

9359.

608.7

THE SOURCES OF INVENTION

BY

JOHN JEWKES

DAVID SAWERS

RICHARD STILLERMAN

LONDON

MACMILLAN & CO LTD

NEW YORK • ST MARTIN'S PRESS

1961



CONTENTS

| | PAGE |
|---------|------|
| PREFACE | ix |

PART I

CHAP.

| | |
|--|-----|
| I. INTRODUCTION | 3 |
| II. MODERN VIEWS ON INVENTION | 27 |
| III. INVENTORS AND INVENTION IN THE NINETEENTH CENTURY | 35 |
| IV. SOME RECENT IMPORTANT INVENTIONS | 71 |
| V. THE INDIVIDUAL INVENTOR | 91 |
| VI. RESEARCH IN THE INDUSTRIAL CORPORATION: I | 127 |
| VII. RESEARCH IN THE INDUSTRIAL CORPORATION: II | 147 |
| VIII. THE DEVELOPMENT OF INVENTIONS | 197 |
| IX. CONCLUSIONS AND SPECULATIONS | 223 |

PART II

SUMMARIES OF CASE HISTORIES

Automatic Transmissions, p. 263; Bakelite, p. 266; Ball-point Pen, p. 268; Catalytic Cracking of Petroleum, p. 269; 'Cellophane', p. 272; Cinerama, p. 274; Continuous Casting of Steel, p. 276; Continuous Hot Strip Rolling, p. 280; Cotton Picker, p. 282; Crease-resisting Fabrics, p. 286; Cyclotron, p. 290; DDT, p. 292; Diesel-Electric Railway Traction, p. 293; Electric Precipitation, p. 296; Fluorescent Lighting, p. 298; Freon Refrigerants, p. 301; Gyro-Compass, p. 303; Hardening of Liquid Fats, p. 305; Helicopter,

p. 308; Insulin, p. 312; Jet Engine, p. 314; Kodachrome, p. 321; Long-playing Record, p. 324; Magnetic Recording, p. 325; Methyl Methacrylate Polymers: Perspex, etc., p. 329; Neoprene, p. 332; Nylon and Perlon, p. 334; Penicillin, p. 338; Polyethylene, p. 339; Power Steering, p. 342; Radar, p. 345; Radio, p. 350; Rockets, p. 355; Safety Razor, p. 359; Self-winding Wrist-Watch, p. 361; Shell Moulding, p. 363; Silicones, p. 366; Stainless Steels, p. 369; Streptomycin, p. 373; Sulzer Loom, p. 375; Synthetic Detergents, p. 377; Synthetic Light Polariser, p. 381; Television, p. 384; 'Terylene' Polyester Fibre, p. 388; Tetraethyl Lead, p. 392; Titanium, p. 395; Transistor, p. 399; Tungsten Carbide, p. 402; Xerography, p. 405; Zip Fastener, p. 409.

INDEX

- Académie des Sciences, 50
 Ackroyd-Stuart, H., 62
 Acoustic Consultants Co., 328
 Acrylic Fibres, Orlon, etc., 72, 79,
 85, 86, 219
 Aero-engine fuels, 70
 Aerofin, 123
 Aeroplanes, 231
 Agfa, 321
 Agricultural Machinery Industry,
 170
 In U.S.A., 171
 Agthe, C. A., 379
 Air Conditioning, 72, 82, 98, 109,
 161, 211, 219
 Small units, 123
 Aircraft Industry:
 In U.S.A., 148, 152, 157
 British, 154, 155
 Airship, 231
 Akers, Sir W., 143
 Alexanderson, E., 350-1, 384, 387
 Alizarin, Synthetic, 68
 Allegheny Ludlum Steel Co., 278
 Allen, W., 67
 Allgemeine Elektrizitäts Gesell-
 schaft, 327, 351
 Allis-Chalmers Co., 285
 Aluminium:
 Electrolytic production process
 for, 57
 Industry, major inventions in,
 168-9
 Aluminium Industry in U.S.A.,
 168-9, 171
 Aluminum Company of America,
 Direct Casting process, 277, 278
 American Association for the Ad-
 vancement of Science, 67
 American Government and peni-
 cillin, 25
American Journal of Science, 64-5
 American Locomotive Co., 294
 American Navy, 348, 353
 American Optical Co., 383
American Philosophical Society,
Transactions of, 64
 American Rolling Mill Co. (Armco),
 281-2
 American Sheet and Tinplate Co.,
 280
 American Smelting and Refining
 Co., 278
 American Steel and Wire Co., 279
 American Telegraphone Co., 326
 American Telephone and Telegraph
 Co., 352, 387
 Ames, Professor A., Jr., 275
 Anderson, Professor J., 65
 Andersonian Institution, 65
 Andrew, J. P., 393
 Anglo-Iranian Oil Co., 271
 Aniline Dyes, 124, 202
 Mauve, 50, 68
 Anschütz-Kaempfe, H., 303-4
 Antz, H., 319
 Appleton, Sir E., 91, 346
 Arkel, van, 396
 Arkwright, Sir R., 45, 46
 Armour Research Foundation, 328-9
 Armstrong, E., 70, 89, 91, 94, 97, 98,
 99, 184, 189, 352-4
 Armstrong, Sir W., 34, 200
 Arnold, H. D., 352
 Asbestos Goods Industry, British,
 171
 Ashland Iron and Mining Co., 281
 Atha, B., 276
 A.B. Atlas Diesel, 294
 Atomic Energy, 6, 74-5
 Manner in which discoveries lead-
 to made, 76
 Optimism about economic advan-
 tages of, 77
 Research on, controlled by govern-
 ments, 77
 Ambitious schemes for, 77-8, 227
 Autogiro, 98, 102, 308-9
 Automatic Guns, 117
 Machine, 122
 Automatic Hook and Eye Co., 409
 Automatic Telephone Dialling Sys-
 tem, 117
 Automatic Transmissions, 72, 82, 98,
 109, 211, 219, 220, 237
 Case History of, 263-6
 Automation, 28, 75, 190
 Automobile Overdrive, 98

- Babbage, Charles, 33, 67
 Babcock and Wilcox Tube Co., 279
 Bachmann, W. S., 324
 Bacon, Francis, 71, 235
 Badische Anilin- und Soda-Fabrik, 378
 Baekeland, L. H., 17, 98, 266-9
 Baird, J. L., 145, 190, 384, 387
 Bakelite, 17, 72, 79, 82, 84, 98, 109, 211
 Case History of, 266-8
 Corporation, 268
 Ball-point Pen, 13, 72, 74, 82, 98, 117, 219
 Case History of, 268-9
 Ball-point Pen Ink, 98, 269
 Banting, Sir F. G., 98, 179, 312-14
 Barbed wire, 20
 Barber, J., 314
 Bardeen, J., 97, 400-1
 Barnard, D. P., 240
 Barnes, W. B., 98
 Barnes, Dr. T., 65-6
 Barnett, M. F., 346
 Bathe, G. and D., 41-2
 Battelle Development Corporation, 407-8
 Battelle Memorial Institute, 243, 407
 Bauer, K., 327
 Baumhauer, A. G. von, 310
 Baumhauer, H., 404
 Bausch and Lomb Ltd., 383
 Beau de Rochas, A., 61
 Bedford, Duke of, 46
 Begun, S. J., 328
 Bell, Alexander Graham, 17, 49, 55-56, 67
 Bell, H., 43
 Bell Telephone Co., 353
 Bell Telephone Laboratories, 86, 137, 150, 328, 384, 399-401, 406
 Benz, C., 62
 Berlin, Sir Isaiah, 15
 Berliner, E., 56-7, 63
 Bernal, J. D., 30
 Berry, H. M., 285
 Bertsch, H., 184, 379
 Bessemer Converter, 52, 201
 Bessemer, Sir H., 51-2, 67, 115, 201
 Bessemer Process, development cost of, 201
 Best, C. H., 312-13
 Bevan, E., 60
 Bicycle Industry, British, 171
 Birdseye, C., 187
 Biro, G., 268
 Biro, L. J., 98, 268-9
 Birtwhistle, W. K., 388
 Biscuits, Crackers, Industry : in U.S.A., 171
 Bituminous Coal Mining Industry, 173
 Black, J., 36, 42, 67
 Blackett, C., 43
 Blackett, Professor P., 347
 Blattnerphone, 327
 Blenkinsop, J., 44
 Blumlein, A. D., 387
 BMW Engine Co., 319-20
 Boehme, H. Th., Fettchemie, 379
 Boer, de, 396
 Boffey, H., 287
 Böhler, Gebrüder, 278
 Bolton, E. K., 332-3, 335
 Boot, H. A. H., 348
 Booth, Professor, 50
 Borchers, W., 370
 Borg Warner Corporation, 186
 Warner Gear Division, 265
 Boulton, Matthew, 36, 144
 Bowen, H. G., 348
 Boyd, T. A., 393
 Boye, Professor, 50
 Boys, C. V., 133
 Brackett, Professor C. F., 55, 67
 Braeburn Alloy Steel Co., 279
 Bramah, J., 46
 Bramo Engine Co., 319-20
 Bramwell, Sir F., 53
 Brandenberger, J. E., 98, 272-4
 Branly, E., 350
 Brattain, W. H., 400-1
 Braun, Professor F., 351, 384
 Braun, W. von, 356-7
 Braunmühl, H. J. von, 328
 Bray, C. W., 280
 Brearley, H., 370-2
 Bréguet, A.-L., 361
 Bréguet, L., 308, 311
 Breil, H., 341
 Breit, G., 124
 Brewing Industry, 155
 Bridgman, P. W., 340
 British Association for the Advancement of Science, 67
 British Broadcasting Corporation, 86, 327
 British Iron & Steel Research Association, 279
 British Nylon Spinners Ltd., 337

- British Oxygen Co. Ltd., 170
 British Thomson-Houston Co., Ltd.
 119, 160, 300, 315
 Broderick, T., 324
 Brown, John, & Co. Ltd., 371
 Brown, S. G., 98, 99, 305
 Brown Bayley Ltd., 371
 Brunel, I. K., 34
 Brunel, Sir M. I., 47
 Brunner Mond Ltd., 307
 Brush, C. F., 57
 Brush Development Co., 328
 Buckley, O. E., 137
 Buick Dynaflo, 265
 Bunsen, Professor R. W. von, 67
 Burbank, L., 120
 Burlington Co., 295
 Burton, W. M., 270
 Bush, V., 92
- Cadillac Co., 263
 Calico Printers' Association Ltd.,
 388-91
 California, State University of, 296
 California, University of, 290-1
 Callis, C. C., 394-5
 Campbell, A., 98, 283-4
 Campbell-Swinton, A. A., 384-5
 Camras, M., 98, 328-9
 Canadian National Railways, 294
 Caproni-Campini, 315
 Carboloy Co., 404
 Carbon Black, first used in tyres,
 181
 Carbuiretors, Aircraft, 220
 Carlson, C. F., 18, 98, 117, 119,
 184, 405-7
 Carlson, W. L., 327
 Carnot Cycle, 63
 Caro, H., 68
 Carothers, W. H., 13, 18, 22, 89, 94,
 97, 109, 184, 216, 333, 334-7,
 366-8, 388-9
 Carpenter, G. W., 327
 Carrier, W. H., 98
 Cartwright, Edmund, 17, 45-6
 Catalytic Cracking of Petroleum, 72,
 74, 82, 83, 98, 118, 219, 220
 Houdry process, development cost
 of, 202
 Case History of, 269-72
 'Cellophane', 72, 82, 98
 Case History of, 272-4
 'Cellophane' Tape, 72, 85, 87, 160,
 211
- Chalmers, W., 98, 330-1
 Charch, W. H., 274
 Chase Brass and Copper Co., 278
 Chemical Industry :
 In U.S.A., 147, 152
 British, 157, 158
 Chemical Research Laboratory (of
 D.S.I.R.), 391
 Chemicals and Allied Trades In-
 dustry, British, 154
 Chromium Plating, 72, 79, 82, 85,
 98
 Chrysler Co., 344
 Chubb, L. W., 382
 Churchill, Sir W., 227, 255
 Cierva, J. de la, 98, 102, 308-11
 Cierva Autogiro Company, 102, 309
 Cinerama, 72, 82
 Case History of, 274-6
 Clark University, 394
 Claude, G., 299
 Coal-mining Industry, British, 172
 Coats, A., 264
 Cocoa and Chocolate Manufacture
 Industry, British, 171
 Codrington, G., 294
 Cold Metal Process Co., 279
 Collins, A. M., 333
 Collip, J. B., 313
 Columbia Broadcasting System, 118
 324-5
 Columbia Records, 324-5
 Columbia Steel Co., 281-2
 Columbia University, 352
 Commons, House of, Committee on
 Letters Patent, 1871, 200
 Competition :
 Factors determining attitude of
 firm under, to research, 175-8
 And development, 213-19
 Comptoir de Textiles Artificiels, 273
 Compton, A. H., 299
 Conant, J. B., 29, 340
 Connaught Laboratories, 313
 Conrad, F., 353
 Continuous Casting of Steel, 72, 88
 98, 100-1, 169
 Case History of, 276-80
 Continuous Hot-strip Rolling of
 Steel, 72, 74, 85, 87, 160, 169
 Case History of, 280-2
 Continuous Metalcast Corporation,
 278
 Controllable Pitch Propeller, 117
 Cooke, Sir W. F., 48

- Coolidge, W. D., 139, 184, 291
 Cooper-Hewitt, P., 298
 Copper Smelting and Refining Industry, in U.S.A., 171
 Corelli, M., 230
 Cornell University, 382
 Corning Glass Works, 367-8
 Cotton Gin, 17, 47
 Cotton Industry, 155
 British, 172
 Cotton Machinery, 44-7
 Jenny, 15, 45
 Mule, 15, 45
 Power loom, 45-6
 Mule, self-acting, 201
 Cotton Picker, 13, 72, 74, 82, 83-4, 98, 109, 219, 234
 Case History of, 282-6
 Cotton Textile Bleaching Industry, British, 171
 Cotton Textile Printing Industry, British, 171
 Cottrell, F. G., 98, 296-7
 Courtauld's Ltd., 201, 337
 Cramer, S. W., 98
 Crawford, J. W. C., 331
 Crease-resisting Fabrics, 17, 72, 85, 87, 155, 160, 211
 Case History of, 286-90
 Crocco, G. A., 308
 Crompton, S., 45
 Croning, J., 98, 363-5
 Crooke's Radiometer, 59
 Crosfield, J., & Co., 306-7
 Cross, C. F., 17, 59-60, 89, 389
 Crown Casting Associates, 365
 Crystal Detector :
 Carborundum, 351
 Psilomelan, 351
 Silicon, 351
 Cuvier, Baron, 33
 Cyclotron, 12, 17, 18, 72, 74, 82, 84-5, 109, 226
 Case History of, 290-2
- Dacron, 129, 391
 Daimler, G., 62, 67
 Daimler, K., 379
 Daimler-Benz A.G., 320
 Dalton, J., 42
 Dantsizen, C., 371
 Darwin, E., 37
 Davis, E. W., 119, 220
 Davis, F. W., 98, 103, 343-4
 Davy, Sir H., 40, 48, 54, 64, 67, 298
- Dayton Engineering Laboratories Co., 392
 DDT, 72, 85, 87
 Case History of, 292-3
 Dean, R. S., 397
 De Dion-Bouton Ltd., 370
 Deere & Co., 285
 Defoe, D., 242
 Department of Scientific and Industrial Research, Chemical Research Laboratory of, 391
 Detergents, Synthetic, 73, 85, 219, 377-80
 Deutsche Hydrierwerke, 379
 Deutsche Wolle Co., 376
 Development :
 Distinction from invention, 17-19
 Nature of, 19-21
 Distinction from invention especially important in industrial research, 128-9
 Modern view of its importance, 197-8
 Questions arising from it, 198
 Definition, 199-200
 In the nineteenth century, 200-2
 Cost of apparently rising, 202-3
 Reasons for this, 203-10
 Examples of less costly development, 211-12
 Monopoly, competition and, 212-221
 Belief now more rapid and efficient than in past, 235-7
- Dewar, Professor Sir James, 67
 Dick, R., 71
 Dickinson, H. W., 36
 Dickson, J. T., 388-90
 Diesel Electric Railway Traction, 72
 Locomotive, 85, 87, 122, 200, 211, 237
 Case History of, 293-5
 Diesel Engine, 62-3, 70, 129
 Diesel, R., 17, 63, 70, 184
 Discoveries :
 Accidental, 68-9
 Chance in, 123-4
 Distilled Liquors Industry, in U.S.A., 171
 Domestic Gas Refrigeration, 72, 82, 98, 117
 Doncaster, D., 324
 Dornberger, W., 356-7
 Dow Chemical Co., 368, 393
 Dow-Corning Corporation, 368

- Drink Industry, British, 158
 Dubos, R., 374
 Duco Lacquers, 68, 73, 85, 124
 Dunlop, J. B., 118
 Dunlop Rubber Co., 180-1
 Dunwoody, H. H., 351
 Du Pont de Nemours, E. I. & Co.,
 22, 86, 129, 150, 188, 210, 215-
 216, 218, 273-4, 331, 332-3, 334-
 337, 379, 391, 393
 Dwyer, H. P., 351
 Dye Industry, British, 171
 Dyes, first aniline, mauve, 50, 68, 124
 Dynamo, 54, 57

 Eastman, G. F., 115, 117
 Eastman Kodak Co. Ltd., 119, 129,
 138, 267, 321, 323, 383, 406
 Eberhard Faber Co., 268
 Economists and innovation, 4-5
 Edison, T. A., 54-5, 67, 69, 91, 97,
 112, 184
 Edison Illuminating Co., 189
 Edlefsen, N. E., 291
 Education, Scientific, in Nineteenth
 Century, 63-66
 Edward, T., 71
 Einstein, A., 163
 Eldred, B. E., 278
 Electric Generator, 69
 Electric Lamp Manufacturers' Assoca-
 tion, 180
 Electric Lamps, 179-80
 Electric Precipitation, 73, 82, 85, 98,
 109, 211
 Case History of, 296-7
 Electric Wire Industry, British, 171
 Electrical and Musical Industries
 Ltd., 202, 212, 385, 387-8
 Electrical, and Other Machinery,
 Industry, in U.S.A., 152
 Electrical Engineering Industry,
 British, 154
 Electrical Equipment Industry, in
 U.S.A., 148
 Electrical Machinery Industry, in
 U.S.A., 152
 Electrolytic Detector:
 Fessenden, 351
 Schlömilch, 351
 Electromotive Co., 187, 294
 Electronic Devices, use of in in-
 dustry, not predicted, 231
 Electron Microscope, 73, 74, 79, 82,
 219

 Ellehammer, J. C., 308
 Ellis, C., 98, 99-100
 Elster, J., 384
 Empire Cotton Growing Corpora-
 tion, 135
Engineer, The, 64
 English Steel Corporation, 264
 Ensign, E. E., 364
 Ethyl Corporation, 302
 Evans, Oliver, 39, 41-2
 Eversharp Co., 268
 Ewart, P., 33

 Fahlberg, Doctor, 56
 Falk, O. T., and Partners, 315-16
 Faraday, M., 47, 48, 50, 54, 64, 369
 Farnsworth, P., 18, 70, 89, 93, 97,
 98, 100, 109, 117, 165, 184, 212,
 385-8
 Farnsworth Radio and Television
 Corporation, 387
 Fats, hardening of liquid, 73, 82, 83,
 98, 219
 Case History of, 305-7
 Feedback Circuit, 99, 352
 Ferguson, H., 98
 Fernseh A.G., 387
 Fessenden, R., 98, 184, 350-1
 Fibersilk Co., 273
 Fink, C. G., 98
 Firth, Thomas, & Sons Ltd., 371
 Firth-Sterling Steel Co., 371, 404
 Firth-Vickers Ltd., 316
 Fischer, E., 366
 Fischer, R., 321-3
 Fitch, J., 42, 43
 Fleming, Sir Alexander, 18, 23-4, 97,
 98, 138, 338-9
 Fleming, Sir Ambrose, 351
 Florey, Sir H., 24, 339
 Fluid Flywheel, 98, 263
 Fluorescent Lamp, 180, 298-300
 Development cost of hot cathode,
 202
 Fluorescent Lighting, 73, 79, 85, 219
 Case History of, 298-300
 Focke, H., 308-11
 Focke-Wulf Ltd., 309
 Food Industry:
 In U.S.A., 157
 British, 158
 Ford, H., 189
 Ford, H. C., 304
 Ford Motor Co., 190
 Forest, L. de, 98, 103, 120, 184, 351-2

- Forest, de, Wireless Co., 351
 Föttinger, H., 118, 263-5
 Foucault, L., 303, 305
 Foulds, R. P., 287
 Franklin, B., 43
 Franklin, C. S., 352-3
 Franklin Institute, 57, 65, 66
 Franz, A., 319
 Frawley Manufacturing Corporation, 269
 Free-Piston Gas Generator, 70, 98
 Pescara, 199, 211
 Freon Refrigerants, 68, 73, 85, 86, 124, 187
 Case History of, 301-2
 Frequency Modulation, 99, 189, 353-354
 Fresnel, 51
 Frigidaire Co., 307
 Fulton, R., 42-3, 46
 Furnas, C. C., 241
- Galbraith, Professor J. K., 29, 173
 Gale, Professor L. D., 50, 67
 Gardinol Corporation, 379
 Gas Refrigeration, 98
 Domestic, 72, 82, 92, 117
 Gas Turbine, 202, 231
 Apparent attitude of motor manufacturers to, 131
 Gauss, K. F., 48
 Geigy, J. R., & Co., 292-3
 Geitel, H., 384
 Gemmer Manufacturing Co., 344
 General Electric Co., 186, 187, 219, 294, 299-300, 328, 348, 350, 352, 368, 384, 404
 Laboratories, 139, 395
 General Electric Co. of England, 160, 300
 General Foods Corporation, 187
 General Machinery Corporation, 265
 General Motors Corporation, 86, 87, 118, 150, 159, 186, 187, 188, 211, 263-4, 294-5, 301-2, 344, 392-5
 German State Broadcasting Service, 328
 Germer, E., 300
 Gibney, R. B., 400
 Gibson, R. O., 340
 Giesen, W., 370
 Gilbert, D., 40, 67
 Gilchrist, P., 53, 67
- Gilchrist-Thomas, S., 17, 51, 53, 67
 Gilfillan, S. C., 234
 Gillette, K., 98, 117, 359-61
 Gillette Safety Razor Co., 360
 Gloster Aircraft Co., 317
 Goddard, R. H., 355
 Godowsky, L., 98, 322-3
 Goettingen, University of, 317
 Goldmark, P., 118, 324-5
 Goldschmidt, R., 351
 Goodrich, B. F., Co., 181, 410
 Goodyear, C., 17, 49-50, 67, 68, 69, 89, 201
 Goodyear Co., 181
 Goss, N. P., 279
 Graham, Professor T., 51
 Gramme, Z., 54
 Gray, E., 49
 Greenewalt, C. H., 233
 Griffith, A. A., 314-15
 Grunow, H., 357
 Guillaume, M., 315
 Guillet, L., 370
 Gulf Refining Co., 270
 Gunther, 378
 Gyro-compass, 73, 82, 83, 98, 99, 190
 Case History of, 303-5
 Gyroscope, 303
- Hackworth, T., 44
 Hadfield, R., 370
 Hagedorn, H. C., 179, 218, 313-14
 Hairpin, 125
 Haldane, J. B. S., 230
 Hall, C. M., 57, 67
 Hallpike, A. W., 264
 Haloid Corporation, 408
 Hamilton, H. L., 294
 Hamilton, W., 30
 Hammond, J. H., Jr., 98
 Hansen, W. W., 348
 Hardening of Liquid Fats, 73, 82, 83, 98, 219
 Case history of, 305-7
 Hardie, D. W. F., 51
 Harding, C. P., 393
 Hargreaves, J., 44-5
 Harris, Doctor, 315
 Harvard University, 382-3
 Harwood, J., 98, 164, 362-3
 Harwood Self-winding Watch Co., 362
 Hatfield, H. S., 93, 253
 Haynes, E., 370-2
 Hedley, W., 43

- Heilborn, J., 360
 Heinkel, E., 318
 Heinkel, E., A.G., 211, 318-20
 Helicopter, 73, 82, 84, 98, 102
 Case History of, 308-11
 Helmholtz, H. L. F. von, 54, 55,
 57
 Henne, A. L., 301
 Henry, Dr., 52, 67
 Henry, J., 48, 49, 54, 67
 Herapath, W. B., 381, 382
 Hero of Alexandria, 314
 Héroult, P., 57, 115
 Hertz, H., 227, 345, 350, 384
 Heterodyne Circuit, 351
 Hetzer, 378
 Heylandt Co., 357
 Hickman, C. N., 328
 Hill, Professor A. V., 347
 Hill, J. W., 335
 Hill, R., 331
 Hitler, A., 244, 358
 Hittorf, 384
 Hobbs, H. F., 98, 265
 Hochwald, C. A., 393
 Hodgkinson, Professor Eaton, 64
 Hofmann, A. W., 50, 67
 Holtzer, Jacob, Co. Ltd., 278
 Holzkamp, E., 341
 Hook, C., 281
 Hooke, R., 33
 Hopkins, 303
 Hotpoint Electric Heating Co., 187
 Houdry, E., 98, 118, 220, 270-2
 House of Commons, Committee on
 Letters Patent, 1871, 200
 House of Lords, Committee on
 Patent Law Amendment Bills,
 1851, 200
 Houston, E., 66, 67
 Howard, F., 394
 Hull, A. W., 299-300, 348
 Hülsmeier, C., 345
 Hunter, A., 31
 Hunter, M. A., 395
 Huntington Heberlein Co., 297
 Huygens, C., 33, 381
 Hyalsol Corporation, 379
 Hyde, J. F., 367-8
 Hydra-Matic Transmission, 263-4,
 266
 Hydraulic Converter-coupling, 263-
 266
 Hydraulic Coupling, 263, 265-6
 Hyland, L. A., 348
 Iconoscope, 212, 385, 387
 I.G. Farbenindustrie, 86, 289, 321,
 327, 337, 378-80
 Imperial Chemical Industries, 18,
 86, 87, 129, 145, 150, 160, 210,
 331, 337, 339-41, 368, 380, 391
 Titanium process, 208, 217, 398
 Incandescent Lamp, Carbon fila-
 ment, 59
 India Rubber, Gutta Percha and
 Telegraph Works, Silvertown,
 181
 Industrial Laboratory, unfavourable
 place for inducing invention,
 132-42
 Industrial Research :
 Survey of expenditure on, 148-50
 Factors leading firms to conduct it,
 150-5
 Position of large firms in, 156-66
 Incidence sporadic, 184-5
 Statistics of expenditure on, 191-6
 Industrial Research Associations,
 178-9, 247
 Industrial Research Laboratories,
 68
 When first appeared, 73
 Whether growing importance desir-
 able, 126
 Often established to link invention
 and development, 182-3
 Provide new form of accommoda-
 tion for some inventors, 183
 But involve them in new frustra-
 tions, 183-4
 Industrial Research Organisations :
 Modern faith in, 127-8
 Difficulty of fitting into business,
 129-32
 Possible obstacle to outside ideas,
 143-6
 Not an adequate source of inven-
 tions, 185-6
 Rarely self-sufficient, 186-7
 Industries :
 Agricultural Machinery, 170 ; in
 U.S.A., 171
 Aircraft : British, 154-5 ; in
 U.S.A., 148, 152, 157
 Aluminium, in U.S.A., 168-9, 171
 Asbestos Goods, British, 171
 Bicycle, British, 161
 Biscuits, Crackers, in U.S.A., 171
 Bituminous coal-mining, 173
 Brewing, 155

Industries—*contd.*

- Chemical : British, 157, 158 ; in U.S.A., 147, 152
 Chemicals and Allied Trades, British, 154
 Coal-mining, British, 172
 Cocoa and Chocolate Manufacture, British, 171
 Copper Smelting and Refining, in U.S.A., 171
 Cotton, 155 ; British, 172
 Cotton Textile Bleaching, British, 171
 Cotton Textile Printing, British, 171
 Distilled liquors, in U.S.A., 171
 Drink industry, British, 158
 Dyes, British, 171
 Electric Wire, British, 171
 Electrical and other machinery, in U.S.A., 152
 Electrical Engineering, British, 154
 Electrical Equipment, in U.S.A., 148
 Electrical Machinery, in U.S.A., 152
 Food : British, 158 ; in U.S.A., 157
 Iron and Steel, 169 ; British, 158
 Linoleum, 170 ; in U.S.A., 171
 Match, British, 171
 Meat Products, in U.S.A., 171
 Mineral Oil Refinery, British, 154
 Motor Car, 169-70
 Motor Vehicles, in U.S.A., 171
 Office Machines, in U.S.A., 171
 Oil, 173
 Paper, British, 158
 Petroleum, British, 171
 Petroleum refining, in U.S.A., 147, 152
 Plumbing Equipment, in U.S.A., 171
 Precision Instruments, British, 154-5
 Rayon and Nylon, British, 154
 Rubber Tyres and Tubes, in U.S.A., 171
 Rubber Tyre, British, 171
 Scientific Instruments, in U.S.A., 147, 148
 Seed Crushing, British, 171
 Sewing and Boot and Shoe Machinery, British, 171
 Sugar and Glucose, British, 171

Industries—*contd.*

- Telecommunications and Broadcasting, in U.S.A., 148
 Textile, British, 158
 Tinplate, British, 171
 Tobacco, British, 171
 Wireless Valves, British, 171
 Wrought Iron and Steel Tube, British, 171
 Industries, 'technically advanced', 152
 Industries, 'technically advancing', 153
 Ingersoll-Rand Co., 294
 Inman, G., 299-300
 Innovation :
 New interest in, 4-5
 Ignorance of means of encouraging, 7
 Why monopoly often said to encourage it, 88
 Insulin, 73, 74, 79, 82, 85, 98, 179, 205, 218-19, 226
 Case History of, 312-14
 N.P.H., 179
 Protamine, 179, 313
 Protamine zinc, 179
 Internal Combustion Engine, 61
 Four-stroke cycle, 61-2
 Gas, 61
 Heavy Oil, 62-3
 Petrol, 62
 International Harvester Co., 283-4, 286
 International Precipitation Co., 297
 Invention :
 Lack of institutions to encourage, 9-10
 Desire to foresee, 10
 Difficulty of defining, 12
 Part played by individuals in, 15
 Importance of individual in, 16-17
 Distinction from development, 17-19
 Conflicting current views on, 27-9
 Modern views of, 29-31
 Modern views of invention in nineteenth century, 31-2, 70
 'Empirical' and 'scientific' or 'systematic', 68-70, 164-6
 Chemical and mechanical contrasted, 68-70, 164-6
 'Individual' defined, 81-2
 Origins of modern, compared with nineteenth century, 89-90

Invention—*contd.*

- Individual, evidence of patent statistics on, 104-8
- Individual, reasons advanced for decline of, 108-10
- Small resources often adequate for, 109
- Contributions of outsiders to, 116-120
- Importance of observation in, 120-121
- Impossible to organise all, 124-5
- And industrial policy, 130-1
- No fundamental change in methods of, 223-5
- Prediction of, 225-35
- Simultaneous, 227-8
- Institutionalisation of, 238-43

Inventions :

- Belief wasted, 9
- Some more important than others, 15
- Accidental, 68-9
- Means by which sample chosen, 73-4
- No finite stock of, 121-2
- Most not predicted, 226
- Arise under varied conditions, 246

Inventor :

- Difficulty of finding, 13
- Dependent on predecessors, 16
- Importance of, 16-17
- Individual, defined, 81-2
- Individual, views on survival of, 91-3
- Individual, definition of, 93-7
- Characteristics of, 94-5
- New alternatives for, 96
- Individual, argument he is disappearing, 97
- Individual, reasons advanced for decline of, 108
- Individual, rewards of, 110-13, 114-15
- Individual, difficulties of, 111-13
- Individual, factors easing problems of now, 113-14
- Individual, prizes independence, 115
- Individual, advantages of, 116-117
- Non-specialist, advantages of, 118-19
- Individual, more important in U.S. than Britain, 242

Inventor—*contd.*

- Individual, scales weighted against in Britain, 242
- Individual, reasons for encouraging, 250
- Individual, whether, can be helped, 89-92, 250-8
- Individual, possible means of helping, 253-8
- Individual, high taxation hinders, 258-60
- Inventors :
 - Nineteenth century, 35
 - Contacts with scientists in nineteenth century of, 66-7
 - Contacts with one another in nineteenth century, 67
 - Teams of, in nineteenth century, 67
 - Individual, rare in chemistry, 88-89, 240
 - Individual, list of twentieth century, 98-9
 - Individual, lives of some recent, 99-104
 - Individual, often well-educated, 110
 - Complaints against society of, 111-113
- Iron and Steel Industry, 169
 - British, 158
- Ives, H., 384, 387
- Jenkins, C. F., 384, 387
- Jenny, the, 45
- Jessup, G. W., 344
- Jet Engine, 5, 6, 12, 18, 20, 21, 69, 73, 74, 79, 82, 83, 98, 109, 122, 125, 129, 165, 189, 199, 210-11, 237
 - Whittle and, 38-9, 101-2
 - Case History of, 314-21
 - Pulse-jet, 318-19
 - Ram-jet, 318-19
- Jewett, F. B., 92
- Jewett, Professor F. F., 57, 67
- Joule, J. P., 67
- Judson Pneumatic Street Railway Co., 409
- Judson, W. L., 409-10
- Junghans, Gebrüder, 277
- Junghans, S., 98, 100-1, 277-8, 280
- Junkers Airplane Co., 317-20
- Junkers Engine Co., 319-20
- Jurgens Co. Ltd., 307

- Kaempfe, Dr., 303
 Kaempffert, W. B., 30
 Kay, J., 44
 Kayser, E. C., 306
 Keicher, Herr, 304
 Keilholtz, L., 301
 Kelly, M. J., 399
 Kelvin, Lord, 49, 67, 231, 303
 Kettering, C. F., 86, 92, 109, 137,
 184, 186, 294-5, 301, 392-3, 395
 Kinetic Chemicals Inc., 302
 Kipling, R., 230
 Kipping, Professor F. S., 366-8
 Kleeberg, 267
 Kluge, Professor H., 265
 Klystron, the, 348
 Kodachrome, 73, 82, 84, 98, 109,
 117, 129
 Case History of, 321-3
 Koppers Co., 218
 Krafft, 378
 Kraiss, 380
 Kraus, C. A., 394-5
 Kriilium, 69, 73, 85, 87, 118, 124
 Kroll Titanium Process, 190, 202,
 217, 396-8
 Kroll, W. J., 18, 89, 93, 94, 98, 104,
 145, 197, 396-8
 Krupps Ltd., 372-3, 404
 Kuznets, Professor S., 28

 La Cellophane Ltd., 273-4
 Laidlaw, Drew & Co., 315
 Laise, C. A., 402
 Lanchester, F. W., 98, 102-3
 Land, E. H., 98, 101, 184, 381-3
 Langen, E., 67
 Langmuir, I., 94, 97, 139, 184, 352
 Lavoisier, A., 161
 Lawrence, E. O., 17, 98, 109, 145,
 290-2
 Leblanc, N., 50
 Leblanc Process, 50-1
 Leduc, R., 211
 Lee, Sir K., 155, 287, 289
 Lenher, Professor V., 392
 Lenoir, E., 61
 Leonardo da Vinci, 111, 203
 Leprince and Siveke, 306
 Leupold, 40
 Lever Bros. Ltd., 307
 Lewis, S., 142
 Ley, W., 356
 Leyland Co. Ltd., 264
 Lieben, von, 352

 Liebmann, A. J., 402
 Lilly, Eli, & Co., 313
 Lindner, F. A., 278
 Linoleum Industry, 170; in U.S.A.,
 171
 Little, Arthur D., Inc., 243
 Littlefield, B., 324
 Livingston, R., 42, 43
 Ljungström Steam Turbine Co., 264
 Lockheed Power Steering, 344
 Lodge, Sir O., 296-7, 350
 Lodge Cottrell Ltd., 297
 Lodge Fume Deposit Co., 297
 London General Omnibus Co., 263
 London, University of, 338
 Long-playing Record, 73, 74, 87-8,
 118
 Case History of, 324-5
 Development cost of, 202
 Longsdon, R., 67
 Lorenz, C., A.G., 327, 346
 Loud, J., 269
 Lubbock, I., 317
 Lucite, 87, 329, 331
 Ludlum Steel Co., 404
 Luft, A., 267
 Lunar Society, 36, 67
 Lysenko, T., 244
 Lysholm, A., 264

 McAfee, A. M., 270
 McBain, Professor E. L., 378
 McGill University, 245, 330
 McGregor, R. R., 367
 McLaurin, W. R., 30, 189, 354
 McLeod, Professor J. J. R., 313
 Machine Tools, 46-7
 Slide-rest lathe, 46
 Magnetic Recording, 73, 82, 98, 211,
 219
 Case History of, 325-9
 Magnetophon, the, 327-8
 Magnetron, 348
 Cavity, 348
 Mallory, P. R. & Co., 406-7
 Manchester Literary and Philosophi-
 cal Society, 33, 65, 67
 Mannes, L., 98, 322-3
 Mannesmann-Hüttenwerke A.G.,
 278
 Manville Bros., 409
 Marconi Co., 60, 190, 327, 352-4
 Marconi, G., 98, 109, 144, 345, 350
 Marks, A. M., 382
 Marsh, J. T., 287

- Marshall, A. L., 367
 Martin, D. H., 341
 Martin, H. G., 268
 Mason, Professor, 382
 Massachusetts Institute of Technology, 56, 393
 Radiation Laboratory of, 349, 400
 Match Industry, British, 171
 Mauch, H., 319-20
 Maudslay, H., 46-7
 Maurer, E., 370, 372
 'Mauve', 50, 68
 Maxim, Sir Hiram, 57-8
 Maxwell, Clerk, 350
 Maybach, W., 62, 67
 Meat Products Industry, in U.S.A., 171
 Mechanics' Institutes, 64-6
Mechanics' Magazine, 64
 Mees, C. E. K., 138, 323
 Mehring, von, 312
 Meissner, 352
 Mellon Institute, 242-3, 367
 Mercedes, 62
 Mercer, J., 89
 Merck and Co., 374
 Messerschmitt A.G., 320
 Metallbank und Metallurgische Gesellschaft, 297
 Methyl Methacrylate Polymers (Per-spex, etc.), 73, 85, 87
 Case History of, 329-31
 Metropolitan Vickers Co., Ltd., 160
 Meyer, F., 300
 Michels, A., 340
 Midgley, T., 86, 89, 94, 118, 159, 184, 186, 187, 301-2, 392-3, 395
 Midland Silicones Ltd., 368
 Miller, A. A., 264
 Miller, Professor F. R., 312
 Miller, P., 42-3
 Millikan, R. A., 227
 Mineral Oil Refinery Industry, British, 154
 Minkowski, 312
 Mirrophone, the, 328
 Mississippi, University of, Experimental Station, 285
 Modern Artificial Lighting, 73, 85
 Moeller, Th., 297
 Moissan, H., 402
 Mond, L., 205
 Monnartz, P., 370, 372
 Monopolies Commission, 179-80
 Monopoly :
 Whether, encourages research, 167-182
 Factors determining attitude of firm under, to research, 173-8
 And development, 212-16
 Why, often said to encourage innovation, 248-9
 Monsanto Chemical Co., 69, 86, 118, 218
 Moore, D. McM., 299
 Moore, G., 71
 Morgan, S. O., 399
 Morse, S., 48-9, 67
 Mosley, R. F., Ltd., 371
 Mote, S. C., 181
 Motor-car Industry, 169-70
 Motor Vehicles Industry, in U.S.A., 171
 Mottelay, P. F., 58
 Mueller, M., 317, 319-20
 Mule, the, 45
 Self-acting, 201
 Müller, P., 184, 292-3
 Munters, C., 98
 Murdoch, W., 144
 Murray, M., 44
 Nasmyth, J., 52, 71
 National Physical Laboratory, Radio Division, 347
 National Research and Development Corporation, 91
 Naugle, H. M., 281-2
 Neoprene, 68, 73, 74, 85, 87, 124
 Case History of, 332-4
 Newcomen, 67
 Nicholson's *Journal*, 64
 Nickerson, W., 98, 360-1
 Nicol, 381
 Nieuwland, J. A., 98, 332-3
 Noble, E. G., 313
 Nordisk Insulinlaboratorium, 179, 218, 313-14
Normandie, 346
 Normann, W., 98, 306-7, 379
 Normanville, E. J. de, 98
 North-Eastern Railway (British), 294
 Notre Dame, University of, 332-3
 Nottingham University, 366
 Nuclear Physics, 75-6, 109
 Nylon, 12, 18, 73, 74, 79, 85, 86, 122, 129, 150, 200, 206, 215-16, 226, 388-91

- Nylon—*contd.*
 Development of, 21-3
 Development cost of, 202
 Case History of, 334-7
- Oberth, H., 355-6, 359
 Office Machines Industry, in U.S.A.,
 171
 Office of Scientific Research and
 Development, 348
 Ohain, H. von, 98, 317-19
 Oil Industry, 173
 Oldknow, S., 33
 Oligopoly:
 And technical progress, 167-73
 And research in industry, 171-2
 Factors determining attitude of
 firm under, to research, 175-8
 Oliphant, Professor M. L., 348
 Orléans, Duke of, 50
 Osram Gesellschaft, 299, 403-4
 Otto, N. A., 61-2, 67
- Pacinnotti, A., 54
 Page, R. M., 348
 Painter, W., 359
 Paper Industry, British, 158
 Paramount Corporation, 387
 Paramount Pictures, 275
 Parking Meter, 118
 Parsons, Sir C., 36, 37-8; 201
 Patent Law, House of Lords Com-
 mittee on Amendment Bills of
 1851, 200
 Patent Law, Royal Commission on, of
 1865, 200-1
 Patent Lawyers, 258
 Patent Office, 25, 110
 Patent System, 10, 34, 238, 251-4
 Patents:
 Statistics, 104-5
 Value of statistics, 106-8
 Patnode, W. I., 368
 Patterson, Robert, 41
 Paul, L., 44, 67
 Pechmann, von, 330
 Peck, E. B., 394
 Pedersen, P. O., 326-7
 Peel, Sir R., 45
 Penicillin, 18, 69, 73, 74, 79, 82, 85,
 98, 122, 165, 190, 204, 226
 Development of, 23-5
 Development cost of, 202
 Case History of, 338-9
- Peoria Research Laboratory, 24-5
 Perkin, W. H., 17, 50, 68, 69, 89
 Perlon, 73, 85, 86, 215, 337
 Perrelet, A.-L., 361
 Perrin, M. W., 339-40
 Perspex, 73, 87, 329-31
 Pescara, The Marquis R. de P., 70,
 98, 308
 Pescara Free-Piston Engine, 199
 Development of, in Britain, 211
 Petro-Chemicals Ltd., 218
 Petrol-Electric Traction, 293-4
 Petroleum, Catalytic Cracking of,
 72, 74, 82, 83, 98, 118, 219,
 220
 Houdry process, development cost
 of, 202
 Case History of, 269-72
 Petroleum Industry, British, 171
 Petroleum Refining Industry, in
 U.S.A., 147, 152
 Petty, Sir W., 111
 Pfeumer, F., 327-9
 Philco Corporation, 386
 Phillips Metall-Glühlampenfabrik
 A.G., 395-6
 Phillips Petroleum Co., 342
Philosophical Magazine, 64
 Pickard, G. W., 351
 Pierce-Arrow Motor Car Co., 343
 Pixii, H., 54
 Planck, Max, Institute, Mühlheim,
 218, 341-2
 Planck, Max, Institutes, 86, 243
 Plant, Sir A., 254, 259
 Plastic Glass, 98, 330-1
 Platz, K., 379
 Playfair, Lyon, 67
 Plexiglas, 87, 329-31
 Plumbing Equipment Industry, in
 U.S.A., 171
 Pohl, R. W., 318
 Poland, F. F., 278
 Polanyi, Professor M., 14
 Suggested reform of patent sys-
 tem, 253-4
 Polariser, synthetic light, 73, 82, 98,
 101, 109, 118, 211
 Polarized Lights Inc., 382
 Polarized Products Co., 382
 Case History of, 381-83
 Polaroid Corporation, 383
 'Polaroid' Land Camera, 73, 82
 Polyethylene, 18, 68, 73, 85, 86, 99,
 124, 129, 150, 226

- Polyethylene—*contd.*
 New methods of producing, 190, 218
 Case History of, 339-42
 Pontalite, 331
Popular Science Monthly, 65
 Porsche, F., 140
 Porterfield, E., 324
 Portevin, A. M., 370
 Poulsen, V., 18, 98, 326-7, 329, 351
 Power Jets Ltd., 211, 315-17
 Power Loom, 45-6
 Power Steering, 73, 82, 83, 98, 103, 109, 211, 219, 220
 Case History of, 342-4
 Precision Instruments Industry, British, 154-5
 Price-Campbell Cotton Picker Corporation, 283-6
 Price, T. H., 284
 Priestley, J., 36, 67
 Prindle, K. E., 274
 Procter & Gamble Ltd., 379
 Prudhomme, E. A., 270
 Pullin, C. G., 310
 Pulse-jet, Schmidt, 319
 Pupin, M., 352
 Purdue University, 350, 400
 Pye, Sir D., 317
- Quick Freezing, 73, 74, 82, 211
- Radar, 73, 88
 Case History of, 345-9
 Radiation Laboratory, 349, 400
 Radio, 70, 73, 74, 79, 82, 83, 98, 109, 226
 Feedback circuit, 99, 351-2
 Frequency modulation, 99, 353-4
 Superheterodyne, 99, 352-3
 Super-regeneration, 99, 353
 Wireless telegraphy, 189
 Broadcasting, 231
 Case History of, 350-4
 Crystal detector, 351
 Electrolytic detector, 351
 Heterodyne, 351
 Short-wave transmission, 353
 Radio Corporation of America, 86, 189, 202, 212, 325, 329, 353-4, 385-8
 Radiometer, Crooke's, 59
 Raistrick, Professor H., 24, 139, 339
 Ram-Jet, aircraft, piloted, 211
 Ram-Jet, Walther, 319
- Randall, J. T., 348
 Rank Organisation, Ltd., 408
 Raper, K. B., 124
 Rayon :
 Viscose, 60-1, 118, 200
 For tyre casings, 181
 Development cost of, 201-2
 Rayon and Nylon Industry, British, 154
 Record, long-playing, 73, 74, 87-8, 118
 Development cost of, 202
 Case History of, 324-5
 Recording Machines, 122
 Recordon, L., 361
 Rectron Co., 300
 Reeves, H., 275-6
 Refrigeration, domestic gas, 72, 82, 98, 117
 Regenerative Furnace, 53
 Renard, C., 308
 Republic Steel Corporation, 279
 Research :
 One aspect of modern, 69
 Industrial, definition of meaning given, to here, 129
 Industrial, difficulty of planning and directing, 132-9
 Conflicting purposes of research and business, 139-42
 Difficulty of deciding firms' expenditure on, 142-3
 Industrial, survey of expenditure on, 148-50
 Factors leading firms to conduct it, 150-6
 Position of large firm in, 156-66
 Whether advantages of scale in, 158-66
 Team-work in, 161-3
 Whether encouraged by monopoly or oligopoly, 167-82
 Statistics of industrial expenditure on, 191-6
 Institutionalisation of, 238-45
 Americans have wide range of institutes for, 242
 British unenterprising in organising, 242-3
 Desirable to have variety of institutions for, 246-7
 Research Corporation of New York, 297
 Retractable Undercarriage, 189
 Reuter, Ernst, 3

- Reychler, A., 378
 Reynolds, M., 269
 Riedel, K., 356
 Riedel, W. J. H., 357
 Rieseler, H., 264
 Risler, J., 299
 Ritchie, G. G., 388
 Ritchie, W., 48
 Roberts, R., 201
 Robinson, Professor Sir R., 340
 Robison, J., 36
 Rochow, E. G., 368
 Rockefeller, L., 275
 Rockets, 73
 Longe-range, 88
 High-altitude, 200
 Case History of, 355-9
 Röhm, O., 330-1
 Röhm and Haas, 87, 330-1
 Rolex Watch Co., 363
 Rolls Royce Ltd., 129, 211, 317
 Rosing, Professor B., 384-5, 387
 Rosse, Third Earl of, 37
 Rossi, I., 277-8
 Rossman, J., 93
 Rossman, R., 98, 376
 Round, H. J., 352
 Rover Ltd., 317
 Rowe, A. P., 347
 Royal Aircraft Establishment, Farnborough, 314
 Royal College of Chemistry, 50
 Royal Commission on Patent Law, 1865, 200-1
 Royal Institution, 40
 Transactions of, 64
 Royal Society, 40, 47, 112
 Philosophical Transactions of, 64
 Rubber:
 Vulcanisation of, 49-50, 68-9, 226
 Development cost of, 201
 Rubber Tyres and Tubes Industry, in U.S.A., 171
 Rubber Tyre Industry, British, 171, 180-1
 Rubber Tyres, 180-1
 Rumford, Count, 40
 Rumsean Society, 43
 Rumsey, J., 42-3
 Russia, admiration of research methods in West, 241-2
 Rust, J., 98, 109, 284-6
 Rust, M., 98, 284-6
 Rutgers University, 373-4
 Rutherford, Lord, 227, 245
 Sabatier, P., 306
 Sachs, H., 360
 Safety Razor, 13, 20, 73, 74, 82, 84, 117, 122
 Case History of, 359-61
 Sailing Ship, 200
 St. Petersburg Technological Institute, 384-5
 Salerni, P. M., 98, 264
 Sanden, Professor von, 265
 Sängner, E., 357
 Sargent, G. J., 98
 Savery, T., 42
 Schaffert, R. M., 408
 Schelp, H., 317-19
 Schilling, 48
 Schlack, P., 337
 Schmidt Pulse-Jet, 319
 Schneider, A., 265
 Schneider, H., 265
 Schneider Torque Converter, 186, 265
 Schöller, C., 380
 Schrauth, W., 379
 Schroeter, K., 403-4
 Schuler, M., 304
 Science:
 Whether connected with technology, 6-7
 Distinction, pure science and technology, 14-15
 Connection with invention in nineteenth century, 32-3, 67-8
 How far invention based on, in nineteenth and twentieth centuries, 68-9
 Case for, not utilitarian, 224
 Why so admired now?, 235-7
Science, the journal, 56
 Scientific Instruments Industry, in U.S.A., 147, 148
 Scientists:
 Contacts with inventors in nineteenth century, 66-7
 Interest in application of discoveries in nineteenth century of, 67
 Scott, D. A., 313
 Seech, F., 98, 269
 Seed Crushing Industry, British, 171
 Self-winding Wrist-watch, 73, 74, 82, 84, 98, 164-5, 189
 Case History of, 361-3
 Senderens, J. B., 306

- Sewing and Boot and Shoe Machinery Industry, British, 171
- Sheets, H. F., 271
- Shell Moulding, 73, 74, 88, 98, 211, 217-18
 Case History of, 363-5
- Shell Petroleum Co., 218, 317
- Shepard, J., 354
- Shockley, W., 97, 184, 399-401
- Shoenberg, I., 184, 212, 387
- Short, F., 382
- Siemens Family, 67
- Siemens, Werner von, 48, 54
- Siemens, Sir William, 51, 52-3, 201
- Siemens and Halske, 396
- Sikorsky, I., 308, 310-11
- Silicones, 73, 85, 87, 123, 237
 Case History of, 366-9
- Silliman, Professor B., 50, 65, 67
- Simon, Sir F., 241
- Sinclair, H., 98, 263
- Sloan, A. P., 188
- Small, W., 36
- Smeaton, R., 33
- Smiles, Samuel, 16, 44, 65, 70-1
- Smith, A., 267
- Smithsonian Institute, 65
- Snepvangers, R., 324
- Social Scientists :
 Present function of, 8
 Confidence in knowledge of invention, 27
 Changing views on technical progress, 27-9
- Société Française Radioélectrique, 346
- Society of Arts, *Transactions* of, 64
- Socony-Vacuum Oil Co., 271
- Solvay Progress, 50-1, 202
- Soundmirror, the, 328
- Spanner, H., 300
- Spannhake, E. W., 265
- Spannhake, Professor W., 265
- Spencer, H., 68, 112
- Sperry, E. A., 304
- 'Spinning Box', the, 61
- Sprengel Mercury Pump, 59
- Stainless Steels, 73, 74, 79, 88
 Case History of, 369-73
- Standard Oil Co. of New Jersey, 271, 394
- Stanford University, California, 348
- Starr, J. W., 59
- Staudinger, Professor H., 366, 368
- Steam-engine, 6, 20
 Newcomen, 36
 Watt's, 36, 69
 The High Pressure, 39-42, 70, 144
- Steam Locomotive, 43-4, 144
- Steamship, 42-3, 200
- Steam Turbine, 13
 Parsons and, 37-8
 Development cost of, 201-2
- Stearn, C. H., 59-61, 67
- Steckel, A., 98
- Steel :
 Invention of cheap production methods, 51-3, 69
 Continuous casting of, 72, 88, 98, 100-1, 169, 276-80
 Continuous hot-strip rolling of, 72, 74, 85, 87, 160, 169, 280-2
 Rolling process for, 98
- Steinmetz, C. P., 139, 184
- Stephenson, G., 43-4, 112
- Stephenson, R., 44
- Stevens, Col., J. C., 42-3
- Stille, K., 327
- Stine, C. M. A., 334-5
- Stokes, Sir G., 298
- Stone, 350
- Stoney, G. G., 37
- Story, H., 267
- Strauss, B., 370, 372-3
- Streptomycin, 69, 73, 82, 85, 99
 Case History of, 373-4
- Stromberg Co. Ltd., 220
- Sturgeon, W., 64
- Sugar and Glucose Industry, British, 171
- Sullivan, E. C., 367
- Sulzer Bros., 129, 294, 376-7
- Sulzer Loom, 73, 82, 98, 189
 Case History of, 375-7
- Sun Oil Co., 271
- Sundback, G., 98, 410
- Superchargers, 220
- Superheterodyne Circuit, 99, 352-3
- Supply, Ministry of, 391
- Swallow, J. C., 340
- Swan, Sir J. W., 59-60, 67
- Swedish General Electric Co., 294
- Swinburne, Sir J., 60
- Sylvania Industrial Corporation, 274
- Symington, W., 43
- Synchro-Mesh, 119-20, 263-4
- Synthetic Alizarin, 68
- Synthetic Detergents, 73, 85, 219
 Case History of, 377-80

- Synthetic Light Polariser, 73, 82, 98, 101, 109, 118, 211
Case History of, 381-3
- Taconite, 119, 220-1, 237
- Tankard, J., 287
- Taxation, high, effects of, on research in corporations and on inventors, 258-60
- Taylor, A. H., 346, 348
- Taylor, W. C., 367
- Technicolor Motion Pictures Ltd., 322
- Technology :
Whether connected with science, 6-7
Distinction from science, 14-15
Division into invention and development, 17-21
Why so admired now ?, 235-7
- Teflon, 124
- Telecommunications and Broadcasting Industry in U.S.A., 148
- Telecommunications Research Establishment, 349
- Telefunken Co., 346, 351, 352, 353, 354
- Telegraph and Telephone Industry, British, 171
- Telegraph, electric, 47-9, 69
- Telegraph, harmonic, 55-6
- Telegraphie-Patent-Syndikat, 327
- Telegraphphone, 326
- Telephone, 49, 55-6
- Television, 70, 73, 74, 85, 86, 98, 100, 109, 117, 165, 190, 212, 219, 229
Development cost of, 202
Colour, 237
Case History of, 384-8
- Terylene, 18, 73, 85, 87, 129, 160, 165, 187, 200, 206, 210
Development cost of, 202
Case History of, 388-91
- Tesla, N., 350
- Tetraethyl Lead, 68, 73, 85, 86, 187
Case History of, 392-5
- Textil-Finanz A.G., 376
- Textile Industry :
Twentieth-century inventions in, 109
British, 158
- Thermodynamics, 70
- Thomas, L., 276
- Thompson, E. A., 98, 119-20, 263-4
- Thomson, E., 57, 66, 67
- Three-dimensional Films, 219
- Till, I., 30
- Time Inc., 275
- Times, The*, Engineering Editor of, 230-1
- Tinplate Industry, British, 171
- Titanium, 73, 79, 82, 84, 98, 104, 109, 217, 220
I.C.I. Process, 208, 217
Case History of, 395-8
- Tizard, Sir H., 347
- Tobacco Industry, British, 171
- Tootal Broadhurst Lee Co. Ltd., 17, 155, 286-9
- Topham, F., 59-61
- Toronto, University of, 312-13
- Torque Converter :
Schneider, 186, 265
Invention of, 263, 265-6
Lysholm-Smith, 264, 266
- Townsend, A. J., 281-2
- Transistor, 20, 73, 79, 85, 86, 109, 117, 122, 124, 150, 226
Case History of, 399-401
- Trevithick, R., 39-40, 43-4, 67
- Trilok Research Society, 265
- Triode Tube, 103, 109, 351-2, 399
- Triode Valve, 103, 109, 351-52, 399
- Troland, L. T., 322
- Tungsten Carbide Tools, 73, 74, 88
Case History of, 402-4
- Turbo-Jet Engine, 69, 101-2
- Tuve, M. A., 346
- Twitchell, E., 378
- Tyndall, Professor J., 33
- Tyre Manufacturers' Conference, 180
- Tyres :
Aeroplane, 180
Bullet-proof, 181
Giant pneumatic, 181
Tubeless, 181
Tubeless, of natural rubber, 181
Retreading of, 181
- Tytus, J. B., 281-2
- Undercarriage, retractable, 189
- Unilever Ltd., 379
- Union Carbide Co., 218
Research laboratories, 397
- Union Pacific Co., 295
- United Aircraft Corporation, 310-311
- United Shoe Machinery Corporation, 170

- United States Bureau of Mines, 397-398
 Reports of, 200
 United States Commissioner of Patents, 50
 United States Government, and penicillin, 25
 United States Naval Laboratory, 348
 United States Navy, 348, 353
 United States Signal Corps, 408
 United States Steel Corporation, 169
 United States Weather Bureau, 350
 Universal Fastener Co., 409
 Universities, autonomy imperilled, 241
 University of California, 290-1
 University of California, State, 296
 University, Cornell, 382
 University of Goettingen, 317
 University, Harvard, 382-3
 University of London, 338
 University, McGill, 245, 330
 University of Mississippi Experimental Station, 285
 University of Notre Dame, 332-3
 University, Nottingham, 366
 University, Purdue, 400
 University, Stanford, 348
 University of Toronto, 312-13
 University of Wisconsin, 392
 Unsplinterable Glass, 13
 Utah Radio Products Co., 328

 Vacuum Oil Co., 271
 Vacuum Tube, Three-Element, 103, 109, 351-2, 399
 Valier, M., 357
 Van den Bergh Ltd., 307
 Varian, R. H., 348
 Varian, S. F., 348
 'Velox' Photographic Paper, 267
 Vickers, H., 343-4
 Vickers Inc., 343-4
 Vickers-Armstrong Ltd., 264
 Viscose Process, 59-61, 139
 Viscose Rayon, 60-1, 118, 200
 Development cost of, 201-2
 Viscose Rayon Industry, 61, 118
 'Vitarama', 275
 Vitruvius, 302
 Vivian, A., 67
 Voigtländer und Lohmann Metallfabrikations G.M.B.H., 402
 Volta Laboratories, 56
 Voltaic Battery, 47

 Vortex Theory of Flight, 102
 Vulcan Mold & Iron Co., 279
 Vulkan Shipyard, 263, 265

 Wagner, H., 317-19
 Waksman, S. A., 69, 99, 374-5
 Walker, A. O., 296
 Walker's *Annals of Philosophy*, 64
 Walker Dishwasher Corporation, 187
 Walker, L., 409
 Waller, F., 274-6
 Wallis, B. N., 118, 184
 Walter, H., 357
 Walther Ram Jet, 319
 Walton, F., 170
 Warner and Swasey Ltd., 377
 Warren Telecon Co., 187
 Wartman, F. S., 398
 Watt, James, 15, 17, 33, 36-7, 38-9, 40, 67, 144
 Watt, Sir R. Watson, 347
 Weber, W., 328
 Weber, W. E., 48
 Wedgwood, J., 71
 Wedgwood, T., 37, 67
 Weinrich, H., 320
 Weir, G. & J. Ltd., 102, 309-10
 Weir, Lord, 102, 309
 Wells, H. G., 225, 226
 Wells, R. D., 393
 Western Electric Co., 329
 Western Precipitation Co., 297
 Westinghouse Co., 353, 385-6, 410
 Wheatstone, Sir C., 48, 54, 55, 64
 Wheelwright, G., 383
 Whinfield, J. R., 18, 89, 165, 388-391
 Whitby, G. S., 330
 Whitehead, A. N., 32, 243
 Whitney, Eli, 17, 47, 111
 Whitney, W. R., 371
 Whittle, Sir F., 17, 36, 38-9, 89, 94, 97, 99, 101-2, 109, 113, 119, 125, 165, 184, 250, 315-17
 Wideroe, R., 290
 Wieland, Herr, 100
 Wieland-Werke A.G., 100-1, 277
 Wiener, N., 75
 Wilkins, A. F., 347
 Willans, P. W., 387
 Williams, E. R., 279
 Willows, R. S., 287
 Wilson, R. E., 393
 Wilson, W. G., 263
 Wilson epicyclic gear-box, 263

- Wimperis, H. E., 347
 Windscreen Wiper, 12, 125
 Winton, A., 294
 Winton Gas Engine and Manufacturing Co., 187, 294
 Wireless Telegraphy, 189
 Wireless Valves Industry, British, 171
 Wisconsin, University of, 392
 Wittwer, M., 380
 Wolfenbüttel Gymnasium, 384
 Wright, Sir A., 338
 Wrought Iron and Steel Tube Industry, British, 171
 Wyatt, J., 44, 67
 Xerography, 18, 73, 82, 98, 109, 117, 119, 220
 Case History of, 405-8
 Yankee Network, 354
 Young, L., 346, 348
 Zeidler, O., 293
 Ziegler, Professor K., 99, 134, 218, 341-2
 Ziolkovsky, K. E., 355
 Zip Fastener, 12, 20, 73, 74, 82, 84, 98, 122, 226, 409-10
 Zirconium, 104, 397
 Zworykin, V., 100, 212, 385-6, 387, 388

THE END