

Index

- AAR plate B equipment clearance diagram, **11-30**
Abaca (manila fiber), **6-137**
Abampere (def), **15-2**
Aberrations, **19-43**
 chromatic, **19-43**
 spherical, **19-43**
Ablators (heat-resisting materials), **6-151**
Abrasive cutoff wheels, **13-61**
Abrasive paper, **6-130**
Abrasive tools (wood sanding), **13-75**
Abrasive wheels (*see* Grinding wheels)
Abrasives, **6-128**
 artificial, **6-128**
 coated, **6-130**
 grains for, manufacture of, **6-128**
ABS resins: properties of (table), **6-186**
ABS/Nylon resins: properties of (table), **6-186**
Absolute-pressure gages, **16-9**
Absolute systems (mechanics, def), **3-2**
Absolute temperature scale, **4-2**
Absolute zero, inferred, **15-5**
Absorber, in refrigeration systems, **19-17**
Absorptance (heat, def), **4-62**
Absorption:
 coefficient of (sound), **12-120**
 of gases by water, **6-7**
 of light (def), **12-99**
Absorption dynamometers, **16-15**
Absorption machines, refrigeration, **19-17**
Absorption refrigerators, **4-18**
Absorptivity (heat, def), **4-62**
Acceleration (def), **3-10**
 angular (def), **3-12**
 composition of, **3-10, 3-11, 3-13**
 conversion (table), **1-33**
 causing curvilinear motion, **3-11**
 equivalents (table), **1-32**
 of gravity, **1-25, 3-2**
 measurement of, **16-17**
 resolution of, **3-11**
 units of, **1-18**
Acceleration resistance (train), **11-39**
Acceleration-time curve (kinematics), **3-10**
Accelerometers, **3-78**
Accidents: prevention of, **18-19 to 18-21**
Accounting (*see* Cost accounting)
Accumulators, hydraulic, **8-39**
Acetal resins: properties of (table), **6-187**
Acetone (solvent), **6-149**
Acid number of lubricating oil, **6-179**
Ackerman steering gear (automobiles), **11-12**
Acme screw threads, **8-16**
Acoustics, in industrial plants, **12-16**
 (*See also* Sound)
Acrylic fibers, **6-140**
Acrylic resins: properties of (table), **6-188**
Acrylonitrile resins: properties of (table), **6-188**
Active power (a-c circuits, def), **15-2**
Actuators, hydraulic, **8-39**
ACV (air cushion vehicles), **11-58**
Ada (computer language), **2-53**
Addendum (gear teeth), **8-88**
Adhesion, coefficient of (locomotives), **11-24**
Adhesive resins, performance of (table), **6-131**
Adhesives, **6-130**
 anaerobic, **6-131**
 classification of (table), **6-130**
 elastomeric, **6-131**
 pressure-sensitive, **6-131**
 properties of (table), **6-132**
 thermosetting, **6-131**
 uses of, **6-130**
 table, **6-132**
Adiabatic expansion of gases, **4-9**
Admiralty brass (table), **6-68**
Admittance (electric circuits, def), **15-3, 15-19**
Advance (resistor alloy), **15-61**
 table, **15-61**
Aerodynamics (def), **11-59**
 axes used in, **11-60**
 coefficients in, **11-60**
 hypersonic (def), **11-59**
 (*See also* Supersonic and hypersonic aerodynamics)
 speed in, **11-60**
 subsonic (*See also* Airfoils)
 supersonic (def), **11-59**
 (*See also* Supersonic and hypersonic aerodynamics)
 transonic (def), **11-59**
Aeronautics (*see* Airplanes)
Aerosols, particle sizes in, **18-10**
Afterburners (jet engines), **11-83**
 effect of, **11-83**
Aftercondensers, **9-82**
Agglomeration test (coal), **7-2**
Aggregates for concrete, **6-161**
Aging of steel (hysteresis), **15-10**
 after temper rolling, **6-26**
AGMA gear standards, **8-100**
Air:
 ambient, quality standards for (table), **18-7**
 composition of (table), **6-10**
 dehumidification of, **4-17**
 by surface cooler, **4-17**
 density of (def), **4-15**
 at altitudes (table), **11-60**
 formula, **14-45**
 in ducts, friction in (charts), **12-88, 12-89**
 enthalpy-pressure diagram for (chart), **4-34**
 heat transfer coefficients to or from, **4-84**
 humidification of, spray chambers for, **4-17**
 ideal-gas, enthalpy and psi functions for (table), **4-31**
 internal energy of (table), **4-28**
 liquefaction of, **19-26**
 moist, properties of, **4-15**
 pressure of, at altitudes (table), **11-60**
 solubility, in water, **6-7**
 surface conductance (table), **12-70**
 surface resistance (table), **12-70**
 temperature at altitudes (table), **11-60**
 temperature-entropy chart for, **4-32**
 thermal conductivity of (table), **4-82, 4-85**
 velocity pressure, **14-45**
 and water-vapor mixtures, **4-15**
Air arc gouging, **13-32**
Air cleaners, characteristics of (table), **18-16**
Air compression, **14-28**
 multistage: power required in, **14-29**
 theory of, **4-12**
 power required for, **14-29**
 theory of, **4-12**
 work of, **4-12**
Air compressors:
 centrifugal (*see* Centrifugal compressors)
 efficiency of, **14-29, 14-30, 14-38**
 lubrication of, **14-32**
 oils for, **6-184**
 rotary-vane, **14-33**
 unloaders for, **14-33**
 uses for, **14-28**
 valves for, **14-31**
Air conditioning, **12-71**
 absorption systems, water and lithium bromide, **19-17**
 air distribution in, **12-89**
 air infiltration (tables), **12-68, 12-69**
 atmospheric cooling for, **12-92**
 of automobiles, **11-16**
 chilled-water systems, water distribution in, **12-92**
 of cold storage rooms, **19-23**
 comfort indexes for: ASHRAE comfort chart, **12-62**
 effective temperature (chart), **12-62**
 temperature-humidity index, **12-62**
 cooling load formulas for, **12-71**
 cooling loads for (table), **12-78**
 cooling towers for, **12-92**
 duct air velocities (table), **12-89**
 ducts, friction of air in (charts), **12-88, 12-89**
 ductwork for, **12-88**
 fans for, **12-89, 14-50**
 filters for, **12-91**
 table, **12-91**
 heat gain, **12-73**
 from appliances (table), **12-83, 12-84**
 from computer equipment (table), **12-83**
 from electric motors (table), **12-85**
 factors for (table), **12-77**
 from lighting fixtures (charts), **12-73**
 from occupants (table), **12-82**
 from office equipment (table), **12-83**
 from people (table), **12-82**
 from restaurant appliances (table), **12-84**
 through roofs (tables), **12-74**
 through sunlit walls (table), **12-72**
 heat rejection, **12-91**
 equipment for, **12-91**
 diagrams, **12-91**
 piping for, **12-96**
 friction losses in (charts), **12-94, 12-95**
of industrial plants, **12-13**
inside design conditions (table), **12-63**
makeup water for, **12-91**
moisture infiltration, **12-64**
moisture load in, **12-85**
outdoor air requirements (table), **12-67**

- Air conditioning, (*Cont.*):
 outside design temperatures (charts), 12-64, 12-65
 overall heat-transfer coefficients (table), 12-70
 power input to (table), 12-92
 processes, 4-16
 psychrometric chart for, 12-86
 return face air velocities (table), 12-89
 supply-air rate, 12-87
 supply-air temperature, 12-87
- Air ejectors, 9-82
 capacities of (table), 9-83
 hogging, 9-83
 materials for, 9-83
 performance of, 9-82
 priming, 9-83
 steam jet pressure for, 9-82
 types of, 9-82
- Air heaters, in furnaces, soot blowers for, 9-31
- Air meters, 16-13
- Air motor hoists, 10-14
- Air pollution, 18-7
 characteristics of (chart), 18-9
 classification of, 18-10
 control of, in industries, 18-15
 from diesel engines, 9-120
 dispersion from stacks, 18-14, 18-15
 effects on vegetation, 18-12
 emission standards for passenger cars and light trucks (table), 9-123
 fans for control of, 14-50
 from gasoline engines, 9-119
 from heavy-duty engines, 9-124
 from internal-combustion engines, 9-119
 from light duty engines, 9-124
 particle sizing in, 18-10
 by power plants, 17-34
 principal pollutants (table), 18-7
 sources of, 18-7
 domestic, 18-8
 table, 18-8
 industrial (table), 18-8
 sulfur effects, 18-12 to 18-15
 from transportation engines (table), 9-119
 (*See also* Environmental control)
- Air preheaters (boilers), 9-43
- Air resistance: of automobiles, 11-4
- Aircraft (def), 11-59
- Aircraft jet propulsion, 11-81
 efficiency and power of, 11-89
 equations, notation, 11-87
 fuels, 7-13
 ramjet, 11-82, 11-90
 performance of, 11-90
 rocket engines, 11-85
 electric, 11-86
 electromagnetic, 11-87
 electrostatic, 11-87
 electrothermal, 11-87
 liquid propellants, 11-85
 nuclear heat-transfer, 11-86
 performance of, 11-93
 propellant combinations (table), 11-86
 scramjet, 11-82
 solid propellant, 11-85, 11-94
 thermal air-jet systems, 11-82
 thrust equations, 11-89
 turbofan, 11-83
 performance of, 11-92
 turbojet, 11-83
 performance of, 11-90
- Aircraft propellers:
 aerodynamic theories: axial-momentum, 11-95
 blade element, 11-95
 vortex, 11-96
- Aircraft propellers (*Cont.*):
 blades, 11-98
 construction of, 11-98
 centrifugal loads on, 11-98
 coefficients for, 11-97
 power, 11-97
 thrust, 11-97
 torque, 11-97
 control, 11-99
 beta, 11-99
 counterweights, 11-98
 design, 11-98
 ENT (emergency negative thrust), 11-99
 excitation factor, 11-98
 fatigue strength, 11-98
 feathering, 11-99
 gyroscopic forces on, 3-20, 11-99
 hubs for, 11-98
 mechanical design, 11-98
 performance characteristics of, 11-96
 advance ratio, 11-96
 velocity coefficient, 11-96
 performance of, 11-97
 compressibility effects, 11-97
 noise, 11-98
 reverse thrust, 11-97
 static thrust, 11-97
 pitch change mechanism for, 11-98
 resonance, 11-98
 reversing, 11-99
 slipstream contraction, 11-95
 store damage, 11-98
 vibratory stresses in, 11-98
- Airflow, through orifices, 4-20
- Airfoils, 11-61
 aerodynamic forces on, 11-60
 angle of attack (def), 11-61
 aspect ratio (def), 11-61
 boundary layer control, 11-64
 camber line of, 11-62
 characteristics of, 11-62
 drag (def), 11-60 to 11-62
 dynamic pressure (def), 11-61
 flaps and slots in, 11-64
 induced drag (def), 11-62
 lift (def), 11-60, 11-61
 moment (def), 11-61
 pressure distribution on, 11-64
 profile drag, 11-62
 sections, properties of (charts), 11-63
 stagnation point (def), 11-61
 stalling angle, 11-62
 transonic, 11-63
 wing section, selection of, 11-62
- Airplane propellers (*see* Aircraft propellers)
- Airplanes (def), 11-59
 aerodynamic forces on, 11-60
 supersonic and hypersonic, 11-72
 ceiling, 11-66
 climbing rate, 11-66
 climbing time, 11-66
 compasses for (gyroscopic), 3-20
 control of, 11-70
 dimensions of (table), 11-67
 drag of, 11-62, 11-66
 (*See also* Airfoils; Drag)
 dynamic stability of, 11-70, 11-71
 engines for, 9-102
 carburetors, 9-109
 cooling, 9-118
 drag of, 11-69
 table, 9-102
 flaps and slots for, 11-64
 flaps for, table, 11-64
 floats (seaplane), drag of, 11-69
- Airplanes (*Cont.*):
 fuselage of, drag of, 11-69
 gas turbines for, 9-124
 gyrocompasses for, 3-20
 jet propulsion (*see* Aircraft jet propulsion)
 landing speed of, 11-65
 parasite drag of (def), 11-66
 performance of, 11-65
 with jet thrust, 11-66
 typical (table), 11-67
 power: available, 11-65, 11-66
 table, 11-66
 range of (table), 11-67
 speed of (table), 11-67
 stability, 11-70
 stalling angle, 11-62
 stalling speed, 11-65
 static stability, 11-70, 11-71
 struts, drag of, 11-68
 tail surfaces, drag, 11-69
 turn-indicator, 3-20
 wings: delta, 11-78
 drag of, 11-62, 11-69
 flaps and slots, 11-64
 scale effect, 11-63
 chart, 11-63
 sections, 11-62, 11-77
 (*See also* Airfoils)
 wire, streamline, drag (chart, table), 11-69
- Airslide conveyors, 10-54
- AJM (abrasive-jet machining), 13-67
- Albumin glue (table), 6-130
- Alclad alloys (aluminum), 6-56, 6-58
- Alcohol, 6-148
 air for combustion of (table), 4-27
 compressibility, 6-9
 denatured, 6-141, 6-148
 heat of combustion of (table), 4-26
 products of combustion of (table), 4-27
 solvents, 6-148
 specific gravity and density (table), 6-8
 wood, 6-142, 6-148
- Algol (computer language), 2-53
- Alkali cleansers, 6-137
- Alkalinity of boiler water, 9-49
- All-day efficiency (transformers, def), 15-35
- Allowance (def), 8-43
 for various types of fit, 8-43
 table, 8-44
- Alloys:
 aluminum, 6-53
 antifriction, 6-61
 for castings, 13-6
 copper, 6-65
 for bearings (table), 6-61
 manufacturing properties of (table), 13-12
 creep rates in (table), 5-11
 fusible (table), 6-75
 for high temperature, 6-77
 superalloys (tables), 6-78 to 6-80
 lead, 6-74
 magnesium, 6-53
 nickel, 6-88
 nonferrous, 6-49
 hardening, 6-52
 heat-treatment of, 6-52
 manufacturing properties of (table), 13-13
 resistivity (table), 15-4
 for resistor materials, 15-61
 specific gravity and density (table), 6-7
 steel, manufacturing properties of (table), 13-12
 (*See also* Steel, alloys)
 superplastic, 5-11
 titanium, 6-91
 zinc, 6-93

- Alnico (magnet material), 15-62
 Alpha iron (def), 6-16
 Alpha particles, atomic, 9-134
 Alphabets:
 German, 19-44
 Greek, 19-44
 script, 19-44
 Alternating-current instruments, 15-21
 Alternating currents (*see* Circuits, alternating-current; Currents, alternating; Electric motors; Generators)
 Alternation, electric current (def), 15-18
 Alternators, 15-66
 Altitude:
 air volume correction factors due to (table), 12-91
 solar (table), 9-12
 variation of atmospheric pressure and temperature with (table), 11-60
 ALU (arithmetic logic unit), 15-80
 Alumina brick, 6-151
 Aluminum:
 conductors of, 6-60, 15-6
 table, 6-60, 15-49
 current-carrying capacities for (table), 15-57
 corrosion resistance of, 6-56
 painting and lacquering of, 6-59
 plastic range chart for, 13-10
 soldering of, 6-56
 tubing of, 8-191
 welding of, 6-56, 13-44
 Aluminum alloys, 6-53
 aging, 6-53
 anodizing treatment of, 6-58
 castings, composition and properties of (tables), 6-57 to 6-60
 designations, 6-53
 die-casting, 6-56
 table, 6-60
 heat-treatment (tables), 6-53, 6-54
 machining, 6-56
 magnesium, 6-53
 mold-casting, 6-56
 protection, 6-56
 riveting, 6-56
 silicon, 6-53
 soldering of, 6-56
 strength at high temperatures (table), 6-55
 welding of, 6-56, 13-44
 wrought, 6-53
 composition and properties of (table), 6-54
 Aluminum brass: composition and properties of (table), 6-68
 Aluminum bronze, 6-67
 for bearings, 6-61
 composition and properties of (table), 6-68
 Aluminum oxide, for wood sanding, 13-75
 Aluminum paint, 6-109
 Aluminum pipe (table), 8-192
 Alundum (abrasive), 6-130
 Amatol (explosive), 7-21
 American farm windmill, 9-6
 American National Standard pipe threads, 8-17
 American Standard wire gage, 15-5
 table, 8-85
 American Unified screw threads, 8-8
 American wire gage, copper wire sizes (table), 15-5
 Ammeters, 15-20, 15-21, 16-16
 Ammonia:
 pipes for, valves and fittings, 8-205
 properties of (chart), 4-34
 saturated (table), 4-33
 as refrigerant, 4-24, 19-3
 Ammonia (*Cont.*):
 saturated: properties of (table), 19-6
 superheated: properties of (table), 19-5
 Ammonia absorption machines, 19-17
 Ammonia compressors:
 condenser pressure (table), 19-15
 horsepower per ton of refrigeration (table), 19-15
 volume of gas per ton of refrigeration (table), 19-15
 Ammonia dynamites, 7-20
 Ammonia gelatins in explosives, 7-21
 Amortisseur windings (a-c armatures), 15-34
 Ampere (def), 1-17, 15-2
 Ampere-turn (def), 15-4
 Amplidyne (d-c generator), 15-26
 Amplification (def), 16-22
 Amplifiers:
 difference, 15-76
 differential (electronic circuit), 15-73
 high-gain operational, 16-29
 instrumentation, 15-77
 radio, 15-72
 transistor, 15-69
 two-stage, 15-73
 AMS specifications, for stainless steel, chemical composition (table), 6-34
 Analog computers, 2-40, 2-53
 Analog-to-digital converters, 16-20
 Analysis:
 dimensional, 3-44 to 3-46
 of factory operations, 17-26
 factors in, 17-27
 Analytical geometry, 2-18 to 2-24
 Anchor ring, volume and area, 2-10
 Ancit process (coke making), 7-35
 Anemometers, 16-15
 ANFO (explosive), 7-20
 Angle of attack (aerodynamics, def), 11-61
 induced, 11-61
 Angle of stall (airfoils, def), 11-62
 Angle valves, 8-206
 Angles:
 analytical geometry formulas, 2-19
 bisection of, 2-6
 complementary (def), 2-14
 congruent (def), 2-14
 conversion tables for, 1-15
 dihedral, 2-5
 half, functions of, 2-16
 measurement of (surveying), 16-53
 units for, 2-15
 multiple, functions of, 2-16
 negative, functions of, 2-16
 solid, 2-9
 steel: radii of gyration for two (tables), 12-41, 12-42
 with unequal legs (table), 12-40
 used as beams, 12-42
 tables, 12-39 to 12-42
 structural steel (tables), 12-39 to 12-42
 sum and difference of, 2-16
 supplementary (def), 2-14
 trigonometric formulas, 2-15
 Angular acceleration (def), 3-12
 Angular displacement (def), 3-12
 Angular momentum (def), 3-18
 Angular velocity, 3-12
 conversion factors (table), 1-32
 Annealing:
 of nonferrous metals, 6-52
 of steel, 6-17
 Annual reports, 17-12
 Annuity tables, 1-7, 1-8
 Annulus:
 area of, 2-7
 number of contiguous circles in, 2-7
 Anodizing, 6-111
 Anomalistic year, 1-25
 ANSI method of generator voltage regulation, 15-32, 15-33
 Anthracite (*see* Coal, anthracite)
 Antifriction alloys, 6-61
 Antifriction curve, Schiele's, 2-23
 Antioch process (molding), 13-3
 Antirolling gyroscopes (ships), 3-20
 Anvils, steam-hammer, 13-22
 Aperiodic decay (def), 3-63
 Aperture (optics), 19-41
 of lenses, 19-41
 numerical, 19-42
 API (American Petroleum Institute) scale (specific gravity) conversion tables, 1-26
 Apothecaries' liquid measure, 1-16
 Apothecaries' weight, 1-17
 Apparent power (a-c circuits, def), 15-2, 15-18
 Apron conveyors, 10-44
 table, 10-45
 Aquifers, for water storage, 6-169
 Arc furnaces, 7-52, 7-55
 Arc welding (*see* Welding, arc)
 Arch beams, 5-42
 Arches:
 furnace, 6-154
 masonry, laying of, 12-28
 Archimedean spiral, 2-23
 Arcs:
 circular, center of gravity of, 3-6
 of contact (belts), 8-53
 Arcsine, 2-17
 Arctangent, 2-17
 Arc (def), 1-19
 Area, units of, 1-16
 Area meters, fluid flow, 16-14
 AREA railway line clearances, 11-38
 Areas:
 centers of gravity for, 3-6, 3-7
 conversion tables, 1-30
 equivalent (table), 1-30
 measurement of, 1-16, 16-7
 methods of calculating, 2-7, 2-29, 2-30
 moments of inertia of, 3-8
 plane: centers of gravity of, 3-6, 3-7
 by graphics, 3-9, 3-10
 moments of inertia of, by graphics, 3-9, 3-10
 of similar figures, 2-5
 of solids, 2-8 to 2-10
 Arithmetic, 2-4
 fixed point, 2-41
 floating point, 2-41
 laws of, 2-4
 Arkansas oilstones, 6-129
 Armature leakage reactance, 15-32
 Armature reactance and resistance, a-c generators, 15-32
 Armature reaction, 15-29, 15-32
 Arms, flywheel, 8-50
 Artificial intelligence, 2-52
 Asbestos, 6-139
 as brake material, friction of, 3-22
 as magnet wire insulation, 15-65
 specific gravity and density of (table), 6-8
 thermal conductivity of (table), 4-83
 Asbestos-cement pipes, 8-194
 Asbestos shingles, 6-146
 ASCII codes, 16-21
 table, 2-42

- Ash:
 coal, 9-29
 tables, 7-4, 7-6
 combustibles in, 9-35
 heat loss due to (chart), 9-35
 content in fuel oil, 9-31
 analysis (table), 9-31
 deposits, 9-30
 eastern, 9-30
 effect of fuel additives on, 9-31
 furnace fouling by, 9-30
 fusibility, 7-6
 table, 7-6
 lignitic, 9-30
 Ash collectors, 9-32
 Ash conveyors, pneumatic, 10-53
 Ashlar masonry (table), 12-28
 ASHRAE comfort chart, 12-62
 ASIC (application-specific integrated circuit), 15-82
 ASME specifications, for stainless steel (table), 6-37
 Aspect ratio (aerodynamics, def), 11-61
 Asphalt, 6-144
 roofing, 6-145
 Asphaltum, specific gravity and density (table), 6-8
 Assay ton (def), 1-17
 Astigmatism (optics, def), 19-43
 ASTM specifications:
 for alloy-steel castings (table), 6-48
 for brick (table), 6-136
 for cement, 6-159, 6-160
 for chains (table), 10-5, 10-6
 high-test, 10-5
 proof-coil, 10-5
 transport, 10-5
 for commercial zinc (table), 6-93
 for copper wire, table, 6-67
 for fire resistance, 18-24
 for gypsum plaster, 6-163
 for Portland cement (table), 6-160
 for stainless steel, chemical composition (table), 6-34
 mechanical properties (table), 6-34
 for standard sieves (proportioning concrete, table), 6-161
 for steel, 6-26
 tables, 6-26
 structural, 6-26, 12-33
 for locomotives (table), 6-26
 for ships (table), 6-26
 for steel castings, 6-48
 Astroid, 2-22
 Astronautics, 11-100
 (See also Space)
 Astronomical unit (def), 11-101
 Asymptote:
 of hyperbola, 2-20
 of tractrix, 2-23
 Atgas process (gasification), 7-35
 Atmosphere:
 control of, in industrial furnaces, 7-44
 impurities in (chart), 18-9
 international standard (table), 4-33
 of planets (table), 11-107
 protective gas (heat treating, table), 7-45
 standard (COESA, def), 11-59
 table, 11-60
 upper, data on (COESA), 11-59
 variation with altitude (table), 11-60
 Atmospheric corrosion, 6-98
 Atom (def), 6-3, 9-133
 Atomic energy:
 fusion systems, 9-148
 (See also Power plants, nuclear)
 Atomic number (def), 6-5
 of elements (table), 6-3
 of metals (table), 6-50
 Atomic power (see Power plants, nuclear)
 Atomic reactors (see Reactors)
 Atomic weights:
 of elements (table), 6-3
 of metals (table), 6-50
 Attenuation of steam, 9-44
 Attenuators, submerged-type, 9-45
 Attenuation (automatic control, def), 16-22
 Attraction, laws of, 3-19
 Austenite (def), 6-16
 grain size, 6-18
 influence of alloys on (table), 6-20
 Authority:
 functional (def), 17-2
 staff (def), 17-2
 Autofacturing, 17-21
 Autogiros (def), 11-59
 Autoignition temperatures (gaseous fuels), 9-115
 Automated storage and retrieval systems (materials handling), 10-73
 Automatic control:
 actuators for, 16-30
 basic system, 16-22
 block-diagrams for, 16-27, 16-32
 algebra, 16-27
 representation, 16-27
 closed-loop, 16-22
 block-diagrams for, 16-32
 commands, 16-22
 compensation: derivative, 16-25
 error, 16-26
 input, 16-26
 output, 16-26
 integral, 16-26
 error, 16-26
 definition of terms, 16-22
 error coefficients, 16-32
 final control elements for, 16-30
 frequency response, 16-33
 equations for common elements (table), 16-36
 graphical display, 16-34
 Bode diagrams, 16-34
 Nyquist plots, 16-34
 polar plots, 16-34
 linear quadratic regulators, 16-43
 performance index for, 16-44
 LQG/LTR systems, 16-40
 command following in, 16-42
 compensator design procedure for, 16-44
 control systems analysis for, 16-48
 controllability of, 16-41
 detectability of, 16-41
 example of, 16-45
 LQG controller design for, 16-46
 LQG/LTR controller design for, 16-46
 multiplicative uncertainty of, 16-43
 noise rejection in, 16-42
 observability of, 16-41
 performance robustness of, 16-41
 PI controller design for, 16-47
 precompensator design for, 16-47
 robustness of, 16-40
 stability robustness of, 16-42
 stabilizability of, 16-41
 modes vs. process characteristics (table), 16-33
 nomenclature, 16-22
 peak overshoot, 16-25
 peak time, 16-25
 pneumatic systems, 16-28, 16-30
 process characteristics for (table), 16-33
 Automatic control, LQG/LTR systems, (Cont.):
 rise time, 16-25
 robustness (def), 16-40
 properties, 16-40
 sampled-data systems, 16-38
 stability of, 16-39
 signal flow representations, 16-28
 stability and performance of, 16-37
 gain margin (def), 16-38
 Nyquist stability criterion, 16-37
 phase margin (def), 16-37
 Routh's stability criterion, 16-38
 steady-state performance, 16-32
 time constants in, 16-26
 transient analysis of system, 16-24
 overshoot, 16-25
 transient frequency, 16-25
 viscous-damped, 16-24
 z transformation, 16-38
 Automatic control systems (def), 16-22
 Automatic controllers (def), 16-22
 Automatic guided vehicles, 10-56
 Automatic pilot (gyroscope), 3-20
 Automatic vehicles (materials handling), 10-36, 10-56
 Automobile engines, 9-94, 9-96
 in buses, 9-97
 compression, 9-93
 compression ratio (tables), 9-96
 cooling, 9-95, 9-96, 9-117
 cylinders, 9-95, 9-111
 firing orders, 9-114
 foreign, 9-96
 table, 9-96
 fuel consumption (charts), 11-5 to 11-7
 ignition, 9-114, 15-66
 lubrication of, 9-118
 passenger-car data, 9-95
 pollution from, 18-8 to 18-10
 power (tables), 9-96
 valve timing, 9-95
 Automobiles, 11-3
 acceleration, 11-5
 aero horsepower of, 11-4
 air conditioning for, 11-16
 cool-down test for, 11-17
 refrigeration capacity required, 11-17
 antilock brakes for, 11-16
 body construction, 11-17
 brakes, 11-13
 adjustment, 11-14
 caliper-disk, 11-15
 drums, 11-14
 hydraulic, 11-14
 internal-expanding, 11-14
 parking, 11-14
 pedal pressure for, 11-15
 power, 11-15
 self-energizing, 11-14
 service, 11-14
 shoes, 11-14
 split systems, 11-14
 stopping distance (tables), 11-14
 braking of, force required during, 11-13
 reaction time in, 11-13
 characteristics purchased, 11-3
 cooling, 11-16
 dimensions of, 11-3
 drag coefficients for (chart), 11-4
 engines (see Automobile engines)
 features, 11-3
 foreign, 9-96
 front suspensions for, 11-11
 front-wheel drive for, 11-10

- Automobiles (*Cont.*):
 fuel consumption of, **11-5**
 charts, **11-5 to 11-7**
 gear ratios for, **11-5**
 heating for, **11-16**
 materials used in (table), **11-18**
 McPherson struts in, **11-11**
 microprocessors in, **15-68**
 miles driven, **11-3**
 rear axles, **11-10**
 differentials for, **11-10**
 semifloating, **11-10**
 rear suspensions, **11-11**
 registration in the United States, **11-3**
 resistance, **11-3**
 air, **11-4**
 tires, **11-3**
 starting and lighting systems, **15-66**
 steering, **11-12**
 Ackermann, **11-12**
 power, **11-12**
 oil pumps for, **11-13**
 road feel of, **11-13**
 rack-and-pinion, **11-12**
 recirculating ball, **11-12**
 worm and roller, **11-12**
 tires for (table), **11-4**
 inflation pressure (table), **11-4**
 (See also Tires)
 traction control for, **11-16**
 traction required in, **11-3, 11-5**
 transmissions, **11-6**
 automatic, **11-9**
 fluid couplings, **11-6**
 friction clutches, **11-6**
 manual, **11-8**
 gear ratios, **11-9**
 synchronesh, **11-8**
 overdrives, **11-9**
 torque converter, **11-7**
 trucks (see Trucks)
 turning radius, **11-12**
 ventilation, **11-16**
 wheel alignment, **11-12**
 camber (def), **11-12**
 caster (def), **11-12**
 toe-in (def), **11-12**
- Autotransformers, **15-36**
 for squirrel-cage motors, **15-37**
- Available heat (def), **4-6**
 in steam engine cycle, **4-19**
- Aviation fuels, **7-13**
- Avogadro's number (def), **4-3**
- Avoirdupois weight, **1-17**
- AWG (American Wire Gauge), **15-5**
- AWS specifications, for stainless steel, chemical composition (table), **6-34**
- Axial fans, **14-44, 14-45**
 characteristic curves, **14-48**
 efficiency of (chart), **14-48**
 formulas, **14-45**
 performance curves for, **12-89, 12-90**
- Axial-flow pumps, **14-15**
- Axis:
 of inertia, principal (def), **3-8**
 optical, **19-41**
 of oscillation, **3-16**
- Axles, of automobiles, **11-10**
- Azimuth (def), **16-54**
 back (def), **16-54**
 solar (table), **9-12**
- Babbitt linings in large bearings, **8-122**
- Babbitt metal (table), **6-61**
- Babcock coefficient of friction (steam flow), **4-23**
- Backhoes, loaders with, **10-25**
- Bagasse, as fuel, **7-10**
- Bainite (def), **6-18**
- Balance:
 dynamic, **3-15, 3-67**
 standing, **3-15**
 static, **3-66**
- Balances:
 equal arm, **16-3**
 spring, **16-4**
 torsion, **16-4**
- Balancing, **3-15**
 of machines, **3-66**
 rotating, **3-65, 3-66**
 steam turbines, **9-62**
- Ball bearings (see Bearings, rolling contact)
- Ball-mill grindability test for coal, **7-7**
- Ball valves (pump), **14-13**
- Ballasts:
 for fluorescent lamps, **12-101**
 instant start, **12-101**
 rapid start, **12-102**
- Balsa, as insulation, **6-150**
- Banana oil, **6-149**
- Band brakes, **8-41**
 friction of, **3-28**
- Band clutches, **8-39**
- Band saws, metal, **13-61**
- Bar codes, **10-62**
 Code 49, **10-67**
 Code One, **10-68**
 Code 128, **10-62**
 Code PDF417, **10-67**
 Code 16K, **10-67**
 Code 39, **10-62**
 Data Matrix, **10-67**
 interleaved 2-of-5, **10-62**
 scanners for, **10-69, 10-70**
 2-of-5, **10-62**
 U.P.C., **10-63**
- Barn (unit of nuclear cross section, def), **9-140**
- Barometers, **3-34**
 mercury, **16-8**
- Barometric condensers, **9-81**
- Barrel, standard (def), **1-16**
- BATEA (best available technology economically achievable), **18-5**
- Batteries, **15-11**
 dry, **15-11**
 block assembly, **15-11**
 effect of temperature, **15-12**
 efficiency of, **15-11**
 flashlight, **15-12**
 radio B, **15-11**
 Ruben-cell, **15-12**
 electrodes, **15-11**
 electromotive force of, **15-11**
 Exide Ironclad, **15-14**
 ignition system, **15-66**
 polarization, **15-11**
 poles, **15-11**
 storage, **15-13**
 capacity of (table), **15-14**
 care of, **15-14, 15-15**
 charging, **15-14, 15-15**
 Edison, **15-13, 15-14**
 efficiency of, **15-14**
 for mine locomotives, **10-21**
 Nicad, **15-13, 15-15**
 pasted-plate type, **15-13**
 Planté, **15-13**
 portable, **15-14**
 rechargeable, **15-15**
 removal from service, **15-14**
- Batteries, storage, (*Cont.*):
 specific gravity for electrolyte, **15-13**
 stationary, **15-14**
 voltage of, **15-13**
- Baumé scale (specific gravity), conversion tables, **1-27**
- Bauschinger effect, **5-5**
- Beam and crank mechanisms, **8-3**
- Beam lengths:
 mean (radiation), **4-69**
 table, **4-69**
- Beams, **5-20**
 angles used as, **12-42**
 bending moment, **5-21**
 cantilever (def), **5-21**
 connections in steel-framed structures, **12-43**
 constrained, **5-32**
 continuous, **5-32**
 uniformly loaded (table), **5-33**
 curved, strength of, **5-42**
 deflection of, **5-28, 12-34**
 Castigliano's theorem, **5-36, 5-42**
 curve for, **5-28, 5-31**
 diagram, **5-22**
 formulas, **5-29**
 as function of stress, **5-30**
 graphical method, **5-31**
 Maxwell's theorem, **5-36**
 design of, **5-21**
 factors governing, **5-28**
 elastic curve, **5-28**
 I (see I beams)
 internal moment beyond elastic limit, **5-26**
 internal resilience, formula, **5-32**
 loads and reactions, **5-21**
 diagram, **5-31**
 oblique, **5-22**
 rolling or moving, **5-32**
 moment and shear diagrams for, **5-22 to 5-25, 5-32 to 5-36**
 moments of inertia of various sections (table), **5-27**
 neutral axis in (def), **5-21**
 neutral plane and line of (def), **5-21**
 radii of gyration of various sections, **5-27**
 rectangular, uniformly loaded, safe loads (table), **5-25**
 reinforced-concrete, **12-52**
 resilience, **5-32**
 per unit volume (table), **5-17**
 section modulus (def), **5-21**
 tables, **5-27**
 sections, properties of (tables), **5-27**
 shear in, **5-21**
 shear diagram, **5-31**
 simple (def), **5-21**
 slope diagram, **5-31**
 steel, deflections (tables), **5-26, 12-47**
 maximum safe load on, **5-21**
 table, **5-26**
 properties of (tables), **12-35**
 proportions of, **12-34**
 safe loads, **5-21, 12-42**
 table, **5-26**
 short, calculation of, **12-42**
 supports for, **12-43**
 web connections for, **12-43**
 stiffness of, **3-73, 5-30**
 strength of (formula), **5-21**
 theory of flexure in, **5-21**
 uniform cross section: bending moments (table), **5-22 to 5-25**
 vertical shear (table), **5-22 to 5-25**
 uniform strength, **5-36**
 table, **5-34**
 vibration, **3-73**

- Beams (*Cont.*):
 wooden, 12-28, 12-29
 properties of (table), 12-29
 safe loads (table), 5-25
- Bearing, determination of (in surveying), 16-54
- Bearing metals, 6-61
 aluminum alloys, 6-61
 babbit (table), 6-61
 copper-base (table), 6-61
 metal-powder-sintered, oil-impregnated (table), 6-63
 miscellaneous, 6-61
 porous, 6-61
 (*See also* Babbitt; Brass; Bronze)
- Bearing pressures of soils and rock (table), 12-26
- Bearings, 8-116, 8-132
 ball, 8-132
 (*See also* Bearings, rolling contact)
 for centrifugal pumps, 14-19
 closures for, 8-136
 conical, friction, 3-27
 efficiencies of, 3-26
 friction in, 3-27, 8-119
 gas-lubricated, 8-127
 compressibility parameter, 8-128
 thrust, 8-127, 8-130
 whirl stability of, 8-128
 guide, 8-116
 journal, 8-116
 allowable mean pressures, 8-118
 table, 8-118
 babbit linings, 8-122
 thickness, 8-123
 bushings, 8-122
 clearance, 8-118
 elements of, 8-122
 film thickness in, 8-117
 friction, 3-27
 variation with clearance, 8-118
 graphite-lubricated, 8-125
 heat dissipation from, 8-120
 length-diameter ratios, 8-118
 load distribution, 8-123
 lubrication, 8-116
 mean pressures (table), 8-118
 oil grooves, 8-123
 for various load directions, 8-123
 oilless, 8-125
 porous-metal, 8-125
 propeller shaft, 11-57
 seals, 8-124
 types of, 8-125
 Kingsbury thrust, 8-126
 friction, 3-28
 lubrication, 6-183
 complete, 8-116
 failure, 8-116
 film thickness, 8-117
 hydrostatic oil lift, 8-121
 minimum oil feed, 8-120
 mixed, 8-116
 pressure feed, 8-120
 semifluid, 8-116
 starting and stopping, 8-121
 wicks, 8-121
 materials for, copper base (table), 6-62
 (*See also* Bearing metals)
- Michell, 8-126
 mine car, 10-21
 mounting, 8-137
 needle, 8-133
 oilers for, 8-121
 for oscillatory motion, 8-124
 plain, 8-116
 porous, 6-61, 8-125
- Bearings (*Cont.*):
 roller, 8-133
 railway, resistance of, 11-39
 (*See also* Bearings, rolling contact)
 rolling contact, 8-132
 AFBMA standards, 8-132
 angular-contact, 8-132
 attachments to shafts, 8-137
 ball and roller, 8-132
 capacity, 8-135
 closures, 8-136
 components, 8-132
 cages, 8-132
 rings, 8-132
 rolling elements, 8-132
 double-row, 8-132
 equivalent loads for, 8-134
 fits (table), 8-137
 friction, 8-136
 grease for, 8-138
 loads and ratings, 8-134
 locking collars for, 8-137
 lubrication of, 8-137
 tables, 8-138
 maximum capacity, 8-132
 mountings, 8-137
 in pillow blocks, 8-137
 radial, 8-132
 rated life (def), 8-134
 selection procedure for, 8-133, 8-136
 speed limits for, 8-136
 split, 8-133
 tapered-roller, 8-133
 thrust bearings, 8-133, 8-135
 types of, 8-132
 shielded (rolling contact), 8-136
 silver, 6-61
 sintered, iron-base (table), 6-62
 sliding, 8-127
 step, friction, 3-28
 thrust, 8-116, 8-125, 8-126, 8-130
 ball, 8-133
 capacities of (table), 8-127
 film thickness, 8-126
 friction, 3-28
 friction coefficient, 8-126
 gas-lubricated, 8-127, 8-130
 grooves, 8-126
 hydrostatic step, 8-126
 Kingsbury, 8-126
 roller, 8-133
 rolling contact, 8-133, 8-135
 segmental, pivoted, 8-126
 Bêché pneumatic forge hammer, 13-23
 Bed moisture (coal), 7-5
 Bell-and-spigot pipe (table), 8-186
 Belleville springs, 8-70
 Belleville washers, 8-70
 Bellows gages, 16-8
 Bellows gas meter, 16-7
- Belts, 8-51
 arc of contact, 8-53
 conveyor, 10-48
 drives, 8-51
 arrangements, 8-51
 efficiency, 3-26
 friction, 3-29
 idler pulleys, 10-48
 power, 8-53
 flat, selection of, 8-56
 high-strength, 10-48
 joints, 8-51
 leather, 8-51
 strength of, 8-51
- Belts (*Cont.*):
 lengths: open and crossed, 8-52
 formulas, 8-52
 graphical methods of determining, 8-52
 power transmission by, 8-53, 8-55
 rubber, 8-51
 minimum pulley diameters for (table), 8-52
 power ratings (tables), 8-52, 8-56
 slack removal, 8-52, 8-57
 tension in, 8-51
 tighteners for, 8-52, 8-57, 10-49
 V (*see* V-belts)
- Bench mark (surveying, def), 16-52
- Bending:
 elastic limit in, 5-27
 of metals, 13-16
 allowance for, 13-16
 loads for, 13-16
 machines for, 13-16, 13-21
 theory of (beams), 5-21, 5-41
 and torsion of shafts, 5-18
- Bending moment of beams, 5-21
- Bendix automobile brakes, 11-14
- Bendix-Weiss universal joint, 8-36
- Bends:
 pipe, 5-57
 for rope, 8-81
- Benzene, as solvent, 6-149
 (*See also* Hydrocarbons)
- Benzol (solvent), 6-149
- Bergbau-Forschung process (coke making), 7-35
- Bergoulli distribution, 2-10
- Bernoulli function, 2-38
- Bernoulli's differential equation, 2-32
- Bernoulli's equation (hydraulics), 3-39, 3-41, 3-46
- Beryllium, 6-84
- Bessel's equation, 2-33
- Bessel's function, 2-38
- Beta decay, 9-134
- Beta function, 2-37
- Beta rays, 9-133
- Bevel gears (*see* Gears, bevel)
- Beveloid gears, 8-100
- Bi-Gas process (gasification), 7-35
- Bidding procedures, 12-17
- Bifilar pendulums, 3-69
- Binary numbers, 2-41
- Binders, core, 13-6
- Binding energy (nuclear), 9-134
- Binomial coefficients, 2-10
 tables, 1-4
- Binomial distribution, 2-10, 17-23
- Binomial theorem, 2-10
- Biogas, as fuel, 7-10
- Biomass fuels, 7-7
- Biosphere (def), 18-2
- Bipropellants (rocket), 7-29
- Birefringent coatings, 5-54
- Birmingham wire and sheet-metal gages, 8-85
- Bisection:
 of angles, 2-6
 of lines, 2-5
- Bisphenol resins: properties of (table), 6-189
- Bit (computers), 2-40
- Bituminous coal (*see* Coal, bituminous)
- Black-surface enclosures (radiant-heat), 4-63
- Blackbody (def), 4-62
- Blades, fan, centrifugal, 14-45
- Blasius equation (friction-drag-coefficient), 11-66
- Blast furnace (def), 6-13
- Blast-furnace gas:
 cleaning of, 18-10, 18-11
 flame temperatures (table), 4-29
- Blasting gelatin, 7-20

- Bleeding cycle (turbines), 4-19
- Blind rivets, 8-30
- Blocks, concrete, 12-28
pulley, 8-8
- Blockwood (def), 7-9
- Blowers, 14-44
for draft, 14-50
rotary, 14-44
for superchargers, 9-106
for ventilation, 14-50
(*See also* Centrifugal compressors; Fans)
- Board drop hammers, 13-22
- Board measure (def), 1-16
- Boats, maximum safe power for, 11-46
- BOD (biological oxygen demand), 6-172
- Bode diagrams, 16-34
for controllers, 16-37
description of, 16-22
- Bohr theory of atoms, 6-5
- Boiler furnaces:
cinder and fly-ash recovery, 9-32
combustion in, 9-34
controls, 9-45
design and construction of, 9-37
draft losses in, 9-46
heat transfer, 9-39
heat transmission, 4-71
mechanical draft, 9-46
pulverized-coal: firing, 9-32 to 9-35
stokers, 9-32
walls, 9-37
water-cooled, 9-36
- Boilers:
acid cleaning of, 9-52
air preheaters for, 9-43
boil-out, 9-52
using carbon monoxide, 9-37
care of, 9-52
chemical cleaning of, 9-52
circulation in, 9-45
natural, 9-37, 9-45
codes for, 9-52
combined circulation, 9-37, 9-46
controls for, 9-45
corner-fired, 9-35
corrosion in, 6-105, 9-49
draft loss through, 9-46
dry storage of, 9-52
economizers for, 9-43
efficiency of, 9-47
calculation by heat balance, 9-47
emergency operation of, 9-52
exhaust gas, 9-37
explosions in, 9-52
external cleaning, 9-52
feedwater (*see* Feedwater)
fireside corrosion in, 6-107
foaming in, 9-49
forced-circulation, 9-37, 9-45
furnace (*see* Boiler furnaces)
heat balance, 9-47
heat losses, 9-47
high-temperature-water, 9-37
inspection and maintenance, 9-52
normal operation, 9-52
nuclear, 9-53
BWR system, 9-53
chemical poisons from, 9-53
chemical reactions in, 9-53
codes and specifications for, 9-53
design considerations, 9-53
economics of, 9-53
hazards, 9-53
heat transfer in, 9-53
- Boilers, nuclear (*Cont.*):
PWR system, 9-53
radioactivity in, 9-53
once-through type, 9-37, 9-45
package, 9-36
performance of: acceptance tests, 9-47
component tests, 9-48
draft loss, 9-46
guarantees, 9-47
heat-absorption calculation, 9-47
thermal losses, 9-47, 9-48
radiant, 9-37
rating (def), 9-47
recovery, 9-37
safety interlocks, 9-52
start-up, 9-52
supercritical, 9-46
superheaters for, 9-41
tubes for: film coefficients for, 4-84
radiation factors for rows of (chart), 4-66
standard dimensions (table), 8-187
types of, 9-36
waste-heat, 9-37
water for (*see* Feedwater)
water-tube, 9-36
- Boiling points:
of the elements (table), 4-58
of hydrocarbons (tables), 4-50, 4-53
of metals (table), 6-50
of various substances, 4-50, 4-53, 4-58
- Bolometer, 16-13
- Bolted joints, design of, 8-24
- Bolts:
carriage, 8-22
drift, pulling resistance, 12-33
heads for, standard dimensions (table), 8-21, 8-22
high-strength: direct tension indicators for, 8-27
materials for, 8-22
ISO metric (table), 8-26
strength of, 8-27
and nuts, thread standards, 8-8
preload-indicating, 8-27
proof loads for, 8-22
proof strength of, 8-23
for steel-framed structures, 12-35
stress due to tightening, 8-22
tension due to tightening nuts on, 3-27
threads for, ANSI metric (table), 8-14
for timber trusses, 12-31
table, 12-31
U.S. Standard, wrench openings for (table), 8-20
- Bonus wage systems, 17-10
- Boolean algebra:
in circuit analysis, 15-80
truth table for, 2-2
- Borers, wood, 13-74
- Boring machines, 13-55
- Boring mills, 13-55
- Boron carbide (abrasive), 6-128
- Boron nitride (abrasive), 6-128
- Borozon (boron carbide), as abrasive, 6-128
- Bosch fuel-injection pumps, 9-111
- Boundary layer (def), 11-66
in aerodynamics, 11-66
in fluid flow, 3-46
- Boundary-layer control (BLC), 11-64
- Bourdon pressure gages, 16-8
- Boxboard, 6-144
- BPCTCA (best practical control technology currently available), 18-5
- Brakes:
automobile and truck, 11-13
composition of, 11-15
- Brakes (*Cont.*):
band, 8-41
cone, 8-42
disk, 8-42
dynamometers, 16-15
eddy-current, 8-42
dynamometer, 16-15
electric, 8-43
fan, 16-15
friction, 3-18, 3-22, 3-28
horsepower absorbed by, 3-18
for hoisting machinery, 10-17
hydraulic (automobile), 11-14
internal, 8-40
multidisk, 8-42
prony, 16-15
railway, 11-32, 11-35, 11-37
vacuum, 11-15
- Braking:
of railway trains, 11-32, 11-35, 11-37
regenerative (def), 10-10
- Brale (hardness-testing device), 5-12
- Brass:
composition and properties of (tables), 6-68
lead, 6-65
table, 6-68
machinability of, 6-73
naval (table), 6-68
pipe (tables), 8-189, 8-190
plastic range chart for, 13-10
press forgings, mixtures for, 13-19
rolled, mechanical properties of (table), 6-72
strength at high temperatures, 5-10
(*See also* Copper alloys)
- Brass-aluminum alloys for condenser tubes, 6-73
- Brayton cycle, 4-11, 4-13, 9-124, 9-135
- Braze welding, 13-29
- Brazing, 13-29
filler metals for (table), 6-76
furnace, 13-29
induction, 13-29
torch, 13-29
- Brick, 6-131
ASTM specifications (table), 6-136
cement, 6-135
chrome, 6-152
common, 6-135
red, 12-27
facing, 6-135
fire (*see* Firebrick)
grades (table), 6-136
high-alumina, 6-151
magnesite, 6-151
manufacture of, 6-135
masonry: specific gravity and density of (table), 6-8
strength of, 12-28
table, 12-28
paving, 6-135
prefabricated panels of, 6-135
properties of (table), 6-136
sand-lime, 6-135
silica, 6-151
silicon carbide, 6-152
specialty, 6-135
- Brickwork:
lateral support, 12-28
laying and bonding, 12-27
strength of, 12-27
- Brightness (illumination, def), 12-99
- Brine coolers, 19-18
double-pipe, 19-20
shell-and-tube, 19-20

- Brinell hardness number (def), 5-12
for metals (table), 5-3
- Brinell hardness test, 5-12, 16-18
- Brines:
circulation of, 19-23
properties of (tables), 19-19
for refrigerating plants, 19-19
- Briquettes, for coke ovens, 7-34
- British thermal units (Btu), 1-19, 4-3
mechanical equivalent, 1-19
- British unit of refrigeration (def), 19-2
- Brittleness, impact tests for, 5-7
- Broaches, 13-60
speeds and feeds for, 13-61
- Broaching, 13-60
- Broaching machines, 13-61
- Bronze, 6-65, 6-67
aluminum (table), 6-68
for bearings, 6-61
tables, 6-68
cupronickels, 6-67
tables, 6-68
as electrical conductor, 15-6
manganese, 6-65
phosphor, 6-67
table, 6-68
silicon, 6-67
table, 6-68
strength at high temperatures (table), 5-10
tin, 6-67
tables, 6-68
various, uses of, 6-67
- Brown and Sharpe wire gage: scheme of, 15-6
table, 8-85
(*See also* American wire gage)
- Brown coat (plastering), 6-163
- Btu (*see* British thermal units)
- Bucket carriers, 10-45
(*See also* Conveyors)
- Bucket elevators, 10-46
casings, 10-47
- Buckets:
clamshell, 10-12
dragline: scraper, 10-11
self-filling, 10-11
grab, 10-12
electrohydraulic, 10-12
for impulse hydraulic turbines, 9-156
orange-peel, 10-12
for steam turbines, 9-62
- Buckingham's II theorem (dimensional analysis), 3-44, 3-45
- Buckling, of columns, 5-38
- Budgets, 17-14, 17-16
- Buffing, 13-64
of plastics, 13-65
- Buhrstones, 6-129
- Building blocks, 12-28
- Building construction, 12-17, 12-18
fire-resisting, 18-23
foundations, 12-26
industrial, 12-2
materials (*see* Building materials)
partitions: sound-adsorption coefficients (table), 12-121
sound-transmission loss (table), 12-120
reinforced-concrete (*see* Reinforced concrete)
steel (*see* Steel-framed structures)
steel for, allowable stresses in (tables), 12-33
structural design, 12-18
- Building materials:
fire resistance of, 12-43, 18-24
specific gravity and density of (table), 6-8
thermal conductivity of (tables), 4-83, 4-84, 12-75
- Building stone, 6-143
specific gravity and density of (table), 6-8
- Buildings:
closed, wind forces on, 12-19
earthquake forces in, 12-18
exits and fire escapes, 18-20
fire protection, 18-23
heating (*see* Heating)
industrial (*see* Industrial plants)
safety provisions, 18-19
soundproofing, 12-119
ventilation (*see* Ventilation)
wind pressure on, 12-19
- Bulk flo conveyor, 10-41
- Bulk modulus of elasticity (def), 3-31, 5-17
of metals (table), 5-4
of various liquids (table), 3-32
- Bulldozers, 10-24
- Buoyancy, 3-36
center of, 3-36
for ships (def), 11-44
- Burglar alarms, 12-123
- Burners, 9-34
air-atomized, 9-34, 9-35
for combustion furnaces, 7-41
corner-fired, 9-35
gas, 9-35
blast-furnace, 9-35
coke-oven, 9-35
oil, 9-34
pulverized coal, 9-34
primary air for, 9-34
secondary air for, 9-34
- Bus bars for switchboards, 15-45
- Buses, engines in, 9-97
(*See also* Automobiles)
- Bushel, U.S. and imperial (def), 1-16, 1-20
- Bushings, dimensions of (table), 8-122
- Butane:
in LPG (table), 7-15
properties of (table), 4-50, 4-52
as refrigerant (table), 19-4
- Butterfly valves for hydraulic turbines, 9-160
- Butyl acetate, uses of, 6-149
- Butyl rubber, 6-147
- BWG (Birmingham wire gage), 8-85
- Bypass engines (turbofan engines), 11-82
- Byte (computers), 2-41
- C (computer language), 2-53
- Cable length (nautical unit), 1-16
- Cable tramways (*see* Cableways)
- Cables:
aluminum, electrical properties of (table), 15-49
copper (table), 15-6, 15-51
resistance and reactance of (table), 15-52
electric: insulation for, 15-50, 15-56
paper for, 6-139
underground power, 15-50
carrying capacity (tables), 15-51
nonmetallic sheathed (interior wiring), 15-56
service entrance (interior wiring), 15-55, 15-57
- Cableways:
deflection, 10-31
factor of safety, 10-31
hoisting and conveying, 10-30
slackline, 10-35
speeds and loads, 10-31
supporting towers, 10-32
tramways, 10-31
cables and traction ropes, 10-32
loading and discharge terminals, 10-32
- Cableways, tramways (*Cont.*):
power required, 10-33
rope, stresses in, 10-32
transporting, 10-30
types of, 10-30
- Cadmium, 6-83
- Caisson method for foundations, 12-26
- Calcinate (coke making, def), 7-34
- Calcium-carbide furnace (electric), 7-59
- Calcium chloride:
brine, properties of (tables), 19-19
as freezing preventive, 6-141
- Calculus, 2-24 to 2-31
rules for differentiation, 2-24
table of integrals, 2-26 to 2-28
- Calendars, 1-25
- Calipers, 16-4
- Calorie, IT (def), 4-3
- Caloric value (*see* Heat value)
- Calorimeters:
separating, 16-18
steam, 16-18
throttling, 16-18
- Calum bronze, as electrical conductor, 15-6
- Camber line, of airplane wing section, 11-62
- Campbell diagram, 11-93
- Cams, 8-4
acceleration of (chart), 8-4
design of, 8-6
diagrams, 8-4
jerk (chart), 8-4
pitch line, 8-4
velocity of (chart), 8-4
- Candela (unit of luminous intensity, def), 1-17, 1-18, 12-99
- Cantilever beams (def), 5-21
(*See also* Beams)
- Capacitance, electrical, unit of (def), 15-2
- Capacitances:
of capacitors, 15-15
in parallel, 15-16
in series, 15-16
- Capacitive circuit, 15-17
- Capacitive reactance (def), 15-3, 15-18, 15-19
- Capacitor motors, 15-39
- Capacitors, 15-15
capacitance of, 15-15
synchronous, 15-40
- Capacity and volume equivalents (tables), 1-30, 1-31
- Capillarity, in tubes (chart), 3-33
- Capillary attraction, 3-33
in tubes (chart), 3-33
- Car dumps:
cross-over, 10-22
rotary, gravity, 10-22
power, 10-22
unit-train, 10-22
- Car positioners (railroad), 10-22
- Carat, metric (def), 1-17
- Carbide, tungsten, 6-62
- Carbides:
cemented, for tools, 6-61
composition, properties and uses of (table), 6-64
- Carbolon (abrasive), 6-128
- Carbon:
air required for combustion, 4-30
heat of combustion of (table), 4-26
- Carbon dioxide:
dissociation of, 4-29
emissivity (table), 4-70
measurement of, 16-18
production of, 19-25
properties of (tables), 4-35

- Carbon dioxide (*Cont.*):
 as refrigerant, **19-5**
 chart, **19-12**
 table, **19-4**
 solid, as refrigerant, **19-25**
- Carbon monoxide:
 flame temperature and dissociation (table), **4-29**
 measurement of, **16-18**
- Carbon-residue test for lubricating oils, **6-179**
- Carbon resistors, **15-62**
- Carbon steel (*see* Steel, carbon)
- Carbon tetrachloride, as solvent, **6-149**
- Carbonic acid (*see* Carbon dioxide)
- Carbonization of coal, **7-31**
 apparatus for, **7-33**
 briquettes for, **7-34**
 coal blending in, **7-32**
 coal-chemical recovery in, **7-34**
 heat-balances (table), **7-33**
 coals for, **7-31**
 coking process, **7-32**
 coking rates in, **7-32**
 gas yield (table), **7-33**
 variations during (table), **7-33**
 heat required for, **7-33**
 high-temperature: yields from, **7-31**
 table, **7-33**
 pilot scale tests for, **7-32**
 plastic zone, **7-32**
 preheated coal for, **7-34**
 processes, **7-34**
 temperature effects during, **7-33**
 gradients in (diagram), **7-32**
 thermal efficiency of, **7-33**
- Carborundum (abrasive), **6-128**
- Carburetors, **9-109**
 electronic, **9-109**
- Carburizing of steel, **6-21**
- Cardan universal joints, **8-36**
- Cardboard, **6-144**
- Cardioids, **2-22**
- Carnot cycle, **4-6, 4-10**
- Carrene (refrigerant), **19-7**
- Carriage bolts, **8-22**
- Carrier wave (television), **15-89**
- Carriers:
 open-top, **10-45**
 pivoted-bucket, **10-45**
 V-bucket, **10-45**
 capacities and weights (table), **10-46**
- Cars:
 box-body dump, **10-21**
 gable-bottom, **10-21**
 hopper-bottom, **10-21**
 industrial, **10-21**
 mine, **10-21**
 friction resistance (table), **10-21**
 railway, **11-27, 11-33**
 for containers, **11-28**
 roller bearing resistance, **11-39**
 wheels and axles for, **11-31**
 rocker side-dump, **10-21**
 scoop-dump, **10-21**
 shakers for, **10-22**
 unloading machinery for, **10-22**
- Cartridge brass (table), **6-68**
- Casein in glues, **6-132**
- Casings, for centrifugal fans, **14-44**
- Cast iron:
 alloys, composition and mechanical properties of (tables), **6-39 to 6-41**
 carbon in, **6-38**
 classification of, **6-38**
 columns (tables), **5-39**
 composition of, **6-38**
- Cast iron (*Cont.*):
 corrosion of, **6-101**
 cutting speeds (lathe, table), **13-53**
 definition of, **6-13**
 ductile, **6-13, 6-39**
 gray, mechanical properties of, **6-38**
 table, **6-39**
 malleable, **6-41**
 mechanical properties of, **6-38**
 tables, **6-39, 6-40**
 nodular, **6-13**
 pipe (*see* Pipe, cast-iron)
 shrinkage of, **6-43**
 strength of (tables), **6-39, 6-40**
 at high temperature (table), **5-11**
 tapping depth, **8-27**
 white (def), **6-42**
 (*See also* Castings)
- Cast steel:
 properties of (charts), **6-46**
 strength of at high temperatures (table), **5-11**
- Castable mixes for refractories, **6-154**
- Castigliano's theorem (beam deflections), **5-36, 5-42**
- Castings:
 of aluminum-base alloys, **13-7**
 cold-chamber machines for, **13-5**
 of copper-base alloys, **13-7**
 gooseneck machines for, **13-4**
 low pressure, **13-4**
 methods, design and cost features (table), **13-3**
 pressure, **13-4**
 piston machines for, **13-4**
 sand, **13-2, 13-3**
 basic steps, **13-2**
 patterns, **13-2**
 processes, **13-3**
 by slush process, **13-4**
 of steel: melting practice, **6-47**
 with steel molds, **13-5**
- Castings:
 alloys for, **13-6**
 aluminum (table), **6-57 to 6-60**
 austempered ductile iron, **6-40**
 austenitic ductile iron, ASTM specifications for, **6-43**
 austenitic gray iron, ASTM specifications for, **6-43**
 cast iron, specialty, **6-42**
 compacted graphite iron, **6-42**
 copper, **6-70**
 corrosion resistant, ASTM designations for (table), **6-45**
 designs for molding, **13-8**
 die, **13-4**
 ductile iron, ASTM specifications for (table), **6-41**
 mechanical properties of (table), **6-41**
 tensile requirements for (table), **6-41**
 gray iron, allowances for, **6-43**
 composition and mechanical properties of, **13-7**
 heat resistant, ASTM designations for (table), **6-45**
 inspection of, **13-7, 13-8**
 iron, **6-38**
 allowances for, **6-42**
 magnesium alloy, **6-84**
 malleable-iron, **6-41**
 composition and mechanical properties of, **13-7**
 ni-resist, corrosion resistance of (table), **6-44**
 sand-blast cleaning of, **13-7**
 steel, **6-38, 6-43**
 allowances for, **6-47**
- Castings, steel (*Cont.*):
 allowances for machine finish, **6-48**
 alloy, **6-44**
 ASTM specifications for (table), **6-48**
 ASTM specifications for (table), **6-48**
 classification of, **6-38**
 composition of, **6-43**
 corrosion resistance of, **6-45**
 design of, **6-49**
 dimensional tolerances for (table), **6-49**
 ductility, **6-44**
 endurance limit, **6-45**
 heat resistance of, **6-45**
 impact resistance of, **6-44**
 machinability of, **6-45**
 table, **6-47**
 machine finish allowances for, **6-48**
 table, **6-49**
 minimum thicknesses for, **6-47**
 properties of, **6-44, 13-6**
 charts, **6-46**
 shrinkage allowance for, **6-47**
 specifications for, **6-46**
 uses of, **6-48**
 wear resistance of, **6-45**
 weight range, **6-44**
 welding of, **6-46**
 white iron, ASTM specifications for, **6-43**
 (*See also* Foundries; Molding)
- Catenary, **2-21**
- Cauchy-Euler equation, **2-33**
- Cauchy's number, **3-42**
- Cavitation (def), **12-122**
 as cleaning process, **12-122**
 in displacement pumps, **14-2**
 effects of, **6-102**
 in screw propellers, **11-53, 11-54**
- Cavitation limits of hydraulic turbines, **9-159**
- CBN (cubic boron nitride), for cutting tools, **13-50, 13-62**
- CD (compact disk), **15-83**
- Ceiling (airplanes), **11-66**
- Cells:
 lead, voltages of, **15-13**
 wet, **15-13**
 (*See also* Batteries)
- Cellulose acetate butyrate resins: properties of (table), **6-189**
- Cellulosic resins: properties of (table), **6-189**
- Celsius, conversion to Kelvin (eq), **4-2**
- Cement, **6-159**
 autoclave soundness test for, **6-160**
 bricks, **6-135**
 compressive strength of (table), **6-160**
 high-early-strength, **6-159**
 insulating, **6-151**
 for masonry, **6-160**
 plaster, **6-163**
 portland, **6-159**
 air-entraining, **6-160**
 ASTM specifications for (table), **6-160**
 blast-furnace slag in, **6-160**
 high-early-strength, **6-159**
 low-heat, **6-159**
 modified, **6-159**
 regulated-set, **6-160**
 shrinkage-compensated, **6-160**
 specific gravity and density of (table), **6-8**
 strength of (table), **6-160**
 sulfate-resisting, **6-159**
 white, **6-160**
 pozzolan, **6-160**
 sand for, tests for, **6-161**
 setting time, **6-160**
 surfaces, painting of, **6-109**

- Cement (*Cont.*):
 tests for, 6-160
 types and kinds of, 6-159
 waterproofed, 6-160
- Cement-lined pipe, 8-191
- Cement plants: pollution from, 18-15
- Cemented-carbide tools, 6-62
- Cemented-carbides, 6-61
 corrosion resistance of, 6-63
 design considerations for, 6-62
 inserts of, 6-62
 mechanical properties of, 6-63
 micrograin, 6-63
- Cementite (def), 6-16
- Center:
 of buoyancy, 3-36
 of curvature, 2-26
 of gravity, 3-6, 3-7
 by experiment, 3-7
 of lines, 3-6
 of plane areas, 3-6
 by graphics, 3-9, 3-10
 of solids, 3-7
 of mass, 3-6
 of percussion, 3-16
- Centesimal measure of angles, 2-15
- Centigrade, conversion to Fahrenheit, 4-2
 (*See also* Celsius)
- Centipoise (unit of viscosity, def), 3-31
- Centistoke (unit of kinematic viscosity), 3-33
- Central heating (*See also* Heating)
- Centrifugal casting, 13-4
 of iron pipe, 8-187
- Centrifugal compressors, 14-38
 axial thrust in, 14-38
 efficiency of, 14-38
 fluid flow in, 3-43
- Centrifugal fans, 14-44, 14-45
 for air conditioning, 12-89
 fan laws for (table), 12-90
 applications of, 14-50
 blade forms, 14-45
 blowback in, 14-50
 casings for, 14-44
 characteristics of, 14-47
 charts, 14-46 to 14-49
 compressibility factor (def), 14-45
 cross-flow, 14-45
 efficiency of, 14-46
 fluid flow in, 3-43
 formulas, 14-45
 head (def), 14-46
 impeller types, 14-44, 14-45
 laws of, 14-49
 mixed-flow, 14-45
 motors for, 15-44
 parallel operation of, 14-48
 performance curves for, 12-89, 12-90
 power output (def), 14-46
 pressures in (def), 14-45
 puffing in, 14-50
 pulsation in, 14-50
 relative characteristics of (table), 12-90
 series operation of, 14-48
 sound power in, 14-46
 stability of, 14-49
 system characteristics of, 14-46
 system matching, 14-47
 tubular, 14-45
- Centrifugal force (def), 3-15
- Centrifugal pumps, 14-15
 application of, 14-23
 axial-flow, 14-15, 14-23
 axial thrust in, 14-17
 balance drums and disks for, 14-18
 balancing holes for, 14-17
- Centrifugal pumps (*Cont.*):
 bearings for, 14-19
 casings, 14-17
 cavitation limits, 14-25
 characteristic curves, 14-24, 14-26
 influence of fluid properties on, 14-24
 influence of viscosity on, 14-24
 classification of, 14-15, 14-17
 condensate-injection sealing for, 14-19
 couplings for, 14-20
 critical speeds of, 14-19
 diffuser type, 14-16
 effect of speed change, 14-23
 efficiency of (chart), 14-21, 14-22, 14-24, 14-26
 fluid flow in, 3-43
 head-capacity curves (charts), 14-24, 14-26
 hydraulic balancing devices, 14-18
 hydraulic theory, 14-21
 impellers (def), 14-15
 shapes for (chart), 14-21
 unbalanced forces on, 14-17
 velocity diagrams for, 14-22
 installation of, 14-26
 lattice-effect coefficient (chart), 14-23
 maintenance of, 14-26
 materials for, 14-20
 table, 14-21
 mechanical construction, 14-15
 mechanical seals for, 14-19
 mixed-flow, 14-21
 motors for, 15-44
 mountings for, 14-20
 multistage, 14-17
 names of parts for (table), 14-16
 nomenclature of, 14-15
 NPSH (def), 14-25
 required for, 14-25
 operation of, 14-26
 packing for, 14-19
 parallel operation of, 14-26
 parts of, recommended names of (table), 14-16
 performance of, 14-21
 priming of, 14-26
 series operation of, 14-26
 shaft sleeves for, 14-19
 shafts for, 14-18
 similarity laws for, 14-23
 specific speed of (def), 14-21
 stuffing boxes for, 14-19
 suction specific speed, 14-25
 system friction losses in, 14-25
 system-head curves for, 14-25
 theory of, 14-21
 vertical end-suction, 14-17
 vertical-shaft construction, 14-20
 volutes, 14-16
 water-seal packing for, 8-140
 wearing rings for, 14-17
 wet-pit, 14-16, 14-20
- Centripetal force (def), 3-15
- Centrode (def), 3-13
- Centroids (def), 3-6
 of lines, 3-6
 of plane areas, 3-6
 of any quadrilateral, 3-6
 of solids, 3-7
- Ceramic products, 6-136
- Ceramics, 6-136
 grinding of, 6-65
 machinable, 6-65
 machining of, 6-56
 manufacture of, 6-136
 properties of, 6-136
 tool inserts of, 6-136
- CERCLA (Comprehensive Environmental Response Compensation and Liability Act), 18-18
- Cermets, 6-63
- Cetane index (fuels, def), 7-14
- Cetane number (fuels, def), 9-116
- CFC (chlorofluorocarbon) chemicals, 19-3
- Cgs system of units, 1-24
- Chain (unit of length, def), 1-16
- Chain blocks:
 differential, 8-8
 triplex, 8-8
- Chain conveyors, 10-45
 (*See also* Conveyors, bucket)
- Chain drives, 8-59
 inverted-tooth (silent), 8-62
 length of chain in, 8-62
 power ratings, 8-61
 table, 8-60
 roller, 8-59
- Chain-grate stokers, 9-32
- Chain hoists, 10-12
 data for (table), 10-13, 10-14
- Chains, 10-4
 alloy, data on (tables), 10-5, 10-6
 ASTM specifications for (table), 10-5, 10-6
 conveyor, 10-8
 end fittings for, 10-7
 grades of, 10-4
 high-test, ASTM specifications for (table), 10-6
 master links for, 10-7
 master rings for, 10-7
 NACM specifications for (tables), 10-5, 10-6
 power transmission, 10-8
 proof coil, ASTM specifications for (table), 10-6
 roller, 8-59
 dimensions and speeds (table), 8-60
 length calculations, 8-62
 multiple-strand, 8-62
 power ratings (table), 8-60
 service factors (table), 8-64
 sprocket wheels for, 8-62
 diameter formulas, 8-62
 teeth, 8-62
 silent, 8-62
 power ratings (tables), 8-63, 8-64
 service factors (table), 8-64
 sling, 10-5
 special, 10-8
 strength of, 10-6
 tables, 10-5, 10-6
 transport, ASTM Specifications for (table), 10-6
 welded-link, 10-7
 wheel, 10-7
 working loads (tables), 10-5, 10-6
- Channels:
 open (hydraulic), 3-59
 roughness coefficients (table), 3-59
 steel, properties of (table), 12-34
- Chaos (automatic control), 16-49
- Characteristic curves:
 of fans, 14-46 to 14-49
 of pumps, 14-24, 14-26
- Charcoal, as fuel, 7-9
- Charpy impact test, 5-7, 5-14
- Chattering, of magnets, 15-64
- Chebyshev polynomials, 2-38
- Chemical compounds (def), 6-3
 calculations of, 6-7
- Chemical elements (def), 6-3
 table, 6-3
- Chemical fire extinguishers, 18-27
- Chemical index, for coal, 9-30
- Chemical processes: corrosion in, 6-107

- Chemical symbols (table), 6-3
 Chemistry, 6-3
 Chézy formula (hydraulics), 3-59
 Chi-square distribution (statistics, table), 1-11, 17-23
 Chimneys:
 compression at base, 5-40
 draft, 9-46
 gases (*see* Flue gas)
 winds on, pressure coefficients for (table), 12-20, 12-23
 (*See also* Stacks)
 Chip breakers, 13-47
 Chips, from cutting tools, 13-46
 Chrome brick, 6-152
 Chromium, 6-78
 in tool steel, 13-48
 Chromizing, 6-21, 6-22
 of steel, 6-22
 Chutes, 10-43
 for bulk materials, 10-43
 for lumpy materials, 10-43
 spiral, 10-44
 for unit loads, 10-43
 CIM (computer integrated manufacturing), 13-51
 Cinder and fly ash, 9-29, 9-32, 9-35
 Cippoletti trapezoidal weir, 3-57
 Circles:
 angles in, 2-5
 area of, 2-7
 circumference of, 2-7
 constructions of, 2-6
 equations of (analytic geometry), 2-19
 involute of, 2-23
 segments of (tables), 1-2, 1-3
 theorems on, 2-5 to 2-7
 Circuit breakers, 15-46, 15-56, 15-61
 air-blast, 15-46
 Circuits (electric), 15-8
 alternating-current: four-phase, 15-20
 interior wiring, 15-55
 parallel, 15-19
 polyphase power: advantages of, 15-20
 measurement of, 15-22
 quarter-phase, 15-20
 solution of problems, 15-19
 three-phase, 15-20, 15-22
 two-phase, 15-20
 voltage drop, 15-53
 Mershon diagram, 15-47, 15-49
 wiring calculations for, 15-54
 branch, voltage drop, 15-53
 capacitive, reactance of, 15-18
 carrying capacity of conductors (tables), 15-51, 15-57
 critical damping resistance of, 15-17
 dielectric, 15-15
 direct-current, wiring calculations, 15-53
 discrete component, 15-71
 effective resistance, 15-19
 impedance of, 15-18
 inductive, 15-17
 time constant, 15-17
 inductive reactance of, 15-18
 integrated, 15-75
 linear ramp generator, 15-78
 loop, 15-52
 magnetic, 15-8
 multivibrator, 15-78
 natural frequency, 15-17, 15-19
 network, 15-53
 parallel, 15-8, 15-52
 phase difference, 15-18
 resonance, 15-19
 sample and hold, 15-78
 series, 15-8, 15-52
 Circuits (*Cont.*):
 series-parallel, 15-52
 street-lighting, 15-52
 three-wire: a-c, 15-53, 15-54
 d-c, 15-52
 resistance and reactance (tables), 15-48, 15-52
 Circular arcs (*see* Circles)
 Circular cutters, 13-16
 Circular inch (def), 1-16
 Circular measure, 1-17
 of angles, 2-15
 tables, 1-15
 Circular mil (def), 1-16, 15-4
 Circular pitch (gears, def), 8-88
 Circular saws, 13-61
 Circulation (aerodynamics, def), 11-61
 Clad steels, 6-21
 Cladding, by rolling, 13-14
 Clairaut, differential equation of, 2-32
 Clapeyron equation, 4-6
 Claude's system of liquefying air, 19-26
 Clay for firebricks, 6-151
 Cleaning, sonic, 12-122
 Cleansers, 6-137
 Clearance in steam engines, 9-56
 Climb of airplanes, 11-66
 Clock motors, 15-41
 Closed system (thermodynamics, def), 4-4
 Cloud point (petroleum oils, def), 6-179
 Cloudburst hardness test, 5-13
 Clouds (particles in suspension, def), 18-10
 of large black particles, radiation from, 4-69
 Clutches, 8-37
 allowable pressures in (table), 8-38
 cone, 8-38
 disk, 8-38
 for automobiles, 11-6
 dynamic, for conveyors, 10-49
 friction, 8-37
 for automobiles, 11-6
 coefficients of (table), 8-38
 jaw, 8-37
 multiple-disk (automobile), 11-6
 overrunning, 8-39
 positive, 8-37
 rim, 8-39
 torque transmissible by, 11-7
 CM (chemical machining), 13-66
 CMRR (common mode rejection ratio), 15-76
 CNC (computer numerical control), 13-51
 Coach screws (table), 8-24
 uses of, 8-21
 Coal (def), 7-2
 analyses (tables), 7-2 to 7-5
 proximate, 7-2, 7-5
 ultimate, 7-6
 anthracite (def), 7-2
 ash in, 7-6, 9-29
 composition of (table), 7-6
 fusibility, 7-6
 table, 7-6
 bituminous, 7-2, 7-5
 bulk density of, 7-7
 caking (def), 7-7
 calorific value, 7-6
 Dulong's formula for, 7-6
 Parr formulas for, 7-2
 tables, 7-2 to 7-4
 carbonization (*see* Carbonization of coal)
 classification of, 7-2
 tables, 7-2 to 7-5
 cleaning, 7-7
 coking characteristics of, 7-31
 coking process, 7-32
 Coal (*Cont.*):
 combustion of, 9-34
 spontaneous, 7-8
 consumption of (table), 7-8
 density and specific gravity of, 7-7
 firing in boiler furnaces, 9-34
 fixed carbon in, 7-6
 free-swelling, 7-7
 free-swelling index for, 7-32
 for gas manufacture (table), 7-33
 gasification of, 7-35
 grindability of, 7-7, 9-34
 tests, 7-7
 gross calorific value (def), 7-6
 heat value (*see* Coal, calorific value)
 for industrial heating, 7-41
 lignitic (def), 7-5
 analyses of (tables), 7-2 to 7-5
 meta-anthracite, 7-2
 mineral-matter-free basis of classifying, 7-2
 mining, 7-7
 moisture in, 7-5
 net calorific value (def), 7-6
 piled, specific gravity and density of (table), 6-9
 preparation of, 7-7
 production of, 7-8
 proximate analyses of (def), 7-2, 7-5
 tables, 7-2, 7-5
 pulverized: air supply for burning, 9-34
 burners for, 9-34
 fineness of, 9-34
 fly-ash recovery in burning, 9-32
 mills for, 9-32
 pulverizing of, 9-32
 purchase of, under specifications, 7-8
 rank (def), 7-2
 mined in various states (table), 7-5
 tables, 7-2 to 7-5
 reserves, 9-3
 sampling, 7-8
 semianthracite (def), 7-2
 separators for, 7-7
 slurry pipeline, 11-132
 specific gravity of, 7-7
 table, 6-8
 specifications for, 7-8
 spontaneous combustion of, 7-8
 storage, 7-8
 subbituminous, 7-5
 tables, 7-3 to 7-5
 sulfur in, 7-6, 7-31
 tables, 7-4
 sulfur removal from, 7-8
 transportation, 7-8
 ultimate analysis of: methods, 7-6
 table, 7-4
 volatile matter in, 7-5
 tables, 7-3, 7-4
 Coal-chemical ovens, 7-33
 Coal gas, flame temperatures (table), 4-29
 Coated carbides, as cutting tools, 13-49
 Cocks, 8-207
 Code 49 (bar code), 10-67
 Code One (bar code), 10-67
 Code 128 (bar code), 10-63
 Code PDF417 (bar code), 10-67
 Code 16K (bar code), 10-67
 Code 39 (bar code), 10-62
 Coefficients:
 of area expansion, 4-2
 binomial, 2-10
 of contraction, 3-60
 of discharge for liquids through orifices, 3-56, 3-60
 of excess air in combustion (def), 4-25

- Coefficients (*Cont.*):
of expansion (def), 4-2
at low temperatures, 19-32
film, 4-83
of form (ships), 11-42
of friction, 3-20 to 3-25, 4-23
in metalworking, 13-19
table, 13-18
Joule-Thomson, 4-5, 4-24
of performance (def), 4-10, 4-18
of restitution, 3-19
of rigidity (def), 5-17
Steinmetz (table), 15-10
of thermal expansion of metals (table), 6-11
of transmission, through light-transmitting partitions (table), 12-76
through skylights (table), 12-76
through windows (table), 12-76
of velocity, 3-60
for steam, 4-23
- COESA atmosphere, 11-59
COGAS (combined gas-turbine and steam-turbine, ships), 11-52
Cohesion of liquids, 3-33
Coils, pipe, 8-185
Coining (metal squeezing), 13-20
Coke, 7-31
analyses of (table), 7-31
blast-furnace, 7-31
foundry, 7-31
high-temperature, 7-31
low-temperature, 7-31
medium-temperature, 7-31
petroleum, 7-31
pitch, 7-31
specific gravity and density of (table), 6-9
Coke-oven gas (table), 7-33
Coke ovens, 7-33
briquettes for, 7-34
heat balances of (table), 7-33
pollution controls for, 7-34
preheated coal for, 7-34
Coking properties of coal, 7-31
tests, 7-31
Cold-air refrigerating machines, 19-17
Cold-diffuser conditioning of storage rooms, 19-24
Cold forging of metals, 13-19
Cold storage, 19-21
insulation requirements, 19-23
lockers, 19-24
product data (table), 19-22
rooms: air conditioning, 19-23
piping, 19-23
temperatures, 19-23
vapor barriers for, 19-21
Cold-working of metals, 13-10
nonferrous metals, 6-52
Colebrook equation for friction, 3-48
Collapsing pressure of tubes, formula, 5-45
Collimators, 16-6
Color, codes, in industrial plants, 12-15
designation of, 12-107
use, in industrial plants, 12-15
Color-measurement systems, 12-107
Color scale for temperatures of iron and steel, 4-57
Color television, 15-90
Color test for lubricating oils, 6-179
Color vision, 12-99
Colorimeters, 16-18
Colors, for electrical wiring, 15-61
for identifying piping, 8-214
Colpitts oscillator, 15-73
Columbium, 6-79
Columns:
cast-iron, 12-43
strength of (tables), 5-39
Columns (*Cont.*):
classification (long and short), 5-38
eccentrically loaded, stresses in, 5-40
ends, forms of, 5-38
long: critical load, 5-38
Euler's formula, 5-38
slenderness ratio, 5-38
strength of (table), 5-39
reinforced-concrete, 12-55
round-ended, strength of, Euler's formula (table), 5-39
short (table), 5-39
formulas, 5-38
steel: allowable unit stresses (tables), 5-39
pipe, 12-43
concrete-filled, 12-56
table, 12-43
properties of (tables), 12-36
proportions of, 12-34
strength of (tables), 5-39
timber, 12-30
wooden, 12-30
working stresses (table), 12-30
wrought-iron pipe, strength of (tables), 5-39
Coma (optics, def), 19-43
Combinations and permutations, 2-10
Combined-cycle turbines, 9-69
Combined flexure and longitudinal force, 5-39
and torsion, 5-18, 5-19
Combined stresses, 5-18
Combustion, 4-24
air required by gaseous fuels, 4-25
in boiler furnaces, 9-32 to 9-35
of coal, 9-32 to 9-35
spontaneous, 7-8
control of, in boilers, automatic, 9-45
dissociation of gases, 4-29
equations, 4-25
excess air for (charts), 4-30
flame temperatures (table), 4-29
of gaseous fuels, 4-25
products (table), 4-27
temperature (table), 4-29
of gases: air required for, 4-25
products, 4-25
heat of formation (def), 4-27
heat value of fuels, 4-27
heats of (def), 4-25
table, 4-26
incomplete, loss due to, 4-30, 9-35
of liquid fuels, 4-27
products of, 4-25, 4-30
table, 4-27
radiation from, 4-68
of solid fuels, 4-30
air required, 4-30
excess air for (charts), 4-30
temperatures attained in, 4-29
volume contraction due to, 4-25
Combustion chambers:
for internal-combustion engines, 9-111
axial swirl in, 9-112
fast-burn, 9-112
pent-roof, 9-112
long, radiation in, 4-75
partially stirred: radiation in, 4-76
Combustion furnaces (*see* Furnaces)
Combustion turbines (*see* Gas turbines)
Come-alongs, 10-13
Comfort conditions (table), 12-63
Comfort indexes, 12-61
Communications channels, bandwidth of, 2-46, 2-48
Communications networks, 2-47
layers for, 2-47
standards for, 2-47
Commutating-pole motors, d-c, 15-29
Commutation in d-c generators and motors, 15-28, 15-29
Commutator motors, a-c, 15-40
Compensator (transformer), 15-36
starting, a-c motor, 15-37
Compiler, 2-52
Complex conjugate (def), 2-3
Complex numbers (def), 2-3
Composites: fiber (*see* Fiber composites)
Composition A (explosive), 7-22
Composition B (explosive), 7-20
Compound, chemical, 6-3
calculation of composition, 6-7
Compound interest (tables), 1-5, 1-6
Compound motors, electric, 15-29
Compound-wound generators, 15-26
Compressed air, for industrial plants, 12-13
Compressed-air machinery:
lubrication of, 6-184
(*See also* Air compressors; Centrifugal compressors)
Compressibility of liquids, 6-9
table, 6-9
Compressible fluids, flow of, 4-20
Compression:
of air (*see* Air compression)
of saturated and superheated vapors, 4-13, 4-14
Compression couplings, 8-34
Compression-ignition (engines), 9-113
Compression machines, vapor, theory of, 4-18
Compression ratios (internal-combustion engines, def), 9-90
permissible, 9-117
Compression testing, 5-5
Compressors:
accessories for, 14-33
adiabatic analysis of, 14-28
air (*see* Air compressors)
ammonia, 19-14
centrifugal (*see* Centrifugal compressors)
cylinders, 14-32
cooling of, 14-33
dual, 19-14
dynamic versus positive-displacement, 14-29
efficiencies, 14-28, 14-38
for gas turbines, 9-131
kinetic, 19-14
lubrication, 14-32
motors for, 15-40, 15-44
multiple effect, 19-14
multistage sizing, 14-29
nonlubricated cylinders for, 14-32
orbiting-scroll, 14-37
piston rings for, 14-32
piston-rod packing for, 14-32
polytropic process in, 14-28
real gas effects in, 14-29
reciprocating, 14-30, 19-14
refrigeration, 19-14
relief valves for, 14-33
rolling-piston, 14-34
rotary, dry-lobe, 14-37
single-screw, 14-36
twin-screw, 14-34
rotary vane, 19-14
screw, 19-14
standard conditions for, 14-28
surging in, 14-30
trochoidal, 19-14
valves for, 14-31
volumetric efficiency of, 14-30
Wankel, 19-14
wet compression, 19-14
Computer-aided design, 2-55
Computer-aided manufacturing, 2-55

- Computers:
 analog, 2-40
 applications of, 2-51
 arithmetic in, 2-41
 compilers for, 2-52
 digital, 2-40
 components for, 2-42 to 2-45
 input to, 2-44, 2-45
 languages for, problem-oriented, 2-53
 procedure-oriented, 2-53
 letters in, representation of, 2-42
 mathematical programming with, 2-53
 memory, 2-43
 multiprocessors in, 2-43
 numbers in, representation of, 2-41, 2-42
 operating systems for, 2-52
 operation of, 2-43
 output from, 2-45
 personal, 2-45
 program-preparation systems for, 2-42
 programming languages for, 2-52, 2-53
 programs for, 2-52 to 2-55
 simulation with, 2-53
 software for, 2-51 to 2-55
 speed of, 2-43
 tapes for, 2-44
 timesharing in, 2-52
 words in (def), 2-41
- Concrete, 6-163
 accelerators for, 6-162
 admixtures, 6-162
 aggregates for, 6-161
 air-entrained, 6-167
 air-entraining agents for, 6-162
 blast-furnace slag for, 6-161
 clay in sand for, 6-168
 compaction of, 6-167
 consistency of, 6-166
 curing of, 6-167
 deformation properties of, 6-168
 dry rodded weight, 6-166
 effect of freezing on, 6-168
 effect of oils and acids on, 6-168
 effect of seawater on, 6-168
 fineness modulus of (def), 6-161
 fly ash as additive for, 6-162
 forms for, 6-167
 lightweight aggregates for, 6-161
 masonry, specific gravity and density (table), 6-8
 for masonry units, 6-167
 materials for, per cubic yard (table), 6-165
 mica in sand for, 6-168
 mixes for, for small jobs, 6-163
 table, 6-164
 mixing, 6-166
 painting of, 6-109
 piles, 12-26, 12-58
 pipe, 8-193
 placement of, 6-167
 proportioning, 6-163
 quality control, 6-166
 ready-mixed, 6-166
 reinforced (*see* Reinforced concrete)
 retarders for, 6-162
 sand for, 6-161
 seawater used for, 6-161
 silica fume for, 6-161
 slump test for, 6-166
 table, 6-165
 strength of, 6-167
 variation with age (table), 6-167
 transverse strength of, 6-168
 water for, 6-161
 water and air requirements for (tables), 6-164, 6-165
 water content (tables), 6-164, 6-165
- Concrete (*Cont.*):
 water reducers for, 6-162
 watertightness, 6-167
 weight, 6-167
- Concrete blocks, 6-135, 12-28
 Concrete mixers, 6-166
 Condensate pumps, 9-80
 Condensation, 9-75
 Condensers:
 circulating water, United States temperatures (map), 9-77
 cooling water, air in (table), 9-82
 direct-contact, low-level, 9-81
 electrical (*see* Capacitors)
 evaporative, 4-18
 refrigeration, 19-14
 double-pipe, 19-14
 evaporative, 19-14
 steam, 9-75
 air-cooled, 9-81
 air ejectors for, 9-82
 two-stage, 9-82
 barometric, 9-81
 deaeration of, 9-75
 direct-contact, 9-81
 ejectors for, 9-82
 flow-induced vibrations in, 9-75
 movements in, 9-76
 noncondensibles, removal of, 9-82
 pressure and circulating-water temperatures for (table), 9-77
 surface-type, 9-75
 calculations, 9-76
 of size, 9-76
 circulating-water pumps for, 9-80
 cleanliness factors for, 9-77
 condensate pumps for, 9-80
 configurations, 9-75
 expansion in, 9-76
 materials for (table), 9-79
 performance curves, 9-79
 proportions of (table), 9-78
 sizing, 9-76
 tube-bundles for, 9-75
 tubes: cleanliness, 9-76, 9-77
 heat-transfer rates, 4-87
 water boxes for, 9-75
 water velocities in, 9-77
 steam tables for (tables), 4-44
 tube selection for, 9-75
 (*See also* Cooling towers)
- Condensing water, cooling of, 9-84
 Conductance:
 a-c (def), 15-19
 electrical (def), 15-2
 Conductances:
 thermal, 4-80
 conversion table, 1-34
 Conduction:
 and convection, 4-80
 heat transmission by, 4-79
 Conductivity:
 electrical (def), 15-2
 thermal (tables), 4-80 to 4-84
 conversion table, 1-34
 of insulation (tables), 4-84
 of liquids and gases (table), 4-82
 in materials for low temperatures (table), 4-84
 of metals (tables), 4-80, 4-81
 of miscellaneous solids (table), 4-83
 (*See also* Heat transmission)
- Conductors, electric (Cont.):
 aluminum (table), 6-60
 copper alloys for (table), 6-67
 cross-sectional areas (table), 15-59
 current-carrying capacities (table), 15-57
- Conductors, electric (*Cont.*):
 economical cross sections, 15-47
 estimating resistances and weights, 15-6
 materials for, 15-5
 properties of metals and alloys (table), 15-4
 specific resistance of (table), 15-4
 temperature coefficients of resistance of (def), 15-4
 table, 15-4
 types and applications of (table), 15-57
 (*See also* Cables)
- Conduits for interior wiring (table), 15-59
 Cone pulleys, 8-52
 Cones, surface and volume of, 2-9
 Conical pendulum, 3-15
 Conradson carbon-residue test for lubricating oils, 6-179
 Conservation:
 of energy, 3-2, 3-17, 3-39, 4-4, 9-134
 of mass, 3-2, 3-39
 of matter, 9-134
 of momentum, 3-2, 3-19
 Consolidation Coal process (coke making), 7-35
 Constant-entropy expansion:
 of gases, 4-9
 of vapors, 4-14
 Constant-pressure expansion:
 of gases, 4-9
 of vapors, 4-14
 Constant-temperature expansion:
 of gases, 4-9
 of vapors, 4-14
 Constant-velocity joints, 8-36
 Constant-volume expansion:
 of gases, 4-9
 of vapors, 4-14
 Constrained beams, 5-32
 Construction (*see* Building construction)
 Constructions, geometrical, 2-5 to 2-7
 Containerization, packaging for, 10-23
 Containers, 11-134
 condensation in, 11-134
 freight cars for, 11-28
 handling equipment for, 11-135
 owners of, 11-135
 refrigerated, 11-134, 11-135
 ships for, 11-59
 sizes of, 11-134
 specifications for, 11-134
 terminals for, 11-135
 types of, 11-134
 Contaminants:
 in drinking water: limits of (table), 6-170
 in water: removal processes for (table), 18-6
 Continuity equation (in fluid flow), 3-37, 4-20
 Continuous beams, 5-32
 Contour lines (maps, def), 16-55
 Contour mapping (surveying), 16-55
 Contracts, 12-17
 Control:
 automatic (*see* Automatic control)
 of material flow, 10-62
 Control action (automatic control, def), 16-22
 Control charts (quality control), 17-24
 Control systems:
 adaptive (def), 16-22
 hydraulic, 16-30
 Controllable-pitch propellers:
 airplane, 11-98
 marine, 11-54
 Controllers: Bode plots for, 16-37
 Convection:
 coefficients of, 4-83
 and conduction, 4-80
 heat transmission by, 4-86
 natural, 4-86
 Convers-Labarre method (pile spacing), 12-27

- Conversion, of mass to energy, **9-134**
- Conversion equations, for kinematic viscosity, **3-33**
- Conversion tables:
 for accelerations, **1-32, 1-33**
 for angular measure: decimals of degrees, minutes, and seconds, **1-15**
 velocity, **1-32**
 for areas, **1-30**
 for conductance, thermal, **1-34**
 for conductivity, thermal, **1-34**
 for density, **1-26, 1-27, 1-34**
 for energy, **1-33**
 for flow of heat, **1-34**
 for heat, **1-33**
 for length, **1-16, 1-28, 1-29**
 for mass, **1-31**
 for power, **1-34**
 for pressure, **1-32**
 for specific gravity and density, degrees API and Baumé, **1-26, 1-27**
 for velocity, **1-32**
 for volume, **1-16, 1-30, 1-31**
 for weight, **1-31**
 for work, **1-33**
- Converters:
 analog-to-digital, **15-78**
 digital-to-analog, **15-78**
 phase, **15-39**
 synchronous, **15-42**
 switchboard equipment for, **15-46**
- Conveying:
 bucket, **10-45**
 (*See also* Conveyors, bucket)
 cableways, **10-30**
 (*See also* Cableways; Conveyors)
- Conveyors:
 apron, **10-44**
 table, **10-45**
 in assembly operations, **10-37**
 belt, **10-47**
 arrangements, **10-47, 10-52**
 belts for, **10-48**
 capacities of (table), **10-50**
 changing direction of materials on, **10-54**
 diverters for, **10-55**
 drive calculations, **10-51**
 drives for, **10-49**
 electromagnetic separators for, **10-51**
 feeders, **10-52**
 horsepower required for, **10-49**
 idler pulleys for, **10-48**
 intersections for, **10-55**
 life of, **10-48**
 magnetic pulleys for, **10-51**
 maximum slope (table), **10-49**
 portable, **10-52**
 pulleys for, **10-48, 10-51**
 sectional, **10-52**
 shuttle, **10-52**
 sliding, **10-52**
 slope for various materials (table), **10-49**
 speed (table), **10-51**
 take-ups, **10-49**
 trippers, **10-49, 10-51**
 width required for lumps (table), **10-51**
- bucket, **10-45**
 open-top, **10-45**
 Peck carrier, **10-46**
 pivoted, **10-45**
 capacities (table), **10-46**
 V-bucket, **10-45**
 capacities and weights (table), **10-45**
- Bulk flo, **10-41**
 carrying, **10-45**
 continuous-flow, **10-41**
 drag-chain, **10-40**
- Conveyors (*Cont.*):
 drives for, **10-49**
 feeders for, **10-52**
 flight, **10-40**
 arrangements for, **10-42**
 scraper type, **10-40**
 suspended-chain type of, **10-40**
 suspended-flight type of, **10-40**
 gravity roller, **10-52**
 hydraulic, **10-54**
 noncarrying, **10-40**
 oscillating, **10-52**
 overhead, **10-35**
 components of, **10-37, 10-39**
 control, **10-39**
 drop-lift, **10-40**
 power-and-free, **10-38, 10-39**
 powered, **10-35**
 safety guards, **10-38**
 switching, **10-38, 10-39**
 controls, **10-39**
 track for, **10-37**
 transfer devices, **10-38**
 trolleys, **10-37**
 turns, **10-37**
 for plant uses (table), **10-36**
 platform, **10-53**
 pneumatic, **10-53**
 reciprocating plate feeder for, **10-52**
 Redler, **10-41**
 ribbon, **10-42**
 roller, **10-52**
 runaround, **10-41**
 scraper, **10-40**
 screw, **10-42**
 cut-flight, **10-42**
 paddle, **10-42**
 power required, **10-43**
 short-pitch, **10-42**
 speeds and capacities (tables), **10-43**
 variable-pitch, **10-42**
 spiral, **10-42**
 speeds and capacities of (table), **10-43**
 suction for, **10-53**
 trolley, **10-35**
 vertical, **10-40**
 vertical interfloor, **10-40**
 vibrating feeders for, **10-52**
 wheel, **10-53**
- Convolution: of functions (def), **2-36**
- Convolution integrals (vibration), **3-69**
- Coolants (cutting fluids), **13-50**
- Coolers:
 for air conditioning systems, **12-91**
 brine, **19-18**
 capacity of (table), **19-19**
 heat-transfer coefficients (table), **19-24**
- Cooling:
 effect of throttling, **4-24**
 of internal-combustion engines, **9-117**
 thermoelectric, **19-17**
- Cooling ponds, **9-86**
 for thermal pollution reduction, **17-35**
- Cooling sprays, **9-86**
- Cooling towers, **4-18, 9-84**
 for air conditioning systems, **12-92**
 approach (def), **9-84**
 cooling range of (def), **9-84**
 corrosion in, **6-107**
 cost evaluation, **9-85**
 drift in, **9-84**
 dry, **9-86**
 height of, **9-85**
 hyperbolic, **9-85**
 induced-draft, **9-85**
 makeup for, **9-84**
 materials for, **9-85**
- Cooling towers (*Cont.*):
 mechanical-draft in, **9-85**
 performance calculations for, **9-85**
 performance of (curve), **9-85**
 for thermal pollution reduction, **17-35**
 wet-bulb temperatures (map), **9-84**
 where used, **18-5**
- Cooling water systems, corrosion in, **6-107**
- Coordinates:
 polar, **2-19**
 rectangular, **2-18**
 transformation of, **2-19**
- COP (coefficient of performance, def), **19-2**
- Copes (molding), **13-5**
- Copper, **6-65**
 alloys (*see* Copper alloys)
 for bus bars, **15-45**
 cable, resistance and reactance of (table), **15-48, 15-52**
 conductors, current-carrying capacities (table), **15-57**
 oxygen-free, **6-67**
 resistivity of, **15-4**
 tough-pitch, **6-67**
 tubing, **8-191**
 welding of, **6-73, 13-45**
- Copper alloys, **6-67**
 for bearings, **6-61**
 table, **6-61**
 brazing of, **6-73**
 castings, composition and properties of (table), **6-71**
 distribution of (table), **6-70**
 classification of, **6-65**
 table, **6-65**
 copper-aluminum, plastic range chart for, **13-10**
 for copper-base castings, **6-70**
 properties of (table), **6-71**
 copper-nickel (tables), **6-68**
 copper-silicon (tables), **6-68**
 copper-tin, **6-67**
 copper-zinc, **6-67**
 corrosion resistance of, **6-73**
 effects of temperature on, **6-72**
 electrical conductivities of, **6-72**
 for electrical conductors (tables), **6-67, 15-4** to **15-6**
 extruded, **6-70**
 fabrication of, **6-73**
 heat treating of, **6-70**
 machining of, **6-67, 6-73**
 mechanical properties of, **6-70**
 processing of, **6-70**
 soldering of, **6-73**
 fluxes for, **6-73**
 strength of (tables), **6-68**
 temper designation codes for (table), **6-66**
 thermal conductivities of, **6-72**
 turning of, **6-73**
 welding of, **6-73, 13-45**
 wrought, composition and properties of (table), **6-68**
 (*See also* Brass; Bronze)
- Copper-nickels, **6-67**
- Copper pipe, **8-191**
- Copper tubing, **8-191**
- Copper wire:
 alloys for (table), **6-68**
 ASTM specifications for (table), **6-67**
 insulation for, **15-57**
 reactance (tables), **15-48, 15-52**
 resistance (tables), **15-5, 15-6, 15-48, 15-52, 15-56**
 temperature coefficient of, **15-4**
 weight (table), **15-5**
- Coppers, **6-65, 6-67**
- Copperweld (electrical conductor), **15-6**

- Copy (printing):
 fitting, 19-43
 preparation of, 19-43
- Copyrights, 18-30
- Cord (lumber measure, def), 1-16, 7-9
- Cordage, 6-137
- Core binders, 13-6
- Core blowers, 13-6
- Core boxes, 13-2
- Core driers, 13-6
- Core molding, 13-3
- Core ovens, 13-6
- Core sands, 13-6
- Coremaking methods, 13-6
- Cores (def), 13-2
- Coriolis acceleration, 3-13
- Cork, specific gravity and density of (table), 6-7
- Corkscrew rule (magnetism), 15-11
- Corner test (statistics), 17-21
- Corona (electrical discharge), 15-50
- Corporation, annual reports for, 17-12
- Corrosion, 6-95
 with anodic protection, 6-105
 in boilers, 9-49
 cathodic inhibitors for, 6-105
 with cathodic protection, 6-105
 caustic, 6-101
 as caustic gouging, 6-101
 by cavitation, 6-102
 chemical, 6-95
 coatings for, 6-104
 conversion coatings, 6-104
 crevice, 6-99
 by dealloying, 6-101
 by dezincification, 6-101
 as ductile gouging, 6-101
 economic impact of, 6-95
 effects of galvanic metals on, 6-99
 effects on safety, 6-95
 electrochemical, 6-95
 Ellingham diagrams for, 6-96
 by environmentally induced cracking, 6-102
 erosion (def), 6-101
 factors influencing, 6-97
 cold-working, 6-97
 concentration cells, 6-98
 dissimilar electrodes, 6-98
 environment, 6-97
 freshwater, 6-97
 hard water, 6-97
 heat treatment, 6-97
 high-purity water, 6-97
 inclusions, 6-97
 microfouling organisms, 6-98
 residual stresses, 6-97
 seawater, 6-98
 soft water, 6-97
 soil corrosivity, 6-98
 soil resistivity, 6-98
 sulfate-reducing bacteria, 6-98
 temperature, 6-98
 thermal cycling, 6-98
 thermogalvanic cells, 6-98
 time of wetness, 6-98
 welding, 6-97
 fatigue, 6-102
 feedwater treatment against, 6-105, 6-106
 galvanic, 6-99
 Gibbs free energy in, 6-95
 graphite, 6-101
 with graphitization, 6-101
 of gray cast iron, 6-101
 high-temperature, 6-103
 hydrogen embrittlement in, 6-102
 hydrogen evolution reaction (HER) in, 6-95
 hydrogen interactions in, 6-102
 by impingement attack, 6-102
- Corrosion (*Cont.*):
 inhibitors, 6-104
 intergranular, 6-101
 kinetics of, 6-96
 activation polarization in, 6-96
 active/passive metals in, 6-96
 equilibrium potential in, 6-96
 mixed polarization in, 6-96
 passive films in, 6-96
 6-97
 passivity in, 6-97
 polarization in, 6-96
 protective films in, 6-97
 resistance polarization in, 6-96
 as knife-line attack, 6-101
 liquid-metal embrittlement in, 6-102
 microbiologically influenced, 6-98
 Nernst equation for, 6-95
 nonabsorbent gaskets to prevent, 6-100
 organic inhibitors for, 6-105
 oxygen scavengers in, 6-106
 passivators, 6-104
 as pitting, 6-100
 pitting factors for, 6-100
 potential-pH plots in, 6-95
 Pourbaix diagrams for, 6-95
 precipitators for, 6-105
 prevention of, 6-104
 protective coatings against, 6-104
 solid-metal-induced embrittlement in, 6-102
 in steam-generating systems, 6-105
 in steam turbines, 6-016
 by stray-current electrolysis, 6-99
 by stray-currents, 6-99
 stress, cracking, 6-102
 as surface carburization, 6-101
 testing, 6-103
 using corrosion coupons for, 6-103
 electrochemical techniques for, 6-103
 standardized methods for, 6-103
 thermodynamics of, 6-95
 as uniform attack, 6-99
 as wick boiling, 6-101
- Corrosion coupons, 6-103
- Corrosion fatigue of metals, 5-9
- Corrosion precipitators, 6-105
- Corrugated paper, 6-144
- Corrugated sheets, for building walls, 12-25, 12-43
- Corundum (abrasive), 6-129
- Cosecant (trigonometry), 2-15
- Cosine (trigonometry), 2-15
- Cosines, law of, 2-17
- Cost accounting, 17-11
 accrual basis, 17-12
 activity based, 17-15
 break-even, 17-17
 budgeting control systems in, 17-16
 cash basis, 17-12
 cost management by, 17-18
 direct costing methods for, 17-18
 factory overheads in, 17-12, 17-14
 labor, 17-14
 materials, 17-14
 methods of, 17-14
 process cost method of, 17-14
 for product costing, 17-12
 purposes of, 17-11
 standard costs, 17-16, 17-17
 transaction costing in, 17-15
 transfer pricing by, 17-17
 types of systems for, 17-16
- Cost analysis, 17-17
- Costs:
 elements of, 17-12
 fixed, characteristics of, 17-12
 of labor, 17-14
- Costs (*Cont.*):
 of materials, 17-14
 variable, characteristics of, 17-12
- Cotangent (trigonometry), 2-15
- Cotter pins, 8-33
- Cotton, mercerized, 6-140
- Cotton fibers (tables), 6-141
- Coulomb (def), 15-2
- Counters (event measurement), 16-2
 electric, 16-3
 electronic, 15-81
 mechanical, 16-2
 pickups for, 16-3
- Counterweights for elevators, 10-18
- Couple (mechanics, def), 3-3
- Couples:
 composition of, 3-4
 displacement of, 3-3
 moment of, 3-3
 rotation moments of, 3-3
- Coupling coefficient (electric circuits), 15-17
- Couplings:
 clutch (*see* Clutches)
 compression, 8-34
 constant velocity, 8-36
 fire-hose: ANSI (table), 8-214
 screw threads for, 8-214
 flanged-face, 8-34
 flexible, 8-34
 chain, 8-35
 Falk Steelflex, 8-35
 Fast, 8-35
 Oldham, 8-35
 Waldron, 8-35
 fluid, 8-36
 for automobiles, 11-6
 torque capacity (eq), 8-36
 torque converter, 8-37
 ribbed clamp, 8-34
 rigid, 8-34
 rubber, 8-35
 sleeve (pipe), 8-185
 slider, double, 8-35
 universal, Hooke's joint, 8-36
- CPM (critical path method), 17-5
- CPU (central processing unit), 15-82
- Cracked gasoline, 7-12
- Cramer equation for pollution calculations, 18-14
- Cranes:
 capacities of (table), 10-28, 10-30
 derricks, 10-27, 10-29
 efficiency of, 3-26
 gantry, 10-27
 hand-power, 10-27
 hooks, 10-7
 industrial (table), 10-28
 jib, 10-27
 locomotive, 10-27, 10-29
 motors for, 15-44
 overhead, 10-26
 special purpose, 10-27
 power shovels as, 10-33
 rotary, 10-27
 telescoping boom, 10-33
 traveling, 10-26
 electric, 10-27
 truck, 10-29
- Crank mechanism, 8-3
- Crankshafts, 8-47, 8-50
 flywheels for, 8-65
 forces and torques on, 8-65
 (*See also* Shafts)
- Creep (def), 13-9
 of low-chromium steel (table), 5-11
 of metals (def), 5-10, 6-77
 testing, 5-10
 of zinc and zinc alloys, 6-94

- Creep rates:
of iron (table), 5-11
of metals and alloys (table), 5-11
of steel (table, chart), 5-10, 5-11
- Crescent beams, 5-42
- Critical cooling rate (steel), 6-18
- Critical damping resistance, 15-17
- Critical data for various gases (tables), 4-50, 4-58
- Critical flow pressure, in gas or vapor flow, 4-21
- Critical path method of scheduling, 12-18, 17-5
- Critical points:
of the elements (table), 4-58
of various substances (table), 4-50
- Critical pressure (def), 4-13
- Critical speed, 3-66
- Critical state for gases (tables), 4-50, 4-58
- Critical temperature (def), 4-13
- Critical temperatures:
of the elements (table), 4-58
of iron (def, chart), 6-16
of various substances (table), 4-50
- Crocus (abrasive), 6-129
- Cross product (mathematics, def), 2-11
- Crossover frequency (control theory), 17-41
- Crowding (metalworking), 13-15
- Crushed steel (abrasive), 6-128
- Cryogenic refrigerators, 19-27
- Cryogenics, 19-26
applications of, 19-29
cryogen hazards, 19-40
definition of, 19-27
equipment materials, 19-32, 19-38
stress analysis, 19-41
gas liquefaction for, 19-29
instruments for, 19-37
insulation for, 19-38
selection of, 19-40
level measurements, 19-37
by capacitance gage, 19-37
by weighing, 19-37
steels for service in, 6-28
temperature measurements, 19-38
vent systems for, 19-40
- Cryogens:
burns from, 19-41
compressibility of, 19-36
liquid density, quantum-mechanical correlation, 19-35
properties of (table), 19-34
specific heat (chart), 19-37
thermal conductivity, 19-37
thermal-expansion coefficient, 19-36
vapor pressure (chart), 19-36
viscosity, 19-37
volumetric latent heats (table), 19-34
- Crystalline alumina (abrasive), 6-128
- Crystolon (abrasive), 6-128
- Crystoplastic (def), 13-9
- Cubic measure, conversion tables, 1-30, 1-31
- Cubical expansion, coefficient of (def), 4-2
- Cupolas, 13-7
- Cupronickel, 6-67
tables, 6-68
- Curl, vector, 2-34
- Current regulators (automobiles), 15-66
- Current transformers, 15-23
- Currents:
alternating, 15-18
active or energy (def), 15-18
circuits (*see* Circuits, alternating-current)
reactive or wattless (def), 15-18
waves: average value, 15-18
effective value, 15-18
form factor, 15-18
- Currents, alternating, waves (*Cont.*):
phasor representation, 15-18
vector representation, 15-18
electric, unit of (def), 15-2
heat developed by, 15-8
wattless, 15-18
(*See also* Circuits; Electric motors)
- Curvature, radius and center of, 2-26
- Curve resistance (train), 11-39
- Curved beams, 5-42
eccentrically curved (table), 5-42
- Curves, railway, radii of, 11-38
- Curvilinear motion, 3-11, 3-12
- Cut and fill:
defining limits of, 16-58
determining land area for, 16-57
establishing boundaries for, 16-57
- Cutters:
circular, 13-16
milling, 13-57
- Cutting:
with laser beams, 13-30
thermal, 13-31
oxyfuel, 13-31
plasma arc, 13-31
(*See also* Metal cutting)
- Cutting fluids (machining), 13-50
- Cutting-off machines (metals), 13-61
- Cutting oils, 6-184
- Cutting processes, 13-31
gears, 13-59
- Cutting tools:
action of, 13-46
applications of, materials for (table), 13-49
back rake of, 13-52
broaches, 13-60
carbide, 13-49
ceramic, 13-50
chip formation by, 13-46
cutting angle of, 13-46
cutting ratios for, 13-46
diamond, 13-50
drills, troubleshooting of (table), 13-54
fluids for, 13-50
hardness vs. temperature (chart), 13-48
for lathes: life of, 13-47
power requirements of, 13-47
shapes for, 13-52
troubleshooting of (table), 13-54
materials for, 13-48
characteristics of (tables), 13-48, 13-49
milling machines, 13-57
feeds and speeds for (table), 13-58
troubleshooting of (table), 13-58
nomenclature of, 13-46, 13-52
nonferrous, 13-49
nose radius of, 13-52
planers, 13-60
rake angle of, 13-46, 13-52
reamers, 13-57
relief angle of, 13-46, 13-52
shapers, 13-60
shapes of, 13-52
shear angles for, 13-46
shear plane of, 13-46
shear strain in, 13-46
side-cutting edge angle, 13-52
side rake of, 13-52
steel, 13-48, 13-49
surface finish by, 13-48
threading, 13-57
tool condition monitoring, 13-47
tool temperatures in, 13-47
tungsten carbide, 13-49
classification of (table), 13-49
wear of, 13-47
- Cutting tools (*Cont.*):
wear notches in, 13-47
wood, 13-72
(*See also* Machine tools)
- Cyaniding (heat-treatment), 6-21
- Cycle:
alternating-current (def), 15-18
ideal gas, 4-10
for perfect gases, 4-10
steam, 4-19
bleeding, 4-19
Rankine, 4-19
reheating, 4-19
- Cycloid, 2-22
- Cyclone furnaces, 9-35
- Cyclone separators, 18-10
for dust exhaust systems, 18-10
- Cylinder-boring machines, 13-55
- Cylinder grinders, 13-64
- Cylinders:
air resistance of (table), 11-68
of automobile engines, 9-111
collapsing pressure, 5-45
hollow, volume of, 2-8
of internal-combustion engines, 9-111
oval hollow, strength of, 5-47
rolling down a plane, 3-16
shrink-fit effects, 5-46
of steam engines, jackets, effect on economy, 9-55
stiffening rings for, 5-45
surface and volume of, 2-8
thick-walled, 5-46
thin-walled, 5-45
- Dacron rope, 6-137
- D'Alembert forces (def), 8-65
- Dalton's law for gases, 4-9, 4-15
- Dampers, viscous, 3-61
- Damping:
in automatic control (def), 16-22
critical, 3-63
friction, 3-21
hysteretic, 3-66
structural, 3-66
of vibrations, 3-62, 3-66
viscous (automatic control), 16-24
- Damping ratio (automatic control, def), 16-24
- Darcy formula in pipeline flow, 11-131
- Darlington connection (electronic circuit), 15-71, 15-73
- Darrieus wind rotor, 9-5, 9-7
- D'Arsonval galvanometer, 15-20
- Dashpot, 3-61
- Data, coding of, for electronic transmission, 16-20
- Data-flow diagrams, 2-50
- Data logging, 16-19
systems for, 16-20
- Data Matrix (bar code), 10-67
- Databases, for computers, 2-49
- Day:
definitions of, 1-25
lengths of, sidereal, solar, and stellar, 11-101
- Dead-weight gage tester, 16-9
- Deaeration: of feedwater, 9-49, 9-89
- Deaerators, 9-89
- Decibel (sound, def), 12-117
- Decimal equivalents (table), 1-15
- Decision making, 17-7
cost accounting to support, 17-18
under certainty, 17-7
under uncertainty, 17-7
- Declination, solar, annual variation (table), 9-12
- Dedendum (gear teeth), 8-88
- Definite integrals, 2-29

- Deflection:
 angular, under torsion (table), 5-37
 of beams (*see* Beams, deflection of)
- Deformants, in engine oil, 6-182
- Deformation (def), 5-15
 plastic flow theory, 5-50
 of spheres and cylinders under compression, 5-45
- Degrees:
 API (table), 1-26
 Baumé (table), 1-27
- Dehumidification of air, 4-17
 (*See also* Air conditioning)
- Delco-Remy distributors, 15-66
- Delta connections, three-phase circuits, 15-20
- Delta iron (def), 6-16
- Demand factor of buildings (electric power), 15-61
- Demodulation of radio waves, 15-74
- De Morgan's theorem (Boolean algebra), 15-80
- Denier (unit of fineness of fibers), 6-140
- Density (def), 1-26
 of air (formula), 14-45
 conversion table, 1-34
 equivalents (table), 1-34
 of metals (table), 6-7, 6-11, 6-50
 of various substances (table), 6-7
 of water (table), 6-8, 6-10
- Depreciation of power equipment, 17-36
- Derivative compensation (automatic control), 16-25
- Derivatives:
 calculus, 2-24, 2-25
 partial, 2-25
- Derricks, 10-29
- Design stresses (mechanics), 5-20
- Desktop publishing, 2-54
- Destec coal-gasifier unit, 7-39
- Detergents, 6-137
- Determinants, 2-13
- Detonation (knock), 7-12
 (*See also* Knock)
- Deuterium as cryogen, 19-34
- Deviation, in automatic control (def), 16-22
- Dew point, 4-15, 12-87
- Dew point method of humidity measurement, 4-15
- Dewpoint recorders, 16-18
- Dextrin baked cores, 13-6
- Diametral pitch (gears, def), 8-88
- Diamond (abrasive), 6-128, 6-129, 13-62
- Diamond cutting tools, 13-50
- Diamond-pyramid hardness (def), 5-13
- Diaphragm gages, 16-8
- Diaphragms to replace packing, 8-142
- Diatomaceous silica (abrasive), 6-129
- Die blocks:
 materials for, 13-20
 proportions of, 13-20
- Die casting, 13-4
 alloys for, zinc-base (table), 6-94
 machines for, 13-4
- Dielectric (def), 15-15
- Dielectric circuit, 15-15
- Dielectric constant (def), 15-2
 of insulating materials (table), 15-16
- Dielectric heating, 7-55, 15-87
- Dielectrics, 15-15, 15-16
- Dieline (refrigerant), 19-7
- Dies:
 clearances required in, 13-15
 resistance to shearing in (table), 13-15
 threading, 13-57
- Diesel cycle, 4-11, 9-90
- Diesel-electric drives:
 locomotive, 11-20
 table, 11-21
- Diesel engines:
 analysis of engine process, 9-91
 combustion chambers, 9-113
 cooling systems for, 9-117
 cycle for, 4-11, 9-90
 efficiency of: indicated, 9-91
 theoretical, 9-91
 volumetric, 9-92
 emissions control strategies, 9-122
 exhaust-gas analysis of (table), 9-94
 exhaust temperatures, 9-94
 exhaust treatments, 9-122
 fuel injection in, 9-110
 nozzles for, 9-111
 fuel lines for, 9-111
 fuel sprays, 9-111
 fuels for, 9-104
 table, 9-104
 (*See also* Diesel fuels)
 governing of, 9-117
 intake manifolds for, 9-106
 locomotive (*see* Locomotives, diesel-electric)
 lubrication of, 6-183
 marine, 9-99
 data on (tables), 9-98, 9-99
 medium-size (table), 9-101
 pollution from, 18-10
 pump injection, 9-110
 stationary, 9-99
 data on (table), 9-98
 supercharging, 9-106
 for tractors, 9-98
 for trucks and buses, 9-97
- Diesel fuels, 7-12, 7-13, 9-116
 additives, 7-14
 distillation curves, 7-11
 grades, 7-13
 specifications for (table), 7-14
- Differential calculus, 2-24 to 2-26
- Differential chain block, 8-8
- Differential equations:
 homogeneous, 2-32
 Laplace transforms, 2-35
 partial, 2-34
 solutions of, 2-31, 2-34
- Differential transformer pick-ups, 3-79
- Differentials:
 in automobiles, 11-10
 calculus, 2-24
- Differentiation: rules for, 2-24
- Digital-to-analog converters, 16-20
- Dihedral (def), 11-71
- Dimensional analysis, 3-44 to 3-46
 theorems, 3-44
- Dimensionless numbers, 3-41 to 3-43
- Dimensions:
 of common variables (table), 3-45
 of a quantity (def), 3-44
- Dings lifting magnets, 10-11
- Dings magnetic separators, 10-51
- Diode (electronics), 15-68
 free-wheeling, 15-71
- Dip brazing, 13-29
- Dipole function, 2-36
- Dirac delta function, 2-36
- Direct-current circuits, wiring calculations for, 15-53
 (*see* Generators, direct-current)
- Direct-current instruments, 15-20
- Direct energy conversion:
 fuel cells, 9-25
 notable surface of action in, 9-25
 magnetohydrodynamic generation, 9-26
 photovoltaic generation, 9-26
- Direct energy conversion (*Cont.*):
 thermionic generation, 9-24
 Fermi level, 9-25
 work-function barrier, 9-25
 thermoelectric generation, 9-24
 figure of merit for, 9-24
- Direct view factors (radiation, def), 4-63
- Directrix:
 of catenary, 2-21
 of ellipse, 2-20
 of hyperbola, 2-20
 of parabola, 2-19
- Discharge coefficients for flow of liquids, 3-54, 3-56, 3-58
- Discounted cash flow, 17-18
- Disk brakes, 8-42, 11-15
- Disk clutches, 8-38, 11-6
- Disk wheels, steam turbine, 5-51
- Disks:
 air resistance of (table), 11-68
 computer, 2-45, 15-83
 controllers for, 15-83
 nutating, liquid-meter, 16-7
 rotating: with central hole, 5-50
 with noncentral hole, 5-51
- Dispersants: in engine oil, 6-182
- Dispersion (optical), 19-41
- Displacement:
 motions, 3-10
 of ships (def), 11-41
- Displays (radar), 15-88
- Dissociation:
 in combustion of gases, 4-29
 of gaseous fuels and explosion temperatures (table), 4-29
- Distance:
 measurement of, 16-4
 analytic geometry formulas for, 2-19
 in surveying, 16-50, 16-51, 16-55
- Distillation of crude oils (chart), 7-11
- Distribution systems, electric (*see* Electric power distribution)
- Distributions (probability), 2-10, 2-11
- Distributors (electric ignition), 15-66
- Disturbance (automatic control, def), 16-22
- Divergence:
 of nozzles for steam flow, 4-23
 vector, 2-34
- Divergence theorem, 2-35
- Diversers, for belt conveyors, 10-55
- DMA (direct memory access) controller, 15-83
- Docks, loading, design of, 10-73
- Dodecahedron, 2-9
- Dolomite, composition of, 6-152
- Domain (algebra, def), 2-3
- Domestic refrigerating machines, 19-16
- Doors, coefficients of heat transmission through (table), 12-70
 for industrial plants, 12-15
- Dot product (mathematics, def), 2-11
- Draft:
 forced, 9-46
 induced, 9-46
 natural, 9-46
 of ships (def), 11-42
 stack effect (table), 9-47
- Draft loss (def), 9-46
- Draft tubes (hydraulic turbines), 9-155
- Drafting, geometrical constructions in, 2-6
- Drag (aerodynamics):
 coefficients of, for various bodies, 11-67
 of floats, 11-69
 of fuselage, 11-69
 in hydraulics, 3-47
 induced, 11-61, 11-62
 interference, 11-70

- Drag (*Cont.*):
of nacelles, **11-69**
parasite, **11-66**
profile, **11-62, 11-69**
supersonic (*see* Supersonic and hypersonic aerodynamics)
of tail surfaces, **11-69**
of various bodies (table), **11-68**
of wings, **11-62, 11-69**
- Drag coefficients (table), **11-68**
- Drag forces, **11-66**
- Drag-free satellites, **11-111**
- Drag-link mechanisms, **8-3**
- Dragline buckets:
scraper, **10-11**
self-filling, **10-11**
- Dragline excavators, **10-22, 10-33, 10-34**
- Drags (molding), **13-5**
- Drain pipe (table), **8-194**
- Drainage fittings, threaded (table), **8-205**
- Dram or drachm:
apothecaries' liquid measure (def), **1-16**
apothecaries' weight (def), **1-17**
avoirdupois weight (def), **1-17**
- Drawbar horsepower, of locomotives, **11-24**
- Drawing of metals, **13-16**
pressure in, **13-17**
various shapes, **13-18**
work done in, **13-18**
- Dredges:
diesel, **10-34**
digging ladders for, **10-33, 10-34**
elevator, **10-34**
hydraulic, **10-34**
placer, **10-33**
- Driers, for paint, **6-108**
(*See also* Evaporators)
- Drift bolts, pulling resistance of, **12-33**
- Drilling:
of plastics, **13-65**
sonic, **12-122**
various metals (table), **13-56**
- Drilling machines, **13-55**
sizes of, **13-55**
- Drills:
for pipe taps (table), **8-20**
sizes of (table), **8-86**
tap, sizes of (table), **8-30**
troubleshooting of (table), **13-56**
twist, **13-55**
sizes of (table), **8-86**
- Drop-forge dies, **13-19**
- Drop forging, **13-19**
- Drop hammers, **13-19, 13-22**
- Drop presses, **13-22**
- Drop-weight test, **5-7**
- Dropping point (greases), **6-180**
- Drums:
for hoisting: rope for, **10-8**
for wire rope, minimum groove dimensions for (table), **8-80**
ratios for, **8-79**
- Dry batteries (*see* Batteries, dry)
- Dry-bulb temperature (def), **4-15, 12-87**
- Dry cells, **15-11**
- Dry ice (solid carbon dioxide), **19-25**
- Dry measure, **1-16**
- DSP (digital signal processor), **15-85**
- Dual (linear programming), **17-9**
- Dual-fuel engines, **9-90**
advantages, **9-90**
- Ductile cast iron (def), **6-13, 6-38, 6-39**
- Ducts:
air friction in (charts), **12-88, 12-89**
air velocities in (table), **12-89**
- Ducts (*Cont.*):
design of, **12-88**
equal friction method for, **12-88**
static regain method for, **12-88**
noise in, **12-90**
pressure loss in, **12-88**
return face velocities (table), **12-89**
- Dulong and Petit's rule (specific heat), **4-3**
- Dulong's formula (calorific value of coal), **7-6**
- Dumbwaiters, **10-19**
- Dumpers (earth moving), **10-26**
- Duralumin, creep rates for, **5-10**
- Dust (def), **7-22, 18-8, 18-10**
explosive, characteristics of (table), **7-23**
removal of: by electrostatic collectors, **9-32**
by mechanical separators, **9-32**
screen scale for (table), **18-11**
size of particles in, **18-8, 18-10**
velocity of settling (chart), **18-9**
- Dust collectors, **9-32**
- Dust explosions:
building design to prevent, **7-27**
characteristics of (table), **7-23**
composition of atmosphere and dust in, **7-22**
concentration of dust in, **7-26**
definition of, **7-22**
effects of inerts on, **7-25**
explosibility index of (def), **7-26**
factors affecting, **7-22, 7-27**
fineness of dust in, **7-22**
ignition sources, **7-22, 7-27**
ignition temperatures for, **7-26**
inerted atmosphere to prevent, **7-27**
maximum pressure in, **7-26**
minimum concentrations for, **7-26**
minimum energy to ignite, **7-26**
oxygen concentrations for, **7-25**
particles in, sizes of, **7-22**
surface area of, **7-22**
pressure-rise rates, **7-26**
prevention of, **7-27**
relative hazards, **7-26**
relief venting for, **7-27**
turbulence in, **7-22**
of various materials (table), **7-23**
- Dynamic balance, **3-67**
- Dynamic braking:
of locomotives, **11-23, 11-26**
of transit cars, **11-35, 11-37**
- Dynamic electricity (def), **15-15**
- Dynamic similarity (models), **3-41**
- Dynamic unbalance (def), **3-67**
- Dynamics, **3-14 to 3-17**
of fluids, **3-37 to 3-41**
- Dynamites, **7-20**
ammonia, **7-20**
ammonia gelatin, **7-20**
gelatin, **7-20**
straight, **7-20**
- Dynamometers, **16-15**
- Dyne (def), **1-24**
- E transformer, **16-5, 16-6**
- Earth:
mass of, **11-101**
moment of inertia of, **11-101**
orbital speed of, **11-101**
packed and loose, specific gravity and density of (table), **6-8**
planetary constants for (tables), **11-101, 11-103**
- Earthmoving equipment, **10-24**
- Earthquake forces in buildings, **12-18**
- Earthquakes, **12-51**
design for, **12-51**
- EBM (electron-beam machining), **13-67**
- Eccentric angle in ellipse, **2-20**
- Eccentric loads:
on circular rings, **5-40**
on cylinders, **5-40**
on short blocks, **5-40**
on various cross sections, **5-40**
- Eccentricity:
of ellipse, **2-20**
of hyperbola, **2-20**
- ECDG (electrochemical discharge grinding), **13-66**
- ECG (electrochemical grinding), **13-66**
- Ecology (def), **18-2**
(*See also* Environmental control)
- Economic lot size, **17-6**
- Economics, industrial, **17-2**
- Economizers, **9-43**
corrosion in, **9-43**
size of, **9-43**
types of, **9-43**
- Ecosystems, **18-2**
- Eddy-current brakes, **8-42, 16-15**
- Eddy-current losses, **15-11**
- Eddy-current testing of materials, **5-66**
- EDG (electric-discharge grinding), **13-66**
- Edison storage cell, **15-13, 15-14**
- EDM (electric-discharge machining), **13-65**
(electronic distance meter), **16-51**
- EDS (Exxon donor solvent), **7-18**
- EER (energy efficiency ratio, def), **19-2**
- Effective temperatures (wind chill, table), **12-62**
- Efficiency:
of Carnot cycle, **4-6**
of machine elements (table), **3-26**
- Eigenvalues, **2-14**
- Eigenvectors, **2-14**
- Ejectors:
air (*see* Air ejectors)
high-vacuum, **14-39**
table, **14-40**
- Elastic constants of metals (table), **5-4**
- Elastic limit (def), **5-2, 5-17**
in flexure, **5-27**
proportional (def), **5-2**
- Elastic solid (def), **3-30**
- Elasticity (def), **5-17**
modulus of (def), **5-17**
for metals (tables), **5-4, 6-50**
theory of, **5-44**
- Elastomers (rubberlike substances), **6-146**
comparative properties of (table), **6-147**
properties of, at low temperatures, **19-34**
- Electric apparatus:
efficiency calculations, **15-43**
rating, **15-43**
symbols for, **15-7**
temperature limits, **15-43**
(*See also* Electric instruments)
- Electric-arc welding (*see* Welding)
- Electric brakes, **8-43**
- Electric circuits (*see* Circuits)
- Electric conductivity, **15-2**
- Electric current (*see* Current)
- Electric-discharge machining of metals, **13-66**
- Electric energy:
measurement of, **15-23**
units of (def), **15-2**
- Electric equipment, safety devices for, **18-20**
- Electric-furnace steel (def), **6-13**
- Electric furnaces:
arc, **7-55**
arcs in, **7-56**
charges, **7-56**
electrode consumption, **7-59**

- Electric furnaces, arc (*Cont.*):
 rating and sizes of (table), 7-56
 reactance, 7-57
 refractories for, 7-55
 regulation characteristics of (chart), 7-57
 single-phase, 7-57
 submerged-arc, 7-59
 temperature in, 7-56
 three-phase, 7-55
- atmosphere: artificial, 7-53
 natural, 7-52
- dielectric heating, 7-55
- energy consumption of (table), 7-59
- high-temperature, resistors for, 7-53
- induction, 7-52, 7-57
 core-type, 7-58
 coreless, 7-57
 frequency for, 7-58
 operation, 7-57
 sizes of (table), 7-58
- induction heating for, 7-55
- power requirements for (table), 7-58
- for refining steel, 6-14
- resistance, 7-52, 7-59
 with fixed or movable electrodes, 7-59
 uses of, 7-59
- resistor, 7-52
 bath heating, 7-53
 heating chamber, 7-52
 high-temperature, 7-54
 losses from, 7-54
 operating efficiency, 7-54
 ovens, 7-54
 resistors for, 7-53, 15-61
 sizes of, 7-54
 temperature regulation of, 7-54
 for tempering, 7-54
 ventilation of, 7-55
 types of, 7-52
- Electric generators (*see* Generators)
- Electric ignition systems (*see* Ignition systems)
- Electric instruments, 15-20, 16-16
 alternating-current, 15-21
 direct-current, 15-20
 high-voltage, 15-24
 impedance bridges, 16-17
 transformers for, 15-23
- Electric lamps, 12-100
- Electric locomotives, 10-19
 (*See also* Locomotives)
- Electric measurements, 15-20
- Electric meters, 15-20
- Electric motors:
 adjustable bases for, 8-57
 alternating-current: branch-circuit maximum ratings (table), 15-60
 brushless, 15-40
 capacitor, 15-39
 commutator, 15-40
 computer control of, 15-86
 heat gain from (table), 12-85
 induction, 15-37
 breakdown torque, 15-37
 efficiency of (table), 15-39
 polyphase, 15-37
 power and weight (table), 15-39
 power factor (table), 15-38
 resistor starters for, 15-38
 rotors, 15-37
 single-phase, 15-39
 starting, 15-39
 speed control, 15-38
 squirrel-cage, 15-37
 starting compensator, 15-37
- Electric motors, alternating current, induction (*Cont.*):
 switchboard equipment, 15-46
 wiring calculations, 15-54
 as induction generator, 15-34
 industrial applications, 15-44
 laminated pole, 15-40
 round-rotor, 15-41
 salient-pole, 15-40
 single phasing of, 15-39
 slip-ring, 15-40
 synchronous, 15-40
 performance of (table), 15-41
 power and weight of (table), 15-41
 synchronous induction, 15-41
 synchronous reluctance, 15-41
 turbine, 15-41
- direct-current, 15-27
 armature reaction, 15-29, 15-32
 commutating pole, 15-28, 15-29
 commutation, 15-29
 compound, performance of (table), 15-29
 computer control of, 15-86
 cumulative compound, 15-29
 full-load currents (table), 15-60
 fundamental equations, 15-27
 industrial applications, 15-44
 series, 15-28
 speed control, 15-30, 15-85
 shunt, 15-28
 armature resistance control, 15-30
 control by changing impressed voltage, 15-30
 field-current control, 15-30
 speed control, 15-30, 15-85
 stabilizing windings for, 15-28
 starters, 15-28
 speed and torque characteristics (chart), 15-28
 industrial applications, 15-44
 selection of, 15-44
 speed control of, 15-30, 15-85
 regulation of (def), 15-28
 traction, 15-30
 Ward-Leonard, 15-30
 universal, 15-40
- Electric power (def), 15-2
 active (def), 15-2
 apparent (def), 15-2
 cost of, 17-32
 formulas, 15-8
 measurement of, 15-21, 15-22
 reactive (def), 15-2
- Electric power distribution:
 circuits, 15-52
 demand factor (buildings), 15-61
 feeders and mains, 15-53
 load centers, 15-61
 networks, a-c, 15-53
 service wires, 15-57
 systems, 15-51
 three-wire: a-c, 15-53
 d-c, 15-52
 wire resistance and reactance (tables), 15-48, 15-52
 wiring calculations, 15-53
- Electric power plants (*see* Power plants)
- Electric power transmission, 15-46
 corona in, 15-50
 d-c, high-voltage, 15-50
 lines: Merston diagram, 15-47, 15-49
 overhead, reactance of (table), 15-48, 15-52
 voltage drop in, 15-49
 symmetrical system, 15-47
 underground cables, 15-50
 ampacities (table), 15-51
- Electric resistor materials, 15-61
 table, 15-61
- Electric steel, 6-14
- Electric switchboards, 15-44
- Electric switches, 15-46
- Electric vehicles, storage batteries for, 15-14
- Electric waves:
 average value, 15-18
 form factor, 15-18
- Electric welding (*see* Welding)
- Electric wiring (*see* Wiring)
- Electrical engineering, 15-2
- Electrical machinery, symbols for, 15-7
- Electrical resistivity of metals (table), 6-50
- Electrical symbols (table), 15-3, 15-7
- Electrical transmission systems, 15-46
- Electrical units, 15-2
 table, 15-3
- Electricity:
 dynamic (def), 15-15
 static (def), 15-15
- Electrochemical machining, 13-66
- Electrodynamometer, 15-21
- Electrohydraulic forming, 13-19
- Electrolux Servel process of refrigeration, 19-17
- Electrolytic cells (def), 6-95
 reference electrodes for, 6-95
 standard hydrogen electrodes for, 6-95
- Electrolytic iron: properties and uses of, 6-13
- Electromagnetic spectrum (chart), 19-42
- Electromagnets, 15-63
 alternating-current, 15-64
 exciting coils for, 15-65
 heating of, 15-65
 lifting, 15-64
 polyphase, 15-64
 sparking of, 15-64
 tractive, 15-64
 wire for, 15-65
- Electromotive force:
 induced, direction of, 15-11
 unit of, 15-2
- Electron (def), 6-5, 9-133
- Electron capture (def), 9-134
- Electron tubes, 15-71
- Electronic components, 15-68
- Electronic voltmeters, 15-21
- Electronics, industrial, 15-85
- Electrostatic collectors (fly ash), 9-32
- Electrotype metal (table), 6-75
- Elektrolift magnets, 10-11
- Elementary substance (def), 6-3
- Elements:
 chemical (def, table), 6-3
 periodic table of, 6-6
 physical properties of (table), 6-50
- Elevator dredges, 10-34
- Elevators:
 automatic control of, 10-18
 belt-and-bucket, 10-47
 bucket, 10-46
 capacity of (table), 10-47
 casings, 10-47
 continuous, 10-47
 gravity discharge, 10-47
 power requirements for, 10-47
 supercapacity, 10-47
 car mileage of, 10-19
 controls for, 10-18
 counterweights for, 10-18
 dispatch systems for, 10-19
 drives for, 10-18
 flight times for, 10-18
 gearless, 10-18
 high-rise, 10-18

- Elevators (*Cont.*):
 hydraulic, **10-18**
 load ratings for, **10-19**
 low-rise, **10-18**
 medium-rise, **10-18**
 motors for, **10-18, 15-44**
 power consumption and efficiency of, **10-19**
 traction-type, **10-18**
- Ellingham diagrams (corrosion), **6-96**
- Ellipses:
 area and perimeter of, **2-8**
 properties of, **2-20**
 quadrant, center of gravity of, **3-7**
- Elliptic integrals, **2-29**
- Elliptical differential equations, **2-34**
- Elongation due to tension (table), **5-3**
- Embossing of metals, **13-20**
- Emery (abrasive), **6-129**
- Emery wheels (*see* Grinding wheels)
- Emissions:
 engine design conditions to reduce, **9-121**
 engine operating conditions to reduce, **9-121**
 exhaust treatments to reduce, **9-121**
 from internal-combustion engines, **9-119**
- Emissivity (radiant heat, def), **4-62**
 of carbon dioxide (table), **4-70**
 gas, **4-68**
 of various surfaces (table), **4-64, 19-39**
 of water vapor (table), **4-70**
- Emittance (radiant heat, def), **4-62**
- Employee relations, **17-10**
 grievance procedures, **17-11**
 promotions, **17-11**
- Employees: of engineers, **18-31**
- Empty set (def), **2-2**
- Emulsions, cutting fluid (machining), **13-50**
- Enamel coatings, **6-108**
- Energy (def), **3-2, 3-17**
 atomic (*see* Atomic energy)
 conservation of, **3-2, 3-17, 3-39**
 thermodynamics, **4-4**
 conversion table for, **1-33**
 electric (*see* Electric energy)
 free (def), **4-6**
 Helmholtz (def), **4-6**
 internal: of perfect gas, **4-9**
 kinetic (def), **3-17**
 law of conservation of, **3-2, 3-17, 3-39**
 mass equivalence of (formula), **9-133**
 of moving fluid, **3-37**
 nuclear (*see* Atomic energy)
 potential (def), **3-17**
 solar (*see* Solar energy)
- Energy conversion:
 direct (*see* Direct energy conversion; Energy converters)
 to mass (formula), **9-133**
- Energy converters, **9-27**
 bioenergetic, **9-27**
 EHD water drop, **9-27**
 electrohydrodynamic, **9-27**
 electrokinetic, **9-27**
 electron convection, **9-27**
 ferroelectric, **9-27**
 magnetostrictive, **9-27**
 magnetothermoelectric, **9-27**
 Nernst effect, **9-27**
 particle-collecting, **9-27**
 photoelectromagnetic, **9-27**
 photogalvanic, **9-27**
 piezoelectric, **9-27**
 pyroelectric, **9-27**
 superconducting, **9-27**
 thermophotovoltaic, **9-27**
 Van der Graaff, **9-27**
 water drop, **9-27**
- Energy equivalents (table), **1-33**
- Energy sources:
 geothermal (*see* Geothermal power)
 heat of the seas, **9-22**
 hydroelectric, **9-4**
 reserves, **9-3**
 coal, **9-3**
 natural gas, **9-3**
 nuclear, **9-4**
 petroleum, **9-3**
 shale oil, **9-3**
 tar sands, **9-3**
 solar (*see* Solar energy)
 from thorium, **9-4**
 from uranium, **9-4**
 from vegetation, **9-10**
 from waves, **9-22**
 from wind, **9-8**
- Energy storage, **9-28**
 in flywheels, **9-27**
- Engineering employees, **18-31**
- Engineering statistics, **17-19**
- Engineer's liability insurance, **18-31**
- Engines:
 airplane (*see* Airplanes, engines)
 automobile (*see* Automobile engines)
 balancing of, **3-67**
 cranks, **8-65**
 cycles for: internal combustion, **4-11**
 steam, **4-19**
 diesel (*see* Diesel engines)
 hot-air, **9-20**
 internal-combustion (*see* Internal-combustion engines)
 jet (*see* Aircraft jet propulsion)
 marine (*see* Marine engines)
 reciprocating, balancing of, **3-67**
 reciprocating parts in: inertia force of, **8-65**
 motion of, analysis of, **8-65**
 velocity and acceleration of, **8-65**
 steam (*see* Steam engines)
- Enthalpy (def), **4-4**
 of gases, **4-29**
 for ideal-gas air (table), **4-31**
 of perfect gases, **4-9**
- Enthalpy-pressure diagram, for air (chart), **4-34**
 (*See also* Pressure-enthalpy chart)
- Entropy (def), **4-6**
 of ideal gas, **4-9**
- Environmental control, **18-2**
 air- and gas-cleaning devices for (table), **18-16**
 air-cleaning apparatus for, **18-10**
 air pollution: sources of, **18-7**
 tables, **18-8**
 condenser water cooling, **18-3**
 construction projects, considerations for, **18-5**
 cost-benefit calculations for, **18-3**
 cyclone separators for, **18-10**
 federal legislation on: air pollution, **18-7**
 water pollution, **11-47, 18-5**
 industrial discharge permits, **18-5**
 national policy, **18-2**
 process selection for, **18-6**
 purposes of, **18-2**
 of radioactive waste, **18-17**
 recycling, **18-6**
 scrubbers for, **18-11**
 size of airborne particles (chart), **18-9**
 standards for industrial discharges (table), **18-6**
 of sulfur gases and particulates, **18-12**
 sulfur oxides removal for, **18-13**
 thermal discharges, **18-4**
 in various industries, **18-15**
 waste disposal, **18-6**
 wastewater, **18-5**
- Environmental releases, radioactive, **18-17**
- Epicyclic gear trains, **8-7**
- Epicycloid, **2-22**
- Epitrochoid, **2-22**
- Epoxy resins: properties of (table), **6-189**
- EPRoM (erasable programmable read-only memory), **15-83**
- Equations:
 Cauchy-Euler equidimensional, **2-33**
 for circle, **2-19**
 differential, **2-31, 2-34**
 linear, **2-32, 2-34**
 methods of solving, **2-31**
 for ellipse, **2-20**
 linear, **2-32**
 of parabola, **2-19**
 simultaneous, **2-13**
 of state (thermodynamics), **4-7**
 of a straight line, **2-18**
- Equilibrium (mechanics, def), **3-3**
 forces, in mechanics, **3-2 to 3-6**
 laws of, in mechanics, **3-3**
- Equilibrium diagram, iron-iron carbide (chart), **6-16**
- Erg (def), **1-21**
- Error:
 absolute and relative, **2-4**
 in automatic control (def), **16-22**
 in measurement, **16-2**
- Error compensation (automatic control), **16-26**
- Escalators, **10-19**
- Escape velocity, **11-101**
- Esters (solvents), **6-149**
- Ethane: as refrigerant, **19-7**
- Ethyl alcohol, as solvent, **6-148**
- Ethyl cellulose resins: properties of (table), **6-189**
- Ethyl chloride, thermal properties of, **4-50, 4-54**
- Ethylene and polyethylene copolymer resins:
 properties of (table), **6-196**
- Ethylene glycol (antifreeze), properties of, **6-142**
- Euler method, **2-39**
- Euler number, **3-42**
- Euler's equations of motion, **3-19**
- Euler's formula for long columns, **5-38**
- Eutectoid (steel), **6-17**
- Evaporative condensers, **4-18, 19-14**
- Evaporative cooling of condenser water, **9-84**
- Evaporators:
 heat transmission in, maximum (table), **4-88**
 refrigeration, **19-15**
 vapor binding in, **4-88**
- Everdur, **15-6**
- Evolute of a curve (def), **2-26**
- Excavating machines, **10-33**
- Excavation, volume computation in, **16-56**
- Excavators, **10-26**
 dragline, **10-34**
- Excess air for combustion (charts), **4-30**
 coefficient of, **4-25**
- Exchangers, heat (*see* Heat exchangers)
- Exciters, switchboard equipment for, **15-46**
- Exfoliation, of aluminum, **6-56**
- Exhaust gas:
 analysis of (chart), **9-94**
 apparatus for, **16-18**
- Exhaust systems, fans for, **14-50**
- Exide ironclad battery, **15-14**
- Expansion:
 of bodies by heat, **4-2**
 coefficients of (table), **6-50**
 of petroleum products (table), **7-12**
 in compound engines, **9-55**
 of functions in series, **2-31**
 of gases (formulas and tables), **4-9**
 of pipelines, stresses due to, **5-55**
 of saturated and superheated vapors (formulas), **4-13, 4-14**
 thermal, coefficients of (def), **4-2**

- Expansion joints for steam pipes (table), **8-208**
Expansion ratio, effect on engine economy, **9-55**
Expected value (def), **2-10**
Expenses:
 fixed, characteristics of, **17-12**
 variable, characteristics of, **17-12**
Expert systems, **2-52**
Explosion welding, **13-31**
Explosions:
 detonation rates of (table), **7-21**
 of dusts (*see* Dust explosions)
 in internal-combustion engines, **4-30**
Explosive D, **7-22**
 table, **7-21**
Explosive forming, **13-19**
Explosives, **7-19**
 ballistic mortar strength of, **7-21**
 deflagrating (def), **7-20**
 dynamite, **7-20**
 emulsions, **7-20**
 military, **7-21**
 table, **7-21**
 permissible in mines, **7-21**
 water-based, **7-20**
Exponential series, **2-31**
Exponents (algebra), **2-4**
Extraction turbines, **9-64**
Extrusion of metals, **13-20**
Eyebolts, **8-19**
 proportions and strength of (table), **8-23**
- F** distribution (statistics, table), **1-13**
Fabrics, **6-140**
 impregnated, for insulation, **6-139**
Face brick, **6-135**
Factories (*see* Industrial plants)
Factory accounts (*see* Cost accounting)
Fahrenheit:
 conversion to Celsius (eq), **4-2**
 conversion to Rankine (eq), **4-2**
Failure, theories of, **5-48**
Falk flexible couplings, **8-35**
False position (root finding), **2-38**
Fans:
 axial-flow, **14-44**
 centrifugal (*see* Centrifugal fans)
 classification of, **14-44**
 forced-draft, **9-46**
 induced-draft, **9-46**
 jet, **14-51**
 laws of, **14-49**
 propeller, **14-44**
 (*See also* Blowers)
Farad (capacitance, def), **15-2**
Fast flexible couplings, **8-35**
Fast Fourier transform, **2-38**
Fasteners, aluminum, properties of (table), **6-60**
Fathom (def), **1-16**
Fatigue:
 endurance limit in (table), **5-9**
 of metals, **5-8**
 effects of corrosion on, **5-9**
 effects of notches on, **5-9**
 effects of overstraining and understraining on, **5-9**
Fatigue failure, **5-8**
 of shafts, **8-47**
Fatigue limit (def), **5-8**
Faure storage battery, **15-13**
Feedback loop (automatic control), **16-28**
Feeder panels, equipment for, **15-46**
Feeders:
 belt conveyor, **10-52**
 of electric distribution systems, **15-53**
- Feedwater:
 alkalinity, **9-49**
 amines for, **9-49**
 ammonia in, **6-106**
 blowdown, **9-49, 9-51**
 combined water treatment for, **6-107**
 corrosion by, **6-106**
 deaeration of, **9-89**
 evaporation, **9-49**
 filtering, **9-48**
 heating, regenerative (turbines), **9-72**
 impurities in, **9-48**
 effect in boiler, **9-49**
 limits, ABMA (table), **9-51**
 oil and grease in, **9-48**
 oxygen removal, **6-106, 9-49**
 oxygen scavengers for, **6-106**
 oxygenated treatment for, **6-107**
 pH, **9-49**
 hydrogen-ion measurement, **9-50**
 indicators for, **9-50**
 table, **9-50**
 polishing of, **6-106**
 purification of, **6-106**
 sampling and analysis, **9-51**
 scale from, **9-48**
 settling of, **9-48**
 silica in, **9-50**
 sludge, **9-48, 9-49**
 softening, **9-48**
 thermal deaerators for, **6-106**
 treatment of, **6-105, 6-106**
 amines, use of, **9-49**
 cation exchange, **9-48**
 chemical, **9-48**
 demineralization, **9-48**
 hardness elimination, **9-50**
 lime-soda process, **9-48**
 of raw water, **9-48**
 solids removal, **9-48**
 Zeolite process, **9-48**
- Feedwater heaters:
 deaerators, **9-89**
 spray-type, **9-89**
 tray-type, **9-89**
 desuperheating section, **9-89**
 drain-cooling section, **9-89**
 friction loss (table), **9-88**
 heat-transfer rates, **9-87**
 high-pressure, **9-87**
 length of, **9-86**
 low-pressure, **9-87**
 materials for, **9-89**
 open-feed, **9-89**
 performance calculations, **9-88**
 pressure drop in, **9-86**
 regenerative cycle for, **4-19**
 tube-wall thickness (table), **9-88**
 types of, **9-86**
 vent condensers for, **9-89**
- Felts, **6-140**
 roofing, **6-145**
Ferrite (def), **6-16**
Ferroalloy furnace (electric), **7-59**
FET (field effect transistor), **15-70**
FHB (fluid-bed hydrogenization), **7-40**
Fiber composites, **6-202**
 advanced, **6-203**
 design of, **6-204**
 fiber properties (table), **11-112**
 fibers in, **6-203**
 properties of (table), **6-203**
 manufacture of, **6-204**
 matrices for, **6-203**
 for space applications, **11-112**
Fiber optics, **19-43**
- Fibers:
 animal, **6-140**
 for cordage, **6-137**
 creep of, **6-140**
 denier (unit of fineness), **6-140**
 elastic properties (table), **6-141**
 glass, **6-139**
 table, **6-141**
 heat endurance, **6-140**
 identification of, **6-140**
 inorganic, **6-139**
 nylon, **6-140**
 table, **6-141**
 properties of (table), **6-141**
 synthetic, **6-140**
 vegetable, **6-140**
Fibonacci series, **2-38**
Field of force, **3-19**
Field intensity (magnetic, def), **15-4**
Film coefficients, **4-83**
 for boiling liquids, **4-87**
 combined convection and radiation, **4-88**
 condensing vapors, **4-87**
 extended surfaces, **4-86**
 factors influencing, **4-83**
 forced-circulation evaporators, **4-88**
 for gases, **4-83, 4-84**
 heat transmission (def), **4-80, 4-83**
 for high-velocity gases, **4-83, 4-84**
 laminar flow, **4-86**
 natural convection, **4-86**
 over tubes, **4-83, 4-84, 4-86**
 turbulent flow, **4-83, 4-84**
Film speed, photographic, **19-42**
Filmogen (paint, def), **6-108**
Filters, capacitor, **15-71**
Filtration of sound, **12-119**
Fineness modulus (concrete, def), **6-161**
Finish shearing, **13-16**
Finite-difference methods, in torsion calculations, **5-37**
Finite-element methods, for space-vehicle analysis, **11-117**
 in torsion calculations, **5-37**
 for vibration analysis, **3-77**
FIR (finite impulse response), **15-84**
Fire extinguishing, hand apparatus for, **18-27**
Fire hose, **18-27**
 couplings for: ANSI (table), **8-214**
 screw threads, **8-214**
Fire point of oil (def), **6-179**
Fire protection, **18-19, 18-23**
 building construction for, **18-23**
 hose for (*see* Fire hose)
 hydrants for, **18-27**
 information sources on, **18-23**
 by isolation, **18-24**
 loss limitation in, **18-23**
 pumps for, **18-26**
 resistant materials for, **18-24**
 sprinkler equipment for, **18-24**
 standpipes for, **18-27**
 with temporary heating, **18-24**
 with temporary storage, **18-24**
 underground piping for, **18-26**
 water supply for, **18-26**
Fire pumps, **18-26**
Fire resistance of building materials, **12-43, 18-24**
Firebrick, **6-152**
 coatings for, **6-154**
 heat losses and heat-storage capacity of (table), **6-155**
 manufacture of, **6-151**
 mortars for, **6-153**
 plastics and ramming mixtures for, **6-154**
 selection of, **6-154**

- Firebrick (*Cont.*):
 shapes and sizes of, 6-152
 table, 6-153
 (*See also* Refractories)
- Fireclay refractories, 6-151
 table, 6-153
- Fires, from dusts, combatting of, 7-27
- Fischer-Tropsch process, 7-18
- Fission of nuclei (*see* Nuclear fission)
- Fits, 8-43
 allowances and tolerances, 8-43
 classification of, 8-43
 force, 8-44
 international, tolerances for (table), 8-46
 limits for (table), 8-48
 locational interference, 8-44
 metric, 8-44
 preferred (table), 8-45
 press, 8-44
 pressures in (charts), 8-46
 pressures required in making, 8-45
 stresses due to, 8-45
 torsional holding of, 8-46
 running, allowances for (table), 8-44
 shrink: allowances for (table), 8-44
 stresses due to, 8-45
 transition, 8-43
- Fittings, pipe (*see* Pipe fittings)
- Flakeboard, 6-128
- Flame propagation in gaseous fuels, 7-16
- Flame radiation, 4-68
- Flame speed, in internal combustion engines, 9-114
- Flame temperatures, of gaseous fuels (table), 4-29
- Flame travel, in internal-combustion engines, 9-93
- Flammability of fuels:
 gaseous, 7-16
 table, 7-16
 limits of (table), 7-16
 Le Chatelier's equation for, 7-16
- Flanged-face couplings, 8-34
- Flanged fittings:
 cast-iron, 8-195
 steel, 8-197
- Flanges:
 cast-iron, 8-195
 steel, 8-197
 unions, 8-201
- Flash intercoolers, for refrigeration systems, 19-15
- Flash point, of lubricating oils (def), 6-179
- Flasks (molding), 13-5
- Flats, of bolts and nuts (table), 8-21
- Flax, properties of (tables), 6-141
- Flexible metal hose and tubing, 8-215
- Flexure, theory of (beams), 5-21
- Flight (*see* Aerodynamics)
- Flight conveyors, 10-40
- Flip-flop (electronic circuit), 15-79
 JK circuit, 15-80
- Float (scheduling), 17-6
- Float glass, 6-142
- Floors:
 earthquake-resistant, 12-19
 industrial plant, 12-15
 loads on, 12-18
 plank, safe load on, and deflection (table), 12-28
 reinforced-concrete, 12-56
 safety provisions for, 18-19
 trusses for, 12-22
 chart, 12-22
 wood, 12-28
 joists for, 12-28
 wood-block, 12-15
- Flow:
 of air: measurement of, 16-13
 in pipes, 4-23
 in pneumatic conveyors, 10-53
 coefficients of friction, 4-23
 of compressible fluids, 3-49, 3-50, 3-55, 3-56, 4-20
 through nozzles, 3-54 to 3-56, 4-21
 through orifices, 3-55, 4-21, 16-14
 in pipes, 4-23
 friction loss, 4-23
 of cryogenics, measurement of, 19-38
 of gases: fundamental equations, 4-21
 measurement of, 16-13
 of heat, 4-79
 conversion table for, 1-34
 (*See also* Heat transmission)
 of liquids: dimensional analysis of, 3-44 to 3-46
 laminar, 3-46
 measurement of, by metering pump, 16-15
 (*See also* Flowmeters)
 through orifices, 3-55
 in pipes, 3-47 to 3-53
 turbulent, 3-46, 3-48
 (*See also* Flow, of water)
 of materials, in plants, 10-2
 (*See also* Materials handling)
 of metal at high temperatures (creep), 5-10
 of steam: through labyrinth packings, 9-63
 through nozzles, 4-21 to 4-23
 through orifices, 4-21
 in pipes, 4-23
 friction loss due to, 4-23
 resistance of fittings to, 4-23
 saturated, 4-23
 of water: measurement of (*see* Flowmeters)
 through notches, 3-57, 3-58
 through nozzles, 3-54, 3-55
 in open channels, 3-59
 in pipes, 3-47 to 3-53
 Chézy equation for, 3-59
 Manning formula for, 3-59
 in streams: estimation by surveying, 16-58
 venturi meter for, 3-54
 over weirs, 3-57, 3-58
- Flowers: effects of sulfur dioxide on (table), 18-12
- Flowmeters, 3-53 to 3-59, 16-7, 16-14
 electromagnetic, 16-15
 integrators, 16-15
 nozzle, 16-14
 propeller, 16-14
- Flue gas:
 analysis of, 4-25, 4-30
 apparatus for, 16-18
 cleaning of, 9-32
 heat loss in, 9-48
- Fluid couplings (*see* Couplings)
- Fluid volume, measurement of, 16-7
- Fluidized beds, in furnaces, 9-29
- Fluids (def), 3-31
 coefficients of friction (formulas), 4-23
 flow (*see* Flow)
 ideal (def), 3-31
 for machining, 13-50
 measurement of, 1-16
 (*See also* Flowmeters)
 Newtonian (def), 3-31
 nonNewtonian (def), 3-31
 throttling of, 4-24
- Fluorescent lamps, 12-101
- Fluoroplastic resins: properties of (table), 6-190
- Flux density (magnetic, def), 15-3
- Fly ash, sintering of, 9-30
- Flywheel effect (def), 3-9
- Flywheels:
 arms, design of, 8-50
 for energy storage, 9-27
 high-speed, stresses in rims, 8-51
 rims, 8-50
 split-rim, 8-50
 stresses in, 8-50
 vehicles powered by, 9-29
 weight determination, 8-66
 Wittenbauer's analysis, 8-66
- FMC coke process, 7-35
- Foaming, in boilers, 9-49
- Focal length of lenses, 19-41
- Focus:
 of ellipses, 2-20
 of hyperbola, 2-20
 of parabola, 2-19
- Foil, laminated, 13-14
- Follow boards (mold making), 13-3
- Food-board, 6-144
- Foot (def), 1-16
- Foot-lambert (def), 12-99
- Footings:
 for foundations, 12-26
 reinforced-concrete, 12-58
- Force (def), 3-2
 centrifugal, 3-15
 centripetal, 3-15
 components of, 3-3, 3-4
 composition of, 3-4
 definition of units, 1-24
 equilibrium of, 3-3
 external and internal (def), 3-3
 field of, 3-19
 intensity of (def), 3-19
 fundamental equation of, 3-2
 line of (def), 3-19
 supporting, 3-4 to 3-6
 unbalanced, 3-14
 units of, 1-24, 4-2
- Force fits, 8-44
- Force polygon, 3-5
- Forced-circulation boilers, 9-37, 9-45
- Forced draft, 9-46
- Forces:
 on irregular surfaces (mechanics), 3-35
 in mechanical linkages, 8-4
 resultant of, 3-3
 system of, in equilibrium, 3-6
- Forging, of metals, 13-10
- Forging dies, 13-19
- Forging hammers, 13-19, 13-22, 13-23
- Forging steel (table), 6-22
 uses of, 6-30
- Fork trucks, 10-23
- Form factor, a-c waves, 15-18
- Formation, heats of (def), 4-27
- Formcoke (coke making), 7-34
- Forms, for reinforced concrete, 12-60
- Forsterite (refractory), 6-152
- Fortran, 2-53
- Forward path (automatic control, def), 16-28
- Fossil fuels, reserves of, 9-3
- Foucault-current losses, 15-10
- Fouling index, of coal, 9-30
- Foundations:
 bearing pressure on soils, 12-26
 caisson methods for, 12-26
 deep, 12-26
 excavation, computations in, 16-56
 footings for, 12-26
 pile, 12-26
 setting stakes for, 16-57
 spread (reinforced-concrete columns), 12-58

- Foundries, **13-2**
 casting inspection in, **13-7**
 cleaning equipment for castings in, **13-7**
 melting processes used in, **13-7**
 molding equipment for, **13-5**
 (*See also* Castings; Molding)
- Four-cycle engines, **9-91**
 advantages, **9-91**
- Fourier coefficients, **2-36**
- Fourier integral equation, **2-37**
- Fourier series, **2-36**
- Fourier transform, **2-37**
- Fourier's law (heat conduction), **4-80**
- FPGA (field-programmable gate array), **15-82**
- Fractionating high-vacuum pumps, **14-41**
- Fractions, decimal values (table), **1-15**
- Fracture:
 at low stress, **5-7**
 under tension and compression, **5-7**
- Fracture mechanics, **5-7**
- Fracture stress (def), **5-2**
- Frame of reference (mechanics, def), **3-2**
- Framed structures, steel (*see* Steel-framed structures)
- Francis turbines, **9-150, 9-151**
- Free energy (thermodynamics), **4-6**
- Free-swelling index test for coal, **7-7, 7-32**
- Freezing points:
 of the elements (table), **4-58**
 of various substances (table), **4-50**
- Freezing preventives, **6-141**
- Freight cars, **11-27**
 axles for, **11-31**
 coupler cushioning for, **11-31**
 design of, **11-30**
 dimensions of, **11-27, 11-28**
 discharge gates for, **11-32**
 lading restraints for, **11-32**
 suspensions for, **11-31, 11-39**
 train resistance, **11-39**
 wheels for, **11-31**
- Freon, properties of (chart, table), **19-4, 19-12**
 (*See also* Refrigerant)
- Freon 22: pressure-enthalpy chart for, **19-8**
- Frequency:
 a-c (def), **15-3, 15-18**
 natural, **15-17, 15-19**
- Frequency bands (tables), **15-87**
- Frequency modulation (radio), **15-74**
- Frequency response:
 of automatic controls, **16-33**
 graphical display, **16-34**
- Fresh air requirements for various locations (table), **12-67**
- Friction:
 coefficients of (def), **3-21**
 clutches (table), **8-38**
 fluid flow in pipes, **4-23**
 journal bearings, **3-27, 8-119**
 rolling (table), **3-25**
 static and sliding (def), **3-21**
 tables, **3-21 to 3-24**
 tables, **3-21 to 3-24**
 thrust bearings, **3-28, 8-126**
 for various materials, **3-21 to 3-24**
 dry (def), **3-20**
 effect of sliding velocity on, **3-22**
 of liquids in pipes, **3-47 to 3-53**
 of machine elements, **3-25 to 3-29**
 rolling (def), **3-25**
 skin (aerodynamics), **11-66**
 of steam engines, **9-54**
- Friction brakes, horsepower absorbed by, **3-18**
- Friction clutches (automobile), **11-6**
- Friction factors for pipes (liquid flow), **3-47 to 3-53**
- Friction head (liquid), **3-37**
- Friction loss in pipe fittings (table), **3-51**
- Friction resistance of ships, **11-45**
- Friction sawing (metal), **13-61**
- Frigorie, European unit of refrigeration (def), **19-2**
- Fringes (optics), **19-42**
- Froude's law (ship resistance), **11-46**
- Froude's number, **3-42, 3-44, 3-60, 11-42, 11-45**
- Frustum, of cone or pyramid, volume of, **2-9**
- Fuel cells, **9-25, 15-34, 18-10**
- Fuel injection:
 for diesel engines, **9-110**
 fuel lines for, **9-111**
 nozzles for, **9-111**
 pump injection systems, **9-111**
 pumps for, **9-111**
 system characteristics, **9-111**
 for spark ignition engines, **9-109**
 central, **9-110**
 injector pulse, **9-110**
 port, **9-110**
 speed-density controls for, **9-110**
 systems, **9-110, 9-111**
- Fuel oils:
 analyses of (table), **7-11**
 API and specific gravity of (tables), **7-11 to 7-13, 7-19**
 ash content (tables), **7-14, 9-31**
 combustion in boiler furnaces, **9-34**
 crude, **7-10**
 flash point of, **7-14**
 grades of, **7-14**
 heat of vaporization of, **7-11**
 table, **7-12**
 heat values (tables), **7-11, 7-12**
 pour point of, **7-14**
 specific heat of, **7-11**
 specifications of (table), **7-14**
 (*See also* Fuels, liquid)
- Fuels, **4-24, 4-25, 4-30, 7-2, 7-41**
 alternative, **9-106**
 autoignition temperatures, **9-115**
 aviation turbine, **7-13**
 table, **7-13**
 biomass, **7-8**
 for boilers, **9-29**
 briquets, **7-9**
 by-product (table), **7-10**
 combustion of (*see* Combustion)
 consumption of (automobiles), **11-5**
 cost, in power plants, **17-36**
 diesel, **9-104**
 table, **9-105**
 (*See also* Diesel fuels)
 flame speed in, **9-114**
 flammability of, **7-16**
 table, **7-16**
 fossil, reserves of, **9-3**
 for gas turbines, grades of, **7-14**
 gaseous, **7-14**
 analysis of, **7-15, 7-16**
 combustion of, **4-25, 4-30**
 air required, **4-25**
 table, **4-27**
 in boiler furnaces, **9-34**
 dissociation in, **4-29**
 table, **4-29**
 products of (table), **4-27**
 temperature, **4-29**
 volume contraction, **4-25**
 composition of (table), **7-15**
 flame propagation, **7-16**
 flammability, **7-16**
 table, **7-16**
 heat value (table), **4-26**
 for industrial heating, **7-41**
- Fuels, gaseous (*Cont.*):
 odorization of, **7-15**
 physical constants of, **7-16**
 specifications for, **7-15**
 heat value (def), **4-25, 7-6**
 high and low (def), **4-25**
 heats of formation, **4-27**
 for industrial heating, **7-41**
 for internal-combustion engines, **7-12 to 7-14, 9-104**
 table, **9-103**
 jet, **7-13**
 table, **7-13**
 knock rating, **9-115**
 knock suppressors (table), **9-116**
 liquid, **7-10**
 ash content, **9-31**
 combustion of, **4-25, 4-30**
 air required (table), **4-27**
 products of (table), **4-27**
 heat values (tables), **4-25, 7-11 to 7-13**
 for industrial heating, **7-41**
 molecular weight (table), **4-25**
 properties of, **7-11**
 volatility of (def), **9-104**
 nuclear (*see* Nuclear fuels)
 oils (*see* Fuel oils)
 peat, **7-9**
 products of combustion of (table), **4-27**
 rocket, **7-28**
 solid, combustion of, **4-30**
 air required for, **4-30**
 products of, **4-30**
 specific gravity and density of (table), **6-8**
 synthetic, **7-16**
 liquefaction of, **7-17**
 from coal, **7-18**
 wood, **7-9**
- Full annealing (def), **6-17**
- Full-duplex (data transmission method), **16-21**
- Fuller-Kinyon system, **10-54**
- Functions:
 algebraic (def), **2-3**
 gamma, **2-29, 2-37**
 hyperbolic (tables), **2-18**
 series for, **2-31**
 implicit, **2-25**
 trigonometric, **2-15**
 series for, **2-31**
 of two or more variables, **2-25**
- Furan resins: properties of (table), **6-191**
- Furlong (unit of length, def), **1-16**
- Furnace brazing, **13-29**
- Furnaces:
 arches for, **6-154**
 boiler (*see* Boiler furnaces)
 combustion, **7-41**
 combustion chambers for, partially stirred, **4-76**
 performance of, **4-78**
 cyclone, **9-35**
 electric (*see* Electric furnaces)
 for electric steel, **6-14**
 forced convection, **7-41**
 heat transmission in, **4-71**
 incineration (*see* Incinerators)
 induction, **6-14**
 industrial-heating, **7-41**
 automatic controls for, **7-44**
 classification of, **7-41**
 construction of, **7-44**
 efficiency of (table), **7-43**
 firing methods for, **7-41**
 flue velocities in (tables), **7-44**
 fuel requirements of (table), **7-43**
 fuels for, **7-41**
 heat balance in (table), **7-43**

Furnaces, industrial-heating (*Cont.*):

- heat conservation, 7-44
 - heat input to, 7-42
 - heat losses in, 7-42
 - heat transfer in, 7-41
 - heating and soaking time, 7-42
 - material handling, 7-42
 - metal parts for, 7-44
 - protective gas atmospheres for, 7-45
 - table, 7-45
 - recuperators and regenerators for, 7-44
 - size of, factors influencing, 7-42
 - temperature control of, 7-44, 7-54
 - temperatures in (table), 7-42
 - useful heat in, 7-42
 - liquid-bath, 7-41
 - melting (casting), 13-7
 - muffle, 7-41
 - oven, 7-41
 - pressure-fired, 9-46
 - radiant-tube fired, 7-41
 - radiation in, 4-71
 - from nongray gas, 4-75
 - recirculating, 7-41
 - refractories for (*see* Refractories)
 - resistors for, materials for (table), 15-61
 - walls for, 6-154, 9-37
 - air-cooled, 6-154
 - expansion joints for, 6-154
 - heat losses and heat storage (table), 6-155
 - membrane tube, 9-41
 - water-cooled, types of, 9-37
 - water-cooled, 9-37
 - construction of, 9-37
 - heat transfer in, 9-39
- Fuses, 15-61
- sizes for motor branch circuits (table), 15-60
- Fusible alloys, 6-75
- table, 6-75
- Fusion:
- heat of (tables), 4-50, 4-58
 - nuclear (*see* Nuclear fusion)
- Fusion points, of refractories (tables), 6-153, 6-156
- Fuzzy control, 16-49
- FWPCA (Federal Water Pollution Control Act), 11-48, 18-5
- G* and *g*, value of, 1-25, 3-2
- GAAP (generally accepted accounting principles), 17-12
- Gage blocks, 16-5
- Gages:
- absolute pressure, 16-9
 - bellows, 16-8
 - Bourdon-tube, 16-8
 - dead-weight tester for, 16-9
 - depth, 16-5
 - dial, 16-5
 - diaphragm, 16-8
 - go no-go, 16-5
 - ionization, 16-9
 - pneumatic, 16-6
 - pressure, 16-8
 - railway track, 11-35, 11-37
 - sheet metal (table), 8-85
 - strain, 5-53
 - in vibration, 3-79
 - thermocouple, for vacuum measurement, 16-9
 - thread, 16-5
 - U-tube, 16-8
 - using beta radiation, 16-7
 - using X-rays, 16-7
 - wire (table), 8-85

- Gainsharing (bonus plan), 17-10
- Gallon (def), 1-16
 - imperial (def), 1-16
- Galvanic corrosion, in aluminum, 6-56
- Galvanic series: for metals and alloys (table), 6-100
- Galvanized conductors (electrical), 15-6
- Galvanized surfaces, paints for, 6-110
- Galvanizing, 6-93
- Galvanometer, 15-20
- Gamma functions, 2-29, 2-37
- Gamma iron (def), 6-16
- Gamma rays, 9-134, 9-142
 - irradiation by, 9-142
- Gang saws, 13-72
- Gangue of iron, 6-13
- Gantry cranes, 10-27
- Gantt charts (scheduling), 17-5
- Garnet (abrasive), 6-129
 - for wood sanding, 13-75
- Gas:
 - adiabatic expansion of, 4-9
 - change of state, 4-9
 - cleaning (*see* Gas cleaning)
 - combustion (*see* Combustion)
 - compressibility factors (chart), 4-8
 - compressors (*see* Air compressors; Centrifugal compressors)
 - constant-pressure expansion of, 4-9
 - constant-volume expansion of, 4-9
 - enthalpy of, 4-9, 4-29
 - entropy of, 4-9
 - expansion of, 4-9
 - with variable specific heat, 4-9
 - flow of (*see* Flow, of gases)
 - flue (*see* Flue gas)
 - ideal: changes of state in, 4-9
 - equation of state for, 4-8
 - ideal cycles with, 4-10
 - laws of, 4-8
 - internal energy of, 4-9, 4-29
 - table, 4-28
 - isentropic expansion of, 4-9
 - isothermal expansion of, 4-9
 - liquefaction of, 19-25
 - natural (*see* Natural gas)
 - perfect (*see* Gas, ideal)
 - polytropic expansion of, 4-9
 - producer (*see* Producer gas)
 - properties of, 4-8
 - radiation from, 4-68, 4-69, 4-71
 - radioactive, control of, 18-17
 - solubility in water (table), 6-7
 - thermal conductivity of (table), 4-82
 - thermal expansion of, 4-2
 - waste, heat in, 7-42
 - water (*see* Water gas)
- Gas chromatography, 7-16
- Gas cleaning: apparatus for (table), 18-16
- Gas cycles, 4-10
 - for nuclear reactors, 9-135
- Gas engines (*see* Internal-combustion engines)
- Gas meters, 16-7, 16-13
- Gas oil (petroleum distillate), 7-14
- Gas pipe (*see* Pipe)
- Gas producers (*see* Gasification; Producer gas)
- Gas turbines, 9-124
 - aircraft, 9-124
 - applications of, 9-132
 - electric power, 9-132
 - industrial, 9-132
 - marine, 9-132
 - as mechanical drive, 9-132
 - in military aviation, 9-132
 - as small engine, 9-132

Gas turbines (*Cont.*):

- categories, 9-124
 - aeroderivative, 9-124
 - as frame machines, 9-124
 - heavy-duty, 9-124
 - closed, 9-129
 - combined cycle, 9-69, 9-127, 9-129
 - bottoming, 9-129
 - cogeneration, 9-130
 - for district heating, 9-130
 - fired, 9-129
 - overall system efficiency of, 9-127, 9-129
 - steam injection, 9-130
 - total energy plant, 9-130
 - unfired, 9-129
 - combustors, 9-131
 - combustion chambers in, 9-131
 - components, 9-131
 - compressors for, 9-131
 - axial flow, 9-131
 - centrifugal flow, 9-131
 - dual-speed, 9-131
 - concentric shaft, 9-129
 - configurations for, 9-128
 - closed system, 9-129
 - concentric shaft, 9-129
 - dual speed, 9-128
 - external combustion, 9-129
 - free turbine, 9-128
 - open system, 9-129
 - cycles for, 4-13, 9-126
 - Brayton, 9-125
 - Joule, 9-125
 - effect of ambient conditions, 9-130
 - effect of inlet temperatures (chart), 9-126
 - effect of pressure ratios (charts), 9-126
 - fuels for, 9-124
 - inlet temperatures in, 9-126
 - intercooled, 9-126
 - intercooled and regenerative, 9-127
 - marine, 9-132
 - maximum cycle temperature (def), 9-126
 - open, 9-129
 - operating characteristics of, 9-130
 - at partial load, 9-130
 - for peaking units, 9-132
 - power rating curves for, 9-130
 - for power stations, cost of, 17-34
 - pressure ratio, 9-128
 - effect of (charts), 9-126
 - regenerative, 9-126
 - reheat, 9-127
 - ship propulsion, 9-132
 - specific power (def), 9-126
 - superalloys for, 6-77
 - turbines for, 9-131
 - types of, 9-128
- Gas welding (*see* Welding, gas)
- Gaseous fuels (*see* Fuels, gaseous)
- Gases:
 - mixtures of: partial pressures in, 4-9
 - specific heat of, 4-9
 - total pressure of (Dalton's law), 4-9
 - natural, pipeline transmission of, 11-126
- Gasification, 7-35
 - of coal, 7-35
 - of liquid hydrocarbons, 7-39
 - processes for, 7-35
- Gasifiers:
 - entrained flow in, 7-38
 - fixed-bed, 7-35
 - types of, 7-35
- Gaskets, 8-138
 - for ammonia fittings, 8-205
 - compressibility (chart), 8-140
 - materials for, for common uses (table), 8-140

- Gaskets (*Cont.*):
 nonabsorbent, to prevent corrosion, **6-100**
 O-ring, **8-138**
- Gasoline, **7-12, 9-104**
 aviation, **7-13**
 grades of (table), **7-13**
 properties and specifications of (table), **7-13**
 condensation temperature of (table), **9-106**
 cracked, **7-12**
 distillation curves for, **7-11**
 heat value of (table), **7-11, 7-13**
 knock characteristics of, **7-12**
 knock rating of, **9-115**
 knock suppressors in (table), **9-116**
 natural, **7-12**
 reformed, **7-12**
 reformulated, **7-12**
 constituents (table), **7-12**
 road ratings of, **9-116**
 straight-run, **7-12**
 vapor pressure of (table), **7-13**
- Gasoline engines, **9-90**
 (*See also* Internal-combustion engines)
- Gasyntan (synthetic gas process), **7-40**
- Gate valves, **8-206**
- Gauss (magnetic flux density, def), **15-3**
- Gear-cutting processes, **13-59**
- Gear pumps, **14-11**
- Gear ratio (def), **8-89**
- Gear-shaving machines, **13-60**
- Gearing, **8-87**
- Gears:
 AGMA standards for, **8-100**
 AGMA strength and durability ratings for, **8-100**
 allowable bending stress in, **8-102**
 allowable contact stress in, **8-102**
 angular spiral, **8-98**
 angular spiral bevel, **8-98**
 automobile, **11-8**
 backlash in, **8-92**
 bevel, **8-95**
 angular, **8-96**
 cutting processes for, **13-60**
 definition of terms, **8-96**
 dimensions of, **8-96**
 efficiency of, **3-27**
 Coniflex, **8-96**
 Gleason, **8-96**
 hypoid, **8-95**
 mounting surfaces, **8-96**
 recommended backlash (table), **8-97**
 registering surfaces, **8-96**
 spiral, **8-98**
 dimensions of (table), **8-98**
 straight, **8-98**
 dimensions of (table), **8-97**
 Zerol, **8-99**
- Beveloid, **8-100**
- Buckingham equation: for durability, **8-100**
 dynamic, **8-100**
- center distance, **8-91**
 computer modeling of, **8-116**
 computerized calculations for, **8-116**
 contact ratio (def), **8-92**
 charts, **8-92, 8-93**
 cutters for, **13-59**
 design standards, **8-100**
 durability, **8-100**
 efficiencies, **3-27**
 enlarged, **8-93**
 geometry factor for, **8-102**
 greases for, **6-183**
 grinding, **13-60**
 hardness factor for, **8-102**
- Gears (*Cont.*):
 helical, **8-94**
 axial pitch (def), **8-94**
 calculations for, **8-95**
 contact ratio (def), **8-91**
 crossed axis, **8-94**
 formulas (table), **8-95**
 friction, **3-27**
 over-pins measurements for, **8-94**
 parallel shafts, **8-94**
 skew shafts, **8-94**
 tooth thickness of, **8-94**
- Helicon, **8-100**
- herringbone, **8-94**
- hypoid, **8-95, 8-99**
 figure, **11-10**
- Lewis formula for strength, **8-100**
 load distribution factor for, **8-102**
 long and short addendum, **8-93**
 lubricants for (tables), **8-114 to 8-116**
 lubrication of, **6-183, 8-113**
 materials for, **8-108**
 tables, **8-102, 8-107, 8-108**
- mesh ratio (def), **8-89**
- metric, **8-89**
 American equivalents (table), **8-90**
 design equations for (table), **8-94**
 ISO specifications, **8-89**
 tooth proportions and standards, **8-89**
 use of, **8-90**
- metric module, **8-89**
- miter, **8-96**
- modified, **8-93**
- nomenclature for, **8-87, 8-88, 8-91, 8-94, 8-96**
- noncircular, **8-100**
- oils for, **6-180, 6-183**
- overload factor for, **8-100**
- pitch: circular (def), **8-88**
 diametral (def), **8-88**
 pitch circle of (def), **8-88**
 pitting resistance of, **8-101**
 plastic, **8-111**
 pressure angle of (def), **8-88**
 profile shifted, **8-93**
 reliability factor for, **8-102**
 rolling of, **13-60**
 safety factor for, **8-102**
 shaving, **13-60**
 sintered metal, **8-108**
 size factor for, **8-102**
 speed ratio, **8-89**
 spiral, bevel, **8-98, 13-60**
 Spiroid, **8-100**
- spur, **8-88**
 contact ratio (def), **8-91**
 friction, **3-27**
 metric, design equations for (table), **8-94**
 over-pins measurements of, **8-92**
 pitch (def), **8-88**
 speed ratios, **8-89**
 teeth of: proportions of, **8-89**
 tables, **8-89, 8-94**
- surface condition factor for, **8-102**
- teeth of: nomenclature for, **8-88**
 proportions of (table), **8-89**
 thickness of, **8-92**
- temperature factor for, **8-102**
- testing radius, **8-92**
- tooth-to-tooth composite error (def), **8-93**
- total composite error (def), **8-93**
- trains: bevel, **8-8**
 epicyclic, **8-7**
- types of, **8-88**
- worm, **8-99**
 double-enveloping, **8-99, 8-100**
 efficiency of, **3-27**
- Gears, worm (*Cont.*):
 friction, **3-27**
 nonreversibility of, **8-99**
 single-enveloping, **8-99**
 teeth, proportions of (table), **8-89**
 velocity ratios for (def), **8-99**
- Geiger counters, **16-19**
- Geisler plastomer coal test, **7-32**
- Gelatin, in explosives, **7-20**
- GEM (ground effect machines), **11-59**
- General Motors two-cycle engines, **9-107**
- Generally accepted accounting principles, **17-12**
- Generators:
 absorption refrigeration, **19-17**
 alternating-current, **15-31**
 armature reaction in, **15-32**
 armature resistance, effective, **15-32**
 classes of, **15-31**
 construction of, **15-31**
 design of, **15-32**
 efficiencies of (tables), **15-31**
 excitation for, **15-33**
 frequency, **15-32**
 ground resistors for, **15-34**
 hunting, prevention of, **15-34**
 induced emf of, **15-32**
 parallel operation, **15-34**
 performance of (tables), **15-31**
 regulation of, **15-32**
 synchronous, **15-31**
 voltage regulation of, **15-32**
- automobile, **15-66**
- direct-current, **15-25**
 armature reaction in, **15-29**
 commutating poles in, **15-29**
 commutation in, **15-29**
 compound-wound, **15-26**
 performance of (table), **15-26**
 induced emf of, **15-26**
 parallel operation, **15-27**
 series, **15-26**
 shunt, **15-26**
 as synchronous converters, **15-42**
- double-current, **15-42**
- efficiency calculations, **15-43**
- induction, **15-34**
- switchboard equipment for, **15-46**
- synchronous (*see* Generators, alternating-current)
- Geometric constructions, various, **2-5 to 2-7**
- Geometric distribution, **2-10**
- Geometric progression, **8-215**
- Geometric similarity (models), **3-41**
- Geometrical series, **2-31**
- Geometry:
 analytical, **2-18 to 2-24**
 elementary, **2-5 to 2-10**
- Geothermal heat pumps, **9-20**
- Geothermal power, **9-17**
 electric energy conversion, **9-18**
 processes, **9-18 to 9-20**
 environmental considerations, **9-20**
 exploration technology, **9-18**
 resources of, **9-18**
- German fraktur alphabet, **19-44**
- Gibbs free energy: in corrosion calculations, **6-95**
- Gibbs function (thermodynamics), **4-6**
- Gifford-McMahon refrigerator (cryogenics), **19-28**
- Gilbert (magnetomotive force, def), **15-3**
- Gilbreth's micromotion study, **17-27**
- Girders, steel, proportions of, **12-34**
 (*See also* Beams)
- Glass, **6-142**
 cellular, uses of, **6-143**
 composition of, **6-142**

- Glass (*Cont.*):
 fiber, 6-139
 properties of (table), 6-141
 as insulation, 6-142
 properties of, 6-143
 at low temperatures, 19-34
 safety, 6-142
 shading coefficients for (tables), 12-81, 12-82
 specific gravity and density of (table), 6-7
 tempered, 6-142
 types of, 6-142
 wire, 6-142
 wool, 6-150
- Glass blocks, 6-135, 6-142
- Gleason bevel gears, 8-96
- Globe valves, 8-206
- Glued-laminated timber, for structures, 12-30
- Glues, 6-130
 (*See also Adhesives*)
- Glulam (glued-laminated wood), 6-123, 12-30
- Glycerol as freezing preventive, 6-141
- GMR Stirling thermal engine, 9-20
- Gold, uses of, 6-74
- Goodman diagram (weld design), 13-40
- Gouging, 13-32
 air arc, 13-32
 plasma arc, 13-32
- Governing, of internal-combustion engines, 9-117
- Governors:
 for hydraulic turbines, 9-159
 for steam turbines, 9-64
- GPIB (general-purpose interface bus), 16-21
- GPS (global positioning system), 15-91, 16-58
 surveying using, 16-58
- Grab buckets, 10-12
- Grad (angular measure, def), 16-4
- Grade resistance (railroads), 11-39
- Graders, motor, 10-25
- Grading, volume of earth, computation of, 16-56
- Grain size, austenitic (metallography), 6-18
- Granite, composition of, 6-143
- Graphical relations, in beams, 5-31
- Graphical statics, problems, 3-5
- Graphite:
 bearings lubricated by, 8-125
 specific gravity and density of (table), 6-8
- Graphite corrosion, 6-101
- Graphitization of pipe, 8-211
- Graphitizing furnace (electric), 7-59
- Grashof's formula for steam flow, 4-21, 4-22
- Gravel:
 for concrete, 6-161
 specific gravity and density of (table), 6-8
- Gravitation, law of, 3-2
- Gravitational systems (def), 3-2
- Gravity:
 acceleration of, 1-25
 center of, 3-6
 equation for, 3-2
 specific (*see Specific gravity*)
 standard (def), 1-25
 standard acceleration of, 1-25
- Gray cast iron (def), 6-13, 6-38
 corrosion of, 6-101
- Gray iron castings: allowances for, 6-43
- Gray surfaces (radiant heat transfer), 4-66
- Greases:
 bleed of, 6-180
 characteristics of (table), 6-181
 consistency of, 6-180
 consistency numbers for (table), 6-180
 consistency tests, 6-180
 dropping point of, 6-180
 firmness of, 6-180
 lubricity of, 6-181
 penetration of, 6-180
- Greases (*Cont.*):
 performance of, 6-181
 soaps as thickeners for, 6-180
 texture of, 6-181
 unworked penetration of, 6-180
- Greek alphabet, 19-44
- Green's theorem, 2-35
- Gregorian calendar, 1-25
- GRH (gas recycle generator), 7-40
- Grid (electron tube), 15-71
- Grinding, 13-61
 allowances for, 13-63
 of ceramics, 13-65
 cross feeds, 13-63
 depth of cut in, 13-63
 surface speeds, 13-63
 workpiece speeds, 13-63
- Grinding machines:
 centerless, 13-64
 cylinder, 13-64
 drill, 13-64
 internal, 13-64
 surface, 13-64
 types of, 13-64
 universal, 13-64
- Grinding wheels, 6-129, 13-62
 abrasives in, 13-62
 bonding processes for, 6-129
 dressing of, 13-63
 grades of, 6-129
 grain size in, 6-129
 speeds, 6-129, 13-63
 standard marking system for (chart), 13-62
 truing of, 13-63
- Grindstones, friction, 3-22
- Grip-springs, 8-32
- Grips, for test specimens, 5-13
- Grog (calcined clay), 6-151
- Ground-fault interrupters, 15-61
- Grounding, of transformer secondary, 15-53
- Grounds for interior wiring, 15-59
- GR-S rubber, 6-147
 table, 6-148
- Gunter's measure (surveying), 1-16
- Gust loads (wind force), 12-21
- Gutta percha, 6-148
- GWP (global warming potential), 19-3
- Gypsum blocks, 6-135
- Gypsum plaster, 6-163
- Gyration, radius of (def), 3-8
- Gyrocompasses, 3-20
- Gyroscopes:
 applications of, 3-20
 motion of, 3-19
 theory of, 3-19, 3-20
- H-coal process, 7-18, 7-35
- H-S diagrams, description of, 4-14
 (*See also Mollier diagram*)
- Hack saws, 13-61
- Half-duplex (data-transmission method), 16-21
- Half-life (def), 5-65
- Half-life of nuclei (def), 9-134
- Hammerlocks (chain couplers), 10-7
- Hammers:
 drop, 13-22
 energy of blows (tables), 13-23
 pneumatic, 13-23
 steam, 13-22
- Hand (unit of length, def), 1-16
- Hand cleaners, 6-137
- Hand-operated squeezer and molding machines, 13-5
- Hand rule (magnetism), 15-11
- Hankinson's formula for strength of wood, 6-116
- Hard-coal (def), 7-2
- Hard finish (plastering), 6-163
- Hard soldering, 13-29
- Hardenability of steel (def), 6-18
 Jominy test, 6-18
- Hardening:
 of nonferrous alloys, 6-52
 by precipitation, 6-52
 of steel, 6-17
- Hardgrove machine-grindability test for coal, 7-7
- Hardness:
 of materials (def), 5-12
 Mohs scale of, 1-25, 5-12
 tests for, 5-12
 of wood, 5-13
- Harmonic motion, 3-11
- Harmonic oscillation, 3-63
- Harmonic series (def), 2-30
- Hartley oscillators, 15-73
- Hastelloy (tables), 6-78 to 6-80, 6-89, 6-90
- Haulage:
 by locomotives, 10-19
 off-highway, 10-24
 wire rope for, 10-8
 (*See also Conveying*)
- HAWT (horizontal-axis wind turbines), 9-5
 rotors for, 9-7
- Hayward grab buckets, 10-12
 electrohydraulic, 10-12
- HBX (explosive), 7-22
- HCFC (hydrochlorofluorocarbon) refrigerant, 19-3
- HCFC-123: pressure-enthalpy chart for, 19-9
- HFC (hydrofluorocarbon) refrigerant, 19-3
- HFC-134a: pressure-enthalpy chart for, 19-10
- Head:
 loss due to fittings (table), 3-51
 potential (hydraulics), 3-37
 pressure (hydraulics), 3-37
 velocity (hydraulics), 3-37
- Head gates, for hydraulic turbines, 9-160
- Heading operations, steel for, 13-19
- Heat:
 available (def), 4-6
 of combustion (table), 4-26
 conduction (*see Heat transfer; Heat transmission; Thermal conductivity*)
 conversion table for, 1-33
 developed by electric current, 15-8
 of earth, power from, 9-18
 into the environment (table), 18-4
 expansion by, 4-2
 of formation: of fuels, 4-27
 of inorganic compounds (table), 4-27
 of fusion: of the elements (table), 4-58
 of metals (table), 6-50
 of various materials (tables), 4-50
 latent, 4-4
 of vaporization (tables), 4-50, 4-58
 measurement of, 4-3
 mechanical equivalent of, 4-3
 of seas, power from, 9-22
 specific (*see Specific heat*)
 units of, 4-3
 of vaporization: of the elements (table), 4-58
 of liquids (tables), 4-50, 4-58
 of various substances (table), 4-50
- Heat capacity (def), 4-3
- Heat equation, 2-37
- Heat exchangers:
 corrosion in, 6-106
 in power plants, 9-75
 tubes for (table), 8-186
- Heat flow, conversion table, 1-34

- Heat gains:
 from equipment, 12-75
 internal, 12-73
 from lighting, 12-73
 from people, 12-73
 solar, 12-73
 table, 12-73
- Heat insulators (*see* Insulators)
- Heat pumps, 19-2
- Heat rates:
 gross (def), 9-71
 net (def), 9-71
 for central stations (table), 9-71, 9-72
 net station (def), 9-71
- Heat transfer:
 coefficients of (def), 4-80
 to or from air, 4-83, 4-84
 to or from boiling liquids, 4-87
 combined convection and radiation, 4-88
 to or from condensing vapors, 4-87
 in refrigerating plants (table), 19-24
 for scale deposits (table), 4-85
 to or from steam (chart), 4-87
 to or from water, 4-83, 4-84
 (*See also* Film coefficients)
 in dielectrics, 19-29
 across evacuated space, 19-38
 through pipe insulation, 4-88
 chart, 4-88
 radiation shield for, refrigerated, 19-39
 radiative, 19-38
 in steam boilers, 9-39
 U values resulting from additional insulation (table), 12-71
- Heat transmission:
 coefficients of, 4-80
 (*See also* Film coefficients; Heat transfer)
 in condensers, 4-87
 by conduction, 4-80, 4-81
 and convection, 4-80
 laws of, 4-80
 by convection, 4-80, 4-81
 and conduction, 4-80
 natural, 4-86
 and radiation, 4-88
 conversion table, 1-34
 in evaporators, 4-88
 with extended surfaces, 4-86
 in furnaces (calculations), 4-72
 to high-velocity gases, 4-85
 with laminar flow, 4-86
 mean temperature difference, 4-81
 nomenclature for, 4-79
 by radiation, 4-62, 4-79
 in surface condensers, 9-76
 temperature gradient in, 4-81
 between tubes and boiling liquids (table), 4-87
 units of, 4-79
- Heat treatment:
 of iron and steel, principles of, 6-17
 of nonferrous alloys, 6-52
 of steel (*see* Steel)
- Heat value (def), 4-25
 of by-product fuels (table), 7-10
 of coal (tables), 7-2 to 7-4
 of coke (table), 7-31
 at constant pressure (def), 4-26
 at constant volume (def), 4-26
 of fuels (def), 4-25, 7-6
 Dulong's formula for, 7-6
 high and low (def), 4-25
 table, 4-26
 per unit of gaseous combustible, 4-26
 (*See also* Calorific value)
 of gaseous fuels (table), 7-15
 of hydrocarbons (table), 4-26
- Heat value (*Cont.*):
 of petroleum products, 7-11
 tables, 7-11, 7-13
 of various liquid fuels, 7-11
 of various solid fuels, 7-10
 of wood, 7-9
 tables, 7-9
- Heaters:
 Heating, 12-85
 air infiltration (tables), 12-68, 12-69
 dielectric, 7-55, 12-87
 ductwork for, 12-88
 inside design conditions (table), 12-63
 moisture infiltration effects on, 12-64
 outdoor air requirements (table), 12-67
 overall heat-transfer coefficients (table), 12-70
 steam piping for, 12-96
 pipe capacities of, 12-96
 tables, 12-98
- Heating coils, film coefficients for, 4-84
- Heating systems:
 corrosion in, 6-107
 fans for, 14-50
- Heave (ships, def), 11-45
- Heaviside function, 2-36
- Heavy water, 9-140
- Hectare (def), 1-21
- Helical gears, 8-94
- Helicon gears, 8-100
- Helicopters, 11-71
 definition of, 11-59
- Helium dilution refrigerators, 19-28
- Helmholtz free energy (thermodynamics), 4-6
- Helve hammers, 13-22
- Hemispherical flux density, total (heat radiation, def), 4-62
- Hemp, 6-136, 6-140
 properties of (table), 6-141
- Henequen fiber, 6-137
- Henry (inductance, def), 15-2
- Herbert cloudburst test, 5-13
- Herbert pendulum hardness test, 5-13
- Hermetian matrices, 16-41
- Herringbone gears, 8-94
- Hexadecimal numbers (computers), 2-41
- Hexagon (geometric construction), 2-6
- Higas process (gasification), 7-35
- High heat value of fuels, 4-26
- High-speed steel, 6-30
 composition and uses of (tables), 6-32
 tools, 13-49
- High-vacuum pumps:
 applications of, 14-43
 baffles and traps for, 14-42
 compression ratio of (def), 14-40
 conductance, 14-43
 cryopumps, 14-41
 diffusion, 14-39, 14-42
 forepressure in, 14-40
 fractionating, 14-41
 gas-ballast, 14-42
 gas flow at low pressure in, 14-43
 getter-ion, 14-41
 installation of, 14-42
 Knudsen number for, 14-43
 mercury-vapor, 14-41
 net pumping speed of, 14-43
 outgassing rates of, 14-43
 pressure range (table), 14-40
 pumping speed of (def), 14-39
 Roots-type, 14-43
 rotary mechanical, 14-39
 roughing time of, 14-43
 sorption, 14-41
 sputter-ion, 14-41
 throughput of (def), 14-39
- High-vacuum pumps (*Cont.*):
 turbomolecular, 14-42
 types and sizes of (tables), 14-40
 ultimate pressure (def), 14-39
 ultrahigh vacuum, 14-40
 vapor contamination in, 14-42
- High-voltage measurements, 15-24
- Hill climbing (optimizing), 2-52
- Histograms, 17-10
- Hitches, in rope, 8-81
- Hitensō bronze (electrical conductor), 15-6
- Hobbing processes, 13-60
- Hodograph (def), 3-11
- Hogging (ships, def), 11-43
- Hogging ejectors, 9-83
 capacity of (table), 9-83
 materials for, 9-83
- Hohmann transfer (space maneuver), 11-106
- Hoisting:
 cableways for, 10-30
 drums for, 10-9
 load-suspension devices for, 10-7, 10-10
 speeds in, 10-17
 wire rope for, 10-8
- Hoisting machinery:
 drums, 10-9
 sheaves, 10-10
 tackle blocks, 10-10
- Hoisting mechanisms, 8-8
- Hoists:
 air-motor, 10-14
 brakes for, 10-13, 10-14, 10-17
 chain, 10-12
 electric, 10-14
 tables, 10-15
 Koepe, 10-16
 lever-operated, 10-13
 table, 10-14
 load brakes for, 10-10
 mine, 10-16
 balanced (def), 10-16
 electrical equipment for, 10-17
 motors for, 10-17
 monorail, 10-26
 table, 10-26
 pneumatic, 10-14
 power: motors for, 15-44
 wire rope for, 10-8
 skip, 10-16
 trolley, 10-13
- Holding, of materials, 10-3
- Holding mechanisms, 10-10
- Holland formula, for stack plumes, 18-14
- Hollow building blocks (table), 12-28
- Honing, 13-64
- Hooke's joint (coupling), 8-36
- Hooke's law, 5-17
- Horizontal-piston power pumps, 14-2
- Horsepower (def), 1-21
- Hose:
 ANSI: couplings for: threads for, 8-214
 table, 8-214
 fire, 18-27
 ANSI: couplings, 8-214
 dimensions of (table), 8-214
 screw thread, 8-214
 flexible metal, 8-215
 pressure, 8-214
 for hydraulic fluids, 8-40
 rubber-lined, 8-214
 SAE standard, 8-40
- Hoses, SAE standard (table), 8-40
- Hot-air engines:
 internally focusing regenerative, 9-21
 solar, 9-21
 for space power, 9-21

- Hot drawing, **13-18**
 Hot-working of metals, **13-9**
 Hotchkiss drive (automobile), **11-11**
 Household refrigerating machines, **19-16**
 HP 80: pressure-enthalpy chart for, **19-11**
 HSPF (heating season performance factor, def), **19-2**
 Human factors engineering, **17-39**
 Human-generated power, **9-4**
 Humans:
 energy output of, **9-5**
 in bursts, **9-5**
 metabolic balance for, **11-120**
 table, **11-120**
 physiological limits of, **9-5**
 Humidification of air, **4-17**
 (See also Air conditioning)
 Humidity:
 measurement, **4-15**
 by chemical analysis, **4-15**
 molal (def), **4-15**
 relative (def), **4-15**
 specific (def), **4-15**
 Huntington's postulates (Boolean algebra), **15-80**
 Huygen's approximation to length of circular arc, **2-8**
 Hydrated lime, **6-160**
 Hydraulic brakes, **11-14**
 Hydraulic control systems, **16-30**
 Hydraulic conveyors, **10-54**
 Hydraulic couplings, **8-36, 11-6, 11-7**
 Hydraulic grade line (def), **3-37**
 Hydraulic jacks, **10-16**
 efficiency of, **3-26**
 Hydraulic power transmission, **8-39**
 flow velocities in, **8-40**
 fluids for, **6-184**
 hose fittings for, **8-40**
 pipe for, **8-40**
 tubing for, **8-40**
 tubing fittings for, **8-40**
 Hydraulic presses, **13-21**
 Hydraulic radius, **3-50**
 table, **3-38**
 Hydraulic torque converter (automobiles), **11-7**
 Hydraulic turbines:
 auxiliaries for, **9-160**
 cavitation in, **9-159**
 plant sigma for prevention, **9-159**
 classification of, **9-150**
 computer-aided design of, **9-160**
 Francis (see Hydraulic turbines, reaction)
 fundamental formulas, **9-149**
 general arrangements (table), **9-151**
 governors, **9-159**
 electric, **9-159**
 electronic, **9-159**
 head limits (table), **9-151**
 homologous turbines, **9-158**
 impulse, **9-150, 9-155**
 basic dimensions, **9-156**
 blade forces in, **3-40**
 buckets, **9-156**
 efficiency of, **9-156**
 general arrangement (table), **9-151**
 housings, **9-156**
 jet deflectors, **9-156**
 nozzles, **9-156**
 regulation of, **9-156**
 runaway speed, **9-157**
 runners, **9-156**
 settings for, **9-156**
 table, **9-151**
 specific speeds, **9-156**
 speed selection, **9-156**
 Hydraulic turbines, impulse (Cont.):
 tailwater level, **9-156**
 usual head limits (table), **9-151**
 model tests of (chart), **9-158**
 number of units in plant, **9-150**
 Pelton-type (see Hydraulic turbines, impulse)
 pressure regulators, **9-160**
 propeller-reaction: adjustable-blade runners, **9-151**
 Kaplan-type, **9-151**
 specific speed, **9-152**
 thrust, **9-153**
 usual head limits (table), **9-151**
 proportionality laws for, **9-150, 9-158**
 reaction, **9-151**
 axial-flow, **9-151**
 types of, **9-151**
 bearings for main shaft, **9-154**
 case velocities (chart), **9-154**
 characteristics of, **9-153**
 design of, **9-152**
 draft tubes for, **9-155**
 general arrangement (table), **9-151**
 number of runners (table), **9-151**
 runners, **9-154**
 settings for (table), **9-151**
 specific speeds, **9-152**
 spiral cases for, **9-154**
 stay rings for, **9-154**
 thrust bearings for, **9-154**
 usual head limits (table), **9-151**
 wearing rings for, **9-154**
 reversible pump, **9-157**
 runaway speed, **9-153, 9-157**
 selection of, **9-150**
 specific speed (def), **9-150**
 speed regulation, **9-159**
 requirements, **9-160**
 speed selection, **9-150**
 surge tanks for, **9-160**
 tests of, **9-160**
 types of, **9-150**
 general arrangements (table), **9-151**
 selection of, **9-150**
 usual head limits (table), **9-151**
 vacuum breakers for, **9-155**
 valves for, **9-156**
 water hammer in penstocks of, **9-160**
 wicket gates and mechanisms for, **9-154**
 Hydrazine (rocket fuel), **7-29**
 Hydrocarbons:
 air for combustion of (table), **4-27**
 boiling points of (table), **4-50, 4-53**
 heats of combustion of (table), **4-26**
 products of combustion of (table), **4-27**
 Hydroelectric power stations, cost of, **17-34**
 Hydrofoil craft, **11-41, 11-57**
 lift-drag ratios (chart), **11-58**
 Hydrogasification processes (gas making), **7-35**
 Hydrogen:
 air for combustion of (table), **4-27**
 as cryogen, **19-34**
 flame temperature and dissociation (table), **4-29**
 as fuel, **9-23**
 heat value (table), **4-26**
 liquid (rocket fuel), **7-29**
 normal saturated, properties of (table), **4-37**
 products of combustion of (table), **4-27**
 Hydrogen peroxide as rocket fuel, **7-29**
 Hydrogenation, of coal, **7-40**
 Hydrometers, **3-36**
 scale for, **1-27**
 Hydrophones, **12-118**
 Hydrostatics, **3-33 to 3-36**
 Hygrometer, **4-15, 16-18**
 Hypalon, uses of, **6-148**
 Hyperbola:
 area of, **2-8**
 conjugate, **2-21**
 equation for, **2-20**
 equilateral, **2-21**
 properties of, **2-20**
 Hyperbolic differential equations, **2-34**
 Hyperbolic functions (sinh, cosh, tanh), **2-18**
 graphs of, **2-18**
 series for, **2-31**
 Hypereutectoid (steel), **6-17**
 Hypergeometric distribution, **2-10**
 Hypersonic aerodynamics (see Supersonic and hypersonic aerodynamics)
 Hypocycloid, **2-22**
 Hypoeutectoid (steel), **6-17**
 Hypoid gearing, **8-95**
 Hypotrochoid, **2-22**
 Hysteresis, magnetic, **15-10**
 Hysteresis loop, **15-10**
 Hysteresis loss, in magnetic metals (table), **15-10**
 Steinmetz's law of, **15-10**
 Hysteretic damping, **3-66**
 Hytemco (resistor alloy), **15-62**
 table, **15-61**
 I beams:
 deflection of (tables), **12-42, 12-47**
 safe loads for, **12-42**
 standard, properties of (tables), **12-35**
 wide-flange, properties of (tables), **12-36**
 IC (see Integrated circuits)
 Ice, specific gravity and density (table), **6-8**
 Ice making, **19-24**
 can system, **19-24**
 extrusion method, **19-24**
 Flakice method, **19-24**
 PakIce method, **19-24**
 Ice-skating rinks, piping for, **19-25**
 ICI color method, **12-107**
 Icosahedron, **2-9**
 Ideal gas law, **3-39**
 Ideal radiator (def), **4-62**
 Ignition coils, **15-66**
 Ignition lag (internal-combustion engines), **9-115**
 Ignition quality of fuels, **9-116**
 Ignition systems:
 in automobile engines, **9-114**
 battery, **15-66**
 electrical, **15-66**
 magnetos for, **15-67**
 spark gaps for, **9-114**
 Ignition temperatures, for fuels, **9-115**
 IIR (infinite impulse response), **15-84**
 Ilgner method of motor-speed control, for mine hoists, **10-17**
 Illuminance (def), **12-99**
 Illumination, **12-99**
 calculation of, **12-107**
 calculation sheet for, **12-114**
 coefficients of utilization of, **12-107**
 color of, **12-100**
 dimming systems for, **12-116**
 fixtures (see Lighting fixtures)
 glare in, **12-105**
 industrial, **12-111**
 prescribing of, **12-105**
 for various activities (table), **12-106**
 for various locations (table), **12-106**
 visual-comfort criteria, **12-106**
 (See also Lamps; Lighting)
 Imaginary numbers (def), **2-3**

- Impact, 3-18, 5-43
 collinear, 3-18
 definition of, 3-18, 5-43
 of elastic and inelastic bodies, 3-19
 oblique, 3-18
 stress due to, 5-44
 of water jet against plate, 3-19
- Impact tests, 5-7
- Impedance (electric circuits, def), 15-3, 15-18
 synchronous, 15-32
- Implicit functions, 2-25
- Impregnating compounds (motor coils), 6-138
- Improshare (bonus plan), 17-10
- Impulse:
 angular (def), 3-18
 linear (def), 3-18
- Impulse function, 2-36
- Impulse turbines (*see* Hydraulic turbines; Steam turbines)
- Incentive wage systems, 17-10
- Inch:
 circular (def), 1-16
 miner's (def), 1-16
- Incinerators, 7-46
 air-pollution control of, 7-49, 18-16, 18-18
 air supplies to, 7-46
 blower capacities for, 7-46
 energy from (table), 7-47
 flues for, 7-48
 fuel used in, 7-45
 furnace configurations in, 7-46
 furnace design, 7-46
 furnace feed for, 7-46
 furnace types, 7-46
 grates for, 7-46
 heat calculations for, 7-49
 heat recovery from, 7-47
 locations for, 7-46
 materials balance in (table), 7-51
 plant cross section (fig), 7-48
 plant design, 7-46
 for refuse-derived fuel (RDF), cross section of, 7-49
 refuse-handling facilities for, 7-46
 residue disposal from, 7-49
 salvage from, 7-51
 waste-to-energy (WTE), 7-51
 energy from (table), 7-47
- Inclined planes, laws of, 3-14
- Income statement (accounting), 17-12
- Inconel:
 composition and properties of (tables), 6-78, 6-79, 6-89, 6-90
 strength of, at high temperatures (tables), 6-78, 6-79, 6-89, 6-90
- Indentation hardness, 5-13
- Indeterminate forms (calculus), 2-25
- Index of refraction, 19-41
- Indicator diagrams of steam engines, 9-54
- Indicators:
 for engines: electric, 16-15
 high-speed, 16-16
- Induced angle of attack (aerodynamics, def), 11-61
- Induced drag (aerodynamics), 11-61, 11-62
- Induced emf, 15-16
 direction of, 15-11
- Inductance (electrical circuits), 15-16
 units of (def), 15-2
- Induction (electrical circuits), 15-17
- Induction brazing, 13-29
- Induction furnaces, 7-57
- Induction generators, 15-34
- Induction heaters, 7-52, 7-55, 15-87
- Induction watt-hour meters, 15-23
- Inductive circuits, 15-2, 15-17
- Inductive reactance, 15-3, 15-18, 15-19
- Industrial accidents, prevention of, 18-19 to 18-21
- Industrial accounting, 17-11
 balance sheets, 17-12
- Industrial cars, 10-21
- Industrial electronics, 15-85
- Industrial engineering, 17-25
- Industrial heating furnaces, 7-41
- Industrial management, 17-2
- Industrial organization, 17-2
- Industrial plants, 12-2
 activities in, 12-3
 air conditioning of, 12-13
 aisle space in (for accident prevention), 18-19, 18-20
 automatic control in (*see* Automatic control)
 bay sizes for, 12-14
 beams in, 12-14
 bearing walls for, 12-25
 braced frames for, 12-25
 building orientation of, 12-5
 color codes for, 12-15
 color use in, 12-15
 columns in, 12-14, 12-25
 compressed air for, 12-13
 configuration of, 12-6
 construction contracts for, 12-17
 contracts for, 12-17
 cost estimates for, 12-17
 design of, 12-3
 doors for, 12-15
 electric power for, 12-11
 emergency egress from, 12-14
 equipment replacement in, 17-7
 equipment specifications for, 12-4
 exterior walls for, 12-15
 flexibility of, 12-2
 floors for, 12-15
 footings for, 12-14
 foundations for, 12-14
 functions required from, 12-2
 geographic location of, 12-5
 heating and ventilating in, 12-13
 interior walls for, 12-15
 lighting in, 12-11, 12-102
 locating of, 12-2
 material flow in, 12-3
 natural light in, 12-11
 noise in, 12-16
 sources of, 12-16
 obsolescence in, 12-2
 parking at, 12-14
 for trucks, 12-14
 partitions for, 12-15
 people movement in, 12-3
 planning of, 12-2
 plans and specifications for, 12-17
 plant security for, 12-14
 plumbing for, 12-12
 purpose for, 12-2
 ramps for, 12-15
 raw materials in, 12-4
 real estate for, 12-2
 regulations covering, 12-15
 roof profiles for, 12-15
 roofs for, 12-15
 safety provisions in, 18-19 to 18-21
 seasonal variations affecting, 12-3
 services in, 12-10
 shear walls for, 12-25
 site selection for, 12-5
 space requirements in, 12-3, 12-4
 specifications for, 12-17
 sprinklers for, 12-12
- Industrial plants (*Cont.*):
 support functions for, 12-4
 system balancing of, 12-2
 system integration of, 12-2
 truck access to, 12-14
 utilities for, 12-4
 walls for, 12-25
 warehousing in, 12-4
 waste disposal from, 12-16
 water for, 12-12
 wind forces on, 12-19
 windows for, 12-7, 12-11
 working drawings for, 12-17
- Inertia (def), 3-2
 force of reciprocating-engine parts, 8-65
 moment of (*see* Moments, of inertia)
 principal axis of (def), 3-8
 product of (def), 3-8
 radius of (def), 3-8
- Inflammability (*see* Flammability)
- Inflection, points of (calculus), 2-25
- Information, coding of, for electronic transmission, 16-21
- Infrared testing of materials, 5-67
- Infusorial earth (abrasive), 6-129
- Ingot iron, 6-13
 effect of cold rolling on (chart), 6-13
- Ingots:
 steel, 6-14
 defects in, 6-14
- Inhibitors (corrosion), 6-104
- Inner product (mathematics, def), 2-11
- Inorganic compounds, heat of formation of, 4-29
- Inspection of castings, 13-7
- Instant center, 8-4
- Instantaneous axis (kinematics), 3-13, 8-4
- Instruments, 16-2
 accuracy of (def), 16-2
 for cryogenics, 19-37
 electrical (*see* Electric instruments)
 error in, 16-2
 gages (*see* Gages)
 nuclear radiation, 16-19
 precision of (def), 16-2
 for pressure measuring, 16-8
 recording, 16-19
 resolution of (def), 16-2
 sensitivity of (def), 16-2
- Insulating materials:
 electrical, 6-138
 properties of (table), 15-16
 thermal conductivity of (tables), 4-83
- Insulating paper, 6-139, 15-51
- Insulating varnishes, 6-138
- Insulation:
 additional, U values resulting from (table), 12-71
 electric, 15-15, 15-16
 classes of, 15-43
 copper wire, 15-56
 impregnated fabrics, 6-139, 15-50
 impregnated paper, 15-51
 for magnet wire, 15-65
 resistance: measurement of, 15-24
 of underground cable, 15-50
- reflective, 6-151
- thermal, 6-149
 of cold-storage rooms, 19-23
 for cryogenic temperatures, 6-150
 for cryogenics, 19-38
 for high temperatures, 6-150
 for moderate temperatures, 6-150
 multilayer, 19-39
 of pipes, heat transmission through, 4-88
 powder, 19-39

- Insulation, thermal (*Cont.*):
 reflective, 6-151
 for refrigeration, heating, and air conditioning, 6-150
 rigid-foam, 19-39
- Insulators:
 conductivity of (tables), 4-84
 electric properties of (tables), 15-16
 heat transmission through, 4-88
- Integers (def), 2-3
- Integral calculus, 2-26 to 2-30
- Integral compensation (automatic control), 16-25
- Integrals:
 approximate computation of, 2-29
 definite, 2-29
 double, 2-29
 elliptic, 2-29
 indefinite (table), 2-26 to 2-28
 probability, 2-29
 triple, 2-30
 volume, 2-30
- Integrated circuits, 15-75
 computer, 15-82
 digital, 15-79
 linear, 15-75
- Intensifiers (pumps), 14-3, 14-10
- Intensity:
 field, unit of, 3-19
 of radiation (heat transfer), 4-62
 of sound (def), 12-117
- Intercondensers, 9-82
- Interest, compound, tables for, 1-5, 1-6
- Interference: optical, 19-42
- Interference drag, 11-70
- Interference fits, 8-44
 preferred metric sizes (table), 8-45
- Interferometer, 19-42
- Interior wiring (*see* Wiring)
- Internal brakes, 8-40
- Internal-combustion engines, 9-90
 air cooling for, 9-118
 air lines, 9-108
 air pollution from, 9-119
 airplane (*see* Airplanes, engines)
 analysis of engine process, 9-91
 automobile (*see* Automobile engines)
 back pressure, 9-106
 carburetion, 9-109
 metering characteristics, 9-109
 combustion chambers, 9-111
 divided, 9-113
 open, 9-113
 combustion knock, 9-115
 combustion process, 9-93
 combustion roughness, 9-112
 compression-ignition, 9-90, 9-113
 compression pressure in, 9-90
 compression process, 9-93
 compression ratios, 9-90
 cooling systems, 9-117
 cycles, 4-11, 9-90
 deviations from ideal processes, 9-92
 diesel (*see* Diesel engines)
 dissociation, 4-30
 dual-fuel, 9-90
 exhaust-gas, analysis of, 9-94
 temperatures, 9-94
 exhaust manifolds for, 9-106
 exhaust process, 9-93
 expansion process, 9-93
 explosions in, 4-30
 flame travel, 9-93
 four-cycle, 9-91
 fuel injection, 9-109, 9-110
 pumps, 9-109, 9-111
- Internal-combustion engines (*Cont.*):
 fuel lines, 9-108, 9-111
 fuels, 9-104
 table, 9-103
 antiknock compounds (table), 9-116
 autoignition temperatures, 9-115
 cetane number (def), 9-116
 flame speed in, 9-114
 gasoline (*see* Gasoline)
 ignition quality, 9-116
 ignition temperatures (table), 9-114
 injection for, 9-109, 9-110
 kerosine (*see* Kerosine)
 knock rating, 9-115
 knock suppression, 9-116
 knock suppressors (table), 9-116
 octane number (def), 9-115
 permissible compression ratios, 9-117
 road ratings, 9-116
 vapor lock, 9-108
 volatility of, 9-104
 gas lines, 9-108
 horsepower, 9-91
 idling jets, 9-109
 ignition systems (*see* Ignition systems)
 indicators, high-speed, 16-16
 intake manifolds, 9-106
 knock, combustion causing, 9-115
 (*See also* Internal-combustion engines, fuels)
 L-head, 9-112
 locomotive, 9-102
 lubrication, 6-181, 9-118
 marine, 9-99
 mean effective pressure in, 9-91
 mixture distribution, 9-108
 muffle pits for, 9-106
 mufflers for, 9-106
 oil cooling, 9-118
 outboard (table), 9-99
 pistons (*see* Pistons)
 precombustion chambers for, 9-113
 pumping work, 9-92
 for recreation vehicles, 9-100
 regulation of (speed and load), 9-117
 scavenging, 9-107
 small, 9-100
 table, 9-101
 spark advance, 9-114
 spark-ignition, 9-90, 9-111
 stationary, 9-99
 stratified-charge spark-ignition, 9-113
 supercharging of, 9-106
 tractor, 9-98
 truck and bus, 9-97
 two-cycle, 9-91
 utility, 9-100
 volumetric efficiency, 9-92
 table, 9-93
 water cooling of, 9-117
- Internal energy of gases, 4-9, 4-29
 table, 4-28
- Internal-friction theory (stress analysis), 5-49
- International Aluminum Standard, 15-6
- International Copper Standard, 15-5
- Interpoles in d-c generators and motors, 15-29
- Inventions, patents for, 18-28 to 18-30
- Inverse hyperbolic functions, 2-18
- Inverse trigonometric functions, 2-17
- Inversion temperature (Joule-Thomson effect), 4-24
- Investment process (molding), 13-4
- Involute gear teeth, 8-88
- Involute splines, 8-33
- Involutes:
 of circles, 2-23
 of curves (def), 2-26
- Ionization, effects of, on materials, 9-138
- Iridium, uses of, 6-74
- Iron:
 alloys, machinability of, 13-47
 alpha (def), 6-16
 cast (*see* Cast iron)
 castings (*see* Castings)
 classification of, 6-13
 corrosion (*see* Corrosion)
 creep rates of (table), 5-11
 delta (def), 6-16
 foundry practice (*see* Foundries)
 gamma (def), 6-16
 ingot, 6-13
 malleable, 6-41
 physical properties of, 6-17
 pig, 6-13
 and steel, 6-13
 strength of at high temperature (table), 5-11
 wrought (*see* Wrought iron)
- Iron-iron carbide equilibrium diagram, 6-16
- Iron ore, sources of, 6-13
- Ironing (thinning of metal in bending, def), 13-16
- Irradiation, effects of, 9-142
 (*See also* Radiation)
- Irrational numbers (def), 2-3
- ISCC-NBS color method, 12-107
- Istropic expansion:
 of gases, 4-9
 of vapors, 4-14
- ISO 9000:
 registration, 18-2
 quality control under, 17-6
- Iso-butane, properties of (table), 4-36
- ISO metric screw threads (table), 8-14
- Isoclinics (stress analysis), 5-52
- Isolation, of vibrations, 3-65
- Isostatics (stress analysis), 5-52
- Isothermal expansion:
 of gases, 4-9
 of vapors, 4-14
- Isotherms, of winter temperatures (chart), 12-63
- Isotopes, 6-7, 9-133
- IT calorie (International Steam Table) (def), 1-20, 4-3
 mechanical equivalent of, 1-20
- Jacks, 10-15
 rack and lever, 10-16
- Jaw clutches, 8-37
- Jet condensers, 9-81
- Jet fans, 14-51
- Jet propulsion (*see* Aircraft jet propulsion)
- Jets:
 pressure of: against blades, 3-40
 water: impact of, 3-19
- JFET (bipolar junction field effect transistor), 15-70
- Jib cranes, 10-27
- Jig boring machines, 13-55
- Jig transits, 16-6
- JIT (just in time) delivery, 17-4
- Job evaluation, of workers, 17-10
- Job-order costing, 17-14
- Job standardization, 17-28
- Johnson counter, 15-81
- Joints:
 in belts, 8-51
 knuckle, 8-33
 method of (stress determination), 3-6
 pin, friction in, 3-28

- Joints (*Cont.*):
 pipe (*see* Pipe, joints)
 riveted (*see* Riveted joints)
 toggle, **8-8**
 universal, **8-36**
 Joists, steel, **12-43**
 Jolt molding machines, **13-5**
 Jominy hardenability test, **6-18**
 Joule (unit of work, def), **1-18, 15-2**
 Joule cycle, **4-11, 4-13, 9-125**
 Joule-Thomson coefficient (def), **4-5, 4-24**
 Joule-Thomson effect (throttling), **4-24**
 Joule's law (electric currents), **15-8**
 Journal bearings (*see* Bearings)
 Journals (*see* Shafts)
 Jupiter, planetary data for (tables), **11-102, 11-103**
 Jute fiber, properties of (table), **6-141**
- Kalman filter (control theory), **16-44**
 Kanthal:
 as resistor material, **15-62**
 table, **6-78**
 Kaolin in firebrick, **6-152**
 Kaplan-type turbines (hydraulics), **9-151**
 Kármán vortices, **12-21**
 Karnaugh maps (circuit analysis), **15-80**
 Keene's cement (plaster), **6-163**
 Kelly ball test for concrete, **6-166**
 Kelvin (unit of temperature, def), **1-17, 1-25**
 Kelvin absolute temperature scale, **4-2**
 conversion to degrees Celsius (eq), **4-2**
 Kelvin double bridge, **15-25**
 Kelvin's law for economical conductor size, **15-47**
 Kepler's laws (satellites), **11-105**
 Kern (def), **5-40**
 Kernel (matrix, def), **2-14**
 Kerosine, **7-13**
 Keys, **8-31**
 feather, **8-31**
 flat, **8-31**
 gib-head (table), **8-32**
 sunk (table), **8-33**
 taper, **3-26, 8-31**
 table, **8-32**
 Woodruff (table), **8-32**
 Kilocalorie, mechanical equivalent of, **1-33**
 Kilogram (unit of mass, def), **1-17**
 Kilovars (reactive current, def), **15-2, 15-19**
 Kilowatt (def), **15-8**
 Kilowatt-hour (def), **15-3, 15-8**
 Kinematic similarity (models), **3-41**
 Kinematic viscosity, **3-33**
 Kinematics (def), **3-10**
 of fluids, **3-36**
 (*See also* Mechanism)
 Kinescope (television), **15-89**
 Kinetic friction (def), **3-21**
 Kingsbury thrust bearings, **8-126**
 coefficient of friction of, **3-28**
 Kirchoff's laws:
 in electrical circuits, **15-8**
 of radiation (def), **4-62**
 Kirsten-Boeing ship propellers, **11-55**
 Klystron, **15-74, 15-88**
 Knock (detonation), **7-12**
 suppression of, **9-116**
 Knock rating:
 of gasolines, **7-12, 9-115**
 aviation, **9-115**
 motor, **9-115**
 research, **9-115**
 supercharge, **9-115**
 Knot (nautical unit, def), **1-16**
 Knots in rope, **8-81**
- Knuckle joints, **8-33**
 Knudsen number, **14-43**
 Koepe hoists, **10-16**
 Koppers-Totzek process, **7-38**
 Kort nozzle system (ship propulsion), **11-55**
 Kraft paper, **6-144**
- Labor, energy produced by, **9-4**
 Labyrinth seal, **8-142**
 for steam turbines, **9-63**
 Lac (resin), **6-112**
 Lacquers, **6-108**
 composition and uses of, **6-112**
 Lag bolts, allowable lateral loads on (table), **12-33**
 Lag screws:
 holding power of, **12-32**
 lead holes for, **12-32**
 proportions of (table), **8-24**
 uses of, **8-21**
 Lambert surfaces (radiant heat, def), **4-63**
 Lamé's formula for collapse of thick tubes, **5-46**
 Laminar flow, **3-46, 3-47, 3-49**
 Laminated foil, **13-14**
 Laminated wood, **6-123**
 Lamps:
 ballasts for, **12-101**
 circuits (chart), **12-103**
 economics of installations, **12-116**
 electric, **12-100**
 energy distribution from (fig), **12-116**
 fluorescent: characteristics of (table), **12-104**
 life of (table), **12-104**
 preheat circuits for, **12-101**
 high-intensity-discharge, **12-102**
 characteristics of (table), **12-104**
 figure, **12-105**
 high-pressure sodium vapor, **12-102**
 figure, **12-105**
 incandescent, **12-100**
 bases for, **12-100**
 bulbs, **12-100**
 characteristics of (table), **12-102**
 metal halide, **12-102**
 figure, **12-105**
 starting circuits for, **12-101**
 vapor, **12-102**
 Lanchester-Prandtl theory (aerodynamics), **11-62**
 Land measure, units of, **1-16**
 Landfill, **18-18**
 Lang-lay wire rope, **10-8**
 Laplace equation, **2-34**
 Laplace operator, in automatic control analysis, **16-26**
 Laplace transformation mathematics, **2-35, 2-36**
 Laplace transforms, **2-35**
 table, **2-35**
 Lapping, **13-64**
 Lapping machines, **13-64**
 Larson-Miller parameter (creep), **6-77**
 Lasers, **15-74, 19-42**
 for machine alignment, **16-6**
 Latent heats (def), **4-4**
 of fusion (tables), **4-50, 4-58**
 of vaporization (tables), **4-50, 4-58**
 Latex, **6-148**
 Lathes, **13-51**
 cutting tools for (*see* Cutting tools)
 sizes of, **13-52**
 troubleshooting of (table), **13-54**
 turning recommendations for (table), **13-53**
 turret, **13-52**
 Latus rectum:
 of parabola, **2-19**
 semi-, of ellipse, **2-20**
- Law of cosines, **2-17**
 Law of sines, **2-17**
 Lay cables, **15-6**
 copper (table), **15-6**
 Layers, for communications networks, **2-47**
 Layouts, industrial, **17-4**
 LBM (laser-beam machining), **13-67**
 L.B.P. (length between perpendiculars, def), **11-42**
 LDPE copolymer resins: properties of (table), **6-196**
- Lead:
 chemical, specifications (table), **6-75**
 corroding, specifications (table), **6-75**
 creep rates for (table), **5-10**
 specifications (table), **6-75**
 in type metals (table), **6-75**
 Lead alloys, for bearings (table), **6-61**
 Lead solders, melting points of (table), **6-76**
 Leaded-coppers, **6-67**
 League (unit of length, def), **1-16**
 Leakage, magnetic, **15-10**
 Leakage loss, through steam turbines, **9-63**
 Leaks: refrigerant: detection of, **19-7**
 Least work, principle of, **5-36**
 Leather:
 in belts (*see* Belts)
 specific gravity and density of, **6-7**
 Leclanché cell, **15-11**
 Ledoux bell flowmeter, **16-14**
 Leidenfrost point (def), **4-87**
 Lemniscate, **2-24**
 Length:
 conversion table for, **1-28, 1-29**
 equivalents (table), **1-28**
 of plane figures, **2-7**
 units of (def), **1-16, 1-17, 1-24**
 Lenses, **19-41**
 power of, **19-41**
 Leveling, **16-51**
 with transit and stadia, **16-55**
 Levels:
 adjustment of, **16-52**
 automatic, **16-52**
 inspection of, **16-52**
 setup and use of, **16-51**
 surveying, **16-6**
 Lever (mechanism), **8-3**
 Lewis formulas for strength of gear teeth, **8-100**
 Liability insurance, **18-31**
 Licensing of engineers, **18-31**
 Lift (aerodynamics, def), **11-60**
 in hydraulics, **3-47**
 Lift coefficient (def), **11-61**
 Lift trucks, **10-23**
 Lifting magnets, **10-11, 15-64**
 Lifting tongs, **10-10**
 Light:
 sources of, **12-100**
 units of, **12-99**
 velocity of, **19-41**
 wavelengths of (chart), **19-42**
 (*See also* Illumination)
 Light meters, **12-99**
 Light year, **11-101**
 Lighting, **12-99**
 artificial, **12-11, 12-105**
 economics of, **12-116**
 heat from, **12-116**
 of industrial plants, **12-11, 12-105, 12-107**
 natural, **12-11**
 of offices, **12-106**
 (*See also* Illumination)
 Lighting design, cavity reflectances (table), **12-108, 12-112**

- Lighting fixtures, **12-100**
 heat gain from (charts), **12-73**
- Lighting systems:
 for automobiles, **15-66**
 design of, **12-107**
- Lignite, **7-5**
 analysis of (table), **7-3 to 7-5**
 combustion of, **9-30**
- Lime:
 common (quicklime), **6-160**
 granulated, **6-160**
 hydrated, **6-160**
 magnesium, **6-160**
 specific gravity and density of (table), **6-8**
- Lime mortar, **6-160**
- Lime-soda process (feedwater treatment), **9-48**
- Limestone, composition of, **6-143**
- Linde liquid-air system, **19-26**
- Line integrals, **2-34**
- Line organization (def), **17-2**
- Linear differential equations, **2-32, 2-34**
- Linear equations, solution of, **2-12, 2-32, 2-38**
- Linear expansion, coefficient of (def), **4-2**
- Linear measurements, **16-4**
- Linear programming (optimization), **2-52, 17-8**
 to minimize costs, **17-8**
- Lines:
 bisection of, **2-5**
 center of gravity of, **3-6**
 equations of, **2-12, 2-18**
 of force (mechanics, def), **3-19**
 directions of (magnetic), **15-11**
 geometric constructions of, **2-5, 2-6**
 rope, breaking strength of (table), **8-81**
- Link (unit of length, def), **1-16**
- Linkages, **8-3**
- Linotype metal (table), **6-75**
- Linseed oil, **6-108**
- Liquid-level sensors, **12-123**
- Liquid measure, **1-16**
- Liquid meters, **16-14**
- Liquids (def), **3-33**
 boiling, heat-transfer coefficients to or from, **4-87**
 coefficients of thermal expansion of, **4-2**
 compressibility, **6-9**
 densities of (table), **3-31**
 evaporation temperatures of (tables), **4-50, 4-53, 4-58**
 flow of (*see* Flow)
 general properties of, **3-31 to 3-33**
 latent heats of (tables), **4-50, 4-58**
 mechanics of, **3-29 to 3-61**
 pressure of, law of, **3-33**
 radioactive, control of, **18-17**
 at rest, properties of, **3-33 to 3-36**
 specific gravity and density of (table), **6-8**
 surface tension of (table), **3-33**
 thermal conductivity of (table), **4-82**
- Liter (def), **1-17**
- Litre (def), **1-17**
- Loaders, **10-24**
- Loading:
 by power shovel, **10-33**
 safety factors for, **5-20**
- Loading docks, design of, **10-73**
- Lobe-type pumps (rotary), **14-12**
- Lock nuts, **8-19**
- Locking fasteners (fig), **8-24**
- Locomotive cranes, **10-29**
- Locomotives, **11-20, 11-25**
 characteristics of (table), **11-21**
 diesel-electric, **11-20**
 airbrake controls for, **11-23**
 batteries for, **11-23**
- Locomotives, diesel-electric (*Cont.*):
 braking, **11-23**
 dynamic, **11-23**
 cabs for, **11-23**
 characteristics of (table), **11-21**
 compatibility of, **11-25**
 controls for, **11-22**
 chart, **11-26**
 propulsion, **11-23**
 wheel slip detection, **11-23**
 engines for, **11-21**
 governors for, **11-21**
 generators for, **11-22**
 power control of, **11-22**
 horsepower of, **11-24**
 brake, **11-24**
 drawbar, **11-24**
 indicated, **11-23**
 rail, **11-24**
 maximum speed of, **11-25**
 performance of, **11-23**
 adhesion, **11-24**
 efficiency (thermal), **11-24**
 speed-tractive effort, **11-24**
 traction motors for, **11-22, 11-24, 11-25**
 characteristics of, **11-22, 11-24, 11-25**
 wheel slip of, control of, **11-23**
 efficiency of, **3-26**
 electric, **11-25**
 arrangement of (chart), **11-26**
 drives, **11-25**
 traction motors for, **11-27**
 voltages used for, **11-25**
 electric haulage: mine, **10-19**
 weight required for, **10-20**
 engines for, **9-102**
 (table), **9-101**
 mine, **10-19**
 haulage capacity of (table), **10-20**
 speed-tractive effort (curves), **11-24, 11-25**
 steel for, ASTM specifications (table), **6-26**
 storage-battery, **10-20**
- Logarithmic decrement (vibrations), **3-63**
- Logarithmic function, series for, **2-31**
- Logarithmic mean temperature difference, **4-81, 4-83**
- Logarithmic spiral, **2-23**
- Logging of data, **16-19**
- Logs, for buildings, **6-124**
- Loop (automatic control), **16-24**
- Loop circuit, **15-52**
- Loop gain (automatic control, def), **16-28**
- Loran (navigational aid), **15-90**
- Lost-wax process (molding), **13-4**
- Loudness level, **12-118**
- Low heat value of fuels (table), **4-26**
- LOX (liquid-oxygen explosive), **7-21**
- LP (linear programming), **17-8**
- LPG (liquefied petroleum gas):
 in manufactured gas, **7-15**
 specifications for (table), **7-15**
- LQG/LTR (linear quadratic gaussian with loop transfer recovery), **16-39**
- LSI (large-scale integrated circuit), **15-81**
- Lubricants, **6-177**
 bonded, **6-181**
 coefficients of friction when using, **3-22**
 disposal of used, **6-185**
 extreme-pressure, **6-180**
 fats as, **6-177**
 fire-resistant, **6-184**
 for gas engines, **6-183**
 for gas turbines, **6-183**
 for gears (tables), **8-114 to 8-116**
 greases, **6-180**
- Lubricants (*Cont.*):
 health considerations, **6-185**
 for hydraulic systems, **6-184**
 for industrial applications, **6-183**
 for internal-combustion engines, **6-181**
 for machining operations, **6-184**
 oils (*see* Oil, lubricating)
 for press work, **13-18**
 properties of, **6-177**
 solid, **3-22, 6-181**
 sulfated-ash test for, **6-179**
 synthetic, **6-177**
 table, **6-178**
 tests for, **6-178**
 unbonded, **6-181**
 viscosity of, **6-178**
 (*See also* Lubrication)
- Lubrication, **6-177**
 of air compressors, **6-184, 14-32**
 of automobile engines, **9-118**
 of bearings, **6-183, 8-117, 8-137**
 boundary (def), **3-20, 6-178**
 complete (def), **3-20, 8-116**
 elastohydrodynamic, **6-178**
 fluid, **8-116**
 of gears, **6-183**
 greasy (def), **3-20**
 hydrodynamic, **6-178**
 hydrostatic, **6-178**
 incomplete, **3-20**
 of internal-combustion engines, **6-181, 9-118**
 and journal friction, **3-27**
 mixed-film, **6-178**
 of refrigerating machinery, **6-184**
 regimes of, **6-178**
 semifluid, **8-116**
 of steam turbines, **6-183**
 of thrust bearings, **8-126**
 viscous (def), **3-20**
 (*See also* Lubricants)
- Lubrication systems, **6-181**
- Lüders lines (rolled steel), **5-3, 6-25**
- Lumber, **6-112 to 6-128**
 allowable unit stresses in (table), **6-115 to 6-124**
 commercial standards for, **6-128**
 composite, laminated veneer, **6-123**
 parallel-strand, **6-123**
 properties of, **6-123**
 stress-graded, **6-119, 6-123**
 structural, composite, **6-123**
 types of, **6-123**
 dimensional, **6-119**
 glued-laminated, **6-123**
 machine-evaluated, **6-123**
 machine-stress-rated, **6-123**
 shrinkage in, **6-119**
 stress-graded, **6-119**
 temperature effects on, **6-121**
 visually graded, **6-119**
 (*See also* Plywood; Wood)
- Lumen (unit of luminous flux, def), **12-99**
- Luminaires, **12-102**
 dirt depreciation factors for (chart, table), **12-113**
 lenses for, **12-105**
 reflectors for, **12-105**
 utilization coefficients for (table), **12-110**
- Luminance (def), **12-99**
- Luminous efficiency (chart), **12-100**
- Lune, **2-9**
- Lurgi process (gasification), **7-35**
- LVDT (linear-variable differential transformer), **16-5**
- L.W.L. (length on load waterline, def), **11-42**

- McAdams and Sherwood coefficient of friction (fluid flow), 4-23
- Mach angle (aerodynamics), 11-74
- Mach cone (aerodynamics), 11-74, 11-77
- Mach number (aerodynamics), 11-60, 11-61, 11-72 (fluid flow), 3-42, 3-43
- Mach-Zehnder interferometer, 11-81
- Machinability (def), 13-47
- Machine elements, 8-8
- efficiencies of (table), 3-26
- rotary and reciprocating, 8-65
- Machine screws:
- driving recesses for (fig), 8-22
- head types for, 8-17, 8-19
- heads for, standards for (tables), 8-21, 8-22
- threads for, 8-8
- standards for (tables), 8-10 to 8-13
- Machine-shop practice, 13-45
- Machine tools, 13-45
- automation of, 13-50
- boring machines, 13-55
- broaching with, 13-60
- chatter in, 13-48
- cutting fluids for, 13-50
- cutting-off, 13-61
- drilling with, 13-55
- gear cutting with, 13-59
- grinders, 13-64
- lathes (*see* Cutting tools; Lathes)
- milling with, 13-57
- mist cooling for, 13-50
- numerical control of, 13-51
- planers, 13-60
- reamers, 13-56
- saws, metal-cutting, 13-61
- screw machines, 13-55
- shapers, 13-60
- tool shapes for, 13-52
- tools for (*see* Cutting tools)
- turret lathes, 13-52
- variable-speed transmissions for, 13-52
- for woodworking, 13-72
- Machine vision, 10-70
- Machinery steel, 6-28
- Machines:
- guarding of, 18-20
- point of operation (def), 18-20
- safety devices for, 18-20
- Machining, 13-65
- adaptive control for, 13-51
- of ceramics, 13-65
- by chemical milling, 13-66
- cutting fluids for, 13-50
- classification of, 13-50
- by electrical discharge, 13-66
- electrochemical, 13-66
- of plastics, 13-65
- recommendations, 13-59
- residual stress after, 13-48
- ultrasonic, 13-67
- (*See also* Machine tools; Metal cutting)
- Machining centers, 13-51
- Maclaurin's series, 2-30
- McLeod gage (high-vacuum), 16-9
- McPherson struts (automobiles), 11-11
- McRuer's rule (operator-controlled machines), 17-41
- McQuaid-Ehn test (austenitic grain size), 6-18
- Magnaflux inspection of castings, 13-8
- Magnesite brick, 6-151
- Magnesium, 6-84
- arc welding of, 6-85
- sheets, 6-85
- Magnesium alloys, 6-84
- casting, mechanical properties (table), 6-85
- forgings, 6-85
- Magnesium alloys (*Cont.*):
- joining of, 6-85
- machining of, 6-85
- properties of (tables), 6-85
- resistance to corrosion of, 6-85
- surface protection of, 6-85
- welding of, 6-85
- Magnesium chloride brine, properties of (table), 19-19
- Magnet wire, 15-65
- diameters of (table), 15-65
- Magnetic circuits, 15-8
- Ohm's law of, 15-9
- Magnetic coercive force (def), 15-10
- Magnetic drag dynamometer, 16-15
- Magnetic field intensity (def), 15-4
- Magnetic flux (def), 15-3
- Magnetic flux density (def), 15-3, 15-9
- Magnetic flux direction, 15-11
- Magnetic forming, 13-19
- Magnetic hysteresis, 15-10
- Magnetic leakage, 15-10
- coefficient of, 15-10
- Magnetic metals: powdered, properties of (table), 6-88
- Magnetic permeability (def), 15-4
- Magnetic permeance (def), 15-4
- Magnetic pickups, 16-3
- Magnetic pole (def), 15-3
- Magnetic pulleys, for conveyors, 10-51
- Magnetic refrigeration, 19-28
- Magnetic reluctance (def), 15-4
- Magnetic reluctivity (def), 15-4
- Magnetic remanence (def), 15-10
- Magnetic symbols (table), 15-3
- Magnetic tape (computers), 2-44
- Magnetic units, 15-3
- table, 15-3
- Magnetism, 15-9
- Magnetization curves, 15-9
- Magneto hydrodynamics, 9-26
- Magnetomotive force (def), 15-3, 15-9
- Magnetos, for ignition systems, 15-67
- Magnetrons, 15-74
- Magnets, 15-62
- lifting, 10-11, 15-64
- permanent, 15-62
- specialty, 10-11
- Magnification, of optical systems, 19-41
- Magnifying power of lenses, 19-41
- Magno (resistor alloy), 15-62
- table, 15-61
- Mains for electric distribution systems, 15-53
- Malleable cast iron, 6-13, 6-38, 6-41
- Malleable castings (*see* Castings)
- Man:
- energy output of, 9-5
- in bursts, 9-5
- physiological limit of, 9-5
- Man-machine interactions, 17-39
- Management:
- controlling by, 17-15
- functions of, 17-15
- industrial, 17-2
- organizing by, 17-15
- participative, 17-3
- planning by, 17-15
- responsibilities of, 17-2
- Manganese steel (table), 6-28, 6-29
- Manganin (resistor alloy), 15-62
- table, 15-61
- Manila fiber, properties of (table), 6-141
- Manila rope, U.S. specifications for (table), 6-138
- MAN/MWM stirling engines, 9-21
- Manning formula for flow in open channels, 3-59
- Manometers, 3-34, 16-8
- amplification of pressures in, 16-8
- inclined, 3-34, 16-8
- U tube, 3-34, 16-8
- well type, 3-34, 16-8
- Mantissa (def), 2-4
- Manufactured gas, 7-15
- Manufacturing:
- autofacturing, 17-41
- designing for, 17-41
- automatic, 17-41
- automatic assembly, 17-41
- procedures for, 17-41
- Manufacturing plants (*see* Industrial plants)
- Mapping, contour, 16-55
- Maraging steel, 6-27
- Marble, composition of, 6-143
- Marbon-B, uses of, 6-148
- Marine compass, 3-20
- Marine engineering, 11-40
- (*See also* Ships)
- Marine engines:
- diesel, 9-99
- gas turbine, 9-132
- internal-combustion, 9-99
- Marine Plastic Pollution Control Act of 1987, 11-48
- Marine steam turbines, 9-64
- Mark (data transmission), 16-21
- Mars, planetary data for (tables), 11-102, 11-103
- Martensite, 6-17
- Mash weld, 13-30
- Masonry:
- ashlar, 6-143, 12-28
- construction, 12-27
- mortar for (tables), 6-162
- specific gravity and density of (table), 6-8
- stone, properties of (table), 6-144
- terms for, 6-143
- working compression (table), 12-28
- Mass (def), 3-2
- center of, 3-6
- conversion to energy, 9-133
- conversion table for, 1-31
- energy equivalence of, 9-133
- equivalents (table), 1-31
- law of conservation of, 3-2, 3-39
- relativistic, 9-134
- units of, 4-2
- defined, 1-17
- variable, 3-19
- Mass defect, nuclear, 9-134
- Materials:
- general properties of, 6-3
- mechanical properties of, 5-2, 5-17
- at low temperatures, 19-32
- storage of, 10-62
- equipment used in, 10-71
- Materials handling:
- automated storage and retrieval systems for, 10-73
- classification of materials for, 10-3
- equipment used in (table), 10-36
- feeding devices for, 10-3
- holding devices used in, 10-3
- planning for, 17-4
- positioning devices for, 10-4
- Materials testing, 5-13
- Mathematical models, 2-52, 2-53
- Mathematical tables, 1-2 to 1-15
- Mathematics, 2-2 to 2-39
- Matrices:
- addition of, 2-12
- inverses of, 2-13
- multiplication of, 2-12
- nonsingular (def), 2-13

- Matrices (*Cont.*):
 row operations on, 2-13
 singular (def), 2-13
 special, 2-14
- Matrix (def), 2-12
 diagonal (def), 2-12
 identity (def), 2-12
 square (def), 2-12
 zero (def), 2-12
- Matrix algebra, 16-41
- Matter:
 conservation of, 9-134
 particles of, 9-133
- Maxima and minima, 2-25
- Maximum-distortion-energy theory (stress analysis), 5-49
- Maximum-shear theory (stress analysis), 5-48
- Maximum-strain-energy theory (stress analysis), 5-46
- Maximum-strain theory (stress analysis), 5-49
- Maximum-stress theory (stress analysis), 5-48
- Maxwell (magnetic flux, def), 15-3
- Maxwell's relations (thermodynamics), 4-6
 table, 4-7
- Maxwell's theorem (beam deflections), 5-36
- Mean, arithmetic, 17-19
- Mean camber line (airfoils, def), 11-62
- Mean effective pressure, 4-11
 in steam engines, 9-54
- Mean specific heats (*see* Specific heat)
- Mean temperature difference in heat transmission, 4-81
- Mean value theorem, 2-29
- Measurements, 16-2, 16-3
 absolute systems (mechanics), 3-2
 of acceleration, 16-17
 of angles, 16-4
 of areas, 16-7
 counting, 16-2
 electrical, 15-20, 16-16
 of fluid flow, 16-13
 integrators for, 16-15
 of fluid volume, 16-7
 of force, 16-7
 of frequency, 16-3
 gravitational systems (mechanics), 3-2
 of heat, 4-3
 of humidity, 16-18
 linear, 16-4
 of liquid level, 16-9
 of mass, 16-3
 of nuclear radiation, 16-19
 of physical and chemical properties, 16-18
 of plasticity, 16-18
 of power, 16-15
 of pressure, 16-8
 of pressure differences, 16-9
 standards for, 16-2
 of temperature, 4-2, 16-9
 of thickness, 16-5
 of time, 16-3
 of torque, 16-7
 of vacuum, 16-8
 of velocity, 16-17
 of viscosity, 16-18
 of weight, 16-3
- Measures and weights:
 metric (*see* Metric measures and weights)
 U.S., 1-16, 1-17
- Measuring instruments (*see* Instruments; Meters)
- Mechanical draft, 9-46
- Mechanical efficiency of steam engines, 9-54
- Mechanical equivalent of heat (def), 4-3
- Mechanical movements, 8-3
- Mechanical properties of materials, 5-2
- Mechanical refrigeration (*see* Refrigeration)
- Mechanical seals, 8-141
- Mechanics:
 of fluids, 3-29 to 3-61
 of materials, 5-14
 Newton's laws of, 3-2
 of solids, 3-2 to 3-20
- Mechanism, 8-3
- Megger (measurement of electrical insulation resistance), 15-24
- Megohm (electrical insulation), 6-138
- Megotalc (electrical insulation), 6-138
- Meissner effect, 19-30
- Melting points:
 of brazing alloys (table), 6-76
 of the elements (table), 4-58
 of fusible alloys (table), 6-76
 of metals (table), 6-11, 6-50
 of refractories (tables), 4-57, 6-153, 6-156
 of resistor alloys (table), 15-61
 of solders (table), 6-76
 of various substances (table), 4-50, 4-57
- Melting pots, resistor heating of, 7-54
- Membranes:
 elastomeric (table), 6-146
 vibration of, 3-73
- Mercury:
 planetary data for (tables), 11-102, 11-103
 properties of (tables), 4-51, 4-55, 4-58
 uses of, 6-74
- Mercury thermometers, 16-9, 16-10
- Mercury vapor lamps, 12-102
- Merit rating, of workers, 17-10
- Mershon diagrams:
 for a-c voltage drop, 15-47, 15-49
 chart, 15-49
- Mesh connections, in three-phase circuit, 15-20
- Metacenter, 3-36
 of ships (def), 11-44
- Metal cutting, 13-46
 basic mechanics of, 13-46
 chips produced, 13-46
 forces in, 13-46
 power requirements for, 13-47
 principles of, 13-46
 tools for (*see* Cutting tools; Machine tools)
 vibration effects during, 13-48
- Metal working (*see* Metalworking)
- Metallurgy, powder, 6-62, 6-87
 (*See also* Alloys; *specific metals*)
- Metals:
 annealing of, 13-9
 antifriction, 6-61
 atomic numbers of (table), 6-50
 atomic weights of (table), 6-50
 b.c.c., for cryogenic equipment, 19-33
 bearing (*see* Bearing metals)
 bending of, 13-16
 boiling points of (table), 6-50
 chemical symbols (table), 6-50
 coefficients of thermal expansion of, 4-2
 tables, 6-50
 coining of, 13-20
 cold-working of, 13-10
 corrosion of (*see* Corrosion)
 creep in (table, chart), 5-10, 5-11
 for cryogenic equipment, 19-32
 crystal structure of (table), 6-50
 density of (table), 6-7, 6-50
 dispersion hardening of, 13-9
 drawing of, 13-16
 elastic constants of (table), 5-4
 electrical resistivity of (table), 6-50, 15-4 to 15-6
 embossing of, 13-20
 emissivity of (table), 4-64
 extrusion of, 13-20
- Metals (*Cont.*):
 fatigue of, 5-8
 f.c.c., for cryogenic equipment, 19-32
 flow lines in, 13-9
 forging of, 13-10
 galvanic series for (table), 6-100
 h.c.p., for cryogenic equipment, 19-34
 heat content at various temperatures (chart), 7-42
 heat of fusion of (tables), 6-50
 for high-temperature use, 6-77
 hot-working of, 13-9
 jewelry, 6-74
 machinability of, 13-47
 melting point of (table), 4-81, 6-50
 modulus of elasticity of (table), 5-4, 6-50
 molten, properties (table), 4-81
 nonferrous, 6-49
 for nuclear-energy applications, 6-82
 physical constants of (table), 6-50
 plastic range of, 13-9
 chart, 13-10
 powdered, fabrication of, 6-62, 6-87
 (*See also* Powdered metals)
 properties of (table), 6-7
 relaxation test for, 5-10
 resistivity (table), 15-4
 resistor materials, 15-61
 shearing of, 13-14
 specific gravity and density of (table), 6-7
 specific heat (table), 6-50
 spinning of, 13-14
 squeezing of, 13-19
 stamping of, 13-20
 strain limit in, 13-10
 strength of (table), 5-4
 at high temperatures, 5-10, 5-11
 stress relief of, 13-9
 structure of, working, 13-8
 superplasticity in, 5-11
 surface finish for, 13-67
 swaging of, 13-19
 thermal conductivity of (tables), 4-80, 4-81, 6-50
 true-stress-strain curves for, 13-11
 for type, composition and properties of (table), 6-75
 welding of (*see* Welding)
 workability of, 13-10
- Metalworking, 13-8, 13-10
 equipment for, 13-21
 plastic working, 13-10
- Meter constants, for watt-hour meters, 15-23
- Metering pumps, 14-3
- Meters, 16-2
 air, 16-13
 differential-pressure, 16-9
 displacement, 16-7
 electric, 15-20
 gas, 16-13
 liquid, 16-13
 mass flow, 16-15
 nutating disk, 16-7
 piston, 16-7
 venturi, 3-54, 16-14
 vortex-shedding, 16-15
 (*See also* Electric instruments; Measurements)
- Methane (*see* Hydrocarbons)
- Methanol (wood alcohol), 6-148
- Method of joints (stresses in structures), 3-6
- Method of sections (stresses in structures), 3-6
- Methods design, 17-26
- Methods engineering, 17-26
- Methyl alcohol, 6-148
 as freezing preventive (table), 6-142
 as solvent, 6-148

- Methyl chloride:
 as refrigerant, **19-5**
 thermal properties of, **4-51, 4-55**
- Metre (unit of length, def), **1-17**
- Metric measures and weights, **1-24**
 conversion tables and equivalents, **1-19 to 1-24**
 prefixes, **1-19**
- Metric system, **1-17**
- Metric units (*see* SI units)
- MHD (magnetohydrodynamics), **9-26**
- Mica, **6-138**
- Micanite (electrical insulation), **6-138**
- Michell bearing, **8-126**
- Microfarad (capacitance, def), **15-15**
- Micrometers, **16-4**
- Micron (def), **1-22**
- Microphones, **12-118**
- Microprocessors (computers), **15-82**
- Microscopes, measuring, **16-6**
 sonic, **12-123**
- Mil, circular (def), **1-16**
- Mill-construction floors, **12-28**
- Milling, of plastics, **13-65**
- Milling cutters, **13-57**
- Milling machines, **13-57**
 feeds and speeds for (table), **13-58**
 troubleshooting of (table), **13-58**
 types of, **13-57**
- Millivoltmeters, **15-20**
- Mills, pulverized coal, **9-32**
- Millstones, **6-129**
- Mine cars, **10-21**
- Mine hoists, **10-16**
- Mine locomotives, **10-19**
- Mineral spirits (solvent), **6-149**
- Minerals, specific gravity and density (table), **6-8**
- Miner's inch (def), **1-16**
- Mines:
 open-pit, **7-7**
 underground: roof supports for, **7-7**
 ventilation of, **7-7**
- Minim (apothecaries' liquid measure, def), **1-16**
- Minimum (point on a curve), **2-25**
- Mining, long-wall, **7-7**
- Minute (circular measure, def), **1-17**
- Minutes to decimals of a degree (table), **1-15**
- Miter gears, **8-96**
- Mixed gas (def), **7-15**
- Mixing of two atmospheres, **4-17**
- Mixture (chemical, def), **6-3**
- Mixtures:
 of air and water vapor, **4-15**
 of liquid and vapor (thermodynamics), **4-14**
- Mmf method of generator voltage regulation, **15-33**
- Models:
 mathematical, **2-52, 2-53**
 similarity of, **3-41**
 theory of, **3-41**
 for wind-pressure tests, **12-21**
- Moderators (for slowing neutrons), **9-138, 9-142**
 table, **9-139**
- Modified PE-TFE resins: properties of (table), **6-190**
- Modula-2 (computer language), **2-53**
- Modulators:
 amplitude-modulation (AM), **15-74**
 frequency-modulation (FM), **15-74**
- Modulus:
 bulk: of elasticity (def), **5-17**
 table, **5-4**
 of elasticity (def), **5-17**
 of metals (tables), **5-4, 6-50**
 table, **5-4**
 of resilience (def), **5-17**
 of rigidity, tables, **5-4**
- Modulus (*Cont.*):
 of rupture (def), **5-26**
 of strain hardening (def), **13-10**
 Young's (def), **5-2, 5-17**
 table, **5-4**
- Mohr's circle, in moments of inertia, **3-8**
- Mohr's strain circle, **5-19**
- Mohr's stress circle, in stress analysis, **5-18**
- Mohs scale (hardness), **1-25, 5-12**
- Moisture:
 in air, measurement of, **4-15**
 in steam, measurement of, **16-18**
- Mol (def), **4-3**
- Mold making, **13-5**
 cement-sand process of, **13-4**
 hand ramming in, **13-5**
 sand preparation for, **13-5**
 aerators for, **13-5**
 sand cutters for, **13-5**
- Molding (def), **13-2**
 centrifugal processes for, **13-4**
 dry and green sand for, **13-3**
 floor, **13-3**
 investment process, **13-4**
 lost-wax process, **13-4**
 pit, **13-3**
 processes, **13-3**
 sand for, **13-3, 13-5**
 sand preparation, **13-5**
 Shaw process, **13-4**
 shell, **13-3**
 (*See also* Casting; Castings; Cores)
- Molding machines:
 flasks for, **13-5**
 jolt and squeeze, **13-5**
 sand slinger, **13-5**
 vibrators, **13-5**
- Molds:
 carbon-dioxide process, **13-3**
 facing sands for, **13-6**
 floor, **13-3**
 full, **13-4**
 graphite, **13-4**
 permanent, **13-4**
 pit, **13-3**
 plaster, **13-3**
 semipermanent, **13-4**
 washers for, **13-6**
- Mole (unit of amount of substance, def), **1-17**
- Molecular weights:
 of common gases (tables), **4-25, 4-27**
 of liquid fuels (tables), **4-25, 4-27**
- Molecule (def), **6-3**
- Mollier diagrams, description of, **4-14**
- Molten salt gasification process, **7-35**
- Molybdenum, **6-78**
 as electric furnace resistor, **7-54**
- Molybdenum alloys, **6-79**
- Moment diagrams for beams, **5-21, 5-31 to 5-33**
- Moments:
 in aerodynamics, **11-61**
 of a couple, **3-3**
 of a force, **3-4**
 of inertia, **3-8**
 of areas (def), **3-8**
 of beam sections (tables), **5-27**
 of builtup sections, **3-9**
 determined experimentally, **3-16**
 about parallel axes, **3-8**
 of plane areas, by graphics, **3-9, 3-10**
 polar (def), **3-8**
 principal, **3-8**
 referred to any axis, **3-9**
 of solid body (def), **3-8**
 of various solids, **3-9**
- Moments (*Cont.*):
 of momentum, **3-18**
 of resistance (beams, def), **5-21**
 and shear in beams, **5-31**
 units of rotation (def), **3-3**
- Momentia (def), **3-18**
 angular (def), **3-2**
 law of conservation of, **3-2, 3-19**
 linear (def), **3-2**
 moment of, **3-18**
- Monel, **6-89 to 6-91**
 composition and properties of (table), **6-89, 6-90, 15-61**
 heat treatment of, **6-89**
 machining of, **6-89**
 magnetic properties of, **6-91**
 mechanical properties of (table), **6-90**
 at high temperature (table), **6-90**
 at low temperature, **6-91**
- Monopropellants (rocket), **7-29**
- Monorail hoists, **10-14**
- Monorails, **10-26**
 trolley dimensions (table), **10-26**
- Monotron hardness test, **5-13**
- Monotype metal (table), **6-75**
- Monte Carlo simulations, **17-10**
- Month:
 sidereal, **11-101**
 synodic, **11-101**
 tropical, **11-101**
- Moody formula for hydraulic turbine efficiency, **9-158**
- Moon:
 mass of, **11-101, 11-103**
 planetary data for (tables), **11-101 to 11-103**
- Morse standard taper pins (table), **8-34**
- Mortar, **6-162**
 for brick masonry, **12-27**
 for firebrick, **6-153**
 lime, **6-160**
 for masonry construction, **12-27**
 mix proportions for, **6-163**
 for plastering, **6-162**
 sand for, **6-161**
 for stonework and masonry (table), **6-162**
 types of, **6-162**
- MOSFET (metal oxide semiconductor field effect transistor), **15-70**
- Motion:
 angular, **3-12**
 curvilinear, **3-11, 3-12**
 forces causing, **3-15**
 harmonic, **3-11**
 plane (def), **3-12, 3-13, 3-17**
 forces causing, **3-14, 3-18**
 polygon of, **3-11**
 rectilinear, **3-18**
 forces causing, **3-14**
 relative, **3-13**
 uniform, **3-10**
 uniformly accelerated or retarded, **3-10**
- Motion economy, principles of, **17-4**
- Motion study, **17-27**
 elements of, **17-27**
 motion classification, **17-28**
 principles of, **17-27**
 time standards for, **17-31**
- Motor vehicles (*see* Automobiles; Trucks)
- Motors (*see* Airplanes, engines; Automobile engines; Electric motors)
- MRG (methane rich gas), **7-40**
- Muffle furnaces, **7-41**
- Mufflers (exhaust), **9-106, 12-120**
- Mullers (molding), **13-5**
- Multiple-effect compression (refrigeration), **19-14**
- Multiplication: arithmetical, **2-4**

- Munsell color scales, 12-107
- Muntz metal (copper-zinc alloy, table), 6-68
- Muscular energy, 9-4
- Mutual inductance, 15-2, 15-3, 15-17
- NACM specifications, for chains (tables), 10-5, 10-6
- Nails, 8-82
- cut steel (table), 8-84
 - holding power of, 12-31
 - lateral resistance in wood, 12-31
 - table, 12-32
 - points for, 8-82
 - wire (table), 8-82 to 8-84
- Naphtha, solvent, 6-149
- Napier's formula for steam flow, 4-21
- Natural frequencies, 3-63
- Natural gas:
 - composition of (table), 7-15
 - flame temperatures (table), 4-29
- Natural numbers (def), 2-2
- Nautical units of length and speed, 1-16
- Naval brass (table), 6-68
- Negative binomial distribution, 2-11
- Neoprene, 6-147
- NEPA (National Environmental Policy Act), 18-2, 18-7
- Neptune, planetary data for (tables), 11-102, 11-103
- Nernst equation (corrosion), 6-95
- Networks, for computers, 2-46
 - local area, for computers, 2-48
- Neutral axis (beams, def), 5-21
- Neutron balance, 9-140
- Neutron diffractometry, 9-135
- Neutron-level instruments, 9-142
- Neutron radiography, 9-135
- Neutrons, 6-5, 9-133
 - mass of, 9-133
 - thermal, absorption and scattering cross sections (table), 9-141
- Newton-Raphson method, 2-38
- Newtonian fluid (def), 3-31
- Newtonian mechanics, 3-2
- Newton's law (mechanics), 3-2
- Nicad battery, 15-13, 15-15
- Nichols diagrams:
 - description of, 16-22
 - uses of, 16-34
- Nichrome (resistor alloy), 15-62
- table, 15-61
- Nickel, 6-88
 - alloys: composition and properties of (tables), 6-78 to 6-80, 6-89, 6-90
 - copper (*see* Monel)
 - heat-resisting, 6-77
 - heat treatment of, 6-89
 - magnetic properties of, 6-91
 - mechanical properties if (table), 6-90
 - strength of, at high temperatures (table), 5-11, 6-78 to 6-80, 6-90
 - composition and properties of (table), 15-61
 - electroplating of, 6-88
 - high-temperature properties of (table), 6-90
 - production of, 6-88
 - properties of (tables), 6-89, 6-90
 - resistor, 15-62
- Nickel plating, 6-88
- Nickel silver, 6-67
- table, 6-68
- Nickel steel (*see* Steel, nickel)
- Nimonic (superalloy, table), 6-78
- Niobium, 6-79
 - uses of, 6-81
- Nitriding (heat-treatment), 6-21
 - steels for, 6-21
- Nitrile rubber, 6-147
- Nodular cast iron (def), 6-13
- Noise, 12-117
 - from aircraft engines, 11-93
 - control of, 12-119, 18-21
 - by damping, 12-119
 - by design changes, 12-119
 - by filtration, 12-119
 - by isolation, 12-119
 - by quieting, 12-120
 - by shielding, 12-120
 - in duct systems, 12-90
 - occupational exposure to, 18-21
 - permissible exposures (tables), 12-123, 18-21
 - safe levels of, 12-123
 - as undesired sound, 12-119
 - (*See also* Sound)
- Noise reduction coefficient (def), 12-121
- Nonferrous metals, 6-49
 - annealing of, 6-52
 - casting of, 6-52
 - cold-working of, 6-52
 - effects of environment on, 6-53
 - effects of temperature on, 5-10
 - precipitation hardening of, 6-52
 - (*See also* Alloys; *specific metals*)
- Normal curves, magnetization, 15-10
- Normal density function (statistics), cumulative,
 - ordinates of (table), 1-10
 - ordinates of (table), 1-9
- Normal distribution (statistics), cumulative, ordinates of (table), 1-10
 - ordinates of (table), 1-9
- Normal induction curves (magnetization), 15-10
- Notch sensitivity in fatigue of metals (def), 5-9
- Notches (*see* Weirs)
- Nozzles, 3-40, 3-54
 - divergence of, 4-23
 - flow in: of compressible fluids, 4-22
 - formula for, 3-54, 3-55
 - of steam, 4-22, 9-56 to 9-60
 - for flow measurement, 16-14
 - fuel-injection (diesel engines), 9-111
 - for hydraulic turbines, 9-156
 - steam, design of, 9-57
- NPSH (net positive suction head), for pumps (def), 14-2
- Nuclear boilers (*see* Boilers, nuclear)
- Nuclear energy:
 - alloys for, 6-82
 - beryllium as absorber, 6-84
 - control rods, 6-83
 - boron, 6-83
 - cadmium, 6-83
 - gadolinium, 6-84
 - hafnium, 6-83
 - coolants, metallic, 6-82
 - fuels, 6-83
 - metals for, 6-82
 - moderators (table), 6-82
 - nuclear properties, 6-82
 - reactor component requirements (table), 6-82
 - slow neutron absorption (table), 6-83
 - sodium, resistance to (table), 6-83
 - stainless steel, uses of, 6-84
 - zircolloys, uses of, 6-84
 - zirconium, uses of, 6-84
 - (*See also* Atomic energy)
- Nuclear fission, 9-134
 - energy available from, 9-134
- Nuclear fuels, 9-138
 - costs of, 9-143
 - chemical reprocessing, 9-144
 - enrichment, 9-144
 - fabrication, 9-144
 - fuel-burnup, 9-144
 - shipping charges, 9-144
 - fabrication of, 9-137
 - properties of (table), 9-139
 - reconversion of, 9-137
 - reprocessing of, 9-137
 - storage and transportation of, 9-137
 - uranium and plutonium recycle, 9-137
 - uranium enrichment for, 9-137
 - waste disposal of, 9-138
- Nuclear fusion, 9-134
 - energy released in, 9-134
 - systems for, 9-148
- Nuclear particles:
 - binding energy of, 9-134
 - elementary, 9-133
- Nuclear physics, 9-133
- Nuclear power, 9-133
 - boilers for (*see* Boilers, nuclear)
- Nuclear power plants (*see* Power plants, nuclear)
- Nuclear radiation instruments, 16-19
- Nuclear reactors (*see* Reactors)
- Nucleus:
 - cross section of, 9-140
 - fission of, 9-134
 - half-life of, 9-134
 - radioactivity of, 9-134
- Nullity, of a matrix (def), 2-14
- Numbers, 2-2
 - preferred, 8-215
 - scientific notation for, 2-4
- Numerical differentiation, 2-39
- Numerical integration, 2-39
- Nutating disk (flowmeter), 16-7
- Nuts:
 - force required to tighten or loosen, 3-27
 - lock, 8-19
 - materials for, 8-22
 - ISO metric (table), 8-26
 - standard threads for, 8-8
 - threads for, ANSI metric (table), 8-14
 - wrench openings for (table), 8-20
- Nuveyor pneumatic ash handling, 10-53
- Nylon, electrical uses of, 6-139
- Nylon fibers, 6-140
 - properties of (table), 6-141
- Nylon rope, 6-138
- Nylon type 6 resins: properties of (table), 6-192
- Nylon type 66 resins: properties of (table), 6-193
- Nyquist plots, uses of, 16-34
- Nyquist stability criterion (automatic control), 2-35, 16-37
- Obsolescence, plant, 12-2
- Occupational diseases, prevention of, 18-21
- Octagon, construction of, 2-6
- Octahedron, 2-9
- Octal numbers (computers), 2-41
- Octane number (def), 9-115
 - mechanical, 9-116
- ODP (ozone depletion potential), 19-3
- Oersted (magnetic field intensity, def), 15-3
- Ohm (def), 15-2
- Ohm's law, 15-8
 - of magnetic circuits, 15-9
- Oil:
 - acidity of, tests for, 6-179
 - additives for, 6-177

- Oil (*Cont.*):
 animal, 6-177
 burners for, 9-34
 castor, 6-108
 cloud point in, 6-179
 compressibility of, 6-9
 core binder, 13-6
 crude, as fuel, 7-11
 cutting fluid (machining), 6-184, 13-50
 density of, 6-179
 engine, 6-181
 antiwear additives for, 6-182
 corrosion inhibitors for, 6-182
 defoamants for, 6-182
 detergents for, 6-182
 dispersants for, 6-182
 friction modifiers for, 6-182
 oxydation inhibitors for, 6-182
 pour-point depressants in, 6-182
 rust inhibitors for, 6-182
 SAE viscosity grades for (table), 6-182
 viscosity grade system for, 6-182
 viscosity-index improvers in, 6-182
 extreme pressure, 6-180
 fish, 6-177
 flash and fire points (def), 6-179
 fuel (*see* Fuel oils)
 in gas manufacture, 7-39
 heat-transfer coefficients to or from (chart), 4-86
 insulating, specifications for, 6-138
 linseed, 6-108
 lubricating, 6-177
 additives for, 9-118
 antifoaming agents for, 6-180
 antirusting agents for, 6-180
 ash in, 6-179
 gravity of, 6-179
 SAE classifications of, 9-118
 tests of, 6-178
 oiticica, 6-108
 for paint, 6-108
 petroleum (*see* Petroleum)
 pour point, 6-179
 soybean, 6-108
 specific gravity of, 6-179
 specific gravity and density of (table), 6-8
 synthetic, 6-177
 tung, 6-108
 vegetable, 6-177
 viscosity of, 3-32, 6-178
 index of (def), 6-179
 recommended (table), 6-182
 temperature variation of, 6-179
 Oil burners (*see* Burners)
 Oil cooling, internal-combustion engines, 9-118
 Oil engines (*see* Diesel engines; Internal-combustion engines)
 Oil grooves, arrangement of, 8-123
 Oil paint, 6-108
 Oil Pollution Act of 1961, 11-47
 Oil Pollution Act of 1990, 11-48
 Oil quenching, 6-20
 Oilless bearings, 8-125
 Oilstones, 6-129
 Oiticica oil, 6-108
 Once-through boilers, 9-37, 9-45
 Open channels:
 critical values for, 3-60
 flow of water in, 3-59
 roughness coefficient of (table), 3-59
 specific energy in flow in, 3-60
 Open system (thermodynamics, def), 4-4
 Operations, manufacturing, planning for, 17-3
 Optical character recognition, 10-71
 Optical comparators, 16-6
 Optical pyrometers, 16-10, 16-13
 Optics, 19-41
 design of, 19-42
 Optimization:
 under certainty, 17-7
 using computers, 2-52
 using linear programming, 17-8
 under uncertainty, 17-7
 Orbiting-scroll compressors, 14-37
 Orbits, elements of, 11-105
 Ores:
 extraction and refining of, 6-52
 pipelines for, 11-131
 specific gravity and density of (table), 6-7
 Organization:
 good, requirements for, 17-3
 industrial, 17-2
 Organization charts (fig), 17-2
 Orifice meters, 3-55, 16-14
 Orifices, 16-14
 diaphragm meters for, 16-14
 discharge coefficients for, 3-56
 table, 3-56
 flow of air through, 4-21
 flow of compressible fluids through, 3-56, 4-21
 flow of gas through, 4-21
 flow of steam through, 4-21
 formulas for, 4-21
 pipe, 3-55, 3-56
 standard, 3-56
 tap locations for, 3-56, 16-14
 Orsat apparatus (flue-gas analysis), 16-18
 Orthocenter (def), 2-5
 Oscillating rolling (metalworking), 13-14
 Oscillation, axis of, 3-16
 Oscillators, 15-73
 Oscilloscope, 16-17
 OSHA (Occupational Safety and Health Act), 18-22
 Ostwald color system, 12-107
 Oswatitsch shock diffuser, 11-76
 Ottawa sand for concrete, 6-161
 Otto cycle, 4-11
 Otto-cycle engines (*see* Internal-combustion engines)
 Outboard engines, 9-99, 11-55
 table, 9-99
 Outdoor air requirements for various locations (table), 12-67
 Outer product (mathematics, def), 2-11
 Outside count test (statistics), 17-21
 Oven furnaces, 7-41
 Ovens:
 for carbonizing coal, 7-33
 core, 13-6
 electric (*see* Electric furnaces)
 resistor, 7-52
 Overdamping, 3-63
 Overdrive (automobiles), 11-9
 Overhead, in cost accounting, 17-14
 Overhead cranes (*see* Cranes, overhead)
 Overhead trackage, 10-37
 Overlap test (statistics), 17-22
 Oxidation tests for lubricating oils, 6-180
 Oxygen:
 corrosion in boilers, 9-49
 high-pressure, effect on materials, 11-113
 liquid (rocket fuel), 7-29
 in water, removal of, 9-49
 Oxygen analyzers, 16-19
 Pack rolling, 13-14
 Packet switching (in computer networks), 2-48
 Packing, 8-138
 carbon, for steam turbines, 9-63
 common forms of (fig), 8-139
 conical ring, 8-140
 diaphragms to replace, 8-142
 dynamic, 8-139
 jamb, 8-141
 labyrinth, for steam boilers, 9-63
 liquid seal, 8-139
 O-ring, 8-139
 oil seals, 8-141
 ring, for steam turbines, 9-63
 shaft, 8-139
 soft, 8-141
 steam turbine, 9-63
 Painting, 6-109
 of aluminum, 6-110
 of concrete, 6-109
 of copper, 6-110
 exterior, 6-109
 by flame spraying, 6-110
 of galvanized iron, 6-110
 interior, 6-109
 of magnesium, 6-110
 of masonry, 6-109
 of plastics, 6-110
 spray methods for, 6-110
 spreading rates during (table), 6-111
 of steel, 6-110
 of water tanks, 6-110
 of wood products, 6-110
 Paints and protective coatings:
 aluminum paint, 6-109
 anodizing, 6-111
 antifouling (ships), 6-109
 application of, 6-110
 bituminous, 6-109
 bonded phosphates as, 6-111
 chemical vapor deposition, 6-112
 copper powder, 6-109
 definition of, 6-108
 destroying agencies of, 6-110
 driers for, 6-108
 dry resin as, 6-110
 drying oils in, 6-108
 ecological restriction on, 6-109
 electroplating as, 6-111
 emulsion paint, 6-109
 enamel, 6-108
 fire-retardant, 6-109
 fungicides added to, 6-109
 galvanizing as, 6-111
 heat radiation of, 6-109
 heat-reflecting, 6-109
 heat-resisting, 6-109
 hot dipping, 6-111
 ingredients of, 6-108
 lacquer, 6-108, 6-112
 latex, 6-108, 6-109
 lead coated copper as, 6-111
 pigments in, 6-108
 plastic, hot, 6-109
 plasticizers for, 6-108
 plating, 6-111
 porcelain enamels as, 6-110
 primers for, 6-109
 resins in, natural, 6-108
 synthetic, 6-108
 ship-bottom, 6-109
 silicone, 6-109
 solvents for, 6-108
 sputtering for, 6-111
 terne as, 6-111
 thinners for, 6-108
 for traffic service, 6-109

- Paints and protective coatings (*Cont.*):
 vacuum deposition for, 6-111
 varnish, 6-108, 6-112
 water-repellent, 6-109
 water-thinned, 6-108
 wood-preservative, 6-109
- PAL (programmable array logic), 15-81
- Palladium, uses of, 6-74
- Pallets:
 in industrial plants, 10-23, 10-72
 lift trucks for, 10-23
 loads on, 10-23, 10-72
- Panhandle equations (natural gas pipelines), 11-127
- Paper:
 bleaching of, 6-145
 coatings for, 6-145
 converting, 6-145
 grades of, 6-144
 insulating, 6-139
 plastic-fiber, 6-145
 pulping, 6-144
 recycling of, 6-145
 refining, 6-145
 sanitary (def), 6-144
- Paper making: pollution from, 18-15
- Parabola, properties of, 2-19
- Parabolic differential equations, 2-34
- Parallel circuits, 15-8, 15-52
 a-c, 15-19
- Parallel operation of synchronous generators, 15-34
- Parallelogram:
 area of, 2-7
 of motion, 3-10
- Parametric equations, 2-20
- Parasite drag (aerodynamics, def), 11-66
- Parasitic currents, 15-10
- Parr formulas (mineral-matter-free coal), 7-2
- Parsec, 11-101
- Partial derivatives, 2-25
- Partial differential equations, 2-34
- Partial pressures, 4-9
- Particle clouds, 4-68, 4-69
- Particles of matter, 9-133
- Partitions:
 in industrial plants, 12-15
 reinforced-concrete, 12-59
- Pascal (computer language), 2-53
- Pascal's law, 3-33
- Pass-by noise test (trucks), 11-20
- Passenger cars (railroad), 11-33
 train resistance, 11-39
- Passenger miles, of automobiles, 11-3
- Passivators (corrosion), 6-104
- Patents, 18-28
 application for, 18-28
 cost of, 18-29
 documentation of invention for, 18-28
 foreign protection for, 18-29
 infringement of, 18-29
 International Convention for the Protection of Industrial Property, 18-29
 procedures, 18-29
 reissues of, 18-29
 rights of owner, 18-29
 terms of, 18-28
 types of, 18-28
 what is patentable, 18-28
- Path (automatic control, def), 16-28
- Path gain (automatic control, def), 16-28
- Patterns, 13-2, 13-5
 distortion allowances for, 13-2
 draft for, for molds, 13-2
 gated, 13-2
 loose, 13-2
- Patterns (*Cont.*):
 machine-finish allowances for, 13-2
 making of, 13-2
 master, 13-3
 match-plate, 13-2
 for mold making, 13-2, 13-5
 shrinkage allowances for, 13-2
 skeleton, 13-3
 sweeps for, 13-3
 types of, 13-2
- Paving, brick, 6-135
- PD (proportional-derivative) control, 16-29
- Pearlite (steel), 6-17, 13-8
- Pease-Anthony venturi, 18-11
- Peat, 7-9
 moisture content of, 7-9
 properties of, 7-9
 specific gravity and density of, 6-9
- Peck, dry measure (def), 1-16
- Peck carrier buckets, 10-46
- PE-TFE, modified (resins): properties of (table), 6-190
- Peltier effect, 9-24, 19-17
- Pendulum:
 compound, time of oscillation, 3-16
 conical, 3-15
 simple, 3-15
- Penetrators (radiographic), 5-65
- Pentolite (explosive), 7-20
- Perch (unit of length, def), 1-16
- Percussion, center of, 3-16
- Perfect gases, 4-10
- Perfectly diffuse surface, 4-63
- Performance rating, of tasks, 17-29
- Periodic table of elements, 6-6
- Permanent set (def), 5-2
- Permeability curves, 15-9
- Permeance, magnetic (def), 15-4
- Permittivity (def), 15-2
- Permutations and combinations, 2-10
- Personal computers, 2-45
- PERT (Program Evaluation and Review Techniques) for scheduling, 2-54, 17-5
- PETN (explosive), 7-22
 table, 7-21
- Petroleum:
 analyses of (table), 7-11
 API and specific gravity (table), 7-11
 distillates (charts), 7-11
 as fuel, 7-11
 table, 7-11
 (*See also* Fuels)
 heat values (table), 7-11
 oil (*See also* Oil)
 refining of, 7-11
 reserves of, 9-3
 specific gravity and density of (table), 6-8, 6-9
- Petroleum oils, 6-177
- Petroleum spirits (paint thinner), 6-108
- Petzval image, 19-43
- Petzval surface, 19-43
- Pewter, 6-74
- pH value:
 definition of, 9-50
 indicators for, 9-50
 relationship to hydrogen ion concentration (table), 9-50
- Phase converters, electric motors as, 15-39
- Phase difference in alternating currents, 15-18
- Phase-transition temperatures:
 of the elements (table), 4-53, 4-58
 of various substances (table), 4-50
- Phenolic resins: properties of (table), 6-191
- Philips Stirling engine, 9-20
- Phon (loudness level of sound, def), 12-118
- Phono-electric bronze (electrical conductor), 15-6
- Phosphor bronze, 6-67
 tables, 6-68
- Photoelasticity, 5-51
 material-fringe value, 5-52
 oblique incidence, 5-52
 stress separation, 5-52
 three-dimensional, 5-52
- Photoelectric cells, 16-3
- Photometers, uses of, 16-18
- Photostress, 5-54
- Photosynthesis, 9-10
- PI (proportional-integral) control, 16-29
- Pickling, of steel, 6-15
- Picric acid (military explosive, table), 7-21
- Piece-rate wage systems, 17-10
- Pierls stress (def), 6-23
- Piezoelectric force measurement, 16-7
- Piezoelectric transducers, 5-66
- Pig iron (def), 6-13
 production of, 6-13
- Pigments, for paints, 6-108
- Piles:
 atomic (*see* Reactors)
 capping of, 12-27
 concrete, 12-26, 12-58
 driving of, 12-26
 for foundations, 12-26
 safe loads for, 12-27
 spacing of, 12-27
 wood, 12-26
- Pillow blocks, 8-137
- Pinions (*see* Gears)
- Pins:
 spring, 8-32
 straight, 8-32
 taper (table), 8-34
 tapered, 8-32
- Pipe (def), 8-146
 aging of, 3-48
 allowance for water hammer, 8-169
 alloy, butt welding of, 8-211
 aluminum (table), 8-192
 anchoring of, 8-212
 asbestos-cement, 8-194
 for ASME Boiler and Pressure Vessel Code, 8-143
 bolting for, properties of (table), 8-199
 branch flow in, compound, 3-52
 brass (tables), 8-189, 8-190
 butt-welded, 8-211
 carbon steel, codes for, 8-169
 cast-iron, 8-187
 for fire protection, 18-27
 soil, 8-189
 cement-lined, 8-191
 chromium-molybdenum steel, codes for, 8-169
 coils, 8-185
 center-to-center dimensions (table), 8-185
 collapsing pressure, 5-45
 commercial classifications of, 8-146
 concrete, 8-193
 copper (tables), 8-189, 8-190
 coverings for, 8-213
 heat transmission through, 4-88
 distance between supports, 8-213
 drain (table), 8-194
 fittings for (table), 8-205
 drill, 8-146
 dry-kiln, 8-146
 ductile-iron, 8-187
 bell-and-spigot (table), 8-188
 ends for, 8-187
 centrifugally cast, 8-187
 for crossing waterways, 8-188
 fittings for (*see* Pipe fittings)
 flexible-joint (table), 8-189

- Pipe, ductile-iron (*Cont.*):
 for gas supply, 8-187
 joints for, 8-187, 8-188
 thickness of (table), 8-188, 8-189
 Universal, 8-186
 expansion of, thermal (table), 8-208
 expansion joints for (table), 8-208
 fabrication methods for, 8-167
 cupping and drawing, 8-167
 electric-fusion welding, 8-167
 electric-resistance welding, 8-167
 electric submerged-arc welding, 8-167
 forged, turned, and bored, 8-167
 hollow-forged, 8-169
 fittings for (*see* Pipe fittings)
 flanges for (*see* Pipe flanges)
 flow in: of compressible fluids, 4-23
 general formulas for, 3-50
 of steam, 4-23
 friction factors for (table), 3-51
 friction loss of water in (charts), 12-94, 12-95
 hard rubber, 8-191
 insulation for, 8-213
 heat transmission through, 4-88
 chart, 4-88
 joints in: expansion, 8-207
 flanged, 8-197, 8-198
 gaskets for, 8-138
 unions, 8-201
 lead-lined, 8-191
 line, 8-146
 materials for: allowable stresses in (table), 8-170
 nipple, 8-147
 oil country goods, 8-146
 orifices in (*see* Orifices)
 plastic, for gas service (table), 8-193
 plugs for (table), 8-204
 plywood, 8-193
 in pneumatic conveyors, 10-53
 polyethylene (table), 8-194
 pressure, 8-146
 PVC (table), 8-193
 quality factors for (table), 8-183
 refrigeration, 8-146
 reinforced-concrete, 8-193
 resistance parameters for (fluid flow), 3-50
 return main, flow capacities of (table), 12-96
 riser, for heating, flow capacities of (table), 12-96
 roughness in (table), 3-48
 rubber-lined, 8-191
 schedule designations for, 8-169
 screw threads for, 8-17
 tables, 8-18, 8-19
 seamless-copper-lined, 8-191
 sewer (table), 8-194
 sleeve couplings for, 8-189
 spiral, 8-185
 standard, 8-146
 standard sizes of, 8-147
 standards for, 8-143
 steel, butt welding of, 8-211
 as columns, 12-43
 concrete-filled, as columns, 12-56
 high-pressure steam, 8-185
 high-temperature steam, 8-185
 materials and weights of (tables), 8-148
 properties of (tables), 8-148
 spiral welded, 8-185
 thickness of (tables), 8-148
 weight tolerances of (table), 8-167
 stress relieving after welding, 8-211
 supports for, 8-212
 cast-iron rollers as, 8-212
 constant-support hangars as, 8-212, 8-213
- Pipe, supports for (*Cont.*):
 location of, 8-213
 stresses in line caused by, 5-55
 sway braces for, 8-212
 variable-spring hangars for, 8-212, 8-213
 taps, drills for (table), 8-20
 threads for, 8-17
 ANSI: straight (table), 8-19
 taper (table), 8-18
 Dryseal threads (table), 8-19
 engagement for tight joints (table), 8-203
 tap drills for, 8-17
 tin-lined, 8-191
 Transite (asbestos-cement), 8-194
 unions for, 8-201
 vitrified-clay (table), 8-194
 water hammer in, 3-61
 water well, 8-146
 welding of, 8-209
 wood-lined, 8-191
 wood-stave, 8-191
 wrench torques for, 8-197
 wrought-iron, butt welding of, 8-211
- Pipe fittings, 8-195
 ammonia, 8-205
 cast-iron, elbows, 8-197
 flanged (table), 8-196
 drilling templates for (table), 8-196
 laterals, 8-197
 long turn, 8-205
 pressure ratings, 8-195
 reducing, 8-195
 sizes of, 8-195
 tables, 8-204, 8-205
 drainage, threaded (table), 8-205
 ductile-iron, 8-187, 8-188
 flanged, ANSI, 8-187
 water pipe, 8-187, 8-189
 head losses in (table), 12-97
 for high-pressure and high-temperature steam, 8-185
 table, 8-197
 loss factors for (table), 3-51
 quality factors for (table), 8-183
 for railings, 8-205
 resistance to fluid flow, 4-23
 schedule designations for, 8-169
 soldered-joint (table), 8-206
 steel: American classes, 8-197
 bolting of, 8-197
 material for, 8-198
 butt-welded (tables), 8-209, 8-210
 materials for, 8-197
 and weights of (tables), 8-155 to 8-166
 pressure-temperature ratings (table), 8-197
 reducing, 8-198
 ring joints for, 8-198
 side outlet, 8-198
 welding neck, 8-198
 threaded, 8-201
 cast-bronze, 8-205
 malleable-iron (table), 8-203
 for welding (tables), 8-209, 8-210
- Pipe flanges:
 cast-iron: ANSI, 8-195
 bolting, 8-195
 bolts for, 8-195
 dimensions of, 8-195
 drilling templates for (tables), 8-196
 facing of, 8-195
 inspection limit, 8-195
 nuts for, 8-195
 screwed companion, 8-197
 spot facing of, 8-195
- Pipe flanges (*Cont.*):
 faces of: male and female, 8-198
 plain straight, 8-198
 raised, 8-198
 serrated, 8-198
 tongue-and-groove, 8-198
 V grooves for, 8-198
 steel: American classes, 8-197
 bolting for, 8-198
 companion (table), 8-202
 dimensions of (tables), 8-201, 8-202
 drilling templates for (table), 8-200
 facing dimensions of (tables), 8-201, 8-202
 fitting dimensions of, 8-198
 metal thickness, 8-198
 pressure-temperature ratings (table), 8-197
 ratings of (table), 8-197
 ring joints for, 8-198
 sizes of, 8-197
 thickness of metal for, 8-198
 welding-neck, 8-198
- Pipe threads:
 American national standard dry-seal, 8-17
 American national standard straight, 8-17
 American national standard taper, 8-17
- Pipelines:
 coal, 11-133
 cost of transportation by, 11-131
 economics and design of, 11-133
 velocity in, 11-134
 wall thickness of, 11-134
 compression, 11-128
 for crude oil and oil products, 11-129
 deflection (formulas), 5-57
 design of, 11-128, 11-131, 11-133
 design pressures, 11-128
 diameters of, 11-127
 economic analysis, 11-129, 11-131, 11-134
 flexure, 5-55
 flow in, 11-127
 flow equations for, 11-127
 horsepower required, 11-128, 11-134
 materials transported in, 11-131, 11-132
 for natural gas, 11-126
 operation of, 11-127
 pipe for, 11-127
 pipe bends for, 11-127
 prime movers for, 11-127
 pumps for, 11-129, 11-131, 11-133
 repairs to, 11-127
 for solids, 11-131
 station spacing, 11-131
 stresses: due to flexure, 5-55
 formulas for, 5-57
 valves for, 11-127
- Pipetran (pipeline computer program), 11-127
- Piping (def), 8-143
 ammonia (table), 19-20
 brine, for cold-storage rooms, 19-23
 colors for identification, 8-214
 corrosion in, 6-106
 expansion and flexibility, 8-207
 refrigerant, 19-20
 for ammonia, 19-20
 flexibility of, 19-20
 for other refrigerants, 19-21
 for R 12, 19-20
 standards for, 8-143
- Pirani gage (high-vacuum), 16-9
- Pistons:
 inertia force of, 8-65
 packing for, 8-140
- Pitch:
 of gears: circular (def), 8-88
 diametral (def), 8-88
 of ships (def), 11-45

- Pitch (*Cont.*):
of sound, 12-118
specific gravity and density of, 6-9
- Pitot tubes, 3-57, 16-14
- PLA (programmable logic array), 15-81
- Placer dredges, 10-33
- Plan equation, for steam engines, 9-54
- Plan position indicator (radar), 15-88
- Planck's constant, 9-134
- Planck's law, 4-62
- Plane, inclined, 3-14
- Plane areas:
center of gravity of, 3-6, 3-7
moments of inertia of, 3-8
- Plane strain, 5-5, 5-44
- Planers:
for metal, 13-60
for wood, 13-74
- Planets, data on (tables), 11-102, 11-103
- Planimeters, 16-7
- Planning:
in industrial management, 17-3
in industrial plants, 12-3
- Planté storage battery, 15-13
- Plants:
chemical: water sources for (table), 6-171
water uses in (table), 6-171
industrial, 12-2
(See also Industrial plants)
material movement in, 10-2
- Plasma arc gouging, 13-32
- Plastering, mortars for, 6-162
- Plastic, ideal (def), 3-30
- Plastic design, 5-19
- Plastic modulus, 5-50
- Plastic range chart (metals), 13-10
- Plasticity (def), 13-9
- Plasticizers (in paints), 6-108
- Plastics:
ABS: properties of (table), 6-186
ABS/Nylon: properties of (table), 6-186
acetal: properties of (table), 6-187
acrylic: properties of (table), 6-188
acrylonitrile: properties of (table), 6-188
bisphenol: properties of (table), 6-189
cellulose acetate butyrate: properties of (table), 6-189
cellulosic: properties of (table), 6-189
epoxy: properties of (table), 6-189
ethyl cellulose: properties of (table), 6-189
ethylene and polyethylene copolymer: properties of (table), 6-196
fluoroplastic: properties of (table), 6-190
Furan: properties of (table), 6-191
LDPE copolymer: properties of (table), 6-196
machining of, 13-65
modified PE-TFE: properties of (table), 6-190
nylon type 6: properties of (table), 6-192
nylon type 66: properties of (table), 6-193
PE-TFE, modified (resins): properties of (table), 6-190
phenolic: properties of (table), 6-191
PMMA: properties of (table), 6-188
polyamide: properties of (table), 6-192
polybutylene terephthalate: properties of (table), 6-195
polycarbonate: properties of (table), 6-194
polychlorotrifluoroethylene: properties of (table), 6-190
polyester, alkyd: properties of (table), 6-195
thermoplastic: properties of (table), 6-195
thermoset: properties of (table), 6-195
polyethylene and ethylene copolymer: properties of (table), 6-196
polyethylene terephthalate: properties of (table), 6-195
- Plastics (*Cont.*):
polyimide: properties of (table), 6-197
polypropylene: properties of (table), 6-197
polystyrene: properties of (table), 6-198
polystyrene and styrene copolymers: properties of (table), 6-198
polytetrafluoroethylene: properties of (table), 6-190
polyurethane: properties of (table), 6-199
polyvinylidene fluoride: properties of (table), 6-190
properties of, at low temperatures, 19-34
PTFE-filled copolymer: properties of (table), 6-187
PVC: properties of (table), 6-200
PVC-acetate: properties of (table), 6-200
silicone: properties of (table), 6-199
styrene and polystyrene copolymers: properties of (table), 6-198
styrene copolymers: properties of (table), 6-198
vinyl: properties of (table), 6-200
- Plate-bending machines, 13-16, 13-23
- Plate-straightening machines, 13-23
- Plates:
circular, strength of (chart), 5-48
elliptical, strength of (chart), 5-48
flat, 5-47
rectangular, strength of (chart), 5-48
strength of, 5-47, 5-48
vibration of, 3-74
- Plating, 6-111
- Platinum:
as resistor material, 15-62
uses of, 6-74
- Pliofilm, 6-148
- Pliolite, uses of, 6-148
- Plug-cocks, 8-207
- Plumbing, in industrial plants, 12-12
- Pluto, planetary data for (tables), 11-102, 11-103
- Plutonium, use of, in nuclear energy applications, 6-83
- Plywood, 6-124
allowable stresses in (table), 6-125
back of (def), 6-124
center of (def), 6-124
commercial standards for, 6-128
crossbands of (def), 6-124
exterior, 6-124
face of (def), 6-124
interior, 6-124
moments of inertia of (table), 6-125
section moduli of (table), 6-125
strength of, 6-123
- PMMA resins: properties of (table), 6-188
- Pneumatic conveyors, 10-53
- Pneumatic hammers, 13-23
- Pneumatic hoists, 10-14
- Pneumatic riveters, 13-24
- Point (printers' type measure, def), 19-43
- Poise (unit of viscosity, def), 3-31
- Poisson distribution, 2-11, 17-10
- Poisson's equation, 2-34
- Poisson's ratio (def), 5-4, 5-15
values of, 5-15
for metals (table), 5-4, 6-11
- Polar coordinates, 2-19
- Polar moment of inertia (def), 3-8
- Polarization in batteries, 15-11
- Pole (unit of length), 1-16
- Polishing, 13-63
of plastics, 13-65
- Polishing wheels, 13-63
- Pollution, air (see Air pollution)
- Polyamide resins: properties of (table), 6-192
- Polybutylene terephthalate resins: properties of (table), 6-195
- Polycarbonate resins: properties of (table), 6-194
- Polychlorotrifluoroethylene resins: properties of (table), 6-190
- Polyester:
alkyd resins: properties of (table), 6-195
thermoplastic resins: properties of (table), 6-195
thermoset resins: properties of (table), 6-195
- Polyester fibers, 6-140
- Polyethylene: as electrical insulation, 6-139, 15-51
- Polyethylene and ethylene copolymer resins: properties of (table), 6-196
- Polyethylene pipe (table), 8-194
- Polyethylene terephthalate resins: properties of (table), 6-195
- Polygons:
areas of, 2-7
construction of, 2-6
of forces, 3-5
regular, 1-4
table of, 1-4
- Polyhedra, 2-9
- Polyimide resins: properties of (table), 6-197
- Polynomials (def), 2-3
- Polyphase induction motors, 15-37
- Polyphase power:
advantages of, 15-20
transformation, 15-35
- Polyphase squirrel-cage motors, 15-37
- Polyphase wattmeter, 15-22
- Polypropylene resins: properties of (table), 6-197
- Polystyrene and styrene copolymers resins: properties of (table), 6-198
- Polystyrene resins: properties of (table), 6-198
- Polytetrafluoroethylene resins: properties of (table), 6-190
- Polytropic expansion:
determination of exponent, 4-9
values of n for water vapor (table), 4-11
- Polyurethane resins: properties of (table), 6-199
- Polyvinylidene fluoride resins: properties of (table), 6-190
- Pomaranчук refrigerator (cryogenics), 19-28
- Pop rivets, 8-30
- Porous-metal bearings, 6-61, 8-125
- Port and Waterways Safety Act of 1972, 11-48
- Portland cement, 6-159
uses of, 6-159
(See also Cement)
- Position descriptions, 17-2
- Positron (radiation), 9-134
- Potential difference (def), 15-2
- Potential energy (def), 3-17
- Potential transformers (instruments), 15-23
- Potentiometers, 15-25, 16-5, 16-12, 16-17
- Pound (def), 1-17
- Pound mol (def), 4-3
- Poundal (def), 1-23
- Pour point of petroleum oils (def), 6-179
- Pourbaix diagrams (corrosion), 6-95
- Powder metallurgy, 6-87
(See also Powdered metals)
- Powdered coal, 9-32, 9-34
- Powdered metals, 6-87
bearings of, 6-88
ferrous, properties of (table), 6-88
nonferrous, properties of (table), 6-88
particle shapes for, 6-87
sintering of, 6-87
soft magnetic, 6-88
uses of, 6-87
- Power:
atomic (see Boilers, nuclear; Reactors)
conversion tables for, 1-34
cost of (see Power costs)

- Power (*Cont.*):
 distribution (*see* Electric power distribution)
 electric (*see* Electric power)
 human-generated, 9-4
 from hydrogen, 9-23
 of lenses, 19-41
 measurement of, 16-15
 one- and multiphase, 15-21, 15-22
 muscular, 9-4
 nuclear (*see* Boilers, nuclear)
 revenue from (table), 17-38
 solar (*see* Solar energy)
 sources (*see* Energy sources)
 tidal, 9-21
 units of, 1-18
 wave, 9-22
- Power costs, 9-142, 17-32
 using coal, 17-36
 of environmental controls, 17-37
 fixed charges, 9-143, 17-35
 cost of money in, 17-35
 depreciation, 17-36
 index for regions of the United States (table), 17-33
 for maintenance, 17-37
 using natural gas, 17-37
 using nuclear fuels, 17-37
 operating and maintenance (table), 17-37
 operating expenses, 17-36
 nuclear, 9-144, 17-37
 for operating labor, 17-37
 overall, 9-144, 17-37
 using petroleum fuels, 17-36
 plant: combined cycle, 17-34
 gas-turbine, 17-34
 geothermal, 17-34
 hydroelectric, 17-34
 industrial, 17-33
 nuclear, 9-142, 17-33, 17-34, 17-37
 pumped storage, 17-34
 steam-electric, 17-33
 prices based on, 17-38
 total (table), 17-38
 for transmission, 17-38
 using various fuels (table), 17-37
- Power factor:
 a-c (def), 15-2, 15-18
 of induction motors (table), 15-39
 of loads, approximate values, 15-54
 measurement of, 15-23
- Power plants:
 costs of, 17-32
 (*See also* Power costs)
 environmental considerations, 17-34
 fuel expenses for, 17-37
 geothermal, 9-18
 cycles for, 9-19
 heat rates of, 9-71
 interest charges for (table), 17-36
 investment costs of (table), 17-33
 multipurpose, 17-38
 nuclear, ACRS staff reviews of, 9-147
 antitrust reviews for, 9-147
 containment features for, 9-146
 continuing reviews for, 9-147
 cycles for, 9-135
 decommissioning of, 9-144, 9-147
 emergency core cooling for, 9-146
 emergency power supplies for, 9-146
 environmental reviews for, 9-147
 final safety analysis report for, 9-147
 fuel enrichment costs, 9-144
 fuels for (*see* Nuclear fuels)
 individual plant examinations for, 9-147
 licenses for, 9-146, 9-147
 NRC staff review, 9-147
- Power plants, nuclear, ACRS staff reviews of (*Cont.*):
 operating and maintenance costs, 9-144
 plant licensing, 9-146
 plant safety, 9-145
 preliminary safety analysis report for, 9-146
 public hearings on, 9-147
 radioactive waste from, 9-147
 reviews for, 9-147
 safety of, 9-145
 safety evaluation report for, 9-147
 standardized designs for, 9-147
 (*See also* Atomic energy)
 for peaking capacity, 17-32
 profits, comparison of private and public (table), 17-35
 sulfur emission from (table), 18-13
 useful life of (table), 17-36
- Power presses (*see* Presses)
- Power pumps (*see* Pumps, power)
- Power series (def), 2-30
- Power shovels, 10-33
- Power spectral density (def), 11-104
- Power steering (automobiles), 11-12
- Power transmission:
 by belts, 8-53, 8-55
 by chain drives, 8-59
 electric (*see* Electric power transmission)
 hydraulic, 8-39
- Power transmission systems, 15-46
- Pozzolan portland cement, 6-160
- Prandtl-Glauert rule (supersonic flow), 11-77
- Precipitators:
 applications of (table), 18-15
 electrical (gas cleaning), 18-11, 18-16
- Precise length equivalents (table), 1-28
- Precision, of numbers, 2-4
- Predictor-corrector methods, 2-39
- Preferred numbers, 8-215
- Preheaters (boilers), 9-43
 corrosion of, 9-44
 types of, 9-43
- Present value (accounting), 17-18
- Press fits, 8-45
 torsional holding ability, 8-46
- Presses:
 double-action, 13-21
 frames for, 13-21
 holding pressures required in, 13-17
 hydraulic, 13-19, 13-21
 power, 13-21
 bearing pressures in, 13-21
 energy required by, 13-21
 flywheel capacity (formula), 13-21
 shaft capacities (table), 13-21
 screw, 13-22
 types of, 13-21
- Pressure:
 absolute (def), 3-33
 between bodies with curved surfaces, 5-47
 conversion table for, 1-32
 critical, for gases (tables), 4-50, 4-58
 critical flow, flow of compressible fluids at, 4-21
 effect on volume of water (table), 6-10
 gage (def), 3-33, 16-8
 mean effective, 4-11
 measurement of, 16-8
 at low temperatures, 19-37
 partial, 4-9
 total, in air (def), 4-15
 units of, 1-18
- Pressure drop:
 in pipes, 4-23
 (*See also* Flow)
- Pressure-enthalpy chart:
 for air, 4-34
 for ammonia, 4-34
 description of, 4-14
- Pressure equivalents (table), 1-31
- Pressure hose, 8-214
- Pressure-volume diagram, description of, 4-9
- Prestone (antifreeze), properties of, 6-142
- Prevention:
 of accidents, 18-19 to 18-21
 codes for, 18-22
 of occupational disease, 18-21
- Primary cells, 15-11
 (*See also* Batteries)
- Printers' type, sizes of, 19-43
- Prisms, surface and volume of, 2-8
- Probability integral, 2-29
- Probable error, table, 1-14
- Process air, fans to provide, 14-50
- Process analysis, 17-3
- Process annealing (def), 6-17
- Process planning, 17-3
- Processes, automatic control of (*see* Automatic control)
- Producer gas, flame temperatures in (table), 4-29
- Product liability, 18-31
- Product of inertia, 3-8
- Production control and planning, 17-4, 17-6
- Products of combustion of fuels, 4-25, 4-30
 table, 4-27
- Professional engineer licensing and registration, 18-31
- Profile drag (aerodynamics, def), 11-62, 11-69
- Profile surveying, 16-52
- Profilometers, 16-18
- Profit-sharing plan, 17-10
- Projectiles, motion of, 3-15
- Prony brake, 16-15
- Proofreaders' symbols, 19-44
- Proofreading, 19-43
- PROM (programmable read-only memory), 15-81, 15-83
- Propane:
 commercial (table), 7-15
 properties of (chart, table), 4-37, 19-4, 19-12
 as refrigerant, 19-7
- Propellants, rocket (*see* Rocket fuels)
- Propeller fans, 14-44
- Propeller shafts (ships), 11-56
- Propeller-type turbines (hydraulics), 9-150, 9-151
- Propellers:
 airplane (*see* Airplane propellers)
 ship (*see* Screw propellers)
- Propan engines, 11-84
- Proportional damping (vibrations), 3-72
- Proportional elastic limit (def), 5-2
- Propulsion:
 jet (*see* Aircraft jet propulsion)
 of ships, 11-48
- Protective coatings (*see* Paints and protective coatings)
- Protons, 6-5, 9-133
- Proximate analysis of coals, 7-2, 7-5
- Psi function, for ideal-gas air (table), 4-31
- Psychrometer, wet-bulb, 4-15, 16-18
- Psychrometric chart, 4-16, 12-86
 normal temperatures, 12-86
 in SI units, 12-86
- Psychrometrics, 12-85
 charts for, 12-86
 terminology for, 12-87
- PTFE-filled copolymer resins: properties of (table), 6-187
- Pullers, lever-operated, 10-13

- Pulleys, **8-50**
 arms for, design of, **8-50**
 for belting, minimum diameters of (table), **8-52**
 block, **8-8**
 efficiency of, **3-29**
 cone, **8-52**
 friction of, **3-26, 3-28**
 magnetic (conveyors), **10-51**
 rims for, design of, **8-50**
 step, **8-52**
 for V-belts (table), **8-54**
- Pulp for papermaking, **6-144**
- Pulsation dampeners, for pumps, **14-14**
- Pulsejets, **11-83**
- Pulverized coal, **9-32, 9-34**
- Pulverized lime, **6-160**
- Pulverizers (coal), **9-32**
 capacities of, **9-32**
 exit temperatures from (table), **9-33**
 high-speed, **9-34**
 medium-speed, **9-34**
 slow-speed, **9-34**
- Pumice (abrasive), **6-129**
- Pumped storage hydro power, **9-157**
- Pumps:
 applications of, **14-2**
 boiler-feed, turbines for, **9-64**
 centrifugal (*see* Centrifugal pumps)
 classification of, **14-2, 14-15**
 controlled-volume, **14-10**
 cushion chambers for, **14-14**
 direct-acting, **14-2, 14-10**
 mechanical efficiency of, **14-11**
 displacement, **14-2**
 volumetric efficiency of, **14-13**
 double-screw, **14-12**
 efficiencies of, **14-13**
 for fire protection, **18-26**
 flexible-member, **14-12**
 fuel-injection, for engines, **9-109, 9-111**
 gear, **14-11**
 hand powered, **14-3**
 heat (*see* Heat pumps)
 high NPSHR in, **14-15**
 high-vacuum (*see* High-vacuum pumps)
 internal-gear, **14-11**
 low NPSHA in, **14-15**
 metering, **14-3, 16-15**
 motors for, **15-44**
 nomenclature, **14-2, 14-15**
 NPSH for, **14-2**
 piston, **14-2**
 packing for, **8-140**
 positive-displacement, **14-2**
 power (def), **14-2**
 acceleration head in, **14-6**
 brake horsepower of, **14-14**
 connecting rods for, **14-5**
 crankshafts for, **14-5**
 crossheads for, **14-5**
 main bearings for, **14-5**
 maximum recommended speeds for, **14-7**
 mechanical efficiency of, **14-14**
 minimum speeds for, **14-7**
 NPSH curves for, **14-5**
 performance curves for (chart), **14-5**
 plungers for, **14-8**
 power ends for, **14-5**
 selection charts for, **14-5**
 speeds for, **14-6, 14-7**
 stuffing boxes for, **14-8**
 torque characteristics of, **14-7**
 vertical, **14-3**
 pressure pulsations in, **14-7, 14-14**
 proportioning, **14-10**
- Pumps (*Cont.*):
 pulsation dampeners for, **14-14**
 radial-plunger, **14-12**
 reciprocating (*see* Reciprocating pumps)
 rotary, **14-11**
 bearings for, **14-13**
 casings for, **14-13**
 circumferential-piston, **14-13**
 clearances in, **14-13**
 gears for, **14-11**
 guided-vane, **14-12**
 lobe, **14-12**
 mechanical efficiency of, **14-14**
 for power steering, **11-13**
 progressing-cavity, **14-12**
 timing gears for, **14-11**
 screw, **14-12**
 slip in (def), **14-13**
 slurry, **14-4**
 suction stabilizers for, **14-14**
 swash-plate, **14-12**
 system design for, **14-14**
 uses of, **14-2**
 vacuum (*see* High-vacuum pumps)
 valves for, **14-4**
 vane, **14-12**
 variable-stroke, **14-10**
 vertical, **14-20**
 vertical-turbine, **14-20**
 very high-pressure, **14-3**
 viscosity effects in, **14-12**
- Punching of metals, **13-14**
- Pure substance (chemistry, def), **6-3**
- Purifiers: steam, **9-51**
- PVC (polyvinyl chloride): as electrical insulation, **15-50**
- PVC-acetate resins: properties of (table), **6-200**
- PVC pipe, commercial sizes (table), **8-193**
- PVC resins: properties of (table), **6-200**
- P-V-T* relations, **4-8**
- PWM (pulse width modulation), **15-79, 15-86**
- Pyramids, surface and volume of, **2-9**
- Pyranometer (solar-radiation meter), **9-12**
- Pyrex glass, **6-142**
- Pyrheliometer (solar-radiation meter), **9-12**
- Pyrometers:
 accuracy of, **16-13**
 optical, **16-10, 16-13**
 radiation, **16-10, 16-13**
- Quadrant, trigonometric, **2-15**
- Quadratic equations, **2-3**
- Quadrature current (def), **15-18**
- Quadrilateral, area of, **2-7**
- Quality circles, **17-11**
- Quality control, **17-6**
 using ISO 9000, **17-6**
 statistical, **17-19, 17-24**
- Quantum field theory, **9-134**
- Quarry machines, **10-33**
- Quart (unit of volume, def), **1-16**
- Quarter-phase a-c circuit, **15-20**
- Quartz, as abrasive, **6-129**
 fused, **6-143**
- Quenching, of steels, **6-17, 6-20**
- Quenching mediums, selection of, **6-19**
- Queuing theory, **17-9**
- Quick freezing, **19-24**
- Quick-return motion, Whitworth, **8-3**
- Quicklime, **6-160**
- Quiet rooms, **12-119**
- Quieting (noise control), **12-120**
- Raceways, for interior wiring, **15-56**
- Racks (gears), cutting processes for, **13-59**
 (shelving), for materials storage, **10-71**
- Radar, **15-88**
 loran, **15-90**
 Plan Position Indicator, **15-88**
 shoran, **15-90**
- Radians (def), **1-17, 1-18**
 measure of angles, **2-15**
- Radiant flux density (heat radiation, def), **4-62**
- Radiant-heat transfer, **4-62, 4-79**
 direct interchange areas in, **4-64**
 direct view factors for, **4-64**
 enclosures in, **4-66**
- Radiating gas, in furnaces, **4-71**
- Radiation, **4-62**
 blackbody (def), **4-62**
 and convection, combined coefficients for, **4-88**
 definition of, **4-80**
 direct view factors for, **4-63**
 emissive power (def), **4-62**
 emissivity, of surfaces (table), **4-64**
 from flames and gases, **4-68, 4-71**
 beam length for, **4-68**
 table, **4-69**
 from furnaces, **4-71, 7-42**
 from gases, **4-71**
 gray-surface (def), **4-63**
 heat transmission by, **4-62**
 intensity of, **4-62**
 laws of, **4-62**
 of nonblack surfaces, **4-66, 4-72**
 from nongray gas, **4-72**
 nuclear: damage caused by, **9-142**
 measurement of, **9-142**
 instruments for, **16-19**
 proportional counter for, **16-19**
 scintillation counter for, **16-19**
 OSHA exposure standards for, **18-22**
 to or from polished metals, **4-63**
 to refractory materials, **4-63**
 solar (*see* Solar energy)
 Stefan-Boltzmann law of, **4-62, 4-74**
 between surfaces, view factors for (charts), **4-65**
 from suspended solids, **4-71**
- Radiation pyrometers, **16-10, 16-13**
- Radio batteries, **15-11**
- Radio-frequency allocations (tables), **15-87**
- Radio-frequency bands, **15-87**
- Radio-frequency identification, **10-69**
- Radio receivers, **15-87**
 superheterodyne, **15-87**
- Radio transmitters, **15-87**
- Radioactive tracers, **16-19**
- Radioactive transformation (chemistry), **6-5**
- Radioactivity, **9-53, 9-134, 9-142**
- Radioisotopes, **16-19**
 table, **9-148**
- Radius:
 of curvature, **2-26**
 of gyration (def), **3-8**
 for beam sections (tables), **5-27**
 of two angles (tables), **12-41, 12-42**
 of inertia (def), **3-8**
 of railway curves, **11-38**
- Railing fittings, **8-205**
- Rails, friction on, **3-22**
- Railway engineering:
 braking, **11-32, 11-35, 11-37**
 car wheels and axles, **11-31**
 cars, air resistance of, **11-39**
 clearance, **11-38**
 curves in, **11-38**
 engines (*see* Locomotives)
 freight cars, **11-27**

- Railway engineering (*Cont.*):
 passenger cars, 11-33
 rails, 11-37
 starting resistance, 11-39
 track, 11-37
 gage, 11-37
 spacing, 11-38
 train resistance, 11-38
 curve and grade, 11-39
 inherent, 11-38, 11-39
 Rake of cutting tools, 13-46, 13-52
 RAM (random-access memory), 15-83
 Ramie fiber (table), 6-141
 Ramjet engines, 11-82
 Ramps, for industrial plants, 12-15
 Ramsbottom coking test for lubricating oils, 6-179
 Random-load testing, 5-10
 Random variable (def), 2-10
 Range (algebra, def), 2-3
 Rank, of a matrix (def), 2-14
 Rank test (statistics), 17-22
 Rankine absolute temperature scale, 4-2
 conversion to Fahrenheit degrees (eq), 4-2
 Rankine cycle, efficiencies, 4-19
 in nuclear reactors, 9-135
 Rankine formula, for retaining walls, 12-27
 Rateau formula, for steam flow, 4-21, 4-22
 Rating, of electrical apparatus, 15-43
 Rational numbers (def), 2-3
 Rayleigh-Ritz method (vibrations), 3-76, 3-77
 Rayleigh's energy method (vibrations), 3-75
 Rayleigh's method (dimensional analysis), 3-44
 Rayleigh's quotient (vibrations), 3-75, 3-76
 Raymond concrete piles, 12-26
 Rayon fibers (table), 6-141
 RCRA (Resource Conservation and Recovery Act), 18-18
 RDF (refuse-derived fuel), 7-10
 RDX (military explosive), 7-22
 table, 7-21
 Reactance:
 capacitive (def), 15-3, 15-18, 15-19
 inductive (def), 15-3, 15-18, 15-19
 table, 15-48, 15-52
 Reaction turbines, hydraulic, 9-151
 Reactive current (def), 15-18
 Reactive power (a-c circuit, def), 15-2
 Reactors:
 controls for, 9-141
 coolants for, 9-138
 gas, 9-140
 liquid metals, 9-140
 properties of (table), 9-140
 design of: breeding ratio, 9-141
 control, 9-141
 of criticality, 9-142
 coolant temperatures for, 9-141
 coolant velocity, 9-141
 cross sections, 9-140
 for thermal neutrons (table), 9-141
 diffusion theory, 9-141
 gamma-ray attenuation, 9-142
 high power density, 9-142
 hot-spot and hot-channel factors, 9-141
 instrumentation, 9-142
 irradiation effects, 9-142
 mechanical, 9-141
 multiplication factor, 9-140
 neutron attenuation, 9-142
 neutron balance, 9-140
 shielding, 9-142
 sources of heat, 9-141
 thermal, 9-141
 thermal design criteria, 9-141
 Reactors (*Cont.*):
 heat from, 4-20
 materials for, 9-138
 for control, 9-138
 damage to, 9-138
 fertile, 9-138
 fissionable, 9-138
 fuel, 9-138
 fuel diluents, 9-138
 metals, 9-138
 moderating, 9-138
 properties of (table), 6-84, 9-139
 neutron-level instruments for, 9-142
 power, 9-136
 boiling-water, 9-136
 fast-breeder, 9-136
 gas-cooled, 9-135, 9-136
 liquid-metal cooled, 9-136
 pressurized-water, 9-136
 types of, 9-136
 power cycles for, 9-135
 power generators, isotopic, 9-148
 research, 9-135
 safety of, 9-146
 test, 9-135
 Read-only memory (computers), 2-40
 Real numbers (def), 2-3
 Reamers, 13-56
 Reaming, of plastics, 13-65
 Rear axles, automobiles, 11-10
 Reciprocating pumps, 14-2
 applications of, 14-3
 liquid end components for, 14-4
 motors for, 15-44
 packing for, 8-140
 plunger loads in, 14-7
 pressure pulsations in, 14-7, 14-14
 problems to avoid, 14-4
 pumping cycle in, 14-5
 quintuplex, 14-4, 14-6
 slip of, 14-13
 for slurries, 14-4
 stuffing boxes for, 14-4
 triplex, 14-4, 14-6
 uses of, 14-3
 valves for, 14-4
 Rectangles, area of, 2-7
 Rectifiers:
 electric, 15-41, 15-68
 circuits for (chart), 15-72
 full-wave, 15-71, 16-16
 half-wave, 15-71
 ignitron, 15-71
 Recuperators, for industrial furnaces, 7-44
 Recycling, of paper, 6-145
 Red lead (paint), 6-110
 Redler continuous-flow conveyor, 10-41
 Reduced values (thermodynamics), 4-8
 Reduction of area, in tensile test, 5-2
 Referencing a point (surveying), 16-57
 Reflectance of heat, 4-63
 Reflection of light (def), 12-99
 Reflective heat insulation, 6-151
 Reformatted gasoline, 9-104
 Refraction (optics), 19-41
 Refractories:
 for arc furnaces, 7-55
 brick shapes and sizes, 6-152
 castable, 6-154
 coatings for, 6-154
 composition of (table), 6-152
 fiber, 6-155
 furnace: heat radiation from (chart), 7-43
 selection of, 6-154
 heat losses and heat-storage capacities of (table), 6-155
 Refractories (*Cont.*):
 heat radiation from, 4-66, 4-72
 high-purity, properties of (table), 6-156
 insulating, 6-151
 metal, properties of (table), 6-81
 mortars for, 6-153
 physical properties of (tables), 6-153, 6-156
 plastics and ramming mixtures for, 6-154
 pure-oxide, 6-154
 for space vehicles, 6-155
 specific heats of (tables), 6-153
 surface temperatures of, in combustion chambers, 4-78
 types of, 6-151
 Refrigerant 11:
 enthalpy-pressure diagram for (chart), 4-38
 properties of (table), 4-38, 4-51, 4-56
 Refrigerant 12:
 enthalpy-pressure diagram for (chart), 4-39
 properties of (table), 4-39, 4-51, 4-56
 Refrigerant 13: properties of (table), 4-51, 4-56
 Refrigerant 21: properties of (table), 4-51, 4-56
 Refrigerant 22:
 enthalpy-pressure diagram for (chart), 4-40
 properties of (table), 4-40, 4-51, 4-56
 Refrigerant 32: properties of (table), 4-41
 Refrigerant 123:
 enthalpy-pressure diagram for (chart), 4-42
 properties of (table), 4-41
 Refrigerant 134a:
 enthalpy-pressure diagram for (chart), 4-43
 properties of (table), 4-42
 Refrigerant 143a, properties of (table), 4-43
 Refrigerant 152a:
 enthalpy-pressure diagram for (chart), 4-45
 properties of (table), 4-44, 4-51
 Refrigerants, 19-2
 ammonia, properties of (table, chart), 4-33, 4-34
 fluorocarbon, properties of (table), 4-51
 ideal performance of (table), 19-4
 standard temperature range, 19-3
 identifying number, 19-2
 pressure-temperature relations of (chart), 19-12
 properties of (tables), 4-33, 4-35 to 4-44, 4-51, 19-3 to 19-7
 (See also Ammonia)
 Refrigerating machines:
 absorption, 19-17
 processes in, 19-17
 Serval process, 19-17
 ammonia volume per ton of refrigeration (table), 19-15
 coefficient of performance of, 4-18, 19-2
 cold-air, 19-17
 compression in, 19-14, 19-15
 condensers for, 19-14
 controls for, 19-15
 horsepower per ton of refrigeration (ammonia, table), 19-15
 household, 19-16
 lubrication of, 6-184
 oil for, 6-184
 rating of (def), 19-2
 unit of capacity of (def), 19-2
 Refrigerating plants:
 brines for, 19-18
 piping of cooling and storage rooms, 19-23
 skating rinks, 19-25
 Refrigeration, 4-19, 19-2
 absorption system of, 4-18
 brine systems for, 19-18
 cascade system, 19-16
 in the chemical industry, 19-25
 cold-storage, 19-21
 compound low-temperature, 19-15

- Refrigeration (*Cont.*):
 in cryogenics, **19-27**
 engines for, **19-27**
 cycles for, **19-12**
 vapor-compression, **19-15**
 deep, **19-25**
 direct-expansion system of, **19-18**
 expansion engines for, **19-27**
 gas intercoolers for, **19-15**
 for ice making, **19-25**
 leak detection in, **19-7**
 low-temperature boosters for, **19-16**
 multiple-effect, compression in, **19-14**
 power required for, **4-18**
 processes for, **19-2**
 quantity of fluid circulated, **4-18**
 quick freezing (cold storage), **19-24**
 unit of (def), **19-2**
 vapor-compression circuits for, **19-15**
 vapor-compression machines for (theory), **4-18**
 water-vapor, **19-16**
- Refuse Act of 1899, **11-47**
- Regenerative braking (def), **10-10**
- Regenerative cycles:
 for feedwater heating, **4-19**
 for turbines, **4-19, 9-71**
- Regenerators:
 for industrial heating furnaces, **7-44**
 tile sizes for, **6-152**
- Register ton (def), **1-16**
- Registration: of engineers, **18-31**
- Reheaters, **9-41**
- Reheating cycle for steam turbines, **4-19, 9-71**
- Reid vapor pressure (fuels), **9-104**
- Reinforced concrete:
 beams of, **12-52**
 shear forces in, **12-54**
 bearing plates for, **12-58**
 bearing walls of, **12-59**
 columns of, **12-55**
 footings for, **12-58**
 spiral reinforcement in, **12-56**
 concrete for, **12-50**
 contraction and expansion joints for, **12-60**
 dead load of, **12-51**
 definition of, **12-49**
 dowels for, **12-58**
 floor systems of, **12-56**
 footings of, **12-58**
 for columns, **12-58**
 combined, **12-58**
 forms for, **12-60**
 design of, **12-60**
 liners for, **12-61**
 removal of, **12-61**
 inspection of, **12-61**
 joints in, **12-60**
 construction of, **12-60**
 joist floors of, **12-56**
 live loads on, **12-51**
 load factors for, **12-51**
 loads on, **12-50**
 moduli of elasticity for, **12-50**
 old, evaluation of, **12-61**
 partitions of, **12-59**
 pipe of, **8-193**
 precast units, **12-60**
 prestressed, **12-50, 12-59**
 allowable stresses in, **12-59**
 protection of reinforcement in, **12-50**
 reinforcing steel for, **12-50**
 dimensions of (table), **12-50**
 retaining walls of, **12-59**
 slabs of, **12-56**
 steel for, **12-50**
 sizes of, **12-50**
- Reinforced concrete (*Cont.*):
 T beams, **12-56**
 two-way slabs, **12-56**
 walls of, **12-59**
- Relative density:
 of liquids: conversion tables for: API,
1-26
 Baumé, **1-27**
- Relative humidity, **4-15, 12-87**
- Relative permeability (def), **15-4, 15-8**
- Relative permittivity (def), **15-2**
- Relative roughness (fluid flow), **3-47**
- Relativistic mass, **9-134**
 formula for, **9-134**
- Relaxation test of metals (def), **5-10**
- Relief angles for cutting tools, **13-46, 13-52**
- Reluctance, magnetic (def), **15-4**
- Reluctivity (def), **15-4**
- Remanence (magnetic hysteresis, def),
15-10
- Replacement of equipment, **17-7**
- Reports, annual, **17-12**
- Residuals, tables of, **1-14**
- Resilience (def), **5-17**
 of beams, **5-32**
 of beams and springs (table), **5-17**
 modulus of (def), **5-17**
 ultimate, **5-17**
- Resin-type adhesives (table), **6-131**
- Resinoid grinding wheels, **6-129**
- Resins, in varnishes, **6-108**
- Resistance:
 effective (electric circuits, def), **15-19**
 electrical, **15-2**
 of conductors: measurement of, **15-24**
 specific (table), **15-4**
 of copper lay cables (table), **15-6**
 of copper wire (tables), **15-5, 15-6, 15-48, 15-52, 15-56**
 of insulating materials (table), **15-16**
 of materials (table), **15-61**
 of parallel circuits, equivalent, **15-8**
 temperature coefficient of (table), **15-4**
 unit of (def), **15-2**
 welding by (*see* Welding, resistance)
 of resistor alloys (table), **15-61**
 of ships, **11-45**
 traction, of automobiles, **11-3, 11-5**
 of trains, **11-38**
- Resistance brazing, **13-29**
- Resistance furnaces (*see* Electric furnaces, resistance)
- Resistance strain gages, **5-53**
- Resistance welding (*see* Welding, resistance)
- Resistivity (def), **15-2, 15-4**
 tables, **6-50, 15-4**
- Resistor furnaces, **7-52**
- Resistor materials, **15-61**
 table, **15-61**
- Resistor ovens, **7-54**
- Resistors for electric furnaces, **7-53, 15-61**
- Resonance:
 in electric circuits, **15-19**
 in vibration, **3-64**
- Resonant cavities (electronics), **15-73**
- Respirators, use of, in hazardous occupations,
18-22
- Respiratory protection, **18-22**
- Response time (automatic control, def), **16-22**
- Restitution, coefficient of (def), **3-19**
- Retaining walls, design of, **12-27, 12-59**
- Return on capital (accounting), **17-18**
- Reynolds number, **3-42, 3-43, 3-46 to 3-50, 11-45, 11-63, 11-65**
 chart for, **3-48**
- RFG (reformulated gasoline), **9-104**
- Rheostats:
 materials for, **15-61**
 table, **15-61**
- Rhodium, uses of, **6-74**
- Rhombus, area of, **2-7**
- Ribbon, area of, **2-8**
- Riccati equation, **2-32, 16-44**
- Right-hand rule:
 for conductor current, **15-11**
 for generators, **15-11**
- Rigid bodies:
 dynamics of, **3-13**
 forces supporting, **3-4 to 3-6**
 instantaneous axis of, **3-13**
 statics of, **3-3 to 3-6**
- Rigidity:
 coefficient of (def), **5-17**
 modulus of, for metals (table), **5-4**
- Ringelman chart, **18-15**
- Rings, strength of, **5-46**
- Rise time (automatic control, def), **16-22**
- Risk, effect on decision making, **17-7**
- Riveted joints:
 design of, **12-35, 12-43**
 punched vs. drilled plates, **8-29**
- Riveters, **13-24**
- Rivets:
 aluminum, properties of (table), **6-60**
 blind, **8-30**
 conventional signs for (fig), **8-30**
 forms and proportions of, **8-27, 8-30**
 lengths and grips of (fig), **8-30**
 pop, **8-30**
 for steel-framed structures, **12-35, 12-43**
 tubular, **8-29**
- Roads:
 friction on, **3-24**
 rolling resistance on, **11-3**
- Robots, **10-56**
 accuracy of, **10-60**
 anatomy of, **10-57**
 articulations for, **10-58**
 configurations of, **10-58**
 motion control of, **10-60**
 payloads of, **10-60**
 programming of, **10-61**
 repeatability of, **10-60**
 resolution of, **10-60**
 size of, **10-58**
 specifications for, **10-58**
 speeds of, **10-60**
 teach-pendants for, **10-61**
 teaching of, **10-61**
 using, **10-62**
 work cells for, **10-57**
 work envelopes for, **10-60**
 workspace of, **10-60**
- Robustness (automatic control, def), **16-40**
- Rock, pipelines for, **11-131**
- Rocker (mechanism), **8-3**
- Rocket engines, **11-85**
 ablative cooling for, **11-85**
 bipropellant, **11-119**
 chemical, **11-85, 11-119**
 combustion temperatures in, **11-85**
 electric, **11-86**
 electromagnetic, **11-87**
 electrostatic, **11-87**
 electrothermal, **11-87**
 fuels for (*see* Rocket fuels)
 liquid-bipropellant, **11-85**
 liquid-propellant, **11-119**
 mercury ion, **11-87**
 mixture ratios in, **11-85**
 monopropellant, **11-119**
 nuclear, **11-119**

- Rocket engines (*Cont.*):
 nuclear heat-transfer, **11-86**
 regenerative cooling for, **11-85**
 solar heating, **11-119**
 solid fuels for, **11-94**
 solid propellant, **11-85, 11-94, 11-119**
 thermal arc-jet, **11-87**
- Rocket fuels:
 alcohol, **7-29**
 ammonia, **7-29**
 bipropellant, **7-29**
 burning rates of, **11-94**
 cartridge-loaded, **7-29**
 case-bonded, **7-29**
 combustion instability in, **7-30**
 composite, **7-29, 11-85, 11-94**
 cost of, **7-28**
 design criteria for, **7-28**
 diergolic (def), **11-85**
 double-base, **7-29**
 double-base powder, **11-85, 11-94**
 heterogeneous, **11-85, 11-94**
 hydrazine, **7-29**
 hydrogen peroxide, **7-29**
 hypergolic (def), **7-29, 11-85**
 liquid, **7-28, 11-85**
 liquid hydrogen, **7-29**
 liquid oxygen, **7-29**
 monopropellants, **7-29**
 nozzle erosion by, **7-30**
 pressure and thrust control of, **7-30**
 safety requirements for, **7-28**
 service life of, **7-28**
 smokiness of, **7-28**
 solid, **7-28, 11-85, 11-94**
 case-bonded, **11-85**
 UDMH, **7-29**
- Rocket motors (*see* Rocket engines)
- Rocket nozzles, **11-75**
- Rockets, nuclear, **11-119**
 space vehicle applications of, **11-119**
 specific impulse of, **11-120**
- Rockwell hardness test, **5-12, 16-18**
- Rod (unit of length, def), **1-16**
- Rods, vibration of, **3-72**
- Roll (ships, def), **11-45**
- Roll-pins, **8-33**
- Roller bearings (*see* Bearings, roller)
- Roller chains (*see* Chains, roller)
- Roller conveyors, **10-52**
- Rolling:
 cold, **13-14**
 contour, **13-14**
 of foil, **13-14**
 hot, **13-14**
 operations, **13-11**
 oscillating, **13-14**
 segmented, **13-14**
 shape, **13-14**
 in tube-reducing mills, **13-14**
- Rolling friction, **3-25**
- Rolling loads on beams, **5-32**
- Rolling motion, **3-16**
- Rolling-piston compressors, **14-34**
- Rolling surface (mechanism), **8-7**
- ROM (read-only memory), **15-83**
- Roofing:
 asphalt, **6-145**
 elastomers for, **6-146**
 materials for, **6-145**
 metallic, **6-146**
- Roofing cement, **6-146**
- Roofs:
 flashings for, **12-15**
 heat gain through (table), **12-74**
 for industrial plants, **12-15**
- Roofs (*Cont.*):
 live loads on, **12-18**
 masonry, coefficients of heat transmission (table), **12-71**
 trusses (*see* Trusses)
- ventilation fans for, **14-45**
 wind pressure on, **12-19, 12-21**
- Room sensible heat factor (def), **12-87**
- Root locus method (automatic control), **16-27**
- Root-mean-square value of a-c wave, **15-18**
- Roots, arithmetical, **2-3**
- Roots blowers, **9-106, 14-40, 14-43**
- Rope, **6-137**
 braided, **6-138**
 breaking strength of (table), **8-81**
 friction of, **3-29**
 for haulage, **10-8**
 for hoist drums, **10-8**
 knots, hitches, and bends for, **8-81**
 lay of (def), **6-137**
 manila, U.S. specification (table), **6-138**
 materials for, breaking strength of (table), **8-81**
 for mine hoists, **10-17**
 nylon, **6-137, 6-140**
 polyester, **6-137, 6-140**
 sheaves for, **10-10**
 wire, **10-8**
- Rotameter (for fluids), **16-14**
- Rotary blowers, **14-44**
- Rotary car dumps:
 gravity, **10-22**
 power, **10-22**
- Rotary cranes, **10-27**
- Rotary pumps, **14-11**
- Rotary shafts (*see* Shafts)
- Rotating machines, balancing of, **3-15, 3-65, 3-66**
- Rotation: of solid bodies about axes, **3-15, 3-16, 3-19**
- Rotation moments of a couple, **3-3**
- Rotoclones, for gas cleaning, **18-10**
- Rouge (abrasive), **6-129**
- Roughness (metal surfaces, def), **13-69**
 (*see* Surface texture)
- Roughness factors for open channels, **3-59**
 table, **3-59**
- Routh's stability criterion (automatic control), **16-38**
- Rubber and rubberlike materials:
 balata, **6-148**
 Buna S, **6-147**
 butyl, **6-147**
 chlorinated, **6-148**
 cyclized, **6-148**
 derivatives, **6-148**
 elastomers (def), **6-146**
 comparative properties of (table), **6-148**
 uses of, **6-147**
 GR-S, **6-147**
 gutta-percha, **6-148**
 latex, **6-148**
 natural, **6-147**
 neoprene, **6-147**
 nitrile, **6-147**
 pigments in, **6-147**
 polysulfide, **6-147**
 polyurethane, **6-147**
 properties of, **6-147**
 on roads, friction of, **3-24**
 silicone, **6-139, 6-151**
 specific gravity and density of (table), **6-7**
 Thiokol, **6-148**
 vulcanization of, effect of, **6-147**
- Rubber belts (*see* V-belts)
- Rubber bonding of grinding wheels, **6-129**
- Rubber-die forming, **13-18**
- Rubber hydrochloride, **6-148**
- Rubble masonry (table), **12-28**
- Ruben cell, **15-12**
- Runge-Kutta methods, for differential equation solutions, **2-39**
- Rupture:
 modulus of (def), **5-26**
 unit work, **5-17**
- Rzeppa universal joints, **8-36**
- S-N diagram (fatigue analysis), **5-8**
- SAE viscosity grades, for crankcase oils (table), **6-182**
- Safety, **18-19**
 corrosion effects on, **6-95**
 in cryogenics, **19-40**
 of grinding wheels, **13-63**
- Safety codes, **18-22**
- Safety devices for machines, **18-20**
- Safety factor (def), **5-20**
- Safety glass, **6-142**
- Sagging (ships, def), **11-43**
- Salinometers, **19-18**
- Salometers, **19-18**
- Salt, common, as freezing preventive, **6-141**
- Salts, inorganic, solubility of (table), **6-5**
- Sampling (statistics), **17-19, 17-24**
- Sand:
 for cement (table), **6-161**
 for concrete, **6-161**
 for cores, **13-6**
 binders for, **13-6**
 for mold making, **13-5**
 additives for, **13-6**
 bonded, **13-6**
 grain size of, **13-6**
 properties of, **13-6**
 molding, **13-3**
 specific gravity and density of (table), **6-8**
- Sand blasting, **13-64**
- Sand casting, **13-2**
- Sand castings, making of, **13-3**
- Sand-lime brick, **6-135**
- Sand slingers (molding machines), **13-5**
- Sanders, wood, **13-75**
- Sandstone, composition of, **6-143**
- Saran (fiber), **6-140**
- SASOL (coal conversion process), **7-19**
- Saturated ammonia, properties of (table), **4-33**
- Saturated carbon dioxide, properties of (table), **4-35**
- Saturated steam:
 properties of (table), **4-44**
 vapor (def), **4-13**
- Saturation of air, in spray chambers, **4-17**
- Saturn, planetary data for (tables), **11-102, 11-103**
- Savonius rotors, **9-7**
- Sawing, of plastics, **13-65**
- Saws:
 metal-cutting, **13-61**
 wood, **13-72**
 classification of, **13-72**
 gullet-feed index for, **13-73**
 materials, **13-73**
 power required for, **13-73**
 table, **13-74**
 teeth for, **13-73**
 set of, **13-73**
 spring-setting of, **13-73**
 swage-setting of, **13-73**
- Saybolt Furol viscometer, **3-33**
- Saybolt Universal viscometer, **3-33**
- Scale deposits, heat-transfer coefficients (table), **4-85**
- Scale effect (aerodynamics), **11-63**

- Scales, **16-3**
 automatic, **16-4**
 batch-type, **16-4**
 continuous, **16-4**
 spring, **16-4**
- Scanning (television), **15-89**
- Scarifying, of steel, **6-15**
- Scavenging two-cycle engines, **9-107**
- Scheduling:
 using CPM (critical path method), **12-18, 17-5**
 flow of materials, **17-6**
 using PERT, **17-5**
 production, **17-4**
- Schiele's antifriction curve (tractrix), **2-23**
- Schlieren optical system (compressible-flow visualization), **11-81**
- Schmitt trigger (electronics), **15-79**
- Scleroscope hardness test, **5-13**
- Scott tap (transformers), **15-36**
- SCR (silicon controlled rectifier), **15-41**
- Scramjets, **11-82**
- Scraper conveyors, **10-40**
- Scrapers, **10-25**
- Scratch coat (plastering), **6-163**
- Scratch hardness (minerals testing), **5-12**
- Screen scale, Tyler (for particle sizes, table), **18-10**
- Screw conveyors, **10-42**
- Screw jacks, **10-15**
- Screw machines, **13-55**
 free-cutting steel stock for (AISI and SAE), **6-28**
- Screw presses, **13-22**
- Screw propellers (ship):
 blade shapes for, **11-53**
 cavitation, **11-53, 11-54**
 controllable and reversible pitch, **11-54**
 design of, **11-53**
 developed area (def), **11-53**
 fitting to shaft, **11-57**
 partially submerged, **11-55**
 pitch of (def), **11-53**
 projected area of, **11-53**
 shafts for, **11-56**
 slip ratio of (def), **11-53**
 slip velocity of (def), **11-53**
 supercavitating, **11-55**
 tandem and contrarotating, **11-55**
 ventilated, **11-55**
 wake velocity of (def), **11-53**
- Screw pumps, **14-12**
- Screw threads:
 Acme (tables), **8-16, 8-17**
 American National Standard, drill sizes for (table), **8-30**
 American Unified (tables), **8-10 to 8-13**
 coarse (tables), **8-12**
 extra-fine (table), **8-13**
 fine (tables), **8-13**
 basic profile for, **8-9**
 design profile for, **8-9**
 Dryseal pipe, **8-17**
 efficiency of, **3-26**
 fits for, Unified standard, **8-9**
 for high-strength bolting (table), **8-18**
 inserts for, **8-27**
 limiting dimensions of, **8-9**
 machine, **8-8**
 machines for cutting, **13-57**
 major diameter of (def), **8-9**
 metric, **8-9**
 ANSI (table), **8-14**
 ISO standard (table), **8-14**
 tolerance classes for, **8-16**
 minor diameter of (def), **8-9**
 modified square, **8-16**
- Screw threads (*Cont.*):
 pipe, American National Standard, **8-18**
 pitch diameter of (def), **8-9**
 for power transmission, **8-16**
 square, friction of, **3-26**
 stub, **8-16**
 tap drill sizes for (table), **8-30**
 tolerance classes for, **8-9**
 UN and UNR (table), **8-10**
 UNC and UNRC (table), **8-12**
 UNEF and UNREF (table), **8-13**
 UNF and UNRF (table), **8-13**
 Unified thread standards for, **8-8**
- Screws, **8-8**
 cap (table), **8-22**
 coach (table), **8-24**
 graphical markings for, ASTM (table), **8-28**
 SAE (table), **8-28**
 lag: holding power of, **12-32**
 table, **8-24**
 machine (*see* Machine screws)
 self-tapping, **8-21**
 forms of (table), **8-25**
 table, **8-26**
 threads for, ANSI metric (table), **8-14**
 V-thread, friction of, **3-26**
 wood (table), **8-24**
 holding power of, **12-31**
- Script alphabet, **19-44**
- Scrubbers, gas, **18-11, 18-16**
- Scruple (apothecaries' weight, def), **1-17**
- SDEL (sulfur dioxide emission limitation), programs for, **18-14**
- Sea, as source of tidal energy, **9-21**
- Seakeeping (ships), **11-44**
- Sealants, **6-155**
 acrylic latex, **6-157**
 adhesion/cohesion of, **6-156**
 butyl, **6-157**
 compression set of, **6-157**
 foamed-in-place, **6-159**
 forever-tacky, **6-159**
 formed-in-place, **6-159**
 as gasket, **6-159**
 hardness of, **6-156**
 hot poured, **6-159**
 modulus of, **6-156**
 oil-based caulks as, **6-157**
 polysulfide, **6-157**
 polyurethane, **6-157**
 properties of, **6-156**
 table, **6-158**
 relaxation of, **6-156**
 silicone, **6-157**
 types of, **6-157**
 urethane, **6-157**
 water-based, **6-159**
 weathering resistance of, **6-157**
- Seals:
 for shafts: controlled-gap, **8-142**
 mechanical, **8-141**
- Seamless steel tubing (tables), **8-186, 8-187**
- Seawater:
 galvanic series for metals and alloys in (table), **6-100**
 purification of, **6-173**
 specific gravity and density of (table), **6-8**
 used in concrete, **6-161**
 (*See also* Water, desalination of)
- Seaworthiness (def), **11-41**
- Secants (trigonometry), **2-15**
- Second (circular measure, def), **1-17**
 (unit of time, def), **1-17**
- Section modulus:
 of beams (def), **5-26**
 table, **5-27**
- Sectors:
 of circle: area of, **2-7**
 center of gravity of, **3-7**
 of sphere: center of gravity of, **3-7**
 volume and area of, **2-9**
- Seebeck effect, **9-24, 15-21**
- SEER (seasonal energy efficiency ratio, def), **19-2**
- Seeger cones, **16-10**
- Segments:
 of circle, **2-8**
 center of gravity of, **3-7**
 of sphere, **2-9**
 center of gravity of, **3-7**
- Seismic forces, **12-51**
- Seismometers, **3-78**
- Self-guided vehicles, **10-56**
- Self-inductance (def), **15-2, 15-16**
 coefficient of (def), **15-2**
- Self-induction, emf of, **15-16**
- Self-tapping screws (table), **8-26**
- Selsyns, **15-42**
- Semiconductor diodes, **15-68**
- Semigels (explosives), **7-21**
- Sensible heat factor (psychrometrics, def), **12-87**
- Separating calorimeters, **16-18**
- Separators:
 for dust exhaust systems, **18-10, 18-11**
 steam, **9-51**
- Sequence (def), **2-30**
- Series (def), **2-30**
 expansion of functions in, **2-31**
 Fourier's, **2-36**
 semigeometric, **8-215**
 Taylor's and Maclaurin's, **2-30**
- Series circuits, **15-16**
 a-c, solution of problems in, **15-19**
- Series generators, **15-26**
- Series motors, **15-28**
- Servel process of refrigeration, **19-17**
- SES (surface-effect ship), **11-58**
- Set point (automatic control, def), **16-22**
- Sets:
 algebra of, **2-2**
 algebraic, **2-2**
 elements of, **2-2**
 operations on, **2-2**
 subsets of, **2-2**
- Setscrews:
 holding power of (table), **8-23**
 points and heads for, **8-19**
- Settling time (automatic control, def), **16-22**
- SEV (surface-effect vehicles), **11-58**
- Sewer pipe, **8-191**
- Sexagesimal measure of angles, **2-15**
- Shadow prices (linear programming), **17-9**
- Shafting, marine, **11-56**
- Shafts:
 alignment of, **16-57**
 bending moments in, **8-47**
 combined torque and bending in, **8-47**
 couplings for (*see* Couplings)
 failure due to fatigue, **8-47**
 fits for, **8-43**
 keys for, **8-31**
 leveling of, **16-57**
 packing for, **8-140**
 resilience of (table), **5-17**
 for ship propellers, **11-56**
 splined, **8-33**
 stiffness of, **8-47**
 strength of, **8-47**
 torsion of, **5-36, 8-47**
 combined with other stresses, **5-18, 5-19, 8-47**
 table, **5-38**

- Shafts (*Cont.*):
 torsional vibration of, 3-72
 vibration of, 3-72
- Shale oil:
 fuel from, 7-19
 reserves of, 9-3
- Shape factor (plastic design, def), 5-20
- Shape rolling, 13-14
- Shapers, 13-60
- Shaving (metalworking), 13-15
- Shaw process (molding), 13-3
- Shear:
 and bending, 5-16
 and bending moment in beams, 5-31
 maximum pressure in, 13-14
 modulus of elasticity in, 5-17
- Shear diagrams, for beams, 5-21, 5-31 to 5-33
- Shearing:
 in dies, resistance to (table), 13-15
 of metals, 13-14
 allowance for shaving, 13-15
 power for, 13-15
- Shearing modulus of metals (table), 5-4
- Shearing stress (def), 5-15, 5-16
 at end of beams, 5-36
 for various cross sections, 5-16
- Shears, metal-cutting, 13-15
- Sheaves:
 stresses in, 8-50
 for V-belts (tables), 8-54, 8-56, 8-58, 8-59
 for wire rope, 8-79
 allowable radial bearing pressure on (table),
 8-79
 minimum groove dimensions for, 8-80
 ratios for (table), 8-79
- Sheet-metal gages (table), 8-85
- Shellac grinding wheels, 6-129
- Shellac varnish, 6-112
- Shells, drawing of (metalworking), 13-18
- Shielding:
 of nuclear power plants, 9-142
 of sound, 12-120
- Shingles:
 asbestos, 6-146
 asphalt, 6-145
 slate, 6-146
 wood, 6-145
- Shipping measure, 1-16
 tons, United States and British, 1-16
- Ships, 11-40
 air resistance of, 11-46
 antirolling gyroscopes for, 3-20
 boilers for, 11-49
 bottom paints for, 6-109
 catamaran, 11-41
 center of buoyancy of (def), 11-44
 center of gravity of, 11-44
 combined propulsion plants for, 11-52
 condensate systems in, 11-49
 deadweight of (def), 11-41
 definitions of power and speed for, 11-46
 delivered power (def), 11-48
 designed load waterline (DWL, def), 11-42
 diesel engines for, 11-50
 displacement of (def), 11-41
 draft of (def), 11-42
 drag, designed, 11-42
 electric drives for, 11-56
 engineering constraints, 11-47
 engines for (*see* Marine engines)
 environment of, 11-40
 environmental constraints, 11-47
 feedwater systems for, 11-49
 form coefficients of (table), 11-42
 gas-turbine drives for, 9-132
 gas turbines for, 11-51
- Ships (*Cont.*):
 high-performance, 11-41, 11-57
 hull forms for, 11-41
 Kort nozzles for, 11-55
 lengths of (def), 11-42
 line shafts for, 11-56
 metacenter of (def), 11-44
 molded beam of (def), 11-42
 motions of, 11-45
 nuclear, 9-148
 nuclear steam plants for, 11-49
 powering of, 11-45
 propeller shafts for, 11-56
 propulsion plants for, 11-48
 propulsors for, 11-52
 reduction gears for, 11-55
 resistance of, 11-45
 frictional, 11-45
 wavemaking, 11-45
 reversing of, 11-56
 screw propellers for, 11-53
 shaft power of (def), 11-48
 stability of, 11-44
 steam plants for, 11-48
 steam turbines for, 11-49
 structural steel for, ASTM specifications
 (table), 6-26
 structure of, 11-42
 submarine, 11-41
 tonnage of (def), 11-41
 trim of, 11-42
 water-jet propulsion for, 11-55
- Shock spectrum (vibrations), 3-69
- Shoran (navigation by radar), 15-90
- Shore scleroscope (hardness testing), 5-13
- Shovels, power, 10-33
- Shrink fits, 8-44
- Shrinkage:
 of refractories (table), 6-153
 of rings on thick cylinders, 5-46
- Shunt generators, 15-26
 parallel operation, 15-27
- Shunt motors, 15-28
 starters for, 15-28
- SI units (The International System of Units):
 base and supplementary (defs), 1-17, 1-24
 conversion tables for, 1-19 to 1-24
 prefixes for (table), 1-19
- Side-cutting-edge angle (tools), 13-52
- Sidereal time, 1-25
- Sidewalks, moving, 10-22
- Siemens (def), 15-2
- Sigma function for moist air, 4-16
- Signal bronze, 15-6
- Signal validation (automatic control), 16-49
- Significant figures, number of, 2-4
- Silent chains, 8-62
- Silica brick, 6-151
- Silica in steam, 9-50
- Silicate grinding wheels, 6-129
- Silicon carbide:
 as abrasive, 6-128, 13-62
 as refractory (table), 6-152
 as resistor material, 15-62
 for wood sanding, 13-75
- Silicon carbide furnace (electric), 7-59
- Silicon controlled rectifier (SCR), 15-69
- Silicone greases, 6-151
- Silicone oils, 6-151
- Silicone paint, 6-109
- Silicone resins, 6-151
 properties of (table), 6-199
- Silicone rubber, 6-139, 6-151
- Silicone varnish, 6-138, 6-151
- Silicone water repellents, 6-151
- Silicones, 6-151
- Silk fibers (table), 6-141
- Silver, uses of, 6-74
- Silver soldering, 13-29
- Similar figures (geometry), 2-5
- Similarity, of models, 3-41
- Simplex method, of data transmission, 16-21
 of optimization, 17-8
- Simpson's rule, for area and volumes, 2-29,
 2-39
- Simulation, on computers, 2-53
- Simultaneous equations, solution of, 2-12
- Sine (trigonometry), 2-15
- Sine waves (a-c circuits), 15-18
- Sines, law of, 2-17
- Single-phase induction motors, 15-39
- Single-phase power measurement, 15-21
- Singular norm (def), 16-41
- Singular values (matrices), 16-41
- Sink (automatic control, def), 16-28
- Sinking fund (table), 1-7
- Sintering, of powdered metals, 6-62
- Siphons, 3-53
- Sirens, 12-118
- Sisal, properties of (table), 6-141
- Sizing (flattening of forgings), 13-19
- Skating rinks, ice, piping for, 19-25
- Skelp (steel, def), 8-167
- Skids (materials handling), 10-72
- Skim coat (plastering), 6-163
- Skin friction (aerodynamics), 11-66
- Skip hoists, 10-16
 loading and unloading of, 10-16
- Skylights:
 coefficients of heat transmission through
 (table), 12-70
 for industrial plants, 12-11
- Slabs (*see* Reinforced concrete)
- Slackline cableways, 10-35
- Slag:
 in boilers, 9-29, 9-32
 specific gravity and density of (table), 6-8
- Slagging index, of coal, 9-30
- Slate, 6-143, 6-146
- Sleds, friction of, 3-24
- Slenderness ratio of columns, 5-38
- Slider couplings, double, 8-35
- Sliding bearings, 8-127
- Sliding-block linkage, 8-3
- Sliding friction (def), 3-21
 tables, 3-23, 3-24
- Slimline lamps, 12-101
- Slip (of pumps), 14-13
- Slip ratio, of screw propellers, 11-53
- Slope, of a curve (def), 2-24
- Sludge, in boiler feedwater, 9-48, 9-49
- Slug (def), 1-23, 3-2
- Slump test, for concrete, 6-166
- Slurry pumps, 14-4
- Smart cards, 10-62
- Smoke (def), 18-8, 18-10
- Snatch blocks, 10-10
- Snell's law (optics), 19-41
- Soap, 6-137
- Sodium chloride brine, properties of (tables),
 19-19
- Soil pipe, cast-iron, 8-189
- Soils: safe bearing power of, 12-26
- Solar cells, 15-34
- Solar energy, 9-11
 applications of, 9-14
 collectors, 9-13, 9-14
 flat plate, 9-14
 heat-transfer coefficients (table), 9-14
 for cooking, 9-16
 direct conversion of, 9-17
 equilibrium temperatures, 9-13

Solar energy (*Cont.*):

furnaces using, **9-16**
 for heating swimming pools, **9-14**
 for house heating, **9-15**
 incident-angle determination, **9-12**
 instruments for: pyranometer, **9-12**
 pyrheliometer, **9-12**
 opaque surface absorptance and admittance of, **9-12**
 power from, **9-16**
 radiation intensity of, **9-11**
 for refrigeration, **9-15**
 from solar ponds, **9-15**
 for stills, **9-15**
 transparent materials for, solar-optical properties of, **9-12**
 utilization of, **9-11**
 heliocchemical (def), **9-11**
 helioclectrical (def), **9-11**
 heliothermal (def), **9-11**
 processes, **9-11**
 for water heaters, **9-15**
 Solar ponds: energy from, **9-15**
 Solar-powered vehicles, **9-17**
 Solar radiation:
 annual variation (tables), **9-12**
 on surfaces (table), **9-12**
 Solar time, **1-25**
 Solder, alloys (table), **6-76**
 Soldered-joints, fittings for (table), **8-206**
 Soldering:
 sonic, **12-122**
 with ultrasonics, **12-122**
 Solders, **6-74, 6-76**
 for brazing (tables), **6-76**
 Solenoids, **15-63**
 magnetic pull of (table), **15-63**
 Solid angle (def), **2-9**
 Solids:
 buoyancy of, **3-36**
 center of gravity of, **3-7**
 melting points of (tables), **4-50, 4-57**
 moments of inertia of, **3-8**
 approximate, **3-9**
 radiation from, **4-71**
 radioactive, control of, **18-17**
 rotation about axes, **3-15, 3-16, 3-19**
 specific gravity and density of various (table), **6-7**
 by immersion, **3-36**
 surface and volume of, **2-8**
 thermal conductivity of (tables), **4-80, 4-81, 4-83**
 volume of, by immersion, **3-36**
 Solubility:
 of gases in water (table), **6-7**
 of inorganic substances in water (table), **6-5**
 of salts in water (table), **6-5**
 Solutions, specific heat of, **4-4**
 Solvents, **6-148**
 alcohols as, **6-148**
 chlorinated, **6-149**
 esters as, **6-149**
 hydrocarbons as, **6-149**
 ketones as, **6-149**
 organic (cleaners), **6-137**
 petroleum, **6-149**
 for polymeric materials, **6-149**
 Sonar (underwater detection), **12-122**
 Sone (loudness level of sound, def), **12-118**
 Sonotone batteries, **15-15**
 Soot: luminosity of, **4-68**
 Soot blowers, **9-31**
 for air heaters, **9-31**
 automatic controls for, **9-32**

Sound:

absorption of: coefficient of (def), **12-120**
 table, **12-121**
 attenuation of, **12-117**
 audible range of, **12-117**
 beat-frequency oscillator, **12-119**
 contact transducers, **12-119**
 industrial applications of, **12-121**
 intensity of, **12-117**
 levels of, of various activities (table), **12-119**
 loudness of, **12-118**
 masking of, **12-119**
 perception of, **12-118**
 pitch of, **12-118**
 production and reception of, **12-118**
 quality of, **12-118**
 specific acoustic impedance, **12-118, 12-120**
 speed of, **3-31**
 testing of materials by, **12-122**
 timbre of, **12-119**
 total absorption of, **12-121**
 transmission loss in building partitions (table), **12-120**
 velocity of, in various media (table), **12-117**
 vibration pickups for, **12-119**
 wavelength of, **12-117**
 of whistles and sirens, **12-118**
 (*See also* Noise)
 Sound analyzer, **12-119**
 Sound-level meter, **12-119**
 Sound levels, of various activities (table), **12-119**
 Sound spectrum (table), **12-117**
 Sound transducers, **12-118**
 Source (automatic control, def), **16-28**
 Sources and sinks (radiation), **4-66**
 Soybean oil (paints), **6-108**
 Space, **11-100**
 as data transmission symbol, **16-21**
 effects due to meteoroids in, **11-115**
 effects due to radiation in, **11-115**
 table, **11-115**
 effects due to vacuum in, **11-114**
 table, **11-115**
 effects on lubrication, **11-115**
 entry from, **11-107**
 orbital mechanics for flight in, **11-105**
 planets in, atmospheres of (table), **11-107**
 solar system: astronomical constants of, **11-101**
 data on bodies in (tables), **11-102, 11-103**
 Space factor in winding magnets, **15-65**
 Space flight:
 hyperbolic excess velocity, requirements for (table), **11-107**
 mechanics of, **11-104**
 interplanetary, **11-107**
 lunar, **11-107**
 trajectories, performance optimized, **11-108**
 (*See also* Space satellites; Space vehicles)
 Space lattice (metals), **13-8**
 Space satellites:
 energy of, **11-108**
 lifetime of, **11-106**
 orbits, perturbations of, **11-106**
 Space-time curve (kinematics), **3-10**
 Space vehicles:
 ablative systems for, **11-108**
 berthing of, **11-125**
 components of (table), **11-100**
 control of, **11-109**
 damage to, by meteoroids, **11-115**
 docking of, **11-125**
 inertia effects on, **11-126**
 engines for, **9-21**
 environments, **11-114**
 launch environments of, **11-103**

Space vehicles (*Cont.*):

life-support systems for, **11-120, 11-121**
 lubricants for, **11-115**
 materials for, **11-111 to 11-113**
 for high-pressure oxygen, **11-113**
 for high-temperatures, **11-112**
 for low-temperatures, **11-111**
 noise from, effects of, **11-103**
 nuclear motors for, **9-148**
 nuclear rockets for, **11-119**
 propulsion of, **11-118**
 radiative-heat-transfer systems for, **11-108, 11-123**
 stability of, **11-109**
 stresses in, **11-116**
 structures of, **11-116**
 analysis of, **11-116, 11-117**
 thermal management systems for, **11-120, 11-122**
 vibrations in, **11-117**
 welding of, **11-112**
 (*See also* Space; Space flight; Space satellites)
 Spacecraft (*see* Space; Space flight; Space satellites; Space vehicles)
 Span (unit of length, def), **1-16**
 Spanwise blowing (airplanes), **11-64**
 Spark coil for ignition systems, **15-66**
 Spark gaps for spark plugs, **9-114**
 Spark-ignition (engines), **9-90, 9-111, 15-66**
 Spark plugs for ignition systems, **15-66**
 Spark voltages for ignition systems, **15-66**
 Specific gravity (def), **3-31**
 of brines (tables), **19-19**
 of calcium chloride solutions (tables), **19-19**
 of liquids (conversion tables): API, **1-26**
 Baumé, **1-27**
 of magnesium chloride brines (tables), **19-19**
 of sodium chloride solutions (table), **19-19**
 of various substances (table), **6-7**
 of water at various temperatures (table), **6-10**
 (*See also* Relative density)
 Specific heat (def), **4-3**
 at constant pressure, for various materials (table), **4-52**
 of gas mixtures, **4-3**
 of gases, **4-3**
 variable, **4-9**
 humid (def), **4-15**
 of metals (table), **6-11, 6-50**
 of mixtures, **4-4**
 ratios of constant-pressure to constant-volume, for various materials (table), **4-52**
 of refractories (tables), **6-153**
 of solids, at low temperatures (chart), **19-29**
 of solutions, **4-4**
 of various materials (tables), **4-52, 4-57, 4-60**
 of various solids (table), **4-57**
 Specific resistance (def), **15-4**
 Specific speed:
 of centrifugal pumps (def), **14-21**
 of hydraulic turbines (def), **9-150**
 Specific volume of ideal gases (eq), **3-31**
 Specific weight of fluids (def), **3-31**
 Spectral lumen (def), **12-99**
 Spectrophotometers, **16-18**
 Spectrum: electromagnetic (chart), **19-42**
 Speed control:
 of d-c motors, **15-30**
 of induction motors, **15-38**
 Sphere gaps (high-voltage measurement), **15-24**
 Spheres:
 drag coefficient of (chart), **11-68**
 and flat plates, deformation of, under compression, **5-47**

- Spheres (*Cont.*):
 hollow: strength of, 5-47
 volume of, 2-9
 solid, deformation of, under compression, 5-47
 surface and volume of, 2-9
 theorems on, 2-9
- Spherical degree (def), 2-9
- Spherical sectors, surface and volume of, 2-9
- Spherical segments, areas of (formulas), 2-9
- Spherical zones, surface and volume of, 2-9
- Spikes, 8-82
 tables, 8-82 to 8-84
 for timber construction, 12-31
- Spiral bevel gears, dimensions of (table), 8-98
- Spiral chutes, 10-44
- Spiral conveyors, 10-42
- Spiral pipe, 8-185
- Spirals:
 Archimedean, 2-23
 logarithmic, 2-23
- Spiroid gears, 8-100
- Splines, 8-33
 dimensions of fittings for (table), 8-35
 involute, 8-33
 parallel-side, 8-34
 proportions of (table), 8-35
- Split-ring piston packing, 8-140
- Spontaneous combustion of coal, 7-8
- Spray chambers (air conditioning), 4-17
- Spray painting, 6-110
- Spray ponds, 9-86
- Spreader stokers, 9-32
- Springs, 8-66
 axially loaded, 8-69
 brass for (table), 6-72
 coiled, 8-68
 compound (leaf or laminated), 8-67
 conical, 8-69
 cylindrical-helical, 8-68, 8-69
 strength and deflection of (table), 8-71
 deflection of, 8-67
 work done in, 8-67
 elliptic, 8-68
 flat-leaf, 8-67
 helical, 8-68, 8-69
 design of: by formula, 8-70
 by table, 8-70
 laminated triangular, 8-67
 leaf, 11-11
 materials for (table), 8-75
 rectangular-plate, 8-67
 resilience of (table), 5-17
 semielliptic, 8-68
 single-leaf flat, strength and deflection of (table), 8-67
 spiral-coiled, 8-69
 steel, 6-31
 type and heat treatment of (table), 6-32
 wire for, 6-31
 straight-bar torsion, 8-69
 time of vibration of, 8-67
 torsion, 8-69
 triangular-plate, 8-67
 truncated conical, 8-69
- Sprinklers, 18-24
 alarms for, 18-25
 deluge, 18-25
 dry pipe systems for, 18-25
 over electrical equipment, 18-25
 heads for, 18-25
 alloys for, 6-76
 location and spacing of, 18-25
 nonfreeze systems for, 18-25
 outside, 18-25
- Sprinklers (*Cont.*):
 preaction, 18-25
 tanks for, 18-26
 temperature rating of (table), 18-25
- Sprocket wheels:
 for chain drives, 8-62
 chains for, 8-59
 diameters of (formulas), 8-62
 teeth for, design of, 8-62
- Spur gears, 8-88, 8-91
- Sputtering, 6-111
- SRCI (solvent-refined coal), 7-18
- Squaring shears, 13-15
- Squirrel-cage motors, 15-37
- Stability:
 of airplanes, 11-70
 of automatic control systems, 16-37
 of floating bodies, 3-36
 of ships, 11-44
 of submerged bodies, 3-36
- Stack effect:
 air flow due to, 9-46
 table, 9-47
- Stack emissions (*see* Air pollution)
- Stack gases (*see* Flue gas)
- Stack molding, 13-5
- Stacks: determination of verticality of, 16-57
- Stadia:
 distance measurements with, 16-55
 leveling with, 16-55
- Staff organization (def), 17-2
- Stagnation (fluids, def), 3-46
- Stagnation point:
 in aerodynamics (def), 11-61
 in fluid flow, 3-46
- Stainless alloys, 6-32
- Stainless steel (*see* Steel, stainless)
- Stairways, safety provisions, 18-20
- Stalling angle (aerodynamics, def), 11-62
- Standard atmosphere, international (table), 4-33
- Standard deviation (statistics, def), 17-19
- Standard time, 1-25
 U.S. zones, 1-25, 1-26
- Standard ton (refrigeration, def), 19-2
- Standpipes for fire protection, 18-27
- Star connections, three-phase circuits, 15-20
- Starting boxes for shunt motors, 15-28
- Starting compensators for a-c motors, 15-37
- Starting devices for a-c motors, 15-37
- Starting resistance (trains), 11-39
- Starting systems for automobiles, 15-67
- Static balance, 3-66
- Static electricity (def), 15-15
- Static friction (tables), 3-24
- Static inverters (electric current), 15-18
- Static loads, safety factors for, 5-20
- Statically determinate and indeterminate supports (def), 3-5
- Statics:
 of framed structures, 12-18
 graphical, 3-5, 3-6
 of rigid bodies, 3-3 to 3-6
- Stationary engines (internal-combustion), 9-99
- Statistical quality control, 17-19, 17-24
- Statistics, 17-19
 average (def), 17-19
 confidence limits in, 17-20
 correlations in, 17-21
 go/no go data in, 17-25
 for life tests, 17-20
 standard deviation (def), 17-19
 tolerance limits in, 17-20
 variability in, 17-19
 variance (def), 17-19
- Steady-flow process (def), 4-5
- Steam:
 attemperature of, 9-44
 constant-pressure expansion of, 4-14
 constant-volume expansion of, 4-14
 critical pressure of, 9-45
 isentropic expansion of, 4-14
 isothermal expansion of, 4-14
 moisture in, measurement of, 16-18
 properties of (tables), 4-44, 4-46 to 4-48
 purification of, 9-48, 9-51
 quality of, 4-13
 determination of, 16-18
 reheating of, 9-41, 9-71
 saturated (charts), 4-45, 4-49
 pressure-temperature conversion (tables), 9-78
 tables, 4-44, 4-46
 silica removal from, 9-50
 superheated (table), 4-48
 isentropic expansion of, 4-15
 tables for, 4-44, 4-46 to 4-48
 temperature control of, 9-44
 temperature-entropy chart for, 4-45, 4-49
 wet: flow of, through nozzles, 4-23
 quality of, 4-13, 16-18
- Steam boilers (*see* Boilers)
- Steam calorimeters, 16-18
- Steam condensers (*see* Condensers)
- Steam cycles, 4-19
- Steam engines:
 clearances in, 9-56
 compound, 9-55
 compounding of, 9-55
 economy factors for, 9-55
 efficiency of, 4-19
 friction horsepower of, 9-54
 indicator diagrams for (theoretical), 9-54
 indicators for, 16-15
 marine (*see* Marine engines)
 mean effective pressure in, 9-54
 mechanical efficiency of, 9-54
 operation of, condensing, 9-55
 Rankine cycle for, 9-55
 Rankine efficiency ratio of (def), 9-56
 ratio of expansion for, 9-54
 separation of inlet and outlet ports of, 9-55
 steam jackets for, 9-55
 steam rates for, 9-55
 superheating, effects of, 9-55, 9-56
 theory of, 4-19
 uniflow, 9-55
 valve and port sizes for, 9-56
- Steam flow:
 effect of fittings on, 4-23
 in nozzles, 4-21, 4-22, 9-56 to 9-60
 in orifices, 4-21
 in pipes, 4-23
 throttling of, 4-24
 in turbine buckets, 9-56 to 9-60
 wiredrawing of, 4-24
- Steam hammers, 13-22
 sizes of, 13-22
- Steam jackets, 9-55
- Steam-jet refrigeration, 19-16
- Steam lines, expansion joints for, 8-207
- Steam nozzles, 4-22
 flow through, 4-22, 4-23, 9-57 to 9-66
- Steam pipes (*see* Pipe; Piping)
- Steam power plants:
 costs of, 17-33
 (*See also* Power costs)
- Steam pumps, 14-10
- Steam purification, 9-51
- Steam reheaters, 9-41
- Steam separators, 9-51
- Steam tables, 4-44, 4-46 to 4-48

Steam turbines:

advantages of, 9-56
 back-pressure, 9-64
 balancing of, 9-62
 blades for: erosion of, 9-62
 materials for, 9-62
 vibrations of, 9-62
 bleeding cycle for, 4-19
 bolting materials for, 9-63
 buckets in, flow of steam through, velocity diagrams, 9-57, 9-62
 casing materials for, 9-63
 classification of, 9-56
 clearances in, 9-63
 for combined cycles, 9-69
 combined thermal efficiency of, 9-69
 corrosion in, 6-106
 cross-compound, 9-60
 damage to, due to water induction, 9-74
 diagram-efficiency of, 9-58
 disk wheels for, 5-51
 divided flow, 9-60
 efficiency of: correction factors for, 9-70
 chart, 9-70
 engine efficiency of (def), 9-69
 extraction, 9-64, 9-70
 in regenerative heating, 9-72
 feedwater treatment for, 9-74
 governors for, 9-64
 heat rates of (charts), 9-72
 effect of regenerative heating on, 9-72
 representative (table), 9-71, 9-72
 helical flow, 9-64
 high-temperature bolting for, 9-63
 impulse, 9-56
 bucket-velocity diagrams for, 9-57, 9-62
 impurities in steam for, 9-74
 internal efficiency of (def), 9-59
 labyrinth packings for, 9-63
 leakage loss in, 9-58
 leakage of steam through, 9-63
 leaving loss in, 9-60
 loss due to moisture in steam in, 9-60
 low-capacity, 9-64
 low-pressure, elements of, 9-60
 lubrication of, 6-183
 marine, 9-64
 mechanical drive, 9-64, 9-70
 modern, large central-station, 9-66, 9-70
 moisture loss in, 9-60
 multirow stages in, 9-59
 nozzles for: design of, 9-57
 efficiency of, 9-57
 mouth area of, 9-57
 theoretical work in, 9-57
 throat area in, 9-57
 velocity coefficient in, 9-58
 oils for, 6-183, 9-74
 operating temperatures for, 9-72
 packings for, 9-63
 performance calculations for, 9-70
 performance of, 9-69
 radius ratio of, 9-57
 reaction, 9-56
 bucket-velocity diagram for, 9-57, 9-62
 (See also Hydraulic turbines, reaction)
 regenerative cycle for, 4-19, 9-71
 reheating cycle for, 4-19
 rotative speeds of, 9-62
 rotor materials for, 9-62
 silica deposits in, 9-50
 stage design of, 9-56
 stage efficiency of, 9-58
 starting and loading of, 9-73
 steam-bled (table), 9-73
 steam-path design, 9-59

Steam turbines (*Cont.*):

steam rate of (def), 9-69
 theoretical (table), 9-69
 superposition of, 9-64
 in tandem, 9-60
 thrust bearings for, 9-63
 turning gears for, 9-63
 velocity ratio, effect on efficiency of (chart), 9-59
 Steam washers, 9-51
 Steel (def), 6-13
 aging, 6-26
 of magnets, 15-63
 AISI, influence of heat-treatment on (tables), 6-31
 properties of (tables), 6-31
 AISI designations, 6-28
 AISI specifications for (tables), 6-28 to 6-31
 alloy, composition of (table), 6-29
 alloys (see Steel alloys)
 annealing of, 6-17
 ASTM specifications for, 6-26
 tables, 6-26
 basic oxygen, 6-13
 boron, 6-28
 carbon (def), 6-13
 AISI specifications for (table), 6-28
 applications of (table), 6-22
 bars, cold finished, 6-30
 castings of, 6-43
 high-manganese (table), 6-28
 transformation reactions in, 6-17
 carbon tool, 13-48
 carburizing of, 6-21
 chromizing of, 6-22
 clad, 6-21
 classification of, 6-13
 cobalt, for tools, 13-48
 cold drawn, mechanical properties (table), 6-32
 cold-rolling of, 6-15
 cold-working of, effects of, 6-15
 commercial, applications of (table), 6-22
 constitution of, 6-16
 continuous casting of, 6-15
 copper-covered (high-voltage transmission), 15-6
 corrosion of (see Corrosion)
 creep rates for (table, chart), 5-10, 5-11
 for cryogenic service, 6-28
 cyaniding of, 6-21
 deep-hardening of, 6-20
 liquids for quenching, 6-20
 defects in, 6-14
 drawing of, 6-17
 dual phase, 6-27
 electric, 6-14
 electric-furnace (def), 6-13
 electrical conductors of, 15-6
 extrusion of, 6-16
 forging of, effects of, 6-15
 foundry practice (see Foundries)
 fracture toughness of, 6-24
 free-cutting, AISI specifications (table), 6-28
 for general construction (table), 6-26
 H-type, 6-28
 hammering of, effect of, 6-15
 hardenability of (def), 6-18
 effect of alloys on (table), 6-20
 hardened, tempering of, 6-17
 hardening of, 6-21
 effect of surface condition on, 6-21
 heat-resisting alloys, properties of (table), 6-78
 heat-treatment of, 6-17
 cooling rates for, 6-19
 heating, 6-19
 heating rates for, 6-19

Steel, heat-treatment of (*Cont.*):

maximum temperatures for, 6-19
 quenching mediums for, 6-20
 relation of design to, 6-21
 time of, and cooling rate of, 6-19
 high-carbon, welding of, 13-43
 high-speed, 6-30, 13-49
 (See also Tool steel)
 high-strength low-alloy (table), 6-27
 hot-working of, effect of, 6-15
 hysteresis loss in (chart), 15-10
 joists of, 12-43
 Jominy test for, 6-18
 local surface hardening of, 6-21
 low-alloy, welding of, 13-43
 low-carbon, 6-25
 alloy, uses of, 6-27
 welding of, 13-43
 Lüders lines in, 6-25
 machinability of, 13-47
 for machine parts (table), 6-26
 McQuaid-Ehn test, 6-18
 magnet (permanent), 15-62
 chart, 15-62
 manganese, AISI specifications (table), 6-28
 manufacture of, 6-14
 manufacturing properties of (table), 13-12
 maraging, 6-27
 martensitic, 6-33
 mechanical properties of, 6-13, 6-22
 (tables), 6-26
 mechanical treatment, 6-15
 medium-carbon, welding of, 13-43
 microscopic structure of, 6-17
 molybdenum: AISI specifications (table), 6-29
 for tools, 13-48
 necking of, 6-24
 nickel, AISI specifications (table), 6-29
 nickel-chromium, AISI specifications (table), 6-29
 nickel-molybdenum, AISI specifications (tables), 6-29
 nitriding of, 6-21
 normalizing of, 6-17
 patenting, 6-17
 pickling, 6-15
 piping in (cavities), 6-14
 plastic range chart for, 13-10
 precipitation hardening, 6-33
 pressing of, effect of, 6-15
 for pressure vessels (table), 6-26
 quenched and tempered, 6-27
 quenching of (heat-treatment), 6-20
 refining of, ladle metallurgy for, 6-14
 reinforcing, for concrete, 12-50
 rolling of, effect of, 6-15
 scabs in, 6-14
 scarfing, 6-15
 seams in, 6-14
 segregation in, 6-14
 shallow-hardening (def), 6-19
 liquids for quenching, 6-20
 shapes of, properties of (tables), 12-34 to 12-48
 sheet, electrical, 6-32
 shipments of, 6-23
 silicon-manganese, AISI specifications (table), 6-29
 special alloy, 6-32
 spheroidizing of, 6-17
 spring, 6-21
 stainless, chemical composition (table), 6-34
 duplex, 6-33
 families of, 6-33
 ferritic, 6-33
 grades of, 6-33
 L-grade, 6-33

- Steel, stainless (*Cont.*):
 maximum stress values for (table), 6-37
 mechanical properties of (table), 6-36
 plastic range chart for, 13-10
 strength of, at high temperatures (table), 5-11
 welding of, 13-43
 strength of: AISI (tables), 6-31
 ASTM (table), 6-26
 low-alloy (table), 6-27
 stretcher strains in, 6-25
 structural: ASTM specifications, 6-26, 12-33
 fire-resistance of (table), 12-48
 for locomotives, ASTM specifications (table), 6-26
 materials for, 12-33
 paints for, 6-110
 properties of (tables), 12-34 to 12-48
 for ships, ASTM specifications (table), 6-26
 specifications for (table), 6-26
 welding of, 12-41
 structure of, 6-16
 temper rolling of, 6-25
 tempering of, 6-17, 6-19
 tensile properties of, 6-22
 chart, 6-20
 thermomechanical treatment of, 6-22
 tool (*see* Tool steel)
 toughness of, 6-24
 for turbine blading, 9-62
 ultimate tensile strength (def), 6-24
 uses of, 6-13
 welding of, 13-43
 heat affected zone in, 6-24
 (*See also* Welding)
 yield strength (def), 6-23
- Steel alloys, 6-13
 AISI specifications (table), 6-29, 6-31
 castings, 6-38, 6-43
 effect of alloying elements, 6-19
 furnaces for (electric), 6-14
 hardenability of, 6-18
 hardness of, influence on: of elements (table), 6-20
 of heat-treatment (table), 6-31
 of specimen size (tables), 6-31
 strength of, at high temperatures (table), 5-11
- Steel angles (*See also* Angles, steel)
- Steel beams, deflection of (table), 12-47
 (*See also* Beams, steel)
- Steel castings (*see* Castings, steel)
- Steel columns, 5-38
 table, 12-36
- Steel construction (*see* Steel-framed structures)
- Steel-framed structures:
 beams and girders for, proportions of, 12-34
 bolts for, 12-35
 columns for, 12-34
 compression members in, 12-34
 fire resistance of (table), 12-48
 riveted connections for, 12-35
 specifications for, 12-33
 tension members in, 12-34
 welding of, 12-41
- Steel I beams (table), 12-35
- Steel pipes (*see* Pipe)
- Steel springs: heat treatment for (table), 6-32
- Steel strip:
 mechanical properties of (table), 6-23
 temper rolling of, 6-25
- Steel tubing (tables), 8-186, 8-187
- Steel wire gage (table), 8-85
- Steepest ascent, 2-39
- Steering gear, automobile, 11-12
- Stefan-Boltzmann law (radiation), 4-62, 4-74
- Steinmetz coefficients (table), 15-10
- Steinmetz law of hysteresis, 15-10
- Step bearings, 3-28
 friction of, 3-28
- Step input (automatic control), 16-27
- Step pulleys, 8-52
- Steradian (def), 1-17, 2-9
- Stereon (def), 2-9
- Stereotype metal (table), 6-75
- Stick-slip vibration (def), 3-21
- Stiffness of beams, 5-30
- Stirling cycle, 4-11
- Stirling engines, 9-20
 for artificial hearts, 9-21
 closed environment, 9-21
 for cryocooling, 9-21, 19-27
 Ford-Phillips, 9-21
 free piston, 9-21
 for heat pumps, 9-21
 liquid piston, 9-21
 low-temperature, 9-21
- Stoddard solvent, 6-149
- Stoke (unit of kinematic viscosity), 3-33
- Stokers:
 chain-grate, 9-32
 spreader, 9-32
 traveling-grate, 9-32
 underfeed, 9-32
- Stokes' law for settling of dust, 18-10
- Stone:
 for building, 6-143
 pipelines for, 11-131
 properties of (table), 6-144
 specific gravity and density of (table), 6-8
- Stonework, mortar for (table), 6-162
 (*See also* Masonry)
- Storage:
 of inflammable liquids, 18-19
 of materials, 10-62
 equipment used for, 10-71
- Storage batteries (*see* Batteries, storage)
- Stovewood, 7-9
- Straight lines, equation for, 2-18
 (*See also* Lines)
- Straightening operations (metals), 13-16, 13-23
- Strain:
 elastic, 5-49
 plane, 5-5, 5-44
 plastic, 5-49
- Strain gages, 3-79, 5-53, 16-7
 foil, 5-53, 5-54
 in rosettes, 5-53
 transverse sensitivity of, 5-53
- Strain hardening:
 coefficient of, 5-49
 modulus of, 13-10
- Strain-rate sensitivity, 5-5
- Strandboard, 6-126
- Strands, wire, 8-75
- Strap hammers, 13-22
- Streamline forms (aerodynamics, def), 11-67
 drag of, 11-67
- Streamlines (def), 3-36
- Streams, flow measurement in (*see* Weirs)
- Strength:
 of bolts (tables), 8-27
 of metals (table), 5-4, 6-11
 tensile (def), 5-2
 yield (def), 5-2
- Strength coefficient (def), 5-4
- Stress (def), 5-3, 5-15
 analysis of, 5-51
 by birefringent coating, 5-54
 by brittle-coating, 5-54
 by holography, 5-54
 theories for, 5-48
 combinations of, 5-5, 5-18
 creep rates due to (table), 5-11
- Stress (*Cont.*):
 determination of, by method of joints, 3-6
 in framed structures, diagrams for, 12-22, 12-24
 in pipelines due to flexure, 5-55
 shearing, 5-15, 5-16
 simple, 5-15 to 5-17
 in static plane structures, 3-5, 3-6
 tangential, 5-15
 true, 5-3
 in turbine-disk wheels, 5-51
 volume change due to, 5-17
- Stress concentration, 5-8
 factors of (charts), 5-5 to 5-7
- Stress corrosion, 5-8
- Stress-corrosion cracking, 6-102
 in space vehicles, 11-113
- Stress-cycle diagram (fatigue analysis), 5-8
- Stress intensity (def), 5-8, 5-15
- Stress moment (def), 5-21
- Stress-optic law, 5-52
- Stress polygon, 3-5
- Stress-rupture test, 5-10
- Stress-strain diagrams, 5-2 to 5-4
 description, 5-2
- Stresscoat (strain indicator), 5-54
- Stresses, thermal, 5-17
- Stretcher strains, 5-3, 6-25
- Strings, vibration of, 3-72
- Stripping by power shovel, 10-33
- Stroboscopes, 16-3
- Strouhal number (vibrations in fluids), 3-42, 3-43, 3-47
- Structural damping (vibrations), 3-66
- Structural steel (*see* Steel, structural)
- Structural timber (*see* Timber)
- Structures:
 combining loads on, 12-21
 statically determinate and indeterminate (def), 3-5
 stresses in, 3-5
 steel-framed (*see* Steel-framed structures)
 stresses in, by method of sections, 3-6
 wind pressure on, 12-19
- Struts, drag of (aerodynamics), 11-68
- Stubs gage (table), 8-85
- Stucco, 6-162, 6-163
 colors for, 6-163
- Student's distribution (statistics), cumulative, ordinates of (table), 1-12
- Studs, drilling and tapping cast iron for (table), 8-30
- Sturm's equation for collapse of cylinders, 5-45
- Styrene and polystyrene copolymers resins:
 properties of (table), 6-198
- Styrene copolymers resins: properties of (table), 6-198
- Submerged bodies, forces on, 3-34 to 3-36
- Submerged openings, flow through, 3-60
- Submerged surfaces, pressure on, 3-34 to 3-36
- Subsonic velocity (def), 11-59
- Subtraction, arithmetical, 2-4
- Subway trains, 11-35
- Suction stabilizers, for pumps, 14-14
- Sulfur:
 in the atmosphere, benefits from, 18-13
 in coal, 7-6, 7-31
 table, 18-13
 effect on vegetation, 18-13
 heat of combustion (table), 4-26
- Sulfur dioxide:
 control systems for (table), 18-13
 effect on vegetation, 18-13
 table, 18-12
 as refrigerant, 19-5
- Sulfuric acid, freezing temperatures of water mixtures (table), 15-13

- Sulfurized oils as cutting fluids (machining), 13-50
- Sulfurous acid (*see* Sulfur dioxide)
- Sulzer two-cycle engines, 9-108
- Summer dew-point temperatures (chart), 12-65
- Summer dry-bulb temperatures (chart), 12-64
- Summer wet-bulb temperatures (chart), 12-65
- Superalloys for high-temperature use (tables), 6-78 to 6-80
- Supercharging (engines), 9-106
- Superconductivity, 19-30
of metals, 19-30
- Superconductors (cryogenics), 19-30
columbium alloys for, 6-81
- Superdiode (integrated circuit), 15-79
- Superfinishing (honing process), 13-64
- Superheated carbon dioxide (table), 4-35
- Superheated steam, properties of (table), 4-48
- Superheated vapors, expansion of, 4-14
- Superheaters:
allowable stresses in (table), 9-42
convection, 9-41, 9-42
hairpin, 9-42
nondraining, 9-42
radiant, 9-41, 9-42
self-draining, 9-42
steam flow rates in, 9-42
table, 9-42
tubes for (table), 9-42
- Superheterodyne reception (radio), 15-87
- Superplasticity (def), 5-11
- Supersaturation, theory of, 4-23
- Supersonic and hypersonic aerodynamics:
acoustic theory of, 11-77
aerodynamic heating, 11-79
airfoil sections for, 11-77
area rule for, 11-79
base drag in, 11-79
diffusers for: Oswatitsch, 11-76
subsonic, 11-76
supersonic, 11-76
force measurements in, 11-80
gas dynamics relations for, 11-72
table, 11-73
hypersonic flow in (def), 11-72
lift in: of axially symmetric body, 11-78
coefficient of, 11-77
curves for wings: delta plan-form, 11-78
rectangular, 11-78
swept-back, 11-78
interference, 11-79
Mach angle in, 11-74
Mach cone in, 11-74, 11-77
Mach number in (def), 11-72
Mach waves in, 11-74
nozzles for: converging, 11-75
ordinates for (table), 11-75
for rockets, 11-75
Prandtl-Glauert rule in, 11-77
pressure measurements in, 11-80
recovery factor in (temperature), 11-79
shock polar for, 11-74
shock relations in (table), 11-74
shock tubes for, 11-76
shock waves in, 11-72
skin-friction drag in, 11-79
stagnation temperatures in, 11-79
subsonic flow in (def), 11-72
supersonic flow in (def), 11-72
past a cone, 11-74
chart, 11-74
transonic flow in, 11-72
wind tunnels for, 11-76
(*See also* Aircraft jet propulsion)
- Surface, of various solids, 2-8
- Surface condensers, 9-75
- Surface finish (*see* Surface texture)
- Surface integrals, 2-35
- Surface temperature, measurement of, 16-10, 16-13
- Surface tension (def), 3-33
of liquids (table), 3-33
- Surface texture:
design criteria for, 13-68
design requirements of, 13-69
table, 13-69
flaws in (def), 13-70
lay of (def), 13-70
symbols used with (table), 13-71
measurement of, 13-70
produced by production processes (chart), 13-72
roughness of, 13-69
symbols for, 13-68
tolerances for, 13-70
waviness in (def), 13-69
- Surge tanks, 9-160
- Surveying, 16-50
distance measurements in, with electronic
distance meter, 16-51
electronic total stations for, 16-54
establishing bearings by, 16-54
instruments, 16-51
automatic level, 16-52
electronic distance meter, 16-51
corrections for, 16-51
electronic total station, 16-53, 16-59
transit, 16-53
Y level, 16-52
laying out horizontal curves by, 16-57
leveling, 16-51
mapping, 16-55
measuring across streams by, 16-56
measuring horizontal angles, 16-54
measuring inaccessible distances, 16-56
measuring vertical angles, 16-54
passing obstacles while, 16-56
producing straight lines by, 16-54
profile, 16-52
referencing a point in, 16-57
special problems in, 16-56
stadia used in, 16-55
traverses for, 16-54
- Surveyor's measure, 1-16
- Susceptance (electrical circuit, def), 15-3, 15-19
- Sutro weir, 16-14
- Swaging: of metals, 13-19
- Swaging machines, rotary, 13-24
- Wash-plate pumps, 14-12
- SWATH (small water-plane area twin hull), 11-41, 11-59
- SWG (wire gage, table), 8-85
- Swinging-block linkage, 8-3
- Switch gear (electric), 15-46
- Switchboards:
bus bars for, 15-45
panels for, 15-45
equipment for standard, 15-46
wiring diagrams for, 15-45
- Switches, electric, 15-46, 15-56, 15-61
- Symbols:
chemical (table), 6-3
for electrical apparatus, 15-7
for electrical units (table), 15-3
proofreaders', 19-44
- Synchromesh (automobile), 11-8
- Synchronous condensers (electric), 15-40
- Synchronous converters, 15-42
switchboard equipment for, 15-46
- Synchronous generators (*see* Generators, alternating-current)
- Synchronous impedance, 15-32
- Synchronous motors, 15-40
- Synchros, 16-5
- Syngas, production of (table), 7-38
- Synthane process (gas making), 7-35
- Tachometers, 16-18
- Tail shafts (ships), 11-56
- Tangential stress, 5-15
- Tangents:
to an ellipse, 2-20
to a hyperbola, 2-21
trigonometric, 2-15
- Tanks:
corrosion in, 6-106
water, for fire protection, 18-26
winds on, pressure coefficients for (table), 12-20, 12-23
- Tantalum, uses of, 6-81
- Tap drill sizes: for pipe threads, 8-17
- Tape:
for computers, 2-44, 15-83
measurements with, 16-50
- Taper keys, friction of, 3-26
- Taper pins, 8-32
table, 8-34
- Tapping, of plastics, 13-65
- Taps:
pipe, drills for (table), 8-20
sizes of (table), 8-30
- Tar:
for roofing, 6-145
specific gravity and density of (table), 6-9
- Tar sands: fuel from, 7-19
- Taylor's diagram for three-blade propellers, 11-54
- Taylor's series, 2-30
- Tees, cut from standard sections (table), 12-44
structural steel, properties of (table), 12-44
- Teflon: as electrical insulation, 6-139
- Telephone communications, 15-90
- Telescopes, alignment, 16-6
- Television, 15-89
- Temperature:
absolute scales of, 4-2
of adiabatic saturation, 4-15
air volume correction factors due to (table), 12-91
of combustion, 4-29
table, 4-30
critical: of gases (def), 4-13
tables, 4-50, 4-58
dry-bulb, 4-15
effect on creep rate (table), 5-11
effect on volume of water (table), 6-10
flame, with gaseous fuels (table), 4-29
inferred absolute zero of, 15-5
of iron or steel by color, 4-57
measurement of, 4-2, 16-9
by pneumatic transmitter, 16-11
of surfaces, 16-10, 16-13
wet- and dry-bulb (def), 4-15
wet-bulb, thermodynamic, 4-15
- Temperature coefficient of resistance (def), 15-4
table, 15-4
- Temperature-entropy chart:
for air, 4-32
description of, 4-14
for steam, 4-45, 4-49
- Temperature gradient (heat flow), 4-81
- Temperature-humidity index, 12-62
- Temperature inversion (Joule-Thomson effect), 4-24
- Temperature limits of electrical apparatus, 15-43
- Temperature stresses, deformation caused by, 5-15

- Temperatures:
 high wet-bulb (chart), 12-66
 summer dew point (chart), 12-65
 summer dry-bulb (chart), 12-64
 summer wet-bulb (chart), 12-65
 winter outdoor (chart), 12-63
- Tempering (def), 6-17
 furnaces for, 7-54
 of hardened steel, 6-21
 of steel (def), 6-17
 (*See also* Steel, heat-treatment of)
- Tempilsticks, 16-10
- Temporary hardness, of water, 6-170
- Tension, elongation and contraction due to, 5-2
- Termites, destruction of wood by, 6-126, 6-127
- Terne, 6-111
- Terneplate, 6-74
- Tesla (def), 15-3
- Test specimens, 5-14
- Testing:
 by acoustic signature analysis, 5-67
 compression, 5-5
 by eddy-current methods, 5-66
 by electrified particles, 5-61
 by gamma rays, 5-65
 by infrared methods, 5-67
 by magnetic particles, 5-61
 of materials, 5-13
 methods of, 5-61
 table, 5-62
 by microwave methods, 5-67
 nondestructive, 5-61
 by penetrants, 5-61
 of porous objects, 5-65
 by radiation, 5-65
 radiographic, 5-65
 ultrasonic: frequencies used in, 5-66
 materials used in, 5-66
 standards for, 5-66
 by X-rays, 5-65
- Testing machines, 5-13
 calibration of, 5-13
 (*See also* Testing)
- Testing methods, nondestructive (table), 5-62
- Tetraethyl lead (knock suppressor), 9-116
 table, 9-116
- Tetrahedron, 2-9
- Tetryl (explosive), 7-22
- Tex (fiber fineness unit), 6-140
- Texaco gasification process, 7-38
- Theorems, geometrical, 2-5
- Therbligs (motion study, table), 17-27
- Thermal conductance, 4-80
 conversion table, 1-34
- Thermal conductivity (def), 4-80
 of air (table), 4-82
 of building materials (tables), 4-83, 4-84
 conversion table, 1-34
 of gases (table), 4-82
 of insulating materials (tables), 4-84
 of liquids (table), 4-82
 of metallic elements (table), 6-50
 of metals (table), 4-80, 4-81, 6-11
 of miscellaneous substances (table), 4-83
 of nickel-chromium with iron (table), 4-80
 of refractories (tables), 4-84
 of steam (table), 4-82
- Thermal insulation (*see* Refractories)
- Thermal properties of substances, 4-31
- Thermal stresses, 5-17
- Thermal unit:
 British (def), 1-19, 4-3
 IT calorie (def), 1-20, 4-3
- Thermistors (resistance thermometer), 16-10, 16-13
- Thermocouples, 15-21, 16-9 to 16-13
 temperature-millivolt relations (chart), 16-12
 use at low temperatures, 19-38
 vacuum, 16-13
- Thermodynamic cycle (def), 4-4
- Thermodynamic efficiency of steam engines, 4-19
- Thermodynamic notation and symbols, 4-4
- Thermodynamic processes (def), 4-4
 reversible and irreversible (def), 4-5
 steady-flow, 4-5
- Thermodynamic properties, of various substances (tables), 4-50, 4-53, 4-58, 4-60
- Thermodynamics:
 equations of state for, 4-7
 first law of, 4-4
 flow processes in (def), 4-5
 of gases, variable specific heat of, 4-9
 second law of, 4-6
 of vapors, 4-13
- Thermoelectric cooling, 19-17
 figure of merit for, 19-18
- Thermometers, 4-2, 16-9, 16-10
 for alarms, 16-11
 with bimetallic elements, 16-9
 gas, 16-9
 hydrogen, 4-2
 for industrial applications, 16-11
 mercury, 16-9, 16-10
 partial immersion, 16-11
 resistance, 16-10, 16-12
 scales for, 4-2
 stem exposure corrections for, 16-11
 vapor-bulb, 16-9
 vapor-pressure, 19-38
- Thermopiles, 16-13
- Thermoplastic substances, 6-139
- Thermoprene, uses of, 6-148
- Thermosetting plastics, 6-139
- Thermosiphon (water-cooled engines), 9-118
- Thinners for paint, 6-108
- Thiokol (synthetic rubber): properties of, 6-148
- Thoma cavitation coefficient (hydraulic turbines), 9-158
- Thorium, 9-5
- Threading dies, 13-57
- Threading machines, 13-57
- Threads, screw (*see* Screw threads)
- Three-phase a-c circuits, 15-20
- Three-phase power, measurement of, 15-22
- Three-phase transformers, 15-35
- Three-wire a-c distribution circuits, 15-54
- Throttling, efficiency loss due to, 4-24
- Throttling calorimeter, 16-18
- Thrust, of jet engines, equations for, 11-90, 11-92
- Thrust bearings (*see* Bearings, thrust)
- Thrustor for wire rope brake, 10-10
- Thyristors, 15-69
 capacitance for, in circuits, 15-71
 characteristics of (table), 15-70
 in rectifier circuits, 15-71
 turn-off time of, 15-69
- Tidal power, 9-21
- Tile, roofing, 6-146
- Timber:
 allowable stresses in (tables), 12-28 to 12-30
 connectors for, 12-31
 allowable loads (table), 12-32
 fire resistance of (table), 12-48
 gluelam, design using, 6-123
 manufacture of, 6-123
 round, 6-124
 specific gravity and density of (table), 6-7
 (*See also* Wood)
- Timber beams, 12-29
- Timber columns, 12-30
- Timber construction, 12-28
- Timber floors, properties of (table), 12-28
- Timber piles, 6-124
- Timber poles, 6-124
- Timber trusses, 12-23
- Timbre (sound), 12-119
- Time (def), 3-2
 measurement of, 1-25, 11-106
 sidereal (def), 1-25
 solar and apparent solar, 1-25
 standard, 1-25
 NBS signals for, 1-26
- Time constants (automatic control), 16-26
- Time standards (work measurement): development of, 17-31
 uses of, 17-32
- Time study, 17-28
 elements of, 17-26
 diagram, 17-26
 fatigue allowances in, 17-31
 forms for, 17-29, 17-30
 formulas for, 17-31
 methods used in, 17-28
 observations in, 17-28
 performance ratings by, 17-29
 standard data for, 17-31
 standards developed from, 17-31
- Time zones, 1-25, 1-26
- Timers, 16-3
 electronic, 16-3
- Timesharing (computers), 2-52
- Timing circuits (electronics), 15-74
- Tin, for bearings (table), 6-61
- Tin solders, melting points of (table), 6-76
- Tires, automobile:
 constructions for, 11-16
 details of (table), 11-4
 effect of temperature on rolling resistance of, 11-4
 friction of, 3-24
 inflation pressures for (table), 11-4
 load limits for (table), 11-4
 metric size designations of (chart), 11-16
 rolling resistance versus tire pressure (chart), 11-3
 time to reach temperature equilibrium, 11-4
- Tirill regulator (a-c generators), 15-34
- Titanium, production of, 6-91
- Titanium alloys, 6-91
 composition of (table), 6-92
 properties of (table), 6-92
- TNT (explosive), 7-22
 table, 7-21
- Tobin bronze, plastic range chart for, 13-10
- Toggle joint, 8-8
- Token passing (computer networks), 2-48
- Token rings (computer networks), 2-48
- Tolerance (def), 8-43
- Toluene, as solvent, 6-149
- Ton:
 assay (def), 1-17
 long (def), 1-23
 metric (def), 1-23
 register (def), 1-16
 shipping (def), 1-16
 standard (refrigeration, def), 19-2
- Tongs, lifting, 10-10
- Tonnage of ships (def), 11-41
- Tool steel, 6-30, 13-48
 cast alloys for, 6-78
 compositions of (table), 6-81
 classification of, 6-30
 cold-work, 6-30
 composition and uses of (tables), 6-32
 for cutting tools, 13-48
 high-speed (table), 6-32
 hot-work, 6-30

- Tool steel (*Cont.*):
 shock-resisting, 6-30
 special-purpose, 6-31
 tungsten-alloy, 6-31
 water-hardening, 6-30
- Tools:
 carbide, 6-62
 machine (*see* Machine tools)
- Toothed and worm gearing efficiency, 3-27
- Topography, 16-55
- Torch brazing, 13-29
- Torpex (explosive), 7-22
- Torque, of electric motors, 15-27
- Torque converters, hydraulic, 11-7
- Torr (def), 14-39
- Torsion, 5-36
 of circular sections, 5-36
 of composite sections, 5-37
 effect of external twisting moment, 5-37
 of noncircular sections, 5-37
 of shafts, 5-36, 8-47
 of various cross sections (table), 5-38
- Torsion balances, 16-4
- Torsional vibration, of shafts, 3-72
- Torus, surface and volume of, 2-10
- Towers, wind pressure on, 12-21
 pressure coefficients for (table), 12-20, 12-23
- Track, railway, 11-37
 curves for, 11-38
 nonstandard gages used, 11-35
 superelevation of, 11-40
- Track jacks, 10-16
- Trackage, overhead, 10-37
 monorail, 10-26
 table, 10-26
- Tracta universal joints, 8-36
- Traction motors (railway), 11-22, 11-24, 11-25
- Tractive electromagnets, 15-63, 15-64
- Tractive force, of locomotives (table), 11-21
- Tractors, 10-24
 engines for, 9-98
 wheeled, 10-24
- Tractrix, 2-23
- Trademarks, 18-29
- Trains (*see* Railway engineering)
- Tramways, bicable, 10-31
 cable, 10-31
 jigback, 10-31
 monocable, 10-31
 saddle-clip, 10-31
 (*See also* Cableways, tramways)
- Transducers (sound), 12-118
- Transfer functions (automatic control), 16-39
- Transfer prices, 17-17
- Transflow (pipeline computer program), 11-128
- Transformers, 15-34
 compensator, 15-36
 data on, 15-36
 differential, 16-5
 E, 16-5, 16-6
 efficiency of, 15-35
 grounding of secondaries of, 15-53
 instrument, 15-23
 insulation for, chlorinated hydrocarbons as, 6-139
 leakage flux in, 15-35
 LVDT, 16-5
 polyphase, connections in, 15-35
 regulation of, 15-35
 Scott taps for, 15-36
 T connections for, 15-36
 testing of, 15-35
 theory of, 15-34
 three-phase, 15-35
- Transient analysis (*see* Automatic control, transient analysis of system)
- Transients (electrical), 15-16
- Transistors, 15-69
 bipolar junction, 15-70
 characteristics of (table), 15-70
 JFET, 15-70
 metal oxide semiconductor, 15-70
 MOSFET, 15-70
- Transit, 16-6, 16-53
 adjustment of, 16-55
 angular measurements with, 16-53
 and stadia, leveling with, 16-55
- Transmission:
 of electrical power (*see* Electric power transmission)
 of heat (*see* Heat transmission)
 of light (def), 12-99
- Transmission dynamometers, 16-15
- Transmission mechanisms (automobiles), 11-6, 11-9
- Transportation, by cableways, 10-30
- Trapezoidal rule, 2-39
- Trapezoidal weirs, 3-57
- Trapezoids:
 areas of, 2-7
 center of gravity of, 3-6
- Traveling cranes, 10-26
- Trees: effects of sulfur dioxide on (table), 18-12
- Trenching, setting stakes for, 16-57
- Trepanning, 13-55
- Triacs, 15-69
- Triangles, plane:
 lengths and areas of, 2-7
 solution of, 2-17
 theorems on, 2-5
- Triangular-notch weirs, 3-57
- Trigonometric functions, 2-15
 inverse, 2-17
 series for, 2-31
- Trigonometry, 2-14 to 2-18
 solutions, of plane triangles, 2-17
- Triplex chain blocks, 8-8
- Tripoli (abrasive), 6-129
- Trippers (conveyors), 10-49, 10-51
- Trochoid, 2-22
- Trolley hoists, 10-13
- Trolley trackage, overhead, 10-26
- Tropical year, 1-25
- Troy weight, 1-17
- Truck cranes, 10-29
 table, 10-30
- Trucks, 11-18
 access to plants, 12-14
 classes of, 11-14
 engines for, 9-97
 (*See also* Automobile engines)
- fork, 10-23
 governors for, 11-20
 lift, 10-23
 noise tests for, 11-20
 power requirements for, 11-19
 service classes of, 11-19
 weight classifications of (table), 11-18
 (*See also* Automobiles)
- True stress-strain curve, 5-3
- Trusses:
 determination of stresses in, 12-23
 for floors, 12-22
 roof, 12-21, 12-23
 timber, joints for, 12-31
 weight of (formula), 12-23
- TTL (transistor-transistor logic), 15-79
- Tubes, 8-185
 boiler (*see* Boilers, tubes for)
 collapsing pressure of, 5-45
 for condensers (*see* Condensers, steam, surface-type)
- Tubes (*Cont.*):
 electron, 15-71
 film coefficients for (heat transmission), 4-83, 4-84, 4-86
 radiation factors for rows of (chart), 4-66
 strength of, 5-45, 5-47
 (*See also* Pipe; Piping; Tubing)
- Tubing (def), 8-146
 aluminum, 8-191
 boiler (table), 8-187
 brass, 8-189
 commercial classifications, 8-147
 condenser (table), 8-186
 copper (table), 8-191
 fabrication methods for, 8-167
 cupping and drawing, 8-167
 forged, turned, and bored, 8-167
 hollow-forged, 8-169
 flash-controlled, 8-147
 flash-in, 8-147
 heat-exchanger (table), 8-186
 mandrel drawn, 8-147
 materials for, allowable stresses in (table), 8-183
 plastic, 8-191
 quality factors for (table), 8-183
 rectangular (table), 12-46
 seamless, 8-147
 seamless mechanical, 8-185
 seamless steel, weight of (table), 8-186, 8-187
 square (table), 12-46
 steel: as columns, 12-43
 finish classifications of (table), 8-169
 mechanical properties of (table), 8-169
 weights and dimensions of (tables), 8-186, 8-187
 tolerances for (tables), 8-167, 8-168
 welded, 8-147
 (*See also* Pipe; Piping; Tubes)
- Tubular heat exchangers, formulas for, 4-83, 4-84, 4-86
- Tung oil, 6-108
- Tungsten:
 as resistor material, 15-62
 uses of, 6-81
- Tungsten-alloy steel, 6-31
- Tungsten carbide alloys, 6-62
 properties of (table), 6-64
- Tungsten tools, 13-48
- Turbidimeters, 16-18
- Turbine disks, stresses in, 5-51
- Turbines:
 gas (*see* Gas turbines)
 hydraulic (*see* Hydraulic turbines)
 steam (*see* Steam turbines)
 wind (*see* Wind turbines)
- Turbofan engines, 11-92
 applications of, 11-92
 blades for, 11-92
 fan noise of, 11-93
 flutter in, 11-92
 natural frequencies of, 11-92, 11-93
 thrust of, 11-92
- Turbojet engines, 11-83
- Turboprop engines, 11-84
- Turbulent flow, 3-46, 3-48, 3-49
- Turn indicator (airplanes), 3-20
- Turning (*see* Lathes; Machine tools)
- Turning-block linkage, 8-3
- Turning lathes, 13-52
- Twist drills, 13-55
 angles for, 13-55
 sizes of (table), 8-86
- Twisting moments on shafts, 5-37, 8-47

- Two-cycle engines, 9-91
 advantages, 9-91, 9-100
 diesel, 9-107
- Two-phase a-c circuits, 15-20
- Tyler standard screen scale, 18-10
- Type metals (table), 6-75
- Type sizes, 19-43
- U-tube manometers, 16-8
- UART (universal asynchronous receiver-transmitter), 15-83
- Ultimate analysis of coal (tables), 7-4
- Ultrasonic machining, 13-67
- Ultrasonic testing, 5-66
- Ultrasonic transducers, 5-66
- Ultrasonics, 12-121
 generation of, by whistle, 12-122
 industrial applications of, 12-121
 for machining metal, 12-122, 13-67
 for testing materials, 12-122
 (See also Sound)
- Underfeed stokers, 9-32
- Underground gasification, 7-35, 7-39
- Ungula, surface and volume of, 2-8
- Unified inch screw-thread standards, 8-8
- Unified screw-thread standards (See also Screw threads)
- Uniflow engines, 9-55
- Uniform distribution, 2-10
- Unijunction (semiconductor), 15-71
- Unions, pipe, 8-201
- Unit impulse (vibrations), 3-69
- Unit pole (magnetism), 15-3
- Unit stress (def), 5-15
- Unit-train unloader, 10-22
- U.S. customary system of units, 1-16
- U.S. standard gages for sheet metal (table), 8-85
- United sterling engines, 9-21
- Units:
 of absolute and gravitational systems, 3-2
 table, 1-24
 cgs system of, 1-24
 of common variables (table), 3-45
 electrical, 15-2
 table, 15-3
 of heat (def), 4-3
 magnetic, 15-3
 table, 15-3
 systems of, 1-24
- Universal product codes, 10-63
- Unloaders:
 airslides for, 10-54
 rotary car dumper, 10-22
- U.P.C. (universal product code), 10-63
- Upper atmosphere, 11-59
- Uranium, 9-137
 properties of (table), 6-84
- Uranus, planetary data for (tables), 11-102, 11-103
- Urea-formaldehyde adhesive, 6-134
- USCS system of units, 1-16
- USM (ultrasonic machining), 13-67
- V-band belts, 8-55
- V-belts, 8-54
 cogged, 8-56
 cross sections of, for required horsepower (chart), 8-56
 groove dimensions for, 8-54
 horsepower ratings for (tables), 8-56
 length-correction factors for (tables), 8-54, 8-55
 minimum pulley diameters for (table), 8-54
 pitch lengths for, 8-54
- V-belts (*Cont.*):
 for quarter-turn drives, 8-56
 ribbed, 8-57
 selection of, 8-55
 service factors for (tables), 8-51, 8-55
 sheave dimensions for (tables), 8-58, 8-59
 standard designations for (table), 8-54
 tensioning of drives for, 8-52, 8-57
- V-bucket carriers, 10-45
 capacities and weights (table), 10-45
- V-guides, friction in, 3-26
- V-notches, flow of water through, 3-57, 3-58, 16-14
- Vacuum, measurement of, 16-8
- Vacuum gages, 16-8
- Vacuum pumps, for condensers, 9-83
 (See also High-vacuum pumps)
- Vacuum tubes (radio), 15-71
- Valence of chemical elements (table), 6-3
- Valves, 8-206
 for ammonia service, 8-205
 angle, 8-206
 ball (pumps), 14-13
 cocks, 8-207
 for compressors, 14-31
 disks for, 8-139
 gate, 8-206
 globe, 8-206
 head losses in (table), 12-97
 for high-pressure and high-temperature steam, 8-185
 hydraulic-power control, 8-39
 for hydraulic turbines, 9-156, 9-160
 for reciprocating pumps, 14-4
 conical-faced wing-guided, 14-5
 disk, 14-5
 seats for, 8-139
 wedge gate, 8-206
- van der Waals equation, 4-8
- Vanadium, in tool steel, 13-49
- Vapor, 4-13
 compressibility factors (chart), 4-8
 condensing, heat transfer coefficients for (chart), 4-87
 saturated (def), 4-13
 superheated (def), 4-13
 thermodynamic equations for, 4-13
- Vapor-compression machines (refrigeration), 4-18, 19-12
- Vapor pressures (def), 4-13
 of water (table), 4-44
- Vaporization, latent heats of (tables), 4-50, 4-58
- Vara (def), 1-16
- Variability (statistics), 17-19
- Variance (statistics, def), 2-10, 17-19
- Varnish, 6-108, 6-112
 catalytic, 6-112
 chemical-resistant, 6-112
 electrically insulating, 6-138
- flat, 6-112
 for floors, 6-112
 oleoresinous, 6-108, 6-112
 shellac, 6-108, 6-112
 silicone, 6-138, 6-151
 spar, 6-112
 spirit, 6-108
 water, 6-112
- Vars (reactive current, def), 15-19
- VAWT (vertical-axis wind turbine), 9-3
- Vector (def), 2-11, 3-2
- Vector addition, 2-11
- Vector calculus, 2-34
- Vector fields, 2-34
- Vector products, 2-11
- Vegetables: effects of sulfur dioxide on (table), 18-12
- Vegetation: effects of sulfur dioxide on (table), 18-12
- Vehicles:
 automatic, for materials handling, 10-36, 10-56
 road resistance of, 3-24
 solar powered, 9-17
- Velocity (def), 3-10
 acoustic (def), 3-31
 angular (def), 3-12
 composition of, 3-10, 3-11
 conversion table for linear and angular, 1-32
 hypersonic (def), 11-59
 of light, 19-41
 resolution of, 3-11
 of sound: in ideal gases, 3-31
 in various media (table), 3-32, 12-117
 subsonic (def), 11-59
 supersonic (def), 11-59
 transonic (def), 11-59
 units of, 1-18
- Velocity coefficients, in turbine nozzles, 4-23
- Velocity diagrams (pumps), 14-22
- Velocity distribution in pipes, 3-47, 3-49
- Velocity equivalents (table), 1-32
- Velocity head (hydraulics), 3-37
- Velocity profiles, of fluids, 3-37
- Velocity ratios (mechanism), 8-4
- Velocity-time curve (kinematics), 3-10
- Venn diagrams, 2-2, 2-3
- Ventilation, 12-61
 outdoor air requirements for (table), 12-67
 (See also Air conditioning)
- Venturi meters, 3-54
 ASME coefficients for (table), 3-54
 factors for (table), 3-54
- Venus, planetary data for (tables), 11-102, 11-103
- Vertex of parabola, 2-19
- Vertical-axis wind turbine, 9-3
- Vertical power pumps, 14-3
- Vessels (see Ships)
- Vibration:
 absorption of, 3-67
 axial, of shafts, 3-72
 convolution integrals in, 3-69
 damped, 3-62
 of damped systems, 3-62
 forced, 3-64
 free, 3-62
 frequency of, measurement of, 16-3
 with harmonic excitation, 3-64
 isolation of, 3-65
 caused by Kármán vortices, 12-21
 logarithmic decrement in (def), 3-63
 measurement of, 3-78
 of membranes, 3-73
 natural frequencies of, 3-71
 natural modes of, 3-71
 pickup of (sound), 12-119
 of plates, 3-74
 with proportional damping, 3-72
 of rods, 3-72
 self-excited, 3-21
 of shafts, 3-72
 in ships, 11-47
 in space vehicles, 11-104, 11-117
 stick-slip, 3-21
 of strings, 3-72
 of turbine blades, 9-62
 of undamped systems, 3-62, 3-71
 unit impulse in, 3-69
- Vibration absorbers, 3-67
 centrifugal pendulums as, 3-67
 undamped, 3-70
- Vibrators (mold making), 13-5
- Vickers hardness test, 5-12
- Vinyl resins: properties of (table), 6-200

- Viscometers, **3-33**
 Viscosimeters, **16-18**
 Viscosity (def), **3-31, 6-178**
 of cryogenics, **19-37**
 dynamic (def), **3-31**
 of gases, table, **3-32**
 kinematic, **3-33**
 conversion formulas for, **3-33**
 of liquids (table), **3-32**
 of lubricating oils, effects of pressure on, **6-179**
 effects of shear on, **6-179**
 tests for, **6-178**
 of oils, variation of, with temperature, **6-179**
 units of (def), **3-31, 3-33**
 Viscosity grades, for lubricants, **6-178**
 Viscosity index, for lubricants (def), **6-179**
 Viscous damping, in automatic control systems, **16-24**
 Vision, **12-99**
 mesopic (def), **12-99**
 photopic (def), **12-99**
 scotopic (def), **12-99**
 Vitalium (heat-resisting alloy, table), **6-79**
 Vitrified grinding wheels, **6-129**
 Vitrified pipe, **8-191**
 table, **8-194**
 VLSI (very large scale integrated circuit), **15-81**
 Voice recognition, **10-71**
 Voith-Schneider propulsion system (ships), **11-55**
 Volatility of liquid fuel (def), **9-104**
 Volt (def), **15-2**
 Voltage drops:
 in a-c circuits, **15-54**
 Mershon diagrams for, **15-47, 15-49**
 Voltage regulation, of a-c generators, **15-32**
 Voltage regulators:
 for automobiles, **15-66**
 Tirrell, **15-34**
 Voltmeters, **15-20, 15-21**
 electronic, **15-21**
 Volume:
 and capacity equivalents (tables), **1-30, 1-31**
 change under stress, **5-17**
 conversion tables for, **1-30, 1-31**
 measures of, **1-16**
 of similar figures, **2-5**
 of solids by immersion, **3-36**
 units of (def), **1-16**
 of various solids, **2-8**
 Volumetric efficiency:
 of compressors, **14-30**
 of internal-combustion engines, **9-92**
 Volute pumps, **14-16, 14-17**
 Vortex theory of propellers, **11-96**
 Vuilleumier refrigerating engine (cryogenics), **19-28**
 Vulcanized rubber, **6-147**
- Waferboard, **6-126**
 Wage systems (industrial management), **17-10**
 Waiting-line theory, **17-9**
 Wakes in fluid streams, **3-47**
 Walls:
 building: heat gain through (tables), **12-72**
 thickness of (table), **12-26**
 corrugated sheeting for, **12-25, 12-42**
 masonry, coefficients of heat transmission for (table), **12-71**
 reinforced-concrete, **12-25, 12-59**
 retaining, design of, **12-27, 12-59**
 sound-absorption coefficients for (table), **12-121**
 sound-transmission loss through (table), **12-120**
 of various constructions, heat-transfer coefficients for table, **12-75**
 Wankel engines, **9-102**
- Ward-Leonard method of speed control, **15-30**
 for mine hoists, **10-17**
 Warehousing, of materials, **10-62**
 Washburn & Moen wire gage (table), **8-85**
 Washers:
 Belleville, **8-70**
 for bolts, **8-21**
 dimensions of (table), **8-24**
 steam, **9-51**
 Waste disposal, solid, **18-18**
 Waste recovery, **18-18**
 of sewage as fertilizer (table), **18-18**
 Water, **6-168**
 agricultural (def), **6-169**
 biological treatment for, **6-173**
 boiler (*see* Feedwater)
 brackish (def), **6-170**
 in chemical plants (tables), **6-171**
 chemical treatment for, **6-173**
 compressibility of (tables), **6-10**
 consumption of (table), **6-169**
 consumptive use (def), **6-169**
 cost of, **6-171**
 critical pressure of, **9-45**
 desalination of, **6-173**
 costs of, **6-174**
 by distillation, **6-174**
 by electro dialysis, **6-174**
 energy required for, **6-174**
 by flash distillation, **6-173**
 locations of plants, **6-174**
 by reverse osmosis, **6-174**
 dissolved oxygen in, **6-172**
 domestic use of, average, **6-169**
 drinking, for industrial plants, **12-12**
 for fire protection, **18-26**
 supply of, **18-26**
 flow of: in open channels, **3-59**
 through orifices, **3-55**
 in pipes, **3-47 to 3-53**
 from tank openings, **3-60**
 over weirs, **3-57, 3-58**
 hardness of (def), **6-170**
 heat-transfer coefficients to or from, **4-83, 4-84, 4-86**
 industrial, **6-171**
 for cooling, **6-171**
 usage, **6-171**
 table, **6-171**
 for industrial plants, **12-12**
 ions in sea water (table), **6-173**
 maximum usable, **6-169**
 measurements of, **1-16, 6-169**
 potable (def), **6-169**
 contaminant limits for (table), **6-170**
 as reactor coolant, **9-140**
 saline (def), **6-170**
 solubility, of inorganic substances in (table), **6-5**
 solubility of, in gases (table), **6-7**
 specific gravity and density of (tables), **6-10**
 temperatures of, for circulating water, U.S. (map), **9-77**
 thermal conductivity of (table), **4-82**
 withdrawal use (def), **6-169**
 Water brake, **16-15**
 Water gas, flame temperatures of (table), **4-29**
 Water hammer (def), **3-61**
 in penstocks, **9-160**
 in pipelines, **3-61**
 relief devices for, **3-61**
 Water index (def), **6-169**
 Water-jet machining, **13-67**
 Water jets:
 abrasive, **6-130**
 impact of, **3-40**
 for ship propulsion, **11-55**
- Water meters, **16-7, 16-14**
 Water pollution:
 control of, **6-172**
 treatments for, **6-173**
 Water power:
 from tides, **9-21**
 (*See also* Hydraulic turbines)
 Water quality (def), **6-169**
 Water resources, **6-168**
 Water runoff (def), **6-169**
 Water seals (packings), **8-140**
 Water treatment (table), **6-172**
 (*See also* Feedwater)
 Water-tube boilers, **9-36**
 Water turbines (*see* Hydraulic turbines)
 Water vapor:
 in air, **4-15**
 emissivity of (table), **4-70**
 permeability, of various building materials (table), **12-69**
 Waterproofed cement, **6-160**
 Waterproofed concrete, **6-167**
 Watt (def), **1-24, 15-2**
 Watt-hour meters, **15-23**
 Wattless current (def), **15-18**
 Wattmeters, **15-21, 15-22**
 polyphase, **15-22**
 Wave equation, **2-34, 2-37**
 Wave-making resistance (ships), **11-45**
 Wave motors, **9-22**
 Wave power, **9-22**
 Wavelength:
 of light, **12-99**
 of radio waves (table), **15-87**
 of sound, **12-117**
 Waves:
 alternating-current, **15-18**
 radio, **15-88**
 Weber (magnetic flux, def), **15-3**
 Weber's number, **3-42, 3-44**
 WECS (wind energy conversion system), **9-5**
 Wedges:
 friction of, **3-26**
 spherical, volume of, **2-9**
 Weighers, continuous, **16-4**
 Weighing scales, **16-4**
 Weights:
 atomic (table), **6-3**
 conversion table for, **1-31**
 corresponding to degrees API (table), **1-26**
 corresponding to degrees Baumé (table), **1-27**
 per cubic foot of various materials (table), **6-7**
 equivalents (table), **1-31**
 fundamental equation of, **3-2**
 and measures: metric (*see* Metric measures and weights)
 U.S., **1-16, 1-17**
 Weirs, **3-57, 3-58, 16-14**
 Cippoletti, **3-57**
 contracted, **3-58**
 hyperbolic, **3-57**
 parabolic, **3-57, 16-14**
 rectangular-notch, **3-57, 3-58, 16-14**
 Sutro, **16-14**
 trapezoidal, **3-57**
 triangular-notch, **3-58, 3-59, 16-14**
 V-notch, **3-57 to 3-59, 16-14**
 Welded connections, **13-32**
 effective throats for, **13-33**
 fillet welds for, **13-32**
 groove welds for, **13-33**
 joint types for, **13-32**
 weld types for, **13-32**
 Welding, **13-24**
 of aluminum, **13-44**
 of aluminum alloys, **13-44**
 welding procedures for, **13-45**

Welding (*Cont.*):

arc, **13-24**
 electrodes for, **13-24**
 carbon, **13-24**
 consumable, **13-24**
 tungsten, **13-24**
 electrogas, **13-28**
 electroslog, **13-28**
 filler metals for, **13-24**
 flux cored, **13-25**
 advantages of, **13-26**
 equipment for, **13-26**
 procedures for, **13-26**
 fluxing of, **13-25**
 fluxing action during, **13-25**
 fundamentals of, **13-24**
 gas metal, **13-27**
 gas-shielded, **13-26**
 gas tungsten, **13-28**
 globular transfer, **13-28**
 metal cored electrodes for, **13-28**
 pulsed arc, **13-28**
 heat for, **13-24**
 metal inert gas, **13-27**
 microwire, **13-27**
 miniwire, **13-27**
 nontransferred arc, **13-29**
 plasma arc, **13-29**
 process selection, **13-25**
 self-shielded, **13-26**
 shielded metal, **13-25**
 manual, **13-25**
 stick, **13-25**
 shielding of, **13-25**
 by gas, **13-25**
 by slag, **13-25**
 short arc transfer, **13-27**
 spray arc transfer, **13-27**
 submerged-arc, **13-27**
 advantages of, **13-27**
 multiple-electrode, **13-27**
 twin, **13-27**
 transferred arc, **13-29**
 braze, **13-29**
 of cast iron, **13-44**
 connections, **13-32**
 (*See also* Welded connections)
 of copper, **13-45**
 welding procedures for, **13-45**
 of copper alloys, **13-45**
 welding procedures for, **13-45**
 drafting symbols for (chart), **13-33**
 electron beam, **13-30**
 explosion, **13-31**
 friction, **13-30**
 gas, **13-29**
 by acetylene, **13-29**
 with carburizing flame, **13-29**
 with neutral flame, **13-29**
 with reducing flame, **13-29**
 laser beam, **13-30**
 continuous wave, **13-30**
 pulsed, **13-30**
 of piping, **8-209**
 preheating for, **8-211**
 projection, **13-29, 13-30**
 resistance, **13-29**
 electrodes for, **13-29**
 machines for, **13-30**
 process of, **13-30**
 projection, **13-29, 13-30**
 seam, **13-29**
 spot, **13-29**
 safety, **13-45**
 seam, **13-29**
 solid state, **13-30**
 sonic, **12-122**

Welding (*Cont.*):

spot, **13-29**
 of structural steel, **12-41**
 ultrasonic, **13-30**
 Weldments, **13-24**
 Welds, **13-32**
 allowable strength of, **13-33**
 aluminum, **13-44**
 aluminum alloys, **13-44**
 welding procedures for, **13-45**
 base metals for, **13-42**
 austenitic stainless steels as, **13-44**
 duplex stainless steels for, **13-44**
 ferritic stainless steels as, **13-44**
 high-carbon steels as, **13-43**
 hot cracking of, **13-44**
 low-alloy steels as, **13-43**
 low-carbon steels as, **13-43**
 martensitic stainless steels as, **13-44**
 medium-carbon steels as, **13-43**
 precipitation-hardening stainless steels for, **13-44**
 sensitization of, **13-44**
 stainless steels as, **13-43**
 cast iron, **13-44**
 fatigue strength of, **13-38**
 Goodman diagram for, **13-40**
 filler metals for, **13-33**
 allowable shear value for, **13-34**
 strength for, **13-33**
 fillet, **13-32**
 allowable loads for (table), **13-34**
 in structures, **12-41**
 forces on, general formulas for, **13-36**
 full-strength, **13-33**
 intermittent, **13-36**
 length of, **13-36**
 spacing of, **13-36**
 matching filler and base metal in (table), **13-40**
 metal, strength of, at low temperatures, **19-34**
 metals for, allowable stresses in (table), **13-40**
 primary, **13-33**
 secondary, **13-33**
 under simple loads, **13-35**
 size determination of, **13-36**
 sizing of, **13-33**
 subject to bending, **13-36**
 subject to horizontal shear, **13-35**
 general rules for, **13-35**
 subject to twisting, **13-36**
 Weston cells, **15-12**
 Wet-bulb psychrometers, **4-15**
 Wet-bulb temperature, **4-15, 12-87**
 isoclines of (map), **9-84**
 Wet cells (electricity), **15-13**
 Wetted perimeter (hydraulics), **3-37**
 Wheatstone bridges, **15-25**
 for strain gages, **5-53**
 Wheels:
 and axles (railway), **11-31**
 friction coefficients for, **3-25**
 tables, **3-25**
 White cast iron (def), **6-13, 6-38**
 White coat (plastering), **6-163**
 White iron (def), **6-42**
 Whitworth quick-return motion, **8-3**
 Wide-flange beams, properties of (tables), **12-36**
 Williams and Hazen formula in pipeline flow, **11-131**
 Williams self-filling buckets, **10-11**
 Wind-chill index, **12-62**
 table, **12-62**
 Wind-electric energy conversion, **9-9**

Wind energy conversion systems, **9-5, 9-8**

economics of, **9-10**
 Wind pressure:
 on buildings, **12-19**
 distribution of, **12-19, 12-21**
 on roofs, **12-19, 12-21**
 on structures, **12-19**
 on towers, **12-21**
 Wind tunnels, **11-76, 11-77**
 intermittent, **11-76**
 shock tubes for, **11-76**
 supersonic, **11-76**
 transonic, **11-77**
 Wind turbines, **9-5**
 blade-element theory for, **9-6**
 Darrieus rotor, **9-5, 9-7**
 general momentum theory of, **9-5**
 horizontal-axis, **9-5**
 vertical-axis, **9-7**
 augmentation of, **9-7**
 blades for, **9-7**
 drag devices as, **9-7**
 rotor configurations for, **9-7**
 Windmills (*see* Wind turbines)
 Window glass, **6-142**
 Windows:
 glass, shading coefficients for (tables), **12-81, 12-82**
 for industrial plants, **12-11**
 Winds:
 gusts, **12-21**
 power in, **9-8**
 on structures, pressure coefficients for (table), **12-20, 12-23**
 velocities of, **12-19, 12-21**
 in the United States (table), **9-9**
 Wings, aircraft (*see* Airfoils; Airplanes, wings)
 Winkler process (gasification), **7-37**
 Winter outdoor temperatures (chart), **12-63**
 Wire:
 airplane, **11-69**
 copper (*see* Copper wire)
 electrical, colors for, **15-61**
 insulated, types of, **15-56**
 table, **15-57, 15-58**
 magnet (table), **15-65**
 steel: gage of (table), **8-85**
 Wire gage:
 table, **8-85**
 American (table), **15-5**
 annealed copper (tables), **15-52, 15-56, 15-57**
 Wire glass, **6-142**
 Wire-guided vehicles, **10-36, 10-56**
 Wire nails (tables), **8-82 to 8-84**
 Wire rope, **8-75, 10-8**
 bending-life factors for (table), **8-80**
 brakes for, **10-10**
 common, cross sections of (fig), **8-76**
 cores for, **8-77**
 cutting of, **8-79**
 drums for, **10-9**
 fittings for, **8-80, 10-9**
 for haulage, **10-8**
 for hoisting, **10-8**
 drums for, **10-9**
 idlers for, **10-9**
 IWRC, **8-77**
 lang-lay, **10-8**
 load suspension with, **10-8**
 lubrication of, **10-8**
 materials for, **8-77**
 nominal strength of (table), **8-78**
 for power hoists, **10-8**
 rotation-resistant, cross-sections of (fig), **8-77**
 seizings for, **8-79**
 table, **8-81**

- Wire rope (*Cont.*):
 selection of, **8-77**
 sheaves for, **10-10**
 allowable radial bearing pressures on
 (table), **8-79**
 special constructions, cross-sections of (fig),
8-77
 tackle for, efficiencies of (table), **10-10**
 terminators for, **8-80**
 track cables of, **10-9**
 table, **10-9**
- Wiredrawing (fluid flow), **4-24**
- Wiring:
 calculations for: for a-c circuits, **15-54**
 for d-c circuits, **15-53**
 interior, **15-55**
 cable for, **15-57**
 conduit and tubing for, **15-56**
 grounds for, **15-59**
 insulation for, **15-56**
 table, **15-58**
 open, **15-56**
 protective devices for, **15-61**
 switches for, **15-57**
- Wiring diagrams, for generator switchboards,
15-45
- Wittenbauer's analysis for fly-wheel perform-
 ance, **8-66**
- WJM (water-jet machining), **13-67**
- Wolfram (*see* Tungsten)
- Wood, **6-112**
 allowable stresses for (tables), **6-115 to 6-124**,
12-28 to 12-30
 beams, **12-28, 12-29**
 char rate of, **6-117**
 chemical composition of, **6-113**
 classification of, **6-113**
 columns, **12-30**
 construction, **12-28**
 decay of, **6-127**
 density and specific gravity, **6-116**
 as dielectric, **6-118**
 dielectric constant of, **6-118**
 dimensional stability of, **6-113**
 electrical properties of, **6-118**
 electrical resistivity of, **6-118**
 fatigue properties of, **6-116**
 fire-retardant treatments for, **6-127**
 flame speed in, **6-117**
 flooring, safe loads and deflections (table),
12-28
 as fuel, **7-9**
 analysis of (table), **7-9**
 heat value of (tables), **7-9**
 fuel value of, **6-117**
 fungi in, **6-127**
 glue-laminated, **6-123, 6-124**
 allowable stresses in, **6-123**
 (*See also* Plywood)
 hardness test for, **5-13**
 hardwood (def), **6-113**
 heartwood (def), **6-113**
 heat of combustion of, **6-117**
 heat value of, **6-117**
- Wood (*Cont.*):
 insect attacks on, **6-127**
 internal friction of, **6-116**
 marine-organism attacks on, **6-127**
 mechanical properties of, **6-113**
 moisture content of, **6-113, 6-126**
 moisture relations of, **6-113**
 naturally durable, **6-126**
 old, strength of, **6-127**
 power factor of, **6-118**
 preservative treatments for, against biological
 action, **6-127**
 methods of, **6-127**
 preservatives for, **6-127**
 properties of (table), **6-115**
 rheological properties of, **6-116**
 sanding recommendations for (table), **13-76**
 sapwood (def), **6-113**
 shrinking or swelling of, **6-113**
 treatments to prevent, **6-113**
 slope of grain of (def), **6-116**
 soapy, friction of, **3-22**
 softwood (def), **6-113**
 sound transmission in, **6-118**
 specific gravity of, **6-116**
 specific gravity and density of (tables), **6-7**,
6-115
 specific heat of, **6-117**
 strength of, **6-113, 6-116, 6-119**
 bolted (table), **12-31**
 effect of age on, **6-127**
 effect of heat on, **6-117**
 effect of moisture on (table), **6-116**
 tables, **6-115 to 6-126**
 for various grain slopes (table), **6-117**
 structural members of, fire resistance of
 (table), **12-48**
 swelling of, in liquids, **6-113**
 thermal conductivity of, **6-117**
 trusses of, joints for, **12-31**
 walls of, stud, **12-25**
 weight density of, **6-116**
- Wood alcohol, **6-148**
- Wood pulp in paper manufacture, **6-144**
- Wood screws, **8-21**
- Wood-stave pipe, **8-191**
- Wood waste as fuel, **7-9**
- Woodruff keys, **8-31**
 table, **8-32**
- Wood's metal, **6-76**
- Woodworking machines, **13-72**
- Wool fibers (tables), **6-141**
- Word (computers, def), **2-41**
- Word processors, **2-54**
- Work (def), **3-2, 3-17**
 computation of: diagram for, **3-17**
 rule for, **3-17**
 conversion tables for, **1-33**
 of friction, **3-25**
 muscular, **9-4**
 units of (def), **1-18, 3-17**
- Work hardenability, determination of, **5-13**
- Work-hardening exponent (def), **5-4**
- Work measurement, **17-28**
- Workers, selection of, **17-11**
- Workman's compensation laws, **18-19**
- Workplace design, **17-26**
- Workstations, computers as, **2-45**
- Worm gears, **8-99**
- Worm hoists, **8-8**
- Worthington feather valve (compressor), **14-32**
- Wrench openings, standard (table), **8-20**
- Wronskian determinant, **2-32**
- Wrought-aluminum alloys, **6-53**
- Wrought iron (def), **6-13**
 pipe (*see* Pipe, wrought-iron)
- Wrought-magnesium alloys (table), **6-86**
- Wythe (masonry, def), **12-27**
- X-ray diffraction, uses of, **16-18**
- X-rays, testing with, **5-65**
- Xylene, as solvent, **6-149**
- Y connections, three-phase circuits, **15-20**
- Y level (surveying), **16-52**
- Yachts, maximum safe power for, **11-46**
- Yamauti principle (radiation), **4-66**
- Yard (def), **1-16**
- Yarns (tables), **6-141**
- Yaw (airplanes), **11-71**
 (ships, def), **11-45**
- Year:
 definitions of, **1-25**
 lengths of, sidereal and tropical, **11-101**
- Yield point (def), **5-3**
 lower (def), **5-3**
 upper (def), **5-3**
- Yield strength (def), **5-2**
 of metals (table), **5-3**
- Yield-tensile ratio, **13-11**
- Young's modulus (def), **5-2, 5-17**
- z-transfer function (automatic control), **16-39**
- z transformation (automatic control), **16-38**
- Zeolite process (feedwater treatment), **9-48**
- Zinc:
 alloys of, **6-93**
 commercial, composition of, ASTM specifica-
 tions for (tables), **6-93, 6-94**
 corrosion resistance of, **6-93**
 die castings of, **6-93**
 composition and properties of (table), **6-94**
 dust, in paint, **6-109**
 effect of temperature on, **6-94**
 fabrication of, **6-93**
 galvanizing, **6-93**
 rolled, **6-93**
 white, in paint, **6-108**
 wrought, **6-93**
- Zirconium, **6-84, 6-92**
 mechanical properties of (table), **6-84**
 in nuclear technology, **6-84**
 slow neutron absorption cross-section (table),
6-82
 uses of, **6-93**
- Zones, of spheres, area of (formula), **2-9**