

Contents

Part I. Phenazine Systems Not Carrying Condensed Rings. By G. A. SWAN

I. General Methods for the Synthesis of Phenazine, Its Homologs and Derivatives Not Containing Condensed Nuclei	3
References	12
II. Phenazine and Its Homologs	14
1. Phenazine	14
A. Physical Constants	14
B. Preparation and Importance	15
C. Structure	15
D. Salts and Addition Compounds	17
E. Phenazine-5-oxide	18
F. Phenazine-5,10-dioxide	19
2. Phenazinium Compounds	19
A. Structure	19
B. 5-Methylphenazinium Methyl Sulfate	20
C. 5-Ethylphenazinium Ethyl Sulfate	22
D. 5-Phenylphenazinium Compounds	22
3. Homologs of Phenazine	25
References	25
III. Hydrogenated Derivatives of Phenazine	28
1. Dihydrophenazines	28
A. 5,10-Dihydrophenazine	28
B. 5,10-Dihydro-5-methylphenazine	29
C. 5-Ethyl-5,10-dihydrophenazine	29
D. 5,10-Dihydro-5,10-dimethylphenazine	29
E. 5,10-Dihydro-5-phenylphenazine	30
F. 5,10-Diaryl-5,10-dihydrophenazines (Perazines)	31
2. The Phenazhydrins, Phenazyls and Semiquinones	36
A. Historical	36
B. Semiquinones of the Phenazine Series	37
C. The Phenazyls	42
D. The Phenazhydrins	46
E. Complexes Formed between Phenazine and Primary or Secondary Aromatic Bases	50
F. Complex Salts of the Phenazhydrins	51
G. Conclusion	52

3. Tetrahydrophenazines	52
A. 1,2,3,4-Tetrahydrophenazine	52
B. 1,2,3,4-Tetrahydro-1-methylphenazine	53
C. 1,2,3,4-Tetrahydro-2-methylphenazine	53
D. 1,2,3,4-Tetrahydro-7-methylphenazine	53
E. 2,3,5,10-Tetrahydro-5,10-dimethylphenazine	53
4. Octahydrophenazines	54
A. 1,2,3,4,6,7,8,9-Octahydrophenazine	54
B. <i>cis</i> - and <i>trans</i> -1,2,3,4,4a,5,10,10a-Octahydrophenazines	55
5. Tetradecahydrophenazines	58
6. Hydrophenazines Derived from Camphor, etc.	59
A. Introduction	59
B. 1,2,3,4,4a,6,7,8,9,9a-Decahydro-1,6,11,11,12,12-hexamethyl- 1,4,6,9-dimethanophenazine	60
C. 1,2,3,4,6,7,8,9-Octahydro-1,6,11,11,12,12-hexamethyl-1,4,6,9- dimethanophenazine	60
D. 1,2,3,4,4a,5,5a,6,7,8,9,9a,10,10a-Tetradecahydro-1,6,11,12,12- hexamethyl-1,4,6,9-dimethanophenazine	60
E. 1,2,3,4,5a,6,7,8,9,10a-Decahydro-1,6,11,11,12,12-hexamethyl- 1,4,6,9-dimethanophenazine	61
F. 1,2,3,4,6,7,8,9-Octahydro-1,9,11,11,12,12-hexamethyl-1,4,6,9- dimethanophenazine	61
G. 1,2,3,4,4a,6,7,8,9,9a-Decahydro-1,9,11,11,12,12-hexamethyl- 1,4,6,9-dimethanophenazine	61
H. 1,2,3,4,4a,5,6,7,8,9,10,10a-Dodecahydro-1,9,11,11,12,12- hexamethyl-1,4,6,9-dimethanophenazine	62
I. Other Related Compounds	63
References	64
IV. Substitution Products of Phenazine (Excluding Hydroxy and Amino Compounds)	67
1. Introduction	67
2. Halogen Derivatives	67
3. Nitro Derivatives	70
4. Sulfones	73
5. Sulfonic Acids	73
6. Phenazinecarboxylic Acids	74
A. 1-Phenazinecarboxylic Acid	74
B. 2-Phenazinecarboxylic Acid	75
C. Phenazinedicarboxylic Acids	76
7. Sirius Light Yellow R. R.	76
8. Arsonic Acids	77
References	78
V. Hydroxy and Keto Derivatives of Phenazine	80
1. Introduction	80
2. Monohydroxy and Monoketo Derivatives	80

A. 1-Phenazinol	81
B. 2-Phenazinol	82
C. Aposafranone	85
D. 3-Hydroxy-10-phenylphenazinium Salts	86
3. Derivatives Containing Two Oxygen Atoms	88
A. Phenazinediols	88
B. 3-Hydroxyaposafranone	91
C. Phenosafranol	91
4. Derivatives Containing Three or More Oxygen Atoms	93
A. 3-Hydroxyphenosafranol	93
B. Derivatives Containing More than Three Oxygen Atoms	93
5. Compounds Containing Hydroxy or Keto Groups and Amino Residues	94
A. Aminohydroxyphenazines	94
B. Phenosafraninone	94
C. Other Amino Derivatives of Aposafranone	99
D. Thio-Analog of Phenosafraninone	99
References	99
VI. Amino Derivatives of Phenazine	103
1. Introduction	103
2. Monoamino Derivatives	103
A. 1-Aminophenazine	103
B. 2-Aminophenazine	105
3. Diamino Derivatives	106
A. 1,3-Diaminophenazine	106
B. 2,3-Diaminophenazine	109
C. 2,7-Diaminophenazine	110
D. 2,8-Diaminophenazine	111
E. Neutral Red	112
References	115
VII. The Safranines	118
1. General Account of the Preparation and Structure of the Safranines	118
A. Historical	118
B. Preparation	118
C. Structure	122
2. Detailed Account of Certain Safranines	129
A. Aposafranine	129
B. Phenosafranine	130
C. Isomers of Aposafranine and Phenosafranine	133
D. Homologs of Phenosafranine	135
E. <i>N</i> -Alkylated Safranines	135
F. Azosafranine Dyes	137
G. 5-Alkylphenazinium Salts	138
H. Miscellaneous	140

I. Phenazine Derivatives in Color Photography	140
References	142
VIII. The Indulines and Nigrosines	149
1. Introduction	149
2. General Account of the Structure and Formation of the Indulines	149
A. The "Induline Melt"	149
B. Mechanism of the "Induline Melt"	151
3. Detailed Account of Certain Indulines and Related Compounds	154
A. 2-Anilino-10-phenylphenazinium Chloride	154
B. 2-Amino-3-anilino-10-phenylphenazinium Chloride	154
C. 2,3-Dianilino-10-phenylphenazinium Chloride	155
D. 2,8-Dianilino-10-phenylphenazinium Chloride	156
E. 2,8-Diamino-3-anilino-10-phenylphenazinium Chloride	156
F. 2-Amino-7,8-dianilino-10-phenylphenazinium Chloride	156
G. 2,3,8-Triamilino-10-phenylphenazinium Chloride	157
H. 2,3,7,8-Tetraamilino-10-phenylphenazinium Chloride	158
I. 1-Amino-2,4,8-trianilino(or 4-amino-1,3,8-trianilino)- 10-phenylphenazinium Chloride	158
J. Indazine	158
K. Mauveine	159
L. Various Commercial Induline Dyestuffs	161
M. The Nigrosines	162
References	162
IX. Aniline Black	165
1. Introduction	165
2. Structure	165
3. Manufacture and Technical Importance	171
References	172
X. The Bacterial Pigments	174
1. Pyocyanine	174
A. Historical	174
B. Physical Properties of Pyocyanine and Its Salts	175
C. Preparation	175
D. Structure	176
2. Chlororaphine	180
A. Historical	180
B. Physical Properties	181
C. Preparation	181
D. Structure	182
E. Biosynthesis of Chlororaphine	185
3. Iodinine	186
A. Historical	186
B. Physical Properties	186
C. Preparation	186

D. Structure	187
References	190
XI. The Biological Properties of Phenazine and Its Derivatives ..	193
1. Introduction	193
2. Natural Occurrence of Phenazines	194
3. Biochemical and Biological Effects of Phenazines	195
A. Phenazines with Separated Enzymes and Cell-Free Systems	195
B. Phenazines and the Metabolism of Cells and Tissues	196
C. Phenazines and Whole Organisms	197
References	204
Part II. Condensed Phenazine Systems. By D. G. I. FELTON	
XII. Monobenzophenazines	213
1. Introduction	213
2. Benzo[<i>b</i>]phenazine. 5,12-Diazanaphthacene	213
A. Benzo[<i>b</i>]phenazine	213
B. Hydrogenated Derivatives	214
C. Benzo[<i>b</i>]phenazine-6,11-quinone	215
D. Halogen Derivatives of Benzo[<i>b</i>]phenazine	216
3. Benzo[<i>a</i>]phenazine	216
A. General	216
B. General Methods of Preparation of Benzo[<i>a</i>]phenazines	217
C. Benzo[<i>a</i>]phenazine. 1,2-Benzophenazine	223
D. Reactions of Benzo[<i>a</i>]phenazine	224
E. Benzo[<i>a</i>]phenazine <i>N</i> -Oxides	226
F. Benzo[<i>a</i>]phenazine-5,6-quinone	228
G. Homologs of Benzo[<i>a</i>]phenazine	229
H. Nitro, Chloro and Bromo Derivatives	230
I. Hydroxy and Amino Derivatives	234
J. Sulfonic Acids	234
K. Miscellaneous	234
4. Benzo[<i>a</i>]phenazinium Salts	237
A. Introduction	237
B. 7-Methylbenzo[<i>a</i>]phenazinium Salts	238
C. 7-Ethylbenzo[<i>a</i>]phenazinium Salts	239
D. 7-Phenylbenzo[<i>a</i>]phenazinium Salts	240
E. 12-Phenylbenzo[<i>a</i>]phenazinium Salts	248
F. Conclusion	251
References	252
XIII. Hydroxy and Amino Derivatives of Benzo[<i>a</i>]phenazines	255
1. Introduction	255
2. Monohydroxybenzo[<i>a</i>]phenazines	255
A. 5-Hydroxybenzo[<i>a</i>]phenazine	255
B. 5-Hydroxy-10-methylbenzo[<i>a</i>]phenazine	257
C. 6-Hydroxybenzo[<i>a</i>]phenazine	258

D. 9-Hydroxybenzo[<i>a</i>]phenazine	259
E. Miscellaneous	259
F. Eurhodol Dyestuffs	260
3. Dihydroxybenzo[<i>a</i>]phenazines	262
A. 5,6-Dihydroxybenzo[<i>a</i>]phenazine	262
B. 9,10-Dihydroxybenzo[<i>a</i>]phenazine	263
4. Hydroxyaminobenzo[<i>a</i>]phenazines	265
A. General	265
B. 5-Acetamido-9,10-dihydroxybenzo[<i>a</i>]phenazine	265
C. 5-Anilino-6-hydroxy-5,6-dihydrobenzo[<i>a</i>]phenazine	267
5. Monoaminobenzo[<i>a</i>]phenazines	268
A. Review of Preparative Methods	268
B. 5-Aminobenzo[<i>a</i>]phenazine	268
C. 5-Amino-10-methylbenzo[<i>a</i>]phenazine	269
D. 5-Alkylamino- and 5-dialkylamino Derivatives of Benzo[<i>a</i>]-phenazine	270
E. 9-Aminobenzo[<i>a</i>]phenazine	270
F. 9-Dimethylaminobenzo[<i>a</i>]phenazine	271
G. Eurhodine Dyes	271
6. Diaminobenzo[<i>a</i>]phenazines	275
References	277

XIV. Hydroxy and Amino Derivatives of Benzo[*a*]phenazinium Salts

1. Introduction	280
2. Monohydroxybenzo[<i>a</i>]phenazinium Salts and Anhydro-Bases	281
A. General Methods of Preparation	281
B. 7-Alkyl- and -Aralkyl- and 12-Alkylmonohydroxybenzo[<i>a</i>]-phenazinium Salts and Anhydro-Bases	282
C. 7-Arylmonohydroxybenzo[<i>a</i>]phenazinium Salts and Anhydro-Bases	285
D. 12-Phenylmonohydroxybenzo[<i>a</i>]phenazinium Salts	295
3. Dihydroxybenzo[<i>a</i>]phenazinium Salts and Derivatives	296
A. 9-Hydroxy-7-phenyl-5(7)-benzo[<i>a</i>]phenazinone. 9-Hydroxy-rosindone, Naphthosafranol	297
B. 10-Hydroxy-7-phenyl-9(7)-benzo[<i>a</i>]phenazinone	298
C. Miscellaneous	302
4. Aminobenzo[<i>a</i>]phenazinium Salts and Derivatives	303
A. General	303
B. General Methods of Synthesis	309
C. General Review of Properties	318
D. Rosinduline. 5-Amino-7-phenylbenzo[<i>a</i>]phenazinium Salts	321
E. Phenylrosinduline. 5-Anilino-7-phenylbenzo[<i>a</i>]phenazinium Salts	322
F. 7-Alkyl-(or aralkyl)-5-aminobenzo[<i>a</i>]phenazinium Salts	324
G. 9-Amino-7-phenylbenzo[<i>a</i>]phenazinium Salts and Derivatives. "Isorosindulines"	325

5. Diamino Derivatives of 7-Phenylbenzo[<i>a</i>]phenazinium Salts . .	328
A. 5,9-Diamino-7-phenylbenzo[<i>a</i>]phenazinium Salts and Derivatives. The Wool Fast Blue Dyes	328
B. Other Diamino Derivatives of 7-Phenylbenzo[<i>a</i>]phenazinium Salts	332
C. Analysis of Azine Dyes	333
D. Miscellaneous	334
6. Aminohydroxy Derivatives of 7- and 12-Substituted Benzo[<i>a</i>]phenazinium Salts	350
A. General Methods of Preparation	350
B. 10-Amino-7-phenyl-9(7)-benzo[<i>a</i>]phenazinone	352
C. Dyes Derived from Aminohydroxy-7-phenylbenzo[<i>a</i>]-phenazinium Salts. The Thion Violets	352
D. Color Photography and Azine Dyestuffs	353
References	357
XV. Dibenzo- and Mononaphthophenazines	363
1. Introduction	363
2. Dibenzo[<i>a,c</i>]phenazine. Phenanthrophenazine	363
A. Preparation and Properties	363
B. Quaternary Derivatives	365
3. Dibenzo[<i>a,h</i>]phenazine	379
A. Methods of Preparation	379
B. Properties, Reactions and Derivatives	384
C. Quaternary Salts	388
D. Uses of Dibenzo[<i>a,h</i>]phenazines	391
4. Dibenzo[<i>a,i</i>]phenazine	393
5. Dibenzo[<i>a,j</i>]phenazine	395
A. Methods of Preparation	395
B. Properties, Reactions and Derivatives	397
C. Quaternary Derivatives	401
6. Dibenzo[<i>b,i</i>]phenazine. 6,13-Diazapentacene	410
7. Naphtho[2,3- <i>a</i>]phenazine	412
8. 7-Naphtho[1,8- <i>ab</i>]phenazine	418
References	421
XVI. Polybenzophenazines	426
1. 1,4-Methanobenzo[<i>a</i>]phenazine	426
2. 8,11-Methanobenzo[<i>a</i>]phenazine	427
3. 1,4-Methanonaphtho[2,3- <i>b</i>]phenazine. 1,4-Methano-5,14-diazapentacene	427
4. 1-Cyclopenta[5,6]naphtho[1,2- <i>b</i>]phenazine	428
5. 1-Cyclopenta[5,6]naphtho[2,1- <i>a</i>]phenazine	428
6. 5-Acenaphtho[5,6- <i>ab</i>]phenazine	429
7. 4-Fluoreno[4,5- <i>abc</i>]phenazine	429
8. Benzo[<i>a</i>]naphtho[2,3- <i>i</i>]phenazine	430
9. Tribenzo[<i>a,c,i</i>]phenazine	431

10. Benzo[<i>a</i>]naphtho[2,3- <i>h</i>]phenazine	431
11. Benzo[<i>a</i>]naphtho[2,3- <i>j</i>]phenazine	433
12. Benzo[<i>a</i>]naphtho[1,2- <i>c</i>]phenazine	433
13. Benzo[<i>a</i>]naphtho[2,3- <i>c</i>]phenazine	434
14. Chrysophenazine. Benzo[<i>a</i>]naphtho[2,1- <i>c</i>]phenazine	434
15. Tribenzo[<i>a,c,h</i>]phenazine	436
A. Nonquaternary Derivatives	436
B. Quaternary Salts	438
16. Phenanthro[4,5- <i>abc</i>]phenazine	443
17. 16-Dibenz[<i>a,c</i>]indeno[2,1- <i>h</i>]phenazine	443
18. Dibenz[<i>h,j</i>]indeno[7,1- <i>ab</i>]phenazine	445
19. Dinaphtho[2,3- <i>a,2',3'-i</i>]phenazine	447
20. Dibenzo[<i>a,c</i>]naphtho[2,3- <i>i</i>]phenazine	447
21. Anthra[2,3- <i>a</i>]benzo[<i>c</i>]phenazine	447
22. Anthrazine. Dinaphtho[2,3- <i>a,2',3'-h</i>]phenazine	448
23. Dibenzo[<i>a,c</i>]naphtho[2,3- <i>h</i>]phenazine	450
24. Dinaphtho[2,3- <i>a,2',3'-j</i>]phenazine	451
25. Anthra[1,2- <i>a</i>]benzo[<i>c</i>]phenazine	451
26. Benzo[<i>a</i>]phenanthro[2,3- <i>c</i>]phenazine	452
27. Benzo[<i>a</i>]phenanthro[9,10- <i>c</i>]phenazine	452
28. Dinaphtho[1,2- <i>a,2',1'-c</i>]phenazine	453
29. Phenanthrazine. Tetrabenzo[<i>a,c,h,j</i>]phenazine	453
30. 4-Benzo[1',2',3',1,10]phenanthro[4,5- <i>abc</i>]phenazine	456
31. Diphenanthro[2,3- <i>a,2',3'-h</i>]phenazine	457
32. Bisbenzonaphtheno[1,2- <i>a,1',2'-h</i>]phenazine	458
33. Dinaphtho[2,3- <i>b,2',3'-i</i>]phenazine	459
34. Dibenzo[<i>a,j</i>]naphtho[2,1- <i>c</i>]phenazine	459
35. Dibenzo[<i>a,c</i>]naphtho[1,2- <i>h</i>]phenazine	459
36. Dibenzo[<i>a,h</i>]dinaphtho[2,1- <i>c,2',1'-j</i>]phenazine. "Chrysazine" ..	460
37. Quinoxalo[2,3- <i>a</i>]coronene	461
References	461
XVII. Indantrone and Related Compounds	464
1. General	464
2. Methods of Preparation	465
3. Structure	467
4. Reactions	468
A. Introduction	468
B. Oxidation	468
C. Reduction	470
D. Benzoylation	475
E. Reaction with Sodium Alkoxides	475
F. Methylation	475
G. Indirect Substitution	476
H. Action of Nitric Acid	477
5. Substituted Indantrones	478
A. Haloidantrones	478

B. Amino and Substituted Aminoindanthrones	480
C. Cyanoindanthrones	480
D. Hydroxyindanthrones	480
E. Alkylsulfonylindanthrones	481
F. Alkylindanthrones	482
6. Mechanism of the Indanthrone Fusion Process	487
A. General	487
B. Historical	488
C. The Work of Bradley and His School	490
7. Indanthrene B	492
8. Isomers, etc., of Indanthrone	494
A. 5,8,10,15,17,18-Hexahydrodinaphtho[2,3- <i>a</i> ,2',3'- <i>i</i>]- phenazine-5,10,15,18-tetrone	494
B. 5,7,9,14,16,18-Hexahydrodinaphtho[2,3- <i>b</i> ,2',3'- <i>i</i>]- phenazine-5,9,14,18-tetrone	496
C. 6,10-Diamino-5,8,11,16,17,18-hexahydrodinaphtho[2,3- <i>a</i> , 2',3'- <i>j</i>]phenazine-5,11,16,18-tetrone	496
9. The Technology of Indanthrone Dyeing	497
References	500

XVIII. Phenazines Condensed with Other Heterocyclic Systems.

Part I. Polyazines	507
1. Introduction	507
2. Pyrazino[<i>b</i>]phenazine. 1,4,6,11-Tetrazanaphthacene	507
3. Quinoxalo[2,3- <i>b</i>]phenazine. 5,7,12,14-Tetrazapentacene	509
A. Introduction	509
B. 5,12-Dihydroquinoxalo[2,3- <i>b</i>]phenazines. Fluorindines	511
4. Quinoxalo[2,3- <i>a</i>]phenazine	520
5. Benzo[<i>a</i>]pyrazino[<i>c</i>]phenazine	521
6. Benzo[<i>a</i>]quinoxalo[2,3- <i>i</i>]phenazine	523
A. 7,14-Dihydrobenzo[<i>a</i>]quinoxalo[2,3- <i>i</i>]phenazine	523
B. 9,16-Dihydrobenzo[<i>a</i>]quinoxalo[2,3- <i>i</i>]phenazine	527
C. 7,9-Diphenyl-1,2-benzoisofluorindine	527
7. Naphtho[1,2- <i>b</i> ,3,4- <i>b'</i>]diquinoxaline	529
8. 1,4,8,11-Dimethanoquinoxalo[2,3- <i>b</i>]phenazine	532
9. 1,4,9,12-Dimethanoquinoxalo[2,3- <i>a</i>]phenazine	533
10. Acenaphtho[1,2- <i>b</i>]quinoxalo[2,3- <i>g</i>]quinoxaline	534
11. Diquinoxalo[2,3- <i>b</i> ,2',3'- <i>i</i>]phenazine. 5,7,9,14,16,18- Hexazaheptacene	534
12. Diquinoxalo[2,3- <i>a</i> ,2',3'- <i>c</i>]phenazine	535
13. Dibenzo[<i>a,c</i>]quinoxalo[2,3- <i>i</i>]phenazine	536
14. 7,9,16,18-Tetrazadibenzo[<i>a,n</i>]pentacene	537
15. Benzo[1,2- <i>a</i> ,4,5- <i>a'</i>]diphenazine	540
16. Dibenzo[<i>c,h</i>]quinoxalo[2,3- <i>a</i>]phenazine	541
17. Dibenzo[<i>a,h</i>]quinoxalo[2,3- <i>c</i>]phenazine	542
18. Benzo[<i>a</i>]naphtho[2,1- <i>c</i>]quinoxalo[2,3- <i>i</i>]phenazine	542
19. Dibenzo[<i>c,c'</i>]benzo[1,2- <i>a</i> ,4,3- <i>a'</i>]diphenazine	543

20. Perylo[2,3- <i>b</i> ,10,11- <i>b'</i>]diquinoxaline	543
21. Diquinoxalo[2,3- <i>b</i> ,2',3'- <i>i</i>]anthracene. 5,9,14,18-Tetraza- heptacene. Benzo[1,2- <i>b</i> ,4,5- <i>b'</i>]diphenazine	544
22. Diquinoxalo[2,3- <i>e</i> ,2',3'- <i>j</i>]pyrene. Dibenzo[<i>hi,wu</i>]5,9,14,18- tetrazahexacene	545
References	545

XIX. Phenazines Condensed with Other Heterocyclic Systems.

Part II. Miscellaneous Systems	548
1. Phenazino[2,3]-1,3,2-diazodolium hydroxide	548
2. Phenazino[2,3- <i>d</i>]-1,3,2-oxazthiolium hydroxide	548
3. [1,2,3]Thiadiazolo[4,5- <i>a</i>]phenazine	549
4. 1-Triazolo[<i>b</i>]phenazine	549
5. 2-Triazolo[<i>a</i>]phenazine	550
6. 3-Triazolo[<i>a</i>]phenazine	551
7. Oxazolo[<i>b</i>]phenazine	552
8. Thiazolo[4,5- <i>a</i>]phenazine	552
9. 1-Imidazo[<i>b</i>]phenazine	553
10. 1-Pyrazolo[3,4- <i>a</i>]phenazine	554
11. 2- <i>p</i> -Oxazino[<i>b</i>]phenazine. 1(2)-Oxa-4,6,11-triazanaphthacene ..	554
12. 7- <i>p</i> -Oxazino[<i>de</i>]phenazine	555
13. Pyrido[2,3- <i>b</i>]phenazine. 1,6,11-Triazanaphthacene	556
14. Pyrido[3,2- <i>a</i>]phenazine	557
15. 1-Pyrano[3,2- <i>a</i>]phenazine	558
16. 1-Benzo[<i>a</i>]triazolo[<i>c</i>]phenazine	559
17. 2-Benzo[<i>a</i>]triazolo[<i>c</i>]phenazine	561
18. 3-Benzo[<i>a</i>]triazolo[<i>c</i>]phenazine	563
19. 5[1,2]Benzisothiazolo[4,3- <i>ab</i>]phenazine	563
20. 6[1,2]Benzisothiazolo[4,3- <i>ab</i>]phenazine	566
21. Benzo[<i>a</i>]pyrazolo[4,3- <i>c</i>]phenazine	566
22. 3-Benz[<i>a</i>]imidazo[<i>c</i>]phenazine	566
23. Benzo[<i>a</i>]furo[2,3- <i>c</i>]phenazine	568
24. 12-Quinoxalo[2,3- <i>b</i>]phenazine	569
25. 14-Quinoxalo[2,3- <i>b</i>]phenoxazine	572
26. Dipyrido[3,2- <i>a</i> ,3',2'- <i>h</i>]phenazine	573
27. Dipyrido[<i>de,kl</i>]phenazine	574
28. 3-Benzo[<i>a</i>]pyrano[2,3- <i>c</i>]phenazine	575
29. 12-Isoindolo[2,1- <i>a</i>]phenazino[2,3- <i>d</i>]imidazole	579
30. 8,11-Methano-8-azepo[1,2- <i>a</i>]quinoxalo[2,3- <i>f</i>]-benzimidazole ..	579
31. 6-Quinoxalo[2,3- <i>a</i>]triazolo[<i>c</i>]phenazine	580
32. 2-Dibenzo[<i>a,h</i>]triazolo[<i>c</i>]phenazine	581
33. 6-Pyrazolo[3,4- <i>a</i>]quinoxalo[2,3- <i>c</i>]phenazine	581
34. 14-Dibenzo[<i>a,c</i>]pyrazolo[3,4- <i>h</i>]phenazine	582
35. Benzo[<i>a</i>]benzofuro[3,2- <i>c</i>]phenazine	582
36. Furo[4,5]phenanthro[9,10- <i>b</i>]quinoxaline	583
37. 7-Benzo[<i>a</i>]-[1,4]benzoxazino[3,2- <i>i</i>]phenazine	584
38. Dibenzo[<i>a,c</i>]pyridazo[4,5- <i>i</i>]phenazine	586

39. Dibenzo[<i>a,c</i>]- <i>p</i> -dioxino[<i>i</i>]phenazine	586
40. Benzo[<i>a</i>]quino [2,3- <i>c</i>]phenazine	587
41. Dibenzo[<i>a,c</i>]pyrido[3,2- <i>h</i>]phenazine	588
42. 2-Pyrano[3',4',5',4,5]naphtho[1,8- <i>ab</i>]phenazine	588
43. Oxepo[3',4',5',6',4,5]phenanthro[9,10- <i>b</i>]quinoxaline	589
44. Benz[<i>a</i>]isoquino[2',1',1,5]pyrazolo[4,3- <i>c</i>]phenazine	589
45. 7-Benz[4,5]isoquino[2,1- <i>a</i>]quinoxalo[2,3- <i>f</i>]benzimidazole	590
46. Dibenzo[<i>a,c</i>]benzofuro[2,3- <i>i</i>]phenazine	591
47. Benzo[<i>a</i>]naphtho[2',3',4,5]furo[2,3- <i>c</i>]phenazine	592
48. Dibenzo[<i>a,c</i>]benzofuro[2,3- <i>h</i>]phenazine	593
49. Benzo[<i>a</i>]naphtho[1',2',4,5]furo[2,3- <i>c</i>]phenazine	594
50. Naph[2',1',4,5]thieno[2,3- <i>b</i>]quinoxalo[2,3- <i>g</i>]quinoxaline	594
51. Naph[1',2',4,5]thieno[2,3- <i>b</i>]quinoxalo[2,3- <i>g</i>]quinoxaline	595
52. 19-Dibenzo[<i>c,e</i>]quinoxalo[2',3',5,6]benzimidazo[1,2- <i>a</i>]azepine.	595
53. Dibenzo[<i>a,c</i>]-[1,4]-benzodioxino[2,3- <i>i</i>]phenazine	596
54. Diquino[2,3- <i>a</i> ,2',3'- <i>c</i>]phenazine	596
55. Diisoquino[5,4- <i>ab</i> ,5',4'- <i>hi</i>]phenazine	597
56. 5-Isoquino[5,4- <i>ab</i>]naphtho[2,3- <i>h</i>]phenazine	598
57. 16-Benz[<i>a</i>]naphtho[2',1',5,6]pyran[2,3- <i>c</i>]phenazine	599
58. Naphtho[1,2,3- <i>cd</i>]naphtho[2',3',5,6]quinoxalo[3,2,1- <i>hi</i>]indazole	600
59. Dinaphtho[2,3- <i>a</i> ,2',3'- <i>i</i>]pyrido[3,2- <i>c</i>]phenazine	600
60. 7,9,18-Triaza-19-dinaphtho[2,3- <i>a</i> ,3',2',1'- <i>hi</i>]naphthacene. Pyrido[2,3,4- <i>lm</i>]anthrazine	601
61. Dibenzo[<i>c,c'</i>]furo[2,3- <i>a</i> ,4,5- <i>a'</i>]diphenazine	602
62. Dibenzo[<i>c,c'</i>]furo[3,2- <i>a</i> ,4,5- <i>a'</i>]diphenazine	603
63. 7,9,17,19-Tetrazadinaphtho[1,2,3- <i>de</i> ,1',2',3'- <i>op</i>]pentacene	603
64. 3-Pyrazolo[4,3- <i>a</i>]phenazine.	604
65. Furo[3,4- <i>b</i>]phenazine	604
66. 10- <i>p</i> -Benzoxazino[2,3,4- <i>de</i>]phenazine	605
67. Quino[2,3- <i>b</i>]phenazine. 5,7,12-Triazapentacene	606
68. Dibenzo[<i>a,c</i>]pyrido[2,3- <i>h</i>]phenazine	606
69. Phenanthro[9',10',4,5]thieno[2,3- <i>b</i>]quinoxalo[2,3- <i>g</i>]quinoxaline	607
70. 1,3,8,11,13,18-Hexazabisbenzonaphtheno[2,1- <i>a</i> ,2',1'- <i>h</i>] anthracene. Bisperimido[5,4- <i>a</i> ,5',4'- <i>h</i>]phenazine	607
71. 4,6,7,14,17-Hexazabisbenzonaphtheno[1,2- <i>a</i> ,1',2'- <i>h</i>]anthracene. Bisperimido[4,5- <i>a</i> ,4',5'- <i>h</i>]phenazine	608
72. Dibenzo[<i>a,j</i>]diquinoxalo[2,3- <i>c</i> ,2',3'- <i>h</i>]phenoxazine, or Dibenzo[<i>a,h</i>]diquinoxalo[2,3- <i>c</i> ,2',3'- <i>j</i>]phenoxazine	609
73. Dinaphtho[2,3- <i>a</i> ,2',3'- <i>h</i>]dipyrido[3,2- <i>c</i> ,3',2'- <i>j</i>]phenazine	610
74. Nigrosulfine	611
75. 6-Naphth[2,3- <i>a</i>]indolo[1,2,3- <i>fg</i>]phenazine	612
76. [1,2]Benzisothiazolo[4,3- <i>ab</i>]-[5,6]benzindolo[2,3- <i>c</i>]phenazine	612
References	613
Addenda	
Part I, By G. A. SWAN	619
Part II, By D. G. I. FELTON	633
Index	645