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INDEX.

ILLUSTRATED ARTICLES.

- Alcohol, Apparatus for Measuring, Paris Exhibition, 1
 Anti-Incrustator, Baker's, 163
 Anvil Block (weight 210 tons) at the Bolton Iron-works, 496
 Attenuator, Atmospheric Tun-room, 135
 Axle-box, Cooke's Railway, 114
 Axle-box patented by M. Delannoy, 37
 Bogie, The Hudson-Bissell, 29
 Boiler, Thomson's Improved Steam, 582
 Boiler of Steamship Bubulina, 578
 Boiler Explosion, The Bubulina, 541
 Boiler, Marine, High-pressure, 542
 Bolt-screwing and Nut-tapping Machine, 493
 Boring-Machine, Vertical, Paris Exhibition, 232
 Boring-Machine, Bergström's, 261
 Bolts, Parsons's Patent, 412
 Bridge Abutments, Examples of Highland Railway, 264
 Bridge, Design for a Cast Iron Arched, 43
 Bridge, Proposed, over Houghly, Calcutta, 436
 Bridge over the River Scorf, at Lorient, 440, 441
 Bridge over the Thames, at Cookham, 403, 414
 Bridge, The Parnitz, Berlin and Stettin Railway, 101
 Bridge, Iron Floating, connecting Portsmouth and Gosport, 122, 123
 Bridge, Suspension, over the Moldau, at Prague, 461
 Bridge, Suspension, over the Ohio, at Cincinnati, 348, 350
 Bridge over the River Loire, Angers and Niort Railway, 359
 Bridge of St. Louis, Paris, 139
 Bridge, Proposed, over the Straits of Messina, 143
 Buffer Plunger, Angus's Fastening, 309
 Buffer and Draw-springs, Sterne's Pneumatic, 599
 Cable, The Florida and Cuba, 16
 Carriage, Sleeping, for the Nicotrail Railway, 366
 Carriages for the New South Wales Railway, 473
 Casting Bessemer Ingots, Holley's Process, 17
 Castings, The Berlin, 14
 Cattle Truck, Iron, for the Belgian Railway, 179
 Colliery Winding Engines, Paris Exhibition, 130
 Copper Smelting Furnace for Wood Fuel, 512
 Cotton Machinery, 220, 252, 253, 256
 Crane at the Midland Works, St. Pancras, 525
 Crane (30 cwt.), Hydraulic, at the Don Steel Works, 508
 Crane at the Works of Messrs. Thwaites and Carrutt, Bradford, Travelling, 606
 Cupolas, Boott's, Blower for, 583
 Cyclograph, The, for setting out Railway Curves, 465
 Digester and Lubricator, Storer's, 398
 Docks, The Millwall, 102, 104, 105
 Docks, Barrow, belonging to the Furness Railway Company, 260
 Dough-dividing Machine, Austrian, 29
 Dovetailing Machine, American, 444
 Dredging Machine of 60 horse power, 178
 Dynamometer, Balk's Friction, 194
 Eccentric Straps, Boring Locomotive, 332
 Eccentric for Portable Engines, 77
 Electricity at the Paris Exhibition, 317
 Engine, Horizontal, Paris Exhibition, 50, 58
 Engine, Horizontal Blowing, 225
 Engine, Justice's Rotary, 480
 Engine Details, Nalder's Portable, 114
 Engine, Tumbling Beam, 504
 Engine, Traction, 158, 579
 Engines, Shifting Eccentric for Traction, 82
 Engines, Sewage Pumping, 602
 Engines of the French Steamship Cerbère, 390, 394
 Engines, Colliery Winding, 133
 Engines, Double-cylinder Marine, 147
 Engines of the French Ironclad Ocean, 170, 171
 Engines of the Friedland, French Navy, 51, 46
 Excavator, Milroy's, Clyde Bridge, Glasgow Railway, 533
 Flight, Artificial, 87
 Engine, The Prussian Ironclad, Wilhelm I., 382, 363
 Furnace, The Landin, Paris Exhibition, 87
 Furnace, Morgan's Puddling, 539
 Girders at the River Don Steel Works, 407
 Grate, Water-tube, 513
 Graving Dock, Millwall Docks, 476, 477
 Gun, Lyman's "Accelerator," 138
 Guns, Cunningham's Method of checking the Recoil of heavy, 97
 Harbour Improvements, Newhaven, 418
 Harbour of St. Helier, Jersey, 543
 Harbour of St. Helier, Plans for the Improvement of, 410, 411
 Heavy Masses, Apparatus for transporting, 399
 Hull, South Bridge, 547
 Hydraulic Press Cylinder and Base-plate, Steel, 398
 Ingot-lifting Apparatus, 382
 Injectors, Donkey, 203
 Jet-Propeller, Randolph's Hydraulic, 198
 Lathe, Whitney's, in the Paris Exhibition, 28
 Lathe for Boring Railway Tyres, 79
 Lathe for Turning Conical Surfaces, 338
 Laundry of the Grand Hôtel, Paris, 150, 151
 Lighthouse, Lowestoft, Low, 537
 Locomotive, Yard, 173
 Locomotive, Details of, for the 3 ft. Gauge, 229
 Locomotive Design for Heavy Gradients, 73
 Locomotive, Meyer's Tank, 76
 Locomotive with Clip-Drum for Steep Gradients, 517
 Locomotive, The American, Paris Exhibition, 64, 65, 69
 Locomotive, Contractors', Paris Exhibition, 432
 Locomotive Tank, for the 3 ft. Gauge, 174
 Locomotive Engines, Machine for Planing the Coupling-roads of, 445
 Locomotive for the Festiniog Railway, 316
 Locomotive Engine Tank, 500, 501
 Locomotive, Vaessen's Tank, 89, 90
 Locomotive Carriage for Mountain Railways, 342
 Locomotive Engine Details, Machine for Finishing, 419
 Locomotives at the Paris Exhibition, 72
 Locomotives for the St. John's Wood Railway, 59, 66
 Locomotives, Pre-Adamite, 453, 456, 457
 Locomotive Carriage for Steep Gradients, 458
 Machine, Vertical Drilling and Boring, 592
 Magnetism, on Saxby's Method of Testing Iron by, 550
 Measuring-machine, 54
 Metals, Wöhler's Experiments on the Strength of, 160
 Millwall Docks, Western Entrance, The, 108
 Museum, Proposed New, at Calcutta, 196
 Ordnance, Steel, 386, 387
 Ordnance and Projectiles, Steel, 433
 Paper from Wood, Machinery for Making, Paris Exhibition, 9
 Plate-planing and Tyre-drilling Machines, 423
 Pier, Wrought Iron, at Clevedon, Somerset, 528, 532
 Plough and Tackle, Mole, 571
 Portal, Ornamental, at the Paris Exhibition, 12
 Portrait of M. Eugene Flachet, 574
 Portrait of John Fowler, Esq., 557
 Portrait of R. Napier, Esq., 595
 Portrait of John H. Roebing, Esq., 343
 Press, Hydraulic, at the Paris Exhibition, 308
 Press, Hydraulic, for Inserting Locomotive Crank-pins, 509
 Pump, Water-jet, at the Don Steel Works, 407
 Pump, Cameron's Direct-acting Steam, 213
 Pumps, Differential, for Hydraulic Presses, 285
 Rail of the Metropolitan Extension Railway, 501
 Rails, Dering's Spring Fastenings for, 55
 Railway, The Lines of the Northern, Paris, 427, 428
 Railway, The Nicaragua Inter-Oceanic, 521
 Railway, The Central Pacific of California, 390
 Railway Carriages, Reifert's, 118
 Railway Carriages and Wagons, Traverser for, 395
 Railway Brake, Creamer's Safety, 32
 Railway, Permanent Way of the Metropolitan District, 547
 Railway System of Norway, The, 4, 6
 Rivetter, Tweedell's Hydraulic, 202
 Road-roller, Steam for, Liverpool, 324
 Rock-tunnelling Machine, Paris Exhibition, 100
 Rope-carrying Pulleys for Steep Gradients, 517
 Scaffolding, Travelling, for the Roof of St. Pancras Station, 524
 Scroll Saw, Wright's Patent, 37
 Sewer-crossing at Sloane-square, 593
 Shipbuilding, Composite, 28
 Shipbuilding Yard, The Fairfield, Glasgow, 449
 Shot-moulding Machinery, Whitworth's, 191
 Shot-finishing Machinery, Whitworth's, 190
 Sir Herbert Muddock, The, 159
 Slotting Machine, Paris Exhibition, 162
 Slotting Machines, Quick Return-motion for, 500
 Spark-arresters, Brown and Cosser's, 452
 Station, Interior of the St. Pancras, 168
 Steam-bollers at the Paris Exhibition, 42
 Steam Engine, Hick's, at the Paris Exhibition, 20, 21
 Steam Yacht, The Avalanche, 86
 Steam-Cultivation, J. Phillips-Smith's, 126
 Steam-ploughing Apparatus, 292, 293, 301
 Steam-ploughing Engine with Double Drums, 296
 Steam Hammer, Double-acting, 374
 Steam Hammer, at the Atlas Works, Glasgow, 563
 Steamboat for the Dusseldorf and Cologne Steam Navigation Company, 429
 Steamship, The Randall Four-wheeled, 585
 Steel, Experiments on the "Fatigue" of Bessemer, 497
 Steel, Apparatus for making Bessemer, 472
 Steel Cutter for the Livingstone Search Expedition, 24
 Steering Gear, Eaplen and Clark's Hydraulic, 119
 Stone-breaking Machinery, Blake's, 167
 Subway under the Thames, A Proposed, 582
 Sugar, Machinery for Manufacturing Beetroot, 329
 Superheaters, Temperature Indicator for, 148
 Target, The Chalmers, 598
 Telegraph Machinery, Atlantic, 488, 489
 Tools and Tool-holders, 370
 Tools, Engineers', 579
 Traction Engine for Steep Gradients, Paris Exhibition, 520
 Traction Engine with Shifting Eccentric, 88
 Travelling Crane, Steam, Paris Exhibition, 187
 Tunnel under the Indus at Attock, 300
 Valve Diagram, Professor Zeuner's, 305
 Valve, Fenby's Hydraulic slide, 485
 Valve Gear, The Walschaert, 33
 Ventilator for Railway Carriages, Creamer's, 77
 Ventilation, Mechanical, 225
 Viaduct, The Conon, Highland Railway, 257
 Viaduct, The Morlaix, Rennes, and Brest Railway, 111
 Viaduct, The Killiecrankie, Highland Railway, 320
 Viaduct, The Spey, Highland Railway, 321
 Viaducts and Bridges on the Highland Railway, 289
 Wagon, Timber, for the Norwegian Railway, 5
 Water, Apparatus for Measuring the Discharge of, 115, 124
 Water Meters, Reciprocating, 536
 Waterworks, The Manchester, 240, 237
 Wheel, Parsons's Carriage and Wagon, 396
 Wheel-boring Machine, 127
 Wheel, Jensen's Horse, 309
 Wood-working Machinery, Paris Exhibition, 281, 284
 Works, Plant for Mineral Oil, 588
 Yacht, The Twin-Screw Wolverine, 369

GENERAL INDEX.

- Abyssinia, 498, 553, 596
 Abyssinia, Entrances to, 498
 Abyssinia, Routes in, 416
 Accident at the Hoosac Tunnel, 447
 Accident, Railway, 502
 Accidents in the Streets, 485
 Accidents in Ironstone Mines, 508
 Act, The Companies', 133
 Admiralty Works, The Deputy Director of, 387
 Aeronautical Society of Great Britain, 56, 78, 84
 Agriculture in Madras, 266
 Agricultural Show, The Royal, 40
 Agricultural Society, The Manchester and Liverpool, 172
 Agricultural Engines, 57
 Agricultural Engineering, 39
 Agricultural Engineering in Egypt, 6
 Agricultural Society, The Meeting at Bury St. Edmunds, 22
 Alcohol, Apparatus for Measuring, Paris Exhibition, 1
 Alkaline Works, 446
 Alpine Climbing, 234
 Amalgamation, 484
 Amazon, Up the, 243
 America, Why not to go to, 353
 Aneroid, Negretti's, 464
 Anti-Incubator, Baker's, 163
 Ante, Antidote for White, 435
 Anvil Block at the Bolton Ironworks, 496
 Armour-plated Vessels, Coasting, 141
 Armour Plate, The 15-in., 234
 Arms for the Russian Army, Small, 584
 Arms, New Small, in Prussia, 399
 Army, The British, 522
 Army, The French, 509
 Artisans at Paris, English, 330
 Arts, Society of, 604
 Ashbury, Mr. James, 99
 Asphalt Pavement in Paris, 122
 Association, the British, 267, 395
 Association, The British, at Dundee, 191, 244
 Attemperator, Atmospheric Tun-Room, 135
 Axle-Box, Patented by M. Delannoy, 37
 Axle-Box, Cooke's Railway, 114
 Barcelona, 326, 485
 Battle, The Haste of, 452
 Beacons and Buoys, Flashing Light for, 196
 Belgium, 155, 169, 380, 562
 Belgium, English Enterprise in, 569
 Bessemer, Mr. Henry, 531
 Bessemer Process in Austria, The, 558
 Bill, The Private, Office, 529
 Birkenhead, 354
 Blast Furnaces, 71, 82, 545
 Blast Furnaces, Scotch, 318
 Blast Furnaces, Monster, 503
 Blower, Roots's, 508
 Boat, The Livingstone Search, 23
 Bogle, The Hudson-Bissell, 29
 Boiler Explosions, 132, 458, 474, 622
 Boiler Explosion, Fatal, 484
 Boiler Explosion at Manchester, 596
 Boiler Explosion near Bradford, 443
 Boiler Explosion, the Bubulina, 557
 Boiler of Steamship Bubulina, 573
 Boiler, Howard's Safety, 72
 Boiler, Thomson's Improved Steam, 582
 Boiler, Rowan and Horton's Marine, 545
 Boiler-setting, 158
 Boiler Plates, Bessemer Steel, 142
 Bolchow, Vaughan and Co., 309
 Bolton, 133
 Bolt-screwing and Nut-tapping Machine, 493
 Bolts, Parsons's Patent, 412
 Bombay, Drainage of, 121
 Bonelli, Death of Signor, 360
 Bordeaux, 233
 Boring Machine, 232
 Boring Machine, Bergström's, 261
 Bottom on Railway Points, 112
 Brakes, Inefficient, 525
 Breakwater, The Tees, 552
 Breech-loader, A New, 173
 Breech-loaders, 493
 Brick-making Kilns, 286
 Brickworks, The Merryflat Glasgow, 319
 Bridge, The New Blackfriars, 173
 Bridge over the Thames, at Cookham, 403
 Bridge, The Humber, 387
 Bridge, Iron Floating, Connecting Portsmouth and Gosport, 122
 Bridge, Clifton Suspension, 590
 Bridge, The Brooklyn, 392, 423
 Bridge over the River Scorf, at Lorient, 441
 Bridge, The Moerdyk, 39
 Bridge of St. Louis, Paris, 140
 Bridge, Proposed, at Louisville, 155
 Bridge over the River Loire, 359
 Bridge, The Parnitz, Berlin and Stettin Railway, 191
 Bridge, Proposed, over the Straits of Messina, 143
 Bridge, The Messina, 172, 208, 227
 Bridge, The Prague, 460
 Bridge, The Mississippi, at St. Louis, 306, 403
 Bridge, The Cincinnati Suspension, 22, 49, 74, 98, 140, 335
 Bridge, The Kansas City, 355
 Bridge over the Niagara River, 203
 Bridge, Proposed, over the Hooghly, Calcutta, 436
 Bridge Abutments, Examples of, 264
 Bridges, The Great Indian Peninsula, 335
 Bridges, The Highland Railway, 323
 Bridges in Holland, Great, 72
 Bridges, Suspension, 25
 Bridges, Floating, 19
 Bridges, Long Span, 25
 Bridges, American, 71
 Bridges, Waterway for, 437
 Broadhead, 133
 Broddingnagian Barrow, Mr. Punch on a, 330
 Brown, Sir John, 155
 Bubulina, The, 596
 Buenos Ayres, The City of (s.s.), 448
 Buffers, Sterne's Pneumatic, 92
 Buffer and Draw-springs, Sterne's Pneumatic, 399
 Buffer-plunger Fastening, Angus's, 309
 Cable, The New England and Belgian, 82
 Cable, The Malta and Alexandria, 507
 Cable, The Placentia and Cape Breton, 283
 Cable, The Florida and Cuba, 16, 173, 232, 268, 295, 314, 385
 Cable, The Atlantic, 149, 295
 Cables, Submarine, 177
 Cail and Co., 382
 Canal, A New Ganges, 577
 Canal, The Suez, 118, 153, 341, 445, 447, 503
 Canal Company, The Madras Irrigation, 484
 Canal, Proposed Canadian Ship, 505
 Canal Lifts, 509
 Canals, Steam-towing on, 204
 Cape Colony, The, 228
 Carpmel, The late Mr., 21
 Carriage, Russian Sleeping, 369
 Carriages for the New South Wales Railway, 473
 Cars, American Railway, 380
 Cast-iron Ordnance, Converted, 173
 Casting Bessemer Ingots from the Bottom, Holley's Process, 17
 Castings, The Berlin, 14
 Cattle-Truck, Iron, for the Belgian Railway, 179
 Cause and Effect, 83
 Cement, Grinding, 185
 Centrifugal Force, 29
 Chassepots, The, 173
 Cherbourg, 166
 Chili, 545
 Chimneys, 502
 Circle, The Properties of the, 509
 City Streets, 19
 Civil Engineers, The Institution of, 36
 Civil Engineering, Public Works and Architecture, 346
 Clare, The Late Dr., 545
 Climbing by Railway, 317
 Coal-fields, Our, 527
 Coal Exports, 399
 Coal and Petroleum, Experiments on, 93
 Coal, Important Discovery of, in Shropshire, 389
 Coal to London, 82
 Coal, Prussian, 308
 Coal in Prussia, 135, 531
 Coal, Belgian, 408
 Coal and Iron in North America, 260
 Coal and Iron Trades, the Foreign, 597
 Coal, South Lancashire and Cheshire, 509
 Coal, South Lancashire, 229
 Coal, Australian, 219, 335
 Coal in the China Seas, 327
 Coal Resources of India, 328, 367
 Coal, Labuan, 484
 Coal-Mining, The Double-shift System, 484
 Coals, Quality of Indian, 440
 Coast, The Pacific, 177
 Coast, The Eastern, 219
 Coast, The Chinese, 378
 Coinage, Report on the International, 231
 Coinage, Ten Years' Indian, 145
 Colliery, The Oaks, 149, 263
 Colliery, The Opening of the Oaks, 242
 Colliery Proprietors, Important to, 295
 Colonies, The Australian, 578
 Combe, The Late Mr. James, 354
 Commercial Middle Men, 43
 Company, The P. and O., 529
 Composition for Lagging Boilers and Steam-pipes, Spence's, 38
 Concrete Buildings, 519
 Constables, Engineering, 581
 Contract, The Cunard, 535
 Contract with the P. and O. Company, New, 518
 Copper Ore, Extracting, 418
 Core Ovens, Steam-heated, 119
 Corn-Mill, Patent, Bovill's, 80
 Cotton, 314
 Cotton, The Trade, 73, 399, 462, 596
 Cotton, Exhibition of British at Broach, 522
 Cotton Prospects in India, 526
 Cotton Machinery for the Preparing and Spinning of, 221, 250, 254
 Court, The Profession at, 325
 Cowes, 572
 Crane, Traversing, at the Steam Plough Works, Leeds, 304
 Crane at the Midland Works, St. Pancras, 525
 Crane, Hydraulic, at the River Don Steel Works, 508
 Crane, Steam Travelling, Paris Exhibition, 187
 Crane at the Works of Thwaites and Carbutt, Bradford, Travelling, 606
 Creusot, &c., 408, 470
 Crucibles, Steel-melting, 438
 Cupola, Woodward's Steam-jet, 506
 Cupolas, Roots's Blower for, 583
 Cyclograph, The, 465
 Cyclone at Calcutta, The, 570
 Danube, The, 66
 Decorations given by the Emperor to Exhibitors, 3
 Defences, Our Coast, 302
 Despatch, The Pneumatic, in Paris, 133
 Digester and Lubricator, Storer's, 398
 Dock, Graving, Millwall, 474
 Dock, The New, at Malta, 133
 Dock, Dagenham, Thames, 202
 Dock, Floating, at St. Thomas's, 141
 Docks, The Barrow, 262
 Docks, Opening of the Barrow, 267
 Docks, The Millwall, 102, 148, 170
 Docks, Liverpool, 3
 Docks, Falmouth, 444
 Docks, Hull, 479
 Docks, Mersey, Estate, 79
 Docks, New, at Belfast, 319
 Docks and Harbour Board, Mersey, 183
 Docks, Lynn, 327
 Doncaster, 430
 Dough-dividing Machine, Austrian, 29
 Dover to Calais, 512
 Dovetailing Machine, 148
 Dovetailing Machine, American, 444
 Dowlaia, 202
 Drainage, The Metropolitan Main, 531
 Drainage, Thames Valley, 569, 600
 Drainage in Holland, 171
 Drainage of Bombay, 18
 Draughtswomen, 577, 559
 Dredging in Blythe Harbour, 183
 Drilling-machine, Ducommun's, 591
 Dundee and its Factories, 227
 Dwellings, Industrial, 83
 Dynamometers, Paris Exhibition, 117
 Dynamometer, Balk's Friction, 194
 Eccentric for Portable Engines, Shifting, 77
 Economy, National, 575
 Editors and Advertisers, 204
 Education, Compulsory, 462
 Education, Editorial, 570
 Education, Industrial, 462
 Education, State, 515
 Education, Technical, 48, 92, 117, 415, 509
 Electric Induction, 224
 Electric Distance Meter, 142
 Electricity at the Paris Exhibition, 317
 Engine-drivers, 523
 Engine-drivers, English, in Egypt, 82
 Engine, Nalder's Portable, 114
 Engine, The Corliss, 8, 92, 109, 233
 Engine, Duvergier's Horizontal, 51, 59
 Engine, Horizontal Blowing, 227
 Engine Trials at Bury, The, 44, 70, 93
 Engine Trials at Billancourt, The, 176
 Engine, Tractor, 579
 Engine, Turner's Traction, 82
 Engine, Tumbling-beam, 503
 Engine, Justice's Rotary, 479
 Engines, Double-cylinder Marine, 147
 Engines, High-speed Portable, 74
 Engines of the Hercules, The, 481
 Engines, Ploughing, 131
 Engines, Marine, 7
 Engines, Rowan's Marine, 590
 Engines, Marine French, 174
 Engines, Agricultural, 57
 Engines, Hot-air, 455
 Engines, Compound, 38
 Engines, French, in England, 354
 Engines, French and English, 505
 Engines, New, for the North London Railway, 378
 Engines, The St. John's Wood Railway, 509
 Engines, Sewage-pumping, 601
 Engines, Colliery Winding, 139
 Engines of the Friedland, French Navy, 51
 Engineer Examination, Indian, 36, 116
 Engineers for India, 322, 496, 499
 Engineers, Indian, 248
 Engineers' Convention, An, 267
 Engineers, Portraits of, 455, 505
 Engineers, South Wales Institute of, 88
 Engineers, The Mechanical, 352
 Engineers, Bombay Association of, 323
 Engineers' Tools at the Paris Exhibition, 41
 Engineers, Society of, 47, 67, 82, 92, 105, 110, 131, 153, 166, 176, 199, 239, 294, 368, 377, 401, 487, 602, 515, 596
 Engineers, Society of, Visit to Blackfriars-bridge, 355
 Engineering in 1867, 595
 Engineering in America, 99, 499
 Engineering, Agricultural, 39
 Engineering Factory, An, 61
 Engineering, Lectures on Civil, 495
 Engineering, Mechanical, 91
 Engineering in New York, 511
 Engineering, Vital, 557
 Engineering Works in Italy, 398
 Errata, 335
 Estuary Company, Norfolk, 187
 Excavator, Milroy's, 534
 Exhibition, The Paris, 25, 34, 47, 99, 176, 232, 323, 343, 479
 Exhibition Catalogues, 119
 Exhibition at the Manchester Institution of Engineers, 522
 Exhibition, An American, 457
 Exhibitions, Circulating, at German Museum, 68
 Expedition, The Abyssinian, 173
 Experimental Researches, 238
 Explosion, A Hot-water Bottle, 133
 Explosion, The, at Liverpool, 539
 Explosion in a French Coal-mine, 579
 Exports, Our, 82, 523
 Facing Points, 29
 Factory, An Engineering, 81
 Fan, Gubal's Ventilating, 625
 Faraday, Michael, 172
 Faraday, The late Professor, 228
 Ferro-manganese, 391
 Fire-engine, Pudsey Steam, 364
 Fire-engines, 82
 Fire Brigade, The Metropolitan, 534
 Fire Protection, 133
 Fire-damp in Mines, Pressure of, 224
 Firearms, Museum of, 496
 Firebox Heating Surface, 19
 Fives-Lille Company, The, 554
 Flachet, M. Eugene, 577
 Floating Bridges, 19
 Forests and Mines, Turkish, 395
 Forests in India, 400
 Forge, The Parkhead, 336, 455
 Forge, The Lanocfield, Glasgow, 466
 Forgings, Testing the Soundness of, by Electric Currents, 395
 Fort, New, at Plymouth, 308
 Forts in the Medway, The, 502
 Forts, Russian Armour-plated, 155
 Foundry, The Phoenix, Glasgow, 379, 412
 Foundry, Railway, at Madras, 506
 Foundry, The Kinning Park, 540
 Fowler, Mr. John, 559
 French Progress, 458
 Frigate, The Prussian Ironclad, 363
 Fees, Professional, 535
 Fuel, The Combustion of, 212
 Fuel, On the Consumption of, 208
 Fuel, Cement for Patent, 308
 Furnace, A New, 531
 Furnace, Copper-smelting, for Wood Fuel, 512
 Furnace, Morgan's Puddling, 339
 Furnace, The Kurrachee, 166
 Furnace, The Wilson, 12, 54, 110, 131
 Furnace, The Landin, Paris Exhibition, 87
 Furnaces, Cleveland Blast, 236
 Furnaces, Scotch Blast, 518
 Furness, R., 509
 Furniture, Apparatus used in the Manufacture of, 409
 Future, England's, 88
 Gabions, Improved, 499
 Galicia, In, 82
 Ganz, The late M., 597
 Gas, Cannel, 173
 Gas-stoking, 172
 Gas-scrubbers, 509
 Gas at Manchester, 239
 Gas in Paris, 3, 79, 456
 Gas in Marseilles and Toulouse, 523
 Gas in Calcutta, 509
 Gas Companies, The, 12, 133
 Gas Company, The Bombay, 572
 Geometrical Figure, A New, 127
 Girders at the River Don Steel Works, 407
 Glacier, Great, of New Zealand, 518
 Gladstone, Mr., at Barrow, 295
 Glass, Brass, and Steel, Experiment on the Rigidity of, 236, 255
 Glassworks, The City Flint, Glasgow, 553
 Glasgow Town Council and the Gas Companies, 239
 Gold, Australian, 260
 Gold and Silver in Nicaragua, 306
 Golden Mare, A, 280
 Good Gracious! 71
 Government Purchases, 581
 Grass, Chinese, 507
 Grate, Water-Tube, 613
 Graving Dock, Millwall Docks, 474
 Great Eastern, The, 525
 Grindstones, Artificial, 327, 392, 498
 Gun Cotton, 133, 391
 Gun Cotton, Manufacture of, 408, 430, 467
 Gun, The Rodman, 234, 364, 458
 Gun, Trial of the Rodman, at Shoeburyneess, 2, 91
 Gun, The 15 in. Rodman, 514
 Gun, Lyman's "Accelerator," 138
 Gun and Plate Question, The, 325
 Gun, The Engineer on the 15 in., 295
 Gun, The Wivern's, 484
 Gun, Trial of the Palliser Converted, 202
 Gun Trials, The American, 523
 Gun Vessel, H.M. Beacon, 15
 Gunboat, New, 87
 Gunboats, The Swedish 15 in., 323
 Gunpowder or Nitro-glycerine, 576
 Guns, Converted, 588
 Guns, The American 15 in., 55
 Guns, The Fraser, 12
 Guns, Method of Checking the Recoil of, 97
 Hammer, A 120-ton Steam, 364
 Harbour, Granton, N.B., 138
 Harbour, Improvements in Newhaven, 420
 Harbour of St. Heller, Jersey, 411, 416, 543
 Harbour, Kurrachee, 164, 228, 490
 Harbour Works, New, at Wick, 202
 Harbours of Refuge, 63
 Harwich, 491
 Hawthorn, The late Mr. Robert, 3
 Heavy Masses, Apparatus for Transporting, 399
 Highland and Agricultural Society, 268
 Highland and Agricultural Society Show, at Glasgow, 106
 Hitch in Whitefriars, The, 534
 Hopkins, Gilkes and Co., Messrs., 448
 Hot-air Engines, 455
 Houses, Working Men's, 145
 Howard, Mr. James, 182
 Hull, 272, 571
 Hungary, 179
 Hurricane, A West Indian, 498
 Hydraulic Press for inserting Locomotive Crank-pins, 509
 Hydraulic Cylinder and Base-plate, Steel, 398
 Ice Machines, 169
 Illness, 464
 Illyrian, The, 202
 Immigration into the United States, 193
 Improvements at Newcastle, 523
 India, Notes from, 3, 110, 286, 357, 390, 422, 436, 518, 556, 584
 India, Telegraph to, 565
 India, New Route to, 540
 India, Statistics of British, 417
 India and her Resources, 507
 Indicator, The Richards, 23, 599
 Indicator Diagrams, Ransome and Sims', 49
 Industry, Chambers of, 386
 Industry, Leeds, 118
 Industry, Foreign Mechanical, 59
 Industry, Russian, 173
 Information, Valuable, 262
 Ingots, Apparatus for Handling, 382
 Injectors, Donkey, 6, 203
 Injectors, Giffard's, 512
 Institution, The, 313, 335
 Institution of Civil Engineers, 128, 485, 502, 522, 539, 549, 570
 Institution of Mechanical Engineers, 448
 Institution of Engineers in Scotland, 442
 Invention, 326
 Iron, Foreign, 534
 Iron and Coal, Chinese, 499
 Iron and Steel in the Paris Exhibition, 245, 281
 Iron and Steel Works, The Mersey, 260
 Iron, The Present State of Manufacture in Britain, 262, 282

- Iron in Canada, Railway, 599
 Iron in France, 235, 596
 Iron and Steel Manufacture in 1867, 536
 Iron, Report of, for the last Indus Railway, 541
 Iron, Scotch Pig, 299
 Iron, Corrosion of Cast, 568
 Iron, Sulphur in Pig, 554
 Iron, Lowmoor and Bowling, 502
 Iron Manufacture, The, 239
 Iron, Malleable Cast, 298
 Iron, Cast in Sea-Water, 427
 Iron Manufactures, German, 455
 Iron and Steel Company, The Bolton, 128
 Iron, Testing, by Electricity, 484
 Iron Trade, The, 72
 Iron Trade, The French, 287
 Iron Trade, The Glasgow Malleable, 541
 Iron Trade, The Foreign Coal and, 597
 Iron, Cleveland, 21, 56, 72, 79, 118, 127, 157, 182, 260, 309, 313, 341, 373, 380, 413, 448, 464, 479, 512, 564, 581
 Ironclad Ram for Japan, 99
 Ironclad for Melbourne, An, 99
 Ironmasters, English, in Belgium, 507
 Ironworks, The Ebbw Vale, 319
 Ironworks, The Monkbridge, 163
 Ironworks, The Dowlais, 153, 167
 Ironworks, The Govan, Glasgow, 446
 Ironworks, The Langloan, 554
 Ironworks, The Gartsherrie, 313
 Irrigation and Canal Company, East Indian, 502
 Irrigation Company, East India, 32
 Irrigation, Indian, 509
 Islands, The Sandwich, 485
 Jarrovi, 137, 239
 Journal, The Title of this, 481
 Judgment, Professional, 555
 Krupp, 435
 Labour, Demand for, in Canada, 161
 LaFitte and Co., Messrs. Charles, 508
 Lairds, The, 282
 Lake, The Regent's Park, 560
 Lang, The late Mr. Oliver W., 67
 Lathe for turning Pillars, Whitney's, 28
 Lathe, Ducommun's, 339
 Launches by the Lairds, 118
 Laundry of the Grand Hotel, Paris, 150
 Lead floating on Molten Iron, 165
 Leather, Nothing like, 509
 Leeds, 439, 503
 Leeds, Progress of, 294
 Letters to be Forwarded, No. 13
 Lighthouse, Lowestoft Low, 537
 Lighthouse on the Great Basins, Ceylon, 36
 Lightning Conductors, 258
 Limited and Reduced, 511
 Literature, 564
 Literature, Indian Professional, 400
 Locomotive Accounts, 388
 Locomotives, American, 71
 Locomotive, The American, Paris Exhibition, 64
 Locomotive Carriage, Fairlie's, 458
 Locomotive Contractors, 431
 Locomotive Contracts, New Standard for, 203
 Locomotive Building and Rail Making in France, 285
 Locomotive Economy, 336, 302, 439, 451
 Locomotive Engine Details, Machines for Finishing, 419
 Locomotive Engines, Machine [for Planing the Coupling-Rods, 445
 Locomotive, Fairlie's Mountain, 341
 Locomotive, Meyer's, 76
 Locomotive, New, for Common Roads, 503
 Locomotive Railway Office, A, 170
 Locomotive Yard, Rhymney Iron Company, 173
 Locomotive, The Road, Act, 511
 Locomotive for the Festiniog Railway, 315
 Locomotive, Vaessen's Tank, 19
 Locomotive for the 3-ft. Gauge, Details of, 229
 Locomotive Works, The Glasgow, 474, 519
 Locomotive Works, The Hyde Park, Glasgow, 364
 Locomotive Workshops, 434
 Locomotives, Pre-Adamite, 457
 Locomotives, Racing Road, 169
 Locomotives, Single-cylinder, 327
 Locomotives at the Paris Exhibition, 71
 Locomotives, French, 399
 Locomotives, German, 29
 Locomotives for India, 21
 Locomotives, The Metropolitan St. John's Wood, 141
 Locomotives for the St. John's Wood Railway, 61
 Locomotives, Mountain, 326
 Locomotives, Smoking, 264
 Lord H. Lennox and *The Engineer*, 109
 Lord Warden, The, 266
 Luggage, The Customs' Examination of, 541
 Machine, A Grading, 591
 Machinery in India, 166
 Mail Communications, Australian, 88
 Mail Contract, New, 485
 Ballet *Mirum in Modum*, 322
 Manufactures, Mysteries in, 353
 Manufactures, Foreign, 173
 Marine Engines, 7
 Marine Engine, Rowan's, 590
 Marine Engine, French, 174
 Marine Engine, Single-cylinder, 181
 Marine Engineering, 460
 Marine Hydraulic and Sanitary Engineering in Scotland, 486, 515
 Maritime Exhibition at Havre, 173
 McGauley, The late Professor, 485, 549
 Measuring Machine, 54
 Meat Extract, Liebig's, 567
 Meat Transport in United States, 281
 Mechanical Engineering, 91
 Mechanical Industry, Foreign, 112
 Mechanical Industry in the North, 8
 Mechanical Industry, French, 198
 Medal, The Society of Arts Albert, 12
 Medals, The Paris Exhibition, 452, 507
 Metallurgy in Prussia, 106
 Meter, Electric Distance, 142
 Motors, Reciprocating Water, 536
 Metric System, The, 319
 Mothven, Mr. David, 72
 Miantonomoh, The, 99
 Middlesboro' and its Fuel, 531
 Middle Level, The, 387
 Mineral Wealth of Japan, 264
 Minerals in France, 99
 Mines, 133
 Mining Districts, 54
 Mining and Metallurgy Apparatus and Processes of, 343
 Mismanagement, Joint-Stock, 581
 Mississippi, The Bar of the, 89
 Molecular Bugbear, A, 576
 Money Market, The, 133
 Monitors for Bombay, 16
 Museum, The East London, 498
 Museum, New, at Calcutta, 197
 Napier, Mr. Robert, 597
 Nations, The Ages of, 432
 Nautica, 8
 Navigation of the Thames, 502
 Navigation in 1803, Steam, 554
 Navy, The, 161
 Navy, The French, 499
 Navy, The Swedish, 26
 Navy, The American, 577
 Navy, The United States, 585
 Needle Gun, The Inventor of the, 578
 Nevada, The State of, 186
 New York, 16
 Newcastle-on-Tyne, 526
 Newton and Pascal, 226
 "Nicholas," An Engineering, 450
 Nitro-glycerine, 548, 585
 Nitro-glycerine, Gunpowder, or, 576
 No Letters to be Forwarded, 13
 North, From the, 200, 341, 360
 North, Notes from the, 10, 30, 41, 77, 112, 132, 147, 189, 189, 213, 258, 269, 302, 356, 393, 421, 443, 464, 474, 502, 527, 562, 568
 Notes and Memoranda, 166
 Nymph and the Daphne, 82
 Oil v. Grease, 464
 Omnibus Subways, 505
 Omnibuses, The, 173
 Opaco, The Island of, 89
 Ordnance, Ancient, 495
 Ordnance, Steel, 387
 Ordnance, American Cast-Iron, 169
 Ordnance and Projectiles, Krupp's Steel, 430
 Ordnance, Bronze and Steel, 157
 Ordnance, Cast-Iron Converted, 183
 Ostend, 59
 Ovens, French Cooking, 285
 Paisley, 439
 Panama, 79
 Paper from Wood, Machine for making, 8
 Paraffine Works, Young's, 478, 494
 Paris, British Artisans Visits to, 400
 Paris, Workmen's Visits to, 565
 Pas de Calais, The, 407
 Pass, The Brenner, 82
 Passage, The North-west, 508
 Passengers and Guards, 484
 Passengers and Guards' Communication, 29
 Patent Agents, 578
 Patents, American, 170, 579
 Patent Laws, The, 239
 Patents, Recent, 1, 15, 58, 84, 108, 120, 148, 182, 200, 223, 269, 288, 294, 314, 373, 381, 406, 426, 468, 471, 514, 566, 605
 Perdonnet, M. Auguste, 354
 Permanent-way, French, 512
 Permanent-way, Griffin's, 447
 Permanent-way Accounts, 179, 180, 188, 181
 Peru, 148
 Peru, The, 228
 Petit, Gaudet, and Co., MM., 507
 Peto, Betts, and Crampton, 93
 Petroleum as Fuel, 1
 Petroleum in Italy, 462
 Philadelphia, 460
 Philosophical Instruments and Apparatus for Teaching Science, 349
 Photography, On Certain New Processes of, 280
 Picking and Stealing, 157
 Pier, The New Clevedon, 526
 Pier, The New Railway, at Burntisland, 125
 Pipe, Lead Encased Block-in, 162
 Planes, Whitworth's True, 82
 Plate-planing and Tyre-drilling Machines, 423
 Plates Rolled v. Hammered, 236
 Plough and Tackle, Mole, 571
 Ploughing Engines, 131
 Ploughing Company, A Proposed New Steam, 71
 Politics and Science, 212
 Portal, Ornamental, at the Paris Exhibition, 12
 Portable Engines, Eccentric for, 77
 Post Office and the Telegraph, 485
 Postage, Newspaper, to America, 323
 Pot Sleepers, 522
 Press, Hydraulic, 306
 Preston, 202, 420, 487
 Prizes, The, at Paris, 47
 Prizes, Distribution of the Paris Exhibition, 3
 Process, The Richardson, 438, 506
 Process, The Siemens, 309
 Process, The Uchatius, 165
 Profession, The, 265
 Propeller, Randolph's Hydraulic, 197
 Prospects, Our, 127
 Protection, American, 169, 290
 Prudence and Steel Rails, 469
 Prussia, 77
 Puddling, Pneumatic, 109
 Pump, Water-jet, at the River Don Steel Works, 407
 Pump, Cameron's Direct-acting Steam, 213
 Pumps, Differential, 285
 Pumping Engine, Model, 105
 Pumping Engines, 21
 Pumping Engines at the Lambeth Waterworks, 122
 Pumping Engines, Cornish, 308
 Queensland, 170
 Raft, A Life, 161
 Raft, The American Life, 82
 Rail, A Broken Steel, 531
 Rails, Steel, 364, 437, 459, 499
 Rails, The Price of Steel, 335
 Rails, Compound, 506
 Rails, Long-priced Iron, 591
 Rails, Belgian, 3
 Rails in Belgium, 539
 Rails in Russia, 407
 Rail, Erie, 501
 Rails, Broken, 558
 Rails, The Chalk Farm, 483
 Rails, Spring Fastenings for, Dering's, 55
 Rails, The Breaking of, 352
 Rails for Russia, 99, 303
 Rails, Steel-topped Iron, 567
 Rails in France, 8
 Rails, Bessemer, in France, 129, 458
 Rails in Holland, 129
 Rails, Tests of Iron and Steel, 561, 569
 Rail-tests, The South-Eastern, 561, 563, 569
 Rails of the Metropolitan Extension Railway, 501
 Railroad, Central Pacific of California, 80
 Railroad, The New York Panama, 283
 Railway Accidents, 144, 502
 Railway Bills of the Session, 472
 Railway, The Metropolitan District, 541, 571
 Railway, The Metropolitan, 199, 409, 416, 606
 Railway, The East London, 236
 Railway, Islington, 503
 Railway, The South-Eastern and Brighton, 554
 Railway, London and North-Western, 133, 581
 Railway, The Midland, 236, 399, 571
 Railway, The Caledonian, 570
 Railway, The Irish, Commission, 4
 Railway, The Atlantic and Great Western, 355, 473
 Railway, The Northern, of France, 71
 Railway, The Eastern, of France, 79
 Railway, The Lines of the Northern, Paris, 427
 Railway, The Mont Cenis, 166, 233, 286, 407
 Railway Journey, The Sultan's First, in Turkey, 173
 Railway, Turin and Savona, 249
 Railway, Paris, Lyons, and Mediterranean, 596
 Railway, The St. Petersburg and Moscow, 393
 Railway, Seville, Xeres, and Cadix, 444
 Railway Enterprise in Hungary, 360
 Railway System of Norway, 4
 Railway, New, in West Prussia, 509
 Railway, The New, over the Alps, 538
 Railway Traffic, French, 328
 Railway, The Samara, Orenburg, 426
 Railway Uniform, An American, 399
 Railway, The Pacific, 194, 443, 509
 Railway, Underground, in New York, 496
 Railway Contract, Large, in America, 370
 Railway Iron in Canada, 599
 Railway, The Construction and Works of the Highland, 205
 Railway Loan, Austrian, 148
 Railway, South Austrian, Lombardo-Venetian, and Central Italy, 147
 Railway Carriages, Reifert's, 118
 Railway Progress in India, 160
 Railway, Indian, 133
 Railway, The Indian Branch, 133
 Railway, A New Indian, 143
 Railway, The Calcutta South-Eastern, 531
 Railway, The Bombay and Baroda, 281
 Railway, Indian Guarantees, 514
 Railway, The Grand Trunk, 431
 Railway, The Great Indian Peninsula, 308, 483
 Railway, The East Indian, 514
 Railway Construction, Indian, 328
 Railway Materials, Indian, 248
 Railway, Indian, Statistics, 377
 Railway Foundry at Madras, 506
 Railway, The Punjab, 389
 Railway, The Proposed Abyssinian, 457
 Railway, A Tin-pot, for Abyssinia, 507
 Railway, The Abyssinian, 437
 Railway, The Mexican, 534
 Railway Company, The Mexican, 554
 Railway, The Euphrates Valley, 434
 Railway, Proposed, between Rangoon and China, 494
 Railway, New South Wales, 522
 Railway, The Nicolai, 236
 Railway, Rangoon and China, 540
 Railway, The Nicaragua Inter-oceanic, 521
 Railway Tunnel, Remington's Channel, 509
 Railway, The Honduras, 507
 Railway Amalgamation, 43
 Railway Iron, 71
 Railway Bears, The, 525
 Railway Bills, New, 526
 Railway Extension, 430
 Railway Materials, 464
 Railway Traffic, 82
 Railway Capital, 201
 Railway Statistics, 280
 Railway Economy, 371
 Railway, Proposed Abandonment of a, 448
 Railway Traffic Receipts, 19
 Railway Loans, 110
 Railway Improvements, 357
 Railway, Cheap, Working, 79
 Railway Gauges, American, 166
 Railway Resistances, 422
 Railway Iron, Exports of, 51
 Railway Guards' and Passengers' Communication, 503
 Railway Carriage of Meat and Milk, 407
 Railway Brake, Creamer's Safety, 32
 Railway Carriages, Ventilator for, Creamer's, 77
 Railway Cars, English, 547
 Railway, Charentes, 418
 Railways in Russia, 418
 Railways, Opening of New Welsh, 155
 Railways in Holland, 16
 Railways in New Jersey, 390
 Railways, French, 249
 Railways, Italian, 340
 Railways, Austrian, 531
 Railways in Baden, 236
 Railways in Russia, 146, 334, 541, 566
 Railways, Russian, 56, 458, 514, 538
 Railways in Prussia, 572
 Railways, Prussian, 492
 Railways in Turkey, 387
 Railways, Progress of Indian, 121, 409, 513
 Railways, Indian, 177
 Railways, Fuel for Indian, 372
 Railways, Traffic on Indian, 490
 Railways, American, 71
 Railways, Tractive Resistance on, 340, 375, 385, 413, 422
 Railways, Imperfect, 371
 Railways Working by Contract, 170
 Railways, Steel-laid, 351
 Rain, The, 82
 Rain, Half a Year's, 110
 Rain in India, 526
 Reaping-machines, The History of, 243
 Reaping-machines, Trials of, in Scotland, 319
 Redesdale, Baron, 323
 Reform, Labour, 595
 Refrigerating Cars, 236
 Remittance, A, 484
 Reports by English Artisans on the Paris Exhibition, 56
 Reservoirs, Hill, 484
 Review, The Naval, 27
 Revolvers, Breech-loading, 507
 Rhone, The Fate of the, 508
 Rifle v. Bayonet, 594
 Rifles, Snider, 82
 Rifles, American, 468
 Rifling, Commander Scott's, 125
 Rivetter, Tweddell's Hydraulic, 202
 River Amazon, The, 519
 Rivers, The Pollution of, 236
 Road, Proposed, from India to China, 148
 Road-rollers, Steam, 297
 Road-roller, Aveling's Steam, 323
 Roads in Central Asia, Russian, 555
 Rock-tunnelling, Machines, 97
 Roebbing, Mr. John A., 360
 Rolling the 15 in. Plate, 224
 Rolling-stock, Valuations of, 536
 Rolling-mill, The, at Essen, 473
 Roof of the Moscow Riding School, 202
 Roofs and Bridges, Theory of Diagrams of Forces as applied to, 235
 Round the World, 535
 Route, The Brindist, to the East, 148
 Royalty, The Bessemer, 415
 Royalty and Railway Signals, 430
 Rowing, Yankee, 118
 Rumour, 166
 Russia, 598
 Sacrifice in Books, A, 518
 Sages, The Trial of, at Paris, 202
 Sages, Trial of Burglar-proof, Paris Exhibition, 182, 154
 Saltburn-by-the-Sea, 596
 Saw Grinders, The Sheffield, 161
 Scheme, A Promising, 399
 Schools, The Middle Class, 96
 Science, The Distinguished Men of, 219
 Scientific Bodies, Unchartered, 641
 Screwing Machine, Smith and Coventry's, 525
 Scroll Saw, Wright's, 37
 Sea, Slipped into the, 82
 Sermon, Meteor, A, 509
 Sewage, Utilisation of Town, 224
 Sewage at West Ham, 512
 Sewer-ventilation, 541
 Sewer-crossing, The Ranelagh, 594
 Sewing-machines, Jackson's, 26
 Shafting of Mills and Factories, Formulas for, 186
 Shafting of Mills and Factories, Formulas and Tables for, 149
 Sheffield, 39, 71, 79, 152, 260, 332, 361, 420, 485, 512, 545, 578, 596
 Sheffield, Progress of, 358
 Shepherd, Hill and Co., Leeds, Messrs., 260
 Shield, The Gibraltar, 466, 502
 Ship, The Troop, Euphrates, 540
 Ships, Turret, 432
 Ships, Sheathing Iron, 535
 Ships, British, for China, 509
 Ships Built, 51
 Ships, The Broadside, at Spithead, 67
 Shipping, Steam, 413
 Shipping, Transatlantic Steam, 306
 Shipping, Foreign Steam, 316
 Shipping, American Steam, 249, 486
 Shipbuilding, Composite, 27
 Shipbuilding, Cleveland, 129
 Shipbuilding, Steel for, 335
 Shipbuilding, Irish Steam, 519
 Shipbuilding Yard, The Fairfield, Glasgow, 449
 Shipbuilding Yards, 361
 Shoddy, 421
 Shot-finishing Machinery, Whitworth's, Paris Exhibition, 190
 Shot, Speed of the 15-in., 295
 Show, The Smithfield Club, 539, 567
 Sir Herbert Maddock, The, 160
 Sleeping-cars of the Chicago Railway, 63
 Slide-valves, Movable Seats for, 239
 Slip, New, at Inglis's Shipbuilding Yard, 337
 Slip in a Railway Cutting, 527
 Slotting-Machine, Hartmann's, 162
 Slotting-Machines, Quick Return Motion for, 560
 Smoke Nuisance, The, 265, 297
 Smoke Nuisance Inspection, 327
 Society of Arts, The, 485
 Society, Civil and Mechanical Engineers', 62, 270, 327
 Society, The Royal Cornwall, 92
 Société des Ingénieurs Civils, The French, 87

- Société Nouvelle des Forges et Chantiers de la Méditerranée, 166
Soda Waste, 236
Somersetshire, The, 82
Spader, Comstock's Rotary, 268
Spark-Arrester, Brown and Cosser's, 452
Spinning Machinery, Leigh's Loose Boss Rollers for, 341
Station, New, Lime-street, Liverpool, 108
Station, The St. Pancras, 148
Steam Dredger, The Greenhorn, 177
Steam Roller for Bombay, 354
Steam Whistle, The First, 169
Steam-Vessels, 389
Steam Brake, Loughridge's, 195
Steam Hammer, Double-acting, 374
Steam Hammer at the Atlas Works, Glasgow, 568
Steam Shipping, French, 183
Steam Cultivation, 207, 290, 299, 328, 458
Steam Cultivation and Under-Drainage, 82
Steam Cultivation, J. Phillips-Smith's, 126
Steam-cultivating Companies, 148
Steam-jet Cupola, Woodward's, 508
Steam Yacht, The Avalanche, 85
Steam Navigation Company, The Azizieh, 455
Steam Navigation, American, 16
Steam Line, Another, 249
Steam to the River Plate, 483
Steam Engine, Mr. Bourne's Treatise on the, 404
Steam Packets, American, 514
Steam and other Shipping, 200
Steam Launch, A Fast, 526
Steam Plough Works, The Leeds, 267
Steam Engine, Hicks's, at the Paris Exhibition, 21
Steam Shipping, American, 63
Steam Boilers, Chevalier's, 43
Steamboat for the Cologne Steam Company, 429
Steamboat Landings, Thames, 509
Steamers, British, 331
Steamers, The Panama and New Zealand, 525
Steaming, Fast, 531
Steamship Line, New, 96
Steamship Performances, 214, 273
Steamship Druid, Raising of the, 264
Steamship, The Australian, 360
Steamship, The Randall Four-wheeled, 585
Steamships, Single Engines on, 492
St. Etienne, 407
St. Haller, Jersey, Harbour of, 575
Steel, A New Kind of, 357
Steel, The Age of, 325
Steel, On the Strength of, containing Different Portions of Carbon, 395
Steel, Experiments on, 267
Steel under the Microscope, 417, 553
Steel Process, The Martin, 540
Steel, Bessemer, 71
Steel Plant, Bessemer, 267
Steel Plant, Bessemer, at Barrow, 286
Steel, Apparatus for making Bessemer, 472
Steel Boiler Plates, Bessemer, 142
Steel, Experiments on the "Fatigue" of Bessemer, 497
Steel Works, Bessemer, 235
Steel Rail, A Broken, 531
Steel Rails, 437, 459, 499
Steel Rails, The Price of, 335
Steel Rails, their Strength and Economy, 549
Steel Rails, Prudence, 469
Steel-topped Iron Rails, 507
Steel-rolling Liquid, 47
Steel-melting Crucibles, 438
Steel, New Modes of Making, 153
Steel Shafts, 408
Steel, Mr. Fairbairn's Trials of, 353
Steel, An Ironmaster's View of, 493
Steel Works, The River Don, 383
Steel Works, The Barrow Hematite, 285
Steel and Iron Company, East India, 142
Steering Engine for the Northumberland, 493
Steering Gear, Esplan and Clark's Hydraulic, 119
Stock, The Brighton New, 92
Stone, The New, 127
Stone, Ransome's Patent, 302
Stone, Ransome's Concrete, 294
Stone, The Ransome Process, 326
Stone-breaker, Blake's, 464
Stone-breaking Machinery, Blake's, 167
Stone, The Decay of, its Cause and Prevention, 230
Streets and Thoroughfares, New Mode of Constructing, 229
Striking out of Spite, 80
Subway under the Thames, A Proposed, 582
Subways, 47
Success the Measure of Ability, 185
Suez, 454
Sugar, Artificial, 268
Sugar, Manufacture of Beetroot, 330
Sugar Refinery, A New, at Greenock, 439
Superheaters, Field's Pyrometer for, 146
Suspension Bridges, 25
Tables referred to in Mr. Fairbairn's Paper on the Properties of Steel, 270
Tank Locomotive Engine, 500
Target, The Chalmers, 154
Tariff, The American, 29, 165, 510
Technical Education, 48, 92
Technical Schools Abroad, 67
Telegraph Cable, New, 452
Telegraph Machinery, Atlantic, 488, 489
Telegraph, The Atlantic, 92, 380
Telegraph, The French-American Atlantic, 493, 528
Telegraph Extension, 227
Telegraph to the East, 29
Telegraph, The Indian, 148
Telegraph to India, The, 57
Telegraph to India via Russia, 15
Telegraph Company, The Anglo-Indian, 492
Telegraph, Anglo-Indian, 12
Telegraph and the Post-Office, The, 450
Telegraphs and the Government, The, 178
Telegraphs, Police Station, 396
Telegraphs in Italy, 581
Telegraphs, Indian, 163
Telegraphic Apparatus, 185
Telegraphic Freak, A Strange, 89
Telegraphic Conference, The, 268
Telegraphy, State, 464
Telegraphy, Submarine, 567
Telegraphy in France, 545
Telegraphy on the Continent, 572
Telegraphy, Indian, 448
Telegraphy, American, 464
Telegraphy in the United States, 39
Temperature, Underground, 212
Tenders for a Brick Gas-holder Tank, 531
Tenders, English, Abroad, 173
Tenders, English, in Belgium, 380
Thames Conservancy, The, 82, 394
Timber Company, Herefordshire, Wagon, 158
Tin-plate Works, The Coatbridge, 319
Tin in America, 165
Tools, Engineers', 379
Tools and Tool-holders, 369
Topographical Indicator, Local, 248
Towns, Dutch, 77
Towns, Indian, 227
Trade Report, Coatbridge, 581
Trade of the Mersey, 430
Trade, The Future of British, 459
Trade, Our Foreign, 407
Trade in America, The State of, 578
Trades' Unions, A Blow at, 331
Train Stopped, The Queen's, 484
Train Stopping, The, 466
Trains, Communication in, 8
Tramway, Mr. Page's, 12
Tramway, Metropolitan, 507
Tramways in Liverpool, 581
Traversers, Ramsbottom's, 394
Tube Wells, 202
Tube-expander, Dudgeon's, 458
Tunnel, A, under the Mersey, 270
Tunnel, The Mont Cenis, 492, 507
Tunnel, India, at Attock, 299, 399
Tunnel under the Chicago River, 598
Tunnelling the Tees, 635
Tunnelling and Mining by Machinery, 310, 332
Tyro-lathe, Greenwood's, 79
University, The Glasgow, 371
Un-steam-engine Conduct, 531
Valve Gear, Walschaert's, 34
Valve, Fenby's Hydraulic Slide, 485
Ventilation, Mechanical, 225
Ventilator for Railway Carriages, Creamer's, 77
Vessels, The Durability of Armour-plated, 571
Viaduct, The Holborn Valley, 82
Viaduct, The Morlaix, 112
Viaduct, Failure of a Railway, in India, 157
Viaducts, Timber, 531
Viaducts, Examples of, on the Highland Railway, 288
Victoria, 15
Vistula, The, 118
Wages, Reduction of, 503
Walk, A 1227-mile, 510
War Steamers on the Clyde, 328
Water, Apparatus for Measuring the Discharge of, 115, 124, 143
Water Supply, 51
Water Supply, London, 393
Water Supply of Lisbon, 354
Water Supply of Malta, The, 160
Waterford, 272
Waterwitch, The, 201
Waterwitch, The, Viper and the Vixen, 131
Waterworks of London, The, 538
Waterworks, Description of the Manchester, 241
Waterworks, The Vartty, 418
What Next? 403
What Will They Buy? 93
What Can It Be? 173
Whale, Very Like a, 355
Wheel-boring Machine, Ganz's, 117
Wheel-cutting at the Paris Exhibition, Specimens of, 122
Wheel, Parsons's Carriage and Wagon, 398
Wheel, Jensen's Horse, 309
Wickham, Mr. H. W., 294
Wilkins, The late Mr. W. P., 82
Winding Engines, Colliery, 129
Wire Gauge, On the Birmingham, 249
"Wonderful, if True," 169
Wood-working Machinery, 96, 163
Wood-working Machinery, Paris Exhibition, 109, 281
Wood Bearings, Mr. Penn's, 525
Work to be Done, 351
Work by the Day, 330
Works, Plant for Mineral Oil, 589
Works, Public, in Turkey, 249
Works, The Atlas, Glasgow, 587
Works, The Forchambault, France, 578
Yacht, Mr. G. R. Stephenson's, 39
Yacht, The Steam, Avalanche, 85
Yacht, Twin-screw Wolverine, 369
Yorkshire, South, 138, 382, 531, 541, 582, 596
Armstrong-Russell Case, The—Iron, 10
Bogie, The Hudson-Bissell—W. S. Hudson, 142
Boilers, Belleville's Inexplosive—J. J. Birckel, 401
Boiler, The Field—Lewis Olrick, 463
Bridge, The Ohio Suspension—English Engineer, 107
Bridge, The Portsmouth Floating—Tomkins, 157
Bridge, Portsmouth Floating—Lewis and Stockwell, 177
Bridge, Portsmouth Floating—W. Tijou, 177
Bridge, The Floating, at Portsmouth—Tomkins, 189
Burgh, Mallet and Co.—An Engineer, 538
Buss's Patent for Concrete Sea Walls—H. Buss, 331
Cannon, A New Breech-loading—Breech-Loader, 157
Carriages, New South Wales and Metropolitan—W. Bridges Adams, 600
Cast-steel and Wrought-iron Tyres—J. J. Birckel, 351
Coal-cutting Machines—J. G., 270, 332
Coal-cutting Machines—X. Y. Z., 303
Cobbler Mended, The—An Engineer, 580
Cold-hammered Steel—Tilt Hammer, 510
Communication between Passenger and Guard—F. J. H., 545
Competition, Foreign—R. Waygood, 435
Corliss Valve Gear, The—W. H. N., 31
Diffusion Process, Roberts's—W. E. Gill, 23
Direct Communication between the Metropolis and South Wales—A. W. Dawney, 397
Dock, Floating—Inquirer, 157
Drainage Discussion, The—C. T. Liernur, 11, 30, 52, 95, 137
Drainage Discussion, The—O. O., 11, 52, 63
Drainage Discussion, The—Fred. C. Krepp, 52
Drainage Discussion—Charles F. Gower, 63, 30, 107
Drainage and Outfalls, Arterial—R. B. Grantham, 189
Drainage, West Ham—Wm. Russ, 523, 545
Drainage Competition, Winchester—Victims of Misplaced Confidence, 304
Drainage, Village—Montague Beal, 534
Draughtswomen—An Englishman, 581
Draughtswomen—A. W. Gordon, 581
Drilled and Punched Holes—G. Hutchinson, 287
Dunderberg, The—William W. Wood, 26
Dunderberg, The—W. Watt, C.E., 26, 330
Ebbw Vale Company, The—E. Grove, 332
Eccentrics, Adjustable—J. H. Pitkin, 177
Education, Editorial—J. J. Birckel, and Co., 601
Electrical Anti-incrustator, The—R. Sabine, 519
Engines, The Corliss—R. Douglas, 10, 53
Engines, The Corliss—John Pinchbeck, 10, 263, 136
Engine, The Corliss—William Inglis, 30, 68, 155
Engine, The Corliss—Anonymous, 31
Engine, The Corliss—A Civil Engineer, 53, 113
Engine, The Corliss—Economy, 53
Engine, The Corliss—W. E. Gill, 63
Engine, The Corliss—Observer, 95, 136, 204
Engine, The Corliss—George Salt, 31, 113
Engine, The Corliss—S. J. C., 113
Engine, The Corliss—Shepherd, Mulliner, and Garstang, 113
Engine, The Corliss—J., 114
Engine, The Corliss—J. Fred. Spencer, 136
Engine, The Corliss—W. E. C., 136
Engine, The Corliss—J. W., 137, 156, 184, 204
Engine, The Corliss—A Yarn-Spinner, 156
Engine, The Corliss—Nexus, 156
Engine, The Corliss—J. W., 184
Engine, The Corliss—C. J. Pooley, 184
Engine, The Corliss—Examiner, 184
Engine, The Corliss—Michael Sell, 184
Engine, The Corliss—J. C. E., 242
Engines, The Corliss and Allen—J. T. B., 172
Engine, The Engerth—E. Couche, 53
Engine Trials at Billancourt—Tuxford and Sons, 197
Engine Trials at Bury, The—E. R. and F. Turner, 107
Engine Trials at Bury, The—Aveling and Porter, 158
Engine Trials at Bury, The—W. Hartnell, 158
Engines, Locomotive—Adolph Brunner, 601
Engines, Festiniog—C. M. Holland, 452
Engines, Marine, for the French Navy—Observer, 197
Engines, Small Pumping—A Journeyman, 535
Engines, Messrs. Turner's Traction—E. R. and F. Turner, 185
Engineers, The Society of—G. W. Harris, 129, 172
Engineers, The Society of—John Fowler, 177
Engineers, The Society of—W. H. Le Feuvre, 189
Engineers' Tools—G. B., 424
Engineers, Remuneration of, under Government, India—A Young Engineer, 427
Engineers and Draughtsmen's Benevolent Association—W. G. B., 53
Engineering School of the University of Glasgow—W. J. Macquorn Rankine, 397
Engineering Schemes, Present and Future—Practical, 18
Engineering, Cancerine—Carapax Cancer, C.E., 580
Engineering Education—J. J. Birckel, 397
Engineering Work in Prospect—J. J. Birckel, 626
Engineering Economy—J. J. Birckel, 548
England and America—J. S., 492
Exhibition, Artisans' Visits to the Paris—J. T. Dexter, 185
Exhibition, The Paris—Eugene Lacroix, 328
Ferries between England and France—T. S., 378
Flax-breaking Machine, Braasler's—Gardiner and Mackintosh, 54
Fuel, The Consumption of—C. J. Spencer, 269
Governor, Nalder's—A. W., 133
Government Competition in India—M., 272
Grates, Water-tube Fire—A Stansfield Rake, 553
Guns, Large-bore—J. E. S., 375
Hammers, Chatwood and Sturgeon's—J. Sturgeon, 101
Harbour Competition, The St. Heller—G. F. Lyster, 523
Harbour, Kurrachee—W. Parkes, 195
Harbour, Kurrachee—Joshua Wilson, 196
Harbour, Aberdeen—J. W., 584
Hercules, The Engines of the—Hercules, 299
Horse Power, Indicated—J. W. R., 133, 280
Horse Power, Indicated—A. W., 300
Horse Power, Indicated—Wm. Moorsom, 303, 380
Hydraulic Propeller, The Ruthven—W. B., 55, 63, 103
Hydraulic Propeller, The Ruthven—Twin-screw, 96
Iron, Quality of, as now used—W. J. C. Muir, 460
Iron, Quality of, as now used—Ewing Matheson, 472
Iron-Sawing—John Dixon, 272
Jet, or Ruthven's Hydraulic Propeller, The—W. B., 37
Knifing Machine—J. W. Mann, 232
Lightning-Arresters—W. Mayes, 208
Locomotive Dimensions—G. H. Hatherton, 197
Locomotive Eccentric Straps—G. Ratcliffe, 332
Locomotives, Road—J. Boulton, 152
Lord Redesdale and Mr. Brassey—R. Sinclair, 287
Machinery in the Paris Exhibition—J. J. Birckel, 378
Mail Contract, New Oriental—Anglo-Indian, 559
Marine Engines, French—J. J. Birckel, 308
Mill, Lloyd's Esparto—W. P. Wilkins, 63
Molecular Deterioration—Robert Mushet, 510
Monitor—J. Bourne, 54
Monitor, Question, The—J. Bourne, 357
Monitor Question, The—W. Watt, 541
Monitor Question, The—John Bourne, 583
Mr. Bourne and the Dunderberg—W. H. Webb, 162
Mr. Brassey and Lord Redesdale—M., 271
Negative Slip—C. R., 11
Negative Slip—Holix, 31
Negative Slip—Anonymous, 129
Negative Slip—C., 263
Negative Slip—Michael Soff, 287
New York Press and the Dunderberg Ironclad, 162
Paraffine Works, Young's—A. Kirk, 523
Paris Exhibition, How to describe the—Ben Lomond, 31
Permanent Way Accounts—A. G. B., 222
Ploughing Engines—Gardiner and Mackintosh, 185
Prizes at Paris, The—W., 55
Process, The, Richardson—St. John Vincent Day, 152, 182, 398
Professional Initials, The—W. B., 285
Puddling, Richardson's Process of—Fettling, 144
Rail, The Chalk Farm—A Foreigner, 584
Ralls, Compound—J. Waddington, 534
Ralls, Compound—H. Rochussen, 548
Ralls, Steel and Iron—Robert Mushet, 584
Ralls, Tests of Iron, 561
Railway Speeds—G. J. T., 55
Railway Carriage Ventilators—F. R. Muntion, 116
Railway, The Metropolitan—E. R. Dutton, 463
Railway, Mont Cenis—R. M., 269
Railway Bridges, Ornamental—J. S. M., 368
Railway Scheme, The Abyssinian—J. J. R., 560
Railway Scheme—R. E., 560
Railway Accidents—Henry N. Maynard, 55
Railway, The Lancashire and Yorkshire—A Constant Traveller on the L and W. Lines, 157
Railway System, The Norwegian—C. Pihl, 53
Railway Guarantees, Indian—Anglo-Indian, 463
Railway Guarantees, Indian—Y., 491
Railways, New South Wales and Metropolitan—R. H. Burnett, 580
Railways, The New South Wales—W. Bridges Adams, 556
Roller, Road—Assistant Surveyor, 582
Sandstone, Flexible—J. Bourne, 157
Screw bolts, The Strain on—S. G., 185
Screw-bolts, Strain on—C. Wawn, 189
Sewers, The Construction of—A. W. Morant, 188
Shaping Machines—F. Williams, 135
Shaping Machines—Margrave Dillon, 135
Shaping Machine—An English Engineer, 157
Ship of the Future, The—Campbell Ross, 586, 606
Shot from American Ordnance, Velocities of—J. Bourne, 54
Slide-valves, Napier and Rankine's—An Engineer, 463
Smoke Nuisance Inspection—W. Sandison, 356
Society of Engineers, The—Lewis Olrick, 108
Society of Engineers and the Institution of Civil Engineers—A Member of the Society of Engineers, 272
Society, The Civil and Mechanical Engineers—J. Dawson, 62
Spring Clips for Railway Bars—H. J. P., 80
Steam Engineering, Schools of—X. Y. Z., 101
Steam-jet Cupola, The—Woodward Brothers, 460
Steam Hammers—C. F. T. Young, 287
Steam Fire-engines—An Apprentice Engineer, 197
Steamer Druid, Raising the—Gwynne and Co., 331
Steamship Performance—W. J. M. Rankine, 272
Steel Castings, M'Haffie's Malleable—M'Haffie, Forsyth, and Miller, 328
Steel Rails in France—F. Valton, 95
Steel Rails—James Deas, 354
Steel Rails—Z., 455
Steel Rails—D. W. Thirlwall, 510
Steel, An Ironmaster's View of—J. B., 435, 484
Steel, Plumbago—F. P. S., 448
Steel, Plumbago—R. G. Blunt, 448
Steel, Plumbago—S., 408
Subway under the Thames, A Proposed—Alex. Doull, 582
Subway under the Thames, A Proposed—J. Tugwell, 601
Sulphur from Fuel, Extraction of—Scotus, 144
Target, The Chalmers—James Chalmers, 598

LETTERS TO THE EDITOR.

- Aëronautical Society, The—Wm. Smyth, 80
Agricultural Show, The Royal—R. Garrett and Sons, 80
American Guns and English Armour—Vindictor, 173
Anti-incrustator, The Electrical—H. P., 580
Anti-incrustator, The Electrical—X. X. X., 584
Anti-incrustator, The Electrical—Boller, 584
Anti-incrustator, The Electrical—John Ramsbottom, 584
Anti-incrustator, The—Kitson and Co., and Vulcan, 598
Arches, Concrete—J. P. Roberts, 606
Armour and Ordnance—James Chalmers, 185
Armour, Solid and Laminated—J. Bourne, 152

- | | | | |
|--|---|---|---|
| <p>Telegraph to India—Anglo-Indian, 491
 Tools and Tool-holders—J. J. Birckel, 406, 115
 Tools and Tool-holders—Smith and Coventry, 492, 552
 Tools and Tool-holders—W. Hackney, 510
 Tools, A Novel Mode of Advertising—W. Sellers and Co., 581
 Tramways, Metropolitan—Observer, 535, 600
 Tramways, Metropolitan—M. M. T. C., 572
 Tumbling Beam-engine—E. R., 523
 Tunnelling-machines—Blanchard and McKean, 129
 Valve Diagram, Professor Zeuner's—A. B., 305
 Valve Diagram, Zeuner's—W. H., 332
 Valve-gear, The Corliss—W. H. N., 53, 95</p> | <p>Viaducts, Economic Spans of—W. B., 454
 Water-jet Propeller, The—J. Wigham, Richardson and Co., 96
 Water-meters, Reciprocating—Alfred W. Pocock, 562
 Water-meters, Reciprocating—H. Frost, 580
 Water-supply, The London—J. J. Birckel, 444
 Waterwitch, The—W. R., 227
 Waterwitch, The Viper, and The Vixen—W. B., 175, 197
 Waterwitch, Viper, and Vixen—J. A. L. Airey, 185, 248
 Waterworks, The Vartry—An Engineer, 357
 Well, How to Drain a—An Economic Utilitarian, 466</p> | <p>Well, How to Drain a—T. Square, 492, 536
 Well, How to Drain a—Chain Pump, 511
 Well, How to Drain a—E. U., 511
 Wheel, Jensen's Horse—Peter Jensen, 331
 Wire-gauge, The Birmingham—R. S. Culley, 331
 Wire-gauge, The Birmingham—Heintzmann and Rochussen, 357
 Wood-working Machinery, Paris Exhibition—S. Worsam, 137</p> <p style="text-align: center;">LITERATURE</p> <p>A Treatise on the Screw-Propeller. By John Bourne, C.E., 195
 Bridges and Viaducts, Examples of. By W. Davis Haskoll, 373</p> | <p>Civil Engineering, The Roorkee Treatise on. By Major J. G. Medley, R.E., 425
 Gold and Silver, The Mining and Metallurgy of. By John A. Phillips, 382
 Irrigation in Spain. By J. E. Roberts, C.E., 233
 Materials, A Treatise on the Strength of. By Peter Barlow, F.R.S., 373
 Modern Marine Engineering. By N. P. Burgh, 454
 Productive Industry in India, How to Develop, with Estimates and Plans of Factories. By P. R. Cola, 426
 Railway Bridges, Long-span. Spon, 373
 Telegraph, A Handbook of Practical. By R. S. Culley, 38, 88</p> |
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APPARATUS FOR MEASURING ALCOHOL, PARIS EXHIBITION.

CONSTRUCTED BY MESSRS. SIEMENS, HALSKE AND CO., TELEGRAPH ENGINEERS, BERLIN.

FIG. 1.

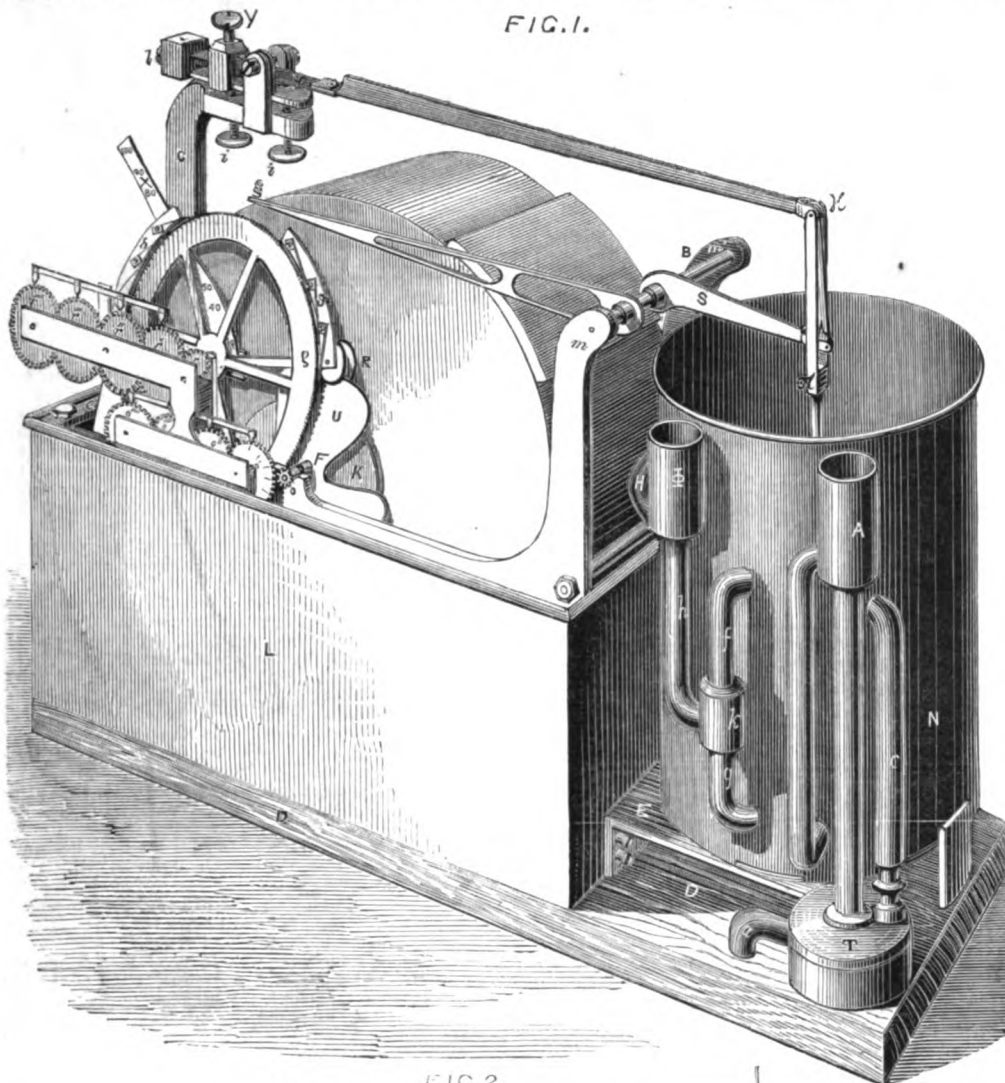
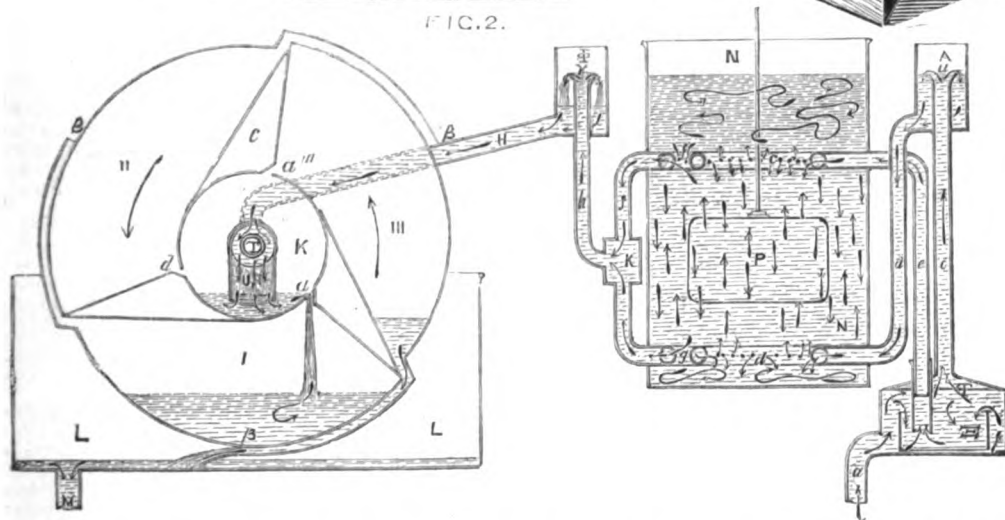


FIG. 2.



In the annexed engravings we illustrate a highly ingenious and beautifully constructed instrument, invented by Messrs. Siemens, Halske and Co., the well-known telegraph engineers of Berlin, and now exhibited by them at Paris. The apparatus is designed for measuring the quantities of alcoholic liquids which pass through it from one vessel into another, and at the same time registering the quantities of pure or absolute alcohol which are contained in those liquids, independent of the different degrees of concentration which the alcoholic liquids may possess. This is a very important function for an apparatus to perform, since alcoholic liquids in most countries are subject to taxation, and the rates are dependent upon the quantities of absolute alcohol they contain. It is, therefore, very desirable, in a distillery or in any similar establishment, to be able to register not only the quantities of spirits produced, but at the same time to measure the quantity of pure alcohol contained in those liquids, which latter quantity alone forms the correct basis for taxation. The apparatus is shown in isometrical projection in Fig. 1, and in section in Fig. 2. It consists of a drum, *g*, mounted on a horizontal axis, and divided into three equal compartments, I, II, III, each of which contains five litres when completely filled. The spirits are conveyed to this drum by a pipe, *H*, which leads into the pipe and mouthpiece, *T*, in the centre of the drum. The liquid passes into the lowest com-

partment through the slit or opening, *a*, and the level in the inner part of the drum, *K*, remains unaltered until the whole compartment, I, is filled completely. The liquid then rises, and ultimately arrives at the opening or slit, *a'*, which leads into the second compartment, II. As soon as the latter is partly filled, the weight of the liquid overbalances the drum, and the latter turns one-third of a revolution, placing the compartment lowest, and bringing I. into the position first occupied by III. In this latter position the liquid is discharged from the compartment by the opening, *B*, which is then placed lowest, and it ultimately escapes from the apparatus through the pipe, *M*. The drum, *g*, being connected with a set of wheels forming a counter for its revolutions, it is very easy to read off the number of turns, or the equivalent volume of liquid which has passed through the apparatus in a given time. The counter-wheels for the volume of liquid are marked, *o o o*, in Fig. 1, and occupy the lowest position in the apparatus. The measurement is independent of the speed with which the liquid passes through the instrument. For measuring the quantity of alcohol contained in the liquid, an alcoholometer is used, *i.e.*, a float of a given size and weight, the immersion of which depends upon the greater or less specific weight of the liquid. Now as the specific weight of a mixture of alcohol and water is exactly in proportion to the relative quantities of both liquids contained in the

mixture, it is obvious that the depth of immersion of the float will be greater in proportion to the amount of absolute alcohol in the liquid. The float, *P*, is inserted in a cylindrical vessel, *N*, through which the liquid is passed before it enters the drum, *g*. The float, *P*, is made of thin sheets of brass in the form of a hollow cylinder, which is filled with a strong alcoholic liquid, which is heated to ebullition, so as to drive out the air. After this the cylinder is allowed to cool, and when completely filled it is closed hermetically. By these means it is possible to make the indications of this float or alcoholometer almost independent of all variations in temperature, since all changes which affect the specific gravity of the liquid to be measured affect the liquid within the cylinder in a similar manner, and the whole expands or contracts accordingly, almost in the same proportion as the liquid itself. The alcoholometer is connected with the lever, *s*, and this carries on its shaft, *m m'*, the long pointer, *E*, which, to an exaggerated scale, copies all the movements of the float within the liquid. Opposite to the point, *G*, is a curved arm, *x*, which is graduated with figures corresponding to the different degrees of alcohol, and this arm moves on a shaft or axis which carries the small pinion, *a*, which forms the first of a set of counting wheels, *r r r*, for registering the pure alcohol. The arm, *x*, is loose on the axis, *r*, and it is connected with another arm, which has a pulley, *R*, at its end. The pulley, *R*, is carried by a trefoil cam, *U*, fixed to the shaft of the first counter-wheel, for registering the quantity of liquid passed through the apparatus, *o o o*, and the pulley, *R*, follows the cam, rising and falling by its weight, just as the curve of the trefoil cam permits that movement. The lever, *R*, also carries a segment fitted with three small ratchets, which work into the teeth of the wheel, *g*, which is fastened to the shaft, *r*. Whenever the pulley, *R*, descends through the entire depth of the recess in the trefoil cam, *U*, the wheel, *g*, is carried forward a certain part of a revolution in the return stroke of the arm, *R*; but if the pulley, *R*, does not descend through the entire depth of the recess, there will be a smaller movement given to the ratchet-wheel corresponding to the smaller depth from which the pulley, *R*, is lifted by the cam, *U*. To effect such differences of movement, corresponding to the depth of immersion of the float, is the function of the point, *G*, and the arm, *x*. As the point, *G*, rises and falls it comes opposite to different parts of the curve, to which the arm, *x*, is cut. This latter arm, when moving forward with the descent of the pulley, *R*, will touch the point, *G*, at a given moment, and will thereby be prevented from going further. This will prevent the pulley, *R*, from sinking further down, and the whole will be kept suspended until the cam, *U*, comes round again and lifts the pulley, *R*, which takes the wheel, *g*, with it by means of the ratchets. It will be seen that the point at which the pulley, *R*, is suspended depends upon the depth of immersion of the alcoholometer, since this regulates the position of the point, *G*. The arm, *x*, is graduated, so as to have its highest point, corresponding to the position of the float when immersed, in the rectified alcohol, and its lowest point at the spot which corresponds to the immersion of the same float in pure water. This lowest point is set so as to suspend the pulley, *R*, entirely, and to allow no movement of the wheel, *g*, by the rotation of the cam, *U*. The liquid which contains no alcohol then passes through the apparatus. Its volume is registered by the lower set of wheels or counters, *o o o*, but the wheels of the alcohol counter, *r r r*, do not turn, and, therefore, no alcohol is registered on that apparatus. As soon as a certain proportion of alcohol is admixed to the water, the float sinks lower in this liquid, the pointer is lifted, and it allows the arm, *x*, to come forward a certain distance, when the cam allows the pulley, *R*, to drop. Yet the pulley cannot drop further than the position of the pointer permits the arm, *x*, to move, and the quantity of alcohol registered is therefore in proportion both to the quantity of the liquid passed through, and to the specific gravity of this liquid. This double proportion is the exact figure representing the quantities of absolute alcohol, and these can be read off directly on the counter, *r r r*. There is another provision yet to be noted in this apparatus. Alcoholic liquids of different densities are liable to settle themselves in a deep vessel like the cylinder, *N*, in distinct superposed layers, according to their specific weight. This must be prevented for the sake of accuracy, and for this purpose the tubes, *c*, *d*, *e*, and *h*, *j*, *k*, are provided, through which the liquid passes into the cylinder, *N*, and out of it. The arrows marked on these tubes in the diagram, Fig. 2, indicate the movement of the liquid within them, and they show that two constant and opposed currents are always maintained throughout the whole height of the vessel. These currents effect a perfect and uniform mixture of the liquid within this vessel, and prevent any stratification such as that just mentioned. The lever, *g*, with the set screws and adjusting screws, *g*, *i*, *l*, serves for adjusting the relative lengths of the levers, *s* and *t*, so as to bring the position of the point, *G*, into exact correspondence with the specific gravity of the liquid. This adjustment being once made, the apparatus is not liable to get out of order, and continues its functions without any readjustment being required for a long time.

PETROLEUM AS FUEL.—The *Army and Navy Journal* (of New York) in describing an experimental trip of the steamer *Palos*, fitted with petroleum furnaces, says: "The *Palos* is a small gunboat, and formerly used four coal fires, and had a crew of twenty firemen and coal-passers. With the petroleum apparatus she requires a crew of only three men, as the supply of fuel is easily regulated, and no cinders or ashes are made. The petroleum is supplied from two large iron tanks placed on deck, each tank having a glass gauge at its side to indicate the height of the petroleum, and a vent-pipe upon the top to permit the escape of vapour. From these tanks the petroleum is conducted by half-inch pipes to the boiler furnaces. It there drops into iron retorts, heated by boilers placed beneath them, and is instantly vaporized. This vapour, in burning, is mixed with steam, decomposed by passing through pipes partially filled with iron filings, and with oxygen supplied by atmospheric air forced in by a common air-pump. The heat thus generated is intense; and it is a noticeable fact that the combustion is so perfect that no smoke is perceptible. A diminution of the supply of air or steam at once creates a smoke. Her engine is about 350 horse power."

RECENT PATENTS.

THE following specifications of completed patents are all dated within the year 1866; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 2895, 6d.) Peter Kirk, of Workington, patents an arrangement of rolls for rolling metals. According to this plan, three rolls, placed one above the other, are employed, the centre roll having fixed bearings, and the upper and lower rolls being adjustable and capable of being moved to and from the centre roll, according to the thickness of metal to be acted on.

(No. 2898, 8d.) George Haseltine, of 8, Southampton-buildings, patents, as the agent of Aaron Higley, Joseph Benjamin Birdsall, and Varium Ogilva Birdsall, of South Bend, U.S., an arrangement of railway brake, which is intended to store up a portion of the power absorbed in stopping a train, and give it out again when required to assist in starting it. The arrangement consists of a friction clutch placed on the axle of the pair of wheels to be acted upon, this clutch, when thrown into gear, causing a chain connected to a spiral spring to be wound on a drum on the axle. At the same time another chain, connected with the spring, is, as the latter is compressed, wound on another drum on the axle in an opposite direction by the reaction of a lighter spring; and when the train is to be started again, the friction-clutch is thrown out of gear, and the compressed spring, acting through the last-mentioned chain and drum, is employed to turn the axle in the direction the train is going. We fear that the spring would take up but a small portion of the power required to stop the train, and that the scheme is far from being carried out in a practical manner.

(No. 2899, 6d.) Charles Churchill, of Norwood, patents, as a communication from Albert Beach, of Newark, New Jersey, U.S., a neat form of chuck for holding drills and similar tools. In this chuck the shank of the drill is held between three jaws, which are capable of moving radially, and which are turned to a conical form on their exterior surfaces. Over these jaws is placed a cap, which is of a correspondingly conical form internally for a portion of its length, the remainder of it being cylindrical, and being screwed on the main body of the chuck. By screwing the cap on to the body for a greater or less distance, the conical part of it can, of course, be made to force the sliding jaws more or less closely together. A similar arrangement is now used by Messrs. Sellers and Co., the well-known tool-makers of Philadelphia, for adjusting the dies in their screwing stocks.

(No. 2900, 4d.) George Haseltine, of 8, Southampton-buildings, patents, as the agent of Asa Hill, of Norwalk, U.S., methods of producing ornamental designs on marble and other calcareous stones by the action of chemical agents which will form combinations with the stone and with each other. Thus, for imparting a red stain, the patentee applies successively a solution of a salt of copper in ammonia and ferrocyanide of potassium; for black, a solution of sulphate of iron and one of gallic acid, and so on.

(No. 2903, 8d.) Alfred Vincent Newton, of 66, Chancery-lane, patents, as the agent of Jacob William Schuckers, of New York, improvements in the construction of reaping-machines. These comprise a cam arrangement for imparting a reciprocating motion to the sickle-bar, and stopping that motion automatically when the machine is backed; a method of connecting the cam and finger-bar so that the former will partially counterbalance the latter; and an arrangement for regulating the height of the cutting apparatus.

(No. 2904, 8d.) William Edward Newton, of 66, Chancery-lane, patents, as the agent of Charles Nivert and Blaise Dussap, of Paris, a method of cleaning the exteriors of buildings, &c. This plan consists merely in the employment of a portable boiler fitted with a Giffard injector, this injector being employed to force a supply of hot water through a hose and nozzle, and another pipe leading from the boiler being used to direct a jet of wet steam upon the surface to be cleaned. The boiler is in some cases to be mounted at the foot of a portable scaffolding from which the jets can be directed.

(No. 2909, 4d.) George Shaw, of Birmingham, patents, as the agent of Conrad Dewies, of Liège, a method of manufacturing coke and "breeze," the object being to obtain a product free, or nearly free, from sulphur and phosphorus. According to this plan, the coal to be coked is powdered and mixed with quicklime or powdered unburnt limestone. The proportion of lime to coal will vary according to the quantity of sulphur or phosphorus contained in the

latter; but generally a mixture of two parts, by weight, of lime to 100 parts of coal is stated to give good results. The mixture of coal and lime is burnt or coked in the ordinary way; and during the coking process, it is stated that the sulphur and phosphorus, combine with the calcium of the lime, forming sulphide and phosphide of calcium. The coke, whilst red hot, is then quenched with a large quantity of water, this water dissolving out the sulphide of calcium, and causing the phosphorus of the phosphide to be eliminated as phosphuretted hydrogen gas. It is also proposed to mix the coal to be used for making coal-gas with a certain proportion of lime, with a view of retaining the sulphur in the retorts in the form of sulphide of calcium, instead of allowing it to pass off and form sulphuretted hydrogen.

(No. 2912, 10d.) James Samuel Cooke, of Abingdon-street, patents, as a communication from Joseph Green Cooke, of Vera Cruz, a form of railway carriage axle-box, in which the pressure of the spring is transmitted directly to the brass or bearing, the brass being capable of moving vertically in the axle-box, and the latter being fitted closely to the collars of the axle-bearing. We shall probably illustrate this axle-box in an early number.

(No. 2914, 10d.) Thomas Horsley, of Kirkly Hall, Puixton, and George Knighton, of Reddings, near Alfreton, patent methods of constructing collapsible core bars or barrels. According to one plan, the core is constructed in three sections, two of these being of large size compared with the third. The small section is fitted on its inner side with a sliding bolt furnished with projecting fingers by which the section is held in place when the core is expanded to its full dimensions. By drawing back this bolt the small section can be removed, and the other section can then contract. Another arrangement is also included in the patent.

(No. 2922, 2s.) Frederick Bernard Döring, of Bayswater, patents improvements in the details of his rock-boring machinery. A description of these improvements was included in our account of this machinery, which we gave on pages 475 and 476 of the second volume of *ENGINEERING*.

(No. 2924, 4d.) William Edward Newton, of 66, Chancery-lane, patents, as the agent of Benjamin Chew Tilghman, of Philadelphia, U.S., methods of manufacturing paper pulp from wood, esparto, and other grasses, and various other vegetable fibres. In making pulp from wood, the latter is to be cut across the grain into slices about $\frac{1}{4}$ in. or $\frac{1}{2}$ in. long; and these slices are to be placed in a strong iron vessel lined with lead, and mixed with a solution of sulphurous acid and sulphate of lime. The vessel is then to be closed and heated by means of a steam jacket to a temperature of about 260° for six or eight hours. The steam is then to be shut off, and the acid solution replaced by water forced in at the top of the vessel. After being washed in this way, the woody substance is left to drain, and if on examination it is found that the fibres are not sufficiently separated and bleached it is again treated with the acid solution.

(No. 2927, 8d.) Henri Adrien Bonneville, of 38, Porchester-terrace, Bayswater, patents, as the agent of Paschal Joseph Hognoul, of Liège, a form of rotary pump, in which a pair of toothed cylinders revolving in a case are employed in the same manner as in Pilliner and Hill's rotary engines, which we illustrated and described on page 564 of our last volume. The pump is intended for raising water or for ventilating purposes.

(No. 2931, 8d.) Henri Adrien Bonneville, of 38, Porchester-terrace, Bayswater, patents, as the agent of Jean Louis Vergniais and Julien Appollinaire Chéron, of Paris, an arrangement of pumping machinery for pumping silt and mud from the bottoms of rivers, &c. The pumps are of the reciprocating class, and we fear that the whole arrangement of jointed pipes, which is somewhat complicated, would be likely to become choked up.

(No. 2940, 2s.) Nicholas Korshunoff, of Birmingham, patents improvements in the manufacture of malleable iron and steel. These consist in forcing into the liquid metal contained in the puddling or other furnace, in which the conversion of the cast iron into malleable iron or steel is to be carried on, the vapour of nitric or chloric acid, or other acid rich in oxygen, and also the vapour hydro acids or other materials rich in hydrogen. Mr. Korshunoff also patents a method of preparing pure cast iron from malleable iron and steel scrap by melting these materials in a cupola with charcoal; and a method of casting hollow steel articles by forcing a tapered core into the metal by hydraulic pressure, this core being removed as soon as the metal is set. This plan for applying hydraulic pressure to steel castings has been anticipated by Mr. Whitworth's patents.

Mr. Korshunoff includes in patent various kinds of apparatus, by the aid of which his plans are to be carried out.

(No. 2943, 1s.) John Henry Johnson, of 47, Lincoln's-inn-fields, patents, as the agent of Josiah Copley, junior, of Alleghany City, U.S., an ingenious machine for manufacturing chains; this machine, which we could not describe without the aid of drawings, forming each link, cutting the scarf or bevel for the weld, and giving the desired overlap for the latter.

TRIAL OF THE RODMAN GUN AT SHOEBOURNNESS.

YESTERDAY week (27th ult.) the first trial was made of the 15 in. Rodman gun lately sent over from America. Its friends have every reason to be satisfied with the results, so far as they go.

The gun, weighing 19½ tons, was mounted on the great wooden carriage formerly used with the 13 in. Horsfall gun, and was fired with two degrees elevation. The trials were for range and accuracy. Fifteen rounds were fired with cast-iron shot averaging rather more than 450 lb. weight. A supply of the large-grained "Mammoth" powder has been sent with the gun, and this was tested against the English large-grain rifle powder, which proved to be about one-fourth stronger. The first seven and the last two rounds were with the American powder, the others with the English. The range was indicated by the first graze upon the sand, the distance of which from the right line gave the accuracy.

The first three rounds were fired with 35 lb. American powder, the ordinary service charge, and gave an average range of 711 yards, the second and third shots, however, going 740 and 737 yards, with a deflection of only .6 yard to the right. Recoil 5 ft., and velocity about 920 ft. per second.

Rounds 4, 5, and 6, were with 50 lb. of the same powder, giving a recoil of 8.7 ft., and a range of about 987 yards. Deflection to right from 2 to 3.2 yards. Velocities, 1110, 1120, and 1133 ft. per second.

Round 7 was fired with the maximum charge of 60 lb. of Mammoth powder, a charge which American officers are strictly forbidden to employ, except as a *dernier resort* against iron-clads. The "soda-water bottle" retreated 10 ft. under its influence, but sent its shot the respectable distance of 1138 yards at a velocity of no less than 1210 ft. per second. Deflection, 1.4 yards only.

Rounds 8, 9, and 10, were with 35 lb. of the English powder, the ordinary service charge of our 9 in. Woolwich gun. These rounds gave good results, especially the ninth, in which the shot flew absolutely true, with a range of 873 yards, and velocity of 1044 ft. per second. Rounds 8 and 10 were but slightly inferior, the greatest deflection in either being 1 yard.

Rounds 11, 12, 13, were with 50 lb. of English powder. Again in round 11 the shot flew straight to the mark; but otherwise in these three rounds the firing improved until No. 13 gave a range of 1140 yards and velocity of 1214 ft. per second. Deflection, 2.4 yards; recoil, 9 ft. 10 in. The general result of this round was slightly better than that of No. 7.

Two more shots were then fired with the full battering charge of 60 lb. Mammoth powder, with much the same result as before, No. 14 again striking in true line. This concluded the experiments.

Of course the real test remains to be applied. Nothing but a thorough trial of this gun against the 8 in. Warrior target and against the target proposed by Mr. Chalmers, if even the Government does that gentleman the tardy justice of fairly trying his plan, can settle the great question of English ordnance *versus* American. There is another way in which it may be settled, but we hope that experiment may long remain untried.

People are ready enough to embark in the turret question—perhaps with more zeal than knowledge as a general rule—because turrets have a visible difference from broadsides, which any landsman can understand. But guns are a little beyond the popular ken, which reaches no further than Armstrong and Whitworth. When the big guns of America are named, it is but for contemptuous dismissal, as barbarisms of the Mons Meg era, propelling, with the wonted inaccuracy of smooth bores, great random shot at low velocities. And are they not cast iron?

After Thursday's experiments we trust we shall hear little more of this parrot cry about *low velocity*. Our own rifled guns, it is true, do more than 1214 ft. per second, but no one in his senses would call that velocity *low*. As regards accuracy, we fancy the results must have surprised some of the judges not a little, while those who understand the radical difference between a hollow-cast Rodman and the old pieces which we (naturally) find useless for rifling, will think hopefully of the material used. When this gun comes to be tested to destruction—as it ought to be—we believe the opponents of cast iron will be somewhat surprised.

But, as we have said, the real question remains to be fought on other lines. Penetration of targets is the true test, or, failing penetration, such utter "racking" as shall shake the plates off bodily. And here we would beg of the Government not to grudge the cost of targets for the coming trial, and even to take the opportunity of erecting a new American laminated target, 15 in. thick, against which to try our own guns. No such important contest has yet taken place, and no money should be begrudged for steel shot, chilled shot, or anything else required. It is difficult to rouse public opinion on these points, or to convince people that the fate of a nation may hang on the way it makes its guns. Have we so soon forgotten Austria and the needle-gun?

The fairest comparison with an English gun would be with the 18-ton 10-inch guns now making specially for the Hercules, but as none of these are ready, it will be necessary to try the Rodman against our 9-inch 250-pounder. Against plating of medium thickness, where the Woolwich bolt will gain entrance nearly every time, it will do more harm by bursting between decks than any number of "racking" blows can do outside; but against very thick plating, Palliser-proof, the great round shot

will probably be the most useful, or the least useless, of the two. Against a wooden or thinly plated ship the large sphere will crush in all before it, while the pointed bolt may but drill a clean hole, and pass delicately through.

However, the question all turns upon the extent of the alleged racking action, and the extent of that must be very great to induce us to give up the penetration system, since it is clearly better to disable the enemy's crew by effective shell fire than to sink him altogether, *a month afterwards*, by "racking" his structure now.

We will add that a 450 lb. shot, at a velocity of 1214 ft. per second, represents an energy of 10,328,400 foot-pounds, and as this was obtained with 50 lb. of powder the work done by each pound was 206,570 foot-pounds. This is far beyond the work done by our powder in our own rifled guns, and is to be attributed in part to the greater room for expansion of the powder gases presented by the large bore of the 15-in. gun. This point is one we have often urged in favour of very large guns.

THE LATE MR. ROBERT HAWTHORN.

THE head of the firm of R. and W. Hawthorn, engineers, of Newcastle-on-Tyne, died on Wednesday week at the age of 71, and was followed to the grave on Tuesday last by about 600 of the men employed at the Forth Banks Works, as well as by many of Messrs. Robert Stephenson and Co.'s men, the works of that firm having been stopped for half a day on the occasion of the funeral.

Mr. Hawthorn and his brother, the sons of Robert Hawthorn, engineer, of Walbottle, were early in the field as locomotive engineers, and nearly 2000 engines have been turned out from their works. Their style of engine was not so distinctive as that of some other makers, although the Hawthorns introduced certain peculiarities, few of which, however, have gained adoption by others. They brought out, years ago, a locomotive boiler with return tubes, and having the chimney over the fire-box. They also introduced the perforated steam-pipe, to draw the steam from the entire length of the boiler. This form of steam-pipe had been patented many years before by Nathaniel Gough, of Manchester, but had not, we believe, been used until the Hawthorns employed it. In many cases it has given good results, but the general opinion of engineers has been against it. Messrs. Hawthorns are generally credited with the first use of compensating levers between the springs of locomotive engines, but they first used these so lately as 1851, twelve years after they had been used by the American engineers, and long after they had been publicly described here. Even yet the compensating levers, which possess undeniable advantages, have made way but slowly. Messrs. Hawthorns introduced an annular safety-valve and some other specialties of construction, but these do not appear to have been adopted by other makers nor even retained in their own practice.

Personally, both Robert and William Hawthorn long enjoyed, and the last named happily still lives to enjoy, the respect of all who knew them through their long and worthy career, and the affection of those immediately connected with them.

NOTES FROM INDIA.

THE Bombay Government has given authority to the Bombay, Baroda, and Central India Railway Company to carry out a complete survey of the projected line from Neemuch to Delhi, with a branch to Agra. The survey from Baroda or Wassud to Neemuch, which was sanctioned some time ago, is nearly finished.

Some Calcutta baboos have formed a "Railway Passengers Society," believing it indispensably necessary that the interests of the passengers should be regularly watched, and all complaints systematically represented and remedied.

It is stated that the Maharajah of Jodhpore has informed Government of his wish to have a railway through his territories.

The Government of India has published a resolution on the reduction of the number of free telegraph messages. They are at present estimated to cost 3,10,123 rupees per annum, and encumber the line, taking precedence of private messages. The Bengal Chamber of Commerce are to be asked if there is now any use for the commercial message sent to Reuter's agent at Bombay twice a month. After three months the long and always badly drawn China and Australian telegrams from Galle are to be sent only to the three presidency cities. The arrival of only the English mail steamers at Bombay is to be telegraphed all over India. The meteorological telegrams are to be arranged in concert with the meteorological committee.

Dr. MacGowan is reported to be progressing satisfactorily with his telegraph negotiations; his scheme embraces Japan, Shanghai, Hong-Kong, the Philippines, Guam, Honolulu, to San Francisco, a total distance of 7200 miles. Gas is being introduced at Peking, at the customs Yamén, in order to show the Chinese its mode of use and preparation.

The Memorial Church at Delhi was opened on May 11th, the tenth anniversary of the mutiny at that place. The edifice was crowded by native Christians, and a large number of Hindoos and Mahomedans remained during the opening services.

The erection of a new building for the Bombay secretariat has been commenced on the esplanade, on the site of the old ramparts, and not far from the band-stand. The edifice has been designed by Captain Wilkins, R.E., and the cost of the building is to be between twelve and thirteen lakhs of rupees.

Cokone Walker, inspector-in-chief of the Bombay cotton frauds department, estimates the breadth of land, in the Bombay Presidency, sown with cotton in 1866-67 at 1,955,366 acres, of which 752,085 acres are under the exotic varieties. The total breadth under cultivation in 1865-66 he states at 1,766,400 acres. He estimates the produce of the crop of 1866-7 at 94,766,794 lb., of which 35,579,089 lb. are exotic, against a total of 82,698,257 lb. actual turn out in 1865-66.

LIVERPOOL DOCKS.—The House of Lords has rejected an application from the Mersey Docks and Harbour Board for powers to raise a further sum of 1,100,000*l.* Already the bonded debt of the Board is 13,000,000*l.*, and the Lords seem to consider this quite enough. In the seven years ending 1866 the Board appears to have added 6,000,000*l.* to its bonded debt. However, the income in 1866-7 was 866,000*l.*

THE PARIS EXHIBITION DISTRIBUTION OF PRIZES.

GRAND PRIZES.

THE following is the list of the grand prizes distributed by the Emperor last Monday:

GROUP I.—*Fine Arts*.—Gabanel, Gérôme, Ernest Meissonier, and Théodore Rousseau, France; Guillaume de Kaulbach, Bavaria; Knaus, Prussia; Leys, Belgium; Ussi, Italy; Eugène Guillaume and Perraud, France; Drake, Prussia; J. Dupré, Italy; Ancelet, France; Ferstel, Austria; Waterhouse, England; Alphonse François, France; J. Keller, Prussia.

GROUP II.—*Materials of the Liberal Arts*.—Alfred Mame and Son, Books and Binding, Tours, France; Japan, Paper, Industrial Arts, Lacker, Culture of the Silkworm; De Jacobi, Application of galvanic-electricity to the arts, St. Petersburg; Garnier, Heliographic engraving, Paris; Adolphe Sax, wind instruments in brass, Paris; J. L. Matthieu, Surgical instruments, Paris; Father Secchi, Meteorograph and meteorological and astronomical labours, Pontifical States; Brunetti, Anatomical preparations, Padua; Eichens, Astronomical instruments, Paris.

GROUP III.—*Furniture*.—Fourdinot, Furniture and tapestry, Paris—Klagman, Works of art—Baccarat Company, Crystals, France.

GROUP IV.—*Clothing*.—City of Lyons, Institutions created to favour silk manufacture, France.

GROUP V.—*Raw Materials*.—Krupp, cast steel, Essen, Prussia; Petit and Gaudet, cast steel and iron, Rive-de-Gier; Schneider and Co., iron, Le Creusot; Japy Brothers, hardware, lockwork, and clockwork, Beaumont, France; Bessemer, manufacture of steel, London; Iriana, collection of medicinal and industrial plants, Bogota, New Granada; Algeria, cultivation of cotton; Brazil, do.; Egypt, do.; Ottoman Empire, do.; British India, do.; Italy, do.; A. W. Hoffman, discovery of aniline colours, Berlin.

GROUP VI.—*Machinery*.—Schneider and Co., working of coal mines, forges, and foundries of Le Creusot; Kind and Chaudron, procedure of bracketing the shafts of the Saint-Avoid Company, Saxony and Belgium; C. W. Siemens, gas stoves, London; C. F. Hirt, Teldynamic cables, Logelbach, France; Farrot and Sons, steam-engine, Saint-Ouen; Whitworth and Co., machine tools, Manchester; P. Meynier, loom for weaving flowered silk, Lyons; P. Viguier, railway signals, Paris; Cyrus Field and the Anglo-American Companies of the Transatlantic Cable; the Transatlantic Cable, United States; Hughes, telegraphic printing, New York; Universal Company of the Maritime Canal of Suez, models and designs, Paris; F. Hoffmann, Annular brick kiln, Berlin.—British Life-boat Association, organisation of means for saving life, creation of the material, England; New Society of foundries and workshops of the Mediterranean, models of ships and naval engines, Paris; R. Napier and Son, models of ships, Glasgow; J. Penn and Son, marine steam-engines, Greenwich.

GROUP VII.—*Horticulture*.—Pasteur, Method of preserving wines by heating, Paris.—H. Maës, Propagation of the procedure of sulphuring the vine, Montpellier.

GROUP IX.—*Agriculture*.—Emperor of Russia, Improvement of the equine race.

GROUP X.—Objects recommended by their useful qualities, combined with cheapness and productions, the object of which is the improvement of the physical and moral condition of the people.—The Emperor of the French, Workmen's houses, Model farms; Geneva Committee, founder of the international work of succour to wounded soldiers. Documents, statutes and material, Switzerland; Sanitary Commission of the United States, Material having served in the war of 1861, United States; Henri Dufresne, damascene engraver; new method of gilding on copper and silver without danger to the workmen, Paris.

GOLD MEDALS.

At the risk of some slight repetition we add the names of all the English exhibitors who have obtained gold medals:

GROUP I.—FINE ARTS.

Class 4.—Grand prize, A. Waterhouse.

GROUP II.—APPARATUS AND APPLICATIONS OF THE LIBERAL ARTS.

Class 6.—Printing and Books.—Gold Medal, V. Brooks.

Class 7.—Paper, Stationery, Binding, Painting, and Drawing Materials.—Gold medals, Cowan and Sons and T. H. Saunders.

Class 8.—Application of Drawing and Modelling to the Common Arts.—Gold medal, Department of Science and Art, South Kensington.

Class 10.—Musical Instruments.—Gold medal, Broadwood and Sons.

Class 11.—Medical and Surgical Instruments and Apparatus.—Gold medal, Ash and Sons.

Class 12.—Mathematical Instruments and Apparatus for Teaching Science.—Gold medals, Dallmeyer, T. Ross, R. and J. Beck, and Chance Brothers.

GROUP III.

Classes 14 and 15.—Fancy Furniture, Upholstery, and decoration Work.—Gold medals, Wright and Mansfield, and Owen Jones, decorative architect.

Class 17.—Porcelain, Earthenware, and other Fancy Pottery.—Gold medals, Minton and Co., and W. Copeland and Sons.

Class 18.—Carpets, Tapestry, and other Stuffs for Furniture.—Gold medals, British India, J. Templeton, and Brinton and Lewis.

Class 19.—Paper-hangings.—Gold medal, C. and J. G. Potter.

Class 20.—Cutlery.—Gold medal, Brookes and Crookes.

Class 21.—Gold and Silver Plate.—Gold medals, Elkington and Co., Hunt and Roskell, C. H. Hancock; and Morel-Ladeuil, co-operator.

Class 23.—Clocks and Watches.—Gold medals, J. Poole, Victor Kulberg, and Parkinson and Frodsham.

Class 24.—Apparatus and Processes for Heating and Lighting.—Gold medal, Windfield and Co.

GROUP IV.

Class 27.—Cotton Thread and Fabrics.—Gold medals, Collective Exhibition of Scotland and England, Armitage and Sons, H. Bazley, Radcliffe and Co., and Horrocks, Miller, and Co.

Class 28.—Thread and Fabrics of Flax, Hemp, &c.—Gold medals, Belfast Chamber of Commerce, Charley and Co. Fenton, Sons, and Co., and J. S. Brown.

Class 29.—Combed Wool and Worsted Fabrics.—Gold medals, Bradford Chamber of Commerce, and J. Ackroyd and Sons.

Class 30.—Carded Wool and Woollen Fabrics.—Gold medals, Cloth manufacture in the south of Scotland, and manufacturers of the west of England, for the towns of Gloucestershire and Wiltshire.

Class 31.—Silk and Silk Manufactures.—Gold medal, Great Britain.

Class 32.—Shawls.—Gold medal, Dewan Sing.

Class 33.—Lace, Net, Embroidery, and Small Ware Manufactures.—Gold medal, town of Nottingham.

Class 34.—Hosiery and Under-clothing, and articles appertaining thereto.—Gold medal, McIntyre, Hogg, and Buchanan.

Class 36.—Jewellery, Precious Stones, etc.—Gold medal, Phillips.

GROUP V.

Class 40.—Mining and Metallurgy.—Gold medals, J. Brown and Co., Johnson, Matthey, and Co., Bowling Iron Company, Barrow, Low Moor Company, Lillishall Company, New South Wales Commission, Burys and Co., Monkbridge Iron Company, and Thomas Turton and Sons. Co-operators, Grand Prize, Bessemer.

Class 41.—Products of the Cultivation of Forests, and of the trades appertaining thereto.—Gold Medal, Abbé Brunet.

Class 43.—Agricultural Products (not used as food) Easily Preserved.—Grand prize, British India; gold medal, Towns.

Class 44.—Chemical and Pharmaceutical Products.—Gold medals, C. Allhusen, Gossage and Sons, Muspratt and Sons, Jarrow Chemical Company, Howard and Sons, Price's Patent Candle Factory, and J. Young.

GROUP VI.

Class 48.—Agricultural Apparatus.—Gold medals, J. and F. Howard, Clayton, Shuttleworth, and Co., J. Fowler and Co., R. Garrett and Sons, Ransomes and Sims, and R. Hornsby.

Class 51.—Apparatus used in Chemistry, Pharmacy, and in Tanneries.—Grand prize, C. W. Siemens; gold medal, John Matthey, and Co.

Class 53.—Machines and Apparatus in General.—Gold medal Merryweather and Sons.

Class 54.—Machine Tools.—Grand prize, Whitworth and Co.; gold medals, Sharp, Stewart and Co.; Shepherd, Hill, and Co.

Class 55.—Apparatus and Processes used in Spinning and Rope-making.—Gold medals, S. Lawson and Sons, and Platt Brothers and Co.

Class 56.—Apparatus and Processes used in Weaving.—Gold medal, Howard Bullough, J. Leeming and Sons, and G. Hodgson.

Class 61.—Carriages and Wheelwright's Work.—Gold medal, T. Peters and Son.

Class 63.—Railway Apparatus.—Gold medals, Kitson and Co., R. Stephenson and Co., and Saxby and Farmer.

Class 64.—Telegraphic Apparatus and Processes.—Grand prize, Anglo-American and Transatlantic Cable Company, Gold medals, W. Hooper and W. T. Henley.

Class 65.—Civil Engineering, Public Works, and Architecture.—Gold medals, Chance Brothers, Minton and Co.

Class 66.—Navigation, Marine Engines, Life-boats, &c.—Grand prizes, Royal National Life-boat Institution, R. Napier and Sons, J. Penn and Son. Gold medals, Laird Brothers, Maudslay, Sons, and Field, Thames Ironworks Company, Randolph, Elder, and Co., Samuda Brothers, Humphrys and Tennant, and E. Clark.

GROUP VII.

Class 67.—Cereals and other eatable farinaceous products, and the products derived from them. Gold medal, A. Bell.

Class 70.—Meat and fish. Gold medal, Commission of Nova Scotia.

Class 72.—Condiments and stimulants, sugar and confectionery. Gold medals, E. Hery, C. Wulfe, H. Pitot, district of Assam, districts of Cachar, of Debra Dhoon, Kumaon, Bengal, and of Neigherry Hills.

Class 78.—Fermented drinks. Gold medal, Allsopp and Sons, and Bass and Co.

GROUP X.

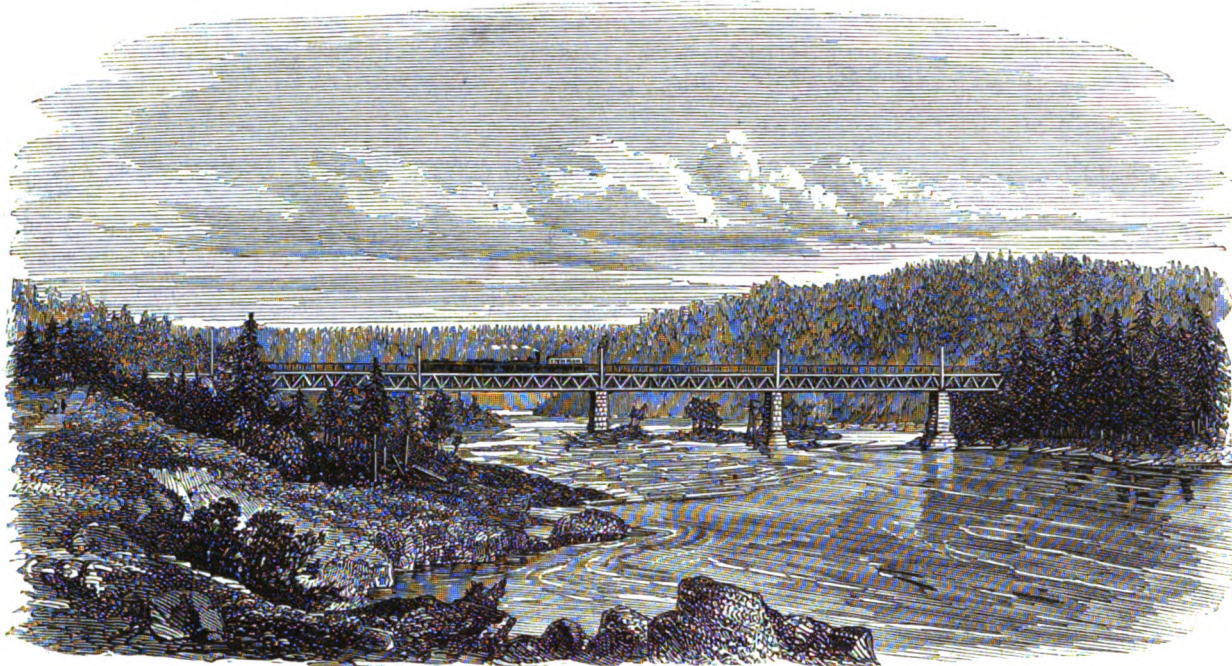
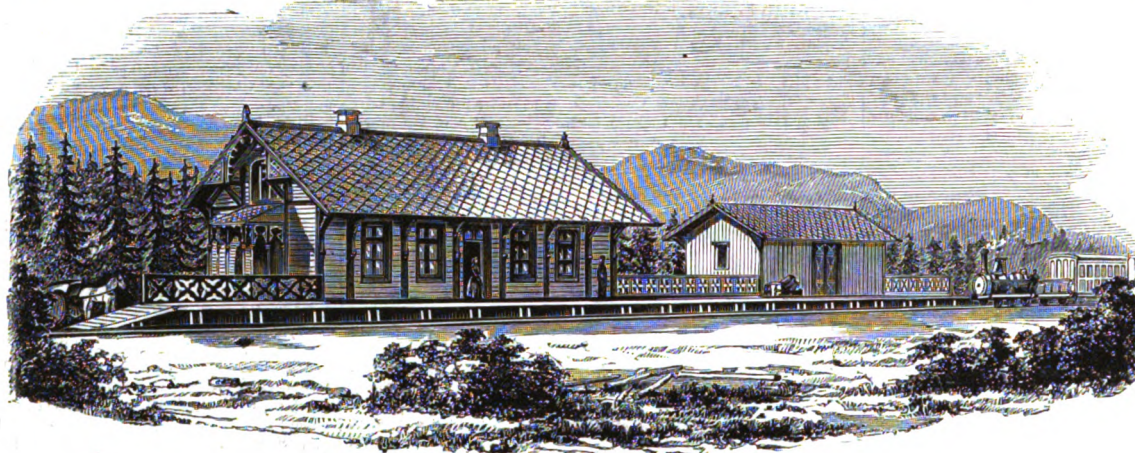
Class 90.—Gold medal, Book Hawking Union, South Kensington.

DECORATIONS GIVEN BY THE EMPEROR TO EXHIBITORS AT PARIS.—The Emperor has decorated with the ribbon of the Legion of Honour a large number of officials, French and others, connected with the Exhibition, as also several of the principal exhibitors. The English law prevents the acceptance of these decorations by Englishmen, and thus none were given to our countrymen. Two Canadian exhibitors, however, Mr. Sterry Hunt and Mr. William Logan, were created officers of the Legion of Honour, and the following officials and exhibitors from the United States were also decorated as follows: with the rank of Officer, Mr. Beckwith, Commissioner-General and President of Commission. Knights: Mr. C. Perkins, Member of Special Jury; Mr. Lawrence Smith, V.P. of Group V.; Mr. S. B. Ruggles, Member of Commission; Mr. Goodwin, sewing-machines; Mr. Berney, Member of the Jury; Mr. Elias Howe, sewing-machines; Mr. Kennedy, Member of Commission; Mr. Mulat, engineer; Mr. Chickering, of Boston, pianofortes.

BELGIAN RAILS.—The exports of rails from Belgium in the first four months of this year amounted to 32,405 tons, as compared with 18,425 tons in the corresponding period of 1866. The deliveries to Russia to April 30 this year were 29,465 tons, as compared with 5800 tons in the corresponding period of 1866. The exports of Belgian rails this year to countries other than Russia present, then, a diminution of about 10,000 tons as compared with the corresponding period of 1866.

GAS IN PARIS.—Although the revenue of the great Parisian Company for Lighting and Heating by Gas experienced in 1866 and 1865 an enormous expansion, the receipts of the undertaking have presented a great further advance this year. To May 31 this year this increase was 47,621*l.*, or 9.19 per cent., as compared with the corresponding period of 1866.

THE RAILWAY SYSTEM OF NORWAY.



NORWAY, although comprising an area about three times as great as that of England, has a population of but about 1,700,000 inhabitants. Of that part of the population distributed along the coasts, the greater number are engaged in maritime pursuits and in the various fisheries; whilst in the interior of the country the inhabitants are occupied principally in agriculture and the raising of cattle, and in felling timber, which latter is at a slight expense floated down the rivers to the various seaports. During the last thirty years a sum which, in proportion to the resources of the country is of considerable amount, has been expended in the improvement and reconstruction of the main roads which lead from the interior to the seaport towns, and connect the latter with each other, this sum having been provided by the State, with the exception of a small portion subscribed by the various corporations. As a general rule, the roads are maintained by a tax levied on the inhabitants of the various towns through which they pass, there being no turnpikes.

The first railway constructed in Norway was a line 42½ miles in length extending from Lake Mjøsen—in the neighbourhood of which are some of the most fertile districts of the country—to Christiania, the capital. This line, which is of the ordinary gauge of 4 ft. 8½ in., was carried out under the direction of the late Mr. Robert Stephenson, and it was principally constructed by private capital, English and Norwegian. It was opened in 1854. In 1861, a branch, extending from the above line to the town of Kongsvinger, was completed, this branch, which was also made to the 4 ft. 8½ in. gauge, being constructed at the ex-

pense of the State; and more recently, in 1865, this line was extended to near the Swedish frontier, its length being now 71½ miles. It is hoped that in a few years a connexion will be made between this railway and one already commenced in Sweden, and that the railway systems of the two countries will thus be united. Of the railways above mentioned, the first was laid with bridge rails on longitudinal timbers, and the second with Vignoles rails on transverse sleepers; and one-third of the first line has since been relaid with transverse sleepers and Vignoles rails.

Although the receipts on the line between Christiania and Lake Mjøsen have given a fair percentage of profit on the original outlay, yet in most parts of Norway it is, owing to the thinness of the population, essential that a line of railway, if constructed, should, if it is to pay, be constructed in a cheaper manner than the lines above mentioned. It is for this reason that Mr. Carl Pihl, the engineer-in-chief of the Norwegian State railways, has adopted for the lines more recently constructed the reduced gauge of 3 ft. 6 in., and it is these lines with their rolling stock that we more particularly intend to describe in the present notice. At present three of these narrow-gauge lines have been constructed in Norway. The first, nearly 24 miles in length, reaches from the town of Hamar, near Lake Mjøsen to Elverum, from which point it is proposed to extend it up to the valley of Glommen to meet a line from Trondhjem, already in operation. This last mentioned line—which is, we believe, the most northerly line which has as yet been constructed—Trondhjem lying in 62½° north latitude—extends from

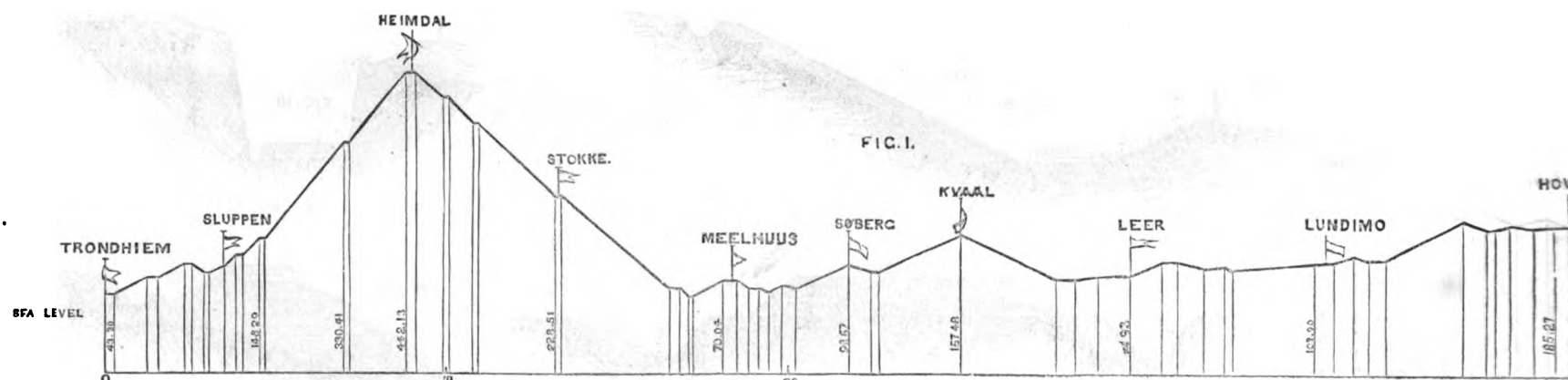
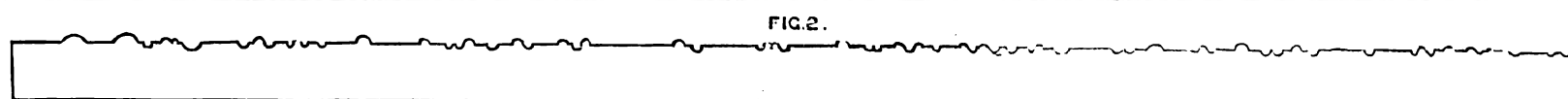
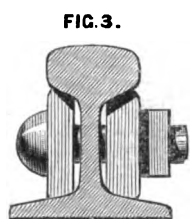
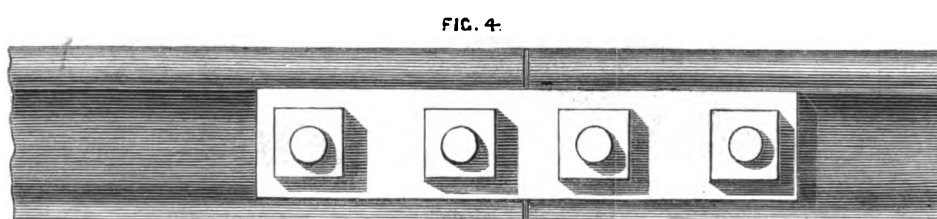
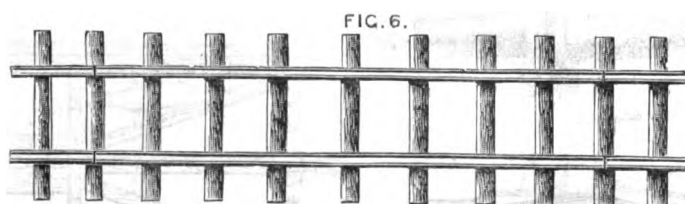
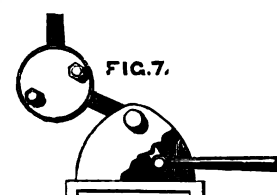
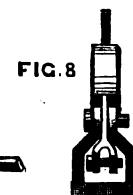
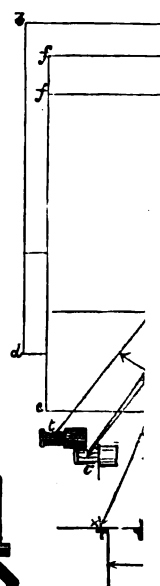
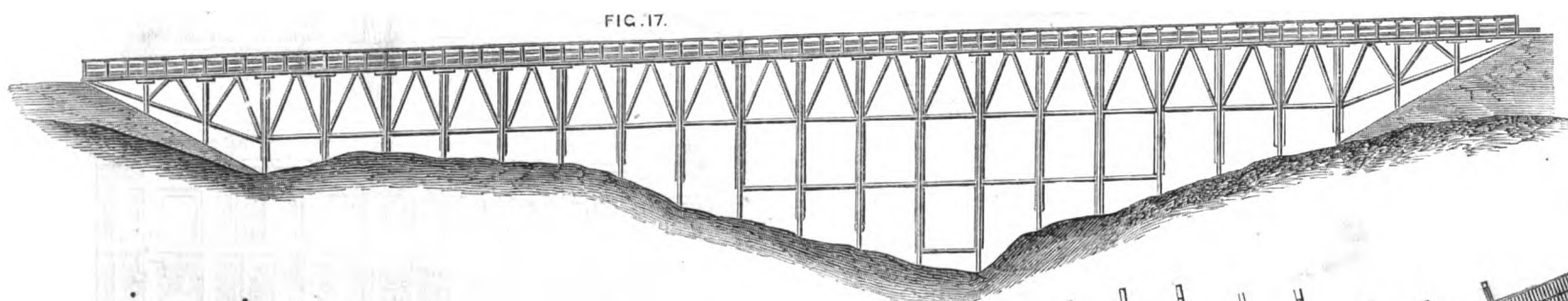
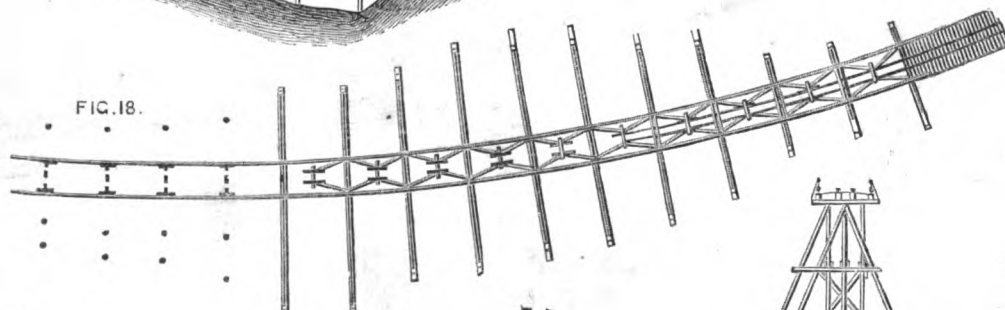
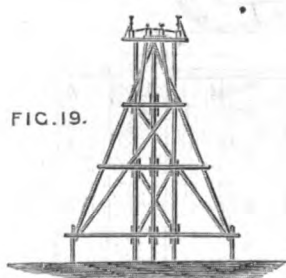
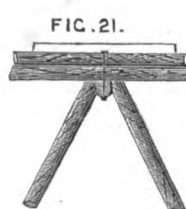
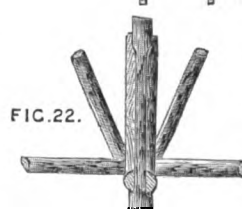
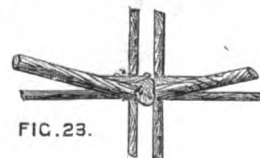
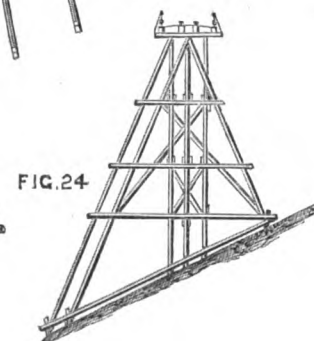
Trondhjem in a southerly direction, down the Guldalen valley, and at present terminates at Stören; but it is intended to prolong it to the town and mines of Røraas. The length of the Trondhjem and Stören line is 30½ miles. The third narrow-gauge railway, which is at present in course of construction, will extend from Drammen to Lake Randsfjorden, a distance of 56 miles, and a portion of it, that between Drammen and Lake Tyrifjorden is already completed, and was opened to the public last autumn. Of the details of construction of all these lines we shall have more to say presently.

We have already, on several occasions, considered in this journal the question of how much the original cost of a line of railways is influenced by its gauge; and we have stated it to be our conviction that practically, within reasonable limits, the fact of a railway being made to a 4 ft. 8½ in. or 3 ft. 6 in. gauge matters but little, so long as in each case the line is constructed to carry the same class of traffic. In other words, we believe that so long as a given weight of train and engines and a given speed of working are adhered to, it will not greatly affect the cost of the line whether their gauge is made a few inches wider or narrower; and that the economy of construction of the so-called "narrow-gauge" lines in Norway and elsewhere has been due not to the fact of narrowness of their gauge, but to their being lines for light traffic, and to this latter fact having been kept well in view in the designing of the whole of the details of their permanent way and rolling stock. These details, which have, in the case of the Norwegian lines, all been planned with great

THE RAILWAY SYSTEM OF NORWAY; DETAIL

M. CARL PIH

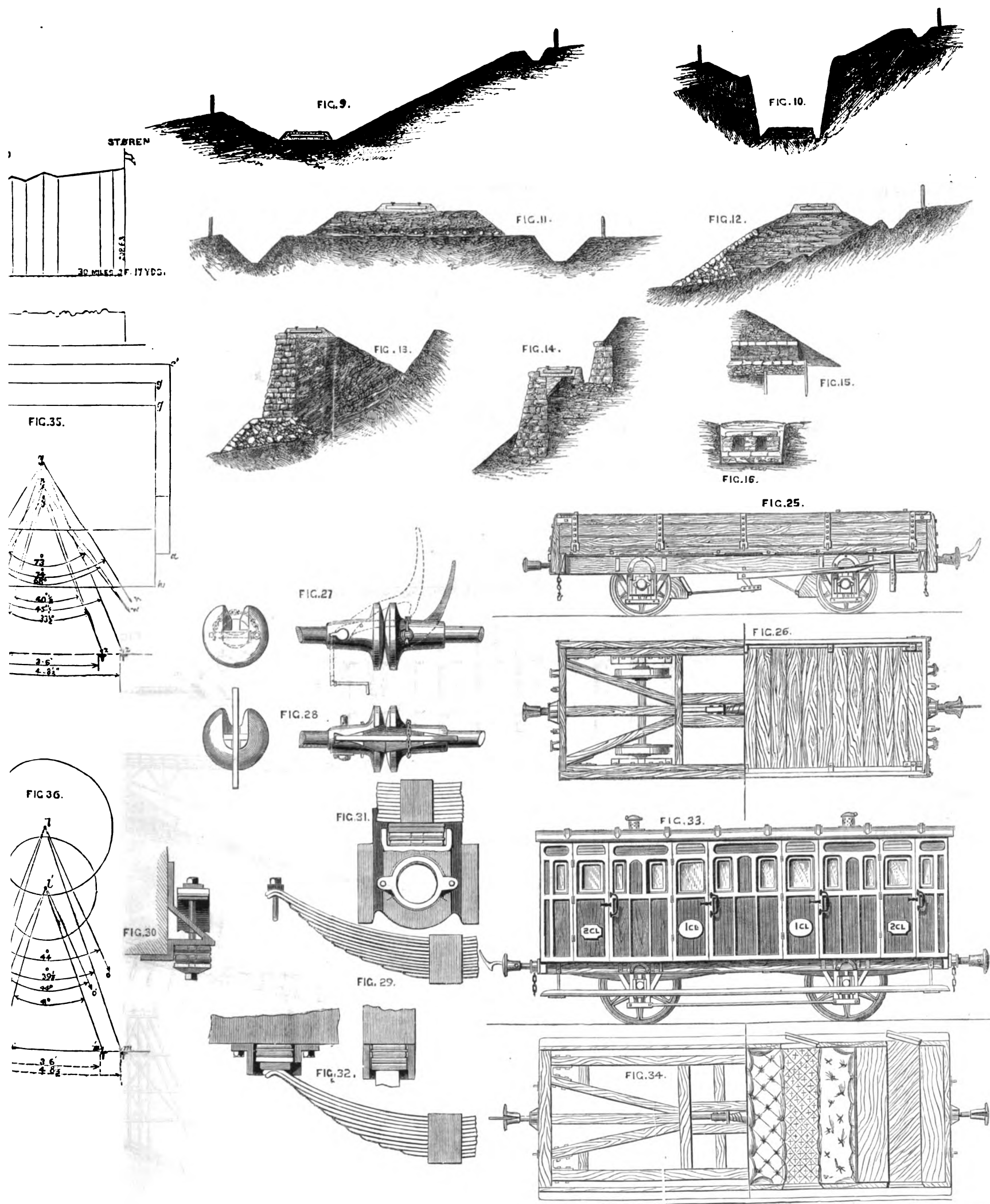
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OF PERMANENT WAY AND ROLLING STOCK.

ENGINEER.

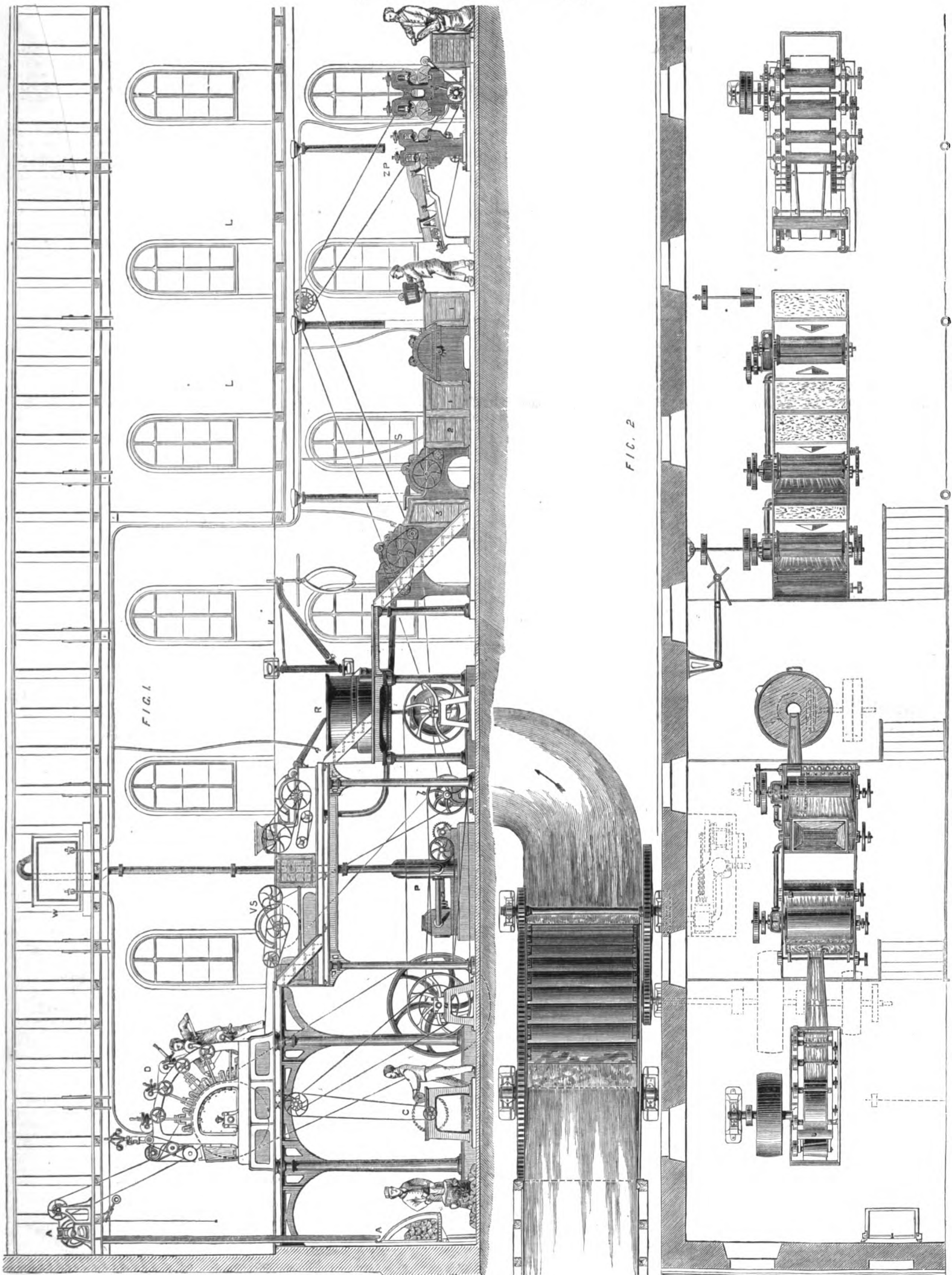
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MACHINERY FOR MAKING PAPER FROM WOOD, AT THE PARIS EXHIBITION.

CONSTRUCTED BY M. HEINRICH VOELTER, ENGINEER.

(For Description, see opposite Page.)



NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Clyde Shipbuilding.—The shipbuilding trade on the Clyde is still dull, but hopes are entertained that in the course of a month or two there will be a decided revival. The late purchases of some of the stock of steamers lying at Liverpool and the Clyde ports have relieved the market considerably, and it is expected that the future demand will thus have recourse to new contracts. The following is a tabulated statement of the number and tonnage of vessels launched during last month and the six months which it terminates:

	1865.	1866.	1867.
Vls. Tons.	Vls. Tons.	Vls. Tons.	
Month	20 19,000	12 6,600	12 6,000
Six Months ...	136 87,300	124 63,700	95 58,800

Of the steamers, the following are amongst the services for which they are intended: The Uruguay, 745 tons, River Uruguay passenger traffic; Trojan, 850 tons, Mediterranean Anchor Line; Erin, 450 tons, Glasgow and Londonderry trade; Palermo, 400 tons, Clyde and Spanish trade; Corsair, 160 tons, Clyde and Highland trade; Pelican, 109 tons, Bordeaux Ocean Fishery Company; Giraffe (screw yacht), 8 tons, pleasure sailing. The following are the principal sailing vessels and their destinations: Carnarvon Castle, 1200 tons (iron), East India trade; Reichstag, 750 tons (iron), Hamburg and New York trade; Mianie, 541 tons (iron), South American trade; Nyanza (composite schooner yacht), 200 tons, Earl of Wilton, Commodore of Royal Yacht Squadron.

Clyde Harbour Trust.—Notwithstanding the dullness of the engineering, shipbuilding, and other important local trades, it is gratifying to learn that, at the meeting of this Trust yesterday, the following statement regarding the revenue was submitted by the treasurer:

	£	s.	d.
Month of June, 1867	...	...	16,258 12 1
" " 1866	...	...	13,885 15 2
Increase	...	...	2,372 16 11
Year ended June, 1867	...	...	181,861 11 2
" " 1866	...	...	125,787 10 0
Increase	...	...	£6,074 1 2

It was mentioned that the revenue for last month was the largest which the trustees had ever had to announce.

Glasgow Customs Revenue.—The following figures speak for themselves. They show most unmistakably that the shipping trade is in a tolerably healthy state:

	£	s.	d.
Month ended June 30, 1867	...	...	103,440 9 7
" " 1866	...	...	71,140 11 8
" " 1865	...	...	74,464 3 9
Quarter ended June 30, 1867	...	...	277,830 17 5
" " 1866	...	...	203,938 1 2
" " 1865	...	...	181,927 11 5

Greenock Customs Returns.—Our neighbouring town, Greenock, naturally follows next in order. Judging by the following figures, there is a hopeful future for it:

	£	s.	d.
Month ended June 30, 1867	...	...	134,657 14 6
" " 1866	...	...	108,086 10 1
" " 1865	...	...	96,840 6 5
Quarter ended June 30, 1867	...	...	384,862 4 9
" " 1866	...	...	356,293 10 2
" " 1865	...	...	290,492 13 3

Leith Customs Returns.—The returns from Leith bear only on the month and quarter just ended as compared with the same periods in 1866:

	£	s.	d.
Month ended June 30, 1867	...	...	54,761 14 8
" " 1866	...	...	42,764 4 7
Quarter ended June 30, 1867	...	...	173,416 9 9
" " 1866	...	...	126,692 6 4

We have no desire to extend these statistical details any further. It is only once a quarter, at most, that they can come under our notice; and as the returns are so striking, in respect of the three ports named, they are worth putting on record in this place.

Leith New Docks.—The trade of Leith, chiefly shipping, is in a somewhat prosperous state. During the year ending Whit-sunday, 1866, there was an increase of revenue to the Dock Commission of nearly 11,000*l.* over that of the preceding year, and the income of the year just closed is expected to be larger than that of any previous year. Hitherto the loading and discharging of ships have been carried on at a great disadvantage; but henceforth this state of things is to be remedied, as a new dock is being constructed with all due speed. By means of a reclaiming wall and clay walls, no less than 36 acres of ground have been secured from the sea. The dock itself is to cover nearly 11 acres of this reclaimed ground; then there is to be an outer basin, of between 2 and 3 acres; and besides these there is to be a connecting lock, 350 ft. long by 60 ft. wide, with a depth of water on the sill of 25 ft. 5 in. at high water of spring tides. This will give 23 ft. and upwards on the sill at 396 tides in the year, and thus even very large steamers may enter or leave the dock any time between half flood and half ebb. At present the contractor, Mr. Scott, has in requisition, to further the progress of the works, such appliances as lime-kilns, mortar mills, railways, inclined planes, platforms, hoists, &c. It is expected that nearly all the quay walls and sill will be built ere winter sets in, and that by June next the dock will be ready for the reception of vessels; but even then much will remain to be done, such as completing the quays, making roads, fitting up cranes and sheds. The machinery for opening and shutting the dock-gates will be so arranged that at any time hydraulic machinery may be applied to it. The resident engineer is Mr. Robertson.

Southern Lighthouse.—A letter has just been received from the secretary of the Northern Lighthouse Commissioners, by the clerk to the Nith Navigation Trustees, stating that the commissioners have come to the resolution that the best course is to leave the Nith Trustees to take their own course, and upon their own responsibility, and that legal proceedings will not be in-

stituted. It will thus be seen that the resolution arrived at some time since, on the part of the Nith Trustees, to discontinue the Southern Lighthouse from the first of the present month, is not to be interfered with. It is not unlikely, however, that the question will again be revived.

Gunpowder Shipments from the Clyde.—Among the "things not generally known" is the fact that gunpowder is very largely manufactured in several of the glens leading into the Firth of Clyde in its lower reaches. On account of the proximity of the several powder-mills to Glasgow and Greenock, the charcoal, sulphur, and refined saltpetre can be obtained on very economical terms, and the gunpowder itself manufactured very cheaply. During the past month there were shipped at the Tail of the Bank, and entered at Greenock Custom House, 380,552 lb.; there were also shipped during the preceding five months, 1,373,394 lb.; and ex-Forth and Clyde Canal, and included in Glasgow clearances, there were shipped 38,000 lb. The total during the half-year is 1,791,946 lb., or 7994 tons.

Paris Exhibition: West of Scotland Prize-takers.—Scotland has not exhibited largely, or even moderately, in the Paris Exhibition; still, however, some few of the prizes have come this way. One of the three grand prizes which come to Britain is awarded to Messrs. Napier and Son; one of the seven gold medals is awarded to Messrs. Randolph, Elder, and Company, engineers and shipbuilders; a silver one is awarded to Messrs. Denny, of Dumbarton; and, as might be expected, a gold medal to Mr. James Young, of the Bathgate, Paraffin Oil and Paraffin Candle Works.

Forthcoming British Association Meeting at Dundee.—The Industrial and Artistic Exhibition, on the occasion of the forthcoming meeting in Dundee, promises to be a great success. Numerous valuable offers of contributions have already been made. Distinguished members of the Association have signified their intention of being present at the meeting in September. The Earl of Airlie has already signified his readiness to entertain one hundred visitors during one of the excursions from Dundee, and the Earl and Countess of Strathmore have followed the Earl of Airlie's excellent example. Arbroath, a neighbouring town, and, like Dundee, devoted to the flax and jute trade, is also making an effort to dispense hospitalities suitable to the occasion.

The Yacht Fiona—a Correction.—This famous Clyde yacht did not run at the Western Yacht Club Regatta, as we announced last week. No other yacht present at Queenstown (not Kingstown) would run with her for the Queen's Cup, and consequently it was not competed for. The second race was made first, and it is it which should have been mentioned in the telegram on which we depended, whereas it was the *Dione* which won the 40*l.* prize announced for the second, and not the *Fiona*.

THE ARMSTRONG-RUSSELL CASE.

TO THE EDITOR OF ENGINEERING.

SIR,—Having read your articles upon the subject of the Armstrong-Russell inquiry, I venture, with some misgiving as to the propriety of adding to the discussion, to make the following observations with the full confidence that, should you deem it undesirable to print them, it will not be because they, to some extent, run counter to your own views.

In the first place, let me say that I think the Annual General Meeting of December 18th, 1866, was not competent to entertain a question of the kind. I say this, having before me the by-laws and regulations of the Institution, and with clause 3, section 11, on the open page, I hold that a special general meeting should have been convened by the council; since it was the council (as I understand it) who, by two of their members, initiated the inquiry. The subject would then, I believe, have been approached with great caution and dealt with more deliberately by an assembly met with pre-knowledge of the object of the meeting thus specially called. Possibly it would have referred the matter to a select committee, as less liable to influence from foregone conclusions than the members of council, who had already had the subject under consideration.

I attended the meeting of 10th April last in ignorance of the nature of the imputations affecting Mr. Russell. My impression remains that the majority of the meeting, knowing little or nothing of the matter the council then reported upon (in terms sufficiently vague), were indisposed to be hurried into adopting a motion that followed very quickly upon the report, but, on the contrary, impressed with the notion of some informality in the procedure, and in great doubt as to the subject being one for the consideration of the Institution, were glad to see in the second amendment a way to escape from a painful dilemma.

That we did not so escape, I must say, I think is attributable to the course Mr. Russell then and there elected to take.

Surely it will not be disputed that the unanimous feeling of the meeting went with those friends of Mr. Russell who appealed to him to withdraw—with an "amende honorable"—the severe reflections he had that day cast upon the motives of the majority of the council, nor that all were pained by his persistently refusing to do so.

Challenged, then, by a member of council either to withdraw those imputations, or to move "that the papers and evidence laid before the council be printed and circulated" to the members and associates, Mr. Russell chose the latter course. The issue involved the reputations of the majority of the council, as well as the character of Mr. Russell.

Having had the opportunity of studying the details of the inquiry, and having heard Mr. Russell reply to the council and their supporters, a very large majority of the meeting voted in sustaining the report, and thus acquitting, as fully as they could, those members of the council upon whose motives Mr. Russell had reflected so injuriously. Sir, I think it due to those who thus voted, and to the council, that these facts should not be lost sight of in a discussion that is becoming rather extended. I would take the liberty of adding, with all respect, Sir, to yourself and those who think with you, that it would have been better for the interests of Mr. Russell, and of the Institution of Civil Engineers, that the friends of the former should have abstained from public discussion of the result of the challenge Mr. Russell accepted under the circumstances I have referred to.

Suffer me, in conclusion, to say that I have never had any communication with Mr. Russell, or with Sir W. Armstrong, or

with any one connected with either of them. Associated to some sixteen years with the Institution, I have always looked upon Mr. Russell as a man we might well be proud of, and I grieve that this wretched inquiry should ever have been entered upon. I beg to remain, Sir, yours faithfully,
Irox.

THE CORLISS ENGINES.

TO THE EDITOR OF ENGINEERING.

SIR,—*Provincialism* seems to be the head and front of my offending in the eyes of "Observer"—a man who happens to live in Kirkcaldy is, for that reason, less than nobody. By the way, I never saw it urged against Adam Smith by any who differed from his theories of the "Wealth of Nations," that he lived and wrote in Kirkcaldy. This hint may be useful to some future "Observer" in the region of political economy.

Neither my time nor your space can be taken up with replying to such fanfaronade as "Observer" delivers himself of in your last. When he is no longer afraid or ashamed to give his name, he can, if he chooses, have full satisfaction on various points regarding which he now confesses or professes ignorance. It is sufficiently evident that he has much to learn, and it just shows how much value is to be attached to the letters of anonymous scribblers, when you find one penning such manifest absurdities as were contained in his first letter, and referring to them in his second as "adverse undeniable facts and damaging arguments." Truly a little knowledge is a dangerous thing. Your correspondent knows as much of Mr. Corliss, of his splendid engine factory, and of the theory and practice of the Corliss engine, as he does of the provincial engineer who now addresses you, who never was heard of beyond the town where he dwells, and whose testimony "acts as a negative quantity" upon an *unknown quantity*, like "Observer."

When he descends from the regions of fancy, he will perhaps favour the world with his definition of a "common engine," this being the type on which his affections are set. In the provinces we don't know what a "common engine" means: that may be owing to our boorish thick-headedness. Is the Allen engine a "common" engine? Does its valve-gearing belong to the "unquestionable rattletrap" order? And as for the Corliss engine, let us have proof, not loose assertion, as to the unsatisfactory and delusive working of this "sterile expedient," this "futile machine," this "pernicious nostrum," which is to be "forced" "down the throat" of "Observer" as he may have swallowed some nauseous specific of quackery.

Your correspondent, Mr. Pinchbeck, writes in a very desponding strain. In choosing or recommending a steam-engine, he does not attempt to go in for one possessing the *best* qualities: all that he ventures on is to "choose the lesser evil;" and this, he adds, somewhat enigmatically, "is eminently the case with the Corliss engine." He joins in the "rattletrap" condemnation, at the same time admitting that the principle of the Corliss engine is good; that it may give a better result than from a slide cut-off; and that the regulation of expansion by the governor may be used with advantage for economy of fuel; but founds his objection to the engine on its unfortunate *valve gear*. The question to be settled then is, *does* this valve gear stand the test of working, or has it only the "slight chance of duration" which Mr. Pinchbeck assigns to it? I unhesitatingly say that it does stand the test of steady and continued work, and can substantiate this statement by abundant evidence. For the present I content myself with one case, being that in which it has had (in my experience) the longest trial. A few days ago I met a gentleman who got from me a Corliss engine to drive one part of his mill; it is 24 in. cylinder, 4 ft. stroke, making 55 revolutions—440 ft. per minute speed of piston. It has been at work, day and night, for about three and a half years, equal to seven years' running of an ordinary factory engine. It is well burdened, and has elicited many remarks of surprise at the amount of work it is doing, from parties in the same trade; and the testimony of the owner is, that the valve gear has given no trouble, and any repair required has been of the most trifling description. This gentleman is widely known, both in England and Scotland, as a man of business, and his name is at the service of any one who desires to inquire further. Had I no other instance to refer to, which is far from being the case, this example is sufficient to prove that Corliss valve gear can be made something else than a "rattletrap."

Having trespassed so much on your space, I shall only say further, that as you have already published in this journal indicator diagrams and other particulars of the performance of Corliss engines, the proper course for those to follow who decry the Corliss and uphold the "common" engine is to point out the defects and short-comings of the former, and the superior results of the latter, to employ specific terms, and, on a subject like this, not to launch out into vague and meaningless generalities.

I am, Sir, yours, &c.,

ROBERT DOUGLAS.

Dunnikier Foundry, Kirkcaldy, N.B., July 2, 1867.

TO THE EDITOR OF ENGINEERING.

SIR,—It is difficult to see (supposing the Corliss engine to have a more perfect expansion than any other) how that circumstance could in any way have increased the power given, as stated by your correspondent, W. E. Gill, in the face of 10 lb. less pressure of steam in the boiler. I can quite understand how the Corliss engine might have given a better economical result, but that the absolute power in one engine was greater than in another, because the former had a more perfect expansion, is evidently a mistake. The first must have been of very inferior construction, the piston and valves out of order or out of time, or perhaps the throttle-valve not properly adjusted. Had these matters been attended to, the proprietors need not have been put to the expense of a new engine, having the same diameter of cylinder, and speed of piston, as the one removed. Mr. Gill's letter would lead one to suppose the greater the degree of expansion the greater the power; we all know, the reverse to this is the fact.

I am, Sir, yours obediently,

JOHN PINCHBECK.

27, Leadenhall-street, London, E.C.

THE DRAINAGE DISCUSSION.

TO THE EDITOR OF ENGINEERING.

SIR,—Allow me, through your columns, to thank Mr. Taylor for the valuable information he has given about his mode of saving the fæces of sewage. There is nothing like "having it out," for then we are apt to come to conclusions.

The "clockwork plan," as the "Croydon Engineer" jokingly calls Mr. Taylor's plan of utilisation, seems to accomplish about as much in that direction as the Croydon plan itself; that is to say, both save for agriculture but a small portion of the fertiliser contained in human excreta. Mr. Taylor manfully confesses that he does not know what to do with the urine, and accordingly allows it to be diluted with slops and rain, to become "mere salt and water, with a small percentage of urea and phosphates," as he describes it, and in this sorry condition leaves it to some of us to do with it what we can. Urine holds in solution, and thus that much sooner available for agriculture, six times more ammonia than the fæces, also more than twice more other organic matter, four times more potash, and fully as much of phosphates. If the total value of excreta per annum per head of population amounts to 10s., then that of the fæces is not quite 2s.; that is to say, about one-fifth is utilised, and four-fifths is lost, which is just about what the rye-grass irrigation plan of Croydon manages to do. Now, it is very praiseworthy of Mr. Taylor to save that one-fifth, and it is far better to do so than to pitch it all in the sea, as, according to Mr. Krepp, the people of Eastbourne have done (I wonder if the engineer of that clumsy job is not ashamed of himself?); but it is highly objectionable of Mr. Taylor to throw away the other four-fifths, which, for a population of 10,000, would, at the above rate, give annually the neat little sum of 4000*l.* worth of fertiliser, capable of raising an increase in yield of grain worth some 8000*l.* So far as national economy and agricultural interests are concerned, this is a serious fault; and as the question of "food" depending thereon is one of "life," Mr. Taylor has no more moral right of advocating his scheme for the sake of making his guano company flourish, than a quack doctor has in largely recommending pills by which 20 per cent. of his patients are saved, and the other 80 per cent. killed outright. Nor is not knowing how to do better a good excuse for that sort of treatment. It would be preferable for a man so situated to try his hand at something else, and thus keep from doing mischief. In my opinion, it is not only the interest, but also the duty, of every individual in Great Britain to expose the absurdity of a project calculated, if largely adopted, to strike such a grievous blow at the national wealth as the loss of 8000*l.* worth of food annually for every 10,000 inhabitants of city population.

Having thus seen, by Mr. Taylor's own statements, that four-fifths of his project (if its value may be estimated by what it accomplishes) is of no account, let us examine the merits of the remaining fifth.

The British Guano Company, it appears, furnishes, at its own cost, the revolving turn-table ash-sprinkling apparatus, and thereby obtains the right of entrance during a certain number of years in the dwellings to collect its "innings." It also appears that eighty householders and "one hen" have tried it on, and rather like it. Now, "*de gustibus non est disputandum*," but I must confess that I would rather object to visits from "guano officers" in the privacy of my dwelling, and think most people are of the same opinion. It may be foolish, or far from philosophical, to get nauseated when forcibly reminded of that sort of dirt; but as sensitive and delicate organisations suffer from it, as from sea-sickness, in spite of all philosophy, it is but fair and just, nay required, to avoid giving such offence. And in the fairer half of humanity such sensitiveness is more agreeable than a stoic complacency about such things.

I have not seen the working of Mr. Taylor's apparatus, but frequently witnessed on the Continent the removal of the so-called "*foeces mobiles*," or "tinettes," and know how unpleasant this is, even when they are hermetically screwed down, and thus in themselves inoffensive. There is always a deal of fussing and giggling among the servants, slamming of doors, sudden disappearance of ladies, mysterious hints and nods, and annoyed looks of the gentlemen, most awkward for visitors to witness. Imagine, in the large buildings, which it is now the mode to erect, each containing several dwellings and privy closets, distributed over four or five stories high, a strange man prowling round in search of what we, upon the anxious inquiry as to what he wants, will explain, with bated breath and a vulgar leer in his eye, to be "British guano"! One involuntarily gives such an individual a "wide berth" in passing, invoking, at the same time, an inverted blessing on his head, while down in the street, his guano-cart stopping the way, is naturally anathematised by others in a similar manner.

As to Mr. Taylor's hen, if she has a taste for making her nest in "British guano" in preference to other material, all I can say is, "*Tant pis pour madame la poule*."

Mr. Taylor seems indignant at me rating his apparatus lower than the "earth closet," and begins by showing that the Rev. Mr. Moule's patent claim is upset by Moses, who, in his turn, is outdone by the cats. For all that, I think Mr. Moule is the first man who worked Moses's plan out by machinery, and the application of the absorbent substances seems by Mr. Taylor to have been an after-thought; for in his patent of April 9th, 1861, no mention is made of it, nor of Moses nor of cats either. It is a fact, that Mr. Taylor needs a far less amount of these substances than Mr. Moule, and so far the thing is better; but at the same time he loses four-fifths of the fertiliser, and thus far the thing is worse.

As to the liability of Mr. Moule's closet to being spoiled by the throwing in of slops, how would Mr. Taylor's arrangement fare, when a couple of buckets of water were soured in it? Would not some of the British guano suffer? I only ask.

Regarding the evil of allowing the urine to run in the sewers by Mr. Taylor's plan, I have only to say that such is done, also that urine is a putrifying liquid, and that there is no use in "denying of it," as Mrs. Gamp would say. It is true that, by parting the fæces and the urine so soon, Mr. Taylor prevents the fermentation due to the action of ammonia, &c., towards solving the substances of the fæces; but urine holds within itself the elements of mischief, and makes the other sewer

water putrid; and in so far his scheme is also worse than Mr. Moule's, where this is avoided, and all the fertiliser saved.

And, finally, on the subject of complication of arrangement, I beg to say that Mr. Taylor's present improvement seems to me a sort of modified Moule's closet with a turntable attachment, whereby the door and the floor of the room are also involved. There are therefore more wearing parts, it is more liable to get out of order, and is thus more inconvenient. For all of which reasons Mr. Moule's machine is the better of the two, as I stated before.

Mr. Taylor seems to object to me asking questions, because, he says, I evidently knew nothing about his apparatus. Well, people generally ask for that very reason. I did so, politely enough, I thought, both for my information and that of your readers. "We wanted to know, you know," and now we do, and that is the object of this discussion. Mr. Taylor also invites me to Romey to look at his apparatus, which his friend, Mr. George Summers, calls "valuable inventions" of great "sweetness and purification," and he thinks that I would be much surprised. Surely if I had time I would be happy to come and take a glass of wine with him, and also doubt not but would be considerably surprised, and perhaps amused too. But that would not change the fact that much harm would result in a sanitary and agricultural sense if his scheme was brought into general use, and that, now we know what it amounts to, it is our duty to do all we can to prevent this.

Your correspondent, Mr. Krepp, I sincerely thank for his gallant offer in my favour.

I am, Sir, respectfully yours,

CHARLES T. LIERNUR.

2, Royal Exchange-buildings, E.C.,
July 1, 1867.

TO THE EDITOR OF ENGINEERING.

SIR,—One of your numerous correspondents on the sewage question, advocating the "dry system," has appealed to nature, and drawn attention to the cat tribe, who deposit their excreta in holes in the ground. From this he argues that we should do the same, and use his "earth or ash closet."

Permit me to quote from the same Author, the book of nature, and show the analogy between the system of the circulation of the blood in the human body and the system of drainage advocated by some of our engineers, and leave your readers to draw their own inferences.

Consider the circulation of the human body and all the functions performed by the heart, the network of arteries distributing the vital fluid over the body and to the various limbs, the system of veins spreading over the whole body absorbing and re-conveying the vitiated blood to the lungs, where, having passed through a process of purification, by absorbing its proper amount of oxygen, &c., &c., is again distributed over the body; this operation is performed continuously.

Such is a brief sketch of the circulation of the blood. See how closely our drainage engineers have followed in the path of nature.

Take, for instance, a large town having its city or body, suburbs or limbs. The waterworks engine may be looked upon as the heart, the arteries the mains which distribute a paler fluid certainly, but an equally necessary one, over the body and limbs of our large towns. The sewers we may consider as representing the veins, absorbing and taking up the vitiated blood, the sewage, in fact, of the town, and conveying it to the lungs, the "sewage farms." Here it is, as in the human circulation, exposed to a purifying process, and, having parted with its objectionable parts, finds its way back into the rivers, and, by evaporation, forms a part of the rainfall by which our wells are supplied, and is again passed through the pumping-engine for re-distribution.

The analogy could be carried out much closer, but I think sufficient has been said for your readers to draw their own conclusions.

I beg to subscribe myself,

Yours faithfully,

London, July 1, 1867.

O.

TO THE EDITOR OF ENGINEERING.

SIR,—I am muckle obligated unto your author correspondent for his kind wishes, but I cannot be fashed to answer him, and will merely keep to the point. As I stated in a former letter, there was no objection to collect refuse in its natural state in a country town, when carried out as Mr. Taylor explains, where the conveniences are placed at the back of a back garden. As you allow all comers for and against the scheme of Mr. Liernur, of the firm of Liernur, &c., &c., Frankfort-on-the-Maine, I will merely take him up at the date of his patent, 25th of September, 1866. In the first place, I will keep him to his "bond," and do not intend allowing him a single drop of pure water to cleanse the apparatus. "Take it all away in its natural state." The drawings show four closets, one above the other, on the separate floors of a dwelling-house, connected to a ventilating-pipe carried up through the roof, that always allows the foul gases to escape, and this continually going on, finding its way into the house, there being no traps or valves to closet-pans, "nothing but a clean, short, white tube with a dark space beyond." Every one knows that with the trap-closets of the present day the refuse will not fall down a clean, short, white tube, but adheres to the side, and is scoured when the water is turned on. Mr. L. says his scheme requires no scouring water, therefore it scarcely requires me to state what an amount of filth would accumulate on the sides of the pan, pipes, &c. (Should he allow me to scour the closets with water, I will prove his scheme to be a thorough nuisance; but I am deviating.) On the bottom of the vertical pipe a bend is formed; the refuse is pounded into this bend to form a piston of paper, rags, &c.; that no such piston can be formed, from the fact, as he states, that the urine forms eight parts of the solids. And now he goes fishing for this muck in the morning, say he commences at four o'clock, with one thousand manure carts. He pumps out the air in the reservoir, opens one of the valves, and, probably to his surprise, the vacuum is completely destroyed, no refuse having been deposited, the family having gone to Brighton, and they have not hung out a signal to that effect. However, that little difficulty

may be got over, even in a dark winter morning (and if the stuff should get frozen up in the pipes, we would be left in an abominable slough). But to proceed: his next haul, he draws out some of the refuse out of the bent pipe, but not all of it; and should the pipe to the reservoir have sufficient inclination, will flow down simply by gravitation, but some will always be left at the bottom of the pipe. The air from the ventilating pipe again rushes in and destroys the vacuum. He states a central valve can be placed on the reservoir in those of the various branch-pipe valves. With such an arrangement no vacuum could be maintained in the reservoir, should one or more of the branch pipes be empty.

And, to conclude, when he has stored up the manure in wooden barrels, he sends it per rail or otherwise to the farmer, who hoists them on a bogie-plough, and as the furrows are formed the manure is turned on, and the earth again scraped back. This plan is sufficiently ingenious to recommend it to the notice of farmers. What size are the barrels? Will they manure a furrow 500 yards long? I am thinking no farmer would be bothered with this hoisting on and taking off or otherwise filling the manure plough, and consider the time taken to do so would make ploughing a very expensive job. Farmers, when they add sewage refuse to their dung-heaps, do so in a more effective way than that, but such has nothing to do with purifying our towns.

Yours perseveringly,

July 1, 1867.

O. O.

NEGATIVE SLIP.

TO THE EDITOR OF ENGINEERING.

SIR,—Having just read through the various articles published in ENGINEERING, during the last few months, upon the negative slip, and upon slip generally, I would say that there is much in them to which I most heartily subscribe. Still some points are raised which, whether from want of sufficient elucidation or of perception on my part, remain muddy, and others which seem to be overlooked. There is also one statement ventured which seems to be antagonistic to one of the first principles of mechanics as generally received and understood, viz., that action and reaction are not in all cases equal. It is stated in the case of firing off a gun, that were the shot harnessed to the gun, the action upon the shot would be sufficient to carry both forward. It is very safe to venture such a statement, as it cannot be put to the practical test of experiment. But it would be strange if this should form an exception to a law which governs the delicate motions of the balance hair spring of a chronometer, governs and regulates the motions of the spheres in space, and also holds so true in all practical matters. I cannot therefore subscribe to the idea that this universal law is to be upset by exploding a quantity of gunpowder in a gun.

The action of this law of action and reaction being equal, in the propelling of ships, seems to be one of the matters overlooked. To begin with the simplest condition, a person in a moored boat pushing it off finds a statical condition of the law in the tension produced on the moorings: if the moorings be loosened, it still remains, the boat absorbing the whole amount of communicated force in the shape of motion; but should the boat be propelled by oars the case becomes modified, as there is as much value of power expended at the outer ends of the oars driving the water in a backward direction as there is applied at the inner end to propel the boat forward, still following out the same law of action and reaction being equal. Then applying this law to steamships generally, it must be that the same principle holds good throughout, i.e., that in all there is as much power expended in giving motion to the water in a backward direction as there is in propelling the ship forward; for it is evident that the whole power exerted by the engines imparted to the paddles or screw is absorbed in proportion to the resistance offered by the ship to pass forward through the water, on the one hand, and the opposing resistance offered by the water to the floats or screw on the other, the first of these resistances being modified by the model of the ship, winds, &c., and the second by the waves, and more particularly in the case of the screw by the following currents in the wake of the ship. When our attention is drawn to the motions of a ship, there is one point which seems to have escaped the attention of those who have written on the subject, that is the motion communicated by the applied power when starting from a state of rest until the full speed the applied power is able to maintain is obtained, as also the redevelopment of this when the engines are being stopped, and the ship again brought to rest. The action of this power is analogous to that in a fly-wheel, except that the fly-wheel rotates about a centre, whereas that in a ship is on the line of its motion. When the engines on board are first started, the ship being at rest, the entire power is expended in slip, which slip is gradually reduced as the vessel acquires motion until such speed is attained as the conditions will permit; then the action of the propelling power on the water and the vessel becomes equalised, that on the water being recognised by the term "slip," whilst the latter produces the motion on the ship. Again, when the engines are stopped we have this imbibed power expended in maintaining the ship's motion for a time thereafter until it is expended. And considering the various circumstances in operation to affect the action of the paddles or screw, a slip varying from 15 to 40 per cent. is what might reasonably be expected to result in practice. As to how negative slip exists without its counterpart of loss, as the name conveys the idea that the whole developed power is concentrated in propelling the ship, which is absurd, and as the primal law of action and reaction being equal must be in operation in this as in all cases, the rationale is not quite apparent, and it may form a subject of demonstration or speculation to some of your various contributors.

There is only one other matter I would draw attention to, viz., the very great stress which is laid upon skin resistance. This appears to me to be surely very much over-estimated, as although no doubt it does exist, and must exercise its amount of value in detracting from the speed of the vessel, still it can bear very little comparison indeed with the amount of power required to displace the large amount of weight represented by the water groove which has to be ploughed out by the ship, equal in area to the midship section into the velocity. The dis-

placement and communicating of motion to such a mass is a representation of a vast amount of power in comparison with any idea we can form of skin resistance, a fair illustration of which may be had by drawing a thin plate edgewise through a body of water. There is no reason, however, to infer from this that any formula ordinarily used and based on experience should be incorrect, although the resistances in name be attributed to something different to what really exists.

I may also refer to the great advantage derived from the concentrated power or momentum contained in the mass of the ship when sailing through a rough sea in enabling it to run over each succeeding wave, without which the steam power alone in many cases would be unable to carry her along, as also to its modified condition in the case of railway trains, coaches, &c., where varying advantage is taken of the power applied. When undulations occur in these as in every other case of a body in motion, the law holds good, and vessels in motion on water, whether propelled by pulling oars, sails, paddles, screw, or any of the hydraulic modes of propulsion, are all subject to the same laws.

Glasgow, July 29, 1867.

C. R.

MR. PAGE'S TRAMWAYS.

It is not often that we find an engineer of reputation advocating the construction of very cheap lines of railway—only those which put large sums of money into motion having for many years past been in favour with railway promoters, engineers, and contractors. But Mr. Thomas Page now proposes to put down very light trams along common roads, with light iron rails for the wagons, and with broad longitudinal timbers, laid parallel with and outside these, to receive the driving wheels of the engine, the latter having guide wheels, working along the iron trams, to keep it on the line. Mr. Page proposes to employ roughened driving wheels upon the sawn surface of the timber. It is easy to start objections, apparently convincing, to such a plan, but a good deal may be also said in reply. We are content at present merely to describe the plan in general terms, and to say that, if reasonable durability and uniformity of surface of the timber could be depended upon, such a system of working would offer many advantages in agricultural districts, and especially abroad.

Perhaps the most interesting fact which Mr. Page has shown in connexion with his scheme is the adhesion of locomotives upon wooden trams. A model carriage with coupled wheels, driven by clockwork, and weighing, with load, but from 16 to 25 lb., ascends readily a comparatively long incline of 1 in 3, and has indeed worked successfully up 1 in 2½. This, of course, represents the adhesion of a very slightly serrated wooden wheel or roller upon a nearly smooth and perfectly dry wooden rail. With iron driving wheels, also serrated, the adhesion would no doubt be as great; but questions of the behaviour of wet timber trams, especially if not maintained in perfect surface, arise here, and it is clear, too, that a heavily loaded and roughened iron wheel would soon tell upon the timber over which it worked. Mr. Page's steam locomotive model, of 7 cwt., with but about half its weight on the driving wheels, has worked readily up an incline of 1 in 10. It is Mr. Page's belief that his system would enable a profitable traffic to be cheaply worked along the routes of ordinary highways, and that over gradients as steep as are ever met with on common roads.

THE WILSON FURNACE.

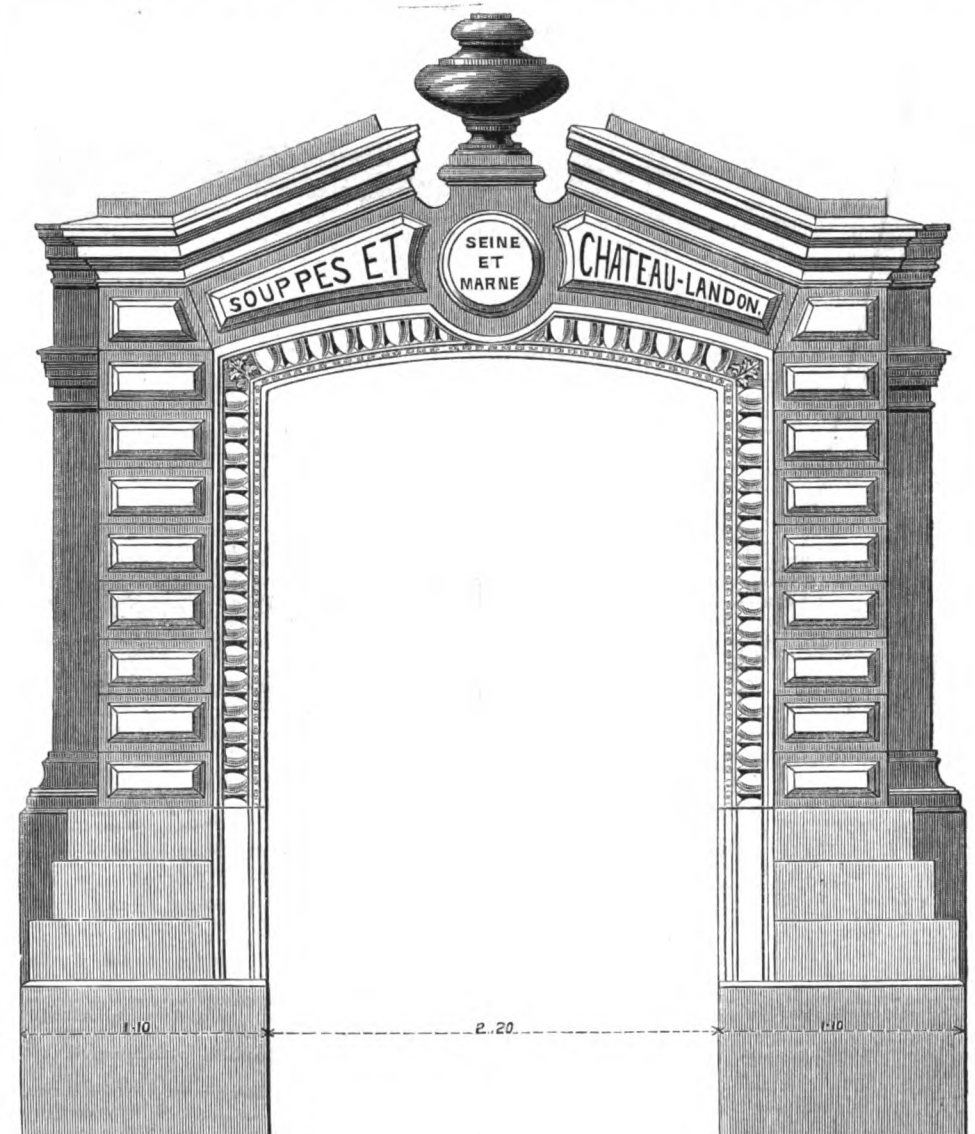
Mr. E. B. Wilson has sent us daily, for some days, the tabulated results of the working of his new puddling furnace at the Bolton Iron and Steel Works, the returns covering a period of a fortnight in all. The furnace is working two shifts, of seven and eight heats respectively, in the 24 hours, and is using from 21 cwt. to 22 cwt. of ordinary coal per ton of pigs charged, and with a waste reported as varying from 8 to 12 per cent., but generally under 10 per cent. These results, if confirmed by continued working, will induce a rapid adoption of the furnace elsewhere.

THE SOCIETY OF ARTS' ALBERT MEDAL.—The Albert medal has this year been awarded to Mr. W. Fothergill Cooke and Professor Charles Wheatstone, F.R.S., in recognition of their joint labours in establishing the first electric telegraph. The first Albert medal was awarded, in 1864, to Sir Roland Hill, K.C.B., "for his great services to arts, manufactures, and commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world." The second medal was awarded, in 1865, to his Imperial Majesty the Emperor of the French, "for distinguished merit in promoting, in many ways by his personal exertions, the international progress of arts, manufactures, and commerce, the proofs of which are afforded by his judicious patronage of art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects." The third medal was awarded, in 1866, to Professor Faraday, D.C.L., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted arts, manufacture, and commerce." In making the award this year, the council were placed in a somewhat peculiar position, inasmuch as by the terms upon which the medal was established they could only make one award, whilst the great object accomplished was due to the combined labours of two men. They felt, however, that so great a national work as the Electric Telegraph was especially worthy of reward by this society, and that the Albert medal could not be more worthily bestowed than in recognition of the services of those to whom the introduction of the Telegraph was due. The award having been made, they have directed that the medal be struck in duplicate, and a copy, with a suitable inscription, be presented to each of the above-named gentlemen.

THE FRASER GUNS.—Mr. Fraser has just been awarded 5000*l.* by the War-Office, as a reward for his services in getting us out of the Armstrong extravagance into a cheaper and better system of gun-construction.

ORNAMENTAL PORTAL AT THE PARIS EXHIBITION.

CONSTRUCTED OF STONE FROM THE QUARRIES OF SOUPPES AND CHATEAU-LONDON.



We give, above, an elevation of the portal at the Paris Exhibition, constructed of stone from the well-known quarries of Souppes and Château-London. The stone from these quarries is of an excellent colour, and, being capable of being freely worked, it is much used for architectural purposes in Paris and its neighbourhood. Much of the stone used in the construction of M. Bassompierre's two-storied bridge at the Point du Jour, and of the other Paris bridges, is from the Château-London quarries. The arch shown in our engraving has a span of 7 ft. 3 in., and its height is 11 ft. 3 in. Our illustration is prepared from an engraving which has appeared in the *Annales du Génie Civil*.

ANGLO-INDIAN TELEGRAPH.

At last there appears some prospect that this country will, ere long, be in a position to enjoy an independent line of telegraphic communication with its Eastern possessions, a scheme having during the present week been put before the public by the Anglo-Indian Telegraph Company, limited, for the establishment of a through line from London to Bombay and Calcutta, which will be entirely independent of either Russian, Turkish, or Persian systems. The unjustifiable delay and mutilation to which messages to India have hitherto been subjected, coupled with the impossibility of obtaining adequate redress or compensation for any loss or inconvenience consequent upon such a defective system as has hitherto been tolerated by the public, have rendered the establishment of some other line, to be wholly under English control, an imperative necessity. Messages which under a well-organised system should not occupy more than six hours in transmission between London and Bombay usually take several days in passing from the one place to the other, and even then arrive not only in a mutilated and frequently unintelligible form, but also without regard to priority of date.

The proposed line will pass from London through Paris, Susa, Florence, Sicily, Malta, Tripoli, Benghazi, Alexandria, Suez, Aden, the Kooria Moorla Islands and Bombay, to Calcutta, provisional arrangements having been made for the transfer to the company of:

I. A concession from the Italian Government for the exclusive use, for forty-one years, of a line of telegraph from Susa (where the French lines terminate) to Modica, in Sicily, to be worked by English clerks appointed by the company.

II. The agreement for a lease from the British Government

of the existing Malta and Alexandria cable for the term of forty-two years from May, 1865.

III. The agreement for a lease for twenty-one years (with the option of purchase) of the existing land lines of the Telegraph to India Company between Alexandria, Cairo, and Suez, together with the concessions and firmans held by that company for establishing telegraphs from Egypt to Aden and India. Thus, with the exception of through France and over the short line of sixty miles from Modica to Malta (which is, however, worked by English clerks) this company will have under its own management, and worked exclusively by an English staff, the whole line of telegraph from England to Bombay.

It is expected that the direct route between London and Suez will be in actual work during the present year, and the company have entered into a contract with the Telegraph Construction and Maintenance Company for making and laying a thoroughly efficient line of telegraph (about 3650 nautical miles in length) from Suez to Bombay, which is to be completed in the course of next year. It is also proposed, immediately upon the completion of the cable to Bombay, to establish land wires along the line of railway thence to Calcutta.

It is not necessary here to allude to the expected annual receipts that will be obtained by the Anglo-Indian Telegraph Company, the vast importance of the commercial relations between this country and India is fully sufficient to justify very liberal anticipations regarding the financial success of this enterprise. Amongst the ten directors of the company, five are already connected as chairmen or directors of existing telegraph lines, and under the superintendence of Sir Charles Bright, M.P., and Mr. Latimer Clark, who are the engineers to the company, it may confidently be anticipated that every precaution will be taken to render the undertaking as complete and successful as possible.

The prospectus alludes to a probable further extension of the company's lines hereafter, to Singapore, China, Japan, and Australia, the fulfilment of which could not fail to render important services to all interested in commercial transactions with those parts of the world.

THE GAS COMPANIES.—The chairman of the Metropolis Gas Committee has suggested to the representatives of the companies that they should consider, and that by Tuesday next the practicability of amalgamating in one great company. If they do not do this, it is understood that the committee will report in favour of the Board of Trade taking possession of the gas-works, as proposed by their Bill.

"NO LETTERS TO BE FORWARDED."

THE quiet lake, the balmy air,
The hill, the stream, the tower, the tree,
Are they still sweet as once they were?
Or is the dreary change in me?

THANK Heaven! for although the committee rooms are still open, the engineers have not been overworked this year. By rail—and here and there, but how seldom, by coach—by gig, on horseback and on foot, and, now and then, a week together on the white-winged bride of the sea, our friend's yacht, the *Hyperia* or the *Cerne*! When Robert Stephenson took himself away for a month, in summer, it is said that no one in Great George-street was permitted to know whither he had gone. He kicked off his profession for the time, wore loose trousers and broad-soled shoes, and roamed and sailed wherever his fancy led him. Not amid cloud-pictures, though he may have seen in the evening splendour of an *Ægean* sky (and his yacht, the *Titania*, had borne him far into the *Levant*) all of Wordsworth's aerial, palatial magnificence:

Far sinking into splendour—without end!
Fabric it seemed of diamond and of gold,
With alabaster domes and silver spires,
And blazing terrace upon terrace, high
Uplifted: here, serene pavilions bright,
In avenues disposed; there towers begirt
With battlements that on their restless fronts
Bore stars—illumination of all gems!

Often he sailed in Scandinavian seas; away up the coast of Norway, and into those higher latitudes where summer has no night:

A Polar day which will not see
A sunset till its summer's gone,
Its sleepless summer of long light,
The snow-clad offspring of the sun.

And once, not in the *Titania*, but in one of Cunard's steamers, he went to America, and we saw him at Portland, and journeyed with him on the Atlantic and St. Lawrence Railway, past the feet of the White Mountains, and where, although hundreds of miles from the first beautiful scene in *Evangeline*, it might equally be said:

This is the forest primeval. The murmuring pines and the hemlocks,
Bearded with moss and in garments green, indistinct in the twilight,
Stand like Druids of old, with voices sad and prophetic,
Stand like harpers hoar with beards that rest on their bosoms.

This is just the time for the woods! But we shall not cross the Atlantic, and we must find them either within our own isle, or in the upper valley of the Rhine, or in the Pyrenees, or the Helvetic Alps, unless we accept Count Platen's invitation, and start for Sweden, or our friend M. Carl Pihl's, and journey over his 3 ft. 6 in. gauge railways in Norway. As for Russia, and the vast and monotonous landscapes between Petersburg and Moscow, and the wilderness around Lake Ladoga, not even the hospitality of the Messrs. Winans shall tempt us.

But to where shall we first run down? Shall we away to the north, first to Glasgow, with its "Fish and Tree," and on to the Trossachs and Loch Katrine?

With promontory, creek, and bay,
And islands that, empurpled bright,
Float amid the livelier light,
And mountains that like giants stand,
To sentinel enchanted land.

Or shall we try North Wales, cutting down by the Irish mail to Chester, and thence on, jaunting more quietly to Snowdon, and

'Mid Cromlechs and the Carnedd's funeral stone,
and again to the midnight sea, where

from shore to shore,
O'er the smooth current streamed a silver light,
Save where along the flood the lonely height
Of rocky Penmaenmaur deep darkness spread;
And all was silence, save the ceaseless roar
Of Conway bursting on the ocean's bed.

And from here it is not so far to Ireland, whose hospitable capital we should soon forsake for the mountains and valleys of Wicklow, and, of all, the vale of Avoca.

There is not in the wide world a valley so sweet
As that vale in whose bosom the bright waters meet.

And, wandering thence, we could hardly fail to run over to see what Mr. Neville has been doing at the Vartny Waterworks, where the embankment was giving way, and about which a heavy arbitration (bitter arbitrations!) is still going on. And thence to the Seven Churches and Glendalough:

By that lake whose gloomy shore
Sky-lark never warbles o'er,
Where the cliff hangs high and steep,
Young Saint Kevin stole to sleep.

And then westward to Killarney, with its grander hills and lovelier lakes—the Eagle's Nest, the Gap of Dunloe, Muckcross Abbey, and the jewelled landscape beyond.

Or shall we drive our hansom to the White Horse Cellar, Piccadilly, and there take the coach to Brighton, sending our man, Spreckley, along with our luggage by train? Telegraph to the Club-house at Cowes that we will race the old coach by land against the *Cerne* by water, and that Midwood is to round the new pier, land at the Old Steyne, and meet us as we are entering the New Ship, where the dinner, telegraphed for six hours before, is just ready to be served up. And, after dinner, to sea. Not for a flapping sail to Rottingdean, nor to float lazily to Dieppe, but to stand straight out at midnight, under a bright July moon, and bound for the Bay of Biscay and Lisbon.

And I have loved thee, Ocean! and my joy
Of youthful sports was on thy breast to be
Borne, like thy bubbles, onward: from a boy
I wanted with thy breakers—they to me
Were a delight; and if the freshening sea
Made them a terror, 'twas a pleasing fear,
For I was as it were a child of thee,
And trusted to thy billows far and near,
And laid my hand upon thy mane, as I do here.

We may take a tack to Cherbourg; we may even put in to Plymouth to make a fresh start, but still on, towards the purple Tagus. And now every other engineer who opposed our bill is forgiven, and we will even stretch our grace to the opposing counsel, their parliamentary agents, and their whole crew of witnesses, and, greater nobleness of heart, to the committee who threw us out altogether! Who thinks of bills, parliamentary or pecuniary, here? Our little yacht, compact and well ordered, as we might imagine a gentleman's villa at sea, if only a villa could be got to float and steer; our bright yet dreamy hours fragrant with Partagas's best *Vuelta de Abajos*, and sweetened by music such as Midwood and Longrove and young Calderon can draw from the horn, the flute, and the guitar, and by song such as even Verdi and Offenbach might delight to hear!

On, on the vessel flies, the land is gone,
And winds are rude in Biscay's sleepless bay.

And, after days scarce counted, rises the Lusian coast.

It is a goodly sight to see
What Heaven hath done for this delicious land!
What fruits of fragrance blush on every tree!
What goodly prospects o'er the hills expand!

And, like Childe Harold, we will, with a short stay in Lisbon—the shorter the better—drive to Cintra and Mafra, passing on our way

The horrid crags by toppling convent crown'd,
The cork trees hoar that clothe the shaggy steep,
The mountain-moss by scorching skies embrown'd,
The sunken glen whose sunless shrubs must weep,
The tender azure of the unruffled deep,
The orange tints that gild the greenest bough,
The torrents that from cliff to valley leap,
The vine on high, the willow branch below,
Mixed in one mighty scene, in varied beauty glow.

On again, to Cadiz, and thence, by Seville, to Madrid, and over the Asturian chain, to Bayonne and Paris. Too much like work, too little quiet, and neither Flachet nor Morin, nor the hundred younger engineers whom one meets here, in the French capital, shall keep us. Let us push on to Geneva, and up Lake Lemman to Villeneuve, and so to Montigny, and gaze upon the wonders of the Gorge du Trient, where a stream, hardly wider than a broad footpath, foams, forty feet in depth, and with a roar like a cataract, for half a mile between steep walls of rock, rising hundreds of feet on either side. And there is the Pissvache, and all the rocky wildness of the neighbourhood. Further on, Mont Blanc rises in its glittering and mighty majesty, and, away to the eastward, the Matterhorn, and further still St. Gothard. And with all its sublimity we are actually "doing" Switzerland within a week; and the blame, if any, is to be laid to its railways and its general accessibility.

And shall we run down the Rhine? Not to our friends, but by steamer and by rail?

The river nobly foams and flows,
The charm of this enchanted ground,
And all its thousand turns disclose
Some fresher beauty varying round:
The haughtiest breast its wish might bound
Through life to dwell delighted here;
Nor could on earth a spot be found
To nature and to me so dear,
Could thy dear eyes in following mine
Still sweeten more these banks of Rhine!

But what, instead of the cruise in the *Cerne*, and the long wandering through Spain, and France, and Switzerland, and down the Rhine—long in these days, even with all the steamers and railways, whereby one *must* journey after all, although, like the railways in the Isle of Wight, they destroy the charm of travelling—what if, instead, we drop into some rich Shropshire or Yorkshire neighbourhood? There are glorious old homes, peopled with the kindest hearts, to bid us welcome. Ah, we shall not quote from the poets here, for a dear English country home is not to be sung in song. From all the "larks," the discomfords, the coquetry, so-so sincerity, or downright insincerity, of foreign life, one comes as to a loving mother to our dear Old England. Its warm, true hearts lengthen its shorter summers, and gild its colder skies, with a truth and warmth with which foreign climes may, as they must perforce, dispense.

Far in from the high road through a winding drive, shaded here by o'er-arching and there by scattered elms, with glimpses of waving corn and rich meadows and distant hills between, and with scented shrubbery, and prismatic banks of flowers, and fresh-faced, golden-haired and laughing maidens gliding in those delightful games of lawn billiards (croquet) and flirtation, we approach the fine old Elizabethan or Tudor mansion. Nor shall we tell all that comes to us there. With warm welcome, hearty cheer, kind entertainment, honest sport, and the witchery of true girls, who would amuse yet never wound, might not the engineer forget his profession here? No, in truth, he cannot! If he has not brought down with him a set of the ordnance maps, and an aneroid, or a Bourdon's barometer, and if he does not have a pedometer ready for strapping to his leg whenever he is about to take a walk across country, it is ten to one he will at least wish he had. Even the trees remind him of great trunk lines and numberless branches; and are not the hills pointing to be tunnelled, and the valleys curtsying to be viaduct'd? He cannot go over an estate to see the crops, the horses, or the cattle, or possibly the reaping machines or the steam-plough at work, without incontinently making a valuation as he goes along; and he is likely to learn how the landholders in the district would regard any possible scheme for a railway or other work of improvement. And then the geology of the district comes in for inspection, and the millstone grit, the sandstone, the lias, the chalk, or other varieties of rock are classified in the engineer's mind. The building stones, if any are to be found, are examined. Here, a splendid bed of gravel is "prospected" with a view to its conversion into concrete; there, is sand for mortar, and here, again, clay for bricks, or limestone for burning. Possibly there may be ironstone, or coal; and how can the engineer keep such things out of his mind, even while airing his horsemanship with the ladies along the avenue, or feeding the chickens, assisted in that pleasing occupation by the girls at the farmstead, or gently persecuting the calves, or lounging under the shade of the headlands of the field, from which Wilkins the ploughman, or let us say Jackson the engine-driver, with his four-furrow Fowler, is knocking out stones from the subsoil of interesting lithological and mineralogical character? And while pulling the six-pound and the eight-pound trout out of the beck, can the engineer keep from mentally gauging the stream, and considering its area of watershed, and consulting the nearest rain gauges, and going into estimates of surface flow, and evaporation and absorption, and bottling off a few pints of the water for Dr. Frankland's or Dr. Miller's analysis on returning to Westminster? Here there is a scheme for water supply, or drainage, or for utilising water power.

But let no engineering come in at dinner, that glorious banquet of friendship and happy humour, if not of sparkling wit—for of the latter there is never much—that culminating paradise of the long summer's day, when the open windows of the dining-hall let in the sun, falling to the west, and subdued in his heat by lengthening shadows across the lawn, the palpitating air bringing the most delicious yet delicate fragrance from the rosary, and the hum of bees, and the light chattering of birds, and the faint sound of far-off church bells, and of distant kine. And near us are the ilex trees—holly and cork—and the elms, the chesnuts, and the oaks shading and breaking the scarlet, and pink, and purple walls of the roses and geraniums beyond. Not even the splendid flowers, the beautiful fountains, the shade, and the distant rattle in the Champs Elysées give half the charm to the best dinner of the Café Ledoyen, in Paris—but a fig for all Paris here, and the comparison is unjust to our hospitable friend and his mansion. What rest! what

enjoyment of Heaven's best gifts—health, plenty, hospitality, beauty, love (eh?). Who can have such repose in town, with its railway whistles and fog signals, now heard almost everywhere, its thundering traffic, its morning yells and evening swells?

Let others go to the Continent, and there are scores of English engineers now in Paris, and Berlin and Vienna, at Homburg, at Interlaken, and in the Tyrol. Business still, for they are with officials of State, bankers, concessionaires, and large proprietors. Well, let us hope they may bring home a few promising foreign undertakings in their pockets. Mr. Brassey is ready for contracts, and so are the Welsh and Cleveland ironmasters, the Manchester, Leeds, Sheffield, and Glasgow locomotive builders and the Openshaw and Sallley carriage works, while hundreds of young men in Westminster are ready for any honest job, here or abroad.

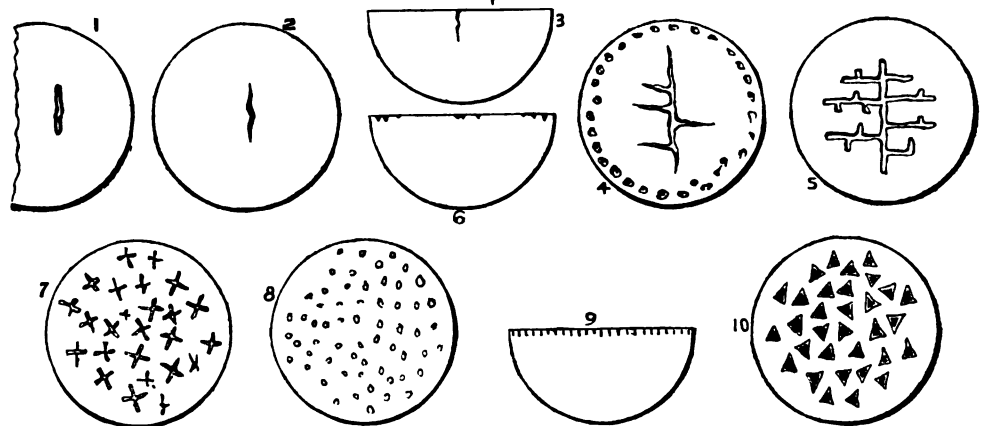
THE BERLIN CASTINGS.

COUNT STOLLBERG'S WORKS AT ILSENBURG, HARZ.

THERE is a peculiar kind of ornamental iron castings, known under the name of "Berlin castings" all over the world, which forms a speciality of manufacture for a small number of foundries in Germany. It is difficult to imitate their delicate forms and beautifully finished surfaces, and their production in the foundry has become more an art than a trade or manufacture. An important requirement for the production of these articles, which must be supplied either by nature, or by scientific research and a suitable treatment of the material, is iron of sufficient fluidity and density to fill all the most delicate undulations of the mould, and retain the impression of the latter when finished and cooled. It is generally known that a slight admixture of phosphorus in the iron produces the last-named effect, but recent experiments and discoveries seem to show that similar results may be obtained from iron which is practically free from phosphorus. The "Berlin castings" proper are extremely small pieces used as toys and ornaments of all kinds; but there are articles now being largely made in France, and particularly in Germany, which combine the beauty and delicacy of outline and the highly ornamental character of the mouldings of the lighter castings with strength and solidity; the objects being occasionally of considerable size and weight, and being used for a variety of purposes. A group of articles of this latter character is that sent to Paris from the ironworks of Count Stollberg at Ilseburg am Harz, in Brunswick. The works carried on under the above name consist of some small charcoal furnaces situated close to several mines of iron-stone in the north of Germany, near the town of Brunswick; their production is not very extensive, and the competition with foreign pig iron at a more recent date made it impossible for this concern to maintain a profitable trade in their old lines of industry, viz., the making of foundry and forge pigs. The manager of these works, M. Schott, who had occupied himself for a long time with researches on the crystallisation of iron as a purely scientific pursuit, fortunately discovered a method of producing very delicate castings from the charcoal iron of Ilseburg, and he very quickly succeeded in establishing an important and lucrative manufacture of ornamental castings in his foundry. The articles made at Ilseburg are now exported to all parts of Europe; they are castings of a highly ornamental character, such as iron gates and doors, tables, plates, church decorations, heraldic ornaments, &c. The models from which these castings are made are mostly classic specimens of mediæval or modern art, and the beauty of surface, the sharp and minute impressions, and the delicacy of outlines can only be compared to those of metallic productions obtained by galvanoplasty. The moulding of these articles is done in sand. There is no natural sand of sufficient fineness and porosity to be found at Ilseburg, and so M. Schott was led to make suitable sand for his foundry. According to his views, the first and most important quality of moulders' sand is porosity. There is an unavoidable accumulation of air produced in each mould by the process of teeming, since the current of liquid metal draws with it an induced current of air, which latter cannot afterwards readily escape, and remains subdivided amongst the liquid mass. With all the precautions now in use in all foundries, this air has no sufficient means for escaping, except in large bubbles or jets. The porosity of the moulders' sand, although known to be a requirement, has not generally been carefully and minutely inquired into, as has been found desirable by M. Schott for the production of his fine castings. M. Schott collected specimens of sandstone, partly natural stone from the neighbourhood of his foundry, and

partly artificial stone produced by burning clay and mixing it with unburnt clay and other substances, and he compared the porosity of these stones by careful experiments. Blocks of the stones were made of equal size and weighed; these blocks were afterwards immersed in water, and the weight of water absorbed by the stone ascertained as well. The quantity of water absorbed by each stone was taken as a measure of its porosity, and M. Schott concluded that each stone, if ground into fine sand, would maintain its character, and the porosity of the sand would vary in the same degree as it was the case with the solid stone. Experience proved that this was very nearly correct, and it was possible by mixing different materials to produce an artificial sand which had the maximum of porosity, and which in that respect was superior to any natural sand known to M. Schott, and certainly very much superior to the average of moulders' sands throughout the foundries of all Europe. This being arrived at, it required nothing but a sufficient fineness of grain to make the most suitable moulds for ornamental work. The sand at the Ilseburg Foundry takes the most delicate impressions from materials and patterns of any kind. M. Schott on one occasion sent a folded napkin from his dinner-table into the foundry for being moulded in the presence of some of his friends, and the casting showed the finest threads of the woven fabric reproduced on its surface. The process of moulding, as far as the mechanical manipulation is concerned, requires much skill and attention; the moulders require long training, and their work remains always comparatively slow and expensive. The preparation of the metal is the principal art in the making of these castings. M. Schott has arrived at his present success by experiments on the melting heat of different kinds and different mixtures of pig iron. His experiments were conducted in a very simple manner, which, although it gives only approximate results, is sufficiently correct for indicating the direction in which practice is to be improved and success is likely to be obtained. M. Schott fills a vessel with a certain weight of water, and maintains the latter at a fixed temperature. A measured quantity of the molten iron is then thrown into the water, and the increase of temperature observed. The rise in temperature nearly corresponds to the number of degrees of heat which the molten iron contains. Although this simple mode of testing the temperature of molten iron has no pretence to accuracy in any respect, it is very useful for giving to the founder a general idea of the relative temperatures at which he is working, and at which his different mixtures of iron are melting or setting. M. Schott has found that by mixing certain kinds of iron together it is possible to raise or lower their melting-point at will. For instance, two marks of pig iron when mixed together may have a lower melting-point than either of the two if melted by itself; or a mixture of several marks may be made which will melt at a higher heat than any one of the marks if melted singly. M. Schott has con-

difference being about 700° F. With this fact another thing is connected, of which founders in general have been aware for a long time past, particularly in works where both charcoal and coke iron is used in the foundry. The contraction of charcoal iron in cooling is greater than that of coke iron, so that the allowance for shrinkage in the patterns, moulds, and cores must be altered accordingly, if the two different kinds of iron are used alternately. The larger amount of contraction in cooling is one of the causes of the superiority of charcoal iron as a material for castings over the iron made with coke, since the greater contraction after solidification necessitates a more compact and dense arrangement of the crystals in the interior of the mass, and this is equivalent to a greater density and cohesive strength of the metal. As a rule, therefore, the iron melting at a high temperature will, under equal circumstances, have a greater density and strength in the casting; but it will be more difficult to cast, since it sets quickly, and does not give the enclosed gases time to escape, producing hollows and honeycombs of all kinds. M. Schott's first researches were directed to the production of an iron with a sufficiently low melting-point, since he expected from this the best results in his foundry; he soon discovered, however, that he could far exceed the proper limits in that respect—i. e. that he could produce mixtures of iron which were so liquid as to be utterly worthless for the production of fine castings. These very liquid irons gave very curious results. When cast into an open mould, the iron invariably produced a hollow casting, with the upper surface bent into a convex shape. The surface was also of a rough character, particularly near the edges, so that no proper castings could be obtained. M. Schott then found that the reason for this was the mode of contraction of the different parts of the castings in cooling. The surface of the iron in the open mould, which cools much sooner than the rest, becomes solidified at a time when the greater portion of the mass is still in a state of perfect fluidity. At a later period the metal in contact with the mould becomes solidified, and forms a bottom crust, there being a quantity of liquid iron inclosed between the two strata of solid iron. Now the cooling of the bottom crust proceeds, and a corresponding shrinkage takes place in it. The upper surface, having been cooled long before, is now unable to follow that shrinkage, and it is in consequence bent by the contraction of the lower portion. The top of the casting then rises, forming a convex surface, and leaving a large hollow between it and the rest of the metal which is still liquid, and remains at the bottom of the mould. Close to the edges of the casting, where the upper and lower crust are in contact, and enclose only a very small stratum of liquid iron, the contraction has a tendency to press the two crusts against each other, and at these spots it happens with very fluid iron that some of the liquid is squeezed out through the pores of the metallic crusts, and comes out at the surface in the shape of globules of iron of



finer his researches to those marks of iron which are employed at his foundry and in its neighbourhood, including several kinds of charcoal and coke pig iron from Germany; also Coltness iron, and a few more of the most largely exported Scotch marks. He has unfortunately omitted to collect the chemical analyses of these irons, so that his experience—however valuable for his own foundry, and however interesting in its general features to the profession at large—is yet incapable of being brought into a scientific form, and does not allow of drawing conclusions of a more widespread utility. M. Schott has found that the different marks of charcoal iron made at his own blast furnaces vary as much as 850° F. in their melting-points. In general the melting-point of charcoal iron has been found much higher than that of coke iron, the mean

microscopic smallness. These globules collect close to each other, forming a kind of rough skin upon the casting, and giving it the appearance of being "burnt" on the surface. It was very difficult to explain this and several corresponding phenomena, until M. Schott called the aid of the microscope to his assistance for examining these impurities. Chemistry, of course, could not show much in explanation of a purely mechanical result, and the many analyses made of the extraneous matter found on the surface of many castings, even if made in the most carefully prepared moulds, failed to throw any light upon the subject. M. Schott, in his search for a suitable iron for his ornamental castings, then returned to mixtures of iron which had a higher melting-point, and which, therefore, showed the last-named difficulties in a lesser

degree. In this manner iron of suitable fluidity has been prepared for all the different kinds of articles required in the Ilseburg Foundry, and the specimens exhibited at Paris show how very far scientific research can assist the founder's art, and how beautiful results may be obtained by the most simple and inexpensive means, if the method of working is based upon sound knowledge and carefully conducted inquiry. The production of a fine casting and of a well-moulded surface is, however, not all that M. Schott has desired and ultimately arrived at in his foundry. He also wanted uniformity of the metal, and a maximum of strength. Starting with the proposition that the cohesive force or strength of the iron will depend upon the nature and relative position of the crystals of which it is composed, M. Schott commenced with microscopic observations of the fractures of cast iron from different foundries and of very different qualities. He then extended his operations upon masses of iron in the liquid state, watching the movement of the liquid and the subsequent movements which take place in the mass at the moment of solidification. For this purpose small moulds of sand were made, each forming a hemisphere, and iron was cast into these moulds. The surface which remained uncovered was then watched during solidification, and sketches were made of the appearance which different kinds of iron presented in succession. We have copied some of M. Schott's sketches, which are very characteristic. The figures in the engraving show the appearance of the surface shortly after casting; at a later period, but before solidification; and the corresponding vertical section of the mould.

Figs. 1, 2, and 3, represent the appearance of very graphitic charcoal iron, almost too graphitic for casting. Figs. 4, 5, and 6, refer to iron of a dark grey colour and fine grain, made with charcoal. Figs. 7, 8, and 9, show the charcoal iron most suitable for foundry purposes in the same three figures. This iron is of a light grey colour, and of fine uniform grain when fractured cold. The liquid mass is covered with a great number of small crosses, which are seen to move about very rapidly, to disappear and reappear, and ultimately to give place to a great number of minute globules, which rise to the surface and solidify there. There is a marked difference between the appearance of charcoal-iron and coke-iron. Instead of the crosses of the charcoal-iron, the coke-iron shows small triangles, which move about with still greater rapidity, and ultimately give way to the globules, same as before said. The appearance presented by coke-iron is shown by Fig. 10. When the iron is still poorer in graphitic carbon, as in the marks above referred to, the crosses in the charcoal-iron and the triangles in the coke-iron, become smaller and smaller, and ultimately give way to the globules altogether. Below each globule there is a hole of corresponding size in the mass of the iron, but the depth of these holes is very small in grey iron, and increases in the white qualities. M. Schott maintains that all crystals of iron are of the form of a double pyramid, the axis of which is variable as compared with the size of the base. The coarser kinds of iron have crystals of about twice the height of pyramids as compared with the finest qualities of crystalline iron. The more uniform the grain, the smaller the crystals, and the flatter the pyramids are, which form each single element, the better the quality, the greater the cohesive force and the finer the surface of the iron. The character of steel has been found in no way different as far as the nature of its crystalline structure is concerned. The pyramids of steel vary in size of axis and in shape. They are more or less pointed, according to the nature and quality of the steel; they are of more or less uniformity in size and relative position, according to the mode of manufacture and treatment. For steel, the parallelism and regularity of the relative position of the crystals is one of the most important elements of its quality, and this can be very well observed under a microscope of sufficient power. We have noted M. Schott's very interesting researches and discoveries with a view of inducing others to follow up this interesting study in the same direction. We hope by these means to arrive at a co-operation of chemical and microscopic research on the qualities of iron and steel, and we have no doubt that the interesting results already arrived at by M. Schott, and the practical advantages which his researches have given to him, will be a sufficient proof that much is to be gained by a study of the subject. The castings of the Ilseburg Foundry are objects of the just admiration of every visitor to the Exhibition; the jury have awarded a gold medal to this exhibit, and merchants from all countries crowd the order-books of this one establishment, while all foundries around are slack in the

extreme. There are many who ascribe this success to a special peculiarity of the iron made at the blast-furnaces of Count Stollberg, which is thought to possess in itself superior qualities for foundry purposes. This, however, is a mistake; the same quality of castings can be produced at any spot by a suitable selection of pigs, and by a sufficient attention to those elementary conditions of success which, although apparently only matters of detail, are still of primary importance. To collect sound information about these details, to study the reasons for the different phenomena which present themselves in the foundry, and to arrive at a scientific mode of commanding success under all circumstances, will make our future foundry practice in a very different position to that which it occupies at present. We shall have a science instead of a craft, and knowledge instead of habit and mere mechanical skill. We shall have more intelligence and fewer secrets in the foundry, and engineering at large will be advanced in one of its most important and, as yet, most neglected branches.

RECENT PATENTS.

THE following specifications of completed patents are all dated within the year 1866; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 2947, 4d.) George Crawshaw, of Gateshead-on-Tyne, and John Thomas, of Newcastle-on-Tyne, patent methods of treating the scoria of ores containing iron, and processes for refining cast iron. The patentees first treat the slag or scoria according to the method patented by Mr. John Thomas and Mr. Alexander Price, in May, 1866 (patent No. 1403). The slag or scoria broken into pieces of a convenient size, is smelted in a furnace of the usual construction; this furnace being raised to a high temperature, and when sufficiently heated, being charged with materials in about the following proportions, viz.: 1 ton of slag or scoria; 1 ton of pig iron; 4 cwt. of clay, raw or burnt; 5 cwt. of chalk or limestone; and 10 cwt. of good coke. The patentees state that if the scoria is of average quality, such as refinery slag, tap cinder, or mill cinder, the above quantities of materials will produce 30 cwt. of good iron, which will need no treatment preparatory to puddling. When the iron from slag or scoria contains those elements which produce, when it is puddled, red-short or cold-short iron, the patentees remelt it in a blast furnace or cupola, with what they term their refining flux. In carrying out this process, the furnace is charged with materials in the following proportions, viz.: 1 ton of pig iron; 3 cwt. of clay; 6 cwt. of cinder or scoria from some previous smelting (the glassy cinder preferred); some wrought iron scraps, varying in quantity from 2 cwt. to 5 cwt., according to the quality of cast iron required; and 5 cwt. of good coke. In this refining process the iron and fluxes are charged in the usual way, and the tap-hole is stopped, so that a bath of flux is formed, the object being that the iron, when melted, should fall through the flux in a divided state, and should thus become cleansed of many impurities.

(No. 2948, 4d.) George Crawshaw, of Gateshead-on-Tyne, and John Thomas, of Newcastle-on-Tyne, patent methods of refining pig or cast iron by melting it in a cupola or blast furnace with clay and iron slag as fluxes, a small quantity of wrought iron or a small portion of lime, limestone, or chalk being added in some instances.

(No. 2953, 8d.) James Ingram and Heinrich Stapfer, of Manchester, patent an apparatus for testing lubricants. The principle upon which this apparatus is constructed is that of placing a given quantity of lubricant between two frictional surfaces, and then measuring the quantity of motion required to use up the lubricant, the exhaustion of the latter being indicated by the rise in the temperature of the rubbing surfaces, and the machine being so arranged that when this rise of temperature exceeds a certain amount, the driving power is thrown out of gear.

(No. 2957, 4d.) George Crawshaw, of Gateshead-on-Tyne, and John Thomas, of Newcastle-on-Tyne, patent methods of treating titaniferous iron ores, and of utilising the scoria from them. The patentees propose first to calcine the ores, and then to throw them, whilst hot, into water, so as to disintegrate them, and at the same time to convert a portion of the titanic acid into titanic oxide. The ores are then to be dried and smelted in a furnace of the ordinary construction, this furnace, when heated, being charged with materials in about the following proportions: 1 ton of titanic iron ore; 1 ton of pig or cast iron; 3 cwt. of clay, raw or burnt; 4 cwt. of lime, chalk, or limestone; and about 15 cwt. of coke, wood, peat, or charcoal.

The patentees propose to employ the slag or scoria from the smelting of the above ores for improving other irons which are not titanic, either by using the slag as a flux in the puddling furnace, or in any other smelting or melting furnace, so that the iron mixed with it may become titanised.

(No. 2973, 10d.) Friederich Wilhelm Dahne, of Swansea, and David Thomas, of Cwm Avon, Saibach, patent making picks for cutting coals with movable points, the handle of the pick carrying a head having sockets in which the points are fixed by means of set screws. We much doubt whether this is new.

(No. 2983, 8d.) Thomas Seaville Truss, of 118, Fenchurch-street, patents forms of pipe joints. According to these plans the pipes to be joined have external grooves formed in them near their ends, and in these grooves are placed elastic packing rings which are clipped by rings formed in halves, and bolted up so that each ring embraces the adjoining ends of a pair of pipes. This is a form of joint which will be convenient in many situations.

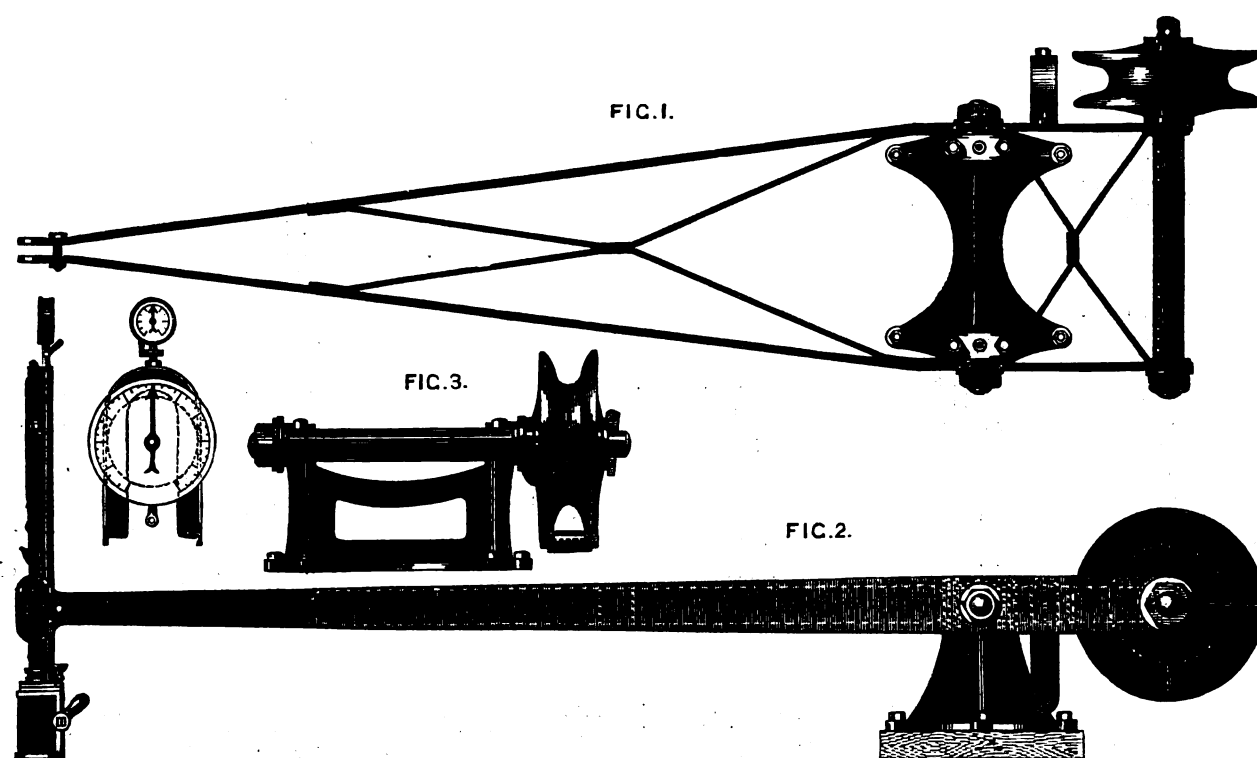
(No. 2985, 10d.) Hesketh Hughes, of Birmingham, patents methods of manufacturing ornamental tubes by producing raised designs on their surfaces by means of an expanding mandril or tool inserted in the tube, and which acts in combination with dies or rollers applied to the exterior.

(No. 2986, 6d.) Thomas Page, of the Adelphi, patents arrangements of locomotive engines and tramways for steep gradients. We described Mr. Page's plans on page 12 of our last number.

TELEGRAPH TO INDIA *via* RUSSIA.—The following are said to be the exact terms of the arrangements lately entered into by the Russian and Prussian Governments with Messrs. Siemens Brothers, of London, and Siemens, Halske, and Co., of Berlin and St. Petersburg, in relation to the construction of a new line of telegraph between England and India through their respective territories. The latter firm have for many years been under contract with the Russian Government to maintain their lines of telegraph in working condition, one of the partners residing for that purpose at Tiflis, in the Caucasus. The Russian Government have now agreed to give a right of way through Russian territory, free of cost, and a concession for working a new line of telegraph and stations for twenty-five years from the date of opening. The Government yield to the company their right of forwarding messages to and from India upon the Imperial Telegraph lines, and engage to hand over to the company all such messages touching Russian territory for transmission over its lines. The company is to work the line by means of its own officials. In return for these privileges the Russian Government exact a royalty of less than one-third of the existing internal tariff—that is to say, a royalty of five francs per message, which is to be diminished rateably as the through tariff between England and India is diminished from the existing rate of 5*l.* 1*s.* On the other hand, the Prussian Government engage to construct and to maintain two special lines through North Germany at their own expense, and to hand them over to the company for the period of twenty-five years. For these services of construction and maintenance, and for the privileges mentioned in the concession, the Prussian Government charge 2*fl.* per message, to be reduced as in the case of Russia, in the event of the through tariff being reduced. All messages to and from India, touching German territory, will be handed over by the German officials to the company for transmission over its lines. A right of landing cables on German territory is given to the company. As there are no private telegraph lines in Russia or in Prussia, the company will enjoy a complete monopoly of all the through messages. The Electric and International Company also agree to lease two wires of the cable lately laid to Hanover, to the company. The British Government assist the whole arrangement and engage to give every facility for the transmission of messages over the lines which they work in Persia between India, Ispahan, and Teheran. The Persian line in British hands consists of two wires, and works very well. The British Government also promise to reduce the tariff over the Persian lines and the Persian Gulf cable so soon as an increase of messages shall occur in consequence of the new line. The Prussian and Russian Governments permit the transmission of half messages to and from India of ten words each at half the present tariff, and it is expected that the same concession will be made by the British Government. At present no message can be charged at less than 20 words. The company will lay a submarine cable in the Black Sea, 280 miles in length, between the Crimea and the Circassian coast. By means of these several arrangements, an English company will hold and work an uninterrupted line of telegraph from England to Persia, the line from Teheran to India being already in the hands of the British Government. The few sections of the line which consist of submarine cables are laid in shallow water, where repairs can be effected without delay or difficulty. The cost of land lines is only one-third or one-fourth that of submarine lines, and the great interest which the respective Governments possess, through whose territories it is proposed to pass, that their countries should form the telegraphic highway to India and the East will, it is considered, ensure the efficient maintenance of the contemplated communication. Negotiations are in progress with the Persian Government for an independent line in the company's hands between the Russian frontier and Teheran. Immediate steps will be taken to raise a portion of the capital in England and to commence the work.

VICTORIA.—This important Australian colony is shown by a recent return to possess 525 post-offices, 79 telegraph stations, and 277 miles of railway. The value of the gold exported from the colony from June, 1851 to the close of 1865, was computed at no less than 144,144,100*l.*

THE FLORIDA AND CUBA CABLE.



We noticed in a paragraph in this paper the week before last, the departure, for Cuba, of the *Narva*, a steamship which had been chartered by the India Rubber and Gutta Percha and Telegraph Works Company (Limited) for the purpose of laying the Florida and Cuba cable. The *Narva* is a screw steamer of 1280 tons burthen and 140 horse-power, and she has been completely fitted up with apparatus for laying and picking up the cable, under the direction of Mr. F. C. Webb, who has gone out in her as engineer in charge of the expedition. The *Narva* will altogether carry out about 1700 tons of dead weight.

The Florida and Cuba cable will consist of two sections, one extending from Cuba to Key West, and the other from Key West to Romania in the Gulf of Florida. The quantities of cable taken out by the *Narva* for these two sections, and their weight per mile, are as follows:

Cuba and Key West Section.

	Weight per mile.
9 miles of thick shore end...	12 tons
14½ " medium ...	4½ "
86 " main cable ...	2.1 "
Total ...	109½ miles.

Key West and Romania Section.

	Weight per mile.
2 miles of shore end ...	4½ tons.
1 " " " ...	2 "
180 " main cable ...	1.1 "
Total ...	183 miles.

The weight of the copper conductor of the cable is 107 lb. per knot throughout, and that of the insulator, 166 lb. per knot. Of the thick shore end, above mentioned, as weighing 12 tons per mile, the greater length will be laid at the Key West end of the Cuba and Key West section, the remainder being, of course, laid at Cuba. To the thick shore ends will be joined the medium-sized cable, whilst the main length will be lighted as stated above. The special feature of the expedition is that from the nature of the ground—if that be a correct term to apply to the bottom of the sea—the main Cuba and Key West section will have to be spliced to a previously laid and buoyed shore end in 300 fathoms of water—a feat in telegraphic engineering which has hitherto never been performed. The operation will also be rendered more difficult by the fact that the buoys will be situated in the Gulf-stream, and that they will thus be liable to be shifted. In laying the cable, the commencement will be made at Cuba, by depositing the shore end there. This having been laid the sea end will be buoyed, and the *Narva* will depart for Key West, and the shore end having been deposited there also, the splice with the main cable will be made, and the latter will be paid out from Key West towards Cuba. On arriving at the spot where the Cuba shore end was buoyed, this end will have to be picked up, and, as we have already stated, the splice made between it and the main cable in a depth of 300 fathoms water. This will be a difficult operation—very different from splicing a picked-up end to a cable on board the vessel, as in the case of the Atlantic cable—but Mr. Webb has no doubt about being able to perform it successfully. The Cuba and Key West section having been laid, the Key West and Romania portion will be laid in a similar way.

The cables are coiled on board the *Narva* in two large circular tanks, which were constructed and erected *in situ* by the Thames Ironworks Company. In each of these tanks the central Newall's cone, around which the cable is coiled, instead of being of wood as has hitherto been usual, is made of iron plates in the same manner as the rest of the tanks, and the latter thus have an annular form. The advantages of this arrangement are, that the quantity of water which has to be carried in each tank to keep the cable covered is lessened, and that the interior of

each cone forms a convenient space, in which ropes and other articles can be stowed. The tanks are well secured in their places by struts extending from them to the sides of the vessel, and the water in them is kept from shifting by the cable in each being covered down by a strong deck of planks well caulked.

When the cable is being paid out from either of the tanks it will be led up between the central cone, and rings placed round it according to Mr. Newall's patented plan, one ring being fixed around the upper part of the cone, and another being adjustable at various heights, so that it can always be kept a short distance above the coils of cable in the tank. In the case of the Great Eastern and other vessels in which Newall's rings have been employed, these rings were only held in place by ropes and other temporary supports, but in the case of the *Narva*, Mr. Webb has had the rings fitted up in a more perfect manner. The rings themselves are formed of wrought-iron gas piping, and the upper one of each tank is securely supported by struts, also formed of gas pipe. The lower or movable rings have each telescopic radial arms of gas piping extending from them, the sliding portion of each arm being capable of being fixed by a set screw; and each ring can thus be supported at any desired point by setting out these arms against the sides of the tank.

From the tank the cable will be taken over a guide quadrant of cast iron fixed above the deck level, and thence it will be led to the stern of the vessel, passing round the brake drum and under the dynamometer sheave on its way. The brake used is arranged on Mr. Amos's self-adjusting plan, but the adjusting levers are so supported that they can, when required, be disconnected, and the brake converted into an ordinary differential brake worked by hand. The dynamometer employed, which has been designed by Mr. Webb, is of very simple construction, as will be seen from the annexed engraving of it. It consists merely of a lever formed of wrought iron bracing, and having arms in the proportion of 5 to 1, the fulcrum of this lever being carried by brackets bolted to the deck. The shorter arm of this lever carries a shaft, on the overhung end of which is placed a sheave, under which the cable passes; and the end of the longer arm is connected by a link with a Salter's spring balance placed above it. The longer end of the lever is also connected to the piston rod of a piston moving in a small cylinder bolted down to the deck, this cylinder containing water. The two ends of the cylinder are connected by a passage fitted with a cock, and by opening or closing this cock more or less resistance can be offered to the passage of the water from the one end of the cylinder to the other, and consequently more or less resistance opposed to the motion of the piston and of the dynamometer arm. The object of this arrangement is to steady the lever and keep it from moving too quickly. The cable is led from the brake apparatus down under the dynamometer sheave, and up again to the stern sheave at such an angle that an upward strain of 1 ton on the cable exerts an upward strain of 10 cwt. on the dynamometer sheave, and this strain is again reduced by the action of the lever to one of 2 cwt. on the spring of the spring balance.

The picking-up machinery presents several points of novelty. The cable to be raised, or rope to be hauled in, is led over a sheave supported by timbers extending out beyond the bows of the vessel, and is conducted over guide-pulleys to the drum of the picking-up gear. This drum, which is cast in one piece with the brake-drum, is fixed upon the overhung end of the main shaft, which is carried by bearings in a strong frame. The picking-up drum is driven by a pinion acting on internal gearing, that portion of the drum surrounding this gearing being encircled by the brake-strap. This employment of internal instead of external gearing enables the amount of the overhang of the drum to be made less than it otherwise would be, to the extent of the width of the teeth. After the cable which is being picked up has been taken several turns round the picking-up drum, it is taken round a smaller drum which

takes up the slack, and keeps the cable constantly bearing tightly on the picking-up drum. To enable it to do this effectually, the small drum is driven at a slightly higher surface speed than the larger drum, so that a small amount of slip is constantly taking place between it and the cable as the latter is hauled in. In some cases, however, it will be necessary to pay out lengths of cable from the picking-up gear, and when this is being done the higher surface speed of the "follower" would be a disadvantage, as it would cause slack to be accumulated between it and the larger drum. To avoid this, arrangements are provided for throwing the follower out of gear, and retarding its motion to any required extent by means of a brake, when the cable is being paid out. The picking-up machinery is driven by a pair of oscillating engines supplied with steam from a boiler on deck. Altogether, the arrangements for laying and picking up the cable are very complete, and as the machinery is in experienced hands, there is every reason to believe that the expedition will be a success. We may add, that we expect at an early date to be able to place before our readers an account of the laying of the cable.

RAILWAYS IN HOLLAND.—The Dutch Government has just adopted a decision which is calculated to notably increase the importance of the Dutch railways. For a long time past works have been projected for the construction of a bridge between Moerdyk and Willemsdorp. This work, which will directly unite the railway network of the Low Countries to the Belgian and French lines, will involve a rather considerable outlay, and the States General have hitherto left the question undetermined. The Government has, however, just presented a law which determines in principle on the construction of the Moerdyk bridge, and applies to the Chambers for a first credit of 20,000*l.*, which is to be devoted to the commencement of the works. The whole estimated cost of the bridge is 814,800*l.*, as its length is 1½ mile. The greatest depth of the water crossed does not exceed 21 ft. or 22 ft., but the nature of the ground will render the establishment of the necessary piers difficult and costly. It is expected, indeed, that the works will extend over five or six years.

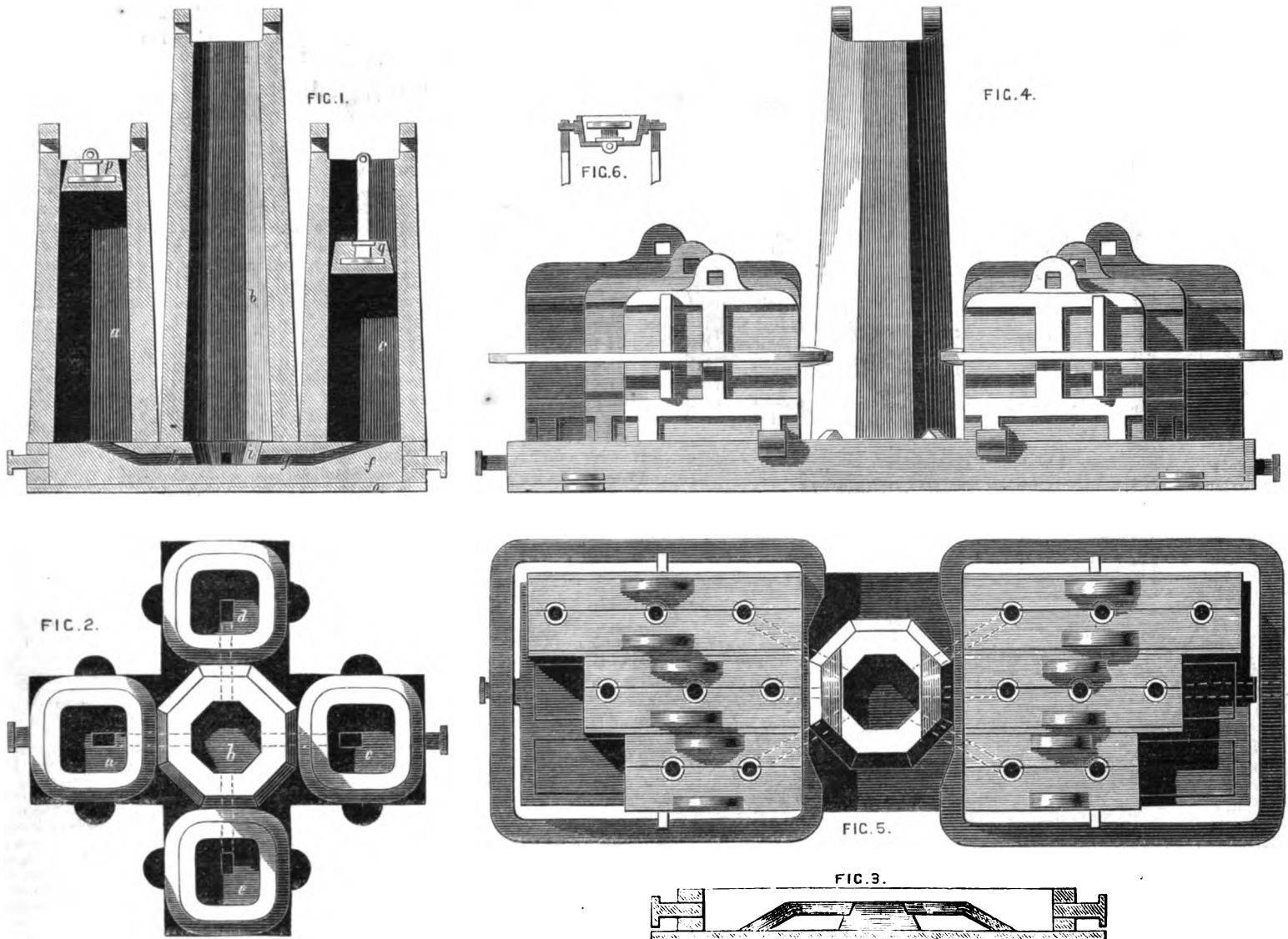
MONITORS FOR BOMBAY.—We are able to state upon authority that the "proposed monitor for Bombay," of which an illustration lately appeared in a contemporary, will not be adopted by the Government. It was professedly designed at the Thames Ironworks, and differed but little from the American type, except in having twin screws and solid armour. The monitor which will be built for Bombay will be constructed from the designs of Mr. E. J. Reed, the Chief Constructor of the Navy, and will be similar to that to be made also upon his plans for Melbourne. The turret will be surrounded, to a certain height, by an armoured breastwork, as represented in the design which Mr. Reed produced during the recent monitor discussion at the Institution of Civil Engineers.

NEW YORK.—In 1866, 1640 American ships, of an aggregate burthen of 990,116 tons, and 3187 foreign ships, of an aggregate burthen of 1,776,818 tons, entered the port of New York. The number of ships which cleared from the port in 1866 was 1201 American, of an aggregate burthen of 799,082 tons, and 3205 foreign, of an aggregate burthen of 1,813,128 tons. The value of the goods imported into and exported from New York in 1866 was as follows: Under the American flag, 144,051,506\$; under foreign flags, 438,458,614\$.

AMERICAN STEAM NAVIGATION.—The American company, which has established a steam line between California and China, will soon have five steamers at work, viz., the *Great Republic*, the *Celestial Empire*, the *America*, the *Nippon*, and the *Colorado* (which opened the line). Each of these steamers is about 4000 tons burthen.

HOLLEY'S PROCESS OF CASTING BESSEMER INGOTS FROM THE BOTTOM.

BY A. L. HOLLEY, PENNSYLVANIA STEEL WORKS, HARRISBURG, U.S.



THE engravings represent a plan of casting a group of sound Bessemer ingots at one pouring, developed and patented by Mr. A. L. Holley, superintendent of the Pennsylvania Steel Works, Harrisburg, U.S.

The five to seven tons of steel in a Bessemer ladle are commonly turned into twenty or thirty moulds, through a nozzle $1\frac{1}{2}$ in. to 2 in. in diameter. To prevent the steel from boiling over in the moulds, even this small stream must be frequently throttled or stopped. The results are as follows:

1st. The steel in and about the nozzle often chills, so that a large scull is formed in the ladle. This is especially the case with mild, soft steel, which chills rapidly from its want of carbon.

2nd. The long time occupied in passing to and from so many moulds, and filling each separately, aggravates this tendency of the steel to chill.

3rd. It is often impossible to shut the stopper quite tight upon the nozzle, when it has once been opened, so that much scrap is formed on the outside of the moulds and on the ground. The stopper not unfrequently burns off or gets fast open, thus causing excessive spilling and scrap, besides filling the moulds so rapidly that the ingots are cracked, or piped, or otherwise unsound.

4th. The stream of steel usually spatters upon the insides of small moulds, thus cutting the moulds, and also forming scales which never perfectly unite with the body of the ingot, but appear as seams when the steel is further manufactured.

5th. It is difficult—practically impossible—to make a large number of small ingots of the same weight by teeming them into the tops of the moulds, especially when the ladle stopper works badly, because, on account of the boiling of the steel in the moulds, its true level cannot be determined, and an excess is let in to ensure any given weight. This excess appears in the form of slag ends, which are unfit for further use, except as scrap. In the production of 1000 tons of rails, there is a certain minimum weight of ingot. The 10 lb. or 12 lb., or often 30 lb. or 40 lb., of each of the 4000 ingots in excess of this minimum are a waste of 20 tons to 50 tons or more of marketable steel.

Mr. Holley remedies these defects by casting from five to nine or more ingots, rapidly, through a large nozzle, at one teeming. The steel is poured into a central sprue mould (which also forms a marketable ingot), and thence passes through small sprues into the bottoms of the surrounding group of moulds. The steel rises in the surrounding moulds to a fixed vented stopper, so that any number of ingots can be cast of precisely the same length and weight; or the length can be varied in a given mould, by changing the height of the stopper.

Ingots thus cast are square and sound at the top as well as at the bottom, and they are more free from cracks and external honeycombs and much smoother than ingots cast from the top. Excessive spilling is avoided, and as the ladle is quickly emptied, less scull or scrap is left in it.

Fig. 1 represents a vertical section through a group of five ordinary cast-iron ingot moulds, *a, b, c, d, e*; and Fig. 2, a plan of the same, standing on a "distributor," *f*. The distributor is simply a moulder's flask filled with loam, in which the spruce or runners, *g, h, i*, are moulded. The central mould, *b*, into which the steel is teemed, is higher than the surrounding moulds, so that when the latter are full, the steel continues to rise in the central mould, thus forming a head or riser, and promoting the soundness of the surrounding ingots by "ferrostatic" pressure.

If the stream of steel were to fall into the mould, *a*, it would cut away the loam around the passage, *f*, and cause much scrap. One of the principal features of this invention is the prolongation of the central mould, *b*, into the flask at *i*, so that the stream of steel falling from the ladle into it may strike on the flat hard bottom, *i*, and thence pass laterally into the sprues.

Another important feature of this invention is that not only the body of the central sprue mould, but the distributing basin or reservoir at the bottom of it, contain together a marketable ingot. A small, high sprue like that used by foundries in casting rolls and guns from the bottom, would not form a marketable ingot, but would be a large piece of scrap.

The distributor, *f*, may be moulded in any suitable manner: that employed by Mr. Holley is shown by Fig. 3. The flask is turned bottom upward upon a follow-board, *k*; the patterns, *l, m, n*, are set upon the follow-board, and good loam, by preference mixed with a little fire-clay and ground crucibles, is rammed into the flask. The bottom plate, *o*, Fig. 1, is then cotted to the flask; the flask is turned over, the patterns, *l* and *n*, are withdrawn upward, and the patterns, *m*, are withdrawn into the space left by the pattern, *l*. The whole is then thoroughly dried in an oven, when it is placed in the casting-pit, and the ingot moulds are set upon it. A man and a boy can mould from ten to twelve distributors in a day, depending on the number of moulds and the convenience of cranes and ovens. From two to four groups of moulds will hold a 5-ton ladleful of steel.

A convenient mode of stopping the tops of the surrounding moulds is shown at Fig. 1. The plug or stopper, *p*, is a mass of loam, made and dried like a core, vented with small holes, and suspended in the top of the mould by a rod passing through the shank of the anchor that holds the core or stopper together. A

little loam is pressed around the stopper, to prevent the steel from running up between it and the side of the mould, and also to hold the stopper down. To cast ingots of different lengths, stoppers with shanks of different lengths are used, as at *p* and *g*, Fig. 1.

All stoppers, irrespective of the length of shank, are moulded in the box, Fig. 6. The anchor, *r*, is set in the shank projecting through a hole in the bottom of the box. Loam is then rammed in, vent-holes are pricked, and the box is turned bottom upward, when the stoppers and anchor together slip out upon a plate, and are carried to the oven. Various other means of stopping the tops of the moulds have been employed with success. A simple perforated iron plate, daubed with loam and wedged upon the top of the mould, answers well if kept down to a bearing.

Fig. 4 is an elevation, and Fig. 5 a plan, of a group of moulds for boiler-plate slabs, standing around a central conical mould. The plate slabs being of uniform thickness at top and bottom (to prevent excessive trimming of the rolled plate), the moulds must be in two parts to let the slab out. A group of three compound moulds, vented by loam plugs or stoppers, are fastened together by a single band and wedge, when they may be lifted as one mould, and set upon one end of the distributor. The other moulds are set upon the other end, and the seven ingots are cast at one teeming. The plate ingots vary in weight from 250 lb. to 800 lb., a part of the variation being in the thickness, but the ribs upon the moulds are so proportioned that the external thickness of all moulds is the same, so that any mould will stand upon any part of the distributor.

It has long been customary in iron founding to form the various parts of a loam mould, for instance, the mould for a gun, in such a manner that the mould shall be filled from the bottom, or, as in case of a chilled roll, to form a mould partly of loam and partly of an iron chill, with sprues so arranged that the mould will be filled from the bottom. In these cases, however, the mould, the sprue, and the place or reservoir into which the liquid iron is received, and from which it is distributed, constitute together one mould, and are formed in one flask, or its equivalent. The peculiarity and value of Mr. Holley's invention lies in the fact that the ingots are cast in ordinary independent cast-iron moulds, while only the small and easily moulded sprues are formed in loam. The distributor is an independent apparatus or machine for distributing liquid iron or steel to ordinary independent moulds of all forms or sizes.

This method of casting ingots was successfully introduced by Mr. Holley, at the Bessemer Steel Works, at Troy, U.S., and has been adopted by the Pennsylvania Steel Company.

DRAINAGE OF BOMBAY.

THE sanitary requirements of Bombay were very forcibly brought to the notice of the Board of Conservancy in 1852 by Mr. H. Conybeare, who stated, in a report of that date, that, with reference to the street drainage, open drains abounded in the native town to an extent believed to be unparalleled elsewhere. These open drains, he said, or rather uncovered receptacles of filth, were the open side gutters by which nearly every street in the native town was polluted. These did not deserve the name of drains; there was seldom any perceptible motion in the liquid contents of the majority of them; they were merely an interval of from 1 to 2 ft. in width left between the kerbstones of the streets and the foundations of houses; they were not regularly sloped, but followed the inclination of the several streets; they were not paved at the bottom, and the scavengers' people, in cleaning out with their shovels any solid matter that may have been thrown into them, constantly stirred and scraped up the mud beneath, so as still further to increase the irregularities of their channels, and render them still more unfit for the performance of the function of a drain. These side gutters could therefore only be considered in the light of continuous open cesspools, extending along the whole length of nearly every street in the native town, and rendered more objectionable than ordinary cesspools by the circumstance of their being in actual contact with, and soaking into, the foundations of the whole street frontage of each house. In 1864, since which time these drains have not been improved, Dr. Leith, when reporting on the sanitary state of the island of Bombay, thus refers to the state of these drains: "The side gutters are, from their want of fall, ill adapted to pass on what they receive, and there were few streets in which there was not seen, in those that were open, black stagnant mud. Some of these gutters are lined with half-dressed stone, and have flat bottoms; others have only the curb stone on one side and the wall of the house along which they pass on the other, and no masonry bottom, so that much of what enters them is absorbed by the ground. These are not merely the remains of former days; both kinds are now seen being constructed in Khetwaddy and elsewhere." This being the present state of the sanitary arrangements for Bombay, it cannot be denied that a perfect and comprehensive system of main drainage is, above all others, the one great desideratum for that town, and, accordingly, Mr. Russel Aitken, the executive engineer to the municipality, has recently submitted a scheme to the Municipal Commissioner of Bombay, having for its object not only the complete drainage of that city, but also the reclamation of about 150 acres of land by filling up the area of low ground lying between Bellasis road and Khetwaddy, which, being only from 2 to 3 ft. above mean sea level, is at present under water during the monsoon.

Referring to Bombay in 1855, we find that at that time it contained very few private cesspools, as they were only allowed in districts where no public drains, either open or covered, were provided, and even in these instances their use was restricted to the reception of liquid sewerage alone, all solid faecal refuse being daily carried away in baskets by the sweepers or nightmen. The method of disposing of the solid faecal refuse was as follows: By regulation, it had been enacted that all privies should be situated in the rear of the houses to which they belong, and, with few exceptions, they were so. Access was obtained to them by means of narrow passages called gullies. A single gully sometimes ran along the rear of two rows of houses facing to different streets, but placed back to back, and forming one block, that gully being common to all the houses of both rows. In other cases, gullies running directly from the street to the rear of each house, were common only to the two houses which they separated. During the few years prior to 1855, the gullies were very generally paved and sloped, the centre of the gully being made lower than its side, and the whole passage being given a sufficient fall to the nearest drain. The object of these paved passages was two-fold: to convey along a non-absorbent surface the scanty slops and wastage water of the houses to the drains, and also to serve as a passage to the halacores, or nightmen, who daily carried away in baskets (one of which, partially filled with straw, was expected to be always placed under each privy) the solid faecal refuse of the inhabitants. These gullies, when once paved, were daily cleaned by the bench's scavenging contractor, and daily inspected by the peons of the overseer's department, who reported for summons to the overseers of the divisions all parties whose privies

were unprovided with baskets, or otherwise in a dirty state.

The native town of Bombay naturally admits of three great physical subdivisions: 1st, the Old Town districts, regularly laid out into streets, and built on a rocky swell facing the harbour; 2nd, the Oart districts, occupying, as the name implies, the site of cocoa-nut plantations, which have become meddensely and irregularly covered with houses, without having ever been laid out into streets or intended for a town, and built on a gentle swell of littoral concrete or recent sand-stone, facing Back Bay; and 3rd, the New Town districts, regularly laid out into streets, and built on the low clay ground, generally below high-water mark, that lies between the two swells on which the Old Town districts and the Oart districts are built, and consequently much further removed than either of them from the sea margin. The sea-beach used formerly to be the only place of ultimate deposit for the contents of the sweepers' baskets; those of the Oart districts being emptied on the beach at Back Bay, and those of the Old Town on the harbour sea-beach at Chinch Bunder. But the New Town districts being much further from the sea than either of the former, the sweepers employed there frequently emptied their baskets in the first dark corner they could find. Previous to the general introduction of supervision by the overseer's department, many of the gullies were nothing better than extensive cesspools, never cleaned, and several feet deep in nightsoil, their contents being seldom removed by any other agency than that of the monsoon. The general paving and regulation of the gullies had, therefore, the immediate effect of greatly augmenting the quantity of nightsoil removed from the native town; and the difficulty of disposing of it was proportionably increased, owing, in the first place, to the greater distance (often exceeding a mile) the halacores had to walk before finding a place for the deposit of their sweepings, and which induced them, whenever they found themselves unwatched, to cast down their burden in the first dark corner they found, thereby much increasing the difficulty of keeping the town clean—and this was particularly the case in the New Town districts, on account of their greater distance from the sea-beach; and secondly, on reaching the sea, the sweepers were in the habit of flinging down the filth barely within the line of water, to be scattered in all directions along the shore, thereby occasioning a most horrible nuisance, which would have been obviated if the soil had been at once flung into the deep water. Captain Crawford, when enlarging on the "most horrible nuisance" arising from the then existing method of flinging down the contents of the sweepers' baskets on the sea-shore instead of into deep water, pointed out that the extension of Boree Bunder would remedy the nuisance at one point only; that Back Bay must be at once rejected as a point for throwing out nightsoil into the sea, as it was little more than a dead water, but that some prominent point should be selected for the purpose, such as the extremity of Colaba or Malabar Point, from which it might be got rid of into the open ocean at once. In accordance with that officer's suggestions, a receiving station for the contents of the sweepers' baskets was established, in 1847, at Khara Tank, whence they were conveyed in nightsoil carts, and cesspools were constructed on the Flats. The establishment of the Khara Tank receiving station did not, however, even during the fair-weather months, sensibly diminish the nuisance in Back Bay, as all the sweepers' baskets of the Oarts districts continued to be thrown there. The night-carts from the Byculla schools, the hospital, the jail, and the large public necessary at Sonapoor, were still emptied there, and its establishment (and that of the nightsoil carts) had the effect of materially increasing the nuisance at Back Bay during the monsoon, as at that season the cesspools on the Flats were under water, and the seven new nightsoil carts had to be emptied on the Back Bay beach.

We will not attempt to follow Mr. Conybeare through his arguments on the several methods at that time proposed for remedying the existing nuisances; but, with reference to a suggestion that the soil should be conveyed to the sea by means of sewers, we find that he stated, "This method of disposing of the nightsoil is clearly out of the question at Bombay."

One great sanitary improvement has recently been effected in Bombay, by the construction of a covered drain across the Flats, which was opened in January last. This new drain is diverted from the old one where the latter comes out on the Flats, at the west-end of the over-bridge on the Ballasis road, and it runs thence in a direct line to Love Grove, where is the

outfall into the sea. Its length, as far as the pumping engines, is 8300 ft., and from the pumping engines to the sea 900 ft.; it is 4 ft. broad and 5 ft. high, and has the form of an arched culvert with invert. The fall is equal to 3 ft. per mile, excepting at the part beyond the pumping engine, where it is 1 ft. in 100. The work and material employed in constructing this drain were as follows: quantity of rubble, 7500 cubic yards; brickwork, 1600 cubic yards; excavation, 46,000 cubic yards; and refilling, 32,000 cubic yards. An area of about 1000 ft. had to be excavated six or eight times, the wet and soft condition of the clay soil causing the sides to slip in over and over again; and, during eight days, though there were 2500 men employed at the excavation, the work made no advance whatever, notwithstanding which, the contractors managed to complete the drain three months before the specified time. The works were begun on the 4th October last and gave constant employment to from 2300 to 2600 men. There are in the course of the drain 27 ventilating shafts and manholes, 300 ft. apart. The sewage will, by this new drain, be carried right out into the open sea. Two 20 horse-power engines have been fitted up, capable of working two powerful chain pumps, or more if necessary. The water will be turned from the old drain into the new, and the old drain is to be cleaned out and cemented over, and used as a flushing sewer during the monsoon. The new drain will not be used during the monsoon months, and will not be in any way needed, for the Flats at that period of the year are usually covered with several feet of water, which keeps down all unpleasant odours. Now that the objection to the use of the Flats for building purposes is removed, it is expected that, beyond doubt, that large space of open ground, pleasantly exposed to the sea breeze, will afford some sites for new buildings, and for an extension of the suburb in that direction.

ENGINEERING SCHEMES—PRESENT AND FUTURE.

TO THE EDITOR OF ENGINEERING.

SIR.—An immense field of operation is now open for development of enterprise and employment of capital and labour, the latter unfortunately at present begging for employment. If properly concentrated on useful objects, this talent must certainly benefit the general community, and advance the cause of civilisation and commercial prosperity. "How not to do it" has had too much away and control for many years past, and "It can't be done" has been the obstructive cry of parties, political and otherwise. Take, for instance, the Isthmus of Suez Canal, which was attacked on all sides as absurd and impossible, and which now is fast approaching success and completion. The cutting through the Isthmus of Panama, so long talked about, will soon follow as a great fact, and Mexico and Brazil will become the great countries for emigrants from the New and Old World, when the North Pacific and North Atlantic Oceans are connected by water channel through the Isthmus of Central America.

The formation of a submarine tunnel from Folkestone to Cape Grisnez is the next undertaking to be carried through, so as to establish unbroken railway traffic and speedy communication between England and the Continent. It has been said, "It can't be done;" but this is only the opinion of a few, possibly interested in offering opposition. It can be done, and well done, if proper means, plans, and appliances are used, and a splendid triple arch tunnel, with double lines of rail in each, could be constructed with perfect ventilation, and lighted by gas, the average journey through of trains being accomplished in half an hour under the ocean. It has been objected that the first cost would be excessive, say sixteen millions sterling, but the revenue from traffic (at least twenty times increase of the present) would compensate for this—say from three to four millions annually; and it is not necessary that the outlay should be paid immediately, but be spread over a period of thirty or forty years, and paid by a sinking fund and compound interest, England and France dividing the responsibilities, each country being naturally benefited and advantaged, and the cost would be fairly and equally divided. The engineering difficulties which may exist are not such as would in any way defy modern engineers and contractors, and a period of three or four years would suffice to open the submarine passage, by which time our connexion with the Indian railways would be completed, and an unbroken line from London to India be established.

Another great project has for several years been discussed, praised by some, ridiculed and abused by others, the latter considering it impossible and ridiculous, because not understood. This is the proposed reclamation of the Goodwin Sands, now a waste pit of destruction to ships, crews, and cargoes, upwards of one thousand millions sterling (valued by proper authorities) having been lost and swallowed up in these quicksands. By judicious arrangements the whole area could be enclosed permanently, and form a splendid harbour of retreat and refuge, together with a recovery of at least a hundred millions sterling of buried wrecks from the close-packing sands, which act as preservatives to sunken ships and cargoes (by close pressure and exclusion of destructive agencies). The estimated outlay for enclosing the sands by iron piles and iron sheet panels would be thirty millions sterling, to be repaid in thirty years or sooner, if the salvage of wrecks and cargoes are within the range of calculation.

These are not idle dreams, but steady and deliberate opinions of practical men, and I have had myself a range of thirty years' hard work and experience on the largest works yet done.

Yours respectfully,

PRACTICAL.

FLOATING BRIDGES.

ONE of the most interesting problems with which the engineer can grapple, provided only it be not altogether hopeless, is that of water-borne bridges. An iron tube or tunnel, resting directly upon the water, would require no piers, with their costly foundations and masonry; and, being supported along its entire length, it would not require to possess the great strength of girders, spanning openings of from 200 ft. to 450 ft. or more. On the other hand, are the instability of floating bridges, especially where the water is liable to great disturbance from storms, their obstruction to navigation, and, where they rise and fall with a considerable tide, the difficulty of connecting them with lines at a fixed level on shore. At first sight these difficulties appear insurmountable, and we shall not, indeed, contend that they are not so. But the whole question is one requiring the most minute consideration, and should means be found for overcoming the apparent impossibilities, none would deny that the system of floating bridges would take its place as one of the most remarkable achievements of our profession. At any rate, it is safe to say that all the more wonderful triumphs of engineering, such as have lent such lustre to our later professional annals, have been won in the face of obstacles which had been previously regarded as insurmountable. Indeed, none of us know, beyond a comparatively limited range of ascertained facts, what is "impossible." The term is much oftener based rather upon our own habits of thought than upon any irrefutable knowledge of the laws of nature. The younger engineers, who are more disposed to take everything, as they find it, as an ordinance of nature, and who, even with the strongest efforts of imagination must fail to realise the apparent impossibilities originally in the way of nearly all great inventions of modern times, will not be able to comprehend how thoroughly hopeless, at one time, were steam navigation, railway locomotion, and electric telegraphy. Nor is it certain that they can estimate the force and point of the practical criticism which once showed that the thin sides of the tubes of the Britannia bridge would crumple up like leather, or that the screw propeller could never obtain a proper hold upon the water; or that concrete, especially when shot in its semi-liquid state into the sea, could never form substantial stone, or that melted iron could never be converted into steel by merely blowing jets of air through it, or that telegraph cables could never be laid, and certainly not be brought up and spliced, in two miles of water, or that any one of a hundred later achievements which we now know to be perfectly practicable, were conspicuous impracticabilities. Nor was it alone the mere blush of novelty, nor as hastily viewed, the superficial incompatibility of these propositions with ordinary experience, that at one time condemned them, for there were excellent reasons, in plenty, always ready, to show that they could never possibly succeed. It is possible, then, that it may be so with the question of floating bridges.

The first consideration is the form of such a bridge; and the engineer would, no doubt, adopt the tubular form, of either rectangular or circular section. The latter would offer advantages over the former, not only as enclosing the greatest sectional area with the least weight of iron, but as being equally strong in all directions. Supposing expansion joints, or ball and socket joints to be required, and it is easy to understand that in some cases they might be, the circular form would of course be the most suitable. At the same time this, or any other form, would require to be well ballasted, or weighted at the bottom, to prevent too much rolling, and deep keels would be useful, if not, indeed, indispensable to the same end, and possibly out-rigged floats might also be desirable.

The tube, apart from the mere consideration of the clear roadway for trains, would require to be so large that its own weight would be well within its own displacement if immersed. A 16 ft. tube would, if wholly immersed, displace 201 cubic feet, or about 5½ tons of sea water per foot run, and as its external circumference would be but 51 ft., it would not, even if made with a double skin, and with a weight of iron in all equal to 1 in. plates throughout each skin, weigh even 2 tons per foot; nor would all extra weight probably increase this beyond ¾ ton, so that the tube would float, like the cigar ship of the same diameter, one half in water and one half out. We mention 1 in. plates, not as the thickness to be used, for probably ½ in. plates would serve every purpose, but as representing in a convenient form the equivalent weight of the whole structure.

With a close circular tube the pneumatic system of

propulsion would obviously offer decided advantages, as compared with locomotive power, with all the strain and wear due to the weight of engines, the smoke, noise, &c., and it may be as well to regard all tubular floating bridges as sections of a pneumatic railway.

Supposing, then, a pneumatic tube, a mile or more in length, floating upon water liable to disturbance from storms (and we are not yet considering the effect of a rising and falling tide), how far will the tube accommodate itself to this state of things? It is here, perhaps, that the verdict of impracticability will be first brought in; but it does not follow that the tube is to bend to every wave, nor to a series of waves. By as much as the crests or peaks of waves rise above the ordinary water level do the hollows, between the waves, fall below that level. No storm can change the mean level of an open sheet of deep water, not even of the ocean for a moment. Only the tide can do this, except, of course, the cases wherein a storm "pounds up" the water in an estuary or in an enclosed harbour, and these are not the cases we have assumed. The only effect of a storm over deep water is to produce waves of oscillation, and which, although they have the appearance of advancing motion, have really no other than an up and down motion, as if water were being churned into waves in a tub. The effect of these waves upon a long floating tube would be merely that they would leave it unsupported at certain points, while unduly supporting it at others, and no alteration of the general level of the tube would result, nor would it alter its form, except in so far as it might deflect between the crests of contiguous waves. How far a tube would bend to the waves is to be inferred, in a measure, from the behaviour of long, narrow, and lightly constructed iron and steel ships, never designed with reference to great vertical stiffness, nor, indeed, stiffness in any direction, although, as a matter of fact, they generally are reasonably stiff as such things go. The Messrs. Bibby, of Liverpool, famous for their long and narrow ships, have a large number over 300 ft. long, although of comparatively narrow beam; others 350 ft., 370 ft., and one or two 400 ft. long, the latter of but 37 ft. beam; and the cigar ship, *Ross Winans*, is believed to be "as stiff as a church," although 256 ft. long and but 16 ft. in diameter. None will assert that Bibby's ships, with their single plating, ½ in. and ¾ in. thick, formed into a great open-topped canoe, can be as stiff as a double-skinned circular tube of ½ in. or ¾ in. plates, even if only 16 ft. in diameter. So far as the strains from the deep-water waves are concerned, we think it will be easy to show that a well-made tube would weather them, year in and year out. In a tide-way such a tube would require to be strongly moored, to prevent lateral movement, and, so long as the tube was half under water, presenting but little surface to the wind above, this would not be a matter of great difficulty. The great strain upon a ship's moorings in a gale is caused, not by the action of the sea against the submerged portion of the hull, but by the wind on the part exposed out of water, often amounting to many thousands of square feet, blown upon by gusts of wind, sometimes rising to 30 lb., or more, per square foot.

In many situations a tube, afloat for its whole length across a navigable channel, would be inadmissible on account of its obstruction to navigation. Yet, here we may suppose that a certain unobstructed opening at a single point, or two or three, or more, in a wide stretch of sea, might reasonably answer the purposes of navigation. It is the business of every commander of a vessel to steer clear of all rocks, shoals, and other obstructions, and, as a matter of course, to steer clear of the coast. It should be as easy to steer clear of a floating tube, of ascertained position, as of Plymouth breakwater, or the Eddystone. Indeed the English Channel should be perfectly navigable, as now, even if spanned nearly the whole way across by a floating bridge, and certainly three well-defined and well-lighted openings of say 1000 ft. each should serve every purpose of navigation. If necessary, vessels should be compelled to take a pilot through as when going into harbour, and pilotage through any one of three 1000 ft. fair ways in the English Channel should be neither a difficult, a dilatory, or a costly matter. As for steamers, they would of course require no help.

But how could a floating tube be so interrupted as to give fair ways of 1000 ft., or any distance, for shipping? Only by submerging the tube for that or a somewhat greater distance at each opening. And could this be done? Could a 1000 ft. length of tube be submerged, say 40 ft., or 50 ft., below

water, with a rise of tide of 20 ft., and that without either touching bottom, or forming any interruption in the through line of communication? A length of 1000 ft. of 16 ft. tube would displace about 5600 tons. If it were made to weigh 5400 tons it would have a force of flotation of 200 tons. At each end of this length the tube would be connected with a weight of perhaps 200 tons or 300 tons hanging below it in the deep water, but, of course, well clear of the bottom, and these weights would be supported, at a constant depth in the water, by buoys, each of, say, 500 tons displacement (if wholly immersed). Thus, although the tube would have a constant tendency to rise out of water, it would be held down by the end weights, and these would be supported by the buoys to which they were attached. This, apparently, would be one way of carrying the tube through the water, although it would be idle to assert, in the absence of any trial of such a plan, that it could be carried out with certain success. At the same time there is enough in it to occupy the thoughts of the engineer. The buoys would, of course, require to be maintained, as would the whole tube, in certain fixed positions in plan, and it would be a matter for consideration how this could be done in a tideway. Only by moorings, and we are all along supposing the depth to be such as to render these practicable, the greatest depth of even the English Channel, on the line between Dover and Calais, being under 30 fathoms. The submerged spans of the tube would be connected with the floating portion at each end by long inclines, rising perhaps 1 in 100, the weights of these portions being made also nearly equal to their displacement. At the shore ends a series of expansion joints, or else a huge ball and socket joint would be necessary to make the connexion with the land, and the bottom would require to be so dredged and protected from deposit in shoal water, that the tube should not strike it as the tide or the waves fell.

We have no intention of pronouncing any opinion upon the practicability of such a scheme, and we know how easy it would be to settle the question off-hand, by asserting that it could never do. There are difficulties, and tremendous difficulties, no doubt, they are, at every step. There would be the risk that vessels might run straight upon the tube, and thus crush it and sink it, and, very likely, at the moment when a train was passing through. Then, again, it might break away from its moorings, and thus pull itself clear of the shore ends, and at once fill and sink, forming a great iron reef along the bottom. It would, however, be quite practicable to make the tube unsinkable, even if the whole inner continuous open way was filled with water. The space between the inner and outer skins would only need to be sufficiently large, and to be well intersected by bulkheads, serving as well for increasing the strength of the tube as for security. The tube would, of course, be lighted along its course at night, as a warning to vessels. It is possible that the greatest difficulty of all would be from corrosion.

We have said all that need be said to present the idea in a form in which engineers who like the contemplation of great and bold undertakings, and who are never frightened by seeming impossibilities, may consider what may, after all, be done in the way of floating bridges, in certain situations at least, if not across great navigable water ways.

RAILWAY TRAFFIC RECEIPTS.—The weekly traffic receipts on railways in the United Kingdom amounted in the aggregate for the 26 weeks, ending the 29th June, to 17,931,743*l.*, and for the corresponding week of 1866 to 17,639,273*l.*, showing the comparatively small increase of 292,470*l.*, or only 1.13 per cent.

FIREBOX HEATING SURFACE.—At the meeting of the French Society of Engineers, on the 21st ultimo, M. Petiet, the well-known engineer of the Northern Railway of France, described an experiment which he made with a locomotive boiler, after the manner of certain experiments said to have been made by Robert Stephenson and the late Mr. John Dewrance, and Mr. C. Wye Williams. M. Petiet divided the barrel of the boiler, along the tubes, in four successive lengths, and although that next the smokebox gave the least steam, the difference in evaporation between the several compartments was not of great magnitude. Experiments made by M. Graham were, however, cited, with results as follows: First division, 100 units of water, second, 27, third, 13, and fourth 8, or 148 in all.

CITY STREETS.—In the course of the evidence taken this Session before the Commons' Select Committee on the Local Government of the Metropolis and the London City Improvement Rates Bill it was noticed that in going from St. Paul's to the Mansion-house fourteen streets are passed, six branching off to the right at right angles, and eight to the left; and only three of the whole number—Queen-street, King-street, and Old Jewry—have room for two vehicles throughout the entire length of the street.

FIG. 7.
SIDE ELEVATION OF PART
ENGINE TO SHOW MANNER
OF ATTACHING EXHAUST PIPE.

FIG. 8.
ELEVATION OF
INNER SIDE OF
STEAM PIPE.

FIG. 9.
SECTION
C.C.

FIG. 10.
SECTION
THROUGH BB.

FIG. 11.
SECTION
THROUGH CC.

FIG. 12.
ELEVATION
OF INNER SIDE OF EXHAUST
PIPE.

FIG. 13.
REAR
END VIEW

FIG. 14.
PLAN OF UNDERSIDE OF PISTONS 2 & 4.

FIG. 15.
FRONT
END VIEW.

FIG. 16.
SECTION
D.D.

FIG. 17.
SECTION
E.E.

FIG. 18.
REAR
END VIEW.

FIG. 19.
PLAN OF UNDERSIDE OF PISTONS 1 & 3.

FIG. 20.
FRONT
END VIEW.

FIG. 21.
SECTION
F.F.

FIG. 22.
SECTION
G.G.

THE CLEVELAND IRON TRADE.—The number of furnaces in blast in the Cleveland district is 88, while there are 31 out of blast. The foreign shipments of pig-iron have been considerable, especially to Belgium. The export trade is becoming of more and more importance, but the home trade is rather dull. Russian contracts for rails are being pushed forward.

THE MEETING OF THE ROYAL AGRICULTURAL SOCIETY AT BURY ST. EDMUND'S.

ALTHOUGH the show of the Royal Agricultural Society at Bury St. Edmund's cannot be said to fairly commence until Monday next, yet the implement yard was opened to the public on Wednesday last, and during the present week the trials of the engines and implements—really the most interesting part of the show to an engineer—will be carried on. The trials of the engines were intended to commence on Wednesday, but the necessary arrangements could not be completed in time, and the commencement of the experiments had therefore to be deferred until yesterday (Thursday) morning. Some of the threshing-machines were, however, tested on Wednesday, and so were some turnip-cutters and other smaller machines. On Wednesday, many of the engines and machines were not in place, and of those which had arrived a great proportion were covered down, so that they could not be inspected. This being the case, we shall defer giving until next week any systematic account of the engines and implements exhibited, and shall confine ourselves for the present to a description of the preparations which have been made for the trials. We may, however, observe that there is every reason to believe that the show will be a great success, and that it will be well worthy of a visit from all interested in the progress of agricultural engineering.

The list of articles submitted for trial includes twenty fixed engines, thirty-six single-cylinder portable engines, ten double-cylinder portable engines, and fifty-nine threshing-machines, besides a great number of smaller machines, such as chaff-cutters, turnip-cutters, &c. It is certainly a fact that several—not to say many—of the engines which have been entered for trial will fail to "show up;" but it is equally certain that the gentlemen by whom the trials are being conducted will have quite as much as they can get through in the appointed time, and it is indeed doubtful whether the trials will not have to be completed next week. The engines and implements to be tested are divided for convenience into five classes, as follows: 1st, fixed engines; 2nd, portable engines; 3rd, machines—such as threshing-machines—requiring considerable power to drive them; 4th, lighter machines; and 5th, machines—such as turnip-cutters, &c.—which are usually driven by hand. For each class special arrangements have been made, and these arrangements we shall now proceed to describe.

For testing the stationary and portable engines, the arrangements are as follows: Along one side of the trial-ground has been erected a long light wooden shed, and in this has been laid a kind of wooden tramway, on which the friction brakes—the frames of which are mounted on wheels—can be traversed. Parallel with the shed and distant from it about 30 ft., is a second wooden tramway which extends nearly the length of the shed, and on which the boiler by which steam is supplied to the fixed engines can be traversed, so as to bring it into its required positions. This boiler, which was made by Mr. William Battley, of Northampton, and is mounted on wheels, is the property of the Royal Agricultural Society. It is of the ordinary locomotive or portable engine construction, and is furnished with a fan placed at the base of the chimney, in order to produce a draught. The fan is driven by a belt from one of Lufford's two-horse portable engines, which traverses along the tramway in front of the boiler. This arrangement appears to us to be a clumsy one; we should have thought that under the circumstances it would have been better to produce the draught by the aid of a jet of steam supplied from a small auxiliary boiler, which might have been carried on the same wheels as the main one. This plan would certainly have been more simple than the arrangement employed, and the auxiliary boiler might have been fed by an injector.

The engines to be tested are placed between the boiler tramway and the shed, each being mounted upon temporary timber packing. Each engine in turn is supplied with steam from the boiler through a flexible pipe, and the latter is provided with a hand-pump for supplying it with feed water, the water being drawn from a couple of wooden tubs placed on raised platforms, one near each end of the boiler tramway. These tubs supply the water under a head of about 12 ft., and flexible pipes leading from them serve to conduct the water to the portable engines under trial also. Each engine, when being tested, has a belt led from its flywheel to one of Mr. Amos's self-adjusting friction brakes. In these brakes, which have been frequently described, the two ends of the brake strap are connected to different points situated near one end of a pair of light levers, these levers being

weight, which the engine has to lift, the end of the strap which is attached to the outer ends of the levers is moved further round than the other end, which is attached nearer the fulcrum, and the consequence is that the strap is tightened on the drum, and the weight again raised. The arrangement will be clearly understood by reference to the foregoing diagram.

There are four of these friction brakes at Bury, two of them being intended for use with the fixed and two with the portable engines. One of the latter is a double brake with two friction drums, the driving pulley being arranged between them. This brake is intended to be used with the larger engines with two cylinders. All the brakes are fitted with counters for registering the number of revolutions made by them. We shall explain next week the manner in which the engine trials are actually carried out; at present we intend, as we have already said, to give a description of the apparatus employed.

In carrying out the trials of the threshing-machines and other driven implements, notice has to be taken not only of the quality of the work performed, but also of the amount of power absorbed in doing it. To enable the power to be registered, the following arrangement is employed: The machine to be tested is placed upon a platform, and the belt from it, instead of being led to the driving-engine direct, is passed round one pulley of a dynamometer of peculiar construction, conveniently placed between the implement and the engine, the belt from the fly wheel of the latter being passed round the second pulley of the dynamometer. The two belt pulleys of the dynamometer—which we may term, for distinction, the engine pulley and the machine pulley respectively—are of the same diameter, and are both placed on the same shaft, the engine pulley being keyed to the shaft, and the machine pulley running loose on it. The rim of the machine pulley is, however, connected to the boss of the engine pulley by a system of curved spring arms or spokes, these arms, when the strain is being transmitted through the apparatus, coiling partially round the boss of the fixed pulley. The effect of this arrangement is, that when the driving power is first applied, the engine pulley moves round without the machine pulley, until the springs are sufficiently deflected to enable them to drive the pulley on which the belt from the machine is placed. Under these circumstances, it will be seen that in order to ascertain the average pull which is being exerted by the belt it is only necessary to register the average deflection of the spring arms, or what is the same thing, the angular movement of the one pulley past the other. To register the average angular movement, a very ingenious, and at the same time very simple arrangement, is employed, and this arrangement, which is, we believe, of French origin, we shall now endeavour to explain.

The boss of the machine belt pulley of the dynamometer, or that which is loose upon the shaft, has fixed to the outer side of it a pair of helical cams, and the faces of these cams bear against a short crossbar which works in a slot in the shaft. This shaft is hollow, and it contains a rod to which the crosspiece just mentioned is fixed, a spring on this rod keeping the crosspiece always in contact with the surfaces of the cams. The effect of this arrangement is, that as the spring arms yield, and the machine pulley turns on the shaft, the helical cams force the crosspiece longitudinally along the slot in the shaft, and the extent of this motion thus becomes a measure of the angular motion of the engine pulley past the machine pulley. If the extent of the movement of the crosspiece was noted very frequently, it would of course be possible to estimate pretty closely the power being transmitted through the apparatus; but this estimation would at the best be merely an approximate one, and if the strain transmitted varied greatly in its amount, the frequent measurement of the movement of the crosspiece would be a matter of considerable difficulty. The registering portion of the apparatus, however, quite does away with the necessity for making any measurements of this kind, and what is still better, it gives, instead of an approximation, a perfectly correct result. This result we should state, however, is the amount of power transmitted to the dynamometer by the engine, the power transmitted from the dynamometer to the machine being driven being equal to this amount minus the small power absorbed by the friction of the registering gear.

This registering gear consists of two portions, the one recording the number of revolutions made by the dynamometer shaft, and the other giving the data for determining the average pull on the belt. The first portion consists of an ordinary counter, and the second of another actuated by an arrangement of driving gear, in which a shaft is driven from the first counter, which, in its turn, derives its motion direct from the shaft of the dynamometer. On the end of this shaft is a plain disc, which, by means of a spring applied to the end of the shaft, is caused to press lightly against a smaller friction wheel. This friction wheel is rounded at its circumference, and it slides freely on the square shaft on which it is placed, its longitudinal movement being governed by a fork, which is connected by a rod to the crosspiece on which the helical cams of the machine pulley act. The second counter is driven by a shaft, and the proportion which the number of revolutions made by it bears to those made by the first counter evidently depends upon the position of the friction wheel. If this wheel is placed so that it bears upon the centre of the disc, no motion whatever is transmitted to the second counter, and by adjusting the length of the rod connecting the fork with the crosspiece acted on by the cams, this central position of the friction wheel is made to correspond with the normal relative positions of the two belt pulleys, or that which they occupy when no strain is being transmitted through the apparatus. Let us suppose now that the springs connecting the two pulleys are of such strength, that when a pull of 200 lb. is being transmitted by the dynamometer they are deflected, so that the friction wheel is removed from the centre of the disc by a distance equal to its own radius; and under these conditions it is evident that the two counters will make an equal number of revolutions in a certain time. If now the strain on the belt be doubled, the friction wheel will, by the action of the cams, be moved to twice the distance from the centre of the disc, and the number of revolutions made by the second counter will therefore also be doubled. If the number of revolutions made in a given time by the first counter be represented by n , and the number made by the second counter in the

same time, by N ; then the average pull, P , transmitted, in pounds, will be given by the simple formula:

$$\frac{N \times C}{P} = P,$$

C in this formula being a constant denoting the number of pounds required to deflect the springs so that the friction wheel, c , is moved to a distance equal to its own radius from the centre of the disc, b . The amount C being once ascertained for each dynamometer, the determination of the strain transmitted through it from the numbers indicated by the counter, becomes a matter of the simplest calculation. The first counter also gives the number of revolutions made by the dynamometer shaft during the time of the trial, and the diameter of the pulleys being known, the speed of the belt can be calculated, and the force transmitted be reduced to horse power.

There are at Bury St. Edmund's two dynamometers of the kind above described—one being used in connexion with the threshing-machine, and the other with the lighter machine. The dynamometer used for testing the threshing-machines is mounted on wheels, so that it can be traversed parallel to one side of the platform on which the machines are placed. This platform is large enough to accommodate two threshing-machines placed side by side; and, whilst one is being tested, the belts for driving the other are adjusted on a "dummy" dynamometer, placed opposite it. When a trial is completed, the real dynamometer and the "dummy" are made to change places, and so on. Two of Burrell's portable engines are provided, one being placed opposite each of the positions alternately occupied by the dynamometer; and thus, whilst the latter is being driven by one engine, the other is available for working the "dummy," and the machine, which is being got into place, can thus be run, and the belts properly adjusted, before the dynamometer is applied. This plan saves a great deal of time, and enables the real testing to be carried on almost continuously. The "dummy" merely consists of a pair of belt-pulleys, of the same size as those of the dynamometer, placed upon a shaft running in bearings on a wooden frame. In the case of the lighter machines, which can be readily got into place, this double or "dummy" arrangement is not required, and the dynamometer for testing them is therefore kept in one position. It is driven by one of Messrs. Ruston and Proctor's 8-horse portable engines.

The dynamometer for testing the small machines, such as turnip cutters, &c., which are usually worked by hand, is constructed on the same principle as those just described, but its details are somewhat differently arranged. It is worked by two men acting on a crank handle on the main, or flywheel, shaft; a second's pendulum hung on one side of the machine "giving the time" to the men, and enabling them to keep the desired speed of 30 revolutions per minute very regularly. On the flywheel shaft is a spur wheel which gears into another spur wheel fixed on a counter shaft. The one end of the counter shaft, which also carries the pulley for the belt leading to the machine being tested, runs in bearings on the frame of the machine; and the other end, close to which the spur wheel just mentioned is placed, is carried by a lever which has its fulcrum on the main shaft. The one end of this lever is connected to a spring balance, and to a kind of dash-pot arrangement, which steadies it, whilst the other end carries the friction wheel corresponding to the friction wheel, in the dynamometer already described. When the dynamometer is in use, the action of the two spur wheels tends to make the lever revolve on the main shaft, this tendency being resisted by the spring balance, and the amount of extension of the latter thus becoming a measure of the power being transmitted. The extension of the spring balance is registered by means of the friction wheel arrangement and two counters, as in the other dynamometers.

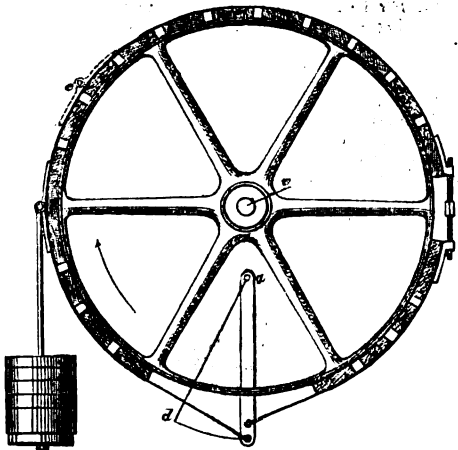
We have now given a general description of the arrangements which have been made for conducting the trials at Bury, and we shall next week give a further account of those trials themselves. In concluding the present notice, we should mention that the testing apparatus which we have described has been all constructed by Messrs. Easton, Amos, and Anderson, and that it is being employed at Bury under the superintendence of the heads of that firm.

THE CINCINNATI SUSPENSION BRIDGE.

THIS suspension bridge lately completed by Mr. J. A. Roebling, at Cincinnati, U.S., has a clear span between the centres of towers of 1057 ft., and is, therefore, the longest suspension span yet executed. We shall shortly give engravings, from large photographs taken by Mr. Roebling, of this important work, which presents features which will be widely approved in England. In the mean time we give, with slight abridgments, Mr. Roebling's report to the directors of the Covington and Cincinnati Bridge Company.

At the lowest stage of water the Ohio river between Cincinnati and Covington has a width of about 1000 ft. By the charter of the bridge company the position of the towers was fixed at low water mark, so that the middle span should present an opening of not less than 1000 ft. in the clear. To comply with this act the distance from centre to centre of towers was fixed at 1057 ft., which leaves a clear space of 1005 ft. between the base of masonry. In the spring of 1832 the river rose 62 ft. 6 in. above low water, and this is the elevation of the approach near Front-street on the Cincinnati side. The centre of this street is only 60 ft. above low water. But such an extreme rise may not occur again in a century. At this stage the width of waterway is over 2000 ft. With one exception, at very high water the entrances may be considered above water at all stages. The approach on the Covington side is 71 ft. above low water, therefore always dry.

With the exception of the towers, the whole waterway between the two cities is thus left unobstructed, a width of 1619 ft. The two small spans left open between the abutments and towers are each 281 ft. from face to centre of tower. In an engineering point of view, this division of spans is not the most economical. The cheapest arrangement would have been one centre span of 800 ft. and two half spans of 400 ft. each. But that plan had been forestalled by previous legislation. One of the provisions of the early charters decreed one single span of 1400 ft. in the clear. But this great and very expensive span was afterwards



placed one on each side of the brake drum, and having their other ends jointed to fulcrum, situated about half way between the rim of the brake drum and the shaft on which it is placed. The levers have thus a radial position, and the effect of the arrangement is, that as the brake strap shifts round the drum in the direction corresponding to the falling of the attached

allowed to be reduced to 1000 ft., and with this amendment the foundations were commenced in 1856.

Owing to the persistent opposition of property, steamboat and ferry interests, the clear elevation of the floor above low water mark, in the centre of the river span, had been fixed at 122 ft. With this elevation the ascent of the Cincinnati approach would have been over 8 ft. in 100 ft. By a later enactment this height was reduced to 100 ft. As the bridge stands now, its elevation is 103 ft. in the clear above low water at a medium temperature of 60°, rising 1 ft. by extreme cold, and sinking 1 ft. below this mark in extreme heat. The greatest ascent is now only 5 ft. in 100 at the Cincinnati approach, and this diminishes as the suspended floor is reached.

The floor of the bridge is formed of a strong wrought-iron frame, overlaid with several thicknesses of plank, and suspended to the two wire cables by means of suspenders attached every 5 ft. The suspenders are arranged between the roadway and footpaths. The latter are 7 ft. wide, and are protected by iron railings towards the river. The roadway is 20 ft. wide, forming two tracks of four lines of iron trams, on which the wheels run, each tram being 14 in. wide, to accommodate all kinds of gauges. The whole width of the floor between the outside railings is 36 ft.

No stays or other obstructions are put up below the floor, such as may be seen under the Niagara bridge. No such means to prevent the floor from rising were admissible in this work; its security and stability are provided for by other appliances. The rock underneath the Niagara bridge afforded a very convenient and cheap mode of anchoring; it would have been a great oversight on my part not to avail myself of under floor stays in such a favourable locality. But in the Ohio bridge no such appendages were admissible.

In the earlier periods of the art of bridge building, large spans could not be attempted. So long as the builder was confined to stone and timber, no great watercourse could be crossed without intermediate supports. But by the application of iron the construction of larger spans became practicable. That mighty lever of modern commerce and intercourse, the railway, owes its efficiency exclusively to the use of wrought iron, and the iron rail is even now gradually being supplanted by a still better servant in the form of steel.

It was left to modern engineering, by the application of the principle of suspension, and by the use of wrought iron, to solve the problem of spanning large rivers without intermediate supports. Cast and wrought iron arches of 100 ft. and more have been quite successful; nor can it be said that the limit of arching has been reached. Timber arches of much greater span have stood for many years, and have rendered good service in this country as well as on the continent of Europe. It is worthy of notice, however, and to be cited as a curious professional circumstance, that the best form of material, so profusely applied by nature in her elaborate constructions, has never been used in arching, although proposed on several occasions. This form is unquestionably the cylindrical, combined in small sections, as is illustrated by vegetable and animal structures. Where strength is to be combined with lightness and elegance, nature never wastes heavy, cumbersome masses. The architects of the middle ages fully illustrated this fact by their beautiful buttresses and flying arches, combinations of great strength and stability, executed with the least amount of material.

The wrought-iron pipe now manufactured, of all sizes, and in such great perfection, offers to the engineer a material for arching which cannot be excelled. A wire cable, composed of an assemblage of wires, constitutes the best catenary arch for the suspension of great weights, and as a parallel to this, if the catenary is reversed, the best upright arch for the support of a bridge, may be formed by an assemblage of wrought-iron pipes, of 1½ in. or 2 in. diameter or more. Arches of 1000 ft. span and more may be rendered practicable and safe upon this system. I venture to predict that the two great rival systems of future bridge engineering will be the inverted and upright arch, the former made of wire and the latter of pipe, both systems rendered stable by the assistance of lattice work, or by stays, trusses, and girders. When this time has come, then I flatter myself that the Ohio bridge will be considered by the profession a good specimen of the suspended system.

To approach the Ohio bridge on the Cincinnati side, Water-street, 66 ft. wide, has been crossed by five plate girders, each of a depth of 4 ft., and strengthened by the suspension of wire ropes arranged on each side of the vertical plates. This bridge, therefore, is a combination of girders and suspension cables on a small scale. There will be no strife between the girders and the cables while contracting and expanding, as the material in both is the same. Now the same combinations have been carried out on the large bridge, only the order has been reversed. A floor of 1000 ft. long is suspended to two wire cables; as such, it is the lightest and the most economical, and at the same time the strongest structure which it is possible, in the nature of things, to put up. But a simply suspended platform is too flexible for the transit of heavy loads; it is also liable to be affected by high winds; therefore other means must be resorted to to insure stability and stiffness. As one of these means, two wrought-iron girders extend from one abutment to the other through the centre line of the bridge. One is 12 in. deep, and suspended underneath the floor beams; the other, of a depth of 9 in., rests on top, both being connected by screw-bolts, firmly embrace the crossbeams, and thus not only form a combined girder of 28 in. deep, running lengthways, but also add greatly to the lateral stiffness of the framing of the bridge floor. The girders are rolled in lengths of 30 ft. The two trusses which extend along each side of the roadway, 10 ft. high, constitute another and more powerful element of stiffness and of stability.

The general plan which I have always pursued in my works insures, by the heavy contraction of the cables in the centre of the span, great lateral stability at this point. The larger and heavier the span, the greater will be its comparative stability at the centre. Vertical stability in the centre is also insured in large spans by the simple weight of the structure. But not so between the centre and the towers. In consequence of the equilibrating tendency of the two opposite halves, vertical oscillations occur easier, and the great length of suspenders, acting like pendulums, promote lateral displacements. These tendencies have to be met, and are thoroughly overcome in the Ohio

bridge by an effective system of stays. The very careless manner in which stays have been attempted heretofore, is a violation of the principle involved. Their arrangement in this bridge not only insures their own freedom from oscillation, but renders them fully effective by the uninterrupted preservation of their lines.

Aside from simply stiffening the floor, the stays are rendering another and very important service; they effectually insure equilibrium between the main and half spans. Without stays, the balance between adjoining spans would sometimes be greatly disturbed by unequal loads. The large crowds of many thousands of people which frequently cover the floor from one end to the other, are occasionally very unevenly distributed, but they have never produced the slightest injurious effect upon the statical condition of this work.

Great doubts are yet entertained by many engineers, particularly in Europe, in regard to the fitness and safety of suspension bridges for railway purposes. By an additional expenditure of \$50,000, and a railway track laid down in the centre of the floor, the Ohio bridge could have been made serviceable for the passage of locomotives and trains at the highest speed. Let any person who doubts this observe the very slight tremor which is produced on this bridge by a long line of heavily-loaded teams, frequently ten in a row, and he will readily understand that but a small addition of rigidity is wanted in order to pass railway trains.

Without the stays and trusses, the elevation of the bridge floor would be too light in appearance, as compared to the massiveness of the towers. As it is, the whole has a pleasing effect, and at the same time presents strong and reassuring proportions, which inspire confidence in the stability of the work.

Towers, Foundations, Masonry.

The two towers are the most conspicuous features in the bridge. Their location was fixed by legislation, and so was the length of the central span. The elevation of the floor above the river, being also determined by the charter at no less than 100 ft. in the clear, the height of masonry at the level of the floor was thus reduced from the original figure of 105 ft. to 90 ft. Excepting the position of the cornice at the level of the floor, no other changes have been made in the original proportions of the towers. And since the security and safety of the superstructure depend in a great measure upon the strength of the towers, I did not consider it prudent or advisable to make any reduction in the proportions of the masonry above the floor. The original design of 1856 has therefore been substantially carried out.

It is a difficult task to produce a proper architectural effect when designing towers for a suspension bridge of large dimensions. Highly ornamented masonry may be built, but it looks out of place when the general impression should be that of simplicity, massiveness, and strength. On the other hand, a public work, which forms a conspicuous landmark across a great river, which separates two large cities, both abounding in ornamental façades, should also serve as a model of appropriate architectural proportions. Public works should educate public taste; at any rate, should not violate it. In the erection of public edifices, therefore, some expense may and ought to be incurred in order to satisfy the artistical aspirations of a young and growing community.

I have made numerous designs for towers, and I know all those which have been executed by others. I trust that those of the Ohio bridge, when entirely completed, will not be found, by competent judges, to be inferior in their architectural appearance to the best specimens which are found in Europe.

The base of each tower is 82 ft. long in the direction of the river, with a width of 52 ft. This mass is not a solid, but divided in two parts, each having the form of a T, the projecting central part forming a buttress. This feature of buttresses is preserved throughout the whole height, not only on account of appearance, but also for the sake of strength, to save material, and to reduce the weight upon the foundations. Mediaeval architecture is distinguished for its remarkable lightness and great strength at the same time, owing principally to the judicious use of the buttress.

The section of the towers is therefore divided in two parts, 30 ft. apart at the base, and this distance is preserved in two vertical lines to the spring of the arch, 165 ft. above the foundation. From the foundation, however, to the top of the lower cornice, which marks the level of the floor, the two opposite shafts are connected by two massive walls, 10 ft. wide at the bottom, and stepped off to 8 ft. before the floor is reached. A well-hole of 30 ft. by 20 ft. is thus left open in the centre of the masonry. As the river rises and falls, the water in this well-hole is allowed by openings to communicate freely.

To support the great weight of this tower, together with the weight of the superstructure and transient loads, and at the same time to guard against unequal settling, good foundations were absolutely demanded. No definite plan of foundation had been fixed upon; none could be safely adopted before the excavations had been sunk some considerable depth. Whether a solid rock bottom could be reached on either side, was uncertain; so also was the question of piling or solid layers of timber, left open. It is known that the bed of the Ohio river is throughout its extent underlaid with rock, at no great distance below the surface. But the depths at which the rock is found varies very considerably. At all the rapids and shallows the rock forms the bed itself; in the pools between, heavy layers of gravel, sand, or mud, are deposited. At or near the mouths of tributaries, the rock has generally been excavated by the action of the water to a great depth; the soft material has taken its place, and consequently good foundations can only be made by heavy expenditures. At the site of the bridge, a bed of blue limestone and shale, not very solid, underlies the river bed at a depth of about 12 ft. below the lowest part of the channel. A short distance above the bridge this shale is laid bare at low water on the Covington side, a part of it extending half way across. Under the Covington tower, a heavy bed of coarse sand, mixed with gravel, is found above the rock, while the surface layer is composed of the original clay bottom, which forms the river banks. On the Cincinnati side, the original clay or loamy bottom has, to some extent, been washed away, and lat-

terly been filled up again by the materials obtained from cellar excavations.

In this artificial bank the excavation of the Cincinnati tower was commenced about the 1st September, 1856, and sunk down to the level of the river, which, during this and the next two months, fell to low water mark. A little rise of 4 ft. intervened, but the river fell again, and continued low until the month of December. It was owing to this remarkably favourable state of the river, that we so well succeeded in our foundations; and at a cost, which must be considered as very small, considering their magnitude, and the sudden floods which may occur at almost any time, and sweep over and destroy costly preparations.

By a wise resolution of the Board of Managers, the work was not to be commenced before a *bond fide* cash subscription of \$300,000 had been secured. Contrary to my expectations, this subscription was rapidly obtained; and in view of the promising state of the river, it was concluded to forthwith commence the foundation work. But no preparations whatever had been made, no materials on hand, no machinery, and no efficient pumps. The total want of the latter proved a very serious drawback, and seriously threatened to defeat the enterprise at the very outset. It is true, the city was full of steamboat pumps, but of such small dimensions and such construction, that they were of no account in such an operation. Raising clean water is an easy process, but to raise large masses of soft mud and sand is not so easy. After experimenting and losing a few precious weeks in an endeavour to work some patent rotary pumps, which utterly failed, we came very near to a complete halt. There was no time to get proper steam pumps of large dimensions constructed at any of the shops at Cincinnati, nor could we expect them in time from the east; every day's loss was irreparable, and so we were thrown back upon our own resources. Accordingly I had four large square box pumps, constructed of 3 in. pine plank, strongly hooped, and 24 ft. long—one pair 18 in. in the clear, the other 20 in. Cast-iron gratings, with large india-rubber flap-valves, formed the piston and lower check-valves. Heavy piston-rods, connected with chains, which passed over sheaves, and were shackled to rods, extending over the coffer-dam down to the river.

(To be continued.)

ROBERT'S DIFFUSION PROCESS.

TO THE EDITOR OF ENGINEERING.

SIR,—Several months have passed away since you made us acquainted with this process, which is so very attractive to theorists.

I then asked for some practical information which would have decided, at once, the practical value of this process. The reply assured us of a gentleman being on the point of leaving for India for that very particular, with others that were deemed necessary. We are now informed of that gentleman's return, and that he brings with him, in addition, some splendid samples of sugar, no doubt made by Robert's process, and what is equally possible, that he has made some 86 tons of sugar, and we are told of the quantity of lime which he used, and, by inference, of the quantity of sugar destroyed by the caustic alkali, as a consequence; and we see how accurately the per-centage of juice obtained from the cane is determined, and various other highly interesting particulars are given, all of which derive their value from the amount of cane, or of cane-juice employed, which amount is not given. As it is not convenient to give us this amount in any shape—cane or juice—I apprehend that the baseless fabric falls into its proper place, where every practical man would unhesitatingly consign it.

Yours respectfully,
W. E. GILL.

75, Herbert-street, N.

THE LIVINGSTONE SEARCH BOAT.

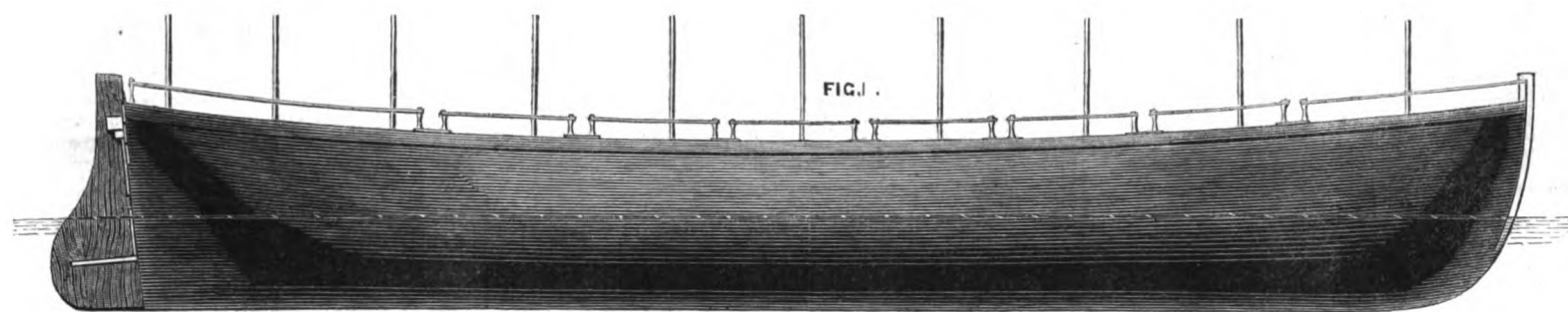
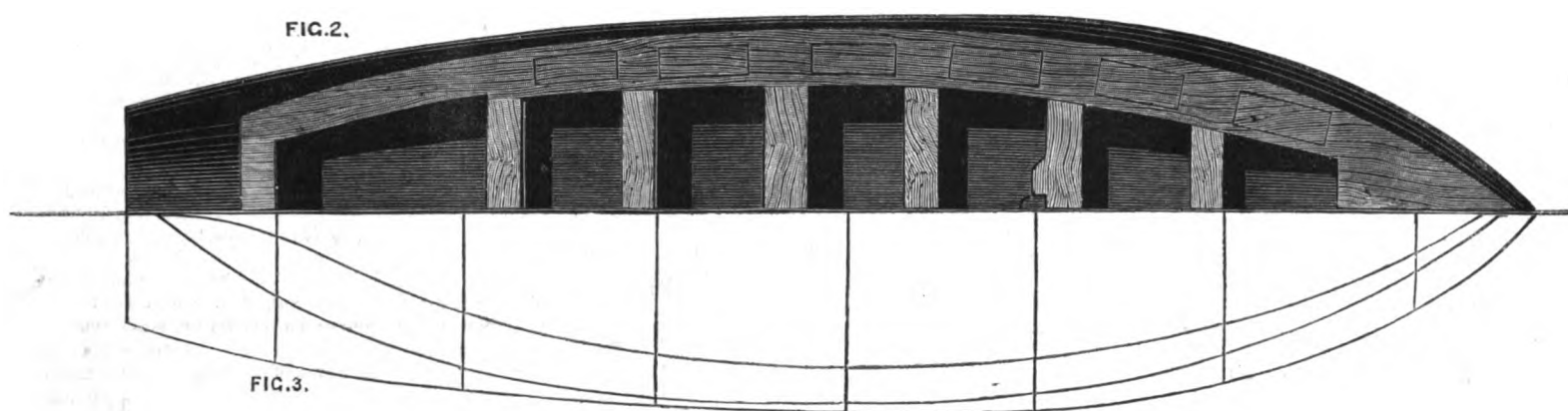
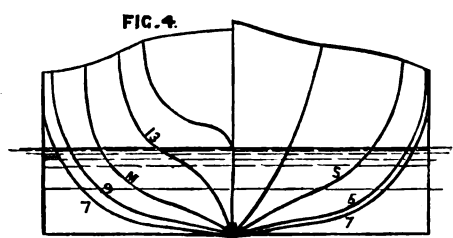
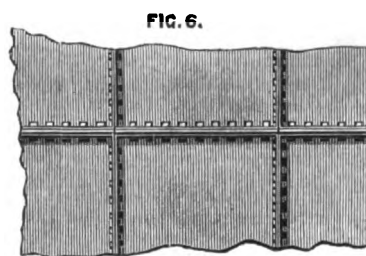
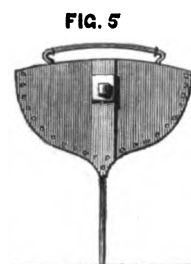
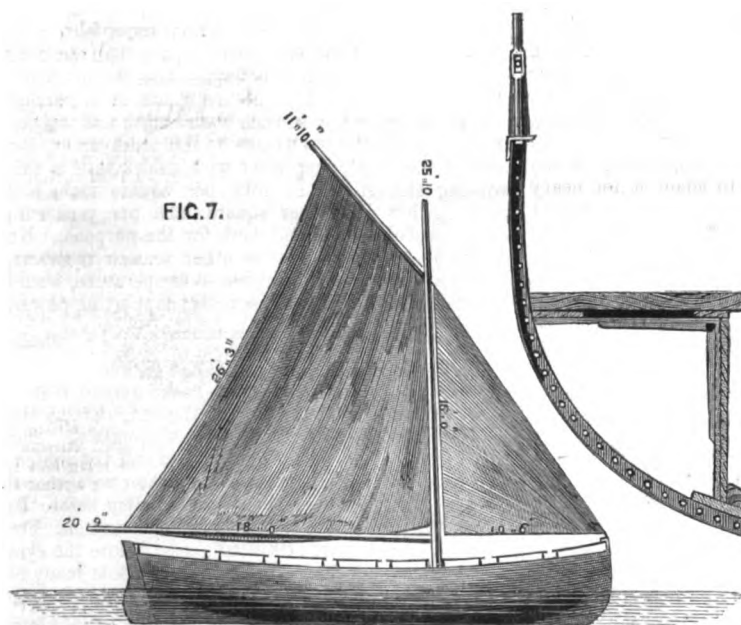
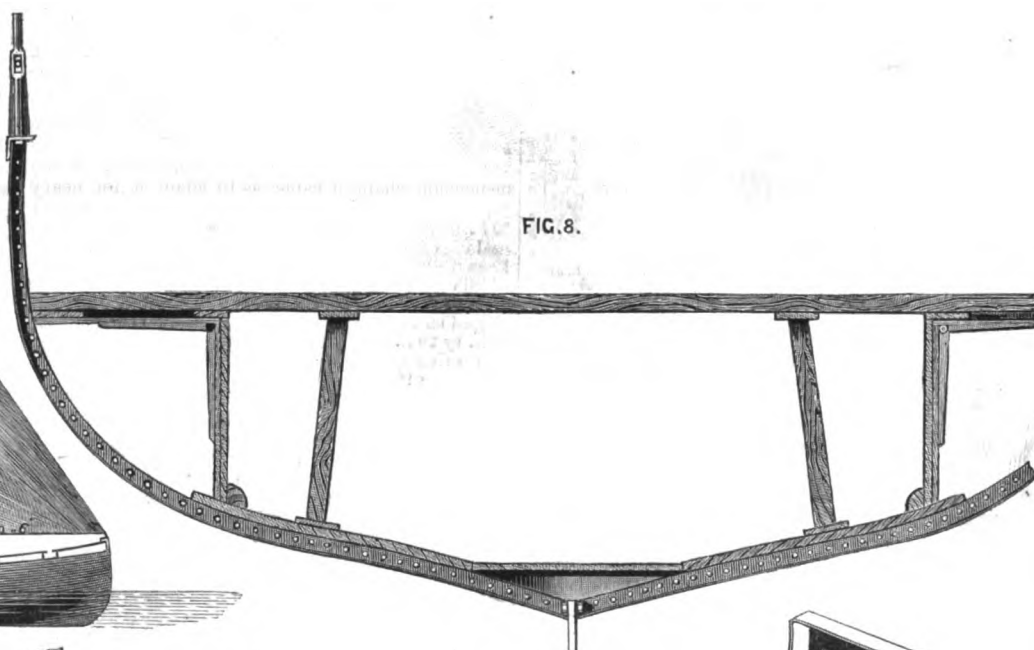
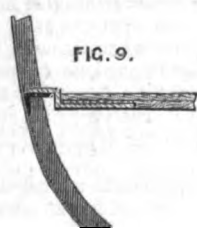
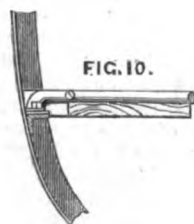
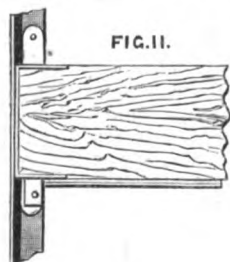
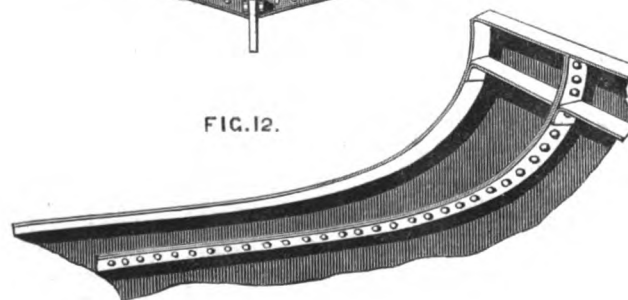
THE steel boat which was taken out from England, June 9th, to be used in the Livingstone search expedition, was specially designed for a peculiar service, and merits a brief notice, from having been thus planned with the aid of the best skill which could be brought to bear by the Chief Constructor of the Navy and his staff.

With more space, in a future number, we may give a more complete description of this boat, but its distinguishing feature is at once apparent from our engravings. It is made of steel plates only ½ in. thick, and formed into a great number of separate sections, no one weighing more than 40 lb., and bolted together by ½ in. bolts. The construction is such that the cutter is well stiffened, vertically and longitudinally, by angle irons and by the flanged edges of the steel plates. No skill has been spared upon the design or construction of this gallant little craft, and it is to be hoped that she may, as Sir Roderick Murchison's strong faith would lead us to hope, help to trace the great African traveller, and find him, yet living, and help to bring him home again to England. To hope this may be hoping against hope, but we shall at all events know within a few weeks. Before that time we trust to give a somewhat detailed account of the vessel to which this hasty notice now applies.

RICHARDS'S INDICATOR.—This now well known steam engine indicator takes its name from a draughtsman once employed by Mr. Charles T. Porter, then of New York, but now of the Whitworth Company, Manchester. Richards designed the parallel motion which removes the necessity, as in Gooch's indicator, of a tedious process of translation, and as the height of the diagram is multiplied fourfold through light arms, as compared with the rise of the small indicator piston, the momentum of the latter, at quick speeds, is practically extinguished, its movement being limited to about ½ in. Messrs. Elliott Brothers have already made upwards of 500 of these indicators, and Mr. Porter is now bringing out a new edition of his work on the indicator. He has made a table showing the motion of the piston for each degree of motion of the crank, carried to seven places of decimals, for connecting-rods of four cranks, five cranks, and six cranks.

STEEL CUTTER FOR THE LIVINGSTONE SEARCH EXPEDITION.

CONSTRUCTED AT THE ROYAL DOCKYARD, CHATHAM.

(For Description, see preceding Page.)

PUBLISHER'S ANNOUNCEMENT.

Advertisements cannot be received for insertion in the current week later than 5 P.M. on Thursday. The charge for advertisements is three shillings for the first four lines or under and eightpence for each additional line.

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The Fourth Volume of *ENGINEERING* commenced with our last number. The extraordinary increase in the circulation of the paper, an increase of nearly 2000 copies weekly since the first of January, has exhausted our stocks of several of the back numbers, with the exception of fifty sets of Vol. III., reserved for binding, and which will be sold bound, and at one guinea each, in the order of application. A very few volumes of Vol. II. remain; but Vol. I. is out of print. The circulation of *ENGINEERING* exceeds that of any other journal of its class of the same or a higher price.

ENGINEERING.

FRIDAY, JULY 12, 1867.

SUSPENSION BRIDGES.

THE practice of the American engineers, in respect of suspension bridges, is remarkable for its boldness, and in some instances for its success. The widest span yet reached in England is that of 703 ft., at Clifton, for roadway traffic only, and this is formed of the heavy chains which once carried the footway of Hungerford-bridge, in a span of 676 ft., with two side spans, across the Thames. The Americans have their double-floor railway bridge of 822 ft. clear span at Niagara, already in use for the last twelve years. On the other hand, a span of 900 ft. over the Ohio river at Wheeling, and another of 1043 ft. over the Niagara river at Lewistown, have been blown down in heavy gales. It is clear, however, that it was not merely the span but the construction of these bridges which caused their failure.

The largest existing span of a suspension bridge is that of 1057 ft. over the Ohio river at Cincinnati, lately completed from the plans of Mr. John A. Roebling, and under the superintendence of his son, Colonel Washington A. Roebling. Of this bridge, which is undoubtedly the finest work, structurally and architecturally, of its class, we shall soon give an engraving. It crosses the Ohio with a clear headway of 100 ft. above low water, the greatest variation between spring freshes and summer low level being 60 ft. The towers, of massive masonry, rise 200 ft. above low water. The supporting members of this bridge are two cables of parallel wires, of No. 9 gauge, drawn by Messrs. Richard Johnson and Nephew, of Manchester, each cable being 12½ in. in diameter, and containing 5250 wires, the breaking strength of the wire being upwards of 60 tons per square inch of net section. A large portion, nearly half, of the weight of the roadway and load is carried by diagonal wires running straight from the tops of the towers to successive points along the floor, so that the main cables, themselves stiffened by this arrangement, really carry but about half of the total weight of the roadway and load. The ultimate strength of the bridge is very greatly in excess of the greatest probable, if not possible, load.

Having completed this work, Mr. Roebling is about to undertake one of far greater magnitude, that for connecting the city of New York with Brooklyn, across the East river. It is necessary, here, that a headway of 130 ft. be maintained in mid-channel, and the great suspension span will be 1600 ft. in the clear, or much more than twice that at Clifton, nearly three times that of the Menai suspension bridge, and nearly six times that of either span of Lambeth suspension bridge. This great opening will be approached, on

either side, by a succession of arches, the whole length being between 1½ miles and 2 miles, and the total estimated expense is six million dollars, or, at the present value of American currency, nearly one million sterling.

The cables will be four in number, 14 in. each in diameter, and formed of No. 9 wire. The cables will be arranged one at each outer side of the platform, and two near the centre, the whole width of the platform being 80 ft. The platform will have six wrought-iron trusses, each 10 ft. deep, for its whole length. There will be a footway, 10 ft. wide, along the centre, a horse railway on each side, occupying, each, 16 ft., and a roadway on each outside of the platform also 16 ft. wide, with a projection of the crossbeams of 3 ft. on each side, to receive the connexions from the outer cables.

As various and conflicting accounts of this undertaking have appeared, we may note that the details now given have been supplied by Colonel Washington A. Roebling, who is now in London, and who, we trust, before his return in January next, will read a paper at the Institution of Civil Engineers upon the great suspension bridges executed and in hand by his father in America.

The towers of the New York and Brooklyn bridge will be of granite, 350 ft. high, and will measure 150 ft. by 90 ft. at their bases. The openings for the railways and roadways will be Gothic arches, 100 ft. high in the clear. The railway carriages ought, perhaps, to be described as tramway carriages, since they are not those of which ordinary railway trains will be made up. They will be of unusual size, seating 100 passengers each, and will be drawn across by wire ropes, working over drums at each end, the latter driven by fixed engines.

As a whole, no work of the same character, yet executed, approaches this in magnitude. It will undoubtedly be the crowning work of Mr. Roebling's life, and we may, not unreasonably, conclude that it will hand his name down to posterity as one of the greatest engineers of modern times. The difficulties of suspension bridge construction are not in general design, but in execution, and the history of the Cincinnati bridge, which will yet be written, will furnish a most interesting chapter in point, while that of the New York bridge will possibly far surpass it.

LONG-SPAN BRIDGES.

THE recent series of articles upon long-span bridges, which has appeared in our columns, and which will probably be yet republished in a collected form, leaves perhaps but little to be said of the economic and ultimate limits of span in existing forms of bridging; but one proposition, which had not been advanced at the time when those articles were written, may now be considered with reference to the possibility of a further considerable extension of the limiting span. The widest attainable span must clearly be upon the suspension principle, but suspension bridges are deficient in stability, and it has long been the object to so stiffen a suspension chain or cable, as to adapt it for heavy and irregular loading, especially when in motion at considerable speed. No attempts to do this have been satisfactory, although, of course, where the spans are moderate, as in the Chelsea and Lambeth Bridges, and where the permanent and uniformly distributed dead load bears a high proportion to the moving load, even a moderate amount of trussing secures considerable stability. In the suspension bridge at Niagara, with a single span of 822 ft., the timber trusses are about 20 ft. deep on each side, and the bridge has two roadways, one over the other, and two pairs of cables of different versed sines, and the platform is guyed by wire ropes to the sides of the rocks below; and yet railway trains are necessarily limited to a low speed in crossing, and a considerable wave rises along the floor of the bridge, in front of the engine. We have often watched from the middle of the span the progress of trains across this bridge, and have always observed as much undulation as we had seen, a few years before, upon the passage of a heavy wagon over the suspension roadway bridge, of about the same span, on the same site, and which had but one pair of cables, one floor, and no stiffening girders.

In the case of girder bridges, no matter what may be the proportion of depth to span, a limit is found, and we may say soon found, at which the dead weight of the structure by itself, or without any moving load, produces the greatest allowable strain upon the material. And beyond this limit we cannot go. But it is sometimes suggested that we may relieve a portion of the dead weight of the truss by means of suspension chains, or inclined tension bars, as in Mr.

Ordish's well-known type of bridge. But a truss and a system of supporting tension bars or suspension chains cannot be made to act properly together. It is practically impossible, under the conditions of varying elasticity, varying temperature, &c., to so adjust the one system to the other that each shall do its share of work. It may take a great deflection, and consequently a great strain upon the truss to bring the suspension system into play, if the chains, cables, or tension bars are at all slack, and if they are too "tight" or too short, they will be made to bear the brunt of the load while the truss is not brought properly into work. In either case the bridge might be expected to break down in detail, the suspension members failing first, and the truss afterwards, or vice versa.

There is another system, however, whereby all, or any part, of the dead weight of a long truss may be supported, even to lifting it off the piers, if we may suppose an extreme case, and this is by carrying tension chains or cables from successive points along the bottom of the girder up to and over high towers at the ends of the span, and loading these chains or cables with counterweights, hanging over pulleys, or bell crank levers, the towers being furthermore stayed to prevent being pulled inwards or towards the mid span, by the strain. The suspension or tension members would thus be always under a definite and constant tension, no matter in what state of strain the truss might be in, and would lift off as much of its weight as would be represented by the counterweights multiplied by the sine of the angle of the inclined tension members. If the average inclination of a series of inclined tension rods was 1 in 4, counterweights to the extent of 4000 tons would take off 1000 tons of the dead weight of the truss. Such weights would, of course, be very bulky, 4000 tons of iron occupying 20,000 cubic feet of space, equal to four cubes, two at each end of the span, of rather more than 17 ft. on a side. Yet as cast iron could be put into counterweights at a cost, probably, of 3l. per ton—for the poorest quality would answer as well as the best—this might not be a costly nor an inconvenient mode of dealing with very large spans. In Mr. Sedley's bridge, with its system of equiposed cantilevers, the principle of counterweighting may be said to be introduced, but our suggestion applies more especially to single wide spans, where there is no occasion for side spans on land, and where, as in many cases, it would be impossible to erect piers, to allow for them, in the waterway. The use of counterweights, in the manner described, represents, we presume, a new principle in bridging, and we shall be glad to see it discussed by engineers, as it undoubtedly opens a way out, in the case of very large spans, where no other mode of dealing with them could be found, admitting, in fact, of much wider spans than could be attained upon any other method. The tension members, it is understood, would be made of increasing section, in proportion to their own length and weight, from the point of attachment to the truss up to the tops of the piers, and steel wire cables with a safe working strength of 10 tons per square inch, and weighing but 10 lb. per square inch per yard run, would probably be found best for the purpose. No stretching of the cables, or other tension members, and no alteration in length due to temperature, would upon this system affect their constant supporting power.

THE PARIS EXHIBITION.

PARIS, July 10, 1867.

WE are at "the beginning of the end," to use the historical phrase of a great French diplomatist. The prizes and honours have been awarded and distributed, the juries have been dismissed from their volunteered services, and are now in their turn standing before the jury of the juries—the tribunal of public opinion. For some days the lists of prizes have been before the eyes of the public, and there can be no doubt that many of the celebrated names who stand at the head of these lists have been gladly seen there by those who know and appreciate the services rendered by our leading men of science and industry to their respective nations and to mankind at large. There are some other names of more doubtful standing placed upon the same platform with our greatest stars, and when we meet with such we are inclined to ascribe to our own ignorance of their special merits what may be a demerit of those who have placed them there. The jury then enjoys the benefit of the doubt, and so far their awards are left unchallenged.

But when the sins become prominent and offensive, that is, in the case of omissions or insufficient acknowledgments, it is by comparison that we then

arrive at our conclusions, and the judgment is passed; it stands before us as a complete and unalterable verdict before we have time to consider the extenuating circumstances, which, in this case, form an ample and well-grounded excuse for many an error. As there have been two kinds of juries, viz., the juries of classes for proposing the prizes and the juries of groups for awarding them, we are tempted to say that the class-juries are responsible for all cases of unmerited award, while the group juries are at fault in all cases of insufficient acknowledgment. It is well known, however, that the refusals of the juries of groups have been, by the subsequent increase of the number of prizes above that originally intended, made comparatively less sweeping and oppressive than was at first expected, and so virtually the class juries are those to whom the praise for their justice and the blame for their shortcomings must be brought home.

We believe that, as a whole, great credit is due to the jurors of all those classes in which our readers are professionally interested, for the intelligence, industry, and impartiality with which they have tried to acquit themselves of their onerous duties; but it will be one of our earnest duties, though not perhaps a very pleasant task, to point out wherever grave errors have occurred. We do not intend to do this in any systematic mode, nor in any articles specially devoted to the criticism of the awards of the jury, but in our descriptions of the articles exhibited, and in our notices of the subjects brought before the public attention on this occasion, we shall not fail in future, as we have done hitherto, to preserve and express our independent opinion, which may be similar to that of the juries, but will in some instances be diametrically opposed to it. At present we will only refer to a few concise examples in order to prove that our general remarks have not been without a sufficient foundation. Looking at the group of prime movers, we find a "grand prix" awarded to Messrs. Farcot and Sons, of Paris; while the Allen engine has a silver medal, Messrs. Galloway's engine a similar award, and Messrs. Clayton and Shuttleworth's neatly finished engine is not named at all. We do not wish to detract from Messrs. Farcot's merits, but are they so far superior to those of their other just-named rival exhibitors, as the merits of Mr. Whitworth are superior to those of some obscure French or German tool-maker who has carried off a silver medal on the present occasion? Again, in the class of tools we find no gold medal amongst the makers of wood-working machinery. This is principally due to the fact of this class of machines having been mixed up in the class of "engineers' tools in general" with other machines of more ostensible importance. Still it is absurd for a jury to award a bronze medal to firms like Messrs. Powis, James, and Co., or Messrs. Robinson and Son, of Rochdale, while men like Mr. Zimmermann, of Chemnitz, carry off a prize of first order in the same class. Still more striking, to quote one more instance of gross mistake, is the difference made in the awards for fire-proof safes. Mr. Chatwood's now well-known safe has a bronze medal, while Mr. Wertheim, a safe-maker, of Vienna, whose articles would not bear an impartial comparison with the former, has managed to obtain a "grand prix." These are facts of sufficient prominence to justify what we have said before, and to make a careful and impartial professional record of this exhibition on our hands all the more necessary and important.

JACKSON'S SEWING-MACHINE.

At the Paris Exhibition a small stand in the British machinery department is occupied by the sewing-machine of Messrs. Jackson and Co., of London. This exhibit is well worthy of general attention. The machines are lock-stitch machines, employing the dead shuttle first introduced by Messrs. Wheeler and Wilson, of New York; but their needles are different from those employed by the last-named firm. Mr. Jackson's needle is straight, and his needle bar is guided in its movement in a pair of simple cylindrical slides. The tension of the thread is regulated by a spring made from a round steel wire, and the elasticity of this spring allows the application of the same machine to very different thicknesses of cloth without requiring a re-adjustment for each change. This is a great advantage with a family sewing machine, as all employers of sewing machines are well aware of. The most important feature of Mr. Jackson's machine, however, is its low price. The retail price of a machine of this kind, as arranged for being worked by hand, is 4*l.* 4*s.* This is a considerable reduction of the usual prices for lock-stitch machines, and one which has been long felt as a necessity. Mr. Jackson's machines are plain but well made, and interchangeable

in all their working parts. They are not likely to get out of order, as they are simple in their construction and sufficiently substantial in their make. Some of the details of outer finish are yet open to improvement, and particularly the price of the tables and threaders for such machines which are to be driven by foot should yet be reduced. This, however, is likely to be easily accomplished with an increasing trade, which this machine can hardly fail to realise very shortly.

THE DUNDERBERG.

TO THE EDITOR OF ENGINEERING.

SIR,—I forward you the following result of trial test for speed over a measured mile (knot), of 6086 ft., of the iron-clad ram Dunderberg, in New York Bay, 13th instant.

Five runs were made—three against, and two with, the tide, as follows:

	Minutes.	Seconds.
First run	4	3
Second "	5	18
Third "	3	55
Fourth "	5	6
Fifth "	4	15
Mean	4	31.4

being at the rate of 18.27 knots per hour.

The fires were not in order, having been banked for several hours previous to the run.

The maximum revolutions of the engines were only 51, and as low as 46 per minute.

The ship drew 21 ft. 2 in. aft, and 18 ft. 7 in. forward. Maximum pressure of steam at any time 25 lb. per square inch, falling in some cases as low as 17 lb.

Vacuum in condenser 24 in. Steam cut off at 21 in. of the stroke.

No forced draught was used at any time during the trials. The ship was designed and constructed by William H. Webb, builder of the Russian frigate *Grand Admiral*, and the Italian frigates *Rey de Italia* and *Portogallo*.

By resolution of Congress, the ship was released to her constructor, and sold to the Emperor Napoleon.

The Dunderberg takes her departure for Cherbourg in the next ten or twelve days.

Yours truly,

WILLIAM W. WOOD,
Chief Engineer U.S. Navy.

Navy Yard, New York, June 22nd, 1867.

TO THE EDITOR OF ENGINEERING.

SIR,—On page 504 of *ENGINEERING*, Mr. John Bourne and Captain Ericsson have summarily disposed of the Dunderberg, and after the verdict of these distinguished engineers, it will be useless to attempt to bolster up the reputation of that vessel. Mr. Bourne informs the world on the page indicated that Ericsson *did not* design the Dunderberg. This of itself will be sufficient to satisfy all but the most sceptical, that the ram is of no account. He also quotes a letter from Ericsson a year old, in which the latter denounces her as a "shapeless mass of timber," and to this Mr. Bourne adds his own condemnation by styling her a "weak monstrosity."

A more convincing evidence of the imbecility of the real designer, Mr. Webb, and of the utter worthlessness of the "great American ram," as she has been pompously styled, could not be desired by an enlightened British public.

With that modesty which accompanies true greatness, these gentlemen, evidently undervaluing the importance which attaches to every opinion uttered by them on the subject of ironclads, graciously sustain their views by stating that her armour is only 3½ in. thick. Although the casemates of the Dunderberg are armoured with solid plates (not laminated like the monitors) that are really 28 per cent. heavier than they have told us, being 4½ in. thick, yet for all practical purposes this duplicate statement is near enough to the truth. There is a certain stupid class of people ever ready to impugn the motives of others, or to doubt their veracity when one fails to state just exactly the truth to a line, whom it is almost impossible to please any how, and it is refreshing to see that some men are sufficiently great to disregard such grumblers—men whose professional reputation is so thoroughly established that they can afford to carry conviction to the minds of their readers by stating facts their own way when troublesome, or omitting them altogether when they conflict with their arguments. If it were not for such independence the world might be kept eternally arguing about one thing or another. For instance, if Mr. Bourne had stated the fact that Ericsson designed nothing about the Dunderberg but the gun-carriage for her 15 in. guns, and that forty-five pounds of powder (three fourths of the service charge) had been found sufficient to disable it when officially tried on the vessel, and that since said break-down it had not been further tested, these grumblers might have questioned the fact of the carriage being really "the wonderful solution of the problem of working great guns in broadside." Indeed, they might have been still more unreasonable, and have asserted, perhaps boldly, that this was the only "weak monstrosity" about the Dunderberg. But as the matter now stands, Mr. Reed and the Admiralty can have their stupidity fully ventilated for not adopting the "wonderful solution" at once.

The more I contemplate the skilful manner with which Mr. Bourne manages to defend the reputation of his *protégé*, the more fully am I impressed with the wisdom of one of the knickerbocker judges of the olden time, who refused to listen to more than one side of a question in his court, because he was always bothered in making up his decision if he heard both. Mr. Bourne seems to understand the importance of letting the court of public opinion know only so much of the facts as may be needed to ensure the cause of his client. If he had stated the fact that three feet below the water line the armour of the Dictator and the Puritan (the ram monitors *par excellence*) designed by Ericsson, was only 2 in. thick, that within 2 ft. of the surface of the water it was only 3 in. thick, and that within 18 in. of the surface it was only 4 in. thick; that this armour was vertical and laminated, while the armour on the

hull of the Dunderberg below its junction with the casemate was inclined, and solid, and that the trajectory of a projectile with this inclination would form an angle so low as to make penetration much less likely to occur than on a vertical surface; his readers might then have been in doubt as to whether the 3½ in. solid plates on the Dunderberg's hull were not fully equal if not superior to the 2 in., 3 in., or even 4 in. of laminated iron on the great monitor rams; especially if he accompanied it with the statement of the fact that the wooden backing of the Dunderberg's "hull plating," was considerably greater than the "shapeless mass of timber" on the Dictator called the shelf or "overhang." He could also have stated with truth that only 8 in. below the water line the plating of the Dictator was but 6 in. thick, and that nowhere on the hull or shelf was it more, except where it was backed with three longitudinal bars of iron 5 by 7 in. It would scarcely be credited in England, after Mr. Bourne's glowing accounts of the wonderful thickness of the armour of the Puritan and Dictator class, that an equal width of belt of the 6 in. armour of the Bellerophon contains a greater sectional area of iron than that on these vessels, including the bars alluded to.

I have studied and consulted, with much interest and advantage, in my professional engagements, the published writings of Mr. Bourne, but have never before discovered in them how nearly allied are the professions of engineer and barrister. By a skilful use of his knowledge of the theory and practice of each, he has almost carried the British nation by storm on the monitor question, and has doubtless provoked the direst indignation against the Lords of the Admiralty for their refusal to invite the great Scandinavian over to England to instruct the designer of the Bellerophon in the art and mysteries of shipbuilding. We are glad he has assumed the guardianship of the reputation of the former, and are encouraged to hope that, as he is probably kept advised by him upon all matters likely to affect it, the scientific world may be enlightened upon some unpublished mysteries respecting the monitors.

We have had elaborate calculations published on this side of the Atlantic, made, I believe, by Captain Ericsson, showing how many millions of foot-pounds the Dictator would develop if driven against one of the English ironclads at 15 knots per hour. We know that this was the speed promised by him to the Government, and upon it his calculations were based; but as the Dictator has never been able to steam more than 10 knots (if that much), it would be interesting, both in a scientific and international point of view, to have those calculations revised by him or Mr. Bourne, and the equations given on the basis of her real speed, so that we could see whether the requisite quantity of foot-pounds could be depended on in such an emergency. As the Dunderberg goes at 13 knots, of course the Ericsson ram would not be expected to "come to time" with that "shapeless mass of timber," as she would be minus the desired *vis viva*, or *vim*. It would be interesting also to know why such enormous boiler power as that carried by the Dictator cannot be half used, without such excessive heating of the journals as to prevent its further development. We know her 100 in. engines were designed by Captain Ericsson, which is of itself a sufficient guarantee of their excellence, but beyond this we know nothing. If the fault be with the engine builder he should not be shielded, for he probably has no reputation to lose, and would not suffer by the exposure, but as it is, the reputation of Ericsson himself is involved. We trust Mr. Bourne will clear up this mystery at once. The science of shipbuilding might be advanced if either of these gentlemen would make some calculations showing how much more seaworthy and rapid the Miantonomah would have proved if she had been designed by Ericsson, and constructed with the "remarkable overhang" invented by him. We fear his reputation is daily suffering, because he is supposed to be the designer of this vessel also. If Mr. Bourne will examine his correspondence, he will probably find a letter from Ericsson disclaiming the paternity of her, and be-rating Mr. Constructor Delano for his stupidity in not designing her with "this extraordinary specimen of human genius" (see Ericsson's letter on the Dunderberg), which was alone wanting to make her equally successful with the Dictator. As the only 15 in. shot that struck the Tennessee at Mobile failed to go through a casemate no stronger than the Dunderberg's, being inclined at about the same angle, and covered with 5 in. of laminated bars, only 8 in. in width (two of 2 in., and one of 1 in. thickness), and as Ericsson in one of his communications to the *Army and Navy Journal*, admits that the turret of the Dictator cannot be expected to resist a gun not in existence when that vessel was designed, it will be interesting to know from him or Mr. Bourne upon what theory he bases his assertion, that "any of our small monitors could send this extraordinary specimen of human genius to the bottom in a few rounds." The Manhattan was the only Ericsson monitor that engaged the Tennessee, and it took her over one hour to fire four 15 in. shot in that action, but one of which struck the Tennessee. How long would it require the Dictator to fire the "few rounds" necessary to send the Dunderberg to the bottom? The other two ironclads in that action (to one of which the Tennessee surrendered) were altogether unlike the monitors, except in having two rotating turrets each, in one of which the guns were worked by steam. Their decks were arched, their side armour was solid, and inclined like the Tennessee's, they had four propellers each, and although the entire deck was covered with armour as thick as the Dictator's deck-armour, with turrets of iron 8 in. thick, and side armour 3½ in., they drew only six feet of water, and steamed faster than the Dictator. There is no knowing how much swifter and better they would have been if their designer, Mr. Eads, had only had sense enough to have put the "remarkable Ericsson overhang" on them.

As it was published to the world that the monitors saved the day and captured the Tennessee in that memorable fight, perhaps Captain Ericsson's reputation has been suffering all this time by having the paternity of those abortions attributed to him also. He certainly has the glory of having had one shot in the fight, and of having designed what stupid people styled "the man-trap Tecumseh," which carried down nearly one hundred gallant souls under the waves of Mobile harbour. Will not Mr. Bourne be able to prove that the Battle of Mobile was won through the genius of Ericsson?

WM. WATT, C.E.

Washington City, June 20, 1867.

THE NAVAL REVIEW.

SOUTHEAST, July 10.

In presence of the beautiful scene which Spithead now presents, it is difficult to sit down to write a calm criticism upon the vessels which offer one so glorious a sight, to point out the weakness of objects which almost oppress one with the sense of their power, and to find fault with a slavish adherence to old models in vessels, whose chief characteristic, at first sight, would appear to be novelty. Engineers are but mortal, and are moved by pretty sights like other men. Like Phryne before her judges, our fleet puts forth all its beauties now, and bids fair to hide its imperfections in the full blaze of its attractiveness. The frailer the specimen the greater the beauty. Plenty of people will fall foul of the hideous Royal Sovereign; few will notice the Bellerophon; all will praise the Duncan, with her two stories of match-wood.

But to the engineer, intent upon securing the safety of his country at any (supposed) sacrifice of beauty, this review offers an unequalled opportunity. However often or correctly different vessels may be described, we can never gain a clear comparative knowledge of them without seeing them together. Would that a few monitors were here to complete the picture. The French ironclads and their new sister, the Dunderberg, we can spare well enough, but Russia and Sweden might send a few specimens to open our eyes.

Before settling down to arts of war, I have just a word for the ways of peace—a word of earnest commendation for the beautiful new railway station at Portsmouth. It was building when I was down here last autumn, and though I know not the architect's name nor any details of the structure, I cannot but allude to it as one of the ornaments of the place (which are few enough in all conscience). The absence of meretricious ornament and the practical appearance of all its parts show the spirit of the engineer, while the excellence of the general effect shows the spirit of an artist. The facade is of red brick, with the arches turned in yellow. Stone is used liberally, a good deal of it being disposed in horizontal lines from end to end of the building. The design of the iron work is very good. Ample provision has been made for waiting-rooms, &c., and altogether the thing does credit to its author. The actual sheds of the station are rather low, and not otherwise noticeable, so far as a hasty inspection allowed me to judge.

The Royal Sovereign, Prince Albert and Wivern are the turret ships present. All are armed with 9-in. "Woolwich" guns, soon, I trust, to be put in fair competition with the 15 in. Rodman, now at Shoeburyness. Of the Royal Sovereign people never tire of talking, and the Wivern comes in for quite as much notice as she deserves, but it is surprising how little is ever said of the Prince Albert. If time of need comes she will be found a useful member of the fleet, all things considered. Though far from what a turret ship ought to be she impresses one very favourably as a specimen of the English breed. I shall pay her a visit before the review, and will let you know if any stronger remarks are justified.

Another visit must be to the Lord Clyde. How Mr. Reed, a thorough engineer, came to build this ship and her sister, the Lord Warden, of wood has never been quite clearly explained, and is probably due to other influence than his own. Nevertheless these two ships mark a distinct step in advance. I allude to the prominence given to the bow battery in their design. End-on fighting being recognised the tendency to turrets is plain, for every successive attempt to imitate their efficiency on the broadside system does but prove their superiority. The bow battery of the Lord Warden is, I believe, the most powerful, and it is to be regretted that she puts in no appearance. The armament of these two vessels suggests a question of very wide application in our navy. The Lord Clyde carries on the main deck four 8-in. and sixteen 7-in. guns; the Lord Warden, sixteen 8-in. guns. The greater power of the latter armament is evident at once, and one cannot help asking, Why this difference? The ships are of equal dimensions in every respect, so that it would seem that a restlessness craving for variety is alone responsible for the Lord Clyde's weak armament. The Royal Alfred, again, goes to sea with a battery of 9 in. (12½ ton) guns on board, though of the same tonnage as the former vessels, and only a converted line-of-battle ship. Her sisters, the Caledonia, Prince Consort, Ocean, and Royal Oak must be content with four 8-in. guns each, and a large proportion of 7-in. Now if the Admiralty have determined that the heaviest guns are the best, why do they send out ships so badly armed? It is useless to tell engineers that their main decks could not carry the requisite weight. A few iron columns beneath, some struts, some ties, and a little ingenuity adapted to each particular case could settle this difficulty very soon. That misbegotten packing case, the Dunderberg, described by one of your contemporaries as a turret ship on the monitor principle covered with 10 in. of armour, carries 15-in. guns well enough; yet the Admiralty decide that those splendid pieces of naval engineering—the Warrior and Black Prince—are not to have a single 9-in. gun, and the Achilles two only, and the Agincourt, Northumberland, and Minotaur four each. Our authorities seem to think more of loading their ships with a dozen extra tons of gun-weight than a hundred of armour, and more of enlarging a port hole than of building a new ship. A more uniform plan of armament is required imperatively if we are to make the best of our broadside squadron.

The Warrior and Black Prince still present their old appearance, figure-head and all complete. It is a great pity they have not been altered to the Achilles pattern, with plating all round the water-line, and a ram bow.

These three ships, with the Minotaur and the Valiant, look imposing beyond description; but there is a far more business-like air about Mr. Reed's ships. The nose of the Bellerophon seems to be always looking for something to stick into. The Research has a far better appearance on the water than her enemies give her credit for. The Pall is a fine, high, buoyant-looking vessel, but she seems rather an expensive machine for carrying four 8-inch guns into action. Sailors still hate the look of the ram bows; and people in general seem to suppose that they spoil the romance of the walls of—iron. I confess they do not so strike me. Nothing exactly adapted to its pur-

pose is ever ugly, if only its construction be guided by common sense. The bow of a ship is now (in my opinion) its deadliest weapon, and it should show it. The Bellerophon's bow looks murderous, which is exactly what it should look. There is grace in its lines too, quite as much, to my taste, as in the overhanging weights of the Black Prince.

This question of fitness of means to ends is sadly set at nought here. With so many fine broadsides bearing on my bow-windows it may be rash to speak ill of them; but the thrice-told tale of their unfitness may be repeated once more with profit. For what object are our ships now built? To carry guns into action. A few heavy, or many light ones? Certainly a few heavy ones, and certainly the proper place to fire these from is the deck, and not windows in the sides. How came these windows or portholes to be thought of then? When first merchant ships were pressed into the service of the Edwards and the Henrys we may be sure that the few pieces they carried were placed upon the upper deck. But when, later, monarchs took to building large ships of war, it was evident that to make full use of them they must carry many more of the light "gonnes" of the period than the upper deck gave room for. So the lower decks were pierced with portholes, and ultimately multiplied in number, till in the Santissima Trinidad—Nelson's old enemy—we find in all five rows of sides. With the increasing weight of guns came not so much a reduction in their number as an increase in the size of the ship, resulting in the splendid three-decker Victoria, now rejoicing my sight (in spite of my engineering proclivity for rams). But at last guns have got too big for this process to be continued, especially as every gun now requires a corresponding quantity of armour. So we fall back on a few large guns. How shall we carry them? Why, how would they have been carried in the Great Harry if guns had been heavy and not light when she was built? How have we always carried guns when, as in sloops, we were obliged to carry but a few? Of course, on the upper deck. Why on earth should we stick to the merchant-ship-with-windows type when the reason for it (the great number of guns) has departed? The Royal Sovereign is far more natural in form than the Bellerophon, to say nothing of the more natural way in which the guns are trained. If a landsman acquainted with railway stations were called upon to explain how he would work a heavy gun, would not his mind at once seize on the turntable which "trains" the locomotive in any direction?

A separate examination of the different ships will provide more specific facts for my next letter. I give you no catalogue of the ships at anchor, nor any table of their tonnage, &c. (carefully compiled from the navy list), as your contemporaries furnish that with charming regularity, and the "beauty of the scene" may safely be left to Russell, D.C.L., or some of his able companions. I will say, however, that the weather is splendid, and that there is no better place in England for jaded engineers to "refresh" at than this quiet and charming Southsea.

The fleet crawled out this morning at the slowest pace consistent with any motion at all; went through a solemn rehearsal, and crawled back again like its own ghost come to announce its destruction. There was no firing. Britannia's latest and ugliest triplet, the double-sterned Vixen and Viper, and the more presentable Waterwitch, brought up the rear. The boatmen here think the latter "nae canny," a sort of yacht du diable.

COMPOSITE SHIPBUILDING.

THE construction, as well as the use, of composite vessels for mercantile purposes is only in its infancy, and they may, without hesitation, be termed *experimental ships*. But as they are becoming more generally used, and as they are more particularly adapted for some trades than either iron or wood ships, and as, before long, Lloyd's must be drawing up some rules more definite than they are at present, and as shipowners, before embarking more capital in the purchase of such ships, should be convinced of the value of the article they buy, it is advisable to inquire into the distinctive peculiarities of such ships.

This can be done best by understanding their construction, and the materials of which they are constructed; and we give, herewith, engravings representing features of the design of such a ship, which will give a general idea of the system.

The keel, stem, and sternpost are of wood, formed in the same manner as for a wooden vessel. If iron is used in the fore and after ends, the deadwood may be partially dispensed with. Iron knee-plates may with advantage be used in fore and after ends, as the frames can be rivetted to them instead of being bolted to the wood. Care must be taken to have the top of the keel, &c., perfectly level, as a plate must be carried fore and aft, from top of deck forward to top of deck aft. This plate should be broad enough to fasten the garboard strakes to, and should be flanged to suit the rise of floors. If through bolts are used, they should be of yellow metal, but a better fastening may be substituted, namely, large wood screws, say 1½ in. diameter, and galvanised; these should also be as long as possible, and screwed in as tight as convenient. A good bolt of this kind has been made by Mr. E. Watteau, of the Cleveland Bolt and Nut Company. A good thick coating of tar should be put on between the plate and the keel, and not less than two bolts in each space of frames.

In the ship which we are now describing, the frames are all rivetted securely to this plate, and the centre keelson is rivetted to the reverse frame upon the top of floors, so that the keel, keel-plate, and keelson, form a threefold backbone to the vessel. All stringers, breast hooks, and keelsons should be terminated and fastened to this plate, so that the wood is only a covering to a rigid iron frame. The frames are of angle-iron—this is the most advisable form—and spaced 18 in. apart; the size of those introduced into Lloyd's is quite narrow enough upon the outer flange; they might with great advantage increase the space of frames, and increase the breadth of frames without increasing the cost.

Besides the keel-plate there is a plate carried fore and aft upon the bilge, and another at the sheer height, and diagonal plates or ties carried from the one to the other and rivetted securely thereto; they are rivetted also to the frames, thus making the ship rigid and strong, more especially when the diagonals are double and crossed in the middle. In the place of

these diagonals, two plates divided into equal spaces between the sheer and bilge might be introduced with advantage.

The keelsons are put in the same as those used in iron vessels what is generally understood as an intercostal keelson might be put in with great advantage, although we know of no one who has put one in.

Bilge stringers are also the same as those in iron ships, but an extra stringer should be fitted on a vessel of great length if her tonnage is over 400 tons register.

The beams, both hold and deck, are placed upon every third frame, or 4 ft. 6 in. apart, in all vessels over 18 ft. depth of hold. Bulb-iron, with angle-iron on each side of top edge, is the most common form. In all cases both hold and deck beams should have welded knees, as they look better, are stronger, and are less liable to destroy the cargo.

The reverse frames are carried in vessels under 400 tons to the upper part of bilge and main deck alternately, but it is necessary that this should be the case in vessels under this tonnage, because if there is no reverse frame there is nothing to fasten the ceiling down.

Deck stringers are placed on each side of the ship on the ends of the beams, as shown in the drawing of *deck beam plan*; it is a good plan to form a gutter waterway, as it forms a good and strong girder round the ship.

Diagonal, as well as fore and aft ties are required by Lloyd's. The fore and aft ties are of great use, but the diagonal ties might be dispensed with, and the stringer and fore and aft ties increased in proportion.

There should be as many deep floors in fore and aft peaks as possible, also not less than three hooks, so that the plank ends may be securely fastened. Each stringer should also form a hook at the ends.

Iron bulwarks may safely be used in these ships; they are light and strong, and quite as cheap as wood. If iron bulwarks are fitted, the top strake of plank should be the breadth of the rail, broader than the other planks, and carried up at least 3 in. over the lower edge of the plate, to allow for caulking between the wood and iron. The moulding will only require bolting on to the top edge of the plank.

The planking is one of the most important works connected with these ships. The planks should be carefully notched over all plates, and fitted to the frames without slivers, which are objectionable and bad work. The plank should not exceed 9 in., and at the same time be thoroughly *double fastened*. At the ends of the planks clamp-plates are used, and the plank-butts are between the frames. These plates should be well rivetted to the frame before the plank is put on. At present they are only required the width of plank; but it would be of advantage to increase the breadth 4 in., so as to lap the planks top and bottom, as it often happens, when the plank has a good deal of set, that the plank is started up in the centre, and thus forms a slight unevenness on the outside, which is generally dressed off, and consequently reduces the butts' ends of the plank more than necessary. The planks should be fastened to all the plates they cross. Care must be taken in boring the plank to bore the hole according to the bevel of the frame, or the nut of the bolt will only hold upon one edge, and in heaving tight will either break or bend the bolt. The bolts should have a broad flat head, say, a ½ in. bolt, should have a 1½ in. flat or head, or ¾ larger than the diameter of bolt. The head should be sunk for a dowel to be driven on top, say, length of dowel two-thirds its diameter. The dowelling bit and starting punch ought to have each a stop, so that the bolt may not be driven too far.

Thick garboards should in all cases be used, and fastened to the keel with through bolts.

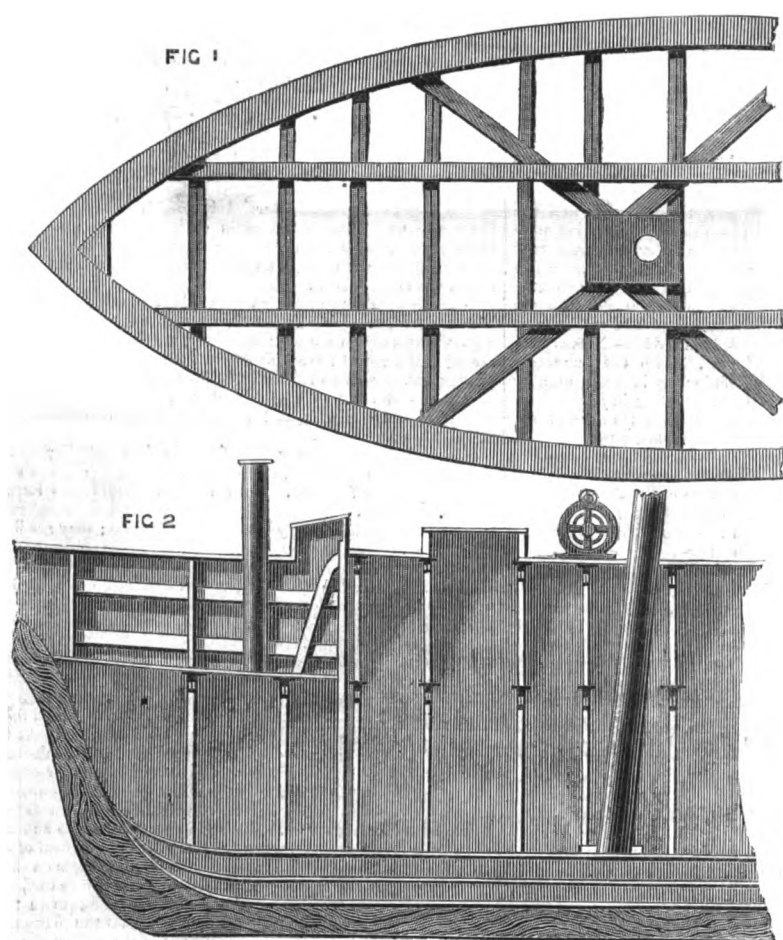
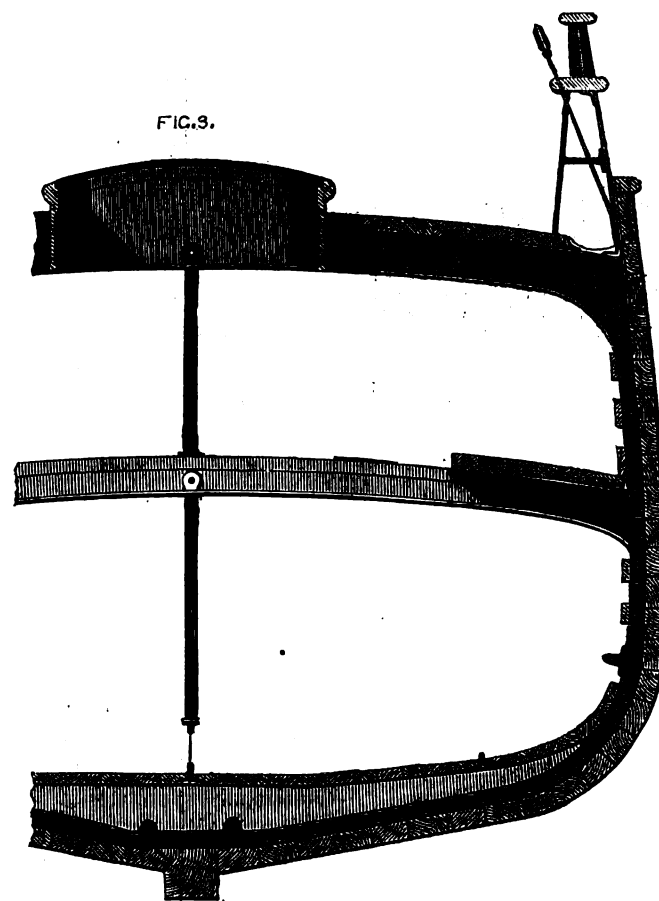
Starting with the garboard strake, and working gradually up, is the most preferable, as all the planks are either to be put up and taken down to notch over diagonals, or a broad lathe used; the latter is not a satisfactory way. The planks should be hove close home before the bolts are put in, so as to put no unnecessary strain upon the bolts. Messrs. Elliott, of Birmingham, and Vivian and Son, are both makers of suitable yellow metal bolts; being made out of bar Y M they are not so liable to break as the cast bolts sometimes used. Canted nuts, and generally hexagonal nuts, are invariably used, but a round nut with two notches might be used with advantage, as 18 in., which is the distance of frames from each other, is too small a space for a man to get a strong leverage to heave the bolt tight; if the round nut was used, a key with a long shaft to stand clear might be used. All planks should be close on inside edge, and properly bevelled for caulking. It is unsafe to ryme with wedges; the tendency is to cut the bolts when the plank and frame join, and an equal strain, so far as practicable, should be brought to bear upon all planks at once in caulking. As the tendency in caulking is to loosen the nuts, all the bolts should be overhauled after caulking.

It is indispensable, whether fastened with yellow metal or galvanised iron bolts, that these ships should be cemented. All the bolts, nuts, rivets, &c., should be entirely covered with a thick covering of cement when there is a wash of water. The safety of the ship depends upon it, for if the nuts are washed off the iron bolts, or if the oxide which water brings off yellow metal acts upon the frames, the bottom of the ship will be destroyed, either by casting adrift the planks, or gradually destroying the frames. According to Lloyd's requirements, these vessels may be battened above the bilge, but as the inside of the planks is likely to be damaged with the cargo, or the bolts destroyed, it would be more advisable to close-ceil the ship up and down, and as it would be fastened with screw bolts, it could be taken down at intervals to overhaul the inside of planks, and cement on the bottom.

All the fittings on deck may be the same as those in iron ships, such as iron combings for hatches, bulkheads, bulwarks, poop or raised quarter-decks, or forecabin sides; thus making everything light, neat, and strong on and about the deck, where it is so necessary to keep the ship steady and decrease the top weight.

These ships possess, in many respects, both the advantages of wood and of iron ships. Like the former, they may be copper or yellow metal fastened and sheathed with the same material, which renders them suitable for the China trade, thus giving them an advantage over iron ships, which are impeded so much in their sailing by the fouling of their bottoms. They are equal

COMPOSITE SHIPBUILDING.



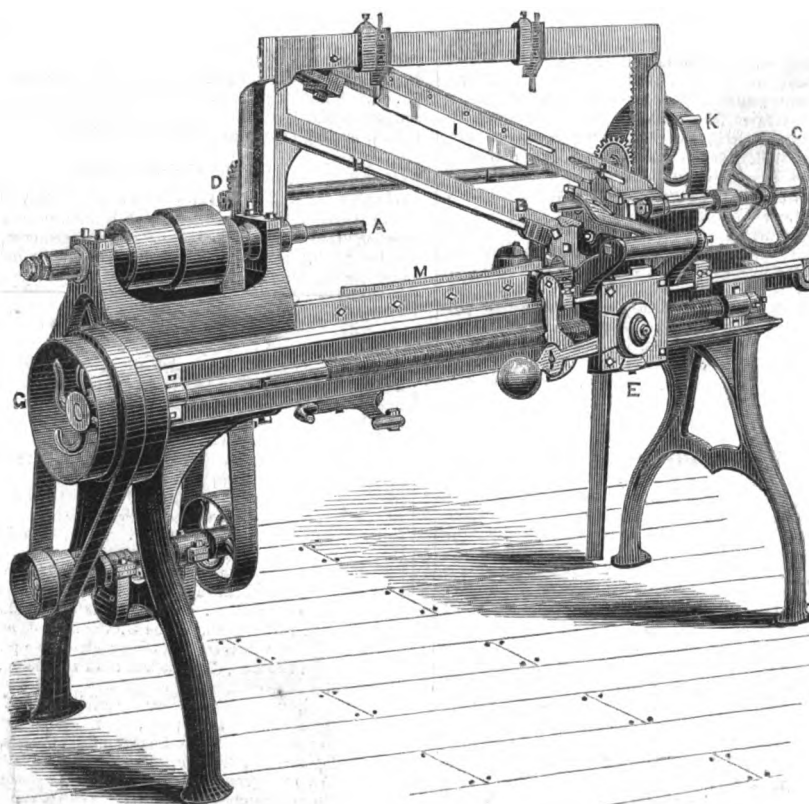
to iron and superior to wood ships in carrying capacity. They can be constructed any ordinary length with safety, are as strong as iron ships, and may be built to the finest lines. If they are damaged, they can easily be repaired. Suppose the keel was damaged, how soon are the bolts unscrewed and it replaced; or if a new plank is required, how easy to unscrew the bolt and renew it. If care is taken in building, by properly attending to a few simple rules, these ships may be made strong and durable. If well ventilated—which can be done with trifling cost—these ships will last longer than wood and as long as iron, as they are not exposed to the dry rot of the former or the influence of the salt water upon the plates and rivets of the latter. They should be carefully examined when the cargo is out, the bolts occasionally screwed up, the cement on the bottom kept good, and they will be suitable for any trade, and can be made the strongest, finest, cheapest, and most durable ships afloat. The principal dimensions of the ship engraved are: length, 160 ft.; breadth, 29 ft. 4 in.; depth of hold, 18 ft. 3 in.; is 599 tons register; will carry 1100 tons dead weight; light draught, 7 ft. 10 in. mean, and 17 ft. 9 in. loaded.

WHITNEY'S LATHE FOR TURNING PILLARS.

ONE of the most ingenious and effective machines displayed at the Paris Exhibition is the gauge lathe of Baxter D. Whitney, of Winchendon, Massachusetts, in America. This lathe turns out small pillars, such as are used in offices and for the backs and legs of chairs with accurately formed mouldings and bulgings upon them with remarkable rapidity, and it will now be proper to explain the nature of the mechanism by which this is accomplished.

The rough piece of wood which has to be turned is placed between the centres A and B. The centre, A, is formed in the manner of a serrated disc, so as to grip the end of the piece of wood to be turned, and the centre, B, is formed with a central raised point and slightly raised rim all round the small disc which constitutes the end of the spindle. The centre, B, is set up or withdrawn by the hand-wheel, C. The wood to be turned is rotated by one of the pulleys at D. The wood to be turned into a pillar is first reduced into the form of a cylinder, which is done by means of a fixed chisel set in a slide-rest, E, which is drawn forward on its bed in the same manner as any common slide-rest by means of the screw, F, driven by the pulley, G. The slide-rest has two chisels in it—one the fixed chisel already mentioned, and the other a chisel susceptible of a slight up and down motion by being fixed to a movable frame hinged to the main slide, E. The slide, E, has an eye upon it, which runs back over the centre, B, and this eye, which is of the exact diameter of the cylinder which is first turned, advances with the chisel so as to steady the thin pillar near the part encountered by the cutting edges of both chisels. H is a diagonal piece, which forms part of a frame that is capable of sliding up and down in guides, and to which frame the diagonal knife, I, is also firmly bolted. K is a pulley, from which a heavy weight is suspended by a leather strap to counterbalance this frame, and which it does by means of the shaft, L, which carries

WHITNEY'S LATHE, IN THE PARIS EXHIBITION.



pinions working into racks on the sides of the sliding-frame. M is a narrow gauge piece of iron or steel, about $\frac{1}{4}$ in. thick, and cut out to the shape of the mouldings and bulgings the pillar is intended to have, and the knife, I, which is brought down at a tangent to the pillar, while it has its cutting edge in a straight transverse line is moulded on the face or side to the shape the pillar is intended to have. The movable chisel attached to the hinged part of the slide-rest is moved up and down by means of a projecting foot, which presses upon the gauge or corrugated rail, M, as the rests, E, advances, thus cutting the piece of wood which before was a cylinder into the proper form. But as the slide-rest, E, is advanced by the screw, F, a notch in the

rest which engages the projecting flange of the diagonal bar, H, brings down the frame in opposition to its counterweight, and with the frame the moulded knife or blade, I, by which the turning operation is completed and the pillar accurately finished and smoothed. Of course a different knife, I, and gauge rail, M, will be required for every different pattern of pillar. But the other parts of the mechanism will remain without alteration, whatever bulgings or mouldings are employed. For the purpose for which it is intended nothing can be more rapid and efficient than this lathe, and a similar device might with advantage be introduced to form the bulging pillars of balustrades in stone in all cases where a large number of them is required.