-way clutches, freewheels, 315 On-road power, 144–149

Ordinary bicycle, 4, 19 Oxygen uptake, absorption, 67, 74 PCr. See Phosphocreatine Pedaling and hand-cranking, 84 Pedaling forces, 77-83 Pedaling position, effects, 72 Pedaling speeds, 78 Pedestrian accelerator, 11 Personal energy requirements, 71 Phosphocreatine (PCr), 51 Pinkerton, John, 3 Plimpton, James, 16 Plunger brakes, 238 Pope, Col. Albert, 16 Positive drives, chains and toothed belts, 316-327 Power and speed, 123-171 PowerCranks, 87 Power-duration data, 42-45 Power equation, 136–140 Power for land locomotion, 153-162 Power, speed, drag, 150–153 Pressure drag, 173 Production data for bicycles, 435 Rail cycles, 408–411 Range of variable gears, 348–349 Recovery from exertion, 69 Recumbent bicycles, 444–450 Recumbent pedaling, 85 Recumbents, history of, 4, 28-32 Regulations and incentives, effects of, 431-435 Resistance effect of road roughness, 226-229 effect of tire pressure, 229-230 Resistance of firm wheel and firm ground, 218 Resistance of firm wheel and soft ground, 219-221 Resistance of soft wheel and firm ground, 222-226 Resistances, 123 Respiratory quotient, 67 Reynolds number, 110, 180–182

Riderless bicycles, experiments with, 279 - 280Rim brakes, 241 Roberts, Derek, 3 Rolling resistance, 208–209 and speed, 230-231 and tire construction, 231-233 Roughness, effect on drag, 181, 196 Rowing motions, power produced with, 83-84 Royal Salvo tricycle, 21 Rules of thumb, power, 140–144 Running machine, 4 Saddle height, effect of, 88 Safety bicycles, 23-27 Sawyer, Willard, 13-14 School bus, human-powered, 411-413 Separated flow, 174-175, 180 Shimmy, 291–296 Skating, ice and roller, 10 Skin friction, 173 Skis for riders with handicaps, 404-405 Slope and rolling resistance, 127–132 Slow oxidative (SO) fibers, 57 Slow-twitch fibers, 58 Snek cable drive, 335–336 Snow removers, 401-404 Stability of bicycles, 285-290 Stability of tricycles, 290-291 Standard atmosphere, U.S., 183 Starch, 55 Starley, James, 17 Starley, John Kemp, 4 Steering and balancing, 263–309 effect of bicycle configuration, 272 Steering, broomstick analogy, 266-268Streamlined shapes, 173–175 Stress raisers, 360–362 Sturmey-Archer hub gears, 26 Submarines, human-powered, 420, 421 Suspension or tension, wheel, 17 Sutton, William, 25

Tambora explosion, 10 Tangent-tension spoking, 17, 19 Tendons, 49 Tension or suspension, wheel, 17 Thermal effects, 109-120 Thomson, R. W., 26 Tires lateral properties of, 297-301 pneumatic, 25-26, 207-233 Titanium, 380 Tools, human-powered, 400-404 Traction drive, 340-341 Trail, effect of, on balancing, 271-279Trampelwurm vehicle train, 411–414 Transmission, efficiency, 315–316, 342-345 Transmission of power, 311-352 Transmissions, linear and oscillating, 333-335 Transportation systems for humanpowered vehicles (HPVs), 450-456 Treadmills, 7, 9 Tricycles and quadricycles, 450-451 Tricycles, history, 4, 20 Tubeless tires, 438-439 Tubing, hollow, 17 Turbulent flow, 179 Two-joint muscles, 70 Union Cycliste Internationale, 31 Unusual human-powered machines, 399-429 Uphill bicycle assistance, 454–456 Use of bicycles in the United States,

Varna Mephisto recumbent bicycle, 406 Vel'Eau 12, twelve-person boat, 416– 420 Velocar recumbent, 31 VO<sub>2max</sub>, 68

435-436

Wales, I. F. recumbent bicycle, 30 Walking and running energy, 162– 163 Water vehicles, human-powered, 416–421 Whatton bars, 22, 23 Wheel resistance, 207 Wheels, stress and stability, 385–392 White Dwarf human-powered blimp, 427–429 Windchill factors, 116 Wind loads from passing vehicles, 196–197 Wing and strut sections, drag, 186 Wingate anaerobic test, 42, 46

Xtraordinary bicycle, 4

Yuri I helicopter, 425-427