

Index

A

- absolute Celsius scales, 13, 14, 15
- absolute Fahrenheit scales, 13, 14
- absolute head pressure, 99
- absolute pressure, 10–11, 13, 38, 54
- absolute suction pressure, 99
- absolute temperature, 11–12
- absolute zero, 21–22, 50
- absorbents, 589–591. *See also* refrigerant-absorbent solutions
- absorber heat exchanger, 591–592, 606
- absorbers, 134
 - in absorption cold generator, 444, 445
 - for commercial absorption systems, 586, 588–590
 - heat-transfer rates for, 597, 601
 - solution cooled, 591–592
 - in water-lithium bromide machines, 595
- absorption cold generator, 444–445
- absorption-system refrigerators
 - adjusting burners in, 147
 - adjusting gas pressure in, 148–150
 - air circulation in, 142–143, 145
 - air-circulator fans for, 141–142, 143
 - air-cooled, 324
 - causes of burner outages in, 159–160
 - causes of condensation in, 161
 - causes of excessively cold temperatures in, 160
 - causes of improper defrosting of, 160
 - causes of noisy burners in, 162
 - causes of partial refrigeration in, 158–159
 - causes of problems with freezer fans in, 161–162
 - checking stability of flames in, 150
 - cleaning burner orifice for, 147, 148
 - cleaning thermostat valve in, 147–148
 - defrosting, 156–157
 - defrost timers for, 141, 142
 - electrical accessories for, 141–142, 143, 144
 - gas-control devices for, 135–141
 - gas-line connection to, 143–147
 - handling burner flame outages in, 154–155
 - handling flames outside of generator flue, 155–156
 - handling temperature problems in, 152–153
 - inoperative light switches in, 157
 - installation of, 320–325
 - installing cooling water lines in, 322–323
 - installing drain lines in, 323
 - installing gas lines in, 323
 - installing gas regulator in, 323–325
 - leveling, 143
 - lighting burner in, 151–152
 - maintenance of, 151–157
 - rapid formation of frost on, 157
 - no refrigeration in, 153–154
 - regularity of defrosting of, 153
 - removal and replacement of, 150–151
 - removing odors from, 157
 - source of heat for, 325
 - testing gas connections to, 157
 - thermostats for, 141–142
 - thermostat valve for, 140
 - troubleshooting guide for, 158–162
 - water-cooled, 321–322

708 Index

- absorption-type refrigeration
 - advantage of, 131
 - application of heat in, 132
 - basic description of, 162
 - commercial uses for (*see* commercial absorption systems)
 - components of, 131, 132
 - versus compression-type, 131
 - flue system in, 135
 - fluid circuits in, 132
 - general description of, 131
 - principle of operation, 131–132
 - refrigerants in, 131–132, 133–134
 - refrigeration cycle in, 132–135
 - stopping, 152
 - troubleshooting guide for, 158–162
 - understanding operation of, 445–446
- accumulators, 116–117, 124, 523
- aeration, 540
- agitators, 541
- agriculture, benefit of refrigeration to, 2
- air
 - condensation of, 43–46
 - convection of, 42
 - for display cases, 499
 - evacuating from refrigeration systems, 190–192
 - purging from condensers, 192–193
- air-change loads, 660–661, 663–664
- air circulation
 - and food preservation, 313
 - symptoms of problems with, 158, 159, 304
 - See also* fans
- air-conditioning systems
 - quick-connect terminals for, 233
 - solar powered, 601–605
- air-cooled condensers, 432–433
- air-cooled refrigerators, 324
- air filters, symptoms of problems with, 158
- air piping, for ice-making systems, 459–460
- alternating current (AC), 370–373
- alternating-current (AC) motors
 - capacitor, 388
 - classifications of, 382
 - effects of reduced voltage starting on, 385
 - repulsion-start, 389–391
 - shaded-pole, 389, 390
 - single-phase, 387–391
 - split-phase, 388
 - squirrel-cage, 382–383
 - starting and controlling, 385–387
 - synchronous, 384–385
 - wound-rotor, 383–384
- alternations, 373
- altitude
 - ceiling of, 37
 - effect on atmospheric pressure, 9, 10, 36
 - and refrigeration capacity, 46–49
- ammonia, 32
 - in absorption-type systems, 131–132, 133–134
 - boiling point of, 49, 417
 - in centrifugal compressors, 88, 89
 - commercial uses of, 73, 417
 - condensation of, 420
 - detecting leaks of, 67, 74
 - health risks from, 69
 - mixed with hydrogen, 132
 - operating pressures of, 60
 - properties of, 58, 65
 - testing brine for, 455–456
- ammonia compression system, 418–421
- ammonia swab, 63–64
- ammonia-water, 134, 591–593, 598–601
- amperes, formula for, 368
- analyzer, 132–133
- anchor bolts, 620–622

- anhydrous ammonia, 417
 - antislug device, 87
 - atmospheric pressure
 - defined, 9, 54
 - effect of altitude on, 9, 10
 - effect on boiling point of liquids, 35–36
 - effect on refrigeration, 46–47, 48
 - gages for (*see* pressure gages)
 - normal density of, 37
 - at sea level, 37
 - standard for, 9, 54
 - automatic expansion valves, 341, 342, 537–538
 - automatic icemakers, 468–469
 - automatic reversing pump, 609
 - autotransformers, 386
- B**
- baffles, for display cases, 499–500
 - barometers, 9, 38–39
 - bearings
 - for compressor motors, 327, 337
 - greasing, 328
 - outboard, 624
 - bellows
 - in commercial refrigerator, 362
 - defrost-control, 400, 401
 - in temperature control, 362
 - during temperature-control cycle, 296–297
 - in thermostatic expansion valve, 346–348
 - bellows-type seal, 93
 - bellows valve, 213
 - belt alignment, in compressors, 97–98
 - belt-driven compressors, 622–623
 - bending springs, 207–209
 - bending tools, 200–201, 202
 - bends, 200–201, 202, 205–211
 - beverage coolers, 540
 - bimetallic thermostats, 398–399
 - blanching, 550
 - bleed connection, 432
 - block system, 467
 - blower motors, 249–250, 251
 - blowers, 560. *See also* fans
 - blown fuses, 244
 - boilers, 586
 - boiling point
 - on Celsius scale, 21
 - defined, 417
 - effect of pressure on, 35–36
 - effect of reduced air pressure on, 40
 - on Fahrenheit scale, 21
 - of various refrigerants, 58
 - bottle water coolers, 527–528, 531, 540
 - Boyle's law, 10–11, 51–52
 - brake horsepower, 103, 109
 - brick walls
 - with 4-inch cut stone, 644
 - heat-transfer coefficient (K) of, 644–645, 654–655
 - with no exterior finish, 645
 - brine, 57
 - absorption of oxygen in, 452–453
 - acidity of, 454–455
 - alkalinity of, 455
 - with calcium chloride (*see* calcium chloride)
 - and circulating pumps, 607
 - congealing tank for, 447
 - for cooling dairy products, 667
 - corrosion in, 452–456
 - determining strength of, 450
 - evaporating-surface area in, 669
 - foaming of, 452
 - freezing methods for, 467–468
 - freezing point of, 450
 - freezing tanks for, 462–463
 - holdover tank for, 447
 - importance of not freezing, 111
 - important qualities of, 450
 - makeup of, 417
 - materials used for making, 450
 - for packing vegetables, 552
 - pH values of, 453–454
 - preparing, 456–457
 - properties of, 448–449

710 Index

brine (*continued*)

- removing from can, 460
- required amounts of, 667
- and sodium chromate, 453
- testing for ammonia in, 455–456
- brine-cell plate system, 466
- brine-coil plate system, 466
- brine systems, 49–50
 - advantage of, 447
 - corrosion retarders for, 453
 - initial charges of, 451
 - preparing brine for, 456–457
 - tanks for, 447
- brine tanks, 669
- British thermal unit (Btu)
 - absorbed by ice, 34
 - calculating for food shipments, 26
 - defined, 22–23
 - equivalents to, 17
 - formula for, 25
 - function of, 23
 - for raising water temperature
 - from melting point to boiling point, 30
 - required to bring ice to melting point, 29
 - and ton of refrigeration, 34
- bubble method, 67, 74, 195–196
- built-up terminals, 232, 233
- bulb-bellows, 361–362
- bull-headed tee, 572
- burner orifice, 139, 159
- burners, 138–139
 - adjusting, 147
 - adjusting pressure of, 148–150
 - causes of outages in, 159–160
 - causes of problems with, 162
 - checking stability of flames in, 150
 - cleaning orifice of, 147, 148
 - handling flame outages in, 154
 - lighting, 151–152
 - symptoms of problems with, 158
- burner thermal valve, 159

C

- calcium chloride
 - alkalinity of, 455
 - dissolved oxygen in, 452
 - flake form of, 451
 - and foam, 452
 - initial charges of, 451
 - necessary quantities of, 451
 - proper strength of, 451
 - properties of, 448–449
 - qualities of, 450
 - and sodium chromate, 453
 - testing for ammonia in, 456
 - in water, 450, 451
- can beverage coolers, 540
- can ice, 473
- can ice system, 459
- capacitor motors, 388–389, 390, 562
- capacitors, 228
 - maintenance of, 401–402
 - starting, 401–402
 - symptoms of problems with, 244, 245, 410
 - testing, 544–545
 - in wiring diagram, 268, 269, 271
- capacity ratings, 662
- capillary-tube method, 115
- capillary tubes
 - calibration of, 116
 - checking bore of, 356
 - cleaning, 356
 - components of, 354–355
 - and condenser replacements, 241
 - connecting to refrigeration system, 357
 - cutting, 240
 - in domestic refrigerators, 120–121, 122
 - in household freezer, 290–291
 - kinked, 222
 - in refrigeration cycle, 116
 - removing ice from, 337
 - replacement of, 356–357
 - restriction in, 219–224, 252
 - symptoms of kink in, 356

- unsoldering, 356–357
 - in upright freezer, 298–299
- capillary-tube system, 290–291, 353–354
- carbon dioxide (CO₂), 32, 33, 65–66
 - for cleaning capillary tubes, 356
 - fumes of, 69
 - operating pressures of, 60
 - properties of, 58
 - safety of, 73–74
 - solid form of, 469–471
- Carnot cycle, 587
- ceilings, heat-transfer coefficient of, 648
- Celsius
 - converting to Fahrenheit, 14
 - relationship to Fahrenheit, 20
 - standard scales for, 13–14
 - thermometers for, 20
- centrifugal compressors, 87–89, 112, 330
- centrifugal fans, 559, 560, 563
- centrifugal pumps, 609–612, 614–616
- centrifuge, 87
- charging
 - of commercial refrigeration systems, 439
 - equipment for, 180, 181, 186
 - of refrigerants, 186, 627, 629
 - of sealed systems, 180, 186–190
 - charging cylinder, 180–186
 - charging hoses, 221
 - charging tool, 181–184
 - removing, 185
- Charles's law, 11–15, 50, 51–52
- check valves, 524
- chest freezers, 302
- chill rooms, 514, 515
- chlorofluorocarbons (CFCs),
 - substitutes for, 59
- cinder block walls, 638–639
- circuits, 368–369
- circulating pumps
 - centrifugal, 609–612, 614–616
 - maintenance of, 613–615
 - motors for, 616
 - power requirements for, 612–613
- reciprocating, 612, 614–615, 616
 - rotary, 607–609, 610, 614, 615
- clearance effect, 109
- coefficient of performance (COP), 587–588, 597
- combination-gage set, 187–188, 198–199
- combined law of Boyle and Charles, 51–52
- commercial absorption systems, 444–445
 - ammonia-water cycle in, 591–592, 598–601
 - basic cycle of, 588–590
 - components of, 586–587
 - finding coefficient of performance (COP) of, 587–588
 - heat-operated, 585–586
 - heat-transfer rates for
 - components of, 597
 - liquid heat exchanger in, 590
 - practical cycle of, 590–592
 - refrigerant-absorbent solutions for, 592–601
 - refrigeration cycles of, 585–592
 - solar cooling, 601–605
 - source of inefficiency in, 590
 - water-lithium bromide machine, 594–597
- commercial refrigeration systems
 - absorption-type, 444–445
 - balancing cooling systems in, 437–438
 - calculating required size of, 657
 - charging, 439
 - components for cooling systems in, 430–437
 - condensers for, 422
 - cooling ponds for, 424
 - cooling towers for, 425–430
 - cooling-water requirements for, 424–430
 - defrosting, 446

712 Index

- commercial refrigeration systems
 - (*continued*)
 - versus domestic refrigeration, 115
 - factors for success of, 565
 - fittings and valves for, 434–436
 - heat exchangers for, 436–437
 - lubrication methods for
 - compressors in, 328–329
 - operation of, 438–441
 - principles of, 445
 - pumping down, 439
 - refrigerants in, 417
 - selecting, 422
 - spray cooling ponds for, 424–425
 - starting, 439–440
 - stopping, 440–441
 - thermoelectric cooling in, 168, 171–172
- commercial refrigerators, 362–363, 418–422
- community locker. *See* locker plants
- compound gages
 - for compressor efficiency tests, 95
 - in diagrams, 179–185
- compound-wound motors, 612–613
- compressed gas cylinders, 69–70
- compression ratio, 99–100, 103, 113
- compression ring, 85
- compression systems, 52–53
- compression-type refrigeration. *See* compressors; refrigeration systems
- compressor motors
 - ball bearings in, 327–328, 337
 - causes of problems in, 409
 - checking, 402
 - contactors for, 391–392
 - controls for, 391–394
 - electrical requirements of, 358–359
 - lubrication of, 327–328
 - overload protector for, 360–361, 392–393
 - relays for, 391–392
 - replacing, 403, 406–407
 - starters for, 391–392
 - start relay for, 359–360
 - start-stop controls for, 359
 - wiring, 359
 - wiring diagram for, 406
- compressors
 - adding oil to, 187–188
 - ammonia systems of, 418–421
 - applying V belts to, 623
 - belt alignment in, 97–98
 - belt-driven, 622–623
 - brake horsepower of, 103, 109
 - calculations for quality of, 102–103, 109–110
 - capacity of, 103, 662
 - in capillary-tube system, 122
 - causes of constant running of, 305–306, 443
 - causes of cycling on overload protector, 244–245
 - causes of failure of, 303–304
 - causes of high head pressure in, 441
 - causes of high-pressure cutout in, 442
 - causes of loud noises in, 412
 - causes of low head pressure in, 441–442
 - causes of oil loss in, 412
 - causes of problems with, 407–409, 410–411
 - causes of short cycles in, 408
 - centrifugal, 87–89, 112, 330
 - cleaning, 91–92
 - compression ratio of, 103
 - controls for, 574–575
 - crankcase-oil heaters in, 331–333
 - crankshafts in, 82
 - cycling on overload protector, 228–229, 244–245, 304–305
 - for dairy manufacturing plants, 669
 - defective, 225–226

Index 713

- during defrost cycle, 260
- direct-connected, 623–624
- discharge lines for, 571–572
- discharge valves for, 175–177
- in domestic refrigerators, 118, 120, 129
- eccentric shaft in, 82–83
- effect of defection in, 252
- effect of moisture on, 433
- efficiency of, 113
- efficiency test for, 94–96
- electrical requirements of, 358–359
- energy consumption of, 100
- evacuating, 406–407
 - and excessive freezer temperatures, 305–306
- finding leaks in seals of, 94
- fixing loose mountings of, 307
- with flooded-type evaporators, 333
- frozen, 407
- functioning of, 77
- function of, 116
 - and halocarbons, 111
- hermetic (*see* hermetic compressors)
- high-pressure cutout switch for, 362–363
- high suction pressure in, 442
- in household freezers, 289–290
- importance of cleaning, 438
- inadequate pumping of, 306–307
- installing, 622–624
- interconnecting piping for, 572–574
 - and kinked capillary tubes, 222
- knocks in, 96, 113
- leveling, 622
- liquid flowing into suction of, 89
- low suction pressure in, 442
- lubrication of, 96–97, 101–102, 328–333, 337–338
- maintenance of, 90–92
- mechanical efficiency of, 103
- method classifications of, 77
- moisture problems in, 335
 - motor-driven, 623–624
 - multiple-unit installations, 570–575
 - noises in, 90
 - no-load run for, 438
 - oil-failure switch in, 330–331
 - oil level in, 90
 - oil pressure in, 90, 394–395
 - on and off period of, 98
 - in open-type refrigeration (*see* open-type compressors)
 - parallel connections of, 571–572
 - performance factor of, 103
 - pistons in, 112
 - in pop machines, 540
 - pounding in, 111
 - precautions during installation
 - and initial operation, 89
 - problems with, 112
 - reciprocating, 77–83, 112
 - in refrigeration cycle, 116
 - relays for, 229–231
 - removing, 97
 - removing oil sludge from, 334–335
 - removing solids from, 336–337
 - replacing, 97, 237–238
 - rotary, 83–84, 85, 112
 - that run continuously, 225
 - running-time check for, 98–99
 - safety precautions for, 111–112
 - shaft seal in, 80
 - short-cycling on low-pressure cutout, 443
 - for small freezers, 670, 671
 - solids found in, 335
 - and stopping commercial refrigeration systems, 440–441
 - stuck, 96
 - suction lines for, 570–571
 - suction strainer in, 90–91
 - suction traps in, 577
 - suction valves in, 175–177
 - support for, 620
 - symptoms of problems with, 245, 246, 247, 413

714 Index

- compressors (*continued*)
 - terminals in, 231–234
 - testing, 303–304
 - testing with direct power, 228–229
 - theoretical capacities of, 109–110
 - and thermostats, 226
 - troubleshooting guide for, 441–443
 - types of, 77
 - valves in, 83, 91, 443
 - volumetric efficiency of, 103
 - in wiring diagram, 267, 268, 269, 271
 - wiring diagram of, 229
 - working with temperature control, 295–296
- compressor valves, 83, 91, 443
- concentrator, 444, 445
- concentric tube cooler, 541
- concrete block walls, 638–639
- concrete floors, 650–653
- concrete walls
 - with brick veneer, 636
 - with exterior stucco finish, 635
 - with 4-inch cut stone, 637
 - heat-transfer coefficient (K) for, 634–637, 659
 - with no exterior finish, 634
- condensation, 43–46
 - in absorption-system refrigerators, 161
 - defined, 49, 418
 - in hair felt, 582
 - and heat, 52
 - point of, 51
 - in wool felt, 581
- condenser fan, 153, 271
- condensers, 45–46
 - in absorption cold generator, 444, 445
 - in absorption-type refrigeration system, 133–134
 - air-cooled, 432–433
 - for ammonia compression systems, 420
 - in capillary system, 122
 - checking cooling fan in, 234–235
 - for commercial absorption systems, 586
 - for commercial refrigerators, 422
 - conveying warm condensate from, 590–591
 - cooling, 422
 - in domestic refrigerators, 118, 121
 - drainage of water from, 323
 - equalizing pressures of, 574
 - evaporative, 431–432
 - function of, 116, 118
 - head-pressure control in, 430
 - heat-transfer rates for, 597, 601
 - and hot-gas manifolds, 569
 - in household freezer, 290
 - for ice cream cabinet freezers, 536–537, 539
 - interconnecting piping for, 572–574
 - liquid lines for, 566, 567
 - for milk coolers, 541, 542
 - overload protector for, 392–393
 - post-loop design change in, 124–125, 126–127
 - purging air from, 192–193
 - in refrigeration cycle, 116
 - regulating valve in, 433
 - replacing, 241
 - required capacities of, 665
 - selecting, 422
 - for small freezers, 670, 671
 - for supermarket refrigeration systems, 500, 501
 - symptoms of clogs in, 441
 - symptoms of problems with, 411
 - types of, 118
 - in upright freezer, 298, 299
 - valves on, 436
 - water-cooled, 430
 - in water coolers, 527
 - in water-lithium bromide machines, 595
 - water-regulating valves for, 431, 569–570
- condensing point, 51
- conduction, 41

- conductors, 269, 271, 372
 - congealing tanks, 50, 447
 - connecting rods, 82
 - contactors, 391–392
 - control bulb, 362
 - control devices. *See* refrigeration control devices
 - convection, 42
 - cooling coils, 315, 411
 - cooling fans, 234–235, 241–243
 - cooling loads, 660, 663
 - cooling ponds, 424
 - cooling surface, formula for, 667–668
 - cooling systems
 - air-cooled condensers in, 432–433
 - balancing, 437–438
 - components for, 430
 - evaporative condensers in, 431–432
 - fittings and valves for, 434–436
 - head-pressure control in, 430
 - heat exchangers for, 436–437
 - water-regulating valves for, 431
 - cooling towers
 - in absorption cold generator, 444
 - closed, 427–428
 - dimensions of, 427
 - driers in, 433–434
 - efficiency of, 427
 - open, 425–427
 - temperature controls for, 428–430
 - copper oxide, removing, 336
 - copper tubing
 - bending by hand, 205–211
 - connectors for, 214
 - cutting, 200
 - flared-type fitting for, 211
 - for liquid-petroleum (LP) gases, 146–147
 - plug for, 213
 - purging copper oxide from, 215–216
 - safety devices for, 213–214
 - sizes and dimensions of, 212
 - solder for, 214, 215
 - cork
 - heat-transfer coefficient of, 659–660
 - as insulation material, 43
 - in locker plants, 517
 - for piping insulation, 578–579
 - corrosion
 - in brine systems, 452–456
 - from refrigerant-absorbent solutions, 593
 - retarders of, 453
 - corrosion solids, removing, 336
 - couple, 165–166
 - crack, 177–178
 - crankcase-oil heaters, 331–333, 338
 - crankcases
 - cleaning, 91, 438
 - equalizing pressures of, 574
 - oil in, 331
 - oil level in, 329
 - preventing excessive concentrations of refrigerant in, 331
 - pumping out, 91
 - crankshafts, 82–83, 86, 87, 120
 - critical pressure, 52, 58
 - critical temperature, 52, 58
 - current relay, 230–231
 - cut-in temperature, 243
 - cutout point, 292
 - cylinder porting, 85
- D**
- dairy plants
 - benefit of refrigeration to, 2
 - load calculations for, 666–670
 - Dalton's law of partial pressures, 134
 - defrost controls, 258–259, 274–276. *See also* defrost thermostats; defrost timers
 - defrost heaters, 272, 273
 - contact with evaporator, 156
 - symptoms of problems with, 160
 - in wiring diagram, 268, 269, 271

716 Index

- defrosting, 243, 252
 - of absorption-system refrigerators, 156–157
 - automatic, 156–157, 256–264
 - causes of problems with, 160
 - in commercial refrigeration systems, 446
 - controls for (*see* defrost controls)
 - direct-electric method of, 502
 - of display cases, 502–504
 - with hot gas, 400
 - with hot water, 256
 - importance of, 277
 - manual, 235–236
 - need for, 235–236
 - pressure method of, 502–503
 - pushbutton control of, 156–157
 - sequence of, 261
 - straight-time method for, 502
 - temperature method of, 503–504
 - voltage considerations for, 504
- defrosting tray, 256
- defrost switch, 161
- defrost systems, 257–261
 - components of, 266, 269, 271–276
 - in upright freezer, 300, 301–302
- defrost thermostats
 - calibration of, 269
 - functioning of, 266, 272
 - testing, 264–265
 - testing for continuity, 269, 271
 - warning against replacement of, 272
- in wiring diagram, 268, 269, 271
- defrost timers, 261–264
 - for absorption-system refrigerators, 141, 142
 - operation of, 400
 - symptoms of problems with, 160
- in wiring diagram, 268, 269
- dehumidifiers, 171
- dehydrating agents, 626
- dehydrators
 - agents in, 626
 - description of, 625
 - figure of, 626
 - function of, 523
 - in locker plants, 523
 - for supermarket refrigeration systems, 498
 - symptoms of problems with, 413
 - temporary installation of, 626
- delta transformer, 375
- density, 5, 6
- dilution flue, 135
- dippers, 96–97
- direct-connected compressors, 623–624
- direct-connected fans, 561–562
- direct current (DC), 369–370
- direct-electric defrosting method, 502
- direct-expansion evaporators, 121–122
- direct-expansion system, 49, 447, 466
- discharge lines
 - and compressor replacements, 237
 - designing, 568–569
 - and evaporator replacements, 239
 - for paralleled compressors, 571–572
 - pressure drop in, 565
 - symptoms of obstruction in, 614
- discharge valves, 83
 - in hermetic compressor, 87
 - repairing, 95
 - in rotary compressor, 84
 - symptoms of leaks in, 441
 - symptoms of problems with, 408, 411
- displacement per revolution, 109–110
- display cases
 - air circulation in, 499–500
 - baffles in, 499–500
 - closed, 495–496
 - coil arrangement in, 496
 - controls for, 499
 - for dairy products, 493
 - defrosting, 502–504

Index 717

- drainage requirements for, 505
- eliminating drafts from, 492
- for fresh produce, 493
- function of, 489
- installation of, 498–500
- insulation of, 491
- lighting in, 489, 494
- maintenance of, 497
- for meat, 489–491, 495–496
- multiple connections of, 496–497
- open, 491–493
- domestic icemakers, 473–477
 - fill trough for, 481
 - ice ejector in, 478
 - ice stripper for, 477, 478
 - installing water supply line to, 481–483
 - mold heaters for, 477
 - motor for, 480, 481
 - replacing parts of, 485–486
 - signal arm for, 479–480
 - test cycling, 483–484
 - thermostat for, 479
 - timing cam for, 480, 481
 - timing gear for, 480, 481
 - timing switches for, 480
 - troubleshooting problems with, 486
 - water fill in, 484–485
 - water valve for, 478
 - wiring for, 481
- domestic refrigeration
 - absorption system for (*see* absorption-type refrigeration)
 - versus commercial refrigeration, 115
 - cycle of operation of, 115–118
 - sealed-system operation, 219–226
- domestic refrigerators
 - accumulation of moisture in, 314–315
 - accumulators for, 124
 - arrangement of refrigerant tubing in, 223
 - average wattages of, 311
 - calibrating controls of, 236
 - capillary tubes in, 120–121, 122
 - circuit arrangement of, 393
 - cleaning, 316
 - compressors in, 118, 120, 129
 - condensers in, 118, 121
 - cooling-coil frosting in, 315
 - cut-in temperature of, 243
 - distance from wall, 319–320
 - drier-strainers in, 119–120, 122
 - electrical systems in, 357–362
 - electrical testing of, 226–235
 - energy conservation with, 124–129
 - evaporator cooling fan for, 241–243
 - evaporators in, 121–124, 129
 - food arrangement in, 311–314
 - functioning in low exterior temperatures, 332
 - gages for, 216
 - and humid weather, 314, 315
 - icemakers in (*see* domestic icemakers)
 - minimizing door openings in, 314, 317
 - odor prevention in, 316
 - operating in warm weather, 315
 - overload protector for, 360–361
 - quick-connect terminals for, 233
 - removing freeze-ups in, 220–224
 - replacing compressor in, 237–238
 - replacing condenser in, 241
 - replacing controls on, 235
 - replacing driers in, 239–240
 - replacing evaporator in, 238–239
 - replacing heat exchanger in, 240
 - service valves in, 216
 - storage bins in, 311, 313
 - styles of, 311
 - temperature-control devices for, 243, 252
 - temperature control on, 236
 - testing for leaks in, 320
 - testing units with capacitors, 228

718 Index

- domestic refrigerators (*continued*)
 - thermostatic control for, 125, 128–129
 - troubleshooting guide for, 244
 - uncrating and locating, 319–320
 - wiring components of, 357
 - wiring diagram for, 128, 129, 360
- door seals
 - correcting, 280
 - importance of, 287
 - magnetic, 280, 287
 - and sweating, 315, 317
 - symptoms of problems with, 247, 250, 251
 - testing, 287
 - testing tightness of, 279–280
- double-effect generators, 592
- drainage systems, 301–302, 505
- drain heater, 261, 268
- drain lines, 323, 325, 531
- driers
 - changing, 435
 - and compressor replacements, 237–238
 - defective, 215
 - full-flow, 433
 - and heat-exchanger
 - replacements, 240
 - in hermetic compressors, 433
 - importance of, 335
 - indications for use of, 433
 - installing, 221
 - location of, 433–434
 - on locker-room plates, 522
 - mounting, 434
 - mullion, 267, 268, 269
 - for removing ice, 337
 - for removing refrigeration solids, 336
 - replacing, 239–240
 - side-outlet, 433–434
 - in wiring diagram, 267, 268, 269
- drier-strainers, 116, 119–120, 122
- driven pulley, 381
- driver pulley, 380–382
- drum valve, 629
- dry-bulb temperature, 46, 47
- dry ice, 33, 469–471
- E**
 - eccentric shaft, 82–83
 - efficiency test, 94–96
 - electrically operated gas valves, 137, 138
 - electrical systems
 - alternating-current (AC) motors in, 382–387
 - checking compressor motors in, 402
 - checking fan motors in, 403
 - checking overload protectors in, 402
 - checking starting capacitors in, 401–402
 - checking starting relay in, 402
 - compressor-motor controls in, 391–394
 - defrost controls in, 400–401
 - direct current in, 369–370
 - in domestic refrigerators, 357–362
 - electric circuit in, 368–369
 - energy in, 376
 - maintenance of, 401–403
 - motor efficiency in, 376–380
 - oil-pressure controls for, 394–396
 - replacing compressor motor in, 403, 406–407
 - single-phase motors in, 387–391
 - solenoid valves for, 395–396
 - temperature controls for, 396–399
 - thermostatic control for, 397–398
 - transformers for, 374–375
 - troubleshooting guide for, 407–413
 - electrical testing, 543–544
 - of compressors, 228–229
 - and compressor terminals, 231–234

- of condenser cooling fan, 234–235
- of units with capacitors, 228
- with volt-ohmmeters, 226–228
- electric circuits, 368–369
- electricity
 - and defrosting systems, 504
 - direct current (DC) of, 369–370
 - frequency of, 373
 - measuring energy of, 376
 - reactive loads of, 371
 - single-phase current of, 370–373
 - three-phase current of, 370–373
 - units of, 367–368
- electronic detector, 66, 196–197
- energy
 - conversion factors for, 51
 - conversion of, 376
 - defined, 376
 - equivalents for, 17
 - forms of, 16–17
 - and heat, 19
 - law of conservation of, 50
 - measuring, 376
 - transmission of, 17
- energy conservation, 124–129
- English system of measurement, 2, 3–5, 7
- enthalpy, 596
- equalizer line, 348
- ethyl chloride, 32, 58
- evacuation
 - of air from refrigeration systems, 190–192
 - of entire refrigerant charge, 193–195
 - equipment for, 181–185
 - of sealed systems, 181–185
- evaporating-surface area, 669
- evaporation
 - effect of reduced pressure on, 39–40
 - and heat, 52
 - latent heat of, 30–31
 - for refrigeration, 34, 47, 49
 - using latent heat from, 71–72
- evaporative condensers, 431–432
- evaporator coils, 275
- evaporator lines, 396
- evaporator liquid-line service valves, 177
- evaporators, 53
 - in absorption cold generator, 444, 445
 - in absorption-type system, 133–134
 - automatic expansion valves for, 342–344
 - in capillary system, 122
 - for commercial absorption systems, 586
 - conveying warm condensate to, 590–591
 - cooling fans for, 241–243
 - determining operating temperature of, 665
 - direct-expansion, 121–122
 - in domestic refrigerators, 121–124
 - flooded-type, 333
 - function of, 116, 121, 129
 - liquid lines for, 566
 - in locker plants, 518, 520–521
 - partial restriction in, 225
 - plate-type, 518, 520–521
 - after recharging refrigerators, 222
 - in refrigeration cycle, 116
 - replacing, 238–239
 - and restricted capillary tubes, 219, 222
 - symptoms of problems with, 412
 - thermostatic control for, 397–398
 - and thermostatic expansion valves, 346, 350
 - unsatisfactory temperatures in, 243
 - in water coolers, 527–528, 529
- evaporator suction-line service valves, 177
- exhausters, 560
- expansion, 37

720 Index

- expansion valves, 53
 - for adding oil, 187–188
 - for ammonia compression systems, 420
 - automatic, 341, 342–344
 - changing, 435
 - charging refrigerant through
 - high side of, 189–190
 - charging refrigerant through low side of, 188
 - for controlling refrigerant distribution, 537–538
 - and evacuation of air from refrigeration systems, 190–192
 - and evacuation of entire refrigerant charge, 193–195
 - on locker-room plates, 522
 - and purging of air from condensers, 192–193
 - symptoms of problems with, 408, 411, 412, 413, 442
 - thermostatic, 344–353
- F**
- Fahrenheit, 13–14, 20
- fan bearings, 101
- fan motors
 - checking, 403
 - for hermetic compressors, 291, 292
 - symptoms of problems with, 248
 - wiring diagrams for, 403, 404–406
- fans
 - for absorption-type refrigerators, 141–142, 143
 - centrifugal, 559, 560, 563
 - characteristics of, 560–561
 - classification of, 559
 - for cooling towers, 427–428
 - efficiency of, 563
 - function of, 563
 - for hermetic compressors, 291, 292
 - lubrication of, 337
 - motors for, 561–562
 - performance of, 559
 - power requirements for, 561
 - propeller, 560, 563
 - selecting, 562
- fan switches, 248
- feed pumps, 587
- felt filter, 137, 138
- ferrules, 620
- filter-driers
 - figure of, 337
 - importance of, 335
 - for installations of compressor motors, 403, 407
 - for removing refrigeration solids, 336
- fish, storage temperature for, 555
- flared joints, 576
- flaring tools, 204–205
- flooded-type evaporators, 333
- flue baffle, 135, 158
- flue system, 135
- food compartment, 247–249, 251
- food preservation, 1
 - in display cases (*see* display cases)
 - in freezing lockers (*see* locker plants)
 - frozen-meat storage, 509–510
 - importance of, 549
 - importance of air circulation to, 313
- food-protection alarm system, 500, 502
- foods
 - arrangement in refrigerators, 311–314, 316
 - blanching, 550
 - display cases for (*see* display cases)
 - and odor prevention, 316
 - preparing for quick freezing, 550–556
 - quick-freeze room for, 515, 516
 - quick freezing of, 62, 549–550
 - specific heats of, 26
 - storage temperatures for, 554–556

- sugar packing, 550–551
- food storage
 - and radiant heat transfer, 494–495
 - temperatures for, 554–556
- foot-pounds per unit time, 15–16
- forced-air evaporators, 523–524
- forced-feed lubrication, 78, 80, 328–329
- foundations, 619–622
- fractional distillation equipment, 589
- frame ceilings, heat-transfer coefficient (K) of, 656
- frame floors, heat-transfer coefficient (K) of, 648, 656
- free metals, removing, 336
- freezer fans, 161–162, 268, 269, 271
- freezer plates, 521–523
- freezers
 - automatic defrost cycle for, 260
 - causes of frost in, 251
 - causes of warmer temperatures in, 249–250
 - chest models, 302
 - circulation of air in, 259–260
 - during defrost cycle, 256
 - defrost-thermostat contacts in, 264–276
 - household (*see* household freezers)
 - for ice cream, 535–540
 - importance of maintaining temperature range of, 255
 - load calculations for, 670–671
 - multiplexing, 538–540
 - removal of moisture from, 259–260
- freeze-ups, remedying, 220–224
- freezing
 - on Celsius scale, 21
 - on Fahrenheit scale, 21
 - of plate ice, 467–468
 - of various refrigerants, 58
- freezing loads, 661
- freezing tanks, 462–463
- Freon, 58–59
 - boiling points of, 73
 - chemical properties of, 59
 - corrosive action of, 61
 - displacement per revolution of, 109–110
 - health hazards from, 61
 - net refrigerating effect for, 110
 - operating pressures of, 60
 - properties of, 59–60, 73
 - safety in using, 61
 - substitutes for, 59
 - in thermostatic expansion valves, 349
 - types of, 60–63
- Freon-11 (CCl_3F), 58, 62
- Freon-12 (CCl_2F_2), 32, 49
 - back pressure for charging with, 189
 - boiling point of, 60
 - fumes of, 69
 - properties of, 58
 - properties of vapors of, 104–108
 - refrigerating unit with, 421
 - uses of, 60–61
- Freon-13 (CClF_3), 58, 63
- Freon-14 (CF_4), 58, 63
- Freon-21 (CHClF_2), 32, 58, 62
- Freon-22 (CH_2ClF), 32, 49, 62, 421
- Freon-113 ($\text{CCl}_2\text{F}-\text{CClF}_2$), 58, 62
- Freon-114 ($\text{C}_2\text{Cl}_2\text{F}_4$), 58, 62–63
- Freon-502, 32, 49
- frequency, 373
- Frigidaire refrigerators, wiring diagrams for, 266, 267–269, 270–271
- frost, 276, 356
- fruits
 - effect of freezing on, 552
 - preparing for quick freezing, 551–552
 - quick freezing of, 549–550
 - storage temperatures for, 554–556
 - sugar packing, 550–551
 - fusion, latent heat of, 29

722 Index

G

gage manifold, 180, 182
gas burners, 138–139
 adjusting, 147
 adjusting pressure of, 148–150
 causes of outages in, 159–160
 causes of problems with, 162
 checking stability of flames in, 150
 cleaning orifice of, 147, 148
 handling flame outages in, 154
 lighting, 151–152
 symptoms of problems with, 158, 159
gas-control devices, 135–141
gases
 adequate ventilation for, 69
 Boyle's law for, 10–11
 Charles's law for, 11–15
 condensation of, 43–46, 52
 condensing point of, 51
 connecting to absorption-type refrigerators, 143–147
 critical pressure of, 52
 critical temperature of, 52
 and Dalton's law of partial pressures, 134
 effect of pressure on, 50–52
 expansion of, 37
 isothermal change in, 11
 laws of, 50–52
 liquid petroleum (LP), 136
 point of liquefaction of, 51
 qualities of, 30
gasket seals, symptoms of
 problems with, 305
gasket-tacking machine, 205
gas lines, 323, 411
gas pressure, 159, 323–325
gas regulators, 323–325
gas release, 137, 138
gas shutoff valve, 136
gas valves, electrically operated, 137, 138
gear pumps, 607–609, 610
generator flue, 135, 155–156

generators, 586, 588–590, 592, 595
grouting, 622

H

hair felt, 582
halide torch, 66–67, 74, 196
halocarbons, 111, 331
halogenated refrigerants, 66–67
hand bends, 206–211
hand valves, 522
head-pressure control, 430
heat
 absolute zero of, 21–22
 in absorption-type systems, 132
 as air-change load, 660
 calculating loss of, 472
 in condensation, 52
 conduction of, 41
 convection of, 42
 in display cases, 494–495
 effect on changes of state, 27–29
 and energy, 17, 19, 43
 in evaporation, 52
 latent, 27–31
 radiation of, 43
 and refrigeration loads, 659
 relation to work, 587
 removing from absorbents, 591
 sensible, 25–26
 specific, 23–27
 theory of, 17–19
 transmission of, 40–43
 units of, 22–23
heat conductors, 41
heat energy, 17, 43
heat-engine condensers, 586
heat-exchanger line, 239
heat exchangers
 absorber, 591–592
 in absorption cold generator, 444, 445
 in absorption-type systems, 134
 in capillary system, 122
 for cooling systems, 436–437
 function of, 116
 liquid-to-liquid, 590

Index **723**

- in refrigeration cycle, 116
- replacing, 240
- selection of, 437
- heat extraction, 52–53
- heat gain, preventing in
 - refrigeration lines, 578
- heat insulation, 42–43. *See also* insulation
- heat leakage, 633, 659–662, 671
- heat loss, groups of, 633
- heat of evaporation, 44–46
- heat transfer
 - of brick veneer, 654–655
 - of brick walls, 644–645
 - calculating coefficient of, 659–660
 - calculating rates of, 597
 - of ceilings, 648
 - of cinder block walls, 638–639
 - of concrete floors, 650–653
 - of concrete wall, 634–637
 - of frame ceilings, 656
 - of frame floors, 648, 656
 - of freezer surfaces, 671
 - of hollow tile walls, 640–642
 - of interior walls, 647
 - of limestone wall, 643
 - of masonry partitions, 649
 - of sandstone wall, 643
 - of shingle walls, 646
 - and thermostatic expansion valves, 344
 - of wood-siding clapboard frame, 646
- helical-screw-gear pump, 608, 615
- hermetic compressors, 84, 86–87, 112
 - in domestic refrigerators, 118, 120
 - effect of moisture on, 433
 - electrical requirements for, 291
 - fan motor for, 291, 292
 - temperature-control in, 291–297
- hertz (Hz), 370
- high-pressure cutout switch, 362–363
- high-pressure gage, 179
- high-pressure side, 77, 118, 119, 129, 418
- high-temperature-short-time method, 545
- hinges, 281, 283, 287
- holdover tank, 50, 447
- hollow tile wall, 640–642
- horizontal freezer, 289, 290
- horsepower (hp), 15–16, 368, 563
- hot-gas defrosting, 400
- hot-gas header, 571
- hot-gas lines, 568
- hot-gas loop, 568, 571–572
- hot-water defrosting, 256
- household freezers
 - capillary-tube system in, 290–291
 - causes of noisy operation of, 307
 - compressors in, 289–290, 295–296
 - condensers in, 290
 - cycle of operation in, 289–290
 - electrical system in, 291–297
 - functioning in low exterior temperatures, 332
 - heat-transfer coefficient for surface of, 671
 - load calculations for, 670–671
 - signal lights in, 293–295
 - temperature control in, 289, 291–297, 307–308
 - thermostats for, 291–292, 293, 294
 - troubleshooting guide for, 302–307
 - upright, 297–302
- humid plate, 116
- hydrogen, 8
 - in absorption-type systems, 132, 133, 134
- I**
- ice
 - artificial forms of, 459
 - British thermal unit (Btu) absorbed by, 34
 - changing state of, 28

724 Index

- ice (*continued*)
 - dry, 469–470
 - freezing tanks for, 462–463
 - inferior, 462
 - plugging expansion valves, 413
 - as refrigeration medium, 417
 - removing from compressors, 337
 - specific heat of, 28
 - storage of, 473
 - for testing thermostatic expansion valves, 350–351
 - using as refrigerant, 33–34
 - ice blocks, 219–220
 - ice cans, 460–466
 - ice cream, refrigeration of, 535–540
 - ice dispenser, 271
 - ice ejector, 478
 - ice maker, 269, 271, 468–469
 - ice-making systems
 - air piping for, 459–460
 - automatic, 468–469
 - calculating capacity of, 471–472
 - calculating freezing time of, 472–473
 - calculating heat losses in, 472
 - for can ice, 459
 - for dry ice, 469–471
 - for household use (*see* domestic icemakers)
 - for plate ice, 459, 466–468
 - ice stripper, 477, 478
 - immediate cooling agents, 57, 58
 - impellers, 616
 - in-and-out adjustments, 284, 286
 - indirect expansion system, 49–50
 - indirect refrigeration systems, 447
 - inert-gas method, 215–216
 - input controls, 136–138
 - inspection mirrors, 199
 - installations
 - of absorption-system refrigerators, 320–325
 - of compressors, 570–575, 622–624
 - of cooling water lines, 322–323
 - of display cases, 498–500
 - of drain lines, 323
 - of driers, 221
 - of gas lines, 144–147, 323
 - of gas regulators, 323–325
 - of refrigeration equipment, 619–629
 - of water supply lines, 481–483
 - insulation
 - classes of, 517
 - for concrete ceiling, 519
 - desirable properties of, 577
 - of locker plants, 516–517
 - for masonry walls, 518
 - materials for, 43, 517, 578–579
 - for refrigeration piping, 577–582
 - selecting thickness of, 577–578
 - interior walls, heat-transfer coefficient of, 647
 - iron oxide, removing, 336
 - iron plates, 622
 - isothermal change, 11
- K**
- Kelvinator refrigerator, 476–477, 484
 - Kelvin scale, 14, 15
 - kilowatts (kW), 368
 - kinetic energy, 376
 - knocks, 96
- L**
- lagging power factor, 371
 - lamp switch, 267, 268, 269
 - latches, replacing, 282, 283
 - latch tongue, 283–284, 286–287
 - latent heat
 - and change of state, 27–29
 - defined, 29
 - of evaporation, 30–31, 32, 71–72
 - of fusion, 29
 - illustration of, 27
 - in refrigerants, 32, 57, 58
 - law of conservation of energy, 50
 - law of conservation of matter, 50
 - leading power factor, 371
 - leak detectors, 624, 625

- leaks
 - detection of, 66–67, 74, 195, 224, 320
 - in shaft seals, 94
 - testing (*see* leak tests)
 - using mirrors for observing, 199
 - leak-testing joints, 197–198
 - leak tests, 195–198
 - for commercial refrigeration systems, 439
 - and heat-exchanger replacements, 240
 - for refrigerant lines, 624–625
 - for thermostatic expansion valves, 352
 - leveling screws, 622
 - lights, interior arrangement of, 284, 287
 - limestone wall, heat-transfer coefficient (K) for, 643
 - liner heaters, 259
 - liquefaction, 51
 - liquefiable vapors, 58
 - liquid heat exchanger, 590, 597, 601, 605
 - liquid lines
 - causes of frost on, 413
 - causes of heat in, 412–413
 - dehydrators for, 498
 - designing, 565–567
 - insulation for, 578
 - in locker plants, 522
 - pressure drop in, 565
 - for supermarket refrigeration systems, 498
 - liquid petroleum (LP) gas, 136, 138–139, 144–147
 - liquids
 - benefit of refrigeration to, 2
 - and boiling points, 417
 - effect of pressure on, 35–36
 - locker plants
 - accumulators in, 523
 - and air-change loads, 660–661
 - arrangement of equipment in, 519
 - chill room in, 514, 515
 - construction of, 513
 - controls for, 523–524
 - dehydrators in, 523
 - design considerations for, 513–516
 - equipment for, 517–523
 - evaporators in, 518–521
 - floor plan of, 514, 515
 - hand valves in, 522
 - insulation of ceilings in, 519
 - insulation of walls in, 518
 - insulation requirements for, 516–517
 - liquid and suction lines in, 522
 - locker room in, 515, 516
 - measuring refrigeration loads for, 659
 - oil separators in, 523
 - processing room in, 514–516
 - and product cooling loads, 660
 - and product freezing loads, 661
 - quick-freeze room in, 515, 516, 517
 - quick-freezing method in, 549–550
 - refrigeration doors for, 517
 - refrigeration space in, 513–514
 - locker-room plates, 520–523
 - locker rooms, 515, 516
 - low-pressure gage, 179
 - low-pressure side, 118, 119, 129, 418
 - lubricants, 100–102. *See also* oil lubrication
 - of compressor motors, 327–328
 - of compressors, 328–333
 - force-feed, 78, 80
 - methods of, 328–330
 - precautions for use of, 331–333
 - splash system of, 327–328
- M**
- magnetic contactors, 392
 - masonry partitions, 649
 - mass, 5, 6

726 Index

measurements

- absolute pressure, 10
- atmospheric pressure,
9–10
- cubic, 4–5
- density, 5–6
- energy, 16–17
- English system for, 2, 3–5, 7
- of heat, 22–23
- horsepower (hp), 15–16
- mass, 5–6
- metric system for, 3–5, 7
- power, 15
- specific gravity, 6–8, 8
- specific heat, 23–27
- square, 4
- standard for air, 8
- of temperature, 19–21
- with thermometers, 19–21
- volume, 5

meat

- calculating freezing load of,
661
- chilling of fresh-killed, 510
- display cases for, 489–491,
495–496
- effect of radiant heat on,
494–495
- frozen storage of, 509–510
- maintaining display cases for,
497
- packaged, 510–511
- storage temperature for, 555,
556
- wholesale storage of, 509
- mechanical efficiency, 103, 559
- mechanical power, 378
- mechanical refrigeration systems.
See commercial refrigeration
systems
- metal oxides, removing, 336
- metals, in bimetallic thermostat,
398–399
- methyl chloride, 32, 60, 64–65
- methylene chloride, 58, 60
- metric system, 3–5, 7
- microfarad rating, 402

milk

- heat loads of, 666–667
- pasteurization of, 545
- storage of, 669–670
- storage temperature for, 555
- milk coolers, 540–542
- mirrors, for observing leaks, 199
- miscellaneous loads, 661, 664
- moisture
 - and cold-storage insulation, 517
 - in compressors, 335
 - and damage of refrigeration
systems, 43
 - importance of removing, 626
 - in oil, 333–334
 - protecting piping from, 581
 - removing from refrigerants (*see*
dehydrators)
- moisture indicators, 434, 627, 628
- mold heaters, 477
- molecular theory, 17–19
- molecules, 18–19
- motor bearings, 407
- motor controls, 341
- motor-driven compressors,
623–624
- motor protector, 267, 269, 271,
545
- motors
 - alternating-current (*see*
alternating-current (AC)
motors)
 - for circulating pumps, 612–613,
616
 - classifications of, 367
 - for compressors (*see* compressor
motors)
 - effects of reduced voltage
starting on, 385
 - efficiency of, 376–380
 - factors for speed of, 373
 - for fans, 561
 - for icemaker timing gear, 480,
481
 - lubrication of, 101
 - measuring torque of, 378–380
 - mechanical power of, 378

- nameplate data on, 372
 - power factor of, 372
 - pulleys for, 380–382
 - slip of, 373, 383
 - synchronous speed of, 373
 - testing continuity of starting
 - winding of, 227
 - three-phase type, 374
 - transformer connections, 374–375
 - motor-winding relays, 394
 - multiple-stage pumps, 611
 - mutual attraction, 18
- N**
- nitrogen cylinders, 216
- O**
- odors, prevention of, 316
 - off-center ring, 83, 84
 - oil
 - acidity of, 334
 - causes of leakage of, 250–251
 - causes of loss of, 412
 - in compressors, 96–97, 101
 - dielectric strength of, 333–334
 - distribution through crankcase, 96–97
 - excessively heavy, 100
 - excessively light, 100
 - good qualities of, 338
 - and halocarbons, 331
 - levels in compressors, 90
 - for motor bearings, 327
 - pour point of, 337
 - pressure in compressors, 90
 - prevention of moisture in, 333
 - reaction to oxygen exposure, 626
 - and refrigerants, 334
 - for refrigeration systems, 100–102
 - sources of pressure for, 394
 - for splash lubrication systems, 327
 - supplying to reciprocating compressor, 80
 - types of circulation for, 102
 - using combination-gage set for
 - adding, 187–188
 - oil-failure switch, 330–331
 - oil knocks, 96
 - oil-pressure controls, 394–396
 - oil separators, 523
 - oil sludge, 334, 335, 336
 - oil slugging, 412
 - one-door refrigerators, 312
 - open-type compressors, 92
 - belt alignment in, 97–98, 113
 - in domestic refrigerators, 118, 120
 - efficiency test for, 94–96
 - finding leaks in seals of, 94
 - knocks in, 96
 - lubrication of, 96–97
 - removing, 97
 - replacing, 97
 - shaft seal in, 93–94
 - stuck, 96
 - orifice spuds, 139
 - outboard bearings, 624
 - overload protectors, 360–361
 - causes of compressors cycling on, 304–305
 - checking, 303, 402
 - for compressor motors, 392
 - on compressors, 228–229
 - making continuity check on, 228
 - symptoms of problems with, 245, 303
 - overload relays, 392, 407
- P**
- packing keys, 203–204
 - packing strips, 205
 - packing valve, 213
 - partitions, 647, 649
 - pasteurization, 545
 - pasteurizers, cooling milk from, 540–541
 - perfect gas, 10–11
 - performance factor, 103
 - Phasco® rods, 221
 - pinch-off tools, 201–203, 237–238

728 Index

- pipe cutters, 199–200
- piping
 - for compressors, 89
 - connections of, 575–577
 - defective, 147
 - flared joints of, 576
 - for gas lines to absorption-type refrigerators, 145–146
 - hanging lines of, 576–577
 - insulated with cork, 578–579
 - insulated with hair felt, 582
 - insulated with rock cork, 579–580
 - insulated with wool felt, 580–581
 - insulation of, 577–582
 - interconnecting, 572–574
 - leak testing, 624–625
 - for liquid petroleum (LP) gases, 146–147
 - repairing lines of, 577
 - soldered joints in, 575–576
 - steel, 575
 - strainers for, 577
 - for supermarket refrigeration systems, 498
 - symptoms of problems in, 613
 - threaded joints of, 575
- piston rings, 81
- pistons, 112
 - in compressor, 81
 - in hermetic compressor, 86, 87, 120
 - securing wrist pins in, 82
 - symptoms of problems with, 407
- plastered partitions, heat-transfer coefficient of, 647
- plate ice, 466–468
- plate-ice systems, 459, 466–467
- plate-type evaporators, 518, 520–521
- polyphase motors, 382–387
- pop machines, 540
- port plug, 176–177
- positive-displacement pumps, 607–609, 610
- positive working pressure, 77
- post-loop condenser, 124–125
- potential energy, 376
- potential relay, 230
- pounding, 111
- power, 376
 - defined, 15
 - formula for, 15
 - mechanical, 378
 - units of, 15–16
- power factor, 372
- precoolers, 529, 591, 601
- pressure
 - absolute, 10, 54
 - atmospheric, 9–10, 54
 - critical, 52
 - devices for relief of, 213–214
 - effect on boiling point of liquids, 35–36
 - effect on gases, 50–52
 - of fans, 559
 - for operation of refrigerants, 60
- pressure defrosting method, 502–503
- pressure drop, 565
- pressure gages
 - for absolute pressure, 38
 - barometers, 38–39
 - calibrations of, 37
 - combination set of, 178–179, 198–199
 - compound, 179
 - for compressor efficiency tests, 95
 - on condenser, 45
 - construction details of, 38
 - external view of, 38
 - high-pressure, 179
 - importance of, 178–179
 - improper location of, 615
 - low-pressure, 179, 199
 - normal atmospheric pressure on, 38
 - for testing thermostatic expansion valves, 350, 352
- pressure regulators, 136, 137, 138

- pressure stabilizer, 432, 433
- pressure-temperature chart, for refrigerants, 67–68
- pressure water coolers, 528–532
- processing rooms, 514–516
- produce, balancing cooling systems of refrigerators for, 437
- Prony-brake test, 377, 378–379
- propeller fans, 560, 563
- protector motor, 268
- pulleys, 380–382
- pump chamber, 83
- pump housing, 85
- pumps
 - circulating (*see* circulating pumps)
 - for commercial absorption systems, 587
- purging line, 192, 193
- pushbutton-valve gas release, 137, 138
- Q**
- quick-connect terminals, 232–233, 234
- quick-freeze room, 515, 516, 517
- quick freezing, 549–556
- R**
- radiant heat, 494–495
- radiated energy, 43
- radiation, 43
- Rankine scale, 14
- reactive loads, 371
- reactors, 386
- reamers, 211
- recharging cylinder, 221–222
- reciprocating compressors
 - components of, 79
 - connecting rods for, 82
 - controls for, 574–575
 - crankshafts in, 82–83
 - figures of, 78, 79
 - lubrication of, 78, 80, 113
 - piston motion in, 77, 78
 - piston rings in, 81
 - pistons in, 81
 - shaft seal in, 80
 - single-cylinder, 77, 78
 - two-cylinder, 77–78, 79
 - valves in, 83
 - wrist pins for, 82
- reciprocating pumps, 612, 614–615, 616
- rectifier, 132–133
- reflux condenser, heat-transfer rates of, 601
- refrigerant-absorbent solutions
 - absence of solid phase in, 592
 - affinity of, 592–593
 - ammonia-water, 598–601
 - in basic absorption cycle, 589–590
 - calculating flow rates of, 595, 596, 599–600
 - characteristics of, 592–601
 - and corrosion, 593
 - enthalpy of, 596
 - explanation of, 605–606
 - latent heat of, 593
 - operating pressures of, 593
 - safety of, 593
 - solar air-conditioning using, 604, 605
 - stability of, 593
 - viscosity of, 593
 - volatility ratio of, 592
 - water-lithium bromide, 593–597
- refrigerant controls, 341
- refrigerant cylinders, 69–70, 74, 186, 189, 190
- refrigerant lines
 - discharge (*see* discharge lines)
 - hanging, 576–577
 - insulation of, 577–582
 - leak testing, 624–625
 - liquid (*see* liquid lines)
 - pressure drop in, 565
 - repairing, 577
 - suction (*see* suction lines)

730 Index

- refrigerants, 49
- in absorption-type systems, 131–132, 133–134
 - accumulators for, 124
 - ammonia (*see* ammonia)
 - in automatic expansion valve, 343
 - in basic absorption cycle, 589–590
 - in capillary-tube system, 353–354
 - carbon dioxide (*see* carbon dioxide (CO₂))
 - careful handling of, 69
 - causes of frost in, 276
 - changing boiling point of, 418
 - charging, 186, 627, 629
 - charging sealed systems with, 180
 - charging through high side, 189–190
 - charging through low side, 188–189
 - and circulating pumps, 607
 - classes of, 57
 - as cleansing agent, 575
 - in commercial refrigeration systems, 417
 - commercial requirements for, 73
 - compression of, 72
 - in compression systems, 420–421
 - condensation of, 418
 - containers of, 70–71
 - controlling flow of, 53, 364
 - in crankcase oil, 338
 - defined, 72
 - description of, 57
 - desirable properties of, 57–58
 - detecting leakage of, 66–67, 195, 224
 - in direct expansion system, 49
 - displacement per revolution of, 109–110
 - drying out, 175
 - effect of pressure on, 418
 - effect on ozone layer, 59
 - evacuating and recharging, 180–181
 - evacuation of, 181–185
 - flow diagram of, 117, 289
 - flow through upright freezers, 298–300
 - Freon (*see* Freon)
 - and frost accumulation, 276
 - handling cylinders of, 69–70
 - in hermetic compressor, 87
 - high-side pressure of, 77
 - in household freezers, 308
 - ideal type of, 72
 - identifying overcharging with, 224, 225
 - identifying undercharging with, 224–225
 - in indirect expansion system, 49–50
 - influence on length and diameter of capillary tube, 120–121
 - latent heat of vaporization of, 32
 - as liquefiable vapors, 58
 - methyl chloride, 32, 60, 64–65
 - mixed with oil, 334
 - most commonly used, 47
 - net refrigerating effect for, 110
 - operating pressures of, 60
 - overcharging of, 250, 442
 - passage to and from compressor, 112
 - pipng systems for, 498
 - positive working pressure of, 77
 - pressure-temperature chart for, 67–68
 - proper amount for capillary-tube systems, 291
 - protection for working with, 111–112
 - recharging sealed systems with, 221–222
 - in refrigeration cycle, 53, 116
 - removing moisture from (*see* dehydrators)
 - required amount of, 629
 - reversing flow of, 166–167
 - in rotary compressors, 83

- in rotary pumps, 608, 610
- R-12 element of, 627
- R-22 element of, 627
- in servicing valves, 363–364
- subcooling effects of, 436
- substitutes for, 59
- successful piping systems for, 565
- sulfur dioxide (*see* sulfur dioxide (SO₂))
- symptoms of problems with, 246
- symptoms of shortage of, 411
- testing leakage of, 65–66
- troubleshooting guide for, 244
- undercharged, 252, 413, 441
- use of ice as, 33–34
- vaporized, 69
- in water cooler, 527–528, 530
- refrigerant solenoid valve, 332
- refrigerating effect, 110
- refrigeration
 - applications of, 1–2
 - defined, 1, 33
 - direct expansion system of, 49
 - effect of altitude on, 46–49
 - by evaporation, 34
 - indirect expansion system of, 49–50
 - measurements for (*see* measurements)
 - original method of, 1
 - replacing driers in, 239–240
 - significance of, 1–2
 - systems of (*see* refrigeration systems)
 - temperature scales for, 13–14
 - thermoelectric cooling (*see* thermoelectric cooling)
 - types of pressure in, 8–10
 - by vaporization, 47, 49
- refrigeration control devices
 - automatic expansion valves, 341, 342–344
 - calibrating, 236
 - in capillary-tube system, 353–357
 - classes of, 341
 - electrical, 357–362
 - overload protector, 360–361
 - replacing, 235
 - in sealed systems, 341
 - servicing valves, 363–364
 - start relay, 359–360
 - temperature control, 361–363
 - thermostatic expansion valves, 344–353
- refrigeration cycle, 52–53, 115–118, 129
 - in absorption-type systems, 132–135
 - for commercial absorption systems, 585–592
- refrigeration equipment
 - capacity of, 662
 - detecting leaks in, 66–67, 74
 - installation of, 619–629
 - for locker plants, 517–523
 - servicing and repairing, 542–545
 - testing for leaks in, 195–198
 - See also* refrigeration equipment names
 - refrigeration loads
 - calculating heat leakage for, 660–662
 - calculating heat-transfer coefficient for, 659
 - and condensers, 665
 - and cooling surface, 667–668
 - for dairy plants, 666–670
 - measurement of, 659
 - miscellaneous, 661, 664
 - for small freezers, 670–671
 - for storage of milk, 669–670
 - for walk-in refrigerators, 662–665
- refrigeration plants. *See* commercial refrigeration systems; locker plants
- refrigeration service equipment
 - for charging sealed systems, 186
 - combination gage set, 178–179
 - for evacuating and recharging sealed systems, 180–187
 - expansion-valve units, 187–195
 - service valves, 175–178
 - for testing leaks, 195–198

732 Index

- refrigeration service tools
 - for bending, 200–201, 202
 - for flaring, 204–205
 - gasket-tacking machine, 205
 - inspection mirrors, 199
 - packing keys, 203–204
 - pinch-off tools, 201–203
 - pipe cutters, 199–200
 - reseating tools, 209–211
 - test-gage set, 198–199
 - tube cutters, 200, 201
 - valve keys, 203
- refrigeration systems
 - absorption-type (*see* absorption-type refrigeration; commercial absorption systems)
 - building foundations for, 619–622
 - causes of frost in, 276
 - causes of high head pressure in, 411
 - causes of low head pressure in, 411
 - charging, 627, 629
 - circulating pumps in (*see* circulating pumps)
 - cleanup of solids in, 335
 - combination gage set for, 178–179
 - commercial (*see* commercial refrigeration systems)
 - commercial versus domestic, 115
 - compression ratio of, 99–100
 - compression type of, 58
 - connecting capillary tubes to, 357
 - copper tubing for, 211–214
 - cut-in temperature of, 243
 - cycle of operation of, 115–118
 - defrosting, 255–264
 - defrost system components in, 266, 269, 271–276
 - dehydration and evacuation of, 625–627
 - for dispensing ice cream, 535
 - domestic (*see* domestic refrigeration)
 - with dry ice, 470–471
 - electrical tests for, 543–544
 - equipment for servicing (*see* refrigeration service equipment)
 - estimating heat loss of rooms serviced by, 633
 - evacuating air from, 190–192
 - evacuating entire refrigerant charge from, 193–195
 - evaporator cooling fan for, 241–243
 - general installation information for, 619
 - heat-operated, 585–586
 - high-pressure side of, 118, 119, 129
 - importance of, 549
 - importance of gages to, 178–179
 - indirect, 447
 - by latent heat of vaporization of liquids, 71–72
 - leaks in, 543
 - leak-testing new joints in, 197–198
 - low-pressure side of, 118, 119, 129
 - lubricants for, 100–102
 - moisture in, 626
 - moisture indicators for, 627, 628
 - need for defrosting, 235–236
 - overcharged, 224, 225
 - pressurizing, 196
 - principal components of, 115
 - removing oil sludge from, 334–335
 - removing solids from, 336–337
 - replacing compressor in, 237–238
 - replacing condenser in, 241
 - replacing evaporator in, 238–239
 - replacing heat exchanger in, 240
 - sealed (*see* sealed systems)
 - service valves for, 175–178

- silver brazing of tubing and fittings in, 214–216
- solar cooling, 601–605
- solids found in, 335
- for supermarkets (*see* supermarket refrigeration)
- symptoms of overcharging of, 304–305
- symptoms of undercharging of, 305–306
- temperature-control devices, 243, 252
- tools for servicing (*see* refrigeration service tools)
- tubing for, 211–214
- types of bends of tubing in, 206
- types of controls in, 341
- undercharged, 224–225, 252
- upright freezers in, 297–300
- use of Freon-12 in, 61
- refrigerator controls. *See* refrigeration control devices
- refrigerator lamps, 267, 268, 269, 271
- refrigerators
 - absorption-type (*see* absorption-system refrigerators)
 - arrangement of refrigerant tubing in, 223
 - cabinet assembly of, 286
 - causes of frost in, 276
 - causes of
 - improperly-refrigerating, 543
 - causes of non-functioning, 542
 - causes of non-refrigerating, 542–543
 - checking for defective, 234
 - commercial (*see* commercial refrigerators)
 - cycle of operation of, 115–118
 - defrosting, 255–264
 - electrical system of, 284
 - electrical tests for, 543–544
 - energy consumption of, 100
 - evacuating, 181–185
 - gages for, 216
 - importance of maintaining temperature range of, 255
 - installing in supermarkets, 498–500
 - interior arrangement of, 285
 - interior-light arrangement of, 284, 287
 - proper fit of door on, 279–280
 - removing oil sludge from, 334–335
 - removing solids from, 336–337
 - replacement of food liner in, 282, 283
 - replacing doors on, 281–288
 - service valves in, 216
 - servicing and repairing, 542–545
 - during shipment, 325
 - testing tightness of door on, 279–280
 - thermoelectric, 172
 - troubleshooting guide for, 244
 - walk-in, 662–665
 - wiring diagrams for, 266, 267–269, 270–271
- refrig-o-plate, 267
- regulating valve, 433
- relative density, 6
- relay mountings, 410
- relays
 - causes of burnouts of, 409–410
 - for compressor motors, 229–231, 391–392
 - current, 230–231
 - motor-protector, 545
 - motor-winding, 394
 - potential, 230
 - for protection from overloads, 392
 - running time of, 98–99
 - starting, 233–234, 402–403
 - for starting compressor motors, 359–360
 - symptoms of problems with, 244, 245, 303, 408, 409, 410
 - in wiring diagram, 268, 269

734 Index

- remote bubblers, 529–530, 532
 - remote water chillers, 532–535, 536, 537
 - repulsion-start motors, 389–391
 - reseating tools, 209–211
 - resistance, formula for, 368
 - resistors, 386
 - restrictor system, 290–291, 353–354
 - ring-plate valve, 83
 - rock cork, 579–580
 - R-134a, 32, 59
 - rotary compressors, 83–84, 85, 112
 - rotary pumps, 607–609, 610, 614, 615
 - rotors
 - air gap between stator and, 624
 - in hermetic compressor, 86, 87
 - in rotary compressor, 85
 - run capacitors, 409, 410
 - running-time check, 98–99
 - running winding, 228
- S**
- safety valve, for gas burners, 139
 - sandstone wall, heat-transfer coefficient (K) for, 643
 - sealed systems
 - advantages of, 341
 - capillary tubes in, 219–224
 - charging with refrigerants, 180, 186–187
 - defective compressors in, 225–226
 - defined, 341
 - for drinking fountains, 533
 - evacuating and recharging, 180–181
 - evacuation of, 181–185
 - operation of, 219–226
 - overcharged, 224, 225
 - recharging with refrigerants, 221–222
 - restriction of evaporators in, 225
 - undercharged, 224–225
 - sealed-type compressors. *See* hermetic compressors
 - Seebeck effect, 166
 - sensible heat, 25–26, 57
 - service drum, 350, 351–352, 353
 - service loads, 663–664
 - service shutoff valve, 175–177
 - service valves, 97, 175–178
 - servicing valves, 363–364
 - shaded-pole motors, 389, 390
 - shaft seal, 80, 93–94
 - shingle walls, 646
 - shunt-wound DC motors, 612
 - side port, closing, 175–176
 - sideways adjustments, 286
 - sight-glass charging cylinder, 186
 - sight-glass charging cylinder hose, 180, 183–184
 - signal lights, 293–295, 304
 - silver brazing, 214–216
 - single-phase current, 370–373
 - single-phase motors
 - advantages of, 387
 - calculating efficiency of, 377
 - capacitor, 388–389, 390
 - contactors for, 392
 - motor-winding relays in, 394
 - repulsion-start, 389–391
 - shaded-pole, 389, 390
 - split-phase, 388
 - starting torque for, 387–391
 - wiring diagram for, 404
 - slug, 6
 - Smith plate, 466
 - soap-bubble method, 195–196
 - sodium chloride, 456
 - sodium chromate, 453, 454–455
 - sodium dichromate, removing, 456
 - solar cooling, 601–605
 - solder, 214, 215
 - soldered joints, 575–576
 - soldering, 576
 - solenoid valves, 395–396
 - electrical interlock of, 332
 - in locker plants, 523, 524

- for reciprocating compressors, 574
- solution-cooled absorber, 591–592, 606
- solution pump, 587
- specific gravity, 6–8, 9
- specific-gravity hydrometer, 450
- specific heat, 23–27
- splash system, 327–328
- split-phase motors, 388
- spray cooling ponds, 424–425
- squirrel-cage motors, 382–383, 385–387, 392
- star-delta starting, 386–387
- starters, 391–392
- starting capacitors, 401–402, 408, 409, 410
- starting relay, 233–234, 402–403
- starting switches, 388
- starting winding, 227
- start relay, 359–360
- static efficiency, of fans, 559
- stators
 - air gap between rotor and, 624
 - in hermetic compressor, 86, 87
 - in repulsion-start motors, 389–390
 - symptoms of problems with, 409
- steam, 30–31
- steam pumps, 612
- steel pipe, 575
- straight-time defrosting method, 502
- strainers, 577
- stroke, 77
- stuck compressors, 96
- suction chamber, 86
- suction header, 570
- suction lines
 - causes of sweating in, 412
 - check valves for, 524
 - and compressor replacements, 237
 - dehydrators for, 498
 - and evaporator replacements, 238–239
 - and heat-exchanger replacements, 240
 - interconnection of, 567–568
 - in locker plants, 522
 - at parallel compressors, 570
 - pressure drop in, 565
 - in refrigeration cycle, 117
 - for supermarket refrigeration systems, 498
 - symptoms of air leaks in, 613, 614
 - symptoms of obstruction in, 614
- suction manifold, 85
- suction strainer, 90–91
- suction temperature, 629
- suction valves
 - in hermetic compressor, 87
 - repairing, 95
 - symptoms of leaks in, 442
 - symptoms of problems with, 411
 - on vacuum pump, 182
- sugar packing, 550–551
- sulfur dioxide (SO₂), 32–33, 63–64
 - back pressure for charging with, 189
 - detecting leaks of, 67
 - health risks from, 69
 - odor of, 73
 - operating pressures of, 60
 - properties of, 58
 - using in refrigeration systems, 71–72
- supermarket refrigeration
 - air circulation in, 499–500
 - coil arrangement in, 496
 - combined systems for, 500, 501–502
 - for dairy products, 493
 - defrosting units of, 502–504
 - display cases for (*see* display cases)
 - food-protection alarm system for, 500, 502
 - for fresh produce, 493
 - frozen-meat storage, 509–510
 - installation of, 498–500

736 Index

supermarket refrigeration

(*continued*)

meat-display counters, 489–491
mechanical centers for, 500, 501
of packaged meat, 510–511
and radiant heat transfer,
494–495

with walk-in coolers, 505–509
wholesale storage in, 509

sweating, 315, 317, 508–509

synchronous motors, 384–387

system compressor, 180

T

Tecumseh compressors, 231–232

tee valve, 198, 199

tee wrench, 203

temperature

calculating heat energy needed to
change, 24–25

critical, 52

dry-bulb, 46

effect on changes of state, 27–29
and heat, 19

normal internal temperature of
humans, 34

refrigerant pressure versus, 48
relation to atmospheric pressure,
37–40

wet-bulb, 46

temperature controls

bimetallic thermostats, 398–399

calibrating, 236

in commercial refrigerators,
361–362

for cooling towers, 428–430

description of, 361

for display cases, 499

in household freezers, 291–297,
307–308

location of, 361

for locker plants, 523–524

operation of, 397–398

and operation of compressor,
295–296

and signal light, 293–294

by suction pressure, 362–363

thermostatic control switches,
396–397, 528, 538, 544

temperature defrosting method,
503

temperature scales, 13–15

templates, 620–622

terminal board, 267, 268, 269,
271

terminals, 231–234

termination thermostats, 503–504

test gage set, 178–179, 198–199

testing manifold, 178–179

test lamps, 264–265

thermal energy, 606

thermocouples, 165–166, 172

thermoelectric cooling

advancements in, 172–173

advantages of, 167, 173

applications of, 166–172

capacity control in, 167

in commercial and appliance
refrigeration, 168, 171–172

couples for, 165–166

disadvantages of, 167–168

expansion and contraction of
materials for, 168

U.S. government sponsorship of,
168

thermoelectric couples, 165–166

thermometers, 19–21

thermostatic control switches

for ice cream cabinets, 538

parts of, 396–397

testing, 544

for water cooler, 528

See also temperature controls

thermostatic expansion valves

construction of, 344

external equalizer application of,
384–349

figure of, 345

functioning of, 344

location of, 350

multiple-valve applications of,
348–349

operation of, 346–350

power element bulb of, 344

Index **737**

- selecting, 346, 349
- sizes of, 349
- sizing of, 349–350
- testing, 350–353
- working principles of, 347
- thermostats
 - for absorption-system refrigerators, 141–142
 - bimetallic, 398–399
 - cut-in point of, 292
 - by Cutler-Hammer, 294
 - cutout point of, 292
 - for defrosting (*see* defrost thermostats)
 - for domestic icemakers, 479
 - energy conservation with, 125, 128–129
 - as gas-control device, 139–141
 - by G.E., 293
 - in hermetic compressor, 86, 226
 - for household freezers, 291–292, 293, 294
 - in icemaker, 486
 - and liner heaters, 259
 - by Ranco, 293
 - for reciprocating compressors, 574
 - and solenoid valves, 395
 - symptoms of problems with, 158, 160, 244, 246, 247, 249
 - terminal-type, 503–504
 - thermostat valve, 147–148
 - three-phase current, 370–373, 374
 - three-phase motors, 405
 - thrust plate, 85
 - tight compressors, 96
 - tile walls, 640–642
 - timer motor, 260–261
 - ton of refrigeration, 34
 - torque, measuring, 378–380
 - TP controls, 503
 - transformers, 374–375
 - tube cooler, 541
 - tube cutters, 200, 201
 - tubing
 - bending by hand, 205–211
 - clearing refrigerant vapor from, 216
 - flaring, 204–205
 - in horizontal freezer, 290
 - ice blocks in, 219–220
 - purging copper oxide from, 215–216
 - turbine pumps, 611
 - turbulators, 138–139
 - two-cylinder compressors, 109, 329–330, 338
 - two-door refrigerators, 312
 - two-phase motors, 404
 - two-way valves, 175–176
- U**
 - universal indicator solution, 453–454
 - upright freezers, 298–302
 - usage loads, 663–664
- V**
 - vacuum, 39–40, 42–43
 - vacuum pumps, 180, 181, 182, 184–185
 - importance of, 627
 - for new commercial refrigeration systems, 439
 - for removing freeze-ups, 220
 - valve cap, 176–177
 - valve keys, 203
 - valves
 - bellows, 213
 - in compressors, 91
 - evaporator-line service, 177–178
 - expansion (*see* expansion valves)
 - forms of, 211–213
 - packing, 213
 - in reciprocating compressors, 83
 - ring-plate, 83
 - safety devices for, 213–214
 - service shutoff, 175–177
 - in test gage set, 178
 - vapor compression cooling, 165
 - vaporized refrigerants, 69, 417
 - vapor seal, 159, 161
 - vat cooling, 540

738 Index

- vegetables
 - blanching, 550
 - coolers for, 438
 - preparing for quick freezing, 552–554
 - quick freezing of, 549–550
 - storage temperatures for, 554–556
 - volt-ohmmeters, 226–228, 265–266, 274–275
 - volts, formula for, 368
 - volume, 5, 6–8
 - volumetric efficiency, 103
- W**
- walk-in coolers, 505–509
 - walk-in refrigerators, 662–665
 - walls
 - brick, 644–645
 - brick veneer, 654–655
 - cinder block, 638–639
 - concrete, 634–637
 - hollow tile, 640–642
 - interior, 647
 - limestone, 643
 - masonry partitions, 649
 - sandstone, 643
 - shingle, 646
 - water
 - in centrifugal pump, 610
 - condensated, 44–46
 - for cooling commercial refrigeration systems, 424–430
 - effect of pressure on boiling point of, 35–36
 - effect of reduced pressure on, 39–40
 - filling icemakers with, 484–485
 - maintaining space between, 509
 - needed for cooling milk, 666–667
 - precoolers for, 529
 - raising temperature from melting point to boiling point, 30
 - specific heats of, 24, 25
 - volume of, 6–8
 - weight of, 6–8
 - wholesale storage in, 509
 - water chillers, 532–535, 536, 537
 - water-cooled condensers, 430
 - water-cooled refrigerators, 313, 321–322
 - water coolers
 - bottle-type, 527–528, 531
 - cycle of operation for, 531–532
 - drain lines for, 531
 - in drinking fountains, 532–535, 536, 537
 - location of, 529
 - plumbing connections for, 530–531
 - precoolers for, 529
 - pressure-type, 528–532
 - remote bubblers in, 529–530
 - remote water chillers, 532–535, 536, 537
 - water-cooling towers, 425–428
 - water fountains, 532–535, 536, 537
 - water-lithium bromide, 593–597, 604, 605
 - water-regulating valves, 431, 478, 569–570
 - water supply lines, 481–483
 - wattless power, 372
 - watts, formula for, 367, 368
 - wax separation, 334
 - welding, of steel pipe, 575
 - wet-bulb temperature, 46, 47
 - wines, storage temperature for, 556
 - wire drawing, 626
 - wood-siding clapboard frame, 646
 - wool felt, 580–581
 - work, 587
 - wound-rotor motors, 383–384, 385–387
 - wrist pins, 82
 - wye transformer, 375
- Z**
- zinc-finished plates, 520