

MINING ENGINEERS' HANDBOOK

WRITTEN BY A STAFF OF FORTY-SIX SPECIALISTS
UNDER THE EDITORSHIP OF

ROBERT PEELE

PROFESSOR EMERITUS OF MINING ENGINEERING IN
THE SCHOOL OF MINES, COLUMBIA UNIVERSITY

WITH THE COLLABORATION OF

JOHN A. CHURCH

MINING AND METALLURGICAL ENGINEER

THIRD EDITION

IN TWO VOLUMES

VOL. I



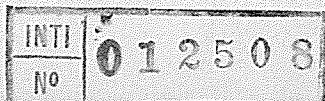
2767

NEW YORK

JOHN WILEY & SONS, INC.

LONDON: CHAPMAN & HALL, LIMITED

1941



2467

VOL. I
INDEX OF SECTIONS
for Ready Reference

SECTION	PAGES
1. MINERALOGY	1- 53
2. GEOLOGY AND MINERAL DEPOSITS.....	1- 34
3. EARTH EXCAVATION.....	1- 19
4. EXPLOSIVES.....	1- 32
5. ROCK EXCAVATION.....	1- 29
6. TUNNELING.....	1- 29
7. SHAFT SINKING IN ROCK.....	1- 33
8. SHAFT SINKING IN UNSTABLE AND WATERBEARING GROUND.....	1- 25
9. BORING.....	1- 71
10. PROSPECTING, DEVELOPMENT AND EXPLOITATION OF MINERAL DEPOSITS.....	1-640
10-A. GEOPHYSICAL PROSPECTING.....	1- 42
11. UNDERGROUND TRANSPORT.....	1- 47
12. HOISTING PLANT, SHAFT POCKETS AND ORE BINS...	1-136
13. DRAINAGE OF MINES.....	1- 21
14. MINE VENTILATION.....	1- 66
INDEX.....	1- 63

For List of Subjects for Vol. II, see inside of back cover.

TABLE OF CONTENTS FOR VOLUME I

Detailed tables of contents are given at the beginning of each section. An alphabetical index appears following Section 14.

SECTION 1. MINERALOGY		SECTION 9. BORING	
	PAGE		PAGE
Identification of Minerals.....	02- 10	Shallow Work: Augers, Spring-pole, Empire Drill, Etc.....	02- 09
Occurrence and Association of Minerals.....	10- 11	Oil-well Drilling, Casing, Sampling; Directional Drilling; Costs.....	09- 40
Uses and Products of Minerals.....	12- 14	Churn Drilling for Prospecting; for Blasting.....	41- 44
Descriptive and Determinative Tables.....	16- 52	Diamond-drilling Equipment, Methods, Costs.....	44- 61
SECTION 2. GEOLOGY AND MINERAL DEPOSITS		Shot or Calyx Drilling.....	61- 63
Geology: Rocks, Composition and Occurrence.....	02- 17	Surveying of Boreholes; Choice of Boring Method.....	63- 69
Mineral Deposits, Metalliferous.....	18- 27	SECTION 10. PROSPECTING, DEVELOPMENT, AND EXPLOITATION OF MINERAL DEPOSITS	
Mineral Deposits, Non-metallic.....	28- 32	Definitions; Surface Prospecting.....	02- 33
SECTION 3. EARTH EXCAVATION		Exploration by Boring; Sampling and Estimating.....	34- 75
Economics, Physics, Mechanics.....	02- 04	Exploration by Shafts, Tunnels, Etc; Equipment.....	76- 80
Excavating Equipment and Methods.....	05- 17	Development: Entry, Drifts and Cross-cuts, Raises, Winzes.....	81-123
Embankments and Dams.....	18	Exploitation: Classification of Methods; Breaking Ground.....	123-132
SECTION 4. EXPLOSIVES		Open Stopes: Gophering, Breasting, Room-and-pillar, Under- and Over-hand, Sub-level Methods.....	132-197
Chemistry and Composition.....	02- 09	Square-set Stopping; Mitchell and other Systems; Timber Preservation	197-236
Transport, Storage, Handling.....	10- 18	Filled Stopes, Horizontal, Inclined; Resuing; Crosscut Method.....	237-274
Charging and Firing; Blasting Supplies.....	19- 31	Shrinkage Stopes.....	274-297
SECTION 5. ROCK EXCAVATION		Caving Methods: Top-slicing; Sub-level Caving; Block-caving.....	297-371
Rock Characteristics.....	02- 03	Combined Methods: Boston Con, Ray, Miami, DeBeers, Etc.....	371-398
Drill Bits; Hand and Machine Drilling.....	03- 11	Mining through Boreholes; Leaching Ore in Place; Chutes and Gates; Mechanical Handling; Sand Filling; Choice of Mining Method.....	398-430
Blasting; Charging and Firing.....	11- 21	Open-cut Mining, Hand- and Machine loading; Glory-holing; Coal Strip-ping.....	430-472
Loading by Hand and Machine.....	21- 23	Coal Mining: Room-and-pillar; Robbing Pillars; Longwall.....	472-519
Quarrying; Open-cutting; Trenching.....	23- 28	Ground Movement and Subsidence... Placer and Hydraulic Mining; Sluices and Riffles; Elevators; Dredges and Dredging; Drift Mining; Thawing..	519-533
SECTION 6. TUNNELING		Mining Alluvial Tin in Malaya.....	619-629
Examples and Organization.....	02- 06	SECTION 10-A. GEOPHYSICAL PROSPECTING	
Plant and Equipment.....	06- 03	Gravimetric, Magnetic, and Electrical Methods.....	02- 21
Drilling, Blasting, Mucking, Tramming.....	08- 20	Seismic Prospecting.....	21- 26
Ventilating, Timbering; Work in Loose Ground.....	20- 26	Temperature, Radioactivity, and Micro-gas Surveys; Choice of Method.....	26- 29
Costs.....	26- 28	SECTION 7. SHAFT SINKING IN ROCK	
SECTION 7. SHAFT SINKING IN ROCK		Shape and Size of Shafts.....	02- 03
Plant and Organization.....	03- 06	Plant and Organization.....	03- 06
Drilling, Blasting, Mucking, Ventilating.....	06- 11	Drilling, Blasting, Mucking, Ventilating.....	06- 11
Working Shafts; Raising of Shafts....	11- 12	Wall Support: Timber, Steel, Concrete, Etc.....	12- 22
Kind-Chaudron Method.....	22- 23	Kind-Chaudron Method.....	22- 23
Speed and Costs.....	23- 32	Speed and Costs.....	23- 32
SECTION 8. SHAFT SINKING IN UNSTABLE AND WATERBEARING GROUND		SECTION 8. SHAFT SINKING IN UNSTABLE AND WATERBEARING GROUND	
Expedients; Piling.....	02- 06	Expedients; Piling.....	02- 06
Drop-shafts; Pneumatic; Honigmann.....	06- 20	Drop-shafts; Pneumatic; Honigmann.....	06- 20
Freezing; Cementation and Grouting.....	20- 24	Freezing; Cementation and Grouting.....	20- 24

	PAGE		PAGE
Physical Properties of Rocks and Minerals.....	30-41	Guides and Tracks; Signal Systems....	82-91
SECTION 11. UNDERGROUND TRANSPORT		Buckets, Cages, Skips: Design and Construction; Overwinding.....	91-119
General Considerations; Primitive Methods.....	02-03	Shaft Pockets.....	119-125
Mine Cars, Track, Dumps.....	03-32	Ore Bins: Design and Construction... ..	126-135
Hand Tramping; Animal Haulage....	32-35	SECTION 13. DRAINAGE OF MINES	
Locomotive Haulage.....	35-41	Sources and Control of Mine Water; Prevention.....	02-04
Rope and Miscellaneous Haulage; Costs; Accidents.....	41-46	Sumps, Dams, Tunnels, Siphons; Hoisting of Water.....	04-11
SECTION 12. HOISTING PLANT, SHAFT POCKETS, AND ORE BINS		Mine Pumps: Steam, Comp-air, Air-lift, Electric.....	11-21
Hoisting Systems; Drums, Brakes and Clutches; Sheaves.....	02-18	SECTION 14. MINE VENTILATION	
Hoisting Ropes: Vegetable-fiber; Wire Hoisting Cycles: Cylindrical, Conical, Cylindro-conical Drums.....	19-29	Mine Atmosphere; Ventilating Systems.....	02-07
Hoists, Types and Calculations: Electric, Steam, Comp-air, Etc.....	29-40	Air Distribution; Velocity and Control Auxiliary Ventilation; Leakage; Effect of Mining Method.....	07-14
Windlass and Whim.....	42-56	Measurements; Air Flow; Mine Resistance.....	14-21
Hoisting in Deep Shafts; Examples and Costs.....	57-58	Ventilating Methods and Equipment: Natural; Mechanical.....	21-34
Headframes: Designs in Wood, Steel, and Concrete.....	58-60	Mine Fans: Characteristics, Applications, Selection.....	34-44
	61-82	Cooling and Air Conditioning.....	44-54
			54-64

For contents of other handbooks of this series, see pages following Index of this volume.

2468

VOL. II

INDEX OF SECTIONS

for Ready Reference

SECTION	PAGES
15. COMPRESSED AIR PRACTICE.....	1-56
16. ELECTRIC POWER FOR MINE SERVICE.....	1-31
17. SURVEYING.....	1-63
18. UNDERGROUND SURVEYING.....	1-27
19. MINE GEOLOGIC MAPS AND MODELS.....	1-12
20. MINE ORGANIZATION AND ACCOUNTS.....	1-12
21. COST OF MINING.....	1-41
22. WAGES AND WELFARE.....	1-36
23. MINE AIR, GASES, DUSTS, HYGIENE, EXPLOSIONS, AND ACCIDENTS.....	1-72
24. MINING LAWS.....	1-40
25. MINE EXAMINATIONS, VALUATIONS, AND REPORTS.....	1-33
26. AERIAL TRAMWAYS AND CABLEWAYS.....	1-51
27. UNDERGROUND MECHANICAL LOADING, CONVEYING, AND HANDLING.....	1-37
28. BREAKING, CRUSHING, AND SORTING OF ORES.....	1-19
29. ORE SAMPLING.....	1-17
30. ASSAYING.....	1-21
31. TESTING OF ORES.....	1-22
32. SELLING, PURCHASING, AND TREATMENT OF ORES.....	1-19
33. GOLD AMALGAMATION AND CYANIDATION.....	1-31
34. PREPARATION AND STORAGE OF ANTHRACITE COAL....	1-32
35. PREPARATION AND COKING OF BITUMINOUS COAL.....	1-39
36. MATHEMATICS AND MECHANICS.....	1-60
37. CHEMICAL AND PHYSICAL NOTES AND TABLES.....	1- 8
38. ELEMENTS OF HYDRAULICS.....	1-34
39. ENGINEERING THERMODYNAMICS.....	1-44
40. POWER AND POWER MACHINERY.....	1-46
41. MECHANICAL ENGINEERING MISCELLANY.....	1-22
42. ELECTRICAL ENGINEERING.....	1-38
43. ELEMENTS OF STRUCTURAL DESIGN.....	1-53
44. PETROLEUM PRODUCTION METHODS.....	1-27
45. ENGINEERS' TABLES.....	1-59
INDEX.....	1-63

TABLE OF CONTENTS FOR VOLUME II

Detailed tables of contents are given at the beginning of each section. An alphabetical index appears following Section 45.

	PAGE
SECTION 15. COMPRESSED AIR PRACTICE	
Applications; Definitions; Data and Calculations.....	02- 14
Compressors: Reciprocating, Turbo, Hydraulic.....	15- 22
Compressor Accessories and Plants; Costs.....	22- 29
Rock Drills, Quarry Tools, Coal Cutters.....	29- 41
Comp-air Hoists, Locomotives, Pumps, Air-lifts.....	41- 47
Working in Compressed Air.....	47- 49
Measurement of Compressed Air; Miscellaneous Applications.....	49- 54
SECTION 16. ELECTRIC POWER FOR MINE SERVICE	
Power Plant; Sub-stations; Transmission; Wiring.....	02- 08
Electric Hoisting, Haulage, Pumps, Lighting, Etc.....	08- 23
Motor Specifications and Prices; Makers.....	24- 31
SECTION 17. SURVEYING	
Surveying and Drafting Instruments; Plotting.....	02- 16
Land Surveying; True Meridian; U. S. Public Lands.....	16- 35
Leveling and Contours.....	35- 41
Topographic, Aerial, Mineral, and Railroad Surveys.....	41- 63
SECTION 18. UNDERGROUND SURVEYING	
Stations, Illumination, Transit Mountings.....	02- 05
Horizontal and Vertical Angles; Traversing and Leveling.....	05- 16
Shaft Plumbing.....	16- 22
Notes, Computations; Makeshift Methods; Maps.....	22- 27
SECTION 19. MINE GEOLOGIC MAPS AND MODELS	
Maps and Models.....	02-11
SECTION 20. MINE ORGANIZATION AND ACCOUNTS	
Management; Business, Technical....	02-04
Accounts, Cost-keeping, Records, Operating Units.....	04-12
SECTION 21. COST OF MINING	
66 Tables of Costs and other Data, illustrating 22 Examples.....	02-41
SECTION 22. WAGES AND WELFARE	
Wages; Bonus; Contract; Leasing....	02-11
Accident Compensation; Pensions and Benefit Funds.....	11-15
Labor Relations; Arbitration and Conciliation.....	15-21
Wash and Change Houses; Communities and Dwellings.....	21-27
Domestic Water and Sewage; Diseases	27-35
SECTION 23. MINE AIR, GASES, DUSTS, HYGIENE, EXPLOSIONS, AND ACCIDENTS	
Mine Air: Composition and Impurities	02-15
Mine Hygiene; Diseases; Sanitation..	15-23
Lamps; Gas-testing Apparatus.....	23-30
Accidents and their Prevention.....	30-54
Rescue and Recovery: Equipment and Methods.....	55-65
Safety Organizations and Regulations	65-69
SECTION 24. MINING LAWS	
Introduction and Theories.....	02-03
United States Mining Laws.....	03-14
California Mining Act; References to Laws of other States.....	14-18
Summary of United States Laws; Extralateral Rights.....	18-29
Federal Tax Laws; Depletion.....	29-31
Mining Laws of Canada.....	31-37
Mining Laws of Mexico.....	37-40
SECTION 25. MINE EXAMINATIONS, VALUATIONS, AND REPORTS	
General; Geology, Maps, Titles, Legal Forms.....	02-08
Sampling; Theory and Practice; Salt-ing.....	08-18
Calculating Tonnage and Value; Prices and Profits.....	18-28
Conduct of Examination; Reports....	28-30
Estimating Standing Timber.....	31-32
SECTION 26. AERIAL TRAMWAYS AND CABLEWAYS	
General Formulas for Design and Operation.....	02-08
Bi-cable Tramways: Design and Erection.....	08-34
Twin-cable, Mono-cable, and Reversible Tramways.....	34-44
Cableways: Design and Construction; Makers.....	44-50
SECTION 27. UNDERGROUND MECHANICAL LOADING, CONVEYING, AND HANDLING	
Mechanization of Coal Mines: Equipment and Practice.....	02-25
Mechanical Loaders in Metal Mines..	26-31
Details of Conveyers and Elevators..	31-36

SECTION 28. BREAKING, CRUSHING, AND SORTING OF ORES		PAGE	PAGE
Coarse Crushing; Jaw and Gyratory Crushers.....	02-08	Feeders; Sizing and Crushing; Con- veying and Loading.....	03-10
Intermediate Crushing; Cones, Rolls, Stamps.....	08-15	Testing for Method; Plant Design; Costs.....	11-15
Hand Sorting: Equipment, Practice, Economics.....	15-19	Wet Cleaning; Jigs, Washers, Tables..	15-21
		Dry Cleaning.....	21-23
		Dewatering, Drying, Dedusting; Flow- sheets.....	23-30
		Coking: Methods and Products.....	30-39
SECTION 29. ORE SAMPLING		SECTION 36. MATHEMATICS AND MECHANICS	
Conditions; Methods in General.....	02-03	Algebra.....	02-08
Preliminary Sampling: By Hand; Mechanical.....	03-07	Geometry and Mensuration.....	08-16
Final Sample; Moisture and Multi- samples; Synchronism.....	07-09	Plane Trigonometry.....	16-19
Plant Practice; Comparison of Assays; Flowsheets; Costs.....	09-17	Analytical Geometry.....	20-26
		Calculus.....	26-28
		Statics.....	29-40
		Friction.....	40-43
SECTION 30. ASSAYING		Centers of Gravity.....	43-45
Equipment, Reagents; Sampling.....	02-07	Moments of Inertia.....	45-49
Crucible Method for Pure and Impure Ores.....	07-13	Kinematics.....	49-54
Scorifying, Cupelling, Parting; Check Assays.....	13-16	Kinetics.....	54-60
Methods for Sundry Metals; Coal....	16-21		
Equipment for Gold-silver Assays....	21	SECTION 37. CHEMICAL AND PHYSICAL NOTES AND TABLES	01-08
		SECTION 38. ELEMENTS OF HYDRAULICS	
SECTION 31. TESTING OF ORES		Definitions; Physical Properties of	
Outline of Procedure; Screen Analysis; Elutriation.....	02-05	Liquids.....	02-04
Testing by Microscope; Size of Par- ticles; Sizing Tests.....	05-09	Hydrostatics.....	04-07
Testing of Machines.....	10	Hydrodynamics.....	07-17
Hand Picking and Jigging; Panning and Vanning; Heavy Solutions....	10-12	Pipes, Pipe Lines, Ditches and Canals	17-27
Flotation Tests.....	12-15	Hydraulic Measurements.....	28-32
Amalgamation and Cyaniding Tests; Other Methods.....	15-18	Water Supply.....	32-33
Formulas for Milling Calculations....	18-22		
		SECTION 39. ENGINEERING THERMODYNAMICS	
SECTION 32. SELLING, PURCHASING, AND TREATMENT OF ORES		Work, Power; Flow of Gases and Vapors.....	02-09
Treatment and Marketing of Lead and Copper Ores.....	02-06	Work and Capacity of Air Compressors	09-15
Valuation; Penalties; Terms of Pay- ment; Smelter Schedules.....	06-12	Steam, Air, and Internal-combustion Engines.....	15-20
Milling Ores; Miscellaneous Ores and Minerals; Contracts.....	13-18	Heat and Temperature Units; Specific Heats; Expansion.....	20-22
		Pressure-volume-temperature Rela- tions for Gases and Vapors.....	22-25
SECTION 33. GOLD AMALGAMATION AND CYANIDATION		Fusion and Evaporation.....	25-26
Amalgamation; Corduroy Tables; Treating Amalgam; Salivation....	02-06	Properties of Steam.....	26-29
Cyanidation: Theory and Practice; Sands and Slimes.....	06-25	Combustion; Transfer of Heat.....	29-37
Flowsheets; Costs; Cyanide Poisoning	25-31	Entropy; Heat Cycles; Air Condition- ing.....	37-44
		SECTION 40. POWER AND POWER MACHINERY	
SECTION 34. PREPARATION AND STORAGE OF ANTHRACITE COAL		Power Systems and Cost; Steam Power Cycles.....	02-09
Market Sizes and Standards; Classifi- cation of Methods.....	02-06	Boilers and their Appurtenances....	09-15
Design of Breakers; Wet Cleaning Sys- tems; Loading.....	06-15	Steam Turbines; Steam Engines.....	15-18
Screens, Rolls, Mechanical Cleaners, Conveyers, Etc; Costs.....	15-27	Condensing; Feed-water Purification; Piping.....	18-23
Storage and Handling; Breakage.....	27-32	Water Wheels; Pumps.....	23-39
		Internal-combustion Engines; Gas Producers.....	39-43
SECTION 35. PREPARATION AND COKING OF BITUMINOUS COAL		Testing of Power Plants; Measuring Water and Steam.....	43-46
General; Standards and Uses; Hand- picking.....	02-03	SECTION 41. MECHANICAL ENGINEERING MISCELLANY	
		Gearing, Belting; Pulleys, Shafting, Bearings.....	02-09

TABLE OF CONTENTS

Rope Drives; Lubricants.....	PAGE 09-13
Pipe and Fittings; Wire, Bolts, Rivets; Springs.....	13-22

SECTION 42. ELECTRICAL ENGINEERING

Definitions; Units and Standards; Principles.....	02-05
Conductors; Measuring Instruments..	05-08
Direct-current Generators, Motors, Motor-generators.....	08-13
Alternating-current Circuits, Gen- erators, Motors.....	13-22
Synchronous Converters and Rectifiers	22-24
Power Plants; Transmission and Dis- tribution.....	24-32
Lighting; Electrochemistry; Batteries; Costs.....	32-38

SECTION 43. ELEMENTS OF STRUCTURAL DESIGN

Principles; Mechanics of Materials...	02-07
Foundations.....	07-09

Masonry and Concrete Structures....	PAGE 09-25
Analysis of Framed Structures.....	25-30
Timber Structures.....	30-42
Steel Structures.....	42-52

SECTION 44. PETROLEUM PRODUCTION METHODS

Petroleum Deposits.....	02-03
Natural Flow; Pressure Maintenance.	03-05
Gas-lift: Continuous, Intermittent....	05-09
Pumping: Centrifugal, Hydraulic, Sucker-rod.....	12-19
Repressuring; Water Flooding; Petro- leum Mining.....	19-24
Treatment and Transportation of Oil.	24-25

SECTION 45. ENGINEERS' TABLES

Mathematical and Mensuration Tables	01-45
Weights and Measures; Conversion Factors.....	45-53
Present Value; Amortization.....	53-57
Values of Foreign Monetary Units...	58-59

For contents of other handbooks of this series, see pages following Index of this volume.

A. W. LAMME, MECHANICAL ENGINEER, INGENIEUR-UND ARCHITECTEN-BÜRO

1. Advantages and Uses of Compressed Air Power in Mines, Quarries and Factories.....	01
2. Theology and Definitions of Compressed Air.....	02
3. Operating Data: Application of Power and Motor-Driven Load, Air Consumption at Various Pressures, Boiler, Engine, Compressor, Receiver, Receiver, Discharge, Temperature, etc. in Compression of Compressed Air.....	03
4. Compressing Compressors: Applica- tions of Various Types, Air Valves, Governors, Regulation, Limits and Interlocks.....	15
5. Vessels Pressure and Heavy Motors	20
6. Types of Compressed Air	21
7. Hydraulic Compressors	22
8. Compressed Air in the Manufacture of Concrete	23
9. Care and Operation of Compressors: Flange Arrangement of Cast- Iron Compressor Lubrication, Air	

10. Cost of Compressed Air Equipment and its Operation.....	27
11. Rock Drills: Various Types and Their Applications, Construction, Details, Rock-Ball Mounting, Operation.....	29
12. Oil Turbines and Compressors for Dredging.....	31
13. Pneumatic Quarry Tools.....	32
14. Compressed-air Coal Milling.....	33
15. Compressed-air Blasts.....	34
16. Compressed-air Locomotives.....	35
17. Pumping by Compressed Air.....	36
18. Working by Compressed Air.....	37
19. Measurement of Compressed Air.....	39
20. Miscellaneous Applications of Com- pressed Air.....	40
21. Makers of Compressed Air: Air Equipment, Parts and Accessories.....	41
Bibliography.....	43

Note.—Numbers in parentheses in text refer to Bibliography at end of this section.