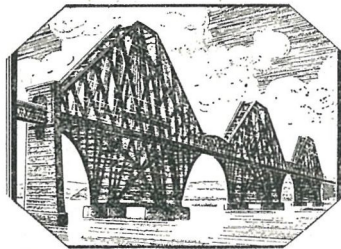


Triumphs of Engineering

A RECORD OF GREAT MODERN ACHIEVEMENTS IN
MAN'S DIFFICULT AND DANGEROUS CONQUEST OF
NATURE. ILLUSTRATED WITH MORE
THAN 200 PHOTOGRAPHS AND
DETAILED DRAWINGS



ODHAMS PRESS LIMITED, LONG ACRE, LONDON, W.C.2

CONTENTS

CONTROLLING AND HARNESSING NATURE	4
<i>Water for irrigation and power. Electricity from Niagara Falls. Power yield of Scottish lochs. Water supply to crowded communities. The Aswan Dam. Taming American rivers. A country reclaimed from the sea. The grid in Britain. Power from coal. Setting Nature at defiance—Eddystone Lighthouse</i>	
BRIDGING THE GAPS	86
<i>Early bridges of primitive man. Advent of steel points a way, and Forth Bridge marks an epoch. How underwater foundations are built. Sydney Bridge was made in England. Transporter bridges and bridge spans that move. The Tower Bridge. How disaster at Quebec was changed to triumph</i>	
OVER HILL AND DALE	146
<i>Blazed trail across a continent—the Canadian Pacific Railway. The barrier of the Rockies. Morass past Lake Superior. Birth of Vancouver. Betwixt locomotive and elevator—some interesting mountain railways. Building the Haifa pipe-line. Modern methods of road construction. Great West Road</i>	
UNDER MOUNTAIN AND RIVER	194
<i>Early tunnelling by hand and by horse-power. Box Tunnel. Alpine triumphs. Dangers of tunnelling. Invention to the rescue. Boring beneath the Severn. Refrigeration—excavation. Mersey and Thames tunnels. Brunel's shield and its development. The rotary excavator. Tunnelling in the United States</i>	
MAN-MADE RIVERS	226
<i>The first canals. Various types and purposes. Short cuts for shipping. Locks and tunnels. De Lesseps and the Suez Canal. Work of the dredgers. Manchester Ship Canal. Stupendous cost of Panama. Difficulties and disasters—cutting deviation tunnels. Ingenious lock gate mechanism. Towing "mule" for ships</i>	
INDEX	474

INDEX

References to illustrations are printed in italic type

A

Abt, 174
 Adamson, Daniel, 238
 Air lock, 210
 All-American Irrigation Canal, 33, 50
 Alp Grum, 166-7
 Alpine Railways, 169
 Alternating current, 70
 Aluminium, 20-1
 "American Devil," 234, 238
 Anæmia, Miner's, 199
 Antwerp Tunnel, 210
 Aqueduct, Bridgewater, 242
 Aqueducts, Roman, 27
 Arch bridges, 103-4
 Arnodin, 129
 Arrol (Sir Wm.) and Co., 100, 136
 Aswan Dam, 16 38 ff., 39-41, 55
 Asyut Barrage, 37

B

Babbit metal, 252
 Baker, Sir Benjamin, 38, 94
 Ballast cars, Emptying, 161
 Banking, 192
 Barogh Tunnel, 197
 Barrage, Asyut, 37
 Nile, 36 ff., 36-7
 River, 33
 Severn, 68
 Barrow road, 241
 Bascule bridges, 127, 134-5
 Battersea Power Station, 76-82, 80-1
 Bauxite, 23
 Big Spring, 207-8
 Black Canyon, 54
 Blackwall Tunnel, 224
 Blackwater Reservoir, 23
 Blackwells Island Bridge, 110
 Blasting, 156
 Blenkinsop, John, 170
 Bonaparte, 231
 Bore, Double, 201
 Bouch, Thomas, 92
 Boulder Dam, 30, 31, 48-9, 50 ff., 52-3, 55
 Tests at, 57-9
 Box girders, 98
 Box Tunnel, 195-6
 Brandt, 200
 Drill, 201
 Brazilian Railways, 163
 Bridge, Blackwater Island, 110
 Brooklyn, 113-4, 115-7, 117
 Buenos Aires, 128
 Forth, 86, 88-9, 90 ff., 92-5, 98-9, 101, 110
 George Washington, 117, 117-9
 Golden Gate, 117, 124-5, 127
 Hell Gate, 117
 Hooghly, 110
 Kill Van Kull, 117
 London, 111
 Manhattan, 117
 Menai, 112
 Middlesbrough, 128, 129, 130
 Middlesbrough Newport, 130-3, 131-3
 Newcastle, 103

Bridge, Newport Transporter, 129
 Pecos, 139
 Quebec, 110, 117, 140-5, 142-4
 Queensboro, 117
 Riachuelo, 129
 Runcorn Transporter, 110, 128, 128-9
 Saltash, 110
 Sydney, 102, 103 ff., 105-7, 109-10
 Tay, 90, 92
 Tibetan, 91
 Tower, 110, 134-9, 134-40
 Victoria Falls, 110
 Westminster, 111
 Williamsburg, 117
 Yarmouth, 145
 Bridge Clearance, 238
 Bridges, 86-145
 Arch, 103-4
 Bascule, 127
 Cantilever, 87, 94-5, 111
 Lifting, 127, 130
 New York, 112
 Over Manchester Ship Canal, 242
 Rope, 90
 San Francisco, 120-1, 120-7
 Suspension, 111
 Swing, 127
 Transporter, 128
 Trestle, 156
 Types, 110
 Bridgewater Aqueduct, 242
 British Aluminium Co., 23
 Brooklyn Bridge, 113-4, 115-7, 117
 Brunel, I. K., 91, 195
 M. I., 217, 222
 Shield, 217
 Bucket excavator, 235, 241
 Bucyrus excavator, 249
 Buenos Aires Bridge, 128
 Burma Road, 193
 Burr concrete, 132

C

Cable-hauled trains, 164, 164-5, 169
 Cable spinning, 116
 winding plant, 60
 Cables, Suspension, 126, 126
 Transmitting 73
 Cableways, 4, 59
 Cadman, Sir John, 177
 Caisson, 95, 96, 120-3, 122
 Disease, 115
 Cajalco Reservoir, 32
 Caledonian Canal, 250-1
 California, 29
 Canadian Pacific Railway, 147 ff., 148-9
 Canadian railways, 147 ff., 148-9
 Canal tunnels, 229
 Canal Zone, 246
 Canal, All-American Irrigation, 33, 50
 Caledonian, 250-1
 Chinese Grand, 226
 Coachella, 50
 Corinth, 226
 Crinan, 227, 228

Canal, Hohenzollern, 240
 Liverpool and Hull, 229
 Panama, 235, 242, 242 ff., 244-5, 247
 Queenston-Chippawa, 20
 Rhône Ship, 229
 St. Quentin, 229
 Suez, 229 ff., 229-31
 Welland, 239
 Canals, 226 ff.
 Irrigation, 227
 Cantilever bridges, 87, 94-5
 Carborundum, 14
 Cassel, Sir Ernest, 38
 Catenary, 111
 Cauvery Mettur Scheme, 40
 Cellar, Tunnelling under, 196
 Cement, Liquid, 211
 Central Electricity Board, 72
 Chagres, River, 249
 Chains, Fender, 248, 252
 Chickamauga Dam, 47
 China, Roads in, 192
 Chinese Grand Canal, 226
 Circuit-breakers, 74, 75
 Clearance, Bridge, 238
 Clyde, River, 238
 Coachella Canal, 50
 Coal delivery at power stations, 78-81
 Coaling stations, 229
 Colorado River, 11, 29-31, 30 47 ff.
 Compagnie Universelle du Canal Interocéanique, 246
 Compressed air drill, 197, 202
 Concrete, 56-9
 Condensers, 79
 Connaught Tunnel, 161, 162
 Control panels, 82
 Conveyer, 232
 Cooper, Hugh, 14
 Corinth Canal, 226
 Crane, Creeper, 104
 Creeper crane, 104
 Crinan Canal, 227, 228
 Cryolite, 23
 Culebra cut, 224, 249
 Current, Alternating and direct, 70
 Cut and cover system, 29, 32

D

Dam, Aswan, 16, 38 ff., 39-41, 55
 Boulder, 30, 31, 48-9, 50 ff., 52-3, 55, 57-9
 Chickamauga, 47
 Gatun, 224, 249
 Gebel Aulia, 40
 Grand Coulee, 11, 34-5, 61-2
 Hales Bar, 40-7
 Hiwassee, 43
 Imperial, 30, 32, 50
 Laguna, 30
 Norris, 42, 44-5
 Parker, 30-1
 Sennar, 40
 Shasta, 4, 60-1
 Wilson, 41-3, 42-3
 Deptford West Power Station, 76
 Detroit River Tunnel, 210, 225

Direct current, 70
 Diving bell, 218, 219
 "Dominion" locomotive, 152-3
 Douglass, Sir J. N., 83
 Dovetailing, Stone, 84, 85
 Dowel bars, 191
 Dredging, 69, 232, 232-4
 Drill, Brandt, 201
 Hydraulic, 200, 201
 Drilling machines, 197
 Drills, Compressed air, 197, 202
 Dufferin, Lord, 12
 Dykes, 63, 63, 67, 69

E

Eads, Capt., 243
 East London Railway, 223
 Economizer, 77
 Eddystone Lighthouse, 82-5, 83
 Electricity Supply, 69 ff.
 Elevator, Ship, 240, 243
 Embankments, 232
 Excavator, Bucket, 235, 241
 Bucyrus, 249
 Mechanical, 233, 238-41
 Rotary, 217, 222

F

Faraday, Michael, 71
 Favre, L., 198
 Fell Centre Rail, 170
 Fender chains, 248, 252
 Flashover, 74
 Fleming, Sandford, 154
 Fleuss, 208
 Fort William, 24, 25
 Forth Bridge, 86, 88-9, 90 ff., 92
 Bouch's plan for, 94
 Repainting, 93
 Stages in building, 95, 98-9,
 101, 110

Foundations, Road, 186, 189
 Fourneyron turbine, 6
 Fowler, John, 94
 Fox, Daniel M., 163
 Foyers, 23
 Francis turbines, 44
 Freeman, Ralph, 108
 Frequency, Electrical, 71

G

Gaillard Cut, 244, 249
 Gate Seal, 252
 Gates, Panama Canal, 247,
 249-52
 Gatun Dam, 244, 249
 Gebel Aulia Dam, 40
 Generator, 18, 45-6
 Heads, 13
 George Washington Bridge, 117,
 117-9
 Gins, 241
 Girders, Box, 98
 Glasgow, 238
 Golden Gate Bridge, 117, 124-5,
 127
 Gradient, Hydraulic, 27
 Grand Canal, Chinese, 226
 Grand Coulee Dam, 11, 34-5,
 61-2
 Grand Trunk Railway of
 Canada, 150
 Greathead Shield, 217, 218-9
 Great West Road, 183 ff., 190-1
 Grid, Electricity, 68 ff., 71
 Grouting, 211

Grove Hill, 183
 Gusher, 178

H

Hales Bar Dam, 46-7
 Hall, 23
 Hamburg Tunnel, 215
 Harlem River Tunnel, 224-5
 Hawkshaw, Sir John, 206
 Hell Gate Bridge, 117
 Hennepin, Fr., 7
 Herodotus, 227
 Heroult, 23
 Hiwassee Dam, 43
 Hohenzollern Canal, 240
 Holland, Reclamation in, 62 ff.,
 64
 Hooghly Bridge, 110
 Hydraulic drill, 200, 201
 Gradient, 27

I

Ice-jams, 17-19
 Imperial Dam, 30, 32, 50
 Insulation, 72, 73-4
 Intake towers, 60
 International Road Congress,
 192
 Iraq, 177
 Irrigation, 5 ff.
 Canals, 277
 Irwell, River, 238, 241
 Isthmian Canal Commission,
 246

K

Khyber Pass, 220-1
 Kicking Horse Pass, 152, 160
 Kill Van Kull Bridge, 117
 Kirkuk, 176, 178-9

L

Laggan, Loch, 24
 Laguna Dam, 30
 Lambert, 207-8
 Landslides, 242
 Landvasser Viaduct, 165
 Laxey Wheel, 6
 Lesseps, Ferdinand de, 231-2,
 235, 243 ff.
 Levelling, 155
 Lifting bridges, 127, 130
 Lighthouses, 82-5, 84
 Limehouse-Rotherhithe Tunnel,
 223
 Liverpool and Hull Canal, 229
 Lochaber scheme, 23 ff.
 Locher, Col. Edward, 170, 172
 Locks, 227-8, 228, 249
 Loetschberg Tunnel, 203-4
 London Bridge, 111
 Los Angeles, 29, 30

M

McAdam, J. L., 187-8
 Mains under roadway, 186
 Manchester Ship Canal, 229, 235
 ff., 236-8
 Manhattan Bridge, 117
 Maritime Canal Company, 246
 Mats, Brushwood, 65, 66
 Mehemet Ali, 36-7
 Menai Bridge, 112
 Mersey, River, 238, 241
 Mersey Railway Tunnel, 213
 Mersey Tunnel, 211-6, 212-3

Middlesbrough Bridge, 128, 129,
 130
 Middlesbrough Newport Bridge,
 130-3, 131-3
 Miner's anemia, 199
 Monessie, Falls of, 24
 Mont Cenis Tunnel, 196 ff.
 Mosul, 177
 Motor roads, 193
 Mougél Bey, 37
 Mount Carmel highway tunnel,
 214
 Mount Stephen, 146, 158
 Mountstephen, Lord, 151
 Mules, 252, 253
 Multi-plane crossing, 192
 Murdoch, Sir Wm., 40
 Muscle Shoals, 42-3

N

Napoleon, 231
 Navvy, Steam, 234
 Newcastle Bridge, 103
 Newport Transporter Bridge,
 129
 New York bridges, 112
 Tunnels, 224 ff.
 Niagara Falls, 7-9, 7 ff., 19
 Power Co., 13
 Nicaragua, Lake, 243
 Nile barrages, 36 ff., 36-7
 Norris Dam, 42, 44-5

O

Oil pipe-line, 176
 Transport, 175 ff.
 Well, 175
 Ontario Power Co., 17

P

Paddles, 24
 Palliser, Capt., 152
 Panama Canal, 235, 242, 242 ff.,
 244-5, 247
 Company, 243
 Revolt, 246
 Parker Dam, 30-1
 Pecos Bridge, 139
 Pelton Wheel, 21, 24
 Penstock, 13
 Pharaohs, 232
 Philæ, 38
 Phœnicians, 229
 Pilatus, Mount, 170, 171
 Pile driving, 223
 Pilot tunnels, 200
 Pioneer bore, 161
 Pipe-line, 31, 175-6, 176
 Section, 182
 Welding, 180, 182
 Polders, 63
 Power stations, 76 ff.
 Battersea, 76-82, 80-1
 Coal delivery at, 78-81
 Deptford West, 76
 Queenston, 13, 14, 15, 20
 Scottish, 20-7, 22
 Prairies, Rail construction over,
 155
 Pumping station, Oil, 180

Q

Quebec Bridge, 110, 117, 140-5,
 142-4
 Queensboro Bridge, 117

Queenston-Chippawa Canal, 20
Queenston Power Station, 13,
14, 15, 20
Queensway, *see* Mersey Tunnel

R

Rack-and-pinion railway, 170,
170-2
Rails, Securing 154
Railways, 147 ff.
Alpine, 169
Brazilian, 163
Canadian, 147 ff., 148-9
Canadian Pacific, 147 ff.,
148-9
East London, 223
Grand Trunk of Canada, 150
Rack-and-pinion, 170, 170-2
St. Lawrence and Champlain,
162
Sao Paulo, 163, 163-4
Snowdon, 173, 174-5
Suspension, 168-9, 169
Reclamation in Holland, 62 ff.,
64
Of Wash, 68
Reservoir, 26
Balancing, 29
Blackwater, 23
Cajalco, 32
Rhône Canal tunnel, 216, 229
Ship Canal, 229
Riachuelo Bridge, 129
Richardson, Chas., 206
Riel, Louis, 157
Rigidity, 99, 100
Road, Barrow, 241
Burma, 193
Great West, 183 ff., 190-1
Road Board, 184
Congress, International, 192
Crossing, Multi-plane, 192
Foundations, 186, 189
Research Board, 188
Research Laboratory, 189
Roads, 183 ff.,
In China, 192
Motor, 193
Roebing, John, 112-5
Roebing, Washington, 115
Roman aqueducts, 27
Rope bridge, 90
Rotary excavator, 217, 222
Rotherhithe Tunnel, 224
Royaulcourt Canal Tunnel, 229
Rudyerd, 83
Runcorn Transporter Bridge,
110, 128, 128-9

S
St. Gotthard Pass, 205
Tunnel, 197 ff., 198-9, 204
St. Lawrence and Champlain
Railway, 162
St. Quentin Canal, 229
Saltash Bridge, 110
San Francisco Bridges, 120-1,
120-7
Sao Paulo Railway, 163, 163-4
Scientific and Industrial Re-
search, Department of, 188
Scottish power stations, 20-7, 22
Searchlights, 235
Sennar Dam, 40

Serra do Mar, 163
Severn Barrage, 68
Tunnel, 204-10, 208-9
Shafts, Tunnel, 195, 206, 214, 218
Shasta Dam, 4, 60-1
Shield, Brunel, 217
Greatest, 217, 218-9
Ship elevator, 240, 243
Simplon Tunnel, 198-9, 200-3,
206
Sleepers, 155
Sluice gates, 40, 68
Sluices, 228, 241
Smeaton, John, 83
Smith, Donald, *see* Strathcona,
Lord
Smoothing board, 191
Snow plough, 159
Shed, 161
Snowdon Railway, 173, 174-5
Snowdrifts, 158
Solenoid, 75
Sommeillier, G., 196
Spiral tunnels, 158, 203, 207
Standedge Tunnel, 229
Steam Navy, 234
Steel construction, 98
Stephen, George, *see* Mount-
stephen, Lord
Mount, 146, 158
Stoney, F. M., 40
Strathcona, Lord, 151, 158
Suez Canal, 229 ff., 229-31
Surge tank, 27
Suspension bridge principle, 111
Cables, 126
Railways, 168-9, 169
Svir, 12
Swing bridges, 127
Sydney Bridge, 102, 103 ff.,
105-6, 110
German design for, 109
Stages, 107
Traffic ways, 109
Syphon, 27
Inverted, 29

T

Tampers, 188-9, 191
Tay Bridge, 90, 92
Telford, Thomas, 91, 188, 250
Tennessee Valley Scheme, 41-7,
44-5
Thames Tunnel, 216-23, 223
Tibet, Bridge in, 91
Time, Regional, 162
Toronto Power Co., 8-9, 14
Tower Bridge, 110, 134-9, 134-40
Tower Subway, 223-4
Traffic lanes, 193
Transformer, 70, 71, 75-6, 76
Transmitting cables, 73
Transporter bridges, 128
Treig, Loch, 24, 25
Trestles, 150, 150-7
Trevithick, 223
Tunnel, Antwerp, 210
Barogh, 197
Blackwall, 224
Box, 195-6
Connaught, 161, 162
Detroit River, 210, 225, 225
Hamburg, 215
Harlem River, 224-5

Tunnel, Limehouse - Rother-
hithe, 223
Loetschberg, 203-4
Mersey, 211-6, 212-3
Mersey Railway, 213
Mont Cenis, 196 ff.
Mount Carmel highway, 214
Rotherhithe, 224
Rove, 216, 229
Royaulcourt Canal, 229
St. Gotthard, 197 ff., 198-9, 204
Severn, 204-10, 208-9
Simplon, 198-9, 200-3, 206
Standedge, 229
Thames, 216-23, 223
Tunnel junction, 213
Tunnelling, Sequence of, 198
Tunnels, 194, 195 ff.
Canal, 229
Curved, 218
New York, 224 ff.
Pilot, 200
Spiral, 158, 203, 207
Turbine, Fourneyron, 6
Turbines, 9, 10-12, 78-9
Turbines, Francis, 44
Turbo-generator, 18, 45-6
Turnpike trusts, 184

U

Underground railways, 194

V

Van Horne, Wm., 151, 154-5
Venetians, 231
Ventilation of tunnels, 202, 212,
216
Viaduct, Landvasser, 165
Viaur, 110
Viaur Viaduct, 110
Vibrators, 191
Victoria Falls Bridge, 110

W

Walker, Thomas, 238
Wash, Reclamation of The, 68
Water-mill, 5
Water-power, conversion into
electricity, 10-12
Waterproofing roadway, 186, 190
Water-supply, 27 ff.
Water-wheels, 5 ff., 6
Welding pipe-line, 180, 182
Welland Canal, 239
Western Avenue, 185
Westkapelle, 62
Westminster Bridge, 111
Wet ground, Consolidating,
210-11, 211
Wheel, Laxey, 6
Pelton, 21, 24
Wieringen, 64-5
Willcocks, Sir Wm., 37-8
Williams, E. L., 242
Williamsburg Bridge, 117
Wilson Dam, 41-3, 42-3
Windmills, 63
Winstanley, Henry, 83

Y

Yarmouth Bridge, 145
Yssel Meer, 65-6

Z

Zuider Zee, 62