Moisture (*continued*)
load, 198, 607
loss per person, 67, 198
movement in materials, 128
permeability, 130
regain, 687
transmission, 128, 607
Mol, 4
Molecular force of water, 128

Motor, motors, 163, 197, 639
alternating current, 641
capacitor type, 644
classification, 642, 643, 649
control, 646, 648
control equipment for, 646
current limitation, 646, 647
design limits, 640
drives, 639
electric, 639
enclosures, 649
glossary, 648
heat generated by, 163, 197
hermetically enclosed, 645
increment limitation, 646, 647
multispeed, 644
polyphase, 641
rating, 648
repulsion induction, 645
selection, 639
single phase, 644, 647
speed characteristics, 640
speed classification, 650
speed ranges, 640
split phase, 645
squirrel cage, 641, 646
starting methods, 646
synchronous, 642, 644, 646
wound rotor, 641, 647
Mountings, flexible, 352

N

Natural draft, 515
towers, 587
Natural ventilation, 143
general rules, 146
heat removal, 144

Noise, noises, 335, 653
absorptive material, 345
air-conditioning system, 335, 653
air supply opening, 343
apparatus for measuring, 336, 636
attenuation, 336
control, 335, 337
controlling vibration, 352
cross transmission between rooms, 352
design room level, 347
duct sound absorbers, 344–347
duct system attenuation, 344
fans, 339
general problem, 336
grille, 343
intakes, 279
kinds of, 339
levels, 274, 339–341
loudness, 336
measurement, 336, 636
plate cells, 346
plenum absorption, 346
recommended levels, 340, 341
through building construction, 339, 352
transmitted through ducts, 339, 352
unit of measurement, 335, 336
Nozzle flow, 39, 40

Nurseries for premature infants, 88
air-conditioning equipment, 88
air-conditioning requirements, 88

O

Odors, 61, 76, 91
human body, 61

Oil burners, 487, 490
atomizing, 488, 491
boiler settings, 490
classification, 488, 491
combustion adjustments, 490
combustion efficiency, 490
combustion process, 489
commercial, 490
controls, 499
domestic, 487
furnace design, 490
gun type, 488
industrial, 490
measurement of efficiency of combustion, 490
mechanical draft, 488
operating requirements, 489
rotary type, 488, 491
vaporizing type, 489

Oil fuel, 471
analysis, 472
calorific value, 473
classification of, 471, 472
combustion index, 473
combustion of, 473, 489
estimating consumption, 498, 537
heating of, 491
piping, 493
storage, 491, 493
Oil storage tanks, 493

One-pipe system, 356, 398
gravity air-vent, 356, 357
hot water, 4, 398
steam, 4, 356
supply riser, 4
unit heater connection, 356
vapor, 357

Opening, openings
air supply noises, 343
sealing of, 143
stacks, 146
types of, 145
doors, 145
roof ventilators, 145
skylights, 145
vertical, 143
windows, 145

Operating rooms, 86
conditions, 87
reducing explosion hazard, 86
sterilization of air in, 88
Orifice
discharge, 39, 361
flow, 39
formulas, 40, 631
heating systems, 360
Orsat apparatus, 635
Outdoor air, 61, 62, 176, 196, 663, 664

Outlet, outlets
air noises, 343
ceiling, 275
duct approaches, 277
location, 237, 276, 277
perforated, 275, 276
performance, 273, 277
selection, 276
side outlets, 237
slotted, 275
sound absorbers, 346
types, 237, 275
vaned, 275

Outlet, outlets (*continued*)
wall outlets, 275
Overhead distribution, 355, 391, 758
Overhead system, 4, 355, 391, 758
Owen jet dust collector, 75
Oxygen
chambers, 91
tents, 90
therapy, 90
Ozone, 62, 78

P

Panel heating, 4, 419
application methods, 419
calculation principles, 421–424
control, 432
convection transfer, 422
design of panel, 424–432
electric, 233, 234, 421, 432
embedded piping, 419, 420
hot water, 419, 425
installation, 432
output from surface, 419, 421
piping, 419
radiation transfer, 421
starting system, 420
steam, 419
warm air, 4, 254, 421, 432
Panel radiator, 4
Particle size chart, 74
Perfect *gas relationships, 15*
Perforated ceilings, 276
Perforated outlets, 275, 276
Perm, 4
Permeability, 4, 129, 131
Permeance, 4, 129–131
pH value, 509, 733, 736, 737
Physical impurities in air, 62

Physiological principles, 61
acclimatization, 64
application to problems, 66
comfort chart, 70
effective temperature, 66
high temperature hazards, 64
thermal interchanges, 62
upper limits of heat, 65
Pipe coils, 207, 209, 671
heat emission, 209, 455–457
wall, 209

Pipe, piping, 435
application, 451, 452
breeching, 508
capacity, 209, 364–370, 395, 415, 749–751
coatings, 744
coil connections, 380
coil output, 209
cold water, 747
color identification, 12
commercial dimensions, 435–439
conduits for, 385
connection to heating units, 380
cooling tower, 753
corrosion, 733, 739
covering, 453
design, hot water system, 391
dimensions, 435–439
economical thickness insulation, 459
expansion, 444–448
fittings, 439–450
fitting equivalent, 363, 396, 397, 416, 752, 753
flexibility, 444–448
forced circulation, 391
freezing, 463
friction loss, 393, 394, 396, 415, 749–751
gas, 496, 497
hangers, 448

Pipe, piping (*continued*)
heat losses, 455–459
hot water heating systems, 391, 412, 414
hot water supply, 759
inside dimensions, 436–438
insulation, 388, 453
insulation to prevent freezing, 463
low temperature insulation, 463
materials, 435, 743
one-pipe forced circulation, 398
one-pipe gravity, 367
one-pipe vapor, 370
overhead distribution, 355, 391, 758
pressure loss, 36, 38
properties, 435–439, 450
refrigerant, 558, 559
sizes, 363, 393, 414
cooling systems, 753
forced circulation, 393–401
gas, 496
high pressure steam, 364–369
high temperature water, 414, 415
hot water forced circulation, 393–401
indirect heating units, 371
low pressure, 364–367
one-pipe riser, 366, 370
one-pipe vapor, 366
orifice systems, 360, 361
pressure drop, 362, 363
tables for steam, 365–367
threading data, 437, 439
two-pipe forced circulation, 397
two-pipe low pressure, 370
two-pipe riser, 366
two-pipe vapor systems, 371
vacuum systems, 371
water supply systems, 747, 749–751
steam distribution, 361–371, 385
steam heating systems, 361–371
supports, 448
surface, 435–439
symbols for drawings, 9
tar, 506
threading practice, 437
tunnels, 387
underground insulations, 465
unit heater connections, 220, 221, 356, 382
water supply, 747
welding, 443
wrought-iron, 435
wrought-steel, 435
Pitot tubes, 44, 630
Plate cell, 346
Plenum absorbers, 346
Plenum chambers, 4
Pneumatic control systems, 609
Pollen, atmospheric, 81

Pollution of air, 73, 75
Polyphase motors, 641
Ponds, 580
Potentiometer, 4, 628
Power, 4
Precipitators, 332
Precooling, 265
Premature infant nurseries, 88

Pressure
absolute, 4
atmospheric, 1
changes in ducts, 283, 291
dynamic, 4
gages, 4, 629
loss, elbows, 249, 290, 363, 396, 416, 752
loss, water supply piping, 749–751
measurement, 629
barometer, 629
regulators, 371

Pressure (*continued*)
saturation, 4
static, 4
taps, 43
total, 4
vapor, 4
velocity, 4
Prime surface (see *Heating surface*), 5
Process and product air conditioning, 681
calculations, 690
conditioning and drying, 689
control of chemical reactions, 689
general requirements, 681
humidities, 681–687
laboratories, 690
machining tolerance, 689
moisture content and regain, 687
polished surfaces, 689
process, 681
temperatures, 681–687
Propeller fan, 303, 306, 311
Protective coatings, 744
Psychrometer, 4, 633
Psychrometric chart, 17, 27–32, 68
Psychrometry, 4

Pump, pumps
condensate return, 375
high temperature, 414
mechanical circulators, 402, 414
vacuum heating, 375
controls, 376
piston displacement, 376
Pyrometer, 4, 629
optical, 629
radiation, 629

R

Radial flow fan, 303
Radiant drying, 721

Radiant heating, (see *Panel heating*)
Radiation, 4, 47
baseboard, 208
equation, 48
finned tube, 209
load, 506
ratings, 210
shape factor, 52
thermal, 4

Radiator, radiators, 4, 207–209
baseboard, 208
codes, 207, 210, 760, 761
concealed, 4, 211
connections, 381
correction factor, 211
direct, 5
effect of paint, 211
enclosed, 211
heat emission of, 207
output of, 207
panel, 4
ratings, 210
recessed, 5, 209
tube, 5, 208
types of, 207
Radioactive contaminants, 81

Railway air conditioning, 663
air cleaning, 664
air distribution, 664
heating, 663
humidity control, 664
refrigeration, 663
summer systems, 663
temperature control, 664
ventilation, 664
winter systems, 663
Reciprocating compressors, 554

Recording equipment, 612
Rectangular duct equivalents, 287–289
Reducing valves, 371
Reflective insulation, 98, 100

Refrigerant, refrigerants, 5, 543
dichlorodifluoromethane, 542–544
feeds, 315
monochlorodifluoromethane, 542, 543, 546
pipe size, 558, 559
trichloromonofluoromethane, 543, 548
water, 551

Refrigeration, 541, 663, 665
absorption system, 552
accessories, 560
air cycle, 551
basic concepts, 541
complex cycles, 550
compressors, 554–556
condensers (see *Condensers*), 556
control, 554, 556, 558
coolers, 557
definitions, 541
discharge pressure, 549
equipment selection, 560
evaporators, 557
expansion valves, 557
float valves, 558
heat pump, 563–578
load, 167
mechanical, 541, 550, 665, 669
piping, 558, 559
reverse cycle, 541, 563
ship, 669
simple cycle, 543
steam jet, 551
subcooling, 550
suction, 548
superheating, 550
symbols for drawing, 9
theory, 541
ton of, 5, 541
types of compressors (see *Compressors*), 554, 555
vapor compression cycle, 543
water jacket, 549

Regain, 687
control of, 687
hygroscopic materials, 688
static, 294

Register, registers, (see *Grilles*) 237, 267, 275, 279, 343
air noises, 343
mechanical furnace systems, 237
noises, 274, 279, 343
selection, 237, 276
Regulator, 489, 490
Reheat, 259, 265
Relative humidity, 3, 14, 27, 133
measurement of, 633
Relief valve, 408, 760

Residence
control systems, 625
air conditioning, 625, 653
domestic hot water supply, 759
heating, 625
cooling methods, 258, 651
gravity furnace systems, 258, 509
heat loss problems, 163
hot water heating system, 391
mechanical furnace system, 237
steam heating system, 355

Residential air conditioning, 651
air distribution, 654
application, 652