961. *Some Derivatives of 4-Amino- and 4-Nitro-pyridine.*

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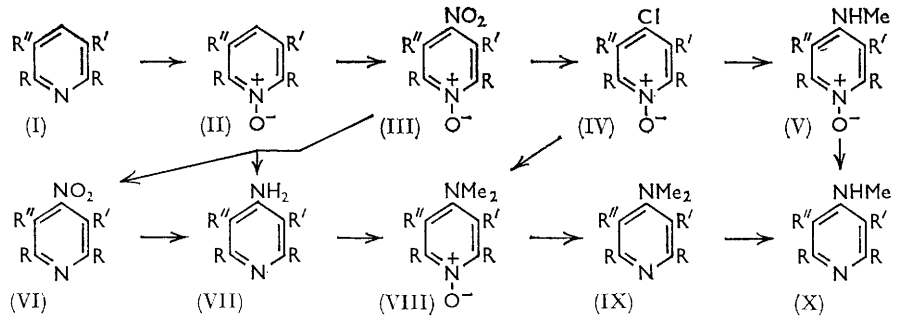
3-Methyl-, 3-ethyl-, and 3-isopropyl-pyridine, and 3,5-dimethyl- and 2,3,5,6-tetramethyl-pyridine have been converted into the 4-nitropyridine 1-oxides, and thence into the 4-chloropyridine 1-oxides from which were derived the 4-amino-, 4-methylamino-, and (except in the cases of the tetramethyl compound) the 4-dimethylamino-pyridine 1-oxides. These series of 1-oxides provided, on deoxygenation, series of 4-nitro-, 4-amino-, 4-methylamino-, and 4-dimethylamino-pyridines.

Nitration of 3-t-butylpyridine 1-oxide proceeds at position 2 or 6.

For physical studies to be described shortly, we required the four series of pyridine derivatives (VI, VII, IX, and X; R = R′ = H, R″ = H, Me, Et, Pr^i, Bu^t, or Br; also R = H, R′ = R″ = Me; and R = R′ = R″ = Me). Of these compounds, 4-nitro-, 4-amino-, 4-methylamino-, 4-dimethylamino-, 3-methyl-4-nitro-, 4-amino-3-methyl-, and 4-amino-3-bromo-pyridine were already known.

4-Methylamino- and 4-dimethylamino-pyridine were prepared from 1-4′-pyridylpyridinium chloride hydrochloride by the method of Jerchel, Fischer, and Thomas.[1] 4-Amino-3-methylpyridine has been prepared similarly from 3-methyl-1-(3-methyl-4-pyridyl)pyridinium chloride hydrochloride,[2] but in attempting to use this reagent as a source of compounds (VII, IX, and X; R = R′ = H, R″ = Me) we found great difficulty in obtaining it pure. Accordingly, we centred our efforts upon the pyridine 1-oxides (II), as promising sources of all four of the series (VI, VII, IX, and X).[3]



The substituted pyridines (I) were oxidised to the 1-oxides (II) by hydrogen peroxide in acetic acid. Conversions of 60—70% were obtained, except in the case of 2,3,5,6-tetramethylpyridine (32%). All these oxides were hygroscopic, except for 2,3,5,6-tetramethylpyridine 1-oxide, which formed stable, anhydrous crystals.

The 4-nitropyridine 1-oxides (III) were obtained by treating the 1-oxides (II) with a mixture of fuming nitric and concentrated sulphuric acid. The yields obtained decreased with increasing substitution in the 1-oxides. The nitration of 3-bromopyridine 1-oxide (at 130°) gave a small proportion of 3-bromo-4-nitropyridine in addition to 3-bromo-4-nitropyridine 1-oxide. Deoxygenation of 4-nitropyridine 1-oxide under similar conditions has been observed.[3] In contrast to all the other examples studied, 3-t-butylpyridine 1-oxide was not nitrated at position 4. The product from this reaction was 3-t-butyl-2(or 6)-nitropyridine, as was shown by the ultraviolet absorption spectrum of the derived

[1] Jerchel, Fischer, and Thomas, *Chem. Ber.*, 1956, **89**, 2921.
[2] Clemo and Swan, *J.*, 1948, 198.
[3] Ochiai, *J. Org. Chem.*, 1953, **18**, 534.

2(or 6)-amino-3-t-butylpyridine. This behaviour is exceptional,[4] and is attributed to the steric influence of the t-butyl group.

Deoxygenation of the nitropyridine 1-oxides to 4-nitropyridines (III ⟶ VI) by phosphorus trichloride in chloroform [3] gave good yields, except in the cases of the 3,5-di- and 2,3,5,6-tetra-methyl compounds.

The 4-aminopyridines (VII) were prepared by reducing the 4-nitro-compounds (VI) with Raney nickel and hydrazine hydrate or with iron and acetic acid, or by reducing the 4-nitropyridine 1-oxides (III) directly, with iron and acetic acid or catalytically. Difficulties in obtaining completely satisfactory analyses of some of the 4-amino-compounds arose from their liability to hydration.

The 4-chloropyridine 1-oxides (IV) were all prepared by treating the 4-nitropyridine 1-oxides with acetyl chloride.[3] They reacted with methylamine and dimethylamine [5] to give the 4-methylamino- (V) and 4-dimethylamino-pyridine 1-oxides (VIII) in satisfactory yields. Only 4-chloro-2,3,5,6-tetramethylpyridine 1-oxide failed to react with dimethylamine. Like the 4-amino-compounds, the chloro- (IV) and the methylamino-pyridine 1-oxides (V) were usually hydrated.

4-Methylamino- (V) and 4-dimethylamino-pyridine 1-oxide (VIII) were reduced to 4-methylamino- (X) and 4-dimethylamino-pyridine (IX) either by iron–acetic acid or catalytically. 3-Ethyl-4-methylaminopyridine was obtained directly when the product of the reaction between methylamine and 4-chloro-3-ethylpyridine 1-oxide was distilled. All the 4-dimethylaminopyridines (IX), except the parent compound (IX; R = R′ = R″ = H), were liquids. Although the reduction of 3-bromo-4-dimethylaminopyridine 1-oxide with iron–acetic acid gave a liquid with the expected physical properties (the pK_a and ultraviolet absorption spectra will be reported later), from which a picrate giving a satisfactory analysis was prepared, this product gave incorrect analyses for 3-bromo-4-dimethylaminopyridine although several preparations were examined. It may be significant that both this compound and 3-bromo-4-methylaminopyridine become brown fairly quickly even when kept in sealed tubes in the dark.

Because of the failure of 3-t-butylpyridine 1-oxide to undergo nitration at position 4, we examined the reaction of this oxide with sulphuryl chloride. Two 3-t-butyl-*x*-chloropyridines were formed, but were not further characterised.

Experimental

Unless otherwise described, picrates were obtained as yellow needles from ethanol.

3-t-Butylpyridine.—The following modification of Brown and Murphey's method [6] was used; 3-isopropylpyridine (60·5 g.) was added in 5 min. to potassamide in liquid ammonia [prepared from potassium (39 g.), liquid ammonia (400 ml.), and ferric nitrate (0·5 g.)]. The mixture was stirred for 45 min., and methyl chloride (56 g.) was then added dropwise during 8 hr., through a condenser cooled in solid carbon dioxide, with vigorous stirring. Ammonia was allowed to evaporate, and ammonium chloride was added. A solution of the residue in water (300 ml.) was extracted with ether. Distillation through a heated column, packed with helices, gave 3-isopropylpyridine (48 g.), b. p. 178—179°, and 3-t-butylpyridine (10·8 g.), b. p. 190—192°.

3-Ethylpyridine 1-Oxide.—3-Ethylpyridine [7] (53·5 g.), acetic acid (300 ml.) and 30% hydrogen peroxide (50 ml.) were heated at 70—80° for 3 hr. More hydrogen peroxide (35 ml.) was added, and heating continued for 9 hr. The cooled mixture was basified with concentrated sodium hydroxide solution and extracted with chloroform. Removal of the solvent from the dried (Na_2CO_3) extract, and distillation, gave an oil (48·2 g.), b. p. 123—125°/12 mm., which solidified but was hygroscopic [picrate, m. p. 95° (Found: C, 44·3; H, 3·4. Calc. for $C_7H_9NO,C_6H_3N_3O_7$: C, 44·3; H, 3·4%).

[4] Katritzky, *Quart. Rev.*, 1956, **10**, 395.
[5] Katritzky, *J.*, 1956, 2404.
[6] Brown and Murphey, *J. Amer. Chem. Soc.*, 1951, **73**, 3308.
[7] Fand and Lutomski, *J. Amer. Chem. Soc.*, 1949, **71**, 2931.

3-*Isopropylpyridine* 1-*Oxide*.—3-Isopropylpyridine [6] similarly gave a hygroscopic oil (71%), b. p. 120—122°/0·8 mm. [*picrate*, m. p. 125—126° (Found: C, 46·3; H, 3·9. $C_8H_{11}NO,C_6H_3N_3O_7$ requires C, 45·9; H, 3·85%)].

3-*t-Butylpyridine* 1-*Oxide*.—A colourless, hygroscopic oil (66%), b. p. 132—134°/1 mm., gave a *picrate*, m. p. 143—144° (Found: C, 47·4; H, 4·2. $C_9H_{13}NO,C_6H_3N_3O_7$ requires C, 47·5; H, 4·2%).

3,5-*Dimethylpyridine* 1-*Oxide*.—This colourless, hygroscopic oil (55%), b. p. 116—118°/0·1 mm., gave a picrate, m. p. 135—136° (Found: C, 44·8; H, 3·5. Calc. for $C_7H_9NO,C_6H_3N_3O_7$: C, 44·3; H, 3·4%).

2,3,5,6-*Tetramethylpyridine* 1-*Oxide*.—This oxidation was carried out at 90—100°. The *oxide* formed colourless needles (32%), m. p. 139—140° (Found: C, 71·6; H, 8·5. $C_9H_{13}NO$ requires C, 71·5; H, 8·7%), from light petroleum (b. p. 60—80°), and gave a *picrate*, m. p. 144—145° (Found: C, 47·5; H, 4·6. $C_9H_{13}NO,C_6H_3N_3O_7$ requires C, 47·4; H, 4·2%).

3-*Bromopyridine* 1-*Oxide*.—This compound was obtained in yields similar to those reported.[8] Its *picrate* (yellow platelets from ethanol) had m. p. 144·5—145·5° (Found: C, 33·4; H, 2·0. $C_5H_4BrNO,C_6H_3N_3O_7$ requires C, 32·7; H, 1·75%).

3-*Ethyl*-4-*nitropyridine* 1-*Oxide*.—3-Ethylpyridine 1-oxide (24·5 g.), sulphuric acid (65 ml.; *d* 1·84), and nitric acid (34 ml.; *d* 1·50) were warmed to 50°, a vigorous reaction then occurring. When this subsided, the solution was heated at 90—100° for 3½ hr. and then poured on ice. After neutralisation of the solution with solid potassium carbonate the precipitated potassium sulphate was collected and washed with ice-water. The combined washings and filtrate were extracted with chloroform. Drying (Na_2CO_3), removal of the solvent, and crystallisation of the residue from ether gave 3-*ethyl*-4-*nitropyridine* 1-*oxide* (19 g.) as yellow needles, m. p. 68—69° (Found: C, 50·1; H, 4·8. $C_7H_8N_2O_3$ requires C, 50·0; H, 4·8%).

3-*Isopropyl*-4-*nitropyridine* 1-*Oxide*.—Prepared similarly, 3-*isopropyl*-4-*nitropyridine* 1-*oxide* (60%) formed lemon platelets, m. p. 138—139° (Found: C, 52·7; H, 5·6. $C_8H_{10}N_2O_3$ requires C, 52·7; H, 5·5%), from acetone.

3,5-*Dimethyl*-4-*nitropyridine* 1-*Oxide*.—The *nitro-compound* (46%) crystallised from acetone as pale yellow needles, m. p. 174—175° (Found: C, 49·9; H, 4·9. $C_7H_8N_2O_3$ requires C, 50·0; H, 4·8%); its *picrate* had m. p. 137·5—138·5° (Found: C, 39·9; H, 2·6. $C_7H_8N_2O_3,C_6H_3N_3O_7$ requires C, 39·3; H, 2·8%).

2,3,5,6-*Tetramethyl*-4-*nitropyridine* 1-*Oxide*.—This *compound* (55%) formed yellow prisms, m. p. 115—116° (Found: C, 53·9; H, 6·3. $C_9H_{11}N_2O_3,\frac{1}{4}H_2O$ requires C, 53·9; H, 6·0%), from ether–light petroleum (b. p. 40—60°), and gave a *picrate*, m. p. 160—161° (Found: C, 42·5; H, 3·65. $C_9H_{12}N_2O_3,C_6H_3N_3O_7$ requires C, 42·4; H, 3·6%).

3-*Bromo*-4-*nitropyridine* 1-*Oxide*.—3-Bromopyridine 1-oxide (10 g.), sulphuric acid (15 ml.; *d* 1·84), and nitric acid (20 ml.; *d* 1·50) were heated at 120—130° for 4 hr. The usual processing gave 3-bromo-4-nitropyridine 1-oxide (4·1 g.) [orange-yellow needles, m. p. 156—157° (reported [9] m. p. 152—153°), from benzene] and 3-*bromo*-4-*nitropyridine* (0·3 g.), b. p. 66—68°/0·1 mm. (Found: C, 30·3; H, 1·5. $C_5H_3BrN_2O_2$ requires C, 29·6; H, 1·5%) (picrate, m. p. 165—167°).

3-*t-Butyl*-2(*or* 6)-*nitropyridine*.—Nitration of 3-t-butylpyridine 1-oxide (4 g.) at 95° for 2 hr. afforded 3-t-*butyl*-2(or 6)-*nitropyridine* (1·4 g.), which separated from light petroleum (b. p. 60—80°) as pale yellow platelets, m. p. 104·5—105·5° (Found: C, 59·9; H, 6·2. $C_9H_{12}N_2O_2$ requires C, 60·0; H, 6·7%).

3-*Ethyl*-4-*nitropyridine*.—To a stirred solution of 3-ethyl-4-nitropyridine 1-oxide (5 g.) in dry chloroform (100 ml.), cooled in ice, phosphorus trichloride (25 ml.) was added dropwise. The temperature was kept below 10°, and when the addition was complete the mixture was stirred for 40 min. more below 10°, and then poured on ice and basified with sodium hydroxide solution. The aqueous layer was washed with chloroform, and the combined washings and chloroform layer were dried (Na_2CO_3). Distillation gave 3-*ethyl*-4-*nitropyridine* as a yellow oil (3·8 g.), b. p. 56—58°/0·25 mm., n_D^{16} 1·5305 (Found: C, 54·9; H, 5·4. $C_7H_8N_2O_2$ requires C, 55·25; H, 5·3%).

3-*Isopropyl*-4-*nitropyridine*.—Prepared as above, the *nitro-compound* (79%) was a yellow oil, b. p. 82—84°/0·85 mm. (Found: C, 58·7; H, 6·6. $C_8H_{10}N_2O_2$ requires C, 57·8; H, 6·1%) [*picrate* (yellow platelets from ethanol), m. p. 106—107° (Found: C, 43·1; H, 3·5. $C_8H_{10}N_2O_2,C_6H_3N_3O_7$ requires C, 42·5; H, 3·3%)].

[8] Murray and Hauser, *J. Org. Chem.*, 1954, **19**, 2008.
[9] den Hertog and Overhoff, *Rec. Trav. chim.*, 1950, **69**, 468.

3,5-*Dimethyl*-4-*nitropyridine*.—Colourless needles of the *nitro-compound* (45%), m. p. 38—39° (Found: C, 54·1; H, 5·1. $C_7H_8N_2O_2$,$\frac{1}{4}H_2O$ requires C, 53·7; H, 5·5%), separated from light petroleum (b. p. 60—80°). The *picrate* had m. p. 169—170° (Found: C, 40·3; H, 2·9. $C_7H_8N_2O_2$,$C_6H_3N_3O_7$ requires C, 40·0; H, 2·9%).

2,3,5,6-*Tetramethyl*-4-*nitropyridine*.—To a stirred solution of 2,3,5,6-tetramethyl-4-nitropyridine 1-oxide (0·7 g.) in dry chloroform (15 ml.), cooled in ice, phosphorus trichloride (3 ml.) was added slowly. The mixture was heated on the water-bath for 45 min. before being worked up as usual. 2,3,5,6-*Tetramethyl*-4-*nitropyridine* (0·3 g.) formed colourless plates, m. p. 198—200° (Found: C, 49·95; H, 6·2. $C_9H_{12}N_2O_2$,$2H_2O$ requires C, 50·0; H, 7·5%), from acetone. The *picrate* formed lemon-yellow plates (from ethanol), m. p. 174—176° (Found: C, 44·2; H, 3·9. $C_9H_{12}N_2O_2$,$C_6H_3N_3O_7$ requires C, 44·0; H, 3·7%).

4-*Chloro*-3-*ethylpyridine* 1-*Oxide*.—When freshly distilled acetyl chloride (60 ml.) was added to 3-ethyl-4-nitropyridine 1-oxide (13 g.), a vigorous reaction occurred. The mixture was poured on ice, basified with 20% sodium hydroxide solution, and extracted with chloroform. Removal of chloroform from the dried (K_2CO_3) extract, and recrystallisation of the residue from ethyl acetate gave cream-coloured needles (8·2 g.) of 4-*chloro*-3-*ethylpyridine* 1-*oxide*, m. p. 86° (Found: C, 52·9; H, 5·7. C_7H_8ClNO requires C, 53·3; H, 5·1%) [*picrate* (yellow plates from ethanol), m. p. 137—138° (Found: C, 40·4; H, 2·9. C_7H_8ClNO,$C_6H_3N_3O_7$ requires C, 40·4; H, 2·9%)].

4-*Chloro*-3-*isopropylpyridine* 1-*Oxide*.—Prepared as above, this hygroscopic compound formed yellow needles (76%) (m. p. 87—88°, after drying *in vacuo*) from ethyl acetate and gave a *picrate* (yellow plates from ethanol), m. p. 130—131° (Found: C, 41·4; H, 3·5. $C_8H_{10}ClNO$,$C_6H_3N_3O_7$ requires C, 42·0; H, 3·3%).

4-*Chloro*-3,5-*dimethylpyridine* 1-*Oxide*.—The *chloro-compound* (85%) formed needles, m. p. 201—202° (Found: C, 53·3; H, 5·1. C_7H_8ClNO requires C, 53·3; H, 5·1%), from ethyl acetate and gave a *picrate*, m. p. 142—143° (Found: C, 41·0; H, 2·7. C_7H_8ClNO,$C_6H_3N_3O_7$ requires C, 40·4; H, 2·9%).

4-*Chloro*-2,3,5,6-*tetramethylpyridine* 1-*Oxide*.—The *chloro-compound* (61%) formed pale orange needles, m. p. 153—154° (Found: C, 50·5; H, 6·7. $C_9H_{12}ClNO$,$1\frac{1}{2}H_2O$ requires C, 50·8; H, 7·1%), from ether–light petroleum (b. p. 60—80°). Its *picrate* had m. p. 154—155° (Found: C, 43·6; H, 3·5. $C_9H_{12}ClNO$,$C_6H_3N_3O_7$ requires C, 43·45; H, 3·65%).

3-*Bromo*-4-*chloropyridine* 1-*Oxide*.—This *compound* (80%) gave pale orange needles, m. p. 153·5—154·5° (Found: C, 29·3; H, 1·5. $C_5H_3BrClNO$ requires C, 28·8; H, 1·45%), from ethyl acetate. The *picrate* had m. p. 120—121° (Found: C, 30·5; H, 1·5. $C_5H_3BrClNO$,$C_6H_3N_3O_7$ requires C, 30·2; H, 1·4%).

4-*Amino*-3,5-*dimethylpyridine* 1-*Oxide*.—4-Chloro-3,5-dimethylpyridine 1-oxide (2·5 g.) and aqueous ammonia (18 ml.; *d* 0·88) were heated in a sealed tube at 140° for 18 hr. The mixture was evaporated to dryness with potassium carbonate (2·5 g.), and the residue was extracted with butan-2-one. The extract deposited crystals, which after recrystallisation from acetone gave 4-*amino*-3,5-*dimethylpyridine* 1-*oxide* (1·6 g.), m. p. 227—229° (Found: C, 48·25; H, 8·3; N, 15·9. $C_7H_{10}N_2O$,$2H_2O$ requires C, 48·3; H, 8·1; N, 16·1%) [*picrate* (yellow plates from ethanol), m. p. 221—223° (Found: C, 42·95; H, 3·7. $C_7H_{10}N_2O$,$C_6H_3N_3O_7$ requires C, 42·5; H, 3·6%)].

4-*Amino*-3-*methylpyridine*.—3-Methyl-4-nitropyridine (2·5 g.), ethanol (50 ml.), and 90% hydrazine hydrate (4 ml.) were warmed on the steam-bath and treated with a small quantity of Raney nickel, which caused a brisk effervescence. After about 30 min. the yellow colour of the solution had disappeared, and more Raney nickel was added to decompose the excess of hydrazine. The catalyst and solvent were removed and the residue was crystallised from light petroleum (b. p. 80—100°), to give the amine (1·2 g.) as colourless needles, m. p. 108—109° (reported [10] m. p. 108—109°).

4-*Amino*-3-*ethylpyridine*.—From 3-ethyl-4-nitropyridine (5 g.) the above procedure gave the *amine* (2·3 g.), which formed colourless needles, m. p. 52—53° (Found: C, 63·1; H, 8·5. $C_7H_{10}N_2$,$\frac{1}{2}H_2O$ requires C, 64·0; H, 8·45%), from ether–light petroleum (b. p. 40—60°). The *picrate* formed yellow plates (from ethanol), m. p. 196—197° (Found: C, 43·7; H, 3·5; N, 19·7. $C_7H_{10}N_2$,$C_6H_3N_3O_7$ requires C, 44·45; H, 3·7; N, 19·9%).

4-*Amino*-3-*isopropylpyridine*.—The *amine* (61%) separated from ether–light petroleum (b. p. 40—60°) as needles, m. p. 69—70° (Found: C, 65·4; H, 9·1. $C_8H_{12}N_2$,$\frac{1}{2}H_2O$ requires

[10] Taylor and Crovetti, *J. Org. Chem.*, 1954, **19**, 1633.

C, 66·1; H, 9·0%), and gave a *picrate* (yellow needles from ethanol), m. p. 156—157° (Found: C, 46·1; H, 4·0. $C_8H_{12}N_2,C_6H_3N_3O_7$ requires C, 46·0; H, 4·1%).

4-Amino-3,5-dimethylpyridine.—(*a*) A stirred solution of 4-amino-3,5-dimethylpyridine 1-oxide (0·5 g.) in acetic acid (5 ml.) was treated with iron pin dust (0·3 g.), and the mixture was then heated on the water-bath, with stirring, for 1½ hr. The mixture was cooled, basified with sodium hydroxide solution, filtered, and extracted with ether. Concentration of the dried (Na_2CO_3) extract and crystallisation of the residue from light petroleum (b. p. 60—80°) gave the *amine* (0·2 g.), m. p. 83—84° (Found: C, 53·6; H, 8·15; N, 17·9. $C_7H_{10}N_2,2H_2O$ requires C, 53·1; H, 8·9; N, 17·7%) [*picrate* (yellow plates from ethanol), m. p. 226—227° (Found: C, 44·9; H, 3·4. $C_7H_{10}N_2,C_6H_3N_3O_7$ requires C, 44·45; H, 3·7%).

(*b*) 3,5-Dimethyl-4-nitropyridine 1-oxide (2 g.), methanol (25 ml.), and Raney nickel (2 g.) were shaken with hydrogen until uptake ceased. Removal of the catalyst and solvent, and recrystallisation of the residue from light petroleum (b. p. 60—80°), gave the amine (1·1 g.), m. p. 83—84°.

4-Amino-2,3,5,6-tetramethylpyridine.—Catalytic reduction of 2,3,5,6-tetramethyl-4-nitropyridine 1-oxide (1·5 g.) gave the *amine* (1·0 g.), m. p. 196—197° (Found: C, 68·4; H, 9·2. $C_9H_{14}N_2,\frac{1}{2}H_2O$ requires C, 67·9; H, 9·5%) [from light petroleum (b. p. 60—80°)]. The *picrate* had m. p. 225—226° (decomp.) (Found: C, 47·6; H, 4·5. $C_9H_{14}N_2,C_6H_3N_3O_7$ requires C, 47·5; H, 4·5%).

2(or 6)-Amino-3-t-butylpyridine.—Reduction of 3-t-butyl-2(or 6)-nitropyridine (0·5 g.) with hydrazine hydrate and Raney nickel gave the *amine* (0·3 g.), m. p. 128—129° (Found: C, 72·3; H, 9·25; N, 18·7. $C_9H_{14}N_2$ requires C, 71·95; H, 9·4; N, 18·65%) after crystallisation from light petroleum (b. p. 40—60°). The ultraviolet absorption spectrum (in 0·01N-KOH) had $\lambda_{max.}$ 292, 228 mμ ($\log_{10}\varepsilon$ 3·56, 4·9). The base gave a *picrate*, m. p. 242° (Found: C, 48·1; H, 4·5; N, 18·7. $C_9H_{14}N_2,C_6H_3N_3O_7$ requires C, 47·5; H, 4·5; N, 18·5%).

3-Methyl-4-methylaminopyridine 1-Oxide.—4-Chloro-3-methylpyridine 1-oxide (3 g.) and 30% aqueous methylamine solution (18 ml.) were heated in a sealed tube at 140° for 18 hr. The mixture was evaporated to dryness with potassium carbonate (3 g.), and the residue was extracted with butan-2-one. Recrystallisation from this solvent gave *3-methyl-4-methylaminopyridine 1-oxide* (2·1 g.) as needles, m. p. 106—107° (Found: C, 48·6; H, 8·0. $C_7H_{10}N_2O,2_2HO$ requires C, 48·3; H, 8·1%). The *picrate* had m. p. 184—185° (Found: C, 42·9; H, 3·7. $C_7H_{10}N_2O,C_6H_3N_3O_7$ requires C, 42·5; H, 3·6%).

3-Ethyl-4-methylaminopyridine.—Treatment of 4-chloro-3-ethylpyridine 1-oxide (6 g.) as above gave a viscous brown oil (5 g.). Distillation gave a colourless oil, b. p. 120—122°/0·5 mm., which solidified when cooled in ice. Recrystallisation from ether gave platelets of *3-ethyl-4-methylaminopyridine* (2·3 g.), m. p. 117—118° (Found: C, 70·9; H, 8·9; N, 20·0. $C_8H_{12}N_2$ requires C, 70·55; H, 8·9; N, 20·6%) [*picrate*, m. p. 182—183° (Found: C, 46·0; H, 4·35. $C_8H_{12}N_2,C_6H_3N_3O_7$ requires C, 46·0; H, 4·1%)].

3-Isopropyl-4-methylaminopyridine 1-Oxide.—This hygroscopic oxide was obtained in 84% yield, and characterised as its *picrate* (yellow platelets from ethanol), m. p. 164—165° (Found: C, 45·8; H, 4·3. $C_9H_{14}N_2O,C_6H_3N_3O_7$ requires C, 45·6; H, 4·3%).

3,5-Dimethyl-4-methylaminopyridine 1-Oxide.—This *amine oxide* (70%) formed cream-coloured needles, m. p. 94·5—95·5° (Found: C, 56·3; H, 8·7. $C_8H_{12}N_2O,H_2O$ requires C, 56·45; H, 8·3%), from acetone and gave a *picrate*, m. p. 172—173° (Found: C, 44·4; H, 4·2. $C_8H_{12}N_2O,C_6H_3N_3O_7$ requires C, 44·1; H, 4·0%).

2,3,5,6-Tetramethyl-4-methylaminopyridine 1-Oxide.—This hygroscopic amine oxide (78%) gave a *picrate*, m. p. 140—141° (Found: C, 47·0; H, 5·0. $C_{10}H_{16}N_2O,C_6H_3N_3O_7$ requires C, 46·9; H, 4·7%).

3-Methyl-4-methylaminopyridine.—The corresponding oxide was reduced with iron and acetic acid, as described for 4-amino-3,5-dimethylpyridine 1-oxide. Crystallisation from ether of the extracted material gave needles of the *amine* (70%), m. p. 125—126° (Found: C, 68·5; H, 8·7; N, 23·0. $C_7H_{10}N_2$ requires C, 68·8; H, 8·25; N, 22·9%), whose *picrate* had m. p. 199—200° (Found: C, 44·7; H, 3·8. $C_7H_{10}N_2,C_6H_3N_3O_7$ requires C, 44·45; H, 3·7%).

3-Isopropyl-4-methylaminopyridine.—Catalytic reduction of the 1-oxide as already described gave the *amine* (50%), which formed needles, m. p. 95—96° (Found: C, 72·0; H, 9·1; N, 18·9. $C_9H_{14}N_2$ requires C, 71·95; H, 9·4; N, 18·65%), from light petroleum (b. p. 60—80°) and gave a *picrate*, m. p. 159—160° (Found: C, 47·7; H, 4·5. $C_9H_{14}N_2,C_6H_3N_3O_7$ requires C, 47·5; H, 4·5%).

3,5-*Dimethyl*-4-*methylaminopyridine*.—Prepared by catalytic reduction of the 1-oxide, this *amine* (79%) separated from light petroleum (b. p. 80—100°) as crystals, m. p. 119·5—120·5° (Found: C, 69·9; H, 8·9; N, 20·8. $C_8H_{12}N_2$ requires C, 70·55; H, 8·9; N, 20·6%). The *picrate* formed small yellow crystals (from ethanol), m. p. 194·5—195·5° (Found: C, 46·8; H, 4·1. $C_8H_{12}N_2,C_6H_3N_3O_7$ requires C, 46·0; H, 4·1%).

2,3,5,6-*Tetramethyl*-4-*methylaminopyridine*.—The *amine* (64%, by catalytic reduction) separated from light petroleum (b. p. 60—80°) as needles, m. p. 118—119° (Found: C, 72·5; H, 9·5; N, 17·5. $C_{10}H_{16}N_2$ requires C, 73·1; H, 9·8; N, 17·1%); it gave a *picrate* (yellow plates from ethanol), m. p. 160—161° (Found: C, 47·8; H, 4·5. $C_{10}H_{16}N_2,C_6H_3N_3O_7,\frac{1}{2}H_2O$ requires C, 47·8; H, 5·0%).

3-*Bromo*-4-*methylaminopyridine*.—3-Bromo-4-methylaminopyridine 1-oxide, prepared in the usual way (62%), was a hygroscopic solid [picrate, m. p. 189—181° (decomp.) (from ethanol)]. Reduction by iron–acetic acid gave the *amine* (54%) which from light petroleum (b. p. 60—80°) formed needles, m. p. 92—93° (Found: C, 38·2; H, 3·8; N, 14·9. $C_6H_7BrN_2$ requires C, 38·5; H, 3·8; N, 15·0%).

4-*Dimethylamino*-3-*methylpyridine* 1-*Oxide*.—4-Chloro-3-methylpyridine 1-oxide (2 g.) and 30% aqueous dimethylamine solution (20 ml.) were heated in a sealed tube at 140° for 16 hr. Working up as in previous cases, extraction with butan-2-one, and removal of the solvent gave a viscous residue. Distillation gave a viscous oil (1·6 g.), b. p. 142—144°/0·15 mm., which set to a hygroscopic solid when cooled in ice. The derived *picrate* had m. p. 130—131° (Found: C, 44·1; H, 4·5. $C_8H_{12}N_2O,C_6H_3N_3O_7$ requires C, 44·1; H, 4·0%).

4-*Dimethylamino*-3-*ethylpyridine* 1-*Oxide*.—Prepared as above, this hygroscopic solid (53%; b. p. 178—180°/1 mm.) gave a *picrate*, m. p. 139—140° (Found: C, 45·9; H, 4·3. $C_9H_{14}N_2O,C_6H_3N_3O_7$ requires C, 45·5; H, 4·3%).

4-*Dimethylamino*-3-*isopropylpyridine* 1-*Oxide*.—This was a hygroscopic solid (90%), it gave a *picrate*, m. p. 151—152° (Found: C, 47·1; H, 4·7. $C_{10}H_{16}N_2O,C_6H_3N_3O_7$ requires C, 46·9; H, 4·7%).

4-*Dimethylamino*-3,5-*dimethylpyridine* 1-*Oxide*.—This formed hygroscopic needles (68%), m. p. 83—84°, from light petroleum (b. p. 60—80°). The *picrate* had m. p. 115—116° (Found: C, 45·75; H, 4·6; N, 17·35. $C_9H_{14}N_2O,C_6H_3N_3O_7$ requires C, 45·6; H, 4·3; N, 17·0%).

3-*Bromo*-4-*dimethylaminopyridine* 1-*Oxide*.—This hygroscopic solid oxide (70%) gave a *picrate* (mustard-yellow needles from ethanol), m. p. 160—161° (Found: C, 35·5; H, 2·8. $C_7H_9BrN_2O,C_6H_3N_3O_7$ requires C, 35·0; H, 2·7%).

4-*Dimethylamino*-3-*methylpyridine*.—Reduction of 4-dimethylamino-3-methylpyridine 1-oxide (4·5 g.) with iron and acetic acid in the way described above gave the *amine* (3·3 g.), b. p. 73—75°/1 mm. (Found: C, 70·9; H, 9·0. $C_8H_{12}N_2$ requires C, 70·55; H, 8·9%) [*picrate*, m. p. 172—173° (Found: C, 45·5; H, 4·1. $C_8H_{12}N_2,C_6H_3N_3O_7$ requires C, 46·0; H, 4·1%)].

4-*Dimethylamino*-3-*ethylpyridine*.—Prepared by reduction with iron–acetic acid, this *amine* (55%) was a colourless liquid, b. p. 82—83°/0·8 mm. (Found: C, 71·9; H, 9·25. $C_9H_{14}N_2$ requires C, 71·95; H, 9·4%). The *picrate* had m. p. 118—119° (Found: C, 47·3; H, 4·5. $C_9H_{14}N_2,C_6H_3N_3O_7$ requires C, 47·5; H, 4·5%).

4-*Dimethylamino*-3-*isopropylpyridine*.—Prepared similarly, the *amine* (50%) was a colourless liquid, b. p. 79—80°/0·45 mm. (Found: C, 72·7; H, 9·6; N, 17·1. $C_{10}H_{16}N_2$ requires C, 73·1; H, 9·8; N, 17·1%), and gave a *picrate*, m. p. 138—139° (Found: C, 48·7; H, 4·4. $C_{10}H_{16}N_2,C_6H_3N_3O_7$ requires C, 48·85; H, 4·9%).

4-*Dimethylamino*-3,5-*dimethylpyridine*.—Catalytic reduction of the 1-oxide (2·2 g.) as described earlier gave the *amine* (1·4 g.), b. p. 69—70°/0·4 mm. (Found: C, 71·6; H, 9·4; N, 18·7. $C_9H_{14}N_2$ requires C, 71·95; H, 9·4; N, 18·65%) [*picrate* (yellow plates from ethanol), m. p. 172—173° (Found: C, 47·9; H, 4·9. $C_9H_{14}N_2,C_6H_3N_3O_7$ requires C, 47·5; H, 4·5%)].

3-*Bromo*-4-*dimethylaminopyridine*.—Reduction of the 1-oxide (1 g.) with iron–acetic acid gave the amine (0·55 g.), b. p. 82—84°/0·5 mm., for which a satisfactory analysis could not be obtained. The *picrate* (yellow needles from acetone) had m. p. 182—183° (Found: C, 36·8; H, 2·9. $C_7H_9BrN_2,C_6H_3N_3O_7$ requires C, 36·3; H, 2·8%).

x-*Chloro*-3-*t*-*butylpyridine*.—3-t-Butylpyridine 1-oxide (3·5 g.) was heated in sealed tubes with sulphuryl chloride (15 ml.) for 2 hr. at 110—120°. Excess of sulphuryl chloride was removed, and the residue was basified and steam-distilled. Extraction of the distillate with ether provided a brown oil, which by adsorption on alumina, and elution with light petroleum (b. p. 40—60°), gave two products, a mobile brown oil and a gelatinous brown solid. The

first provided a *picrate*, m. p. 152—153° (Found: C, 44·4; H, 3·4. $C_9H_{12}ClN,C_6H_3N_3O_7$ requires C, 45·2; H, 3·8%), and the second a *picrate* (a mustard-yellow solid from ethanol), m. p. 149—150° (Found: C, 45·2; H, 4·2%).

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