CHAPTER TWO

SOLUTION STUDIES

The Bjerrum-Calvin pH titration technique as adopted by Irving and Rossotti[1] was employed for the determination of proton ligand and metal ligand formation constants in solution. This involved the measurements of pH which was carried out using the combined electrode pH meter combination. Since metals, ligands and metallic complexes are soluble in water, it was used as a solvent throughout.

A. Materials and their purification :

(1) Water - Distilled water was redistilled over alkaline potassium permanganate. The resulting distillate was boiled to expel the carbon-dioxide and was cooled in well stoppered Pyrex flasks. The pH of this water was about 6.7. This water was used for preparing all the solutions.

(2) Pyridine and substituted pyridines -

(i) Pyridine - C_5H_5N - Pyridine (B.D.H.A.R.) was redistilled and boiling point was checked which agreed with the reported value[2] of 115.5°C. (found 115°C.).

(ii) α-Picoline - $CH_3.C_5H_4N$ - α-picoline (Rutgerswerke Aktingesellschaft, Germany) was redistilled and boiling point found to be 128.5°C. agreeing with the literature value[2] of 129.4°C.

(iii) β-Picoline - $CH_3.C_5H_4N$ - β-picoline (Fluka pure) was redistilled. Boiling point was found 143°C. in close agreement with the reported value[2] of 143.5°C.

(iv) γ-Picoline - $CH_3.C_5H_4N$ - γ-picoline (B.D.H.L.R.) was redistilled. Boiling point was found to be 142°C. agreeing with the literature value[2], 143.1°C.

(v) 2:4-Lutidine - $(CH_3)_2.C_5H_3N$ - 2:4-lutidine (Rutgerswerke Aktingesellschaft, Germany) was redistilled. Boiling point was found to be 157°C. which agrees with the reported value[2] of 157.9°C.

(vi) 2:6-Lutidine - $(CH_3)_2.C_5H_3N$ - 2:6-lutidine (Fluka pure) was redistilled and boiling point checked which was 142°C. agreeing with the literature value[2], (142.3°C).

(vii) 2:4:6-Collidine - $(CH_3)_3.C_5H_2N$ - 2:4:6-collidine (B.D.H.L.R.) was redistilled. Boiling point was found to be 171°C., nearly same as the reported value[2], (171.2°C.).

(viii) 2-Aminopyridine - $\underline{N:CH(CH)_3.C}.NH_2$ - 2-aminopyridine (B.D.H.L.R.) was recrystallised from water. Melting point found to be 55°C. which was in close agreement with the literature value[2], 56°C.

(ix) 2-Amino-4-methylpyridine - $NH_2.CH_3.C_5H_3N$ - 2-amino-4-methylpyridine (Fluka pure) is a solid and was recrystallised from water before use.

B. Preparation of solutions :

(1) Sodium hydroxide solution - Sodium hydroxide solution free from carbonate was prepared according to the method of Allen and Low[3]. 50 g. of sodium hydroxide were dissolved in 500 ml. of double distilled water in a Pyrex flask. The flask was corked and left over 48 hrs. The clear supernatent liquid was filtered rapidly through sintered-bed Jena glass crucible of porosity G4 using a vacuum pump. A suitable volume of the filtrate was diluted to obtain approximately 0.5N solution which after estimation

(by conventional method) was preserved out of contact with carbondioxide.

(2) Sodium perchlorate solution - Sodium perchlorate was B.D.H.analar quality. An accurate 1.0M solution was prepared and stored in well stoppered Pyrex flask.

(3) Perchloric acid solution - The 70% acid was diluted with double distilled water to obtain one litre of approximately 0.5M perchloric acid solution. This was standardized by titration against standard alkali solution.

(4) Metal salt solutions -

(i) Nickel nitrate solution - $Ni(NO_3)_2.6H_2O$ - Nickel nitrate (B.D.H.A.R.) was recrystallised from water and approximately 0.1M solution was prepared in double distilled water. Nickel was estimated as nickel dimethylglyoxime[4] to know the exact strength of the solution. Further solutions were prepared by proper dilution of the stock solution.

(ii) Cadmium nitrate solution - $Cd(NO_3)_2.4H_2O$ - Cadmium nitrate (Reanal A.R.) was recrystallised from water and a solution of approximate strength, 0.1M was prepared. Cadmium was estimated as cadmium ammonium phosphate monohydrate[5] ($CdNH_4.PO_4.H_2O$) in order to prepare the stock solution of known strength which was used to prepare further solutions after proper dilution with double distilled water.

(iii) Magnesium nitrate solution - $Mg(NO_3)_2.6H_2O$ - Magnesium nitrate (E.Merck, Germany, extra pure crystals) was recrystallised from water. Approximately 0.1M solution was prepared. Magnesium was estimated as magnesium ammonium-phosphate hexahydrate[6] ($Mg\ NH_4.PO_4.6H_2O$). Further solutions

were prepared from this standard solution by diluting with double distilled water.

Metallic nitrates were selected because nitrate ions are less complexing than water and do not remain associated with the metal ion in dilute aqueous solutions[7].

(5) Solutions of the complexing agents - 0.5M solutions of the reagents were prepared by dissolving the requisite quantity of the compounds in double distilled water.

C. Apparata -

The glassware used were all Pyrex. The micro-burette which was graduated upto 0.01 ml. was calibrated in accordance with the method described by Vogel[8]. The pipettes were also similarly calibrated and the apparata like measuring flasks etc. were checked with the help of the standard burette.

D. pH Meter and accessories -

A Metrohm pH meter E.350A having combined glass and calomel electrode and working on 110-125 and 220-240 volts, 40-60 cycles, was employed throughout this investigation for pH determinations. The pH meter has a limit of error ± 0.1 pH unit and a reproducibility of ± 0.02 pH.

E. Calibration of the pH meter -

Before every set of readings, the pH meter was calibrated with the standard buffers M/20 potassium biphosphate, M/100 borax containing 0.02M sodium chloride and neutral buffer supplied with the instrument. After the completion of the whole set the calibration was checked again.

F. Details of the Irving Rossotti titrations -

All the titrations were carried out in 100 ml. beakers kept in a water thermostat maintained at 35 ± 0.1°C. or 45 ± 0.1°C. In all three solutions were prepared viz. (i) Perchloric acid, (ii) Perchloric acid + ligand and (iii) Perchloric acid + ligand + metal. The total volume (50 ml.) and the ionic strength of the solutions (0.2M) were kept constant in all the cases by the addition of water and neutral salt i.e. sodium perchlorate, respectively. Solutions stated below were prepared in all the cases except in case of 2-amino-4-methylpyridine (vide tables II9 (i)-(ii)) in which the concentrations were taken a bit different due to the less solubility of the ligand in water though the ionic strength of the solutions and the total volume were kept the same i.e. 0.2M and 50 ml. respectively.

(i)	Molarity	Volume	Ultimate ionic strength
Perchloric acid	0.5878 M	5.00 ml.	0.05878 M
Sodium perchlorate	1.0 M	7.06 ml.	0.14122 M
Water	-	37.94 ml.	-
		50.00 ml.	0.200 M
(ii)			
Perchloric acid	0.5878 M	5.00 ml.	0.05878 M
Ligand	0.50 M	5.00 ml.	0.050 M
Sodium perchlorate	1.0 M	4.56 ml.	0.09122 M
Water	-	35.44 ml.	-
		50.00 ml.	0.200 M

(iii)	Molarity	Volume	Ultimate ionic strength
Perchloric acid	0.5878 M	5.0 ml.	0.05878 M
Ligand	0.50 M	5.0 ml.	0.050 M
Metal	0.01 M	5.0 ml.	0.001 M
Sodium perchlorate	1.0 M	4.50 ml.	0.09022 M
Water	-	30.50 ml.	-
		50.00 ml.	0.200 M

Every time when the titration was performed, the titration beaker containing the solution concerned was kept for 15-20 minutes in the water bath so as to attain its temperature. The titrations were carried out with sodium hydroxide solution already standardized (0.4878 M). After the addition of each 0.02 ml. of alkali the pH of the solution was noted. Always the highest reading which remained steady was recorded. The titrations were repeated at two temperatures i.e. 35° and 45°C. The volumes of alkali added and the pH recorded have been presented in Tables II 1(i) - II 9(ii).

The titration curves were plotted between the volume of the alkali added and the pH of the solution recorded. In all thus, three curves were obtained for each ligand at one temperature as shown in figures II 1 - II 18. Since the curves representing the alkali titrations of Ni + ligand and Cd + ligand overlap each other, the latter have been shown seperately in the same figure alongwith the ligand titration curves.

F.(1) Second method of titration -

In this method the ligand itself was used as titrant. In all two solutions were prepared viz. (i) perchloric acid and

(ii) perchloric acid + metal. For both the solutions constant volume and molarity were maintained by the addition of water and neutral salt as shown below :

(i)	Molarity	Volume	Ultimate ionic strength
Perchloric acid	2.0 M	10.0 ml.	0.40 M
Sodium perchlorate	1.0 M	5.0 ml.	0.10 M
Water	-	35.0 ml.	-
		50.0 ml.	0.50 M
(ii)			
Perchloric acid	2.0 M	10.0 ml.	0.40 M
Metal	0.1 M	10.0 ml.	0.02 M
Sodium perchlorate	1.0 M	4.0 ml.	0.08 M
Water	-	26.0 ml.	-
		50.0 ml.	0.50 M

These solutions were titrated with the ligand solutions of 5.0 M strength. The beaker containing the titration solution was kept in the thermostat maintained at 35 $\pm$ 0.1°C. during the titration. The titration curves were plotted between the volume of the ligand added and the pH of the solution recorded. The curves are shown in Figures II 19 - II 26. This method could not be tried in case of 2-amino-4-methyl pyridine as it was not possible to prepare a concentrated aqueous solution of the ligand as in case of other ligands.

Table II 1(i)

Heading

$N = 0.4878M$ $V^o = 50$ ml. $\mu = 0.2M$ $t = 35^oC.$

$E^o = 0.05878M$ $T_L^o = 0.05M$ $T_M^o = 0.001M$

Perchloric acid		Pyridine		Nickel		Cadmium		Magnesium	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.35	0.80	2.72	0.80	2.60	0.80	2.60	0.80	2.62
1.00	1.40	0.90	2.95	0.90	2.82	0.90	2.82	0.90	2.85
1.50	1.45	1.00	3.30	1.00	3.20	1.00	3.20	1.00	3.25
2.00	1.50	1.10	3.65	1.10	3.50	1.10	3.52	1.10	3.55
2.50	1.55	1.20	3.90	1.20	3.77	1.20	3.80	1.20	3.82
3.00	1.60	1.30	4.05	1.30	3.97	1.30	4.00	1.30	4.02
3.50	1.70	1.40	4.20	1.40	4.12	1.40	4.13	1.40	4.15
4.00	1.80	1.50	4.30	1.50	4.22	1.50	4.23	1.50	4.25
4.50	1.90	1.60	4.40	1.60	4.32	1.60	4.33	1.60	4.35
5.00	2.10	1.80	4.55	1.80	4.46	1.80	4.48	1.80	4.50
5.20	2.20	2.00	4.68	2.00	4.60	2.00	4.62	2.00	4.65
5.40	2.35	2.20	4.78	2.20	4.70	2.20	4.72	2.20	4.75
5.50	2.48	2.40	4.86	2.40	4.80	2.40	4.80	2.40	4.82
5.60	2.65	2.60	4.95	2.60	4.90	2.60	4.90	2.60	4.92
5.70	2.85	3.00	5.05	3.00	5.02	3.00	5.02	3.00	5.02
5.80	3.25	3.40	5.20	3.40	5.18	3.40	5.18	3.40	5.18
5.84	3.75	3.80	5.35	3.80	5.32	3.80	5.33	3.80	5.35
5.86	5.00	4.00	5.40	4.00	5.38	4.00	5.38	4.00	5.38
5.88	7.30	4.20	5.50	4.20	5.48	4.20	5.50	4.20	5.50
5.90	9.20	4.40	5.60	4.40	5.58	4.40	5.60	4.40	5.60
		4.60	5.65	4.60	5.65	4.60	5.65	4.60	5.65
		4.80	5.75						
		5.00	5.90						

Table II 1(ii)

N = 0.4878M V^o = 50 ml. μ = 0.2M t = 45°C.

E^o = 0.05878M T_L^o = 0.05M T_M^o = 0.001M

Perchloric acid		Pyridine		Nickel		Cadmium		Magnesium	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.35	0.80	2.68	0.80	2.55	0.80	2.55	0.80	2.58
1.00	1.40	0.90	2.90	0.90	2.75	0.90	2.75	0.90	2.77
1.50	1.45	1.00	3.25	1.00	3.08	1.00	3.10	1.00	3.12
2.00	1.50	1.10	3.60	1.10	3.50	1.10	3.52	1.10	3.55
2.50	1.55	1.20	3.87	1.20	3.78	1.20	3.80	1.20	3.82
3.00	1.60	1.30	4.05	1.30	3.97	1.30	3.98	1.30	4.00
3.50	1.68	1.40	4.18	1.40	4.08	1.40	4.10	1.40	4.12
4.00	1.78	1.50	4.28	1.50	4.18	1.50	4.20	1.50	4.23
4.50	1.90	1.60	4.37	1.60	4.28	1.60	4.28	1.60	4.32
5.00	2.10	1.80	4.50	1.80	4.40	1.80	4.42	1.80	4.45
5.20	2.20	2.00	4.58	2.00	4.52	2.00	4.53	2.00	4.55
5.40	2.35	2.20	4.65	2.20	4.60	2.20	4.62	2.20	4.62
5.50	2.45	2.40	4.72	2.40	4.68	2.40	4.70	2.40	4.70
5.60	2.60	2.60	4.80	2.60	4.75	2.60	4.75	2.60	4.77
5.70	2.75	2.80	4.87	2.80	4.83	2.80	4.83	2.80	4.85
5.80	3.00	3.00	4.95	3.00	4.92	3.00	4.92	3.00	4.92
5.84	3.20	3.40	5.10	3.40	5.07	3.40	5.08	3.40	5.08
5.88	3.60	3.80	5.25	3.80	5.22	3.80	5.22	3.80	5.22
5.90	4.10	4.00	5.30	4.00	5.28	4.00	5.28	4.00	5.28
5.92	6.10	4.40	5.45	4.40	5.42	4.40	5.42	4.40	5.42
5.94	9.10	4.80	5.65	4.80	5.62	4.80	5.63	4.80	5.62
		5.00	5.80	5.00	5.78	5.00	5.78	5.00	5.78

Table II 2(i)

$N = 0.4878M$ $V^o = 50$ ml. $\mu = 0.2M$ $t = 35^o$

$E^o = 0.05878M$ $T_L^o = 0.05M$ $T_M^o = 0.001M$

Perchloric acid		α-Picoline		Nickel		Cadmium		Magnesium	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.35	0.80	2.65	0.80	2.55	0.80	2.55	0.80	2.57
1.00	1.40	0.90	2.90	0.90	2.80	0.90	2.82	0.90	2.82
1.50	1.45	1.00	3.30	1.00	3.15	1.00	3.20	1.00	3.20
2.00	1.50	1.04	3.62	1.04	3.25	1.04	3.30	1.04	3.32
2.50	1.55	1.10	4.35	1.10	3.90	1.10	3.95	1.10	4.00
3.00	1.60	1.20	4.65	1.20	4.40	1.20	4.50	1.20	4.58
3.50	1.70	1.30	4.80	1.30	4.62	1.30	4.70	1.30	4.72
4.00	1.80	1.40	4.93	1.40	4.75	1.40	4.80	1.40	4.86
4.50	1.90	1.50	5.00	1.50	4.85	1.50	4.90	1.50	4.95
5.00	2.10	1.60	5.08	1.60	4.95	1.60	4.98	1.60	5.02
5.20	2.20	1.70	5.16	1.70	5.05	1.70	5.08	1.70	5.10
5.40	2.35	1.80	5.23	1.80	5.12	1.80	5.13	1.80	5.17
5.50	2.48	2.00	5.35	2.00	5.27	2.00	5.28	2.00	5.30
5.60	2.65	2.20	5.45	2.20	5.38	2.20	5.40	2.20	5.42
5.70	2.85	2.40	5.53	2.40	5.50	2.40	5.50	2.40	5.52
5.80	3.25	2.60	5.63	2.60	5.60	2.60	5.60	2.60	5.60
5.84	3.75	2.80	5.70	2.80	5.67	2.80	5.67	2.80	5.68
5.86	5.00	3.00	5.78	3.00	5.75	3.00	5.75	3.00	5.75
5.88	7.30	3.20	5.85	3.20	5.82	3.20	5.82	3.20	5.82
5.90	9.20	3.40	5.92	3.40	5.90	3.40	5.90	3.40	5.90

Table II 2(ii)

$N = 0.4878M$ $V^\circ = 50$ ml. $\mu = 0.2M$ $t = 45°C$

$E^\circ = 0.05878M$ $T_L^\circ = 0.05M$ $T_M^\circ = 0.001M$

Perchloric acid		a-picoline		Nickel		Cadmium		Magnesium	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (im ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.35	0.80	2.60	0.80	2.50	0.80	2.50	0.80	2.52
1.00	1.40	0.90	2.85	0.90	2.70	0.90	2.72	0.90	2.75
1.50	1.45	1.00	3.15	1.00	3.00	1.00	3.05	1.00	3.10
2.00	1.50	1.04	3.40	1.04	3.20	1.04	3.25	1.04	3.30
2.50	1.55	1.08	3.70	1.08	3.50	1.08	3.55	1.08	3.60
3.00	1.60	1.10	3.85	1.10	3.60	1.10	3.65	1.10	3.70
3.50	1.68	1.20	4.35	1.20	4.17	1.20	4.20	1.20	4.25
4.00	1.78	1.30	4.60	1.30	4.42	1.30	4.50	1.30	4.53
4.50	1.90	1.40	4.75	1.40	4.57	1.40	4.63	1.40	4.67
5.00	2.10	1.50	4.85	1.50	4.70	1.50	4.75	1.50	4.78
5.20	2.20	1.60	4.95	1.60	4.80	1.60	4.85	1.60	4.88
5.40	2.35	1.70	5.00	1.70	4.90	1.70	4.92	1.70	4.95
5.50	2.45	1.80	5.07	1.80	4.95	1.80	4.98	1.80	5.02
5.60	2.60	2.00	5.18	2.00	5.08	2.00	5.12	2.00	5.13
5.70	2.75	2.20	5.32	2.20	5.22	2.20	5.22	2.20	5.25
5.80	3.00	2.40	5.40	2.40	5.34	2.40	5.35	2.40	5.37
5.84	3.20	2.60	5.50	2.60	4.54	2.60	5.45	2.60	5.48
5.88	3.60	3.00	5.67	3.00	5.62	3.00	5.62	3.00	5.65
5.90	4.10	3.40	5.80	3.40	5.75	3.40	5.75	3.40	5.78
5.92	6.10	3.80	5.95	3.80	5.90	3.80	5.90	3.80	5.92
5.94	9.10	4.00	6.00	4.00	5.97	4.00	5.98	4.00	5.98

Table II 3(i)

$N = 0.4878M$ $V^o = 50$ ml. $\mu = 0.2M$ $t = 35^oC$

$E^o = 0.05878M$ $T_L^o = 0.05M$ $T_M^o = 0.001M$

Perchloric acid		β-Picoline		Nickel		Cadmium		Magnesium	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.35	0.80	2.75	1.00	3.45	1.00	3.50	1.00	3.55
1.00	1.40	0.90	3.10	1.04	3.70	1.04	3.75	1.04	3.90
1.50	1.45	1.00	3.70	1.08	3.90	1.08	3.92	1.08	4.00
2.00	1.50	1.04	3.90	1.10	4.00	1.10	4.02	1.10	4.10
2.50	1.55	1.08	4.08	1.20	4.25	1.20	4.37	1.20	4.40
3.00	1.60	1.10	4.16	1.30	4.45	1.30	4.52	1.30	4.55
3.50	1.70	1.20	4.48	1.40	4.57	1.40	4.62	1.40	4.66
4.00	1.80	1.30	4.62	1.50	4.68	1.50	4.70	1.50	4.72
4.50	1.90	1.40	4.73	1.60	4.78	1.60	4.80	1.60	4.83
5.00	2.10	1.50	4.82	1.80	4.92	1.80	4.93	1.80	4.95
5.20	2.20	1.60	4.90	2.00	5.02	2.00	5.05	2.00	5.07
5.40	2.35	1.80	5.02	2.20	5.13	2.20	5.15	2.20	5.17
5.50	2.48	2.00	5.12	2.40	5.25	2.40	5.25	2.40	5.27
5.60	2.65	2.20	5.20	2.60	5.35	2.60	5.35	2.60	5.35
5.70	2.85	2.40	5.30	2.80	5.42	2.80	5.42	2.80	5.42
5.80	3.25	2.60	5.40	3.00	5.52	3.00	5.52	3.00	5.52
5.84	3.75	2.80	5.47	3.40	5.68	3.40	5.68	3.40	5.68
5.86	5.00	3.00	5.55	3.80	5.80	3.80	5.80	3.80	5.80
5.88	7.30	3.40	5.70	4.00	5.88	4.00	5.88	4.00	5.88
5.90	9.20	3.80	5.83	4.20	5.95	4.20	5.95	4.20	5.95
		4.20	5.97						
		4.40	6.05						

Table II 3(ii)

N = 0.4878M V^o = 50 ml. μ = 0.2M t = 45°C

E^o = 0.05878M T_L^o = 0.05M T_M^o = 0.001M

Perchloric acid		β-Picoline		Nickel		Cadmium		Magnesium	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.35	0.80	2.78	1.00	3.35	1.00	3.38	1.00	3.40
1.00	1.40	0.90	3.07	1.04	3.55	1.04	3.55	1.04	3.58
1.50	1.45	1.00	3.60	1.08	3.75	1.08	3.75	1.10	3.95
2.00	1.50	1.04	3.80	1.10	3.85	1.10	3.90	1.20	4.20
2.50	1.55	1.10	4.00	1.20	4.12	1.20	4.15	1.30	4.42
3.00	1.60	1.20	4.28	1.30	4.30	1.30	4.40	1.40	4.55
3.50	1.68	1.30	4.48	1.40	4.47	1.40	4.52	1.50	4.62
4.00	1.78	1.40	4.60	1.50	4.56	1.50	4.60	1.60	4.70
4.50	1.90	1.50	4.68	1.60	4.63	1.60	4.67	1.70	4.77
5.00	2.10	1.60	4.75	1.70	4.72	1.70	4.75	1.80	4.82
5.20	2.20	1.70	4.82	1.80	4.78	1.80	4.80	2.00	4.93
5.40	2.35	1.80	4.87	2.00	4.88	2.00	4.90	2.20	5.05
5.50	2.45	2.00	4.98	2.20	5.00	2.20	5.02	2.40	5.15
5.60	2.60	2.20	5.10	2.40	5.12	2.40	5.15	2.60	5.25
5.70	2.75	2.40	5.20	2.60	5.25	2.60	5.25	2.80	5.32
5.80	3.00	2.60	5.30	2.80	5.32	2.80	5.32	3.00	5.42
5.84	3.20	2.80	5.37	3.00	5.42	3.00	5.42	3.40	5.52
5.88	3.60	3.00	5.45	3.40	5.52	3.40	5.52	3.80	5.62
5.90	4.10	3.40	5.55	3.80	5.62	3.80	5.62	4.00	5.72
5.92	6.10	3.80	5.65	4.00	5.72	4.00	5.72	4.40	5.88
5.94	9.10	4.00	5.75	4.40	5.88	4.40	5.88	4.80	6.08
		4.40	5.90	4.80	6.08	4.80	6.08	5.00	6.20
		4.80	6.10	5.00	6.20	5.00	6.20		
		5.00	6.22						

Table II 4(i)

N = 0.4878M V^o = 50 ml. μ = 0.2M t = 35°C

E^o = 0.05878M T_L^o = 0.05M T_M^o = 0.001M

Perchloric acid		γ-Picoline		Nickel		Cadmium		Magnesium	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.35	0.80	2.60	1.00	3.20	1.00	3.22	1.00	3.25
1.00	1.40	0.90	2.85	1.10	3.80	1.10	3.90	1.10	4.00
1.50	1.45	1.00	3.35	1.20	4.30	1.20	4.42	1.20	4.45
2.00	1.50	1.08	4.02	1.30	4.58	1.30	4.65	1.30	4.70
2.50	1.55	1.10	4.20	1.40	4.75	1.40	4.82	1.40	4.88
3.00	1.60	1.20	4.65	1.50	4.92	1.50	4.95	1.50	5.02
3.50	1.70	1.30	4.85	1.60	5.05	1.60	5.08	1.60	5.12
4.00	1.80	1.40	5.02	1.70	5.15	1.70	5.18	1.70	5.20
4.50	1.90	1.50	5.13	1.80	5.22	1.80	5.25	1.80	5.28
5.00	2.10	1.60	5.18	2.00	5.37	2.00	5.38	2.00	5.40
5.20	2.20	1.70	5.25	2.20	5.48	2.20	5.50	2.20	5.50
5.40	2.35	1.80	5.32	2.40	5.58	2.40	5.58	2.40	5.58
5.50	2.48	2.00	5.45	2.60	5.68	2.60	5.68	2.60	5.68
5.60	2.65	2.20	5.53	2.80	5.75	2.80	5.75	2.80	5.75
5.70	2.85	2.40	5.62	3.00	5.85	3.00	5.85	3.00	5.85
5.80	3.25	2.60	5.72	3.20	5.92	3.20	5.92	3.20	5.92
5.84	3.75	2.80	5.80	3.40	6.00	3.40	6.00	3.40	6.00
5.86	5.00	3.00	5.88	3.80	6.15	3.80	6.15	3.80	6.15
5.88	7.30	3.20	5.95	4.00	6.20	4.00	6.20	4.00	6.20
5.90	9.20	3.40	6.05	4.20	6.25	4.20	6.25	4.20	6.25
		3.80	6.20						
		4.00	6.25						
		4.20	6.30						

Table II 4(ii)

N = 0.4878M V^o = 50 ml. μ = 0.2M t = 45°C

E^o = 0.05878M T_L^o = 0.05M T_M^o = 0.001M

Perchloric acid		γ-Picoline		Nickel		Cadmium		Magnesium	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.35	0.80	2.65	1.00	3.20	1.00	3.22	1.00	3.25
1.00	1.40	0.90	2.90	1.04	3.45	1.04	3.50	1.04	3.52
1.50	1.45	1.00	3.40	1.10	3.92	1.10	4.00	1.10	4.00
2.00	1.50	1.04	3.75	1.14	4.12	1.14	4.18	1.14	4.20
2.50	1.55	1.10	4.15	1.20	4.30	1.20	4.40	1.20	4.43
3.00	1.60	1.14	4.30	1.30	4.52	1.30	4.58	1.30	4.62
3.50	1.68	1.20	4.56	1.40	4.67	1.40	4.72	1.40	4.75
4.00	1.78	1.30	4.75	1.50	4.80	1.50	4.82	1.50	4.85
4.50	1.90	1.40	4.85	1.60	4.88	1.60	4.90	1.60	4.95
5.00	2.10	1.50	4.93	1.70	4.96	1.70	4.98	1.70	5.02
5.20	2.20	1.60	5.03	1.80	5.05	1.80	5.07	1.80	5.10
5.40	2.35	1.70	5.10	2.00	5.20	2.00	5.22	2.00	5.25
5.50	2.45	1.80	5.16	2.20	5.35	2.20	5.35	2.20	5.35
5.60	2.60	2.00	5.30	2.40	5.43	2.40	5.45	2.40	5.45
5.70	2.75	2.20	5.40	2.60	5.55	2.60	5.55	2.60	5.55
5.80	3.00	2.40	5.48	2.80	5.62	2.80	5.63	2.80	5.65
5.84	3.20	2.60	5.60	3.00	5.72	3.00	5.72	3.00	5.72
5.88	3.60	2.80	5.68	3.20	5.80	3.20	5.80	3.20	5.80
5.90	4.10	3.00	5.78	3.40	5.90	3.40	5.90	3.40	5.90
5.92	6.10	3.20	5.85	3.60	5.95	3.60	5.95	3.60	5.95
5.94	9.10	3.40	5.93	3.80	6.02	3.80	6.02	3.80	6.02
		3.60	5.98	4.00	6.08	4.00	6.08	4.00	6.08
		3.80	6.05	4.20	6.15	4.20	6.15	4.20	6.15
		4.20	6.17						

Table II 5(i)

$N = 0.4878M$ $V^o = 50$ ml. $\mu = 0.2M$ $t = 35^oC$

$E^o = 0.05878M$ $T^o_L = 0.05M$ $T^o_M = 0.001M$

Perchloric acid		2:4-Lutidine		Nickel		Cadmium		Magnesium	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (im ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.35	0.80	2.00	1.50	2.45	1.50	2.48	1.50	2.50
1.00	1.40	1.00	2.10	1.60	2.60	1.60	2.62	1.60	2.65
1.50	1.45	1.10	2.17	1.70	2.85	1.70	2.85	1.70	2.90
2.00	1.50	1.20	2.23	1.74	3.00	1.74	3.02	1.74	3.05
2.50	1.55	1.30	2.30	1.78	3.22	1.78	3.25	1.78	3.30
3.00	1.60	1.40	2.40	1.80	3.40	1.80	3.45	1.80	3.60
3.50	1.70	1.50	2.53	1.84	4.20	1.84	4.30	1.84	4.40
4.00	1.80	1.60	2.70	1.86	4.40	1.86	4.50	1.86	4.60
4.50	1.90	1.70	3.00	1.88	4.62	1.88	4.70	1.88	4.80
5.00	2.10	1.74	3.20	1.90	4.80	1.90	4.83	1.90	4.90
5.20	2.20	1.78	3.63	1.94	4.92	1.94	4.95	1.94	5.10
5.40	2.35	1.80	4.03	2.00	5.13	2.00	5.15	2.00	5.20
5.50	2.48	1.84	4.65	2.10	5.40	2.10	5.45	2.10	5.52
5.60	2.65	1.86	5.00	2.20	5.60	2.20	5.62	2.20	5.70
5.70	2.85	1.90	5.20	2.30	5.75	2.30	5.78	2.30	5.82
5.80	3.25	1.94	5.35	2.40	5.88	2.40	5.88	2.40	5.90
5.84	3.75	2.00	5.50	2.50	5.98	2.50	5.98	2.50	6.00
5.86	5.00	2.10	5.68	2.60	6.08	2.60	6.08	2.60	6.10
5.88	7.30	2.20	5.80	2.70	6.15	2.70	6.15	2.70	6.18
5.90	9.20	2.40	5.98	2.80	6.25	2.80	6.25	2.80	6.25
		2.60	6.15	2.90	6.32	2.90	6.32	2.90	6.32
		2.80	6.30	3.00	6.40	3.00	6.40	3.00	6.40
		3.00	6.45	3.10	6.48	3.10	6.48	3.10	6.48
		3.10	6.52						

Table II 5(ii)

N = 0.4878M V^o = 50 ml. μ = 0.2M t = 45°C

E^o = 0.05878M T_L^o = 0.05M T_M^o = 0.001M

Perchloric acid		2:4-Lutidine		Nickel		Cadmium		Magnesium	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.35	0.80	2.00	1.50	2.45	1.50	2.45	1.50	2.48
1.00	1.40	1.00	2.10	1.60	2.65	1.60	2.65	1.60	2.68
1.50	1.45	1.20	2.22	1.70	2.90	1.70	2.92	1.70	2.95
2.00	1.50	1.40	2.40	1.78	3.40	1.78	3.42	1.78	3.50
2.50	1.55	1.50	2.52	1.80	3.70	1.80	3.75	1.80	3.80
3.00	1.60	1.60	2.70	1.84	4.30	1.84	4.35	1.84	4.40
3.50	1.68	1.70	3.00	1.88	4.55	1.88	4.60	1.88	4.70
4.00	1.78	1.78	3.72	1.90	4.67	1.90	4.70	1.90	4.80
4.50	1.90	1.80	4.20	1.94	4.80	1.94	4.88	1.94	5.00
5.00	2.10	1.84	4.60	2.00	5.05	2.00	5.10	2.00	5.20
5.20	2.20	1.88	5.05	2.10	5.27	2.10	5.30	2.10	5.38
5.40	2.35	1.90	5.13	2.20	5.45	2.20	5.48	2.20	5.55
5.50	2.45	2.00	5.35	2.30	5.57	2.30	5.58	2.30	5.68
5.60	2.60	2.10	5.50	2.40	5.70	2.40	5.72	2.40	5.77
5.70	2.75	2.20	5.65	2.50	5.80	2.50	5.82	2.50	5.85
5.80	3.00	2.30	5.75	2.60	5.92	2.60	5.92	2.60	5.95
5.84	3.20	2.40	5.82	2.80	6.08	2.80	6.08	2.80	6.10
5.88	3.60	2.60	6.00	3.00	6.20	3.00	6.20	3.00	6.22
5.90	4.10	2.80	6.13	3.20	6.32	3.20	6.32	3.20	6.32
5.92	6.10	3.00	6.25	3.40	6.40	3.40	6.40	3.40	6.40
5.94	9.10	3.20	6.37	3.60	6.48	3.60	6.48	3.60	6.48
		3.40	6.45						
		3.60	6.52						

Table II 6(i)

$N = 0.4878M$ $V^o = 50$ ml. $\mu = 0.2M$ $t = 35^oC$

$E^o = 0.05878M$ $T_L^o = 0.05M$ $T_M^o = 0.001M$

Perchloric acid		2:6-Lutidine		Nickel		Cadmium		Magnesium	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.35	0.80	3.20	0.80	2.80	0.80	3.00	0.80	3.05
1.00	1.40	0.84	3.55	0.84	3.25	0.84	3.25	0.84	3.30
1.50	1.45	0.88	4.25	0.88	3.70	0.88	3.70	0.88	3.75
2.00	1.50	0.90	4.50	0.90	4.05	0.90	4.15	0.90	4.18
2.50	1.55	0.94	4.80	0.94	4.50	0.94	4.55	0.94	4.58
3.00	1.60	0.98	5.00	0.98	4.70	0.98	4.73	0.98	4.80
3.50	1.70	1.00	5.05	1.00	4.75	1.00	4.80	1.00	4.88
4.00	1.80	1.04	5.18	1.04	4.87	1.04	4.90	1.04	5.00
4.50	1.90	1.10	5.32	1.10	5.02	1.10	5.05	1.10	5.15
5.00	2.10	1.20	5.52	1.20	5.20	1.20	5.23	1.20	5.35
5.20	2.20	1.30	5.62	1.30	5.40	1.30	5.45	1.30	5.55
5.40	2.35	1.40	5.72	1.40	5.55	1.40	5.58	1.40	5.65
5.50	2.45	1.50	5.80	1.50	5.65	1.50	5.68	1.50	5.72
5.60	2.65	1.60	5.88	1.60	5.75	1.60	5.78	1.60	5.80
5.70	2.85	1.70	5.95	1.70	5.82	1.70	5.85	1.70	5.88
5.80	3.25	1.80	6.00	1.80	5.90	1.80	5.93	1.80	5.95
5.84	3.75	2.00	6.12	2.00	6.03	2.00	6.05	2.00	6.08
5.86	5.00	2.20	6.22	2.20	6.15	2.20	6.17	2.20	6.18
5.88	7.30	2.40	6.30	2.40	6.25	2.40	6.25	2.40	6.28
5.90	9.20	2.60	6.40	2.60	6.35	2.60	6.35	2.60	6.35
		2.80	6.50	2.80	6.47	2.80	6.47	2.80	6.48
		3.00	6.62	3.00	6.60	3.00	6.60	3.00	6.60

Table II 6(ii)

$N = 0.4878M$ $V^o = 50$ ml. $\mu = 0.2M$ $t = 45^oC$

$E^o = 0.05878M$ $T_I^o = 0.05M$ $T_M^o = 0.001M$

Perchloric acid		2:6-Lutidine		Nickel		Cadmium		Magnesium	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.35	0.80	3.10	0.80	2.90	0.80	2.95	0.80	3.00
1.00	1.40	0.88	4.00	0.88	3.60	0.88	3.65	0.88	3.70
1.50	1.45	0.90	4.35	0.90	3.85	0.90	3.90	0.90	4.10
2.00	1.50	0.94	4.62	0.94	4.35	0.94	4.42	0.94	4.55
2.50	1.55	0.98	4.85	0.98	4.58	0.98	4.60	0.98	4.70
3.00	1.60	1.00	4.95	1.00	4.65	1.00	4.70	1.00	4.82
3.50	1.68	1.04	5.00	1.04	4.75	1.04	4.83	1.04	4.90
4.00	1.78	1.10	5.20	1.10	4.93	1.10	4.97	1.10	5.05
4.50	1.90	1.20	5.38	1.20	5.12	1.20	5.15	1.20	5.25
5.00	2.10	1.30	5.50	1.30	5.30	1.30	5.30	1.30	5.40
5.20	2.20	1.40	5.62	1.40	5.43	1.40	5.45	1.40	5.52
5.40	2.35	1.50	5.72	1.50	5.55	1.50	5.57	1.50	5.62
5.50	2.45	1.60	5.80	1.60	5.65	1.60	5.67	1.60	5.75
5.60	2.60	1.70	5.87	1.70	5.75	1.70	5.77	1.70	5.82
5.70	2.75	1.80	5.92	1.80	5.85	1.80	5.85	1.80	5.88
5.80	3.00	2.00	6.05	2.00	5.98	2.00	5.98	2.00	6.00
5.84	3.20	2.20	6.15	2.20	6.10	2.20	6.10	2.20	6.12
5.88	3.60	2.40	6.25	2.40	6.20	2.40	6.20	2.40	6.20
5.90	4.10	2.60	6.35	2.60	6.30	2.60	6.30	2.60	6.30
5.92	6.10	3.00	6.45	3.00	6.40	3.00	6.40	3.00	6.40
5.94	9.10								

Table II 7(i)

$N = 0.4878M$ $V^o = 50$ ml. $\mu = 0.2M$ $t = 35^oC$

$E^o = 0.05878M$ $T_L^o = 0.05M$ $T_M^o = 0.001M$

Perchloric acid		2:4:6-Collidine		Nickel		Cadmium		Magnesium	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.35	0.80	2.88	0.80	2.78	0.80	2.80	0.80	2.82
1.00	1.40	0.90	3.45	0.90	3.20	0.90	3.25	0.90	3.30
1.50	1.45	0.94	4.20	0.94	3.65	0.94	3.70	0.94	3.75
2.00	1.50	0.98	4.85	0.98	4.30	0.98	4.35	0.98	4.40
2.50	1.55	1.00	5.00	1.00	4.55	1.00	4.62	1.00	4.70
3.00	1.60	1.04	5.23	1.04	4.80	1.04	4.85	1.04	4.98
3.50	1.70	1.10	5.50	1.10	5.05	1.10	5.08	1.10	5.22
4.00	1.80	1.20	5.70	1.20	5.30	1.20	5.35	1.20	5.55
4.50	1.90	1.30	5.90	1.30	5.58	1.30	5.60	1.30	5.75
5.00	2.10	1.40	6.05	1.40	5.75	1.40	5.78	1.40	5.92
5.20	2.20	1.50	6.20	1.50	5.95	1.50	5.98	1.50	6.10
5.40	2.35	1.60	6.30	1.60	6.15	1.60	6.18	1.60	6.22
5.50	2.45	1.70	6.40	1.70	6.28	1.70	6.30	1.70	6.35
5.60	2.65	1.80	6.48	1.80	6.38	1.80	6.40	1.80	6.45
5.70	2.85	1.90	6.58	1.90	6.48	1.90	6.48	1.90	6.53
5.80	3.25	2.00	6.65	2.00	6.58	2.00	6.58	2.00	6.60
5.84	3.75	2.20	6.75	2.20	6.70	2.20	6.70	2.20	6.72
5.86	5.00	2.40	6.82	2.40	6.78	2.40	6.78	2.40	6.78
5.88	7.30	2.60	6.90	2.60	6.85	2.60	6.85	2.60	6.87
5.90	9.20								

Table II 7(ii)

$N = 0.4878M$ $V^0 = 50$ ml. $\mu = 0.2M$ $t = 45^oC$

$E^0 = 0.05878M$ $T_L^0 = 0.05M$ $T_M^0 = 0.001M$

Perchloric acid		2:4:6-Collidine		Nickel		Cadmium		Magnesium	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.35	0.80	2.82	0.80	2.60	0.80	2.62	0.80	2.65
1.00	1.40	0.90	3.38	0.90	3.22	0.90	3.28	0.90	3.35
1.50	1.45	0.94	4.00	0.94	3.60	0.94	3.65	0.94	3.70
2.00	1.50	0.98	4.65	0.98	4.20	0.98	4.25	0.98	4.40
2.50	1.55	1.00	4.85	1.00	4.55	1.00	4.60	1.00	4.65
3.00	1.60	1.04	5.05	1.04	4.75	1.04	4.80	1.04	4.88
3.50	1.68	1.10	5.30	1.10	4.95	1.10	4.98	1.10	5.08
4.00	1.78	1.20	5.55	1.20	5.18	1.20	5.22	1.20	5.35
4.50	1.90	1.30	5.73	1.30	5.40	1.30	5.43	1.30	5.58
5.00	2.10	1.40	5.87	1.40	5.60	1.40	5.62	1.40	5.75
5.20	2.20	1.50	6.00	1.50	5.78	1.50	5.80	1.50	5.90
5.40	2.35	1.60	6.10	1.60	5.92	1.60	5.95	1.60	6.05
5.50	2.45	1.70	6.20	1.70	6.05	1.70	6.08	1.70	6.15
5.60	2.60	1.80	6.28	1.80	6.17	1.80	6.20	1.80	6.25
5.70	2.75	1.90	6.35	1.90	6.25	1.90	6.28	1.90	6.30
5.80	3.00	2.00	6.42	2.00	6.35	2.00	6.35	2.00	6.38
5.84	3.20	2.20	6.52	2.20	6.45	2.20	6.45	2.20	6.48
5.88	3.60	2.40	6.62	2.40	6.55	2.40	6.55	2.40	6.58
5.90	4.10	2.60	6.70	2.60	6.65	2.60	6.65	2.60	6.68
5.92	6.10	2.80	6.78	2.80	6.73	2.80	6.72	2.80	6.75
5.94	9.10	3.00	6.85	3.00	6.80	3.00	6.80	3.00	6.82

Table II 8(i)

N = 0.4878M V^o = 50 ml. μ = 0.2M t = 35°C

E^o = 0.05878M T_L^o = 0.05M T_M^o = 0.001M

Perchloric acid		2-Aminopyridine		Nickel		Cadmium		Magnesium	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.35	0.80	2.95	0.80	2.88	0.80	2.90	0.80	2.90
1.00	1.40	0.90	3.83	0.90	3.48	0.90	3.50	0.90	3.52
1.50	1.45	0.94	4.50	0.94	4.10	0.94	4.12	0.94	4.15
2.00	1.50	0.98	4.80	0.98	4.40	0.98	4.50	0.98	4.60
2.50	1.55	1.00	4.90	1.00	4.52	1.00	4.60	1.00	4.70
3.00	1.60	1.04	5.07	1.04	4.68	1.04	4.75	1.04	4.90
3.50	1.70	1.10	5.23	1.10	4.86	1.10	4.92	1.10	5.05
4.00	1.80	1.20	5.42	1.20	5.13	1.20	5.17	1.20	5.27
4.50	1.90	1.30	5.58	1.30	5.32	1.30	5.35	1.30	5.43
5.00	2.10	1.40	5.68	1.40	5.45	1.40	5.48	1.40	5.48
5.20	2.20	1.50	5.75	1.50	5.60	1.50	5.62	1.50	5.70
5.40	2.35	1.60	5.83	1.60	5.72	1.60	5.75	1.60	5.78
5.50	2.45	1.70	5.90	1.70	5.82	1.70	5.84	1.70	5.85
5.60	2.65	1.80	5.97	1.80	5.88	1.80	5.90	1.80	5.92
5.70	2.85	2.00	6.10	2.00	6.02	2.00	6.05	2.00	6.05
5.80	3.25	2.20	6.20	2.20	6.15	2.20	6.15	2.20	6.17
5.84	3.75	2.40	6.28	2.40	6.22	2.40	6.22	2.40	6.25
5.86	5.00	2.60	6.35	2.60	6.30	2.60	6.30	2.60	6.32
5.88	7.30	2.80	6.45	2.80	6.40	2.80	6.40	2.80	6.40
5.90	9.20	2.90	6.50	2.90	6.45	2.90	6.45	2.90	6.45
		3.00	6.55	3.00	6.50	3.00	6.50	3.00	6.52

Table II 8(ii)

N = 0.4878M V^o = 50 ml. μ = 0.2M t = 45°C

E^o = 0.05878M T_L^o = 0.05M T_M^o = 0.001M

Perchloric acid		2-Aminopyridine		Nickel		Cadmium		Magnesium	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.35	0.80	2.90	0.80	2.82	0.80	2.85	0.80	2.85
1.00	1.40	0.90	3.52	0.90	3.40	0.90	3.42	0.90	3.42
1.50	1.45	0.92	3.80	0.94	3.60	0.94	3.65	0.94	3.70
2.00	1.50	0.94	4.13	0.98	4.25	0.98	4.28	0.98	4.35
2.50	1.55	0.98	4.50	1.00	4.35	1.00	4.40	1.00	4.50
3.00	1.60	1.00	4.65	1.04	4.53	1.04	4.58	1.04	4.65
3.50	1.68	1.04	4.80	1.10	4.70	1.10	4.75	1.10	4.85
4.00	1.78	1.10	5.00	1.20	4.90	1.20	4.95	1.20	5.07
4.50	1.90	1.20	5.20	1.30	5.12	1.30	5.15	1.30	5.25
5.00	2.10	1.30	5.37	1.40	5.25	1.40	5.28	1.40	5.38
5.20	2.20	1.40	5.50	1.50	5.40	1.50	5.42	1.50	5.50
5.40	2.35	1.50	5.57	1.60	5.52	1.60	5.55	1.60	5.58
5.50	2.45	1.60	5.63	1.70	5.60	1.70	5.62	1.70	5.65
5.60	2.60	1.70	5.70	1.80	5.70	1.80	5.70	1.80	5.72
5.70	2.75	1.80	5.77	2.00	5.82	2.00	5.85	2.00	5.85
5.80	3.00	2.00	5.90	2.20	5.95	2.20	5.95	2.20	5.95
5.84	3.20	2.20	6.00	2.40	6.05	2.40	6.05	2.40	6.05
5.88	3.60	2.40	6.10	2.60	6.12	2.60	6.12	2.60	6.15
5.90	4.10	2.60	6.18	2.80	6.20	2.80	6.20	2.80	6.22
5.92	6.10	2.80	6.25	3.00	6.28	3.00	6.28	3.00	6.28
5.94	9.10	3.00	6.32	3.20	6.35	3.20	6.35	3.20	6.35
		3.20	6.37	3.40	6.42	3.40	6.42	3.40	6.45
		3.40	6.48						

Table II 9(i)

$N = 0.63M$
$E^o = 0.075M$

$V^o = 50$ ml.
$T_L^o = 0.05M$

$\mu = 0.2M$

$t = 35^oC$

$T_M^o = 0.001M$

Perchloric acid

Vol.of alkali (in ml.)	B
0.00	1.40
1.00	1.55
1.50	1.60
2.00	1.65
2.50	1.70
3.00	1.75
3.50	1.85
4.00	1.95
4.50	2.05
5.00	2.22
5.20	2.30
5.40	2.48
5.50	2.57
5.60	2.65
5.70	2.80
5.80	3.05
5.90	3.68
5.94	5.72
5.96	6.80
5.98	8.90

2-Amino-4-methylpyridine

Vol.of alkali (in ml.)	B
0.20	2.00
0.40	2.05
0.60	2.10
0.80	2.18
1.00	2.25
1.10	2.32
1.20	2.38
1.30	2.45
1.40	2.52
1.50	2.60
1.60	2.70
1.70	2.87
1.80	3.12
1.84	3.40
1.88	3.84
1.90	4.40
1.96	5.20
2.00	5.57
2.10	5.92
2.20	6.13
2.30	6.28
2.40	6.40
2.50	6.47
2.60	6.52
2.80	6.65
3.00	6.75

Nickel		Cadmium		Magnesium	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
1.20	2.30	1.20	2.30	1.20	2.32
1.30	2.40	1.30	2.40	1.30	2.40
1.40	2.45	1.40	2.48	1.40	2.48
1.50	2.52	1.50	2.55	1.50	2.57
1.60	2.62	1.60	2.62	1.60	2.65
1.70	2.80	1.70	2.80	1.70	2.82
1.80	3.00	1.80	3.02	1.80	3.05
1.84	3.18	1.84	3.20	1.84	3.22
1.88	3.60	1.88	3.62	1.88	3.65
1.90	3.75	1.90	3.85	1.90	3.90
1.96	4.85	1.96	4.95	1.96	5.00
2.00	5.20	2.00	5.28	2.00	5.30
2.10	5.58	2.10	5.65	2.10	5.70
2.20	5.85	2.20	5.88	2.20	5.96
2.30	6.05	2.30	6.08	2.30	6.15
2.40	6.22	2.40	6.22	2.40	6.30
2.50	6.37	2.50	6.38	2.50	6.42
2.60	6.45	2.60	6.45	2.60	6.50
2.80	6.60	2.80	6.60	2.80	6.62
3.00	6.70	3.00	6.70	3.00	6.70

Table II 9(ii)

N = 0.63M V_i^o = 50 ml. μ = 0.2M t = 45°C

E^o = 0.075M T_L^o = 0.05M T_M^o = 0.001M

Perchloric acid		2-Amino-4-methylpyridine		Nickel		Cadmium		Magnesium	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.38	0.00	1.78	1.80	2.82	1.80	2.87	1.80	2.87
1.00	1.40	0.40	1.85	1.84	2.98	1.84	3.05	1.84	3.08
1.50	1.42	0.80	1.98	1.88	3.25	1.88	3.32	1.88	3.35
2.00	1.48	1.00	2.08	1.90	3.48	1.90	3.52	1.90	3.55
2.50	1.52	1.20	2.18	1.94	4.42	1.94	4.45	1.94	4.50
3.00	1.58	1.40	2.30	1.98	4.90	1.98	4.95	1.98	5.00
3.50	1.65	1.50	2.40	2.00	5.02	2.00	5.08	2.00	5.20
4.00	1.75	1.60	2.53	2.04	5.25	2.04	5.30	2.04	5.33
4.50	1.88	1.70	2.70	2.10	5.43	2.10	5.47	2.10	5.50
5.00	2.05	1.80	2.90	2.20	5.65	2.20	5.67	2.20	5.72
5.20	2.15	1.84	3.10	2.30	5.82	2.30	5.85	2.30	5.90
5.40	2.30	1.88	3.65	2.40	5.97	2.40	5.98	2.40	6.02
5.60	2.50	1.90	4.20	2.60	6.18	2.60	6.18	2.60	6.25
5.70	2.65	1.94	4.75	2.80	6.40	2.80	6.40	2.80	6.42
5.80	2.95	1.98	5.22	3.00	6.50	3.00	6.52	3.00	6.55
5.90	3.68	2.00	5.30	3.20	6.60	3.20	6.62	3.20	6.65
5.94	6.10	2.04	5.48	3.40	6.75	3.40	6.75	3.40	6.75
5.96	8.50	2.10	5.65						
		2.20	5.85						
		2.30	6.00						
		2.40	6.12						
		2.60	6.32						
		2.80	6.48						
		3.00	6.58						
		3.20	6.68						
		3.40	6.80						

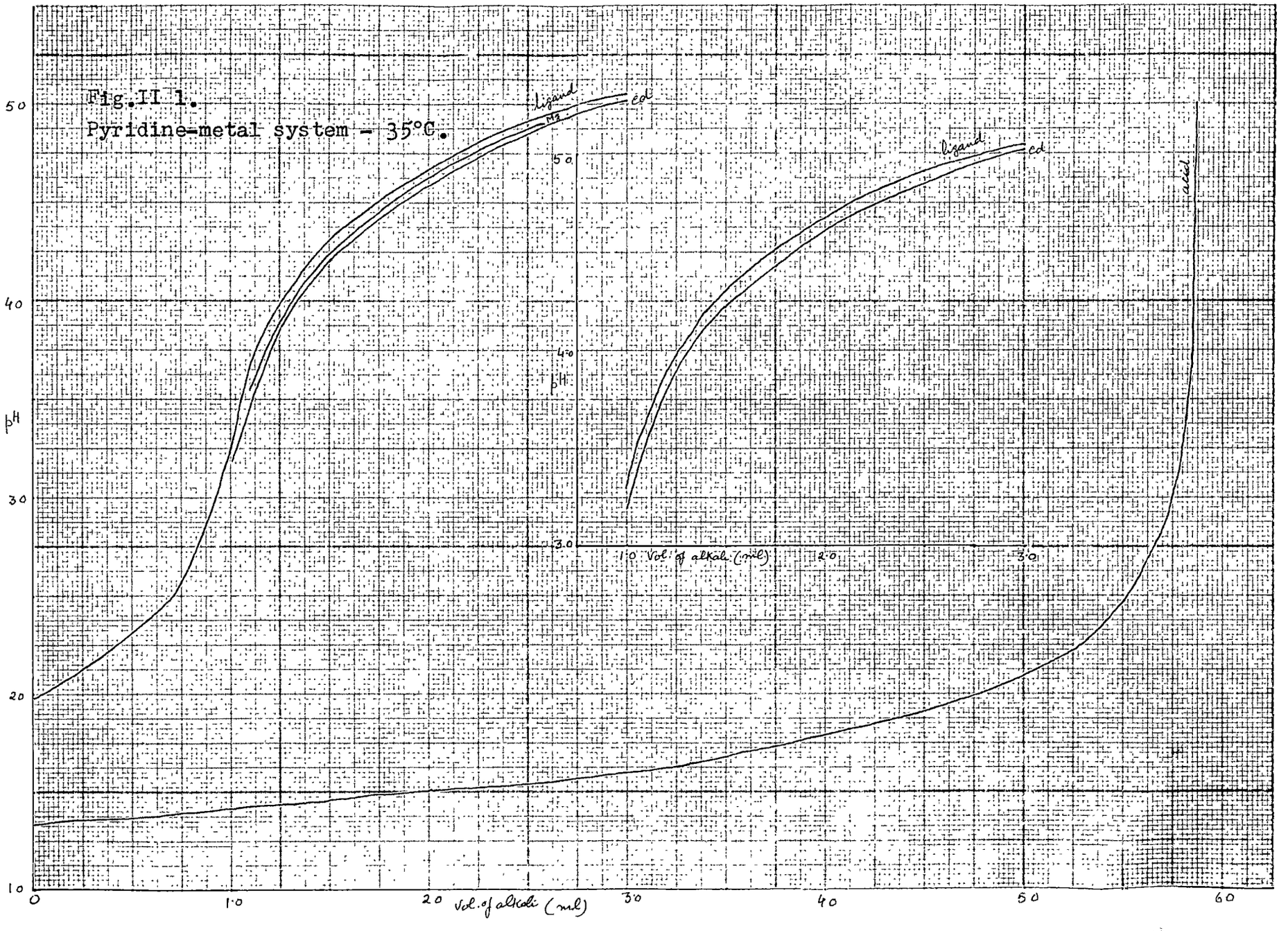


Fig.II 1.
Pyridine-metal system - 35°C.
ligand
M2
acid
pH
Vol. of alkali (ml)
5.0
4.0
3.0
1.0
2.0
3.0
10
20
30
40
50
60

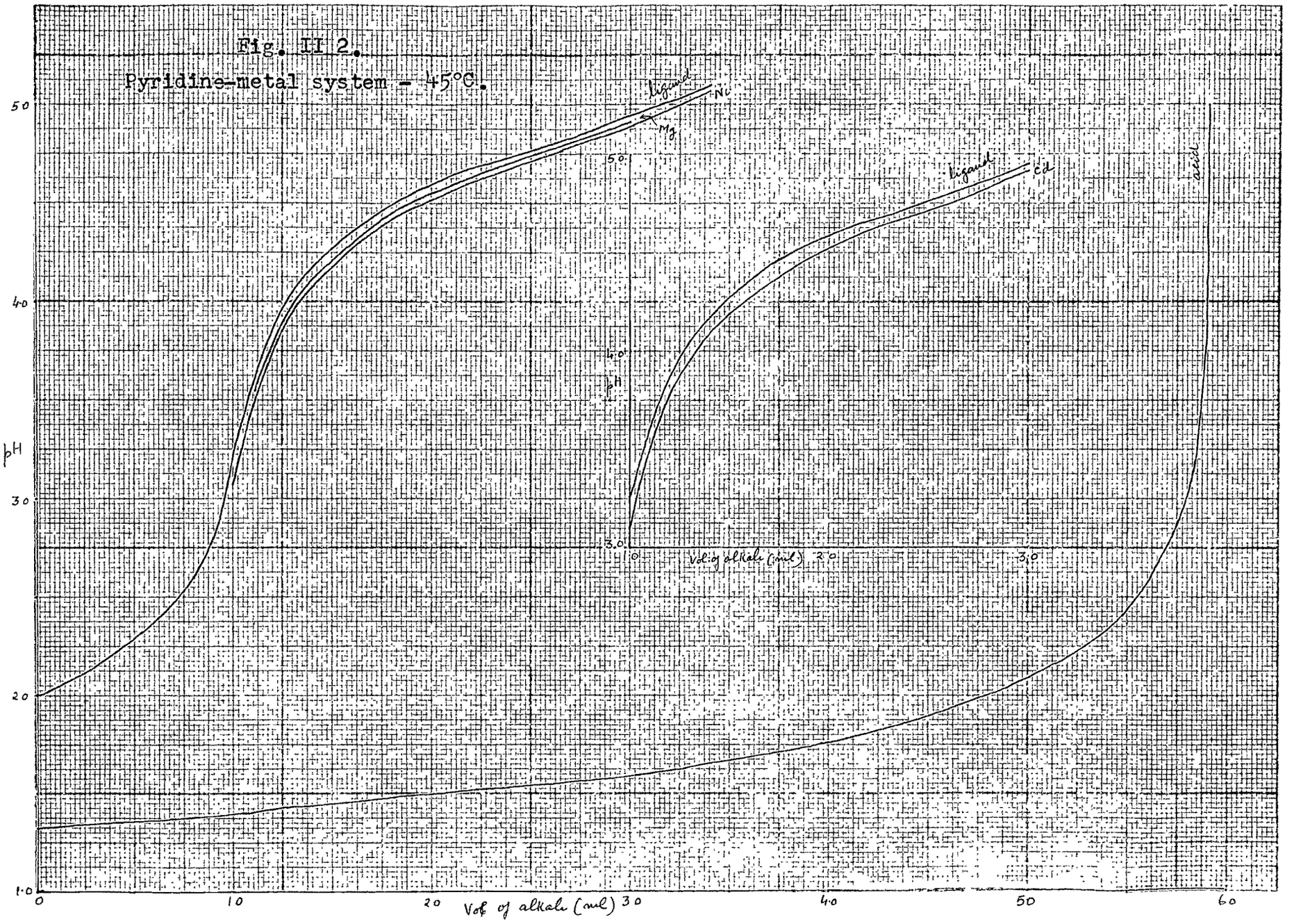


Fig. II 2.
Pyridine-metal system - 45°C.
pH
Vol of alkali (ml)
Ligand
Ni
Mg
Cd
Acid
5.0
4.0
3.0
0
10
20
30
40
50
60
1.0
2.0
3.0
4.0
5.0

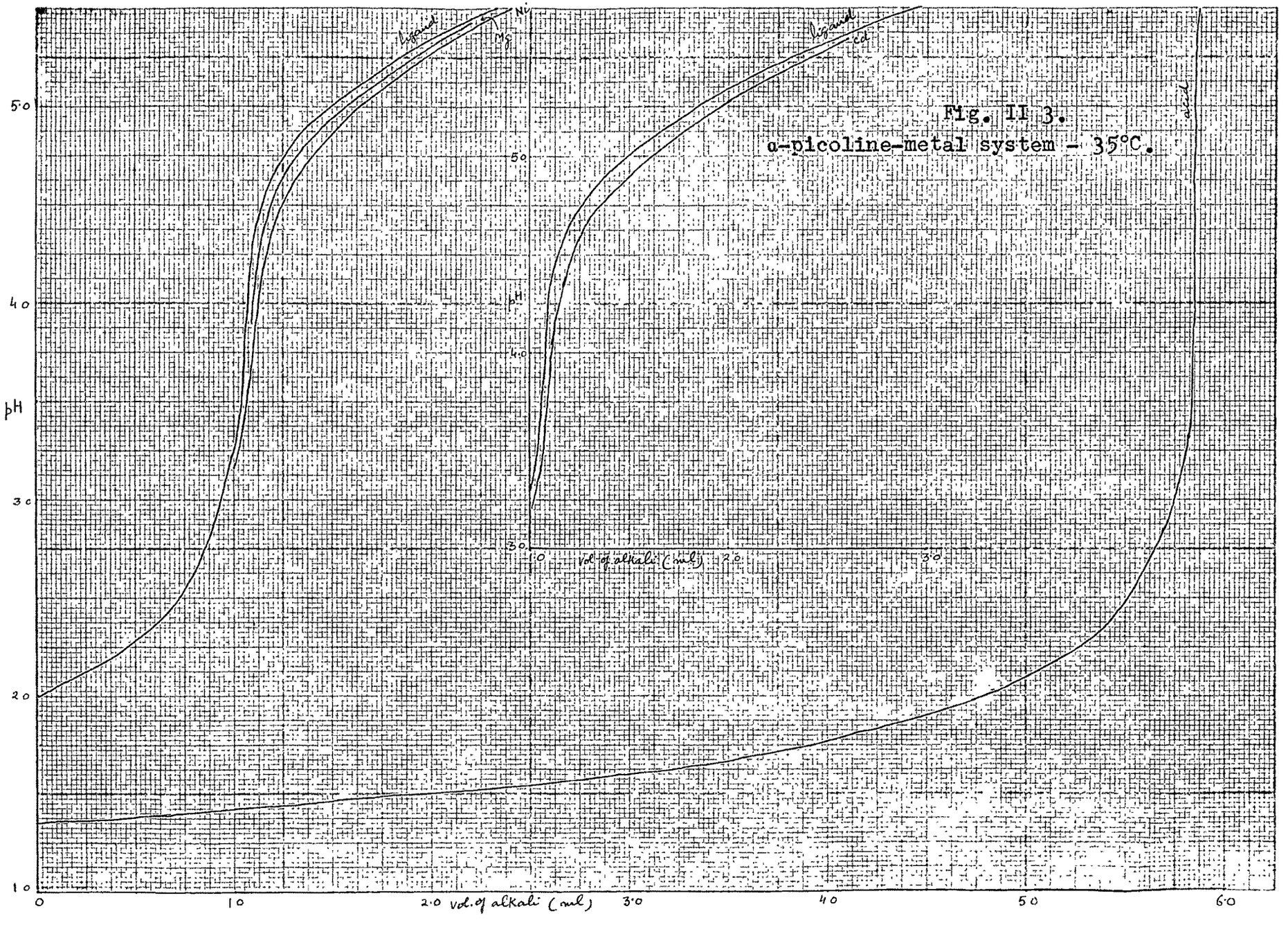


Fig. II 3.
α-picoline-metal system - 35°C.
Ligand
Ni
Mg
Cd
Acid
pH
5·0
4·0
3·0
2·0
1·0
0
1·0
2·0
3·0
4·0
5·0
6·0
Vol. of alkali (ml)

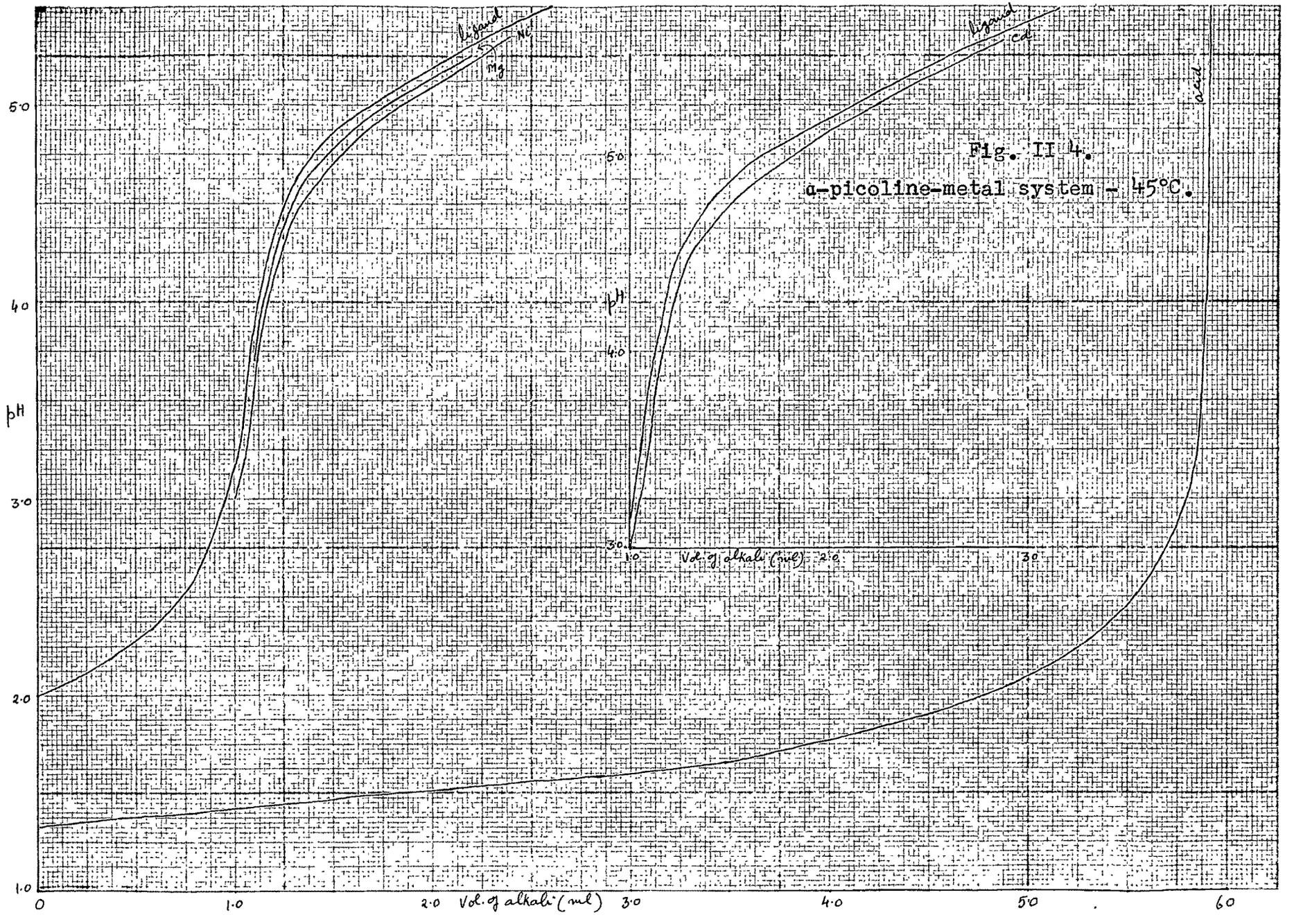


Fig. II 4.

a-picoline-metal system - 45°C.

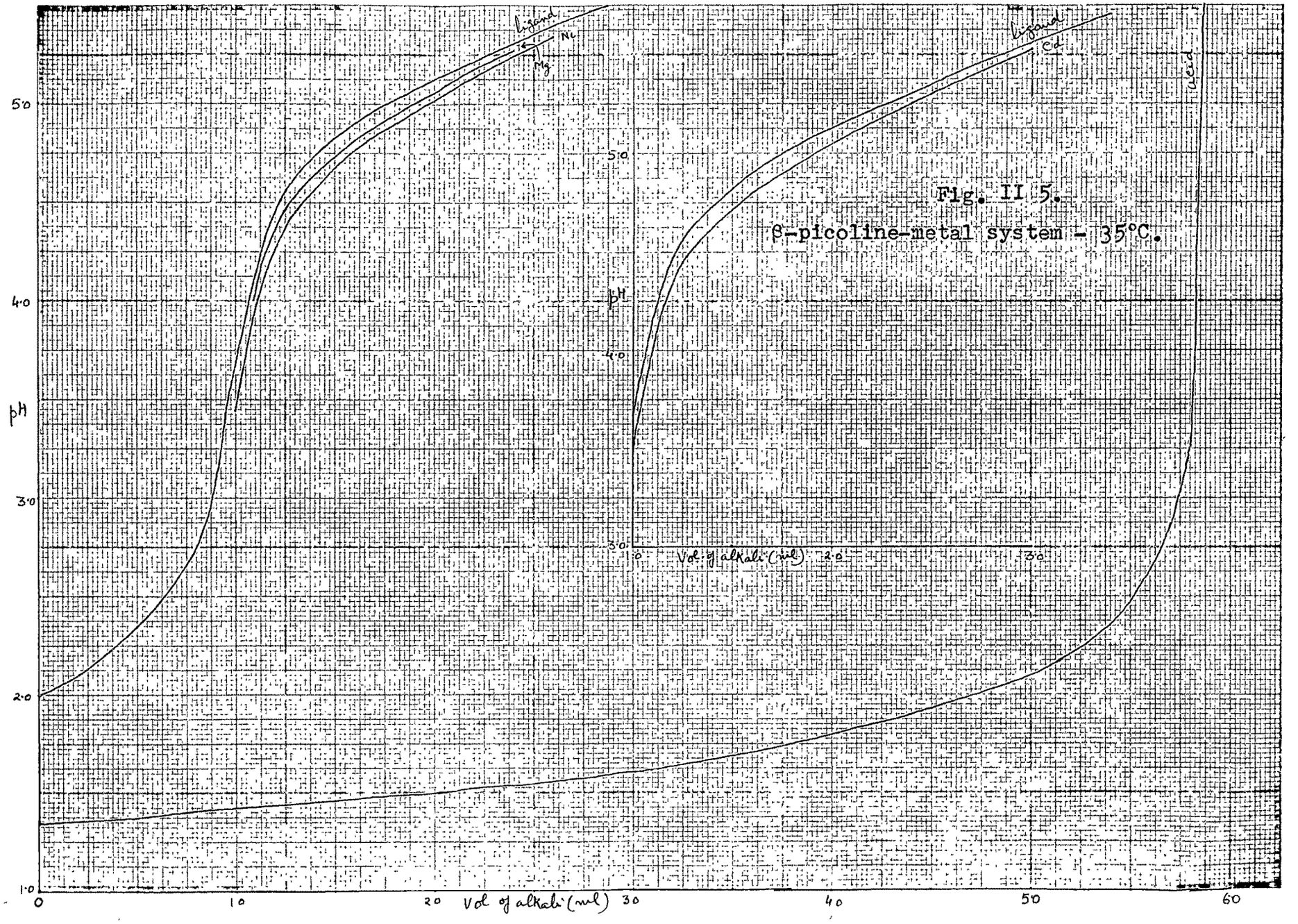


Fig. II 5.

β-picoline-metal system - 35°C.

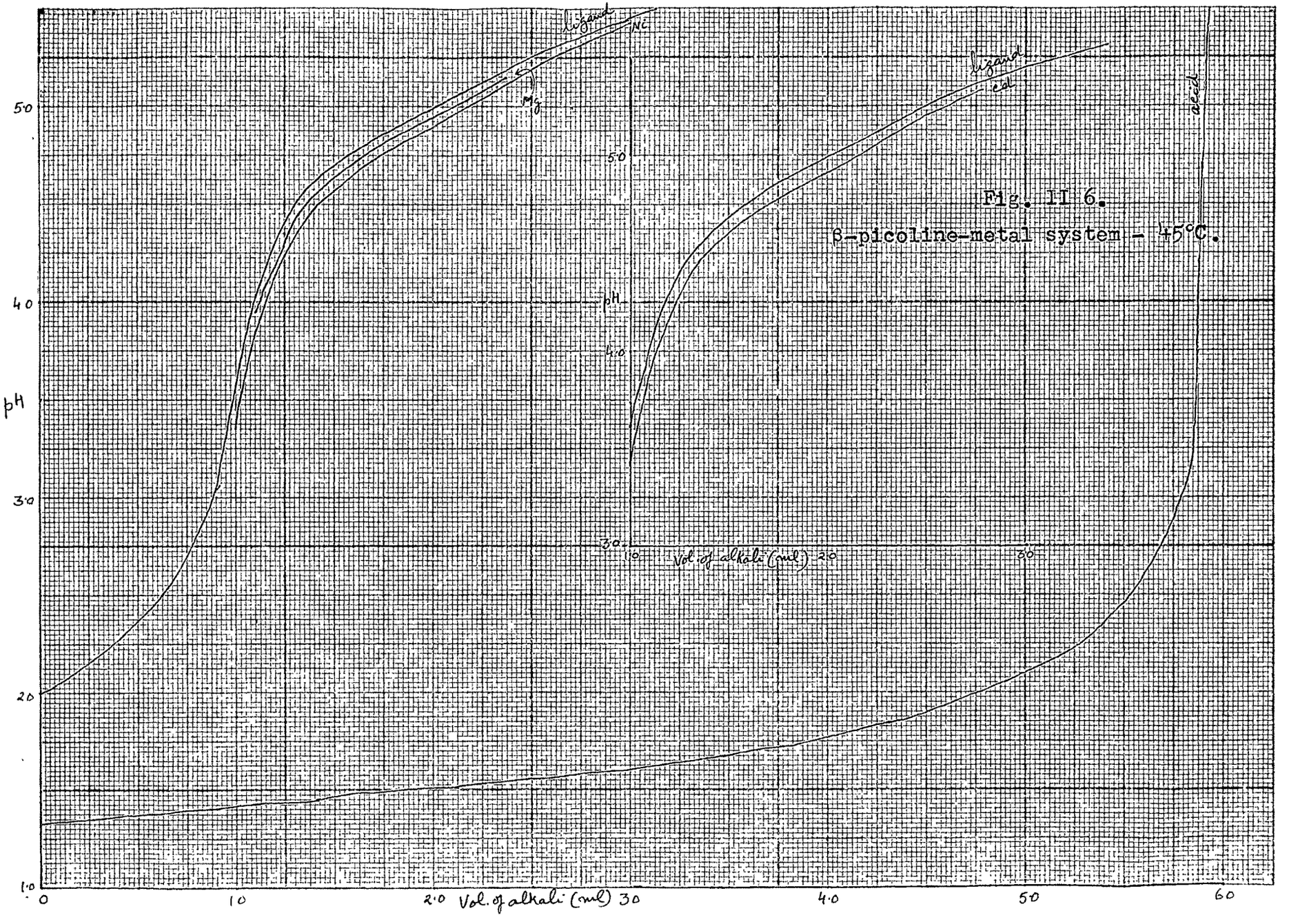


Fig. II 6.

8-picoline-metal system - 45°C.

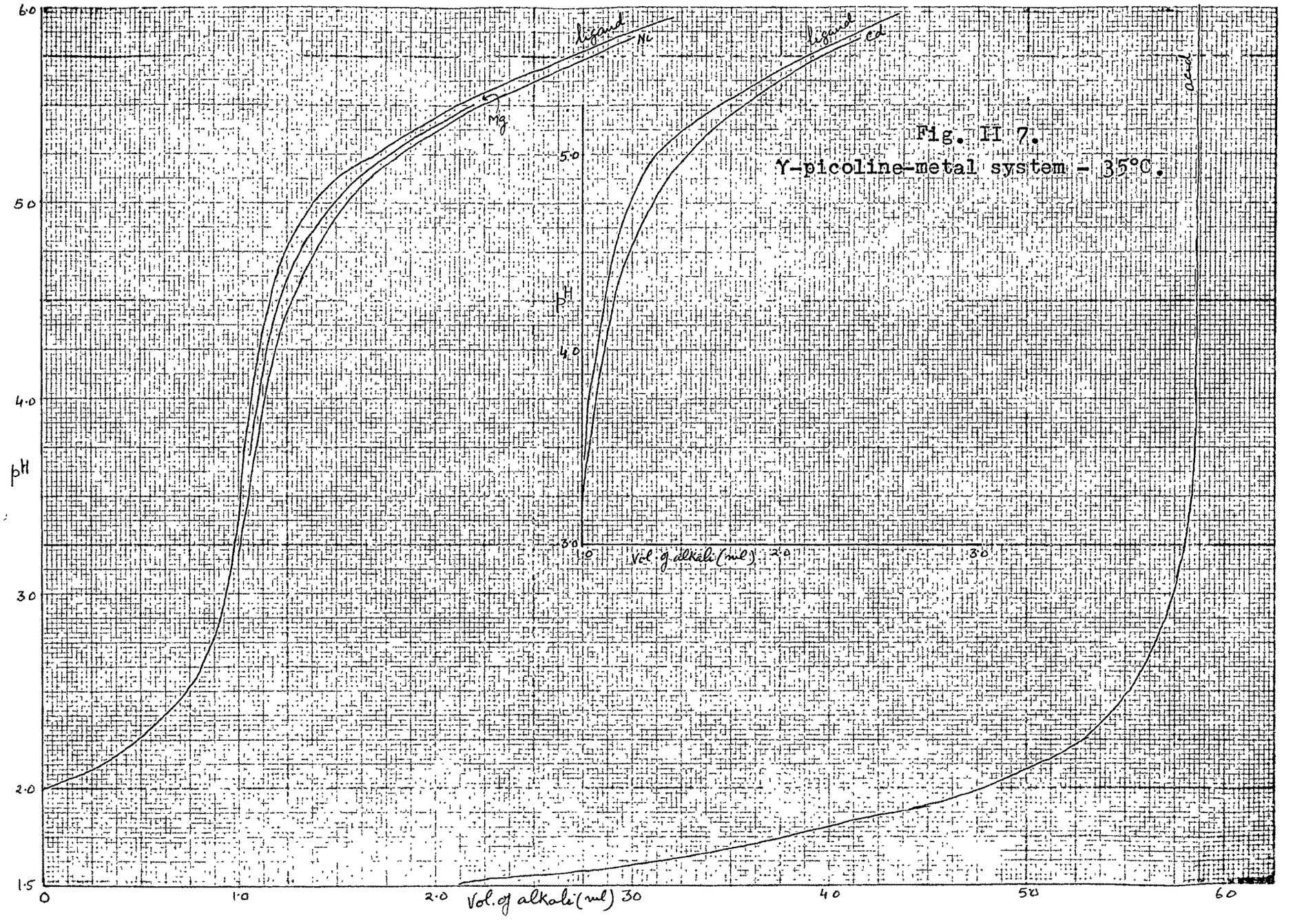


Fig. II 7.
Y-picoline-metal system - 35°C.
ligand
Ni
Mg
ligand
Cd
pH
Vol. of alkali (ml)
6.0
5.0
4.0
3.0
2.0
1.5
0
1.0
2.0
30
40
50
60

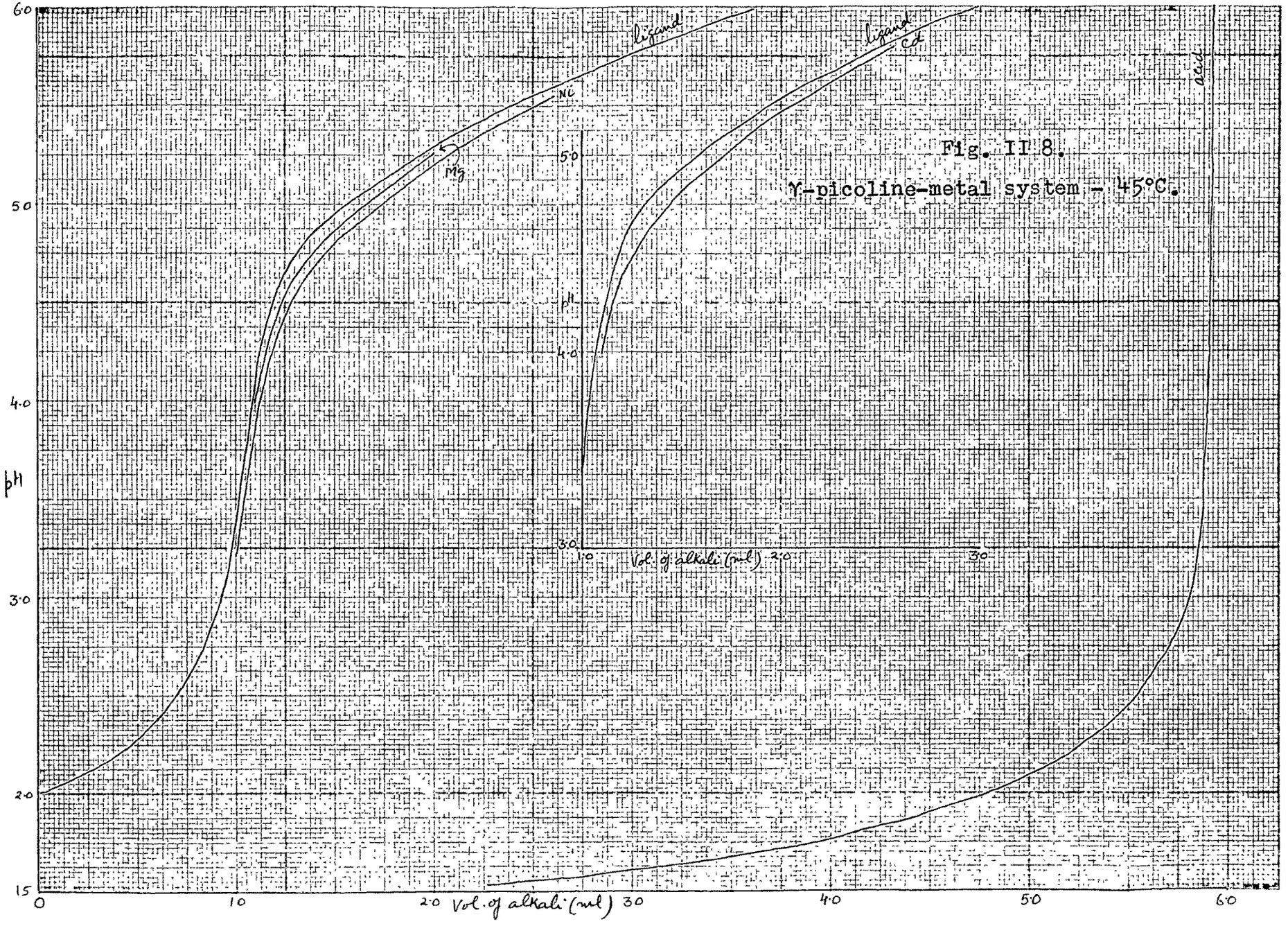


Fig. II 8.
γ-picoline-metal system – 45°C.
ligand
NC
Mg
ligand
Cd
acid
pH
Vol. of alkali (ml)
6·0
5·0
4·0
3·0
2·0
1·5
0
1·0
2·0
3·0
4·0
5·0
6·0

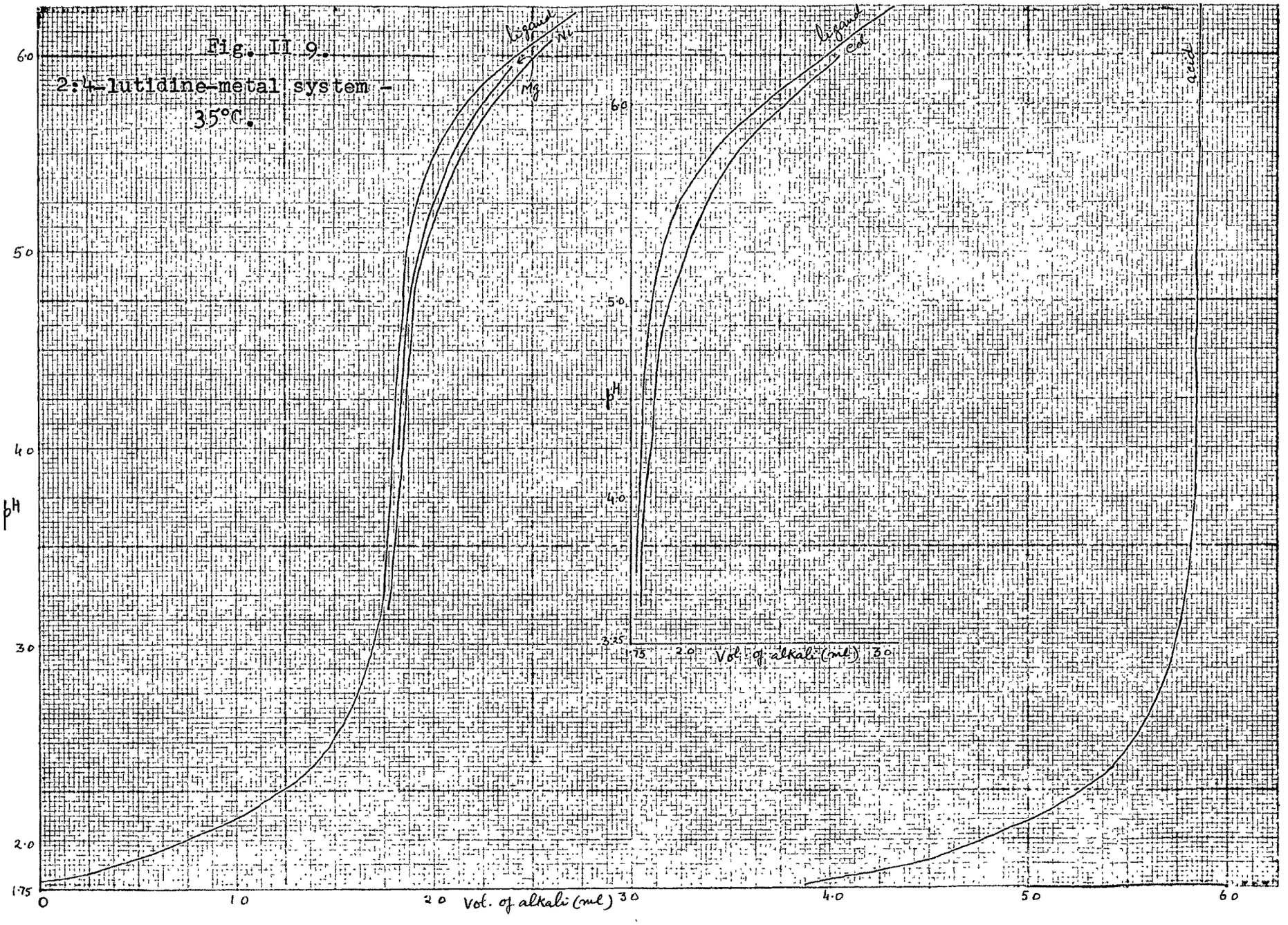
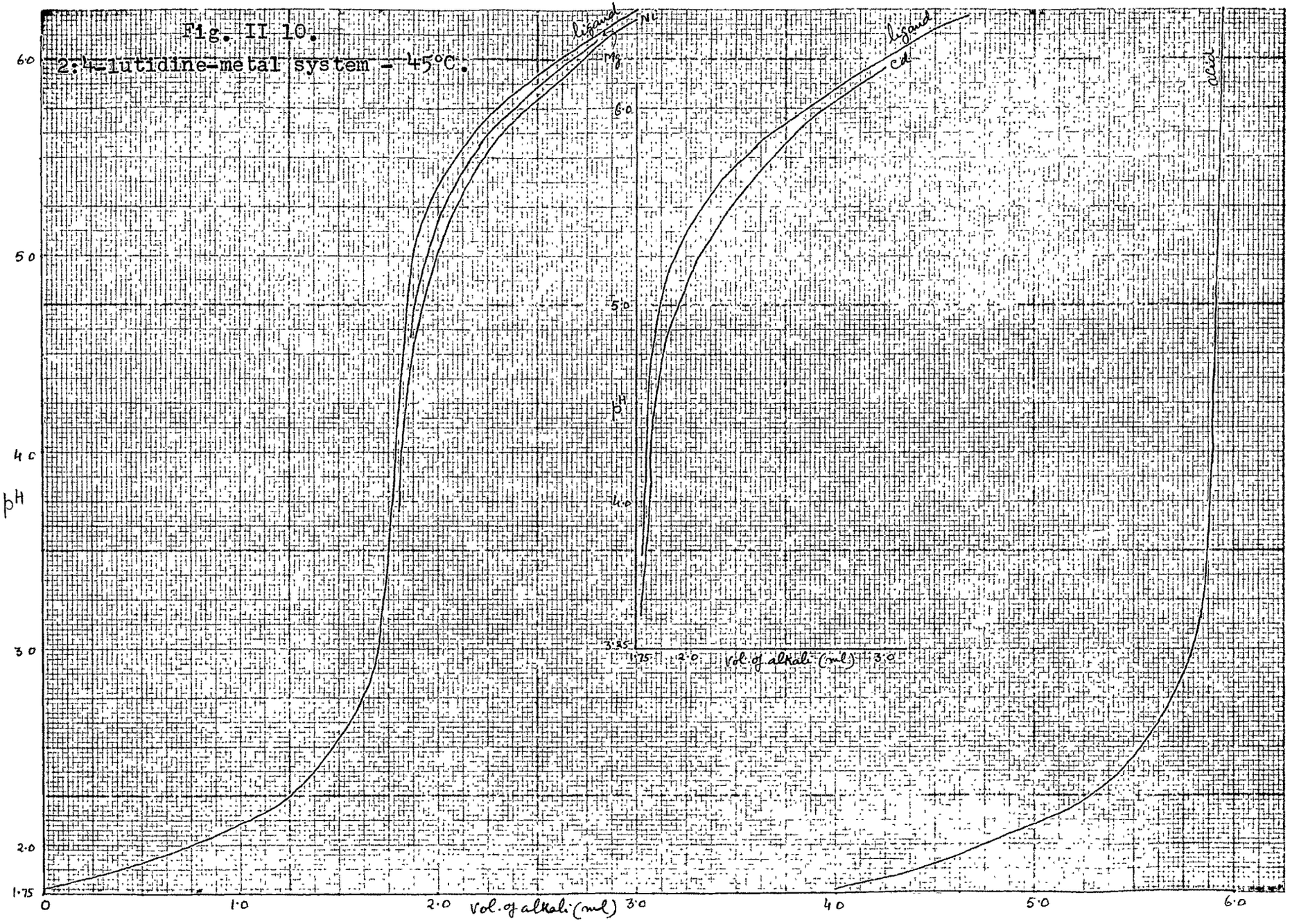


Fig. II 9.
2:4-lutidine-metal system -
35°C.
Ligand
Ni
Co
Mg
Ligand
acid
pH
Vol. of alkali (ml)
6·0
5·0
4·0
3·0
2·0
1·75
0
10
20
30
40
50
60
3·25

Fig. II 10.

2:4-lutidine-metal system – 45°C.



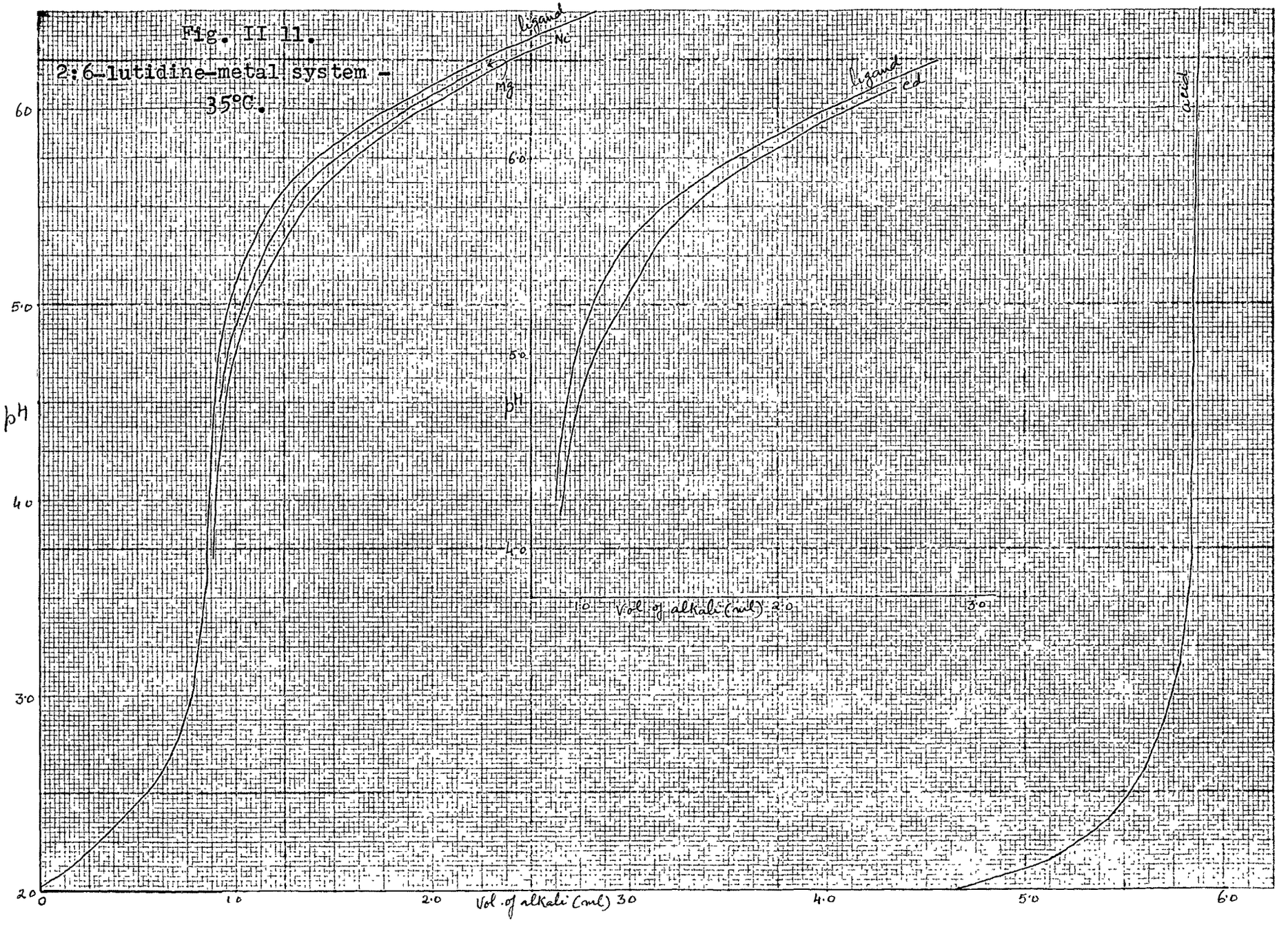


Fig. II 11.
2:6-lutidine-metal system -
35°C.
Ligand
Ni
Mg
Ligand
Cd
Ligand
pH
Vol. of alkali (ml)
1.0
2.0
3.0
4.0
5.0
6.0

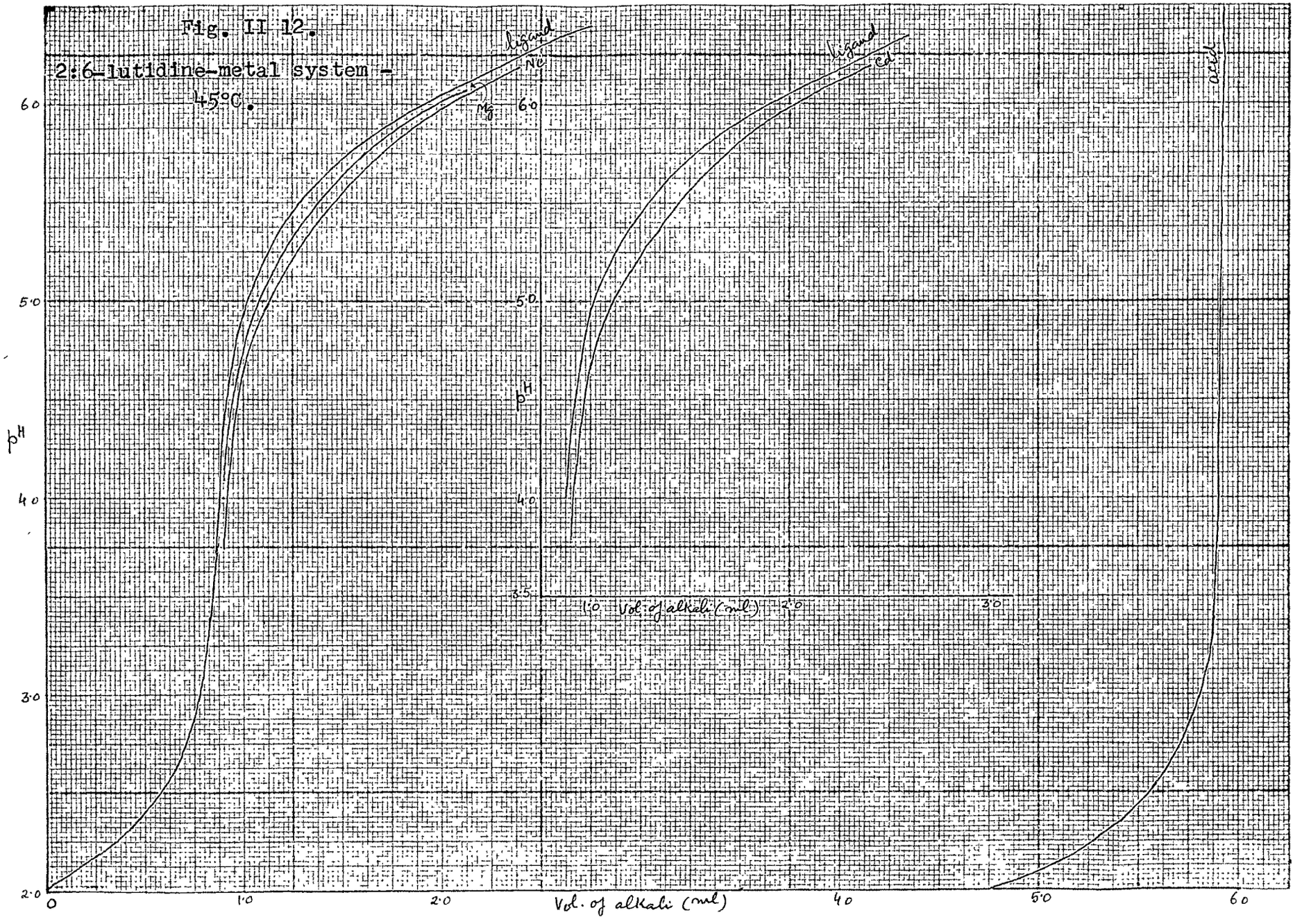


Fig. II 12.
2:6-lutidine-metal system -
45°C.
ligand
Ni
Mg
6·0
5·0
4·0
3·5
3·0
2·0
pH
1·0
2·0
3·0
Vol. of alkali (ml)
ligand
Cd
acid
4·0
5·0
6·0
Vol. of alkali (ml)

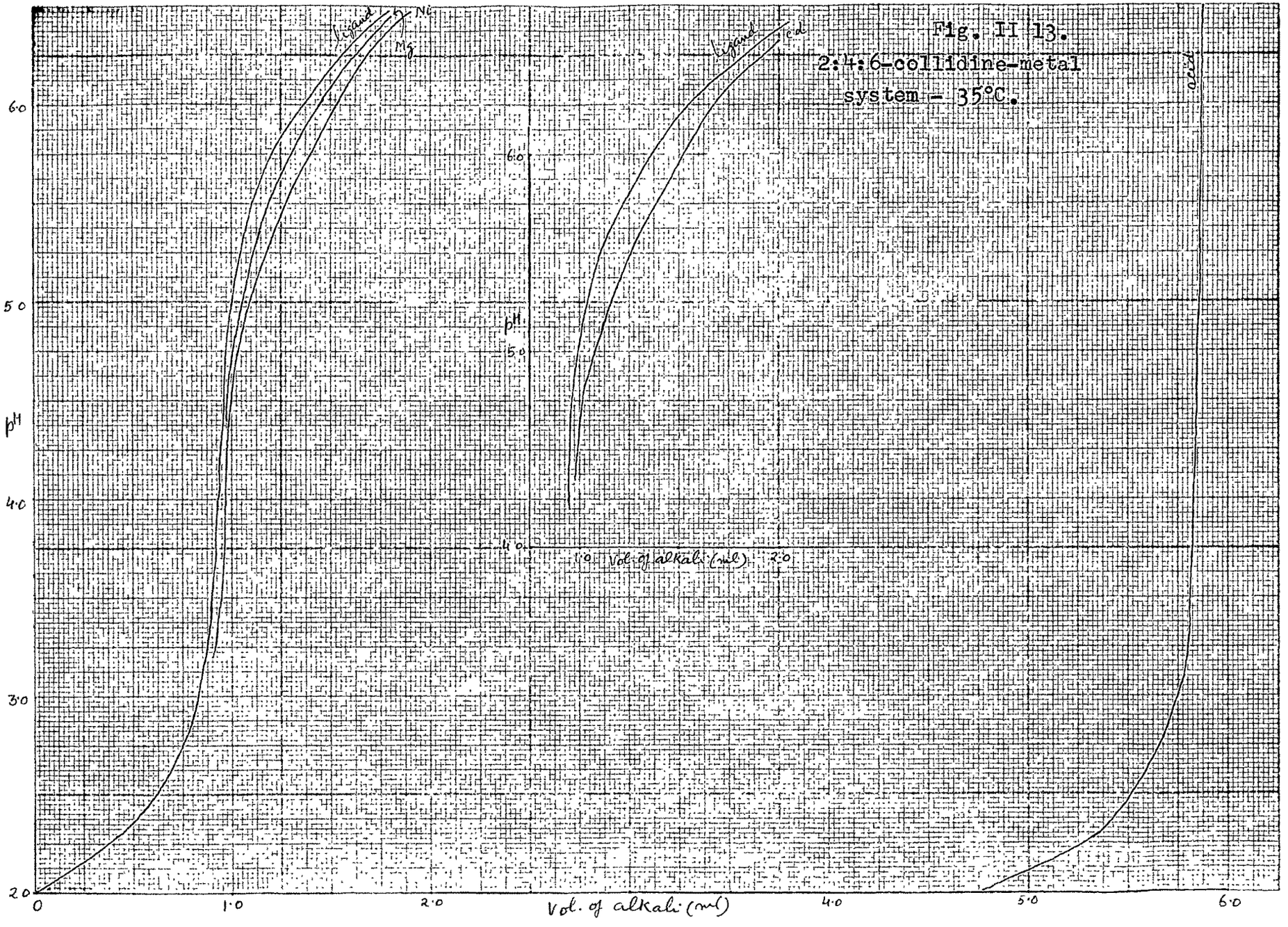


Fig. II 13.
2:4:6-collidine-metal
system - 35°C.
Ligand
Mg
Ligand
Cd
pH
Vol. of alkali (ml)
6.0
5.0
4.0
3.0
2.0
0
1.0
2.0
4.0
5.0
6.0

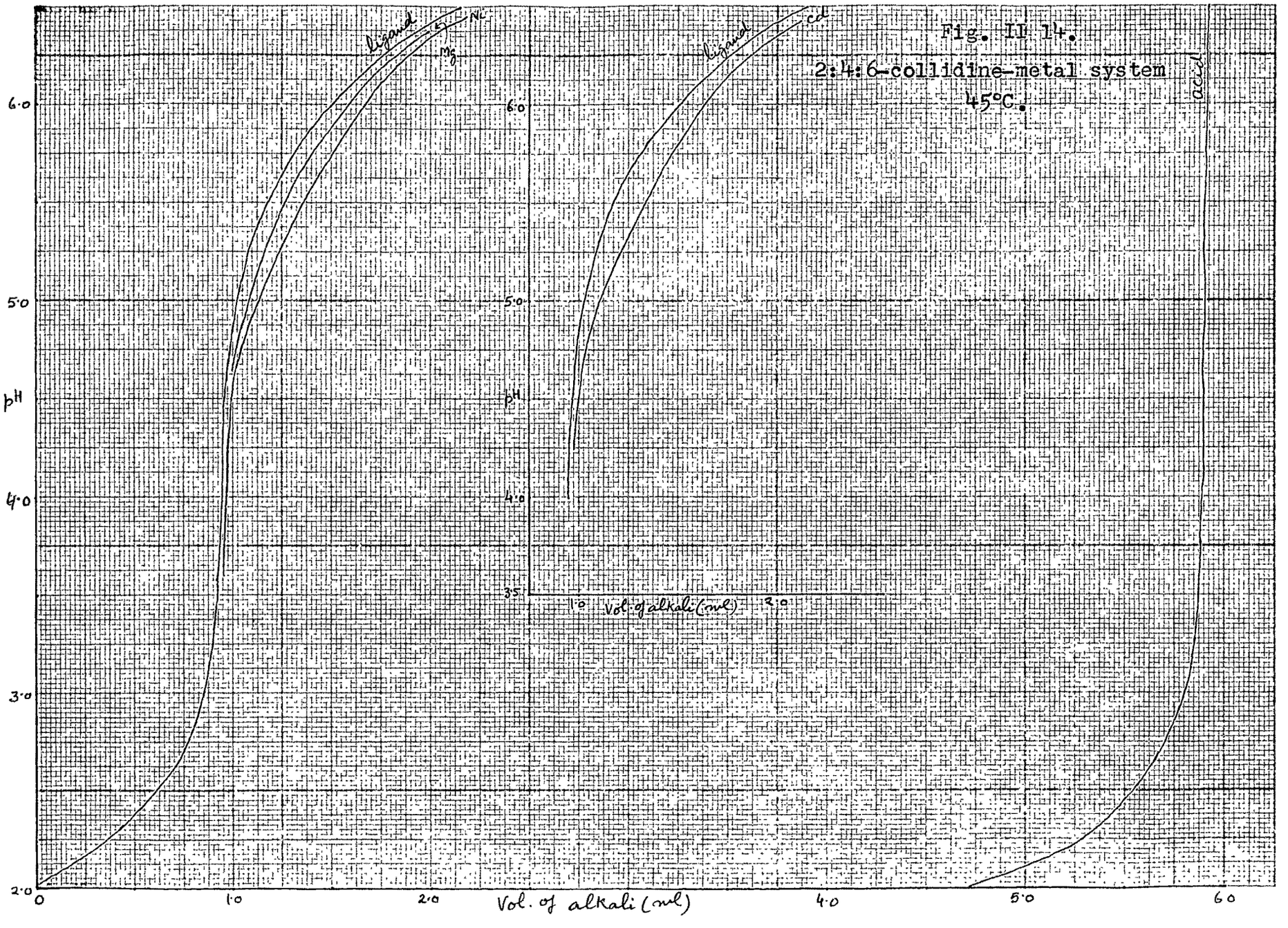


Fig. III 14.
2:4:6-collidine-metal system
45°C.
Ligand
Ni
Mg
Ligand
Cd
acid
pH
6·0
5·0
4·0
3·0
2·0
3·5
0
1·0
2·0
4·0
5·0
6·0
Vol. of alkali (ml)
Vol. of alkali (ml)

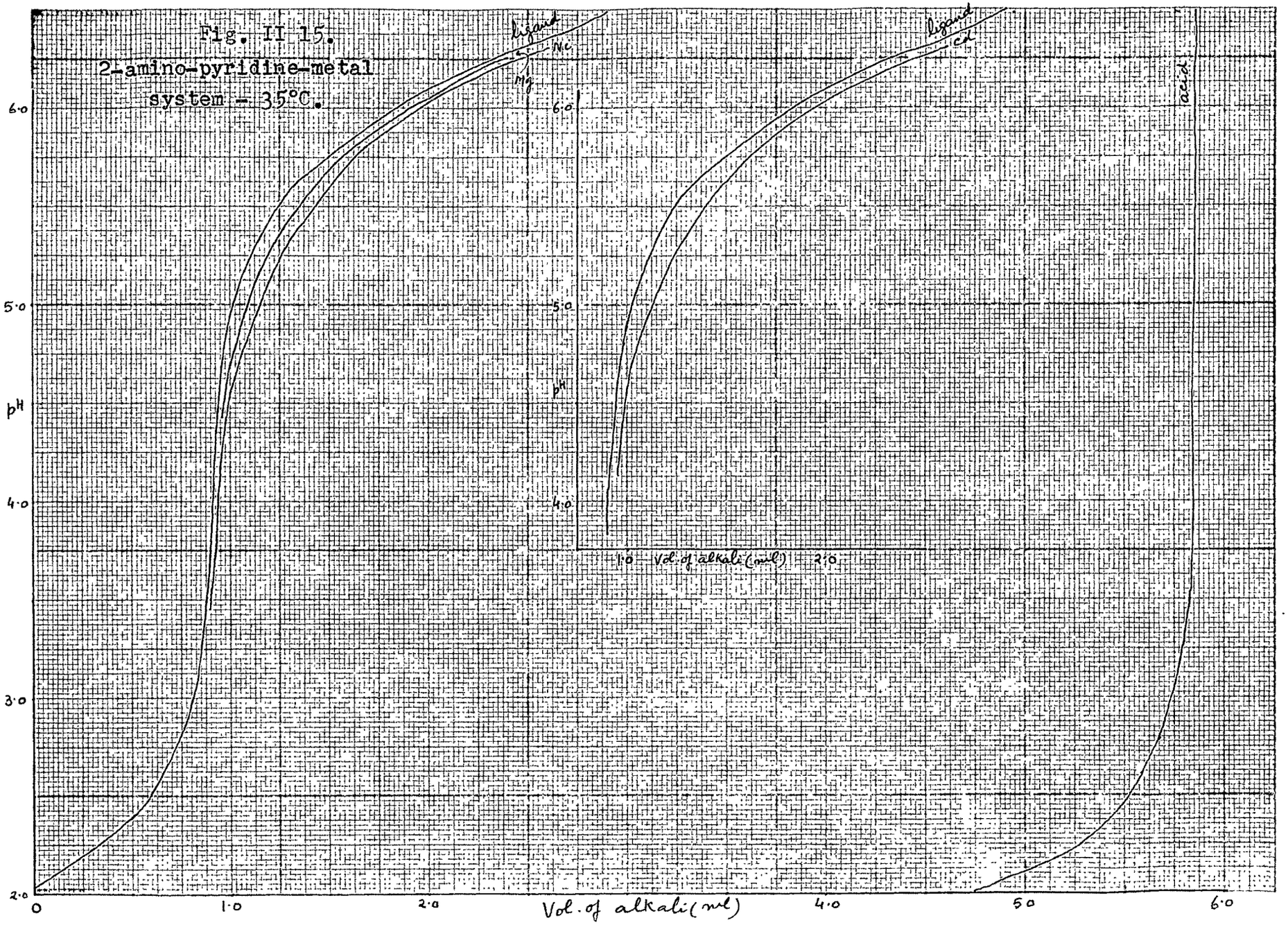
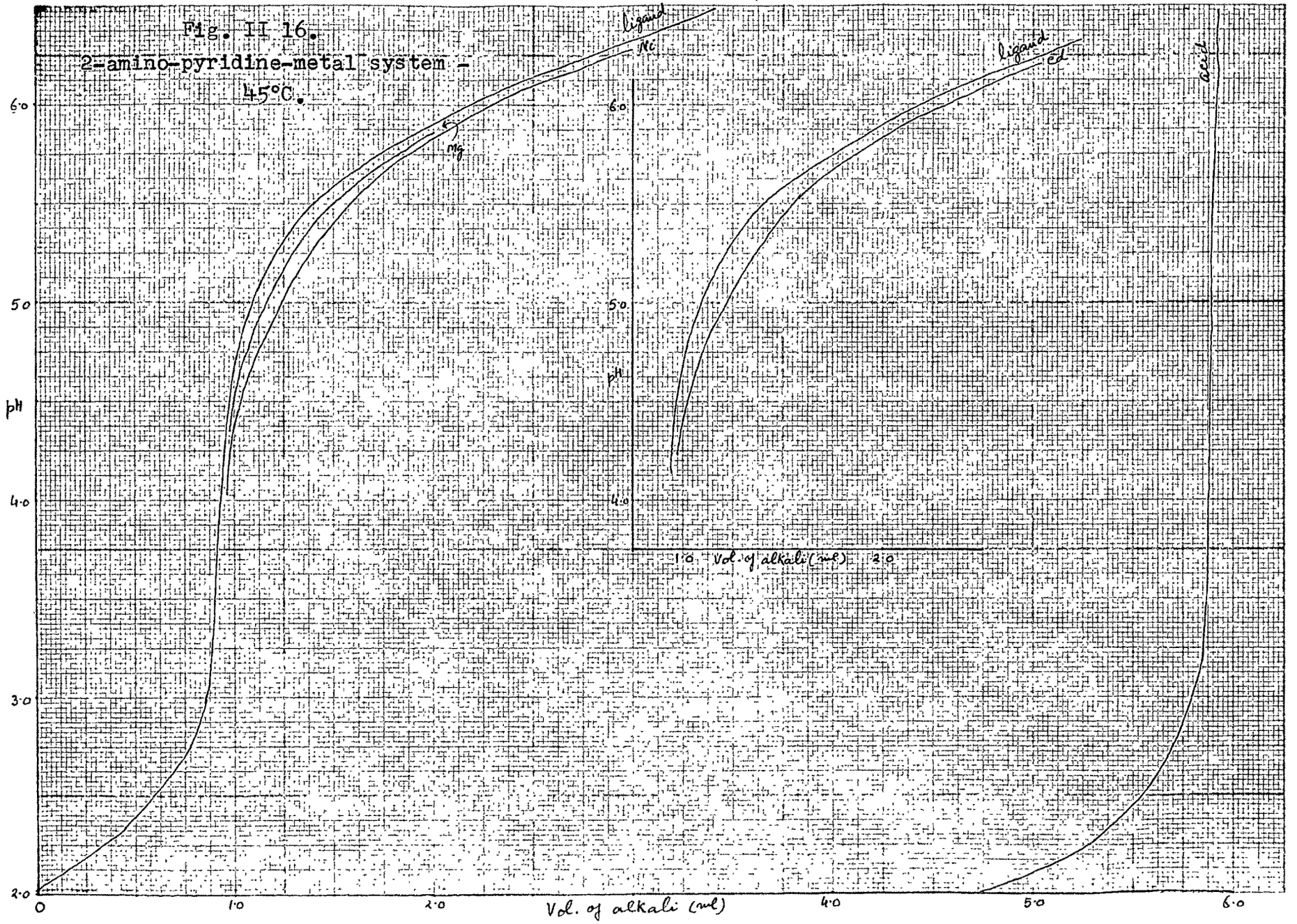


Fig. II 15.
2-amino-pyridine-metal system - 35°C.
Ligand
Ni
Mg
Ligand
Cu
acid
pH
6·0
5·0
4·0
3·0
2·0
0
1·0
2·0
4·0
5·0
6·0
Vol. of alkali (ml)

Fig. II 16.

2-amino-pyridine-metal system -

45°C.



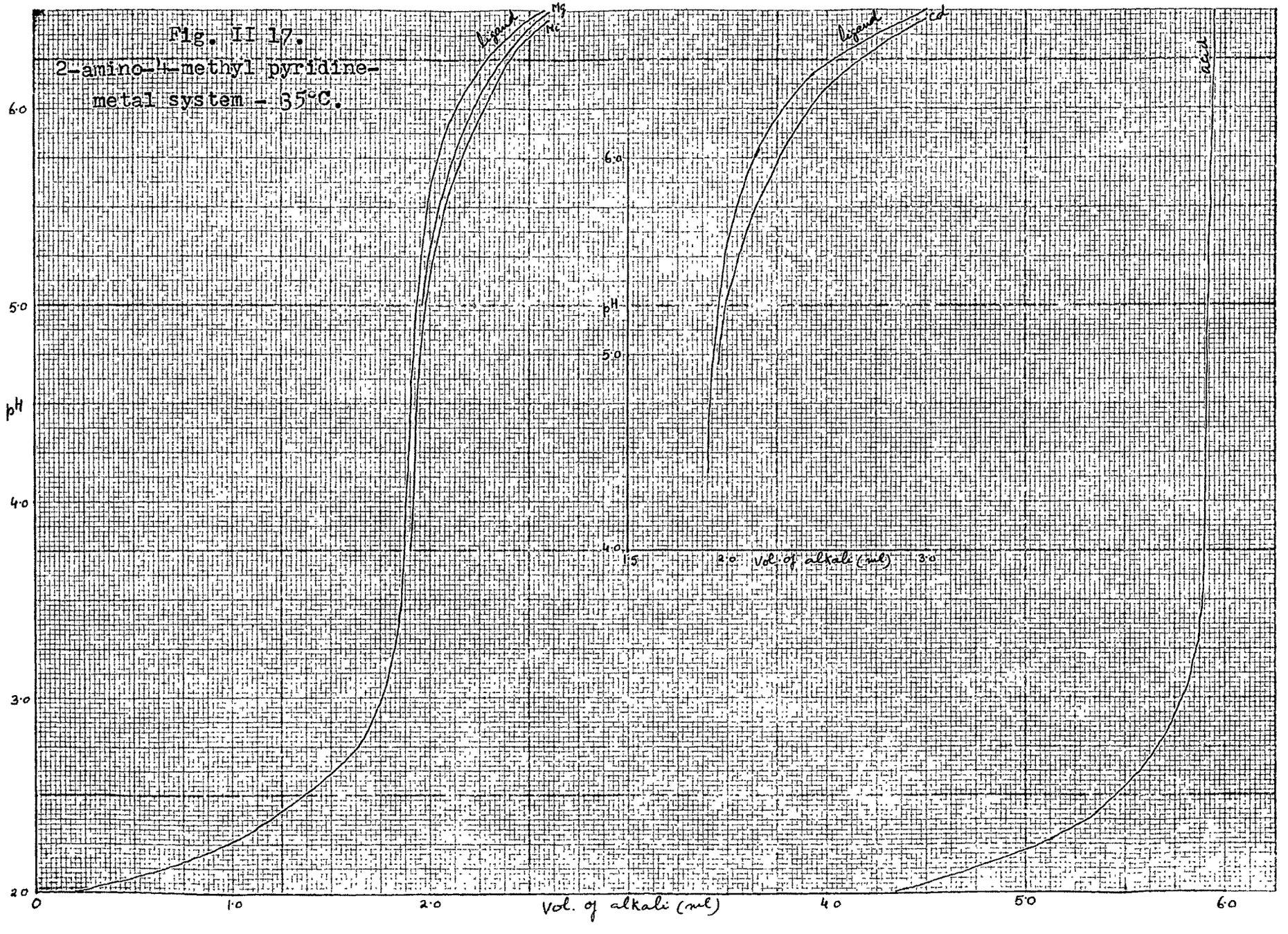


Fig. II 17.
2-amino-4-methyl pyridine-
metal system - 35°C.
Ligand
Mg
Mn
Ligand
Cd
acid
pH
6.0
5.0
4.0
3.0
2.0
0
1.0
2.0
Vol. of alkali (ml)
4.0
5.0
6.0
1.5
2.0
Vol. of alkali (ml)
3.0

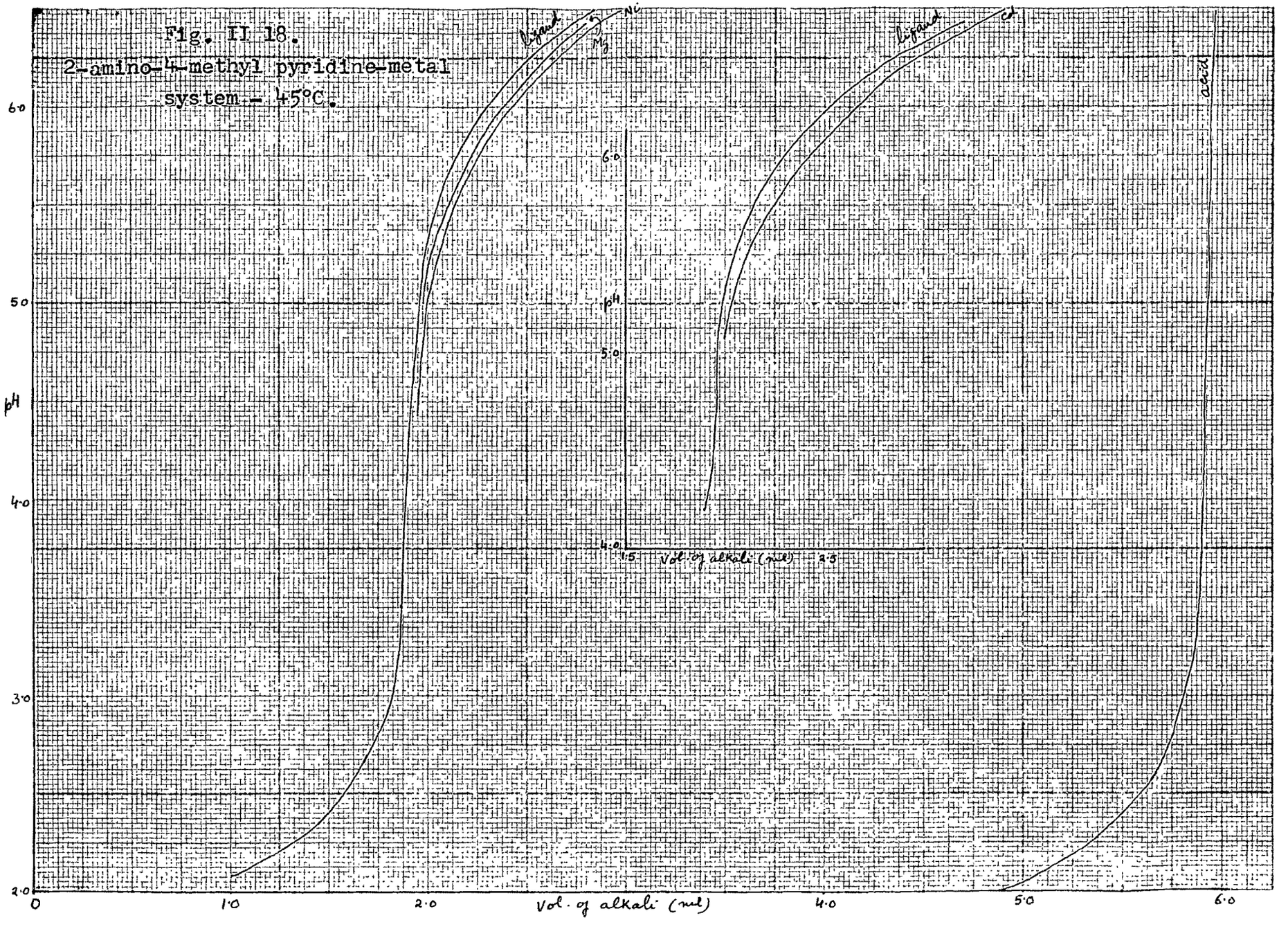


Fig. II 18.
2-amino-4-methyl pyridine-metal system – 45°C.
Ligand
Ni
Mg
Cu
Ligand
Acid
pH
6·0
5·0
4·0
3·0
2·0
1·5
Vol. of alkali (ml)
2·5
0
1·0
2·0
Vol. of alkali (ml)
4·0
5·0
6·0

Fig. II 19.

Pyridine-metal system

(Second method)

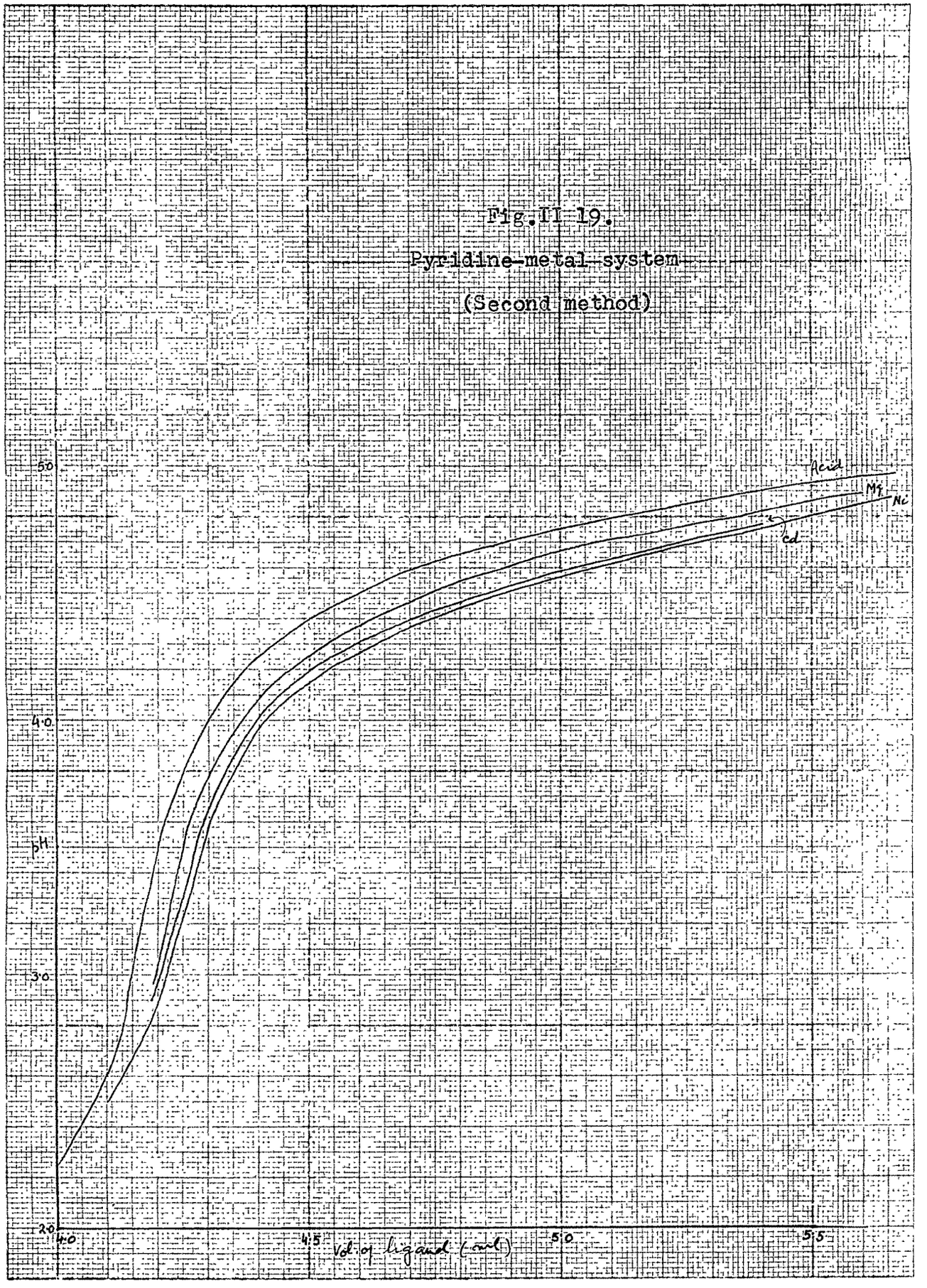


Fig. II 20.

α-picoline-metal system

(second method)

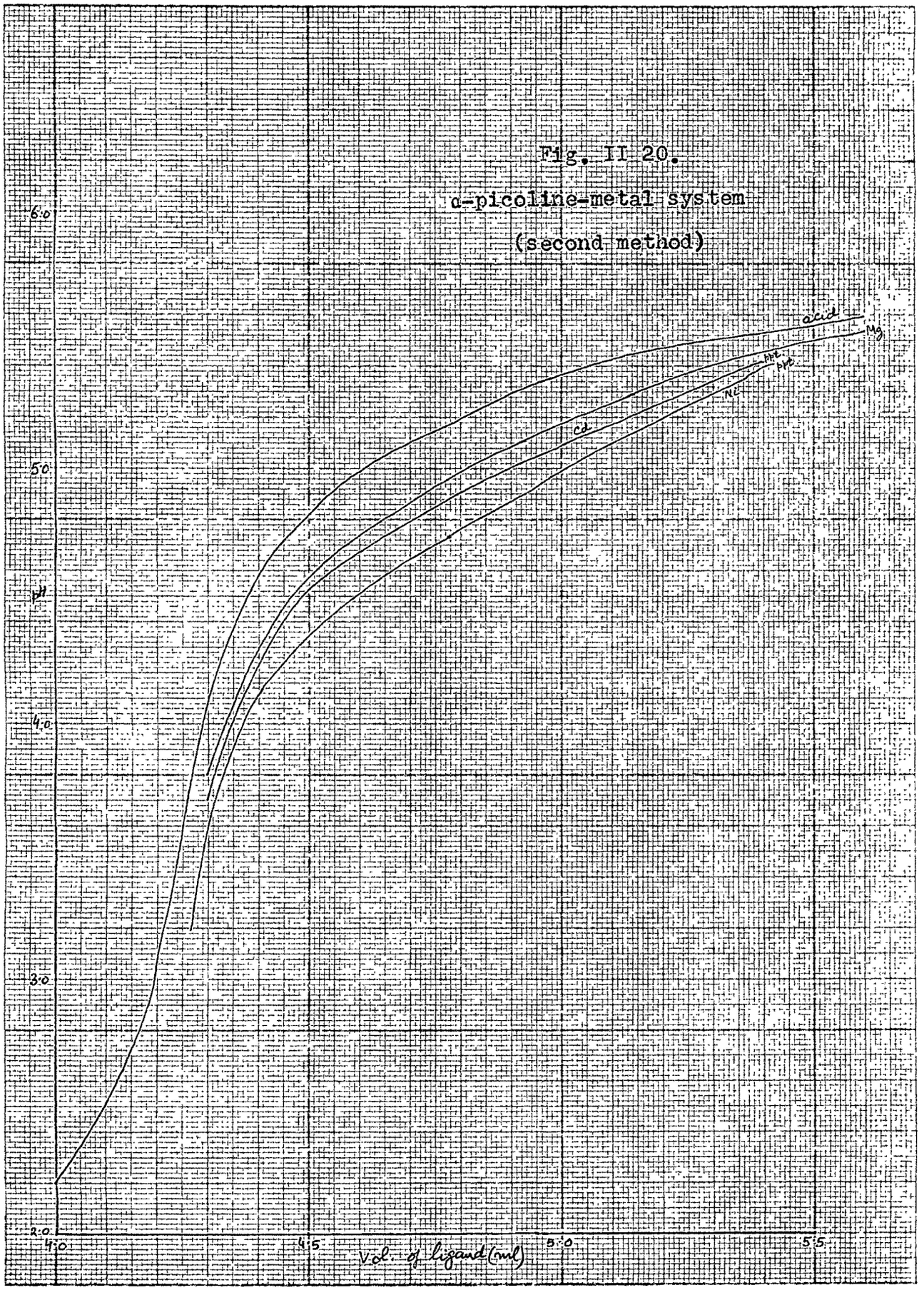


Fig. II 21.

8-picoline-metal system

(second method)

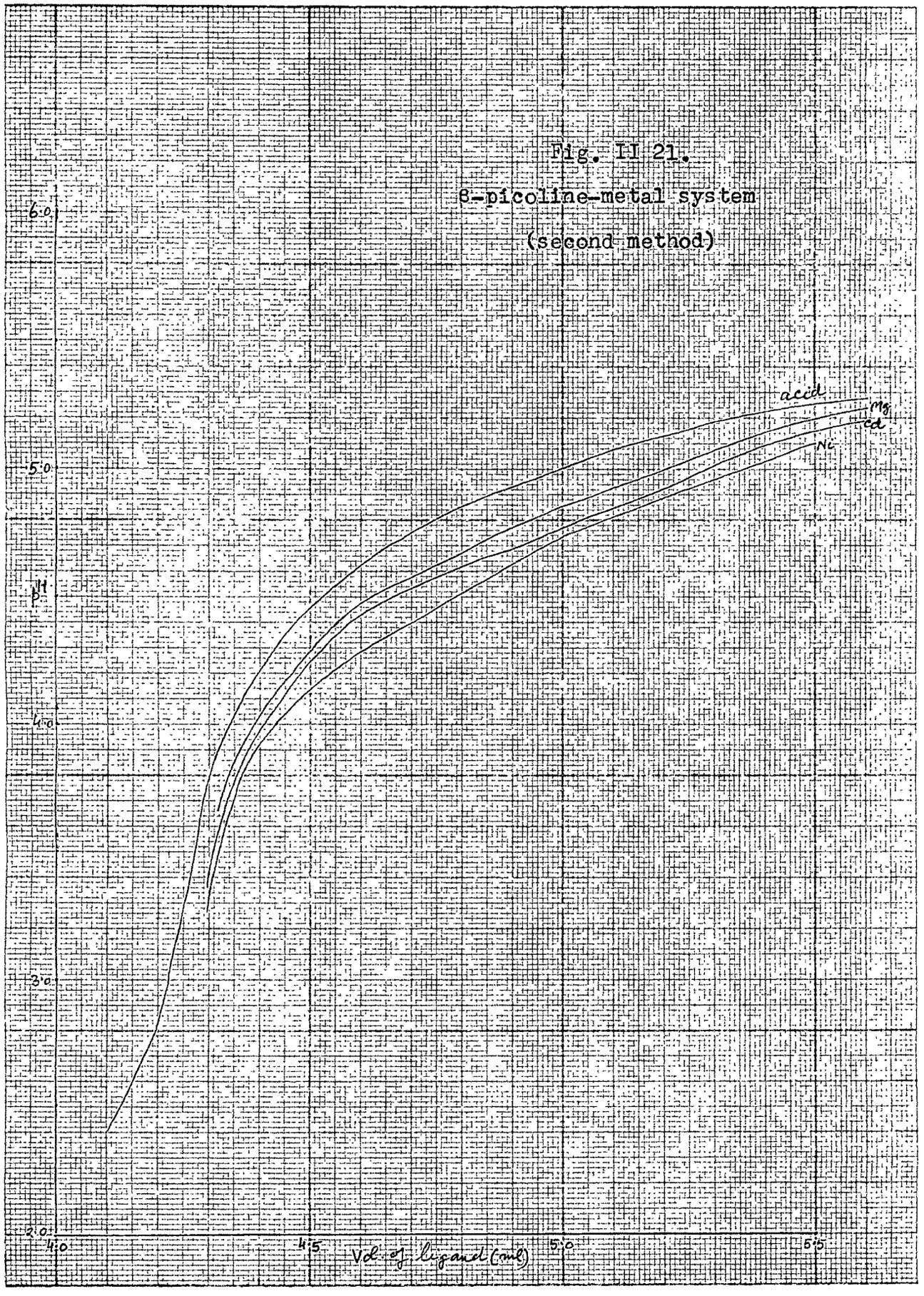


Fig. II 22.

γ-picoline-metal system

(second method)

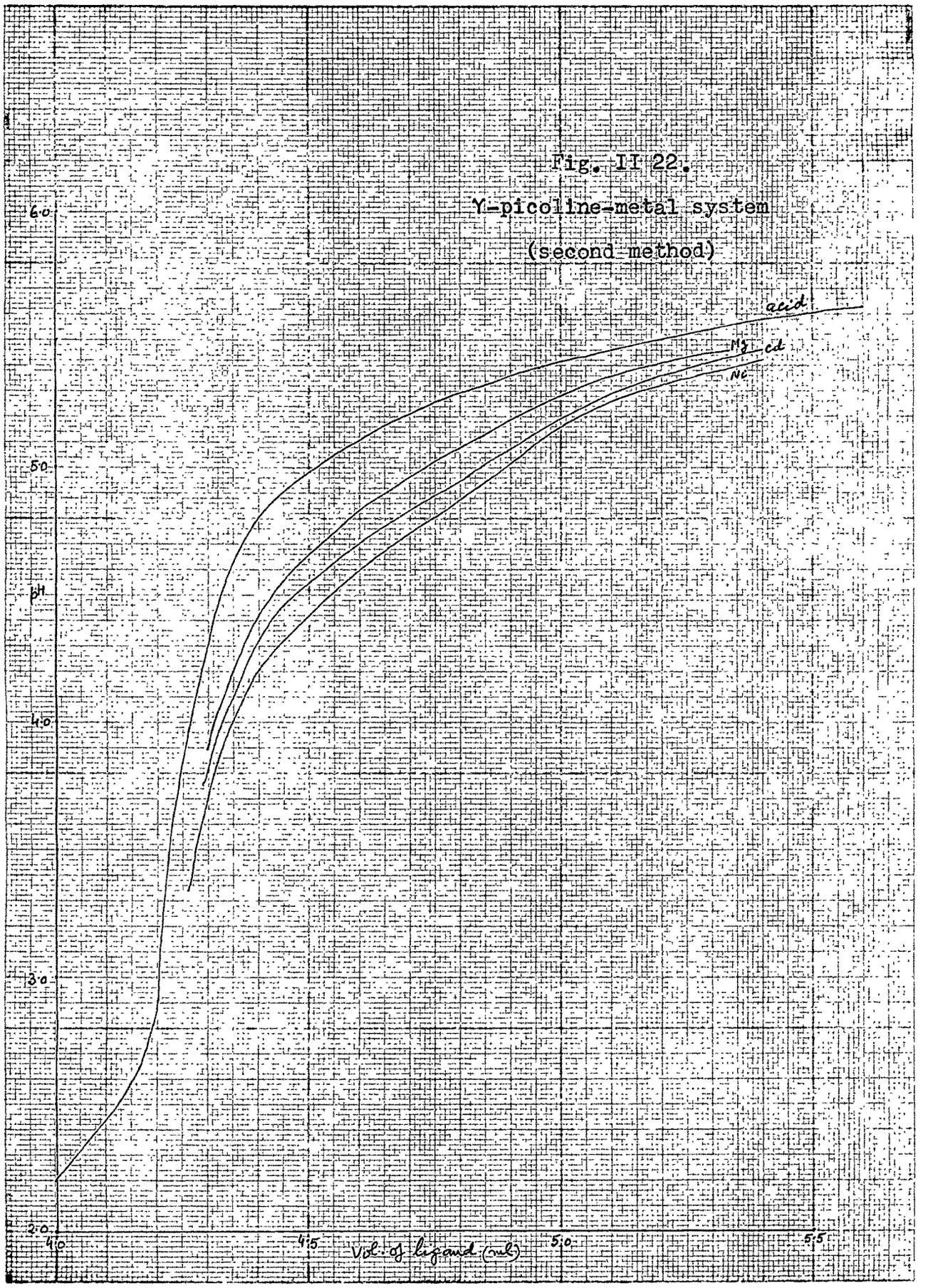


Fig. II 23.

2:4-lutidine-metal system

(second method)

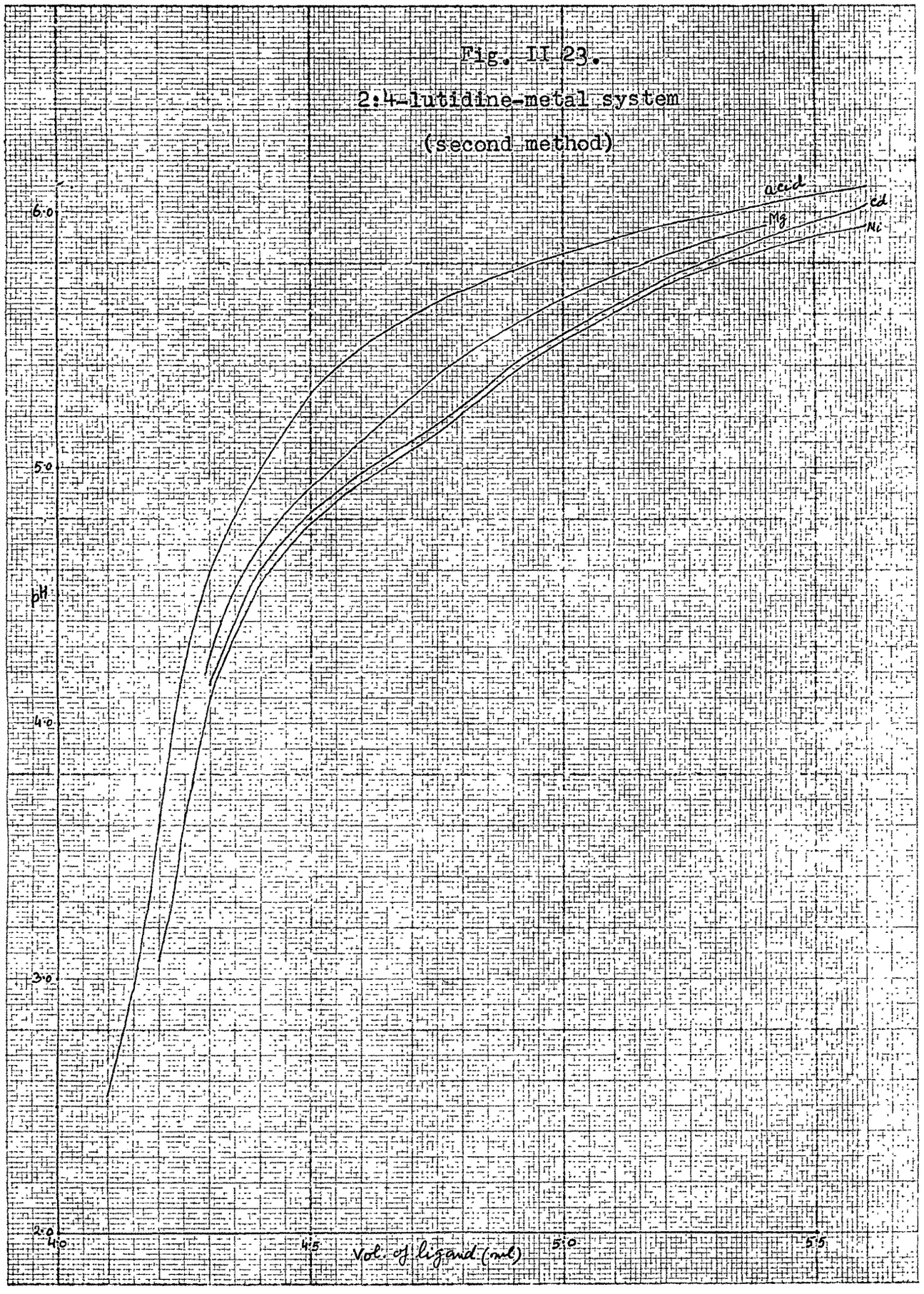


Fig. II 24.

2:6-lutidine-metal system

(second method)

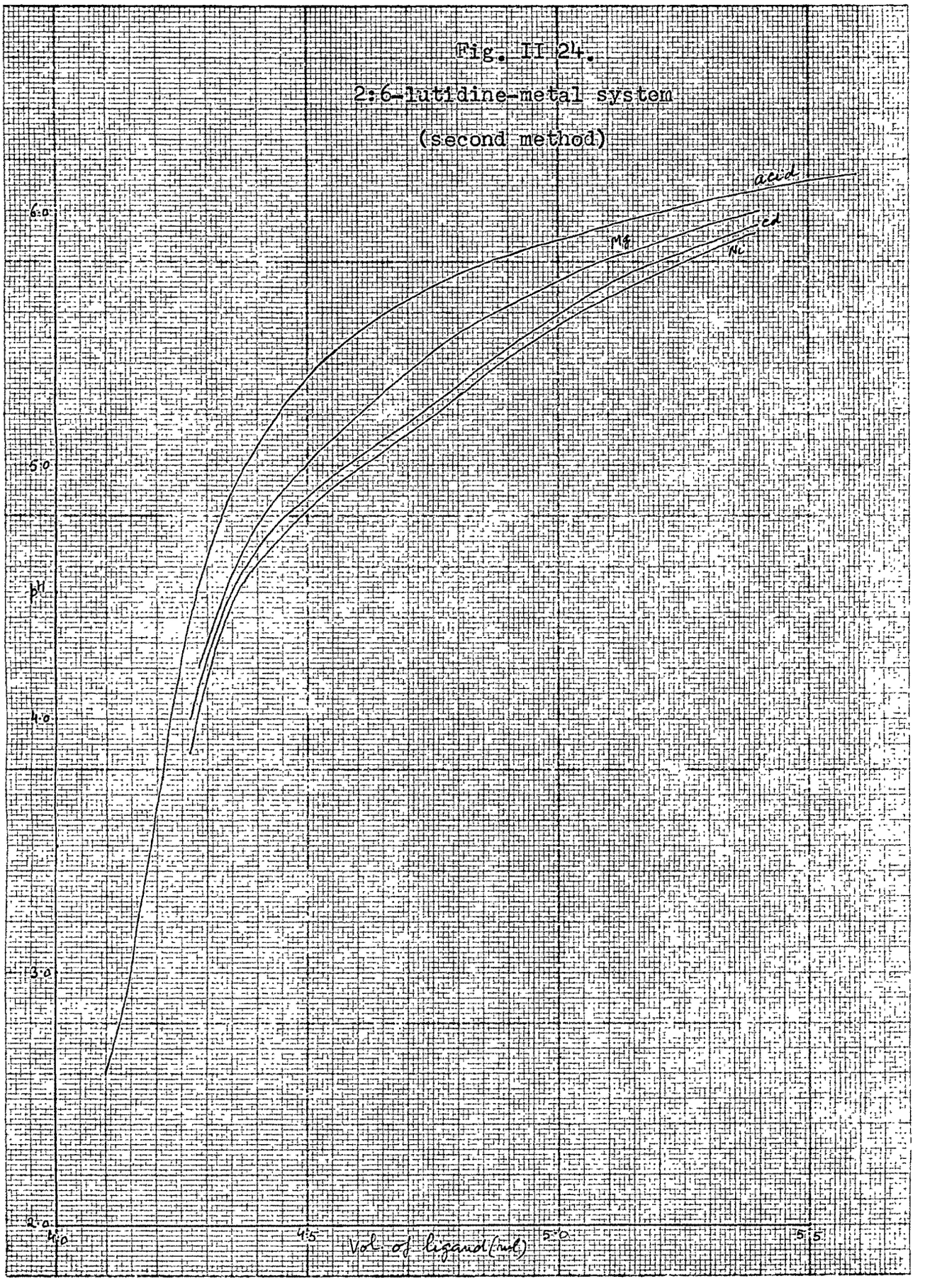


Fig. II 25.

2:4:6-collidine-metal system

(second method)

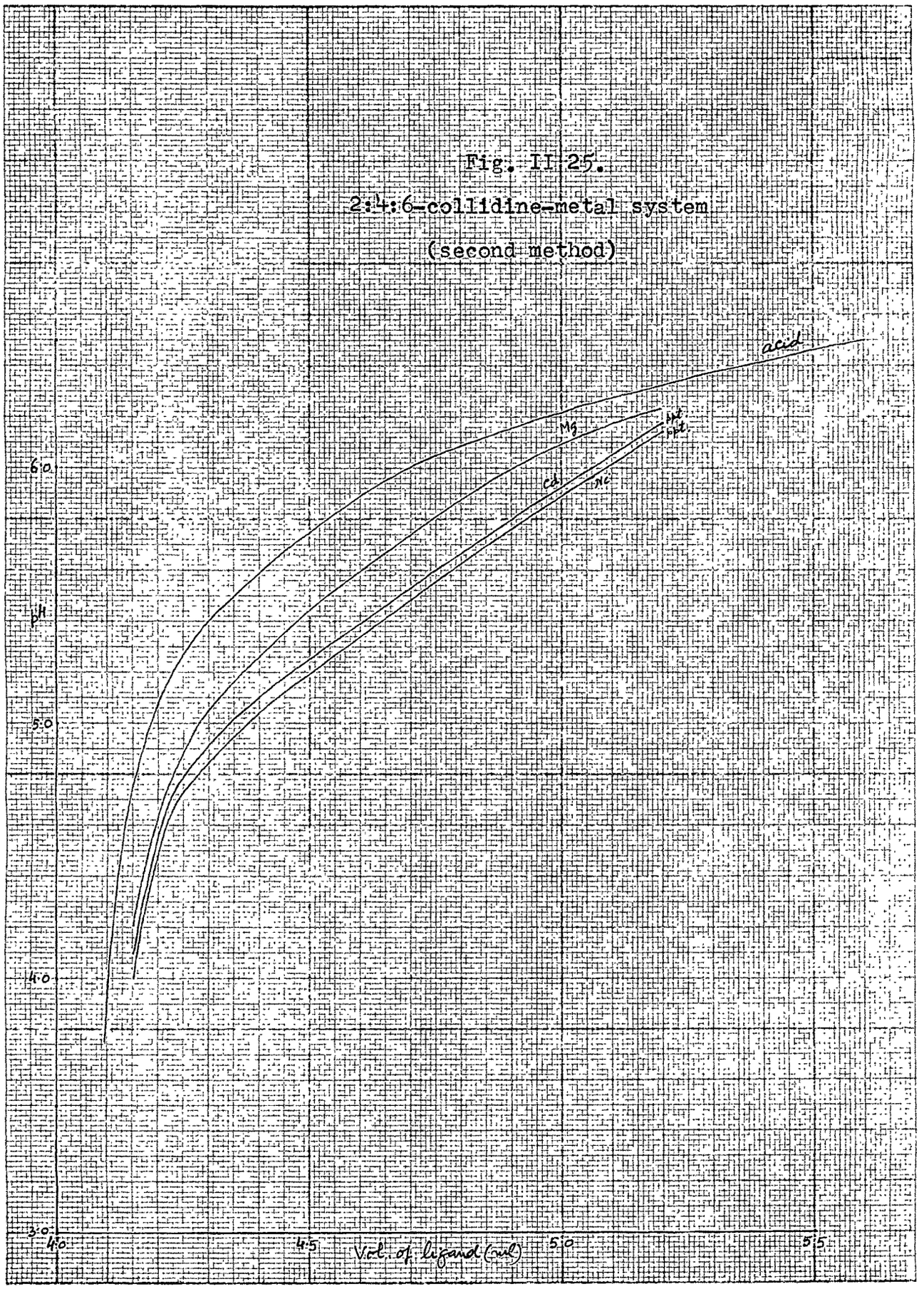
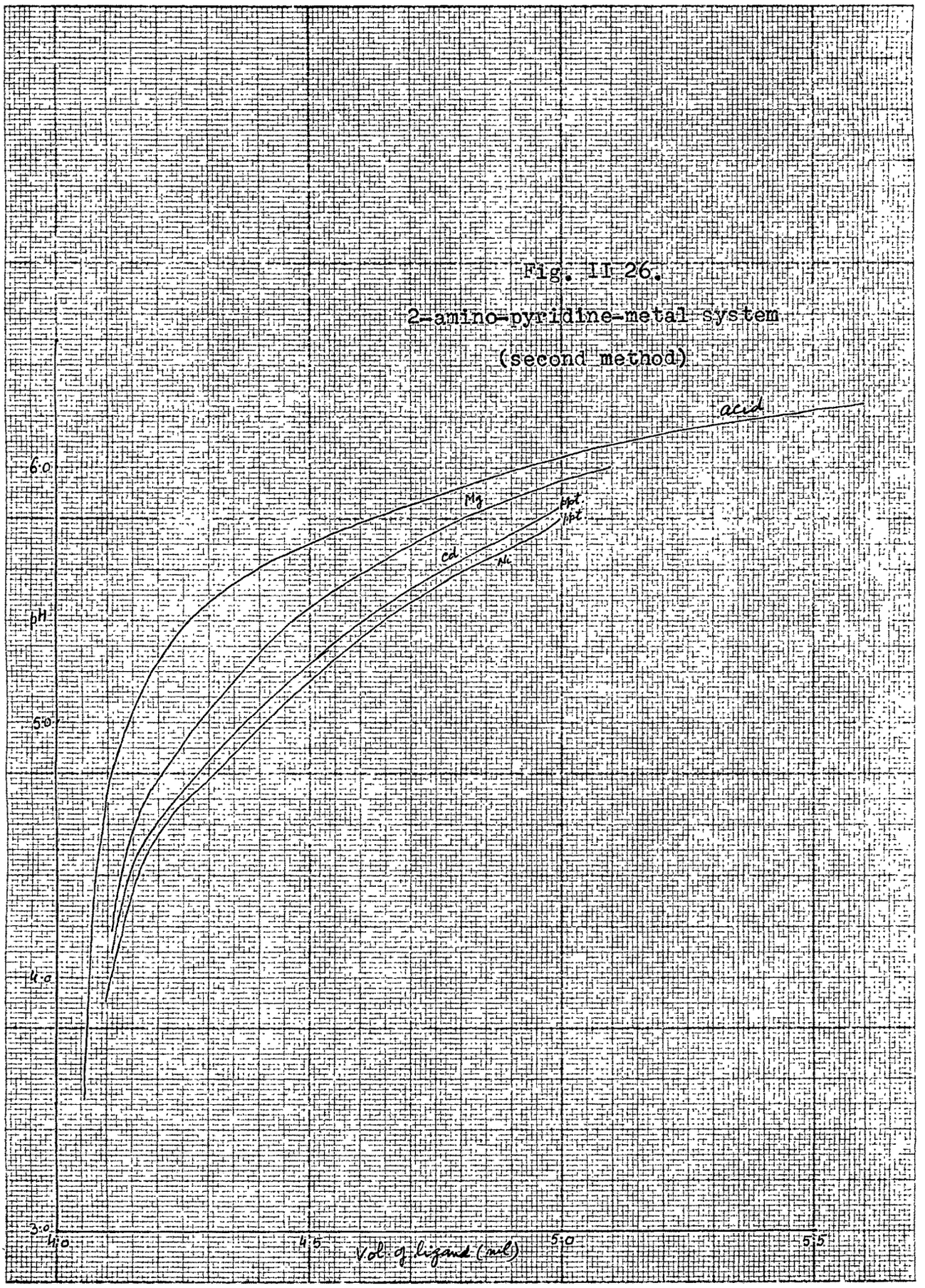


Fig. II 26.

2-amino-pyridine-metal system

(second method)



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