position of the two liquid phases and the vapor phase can be determined from Fig. C. To illustrate, at a pressure of 300 psia, and a temperature of —248°F, any feed mixture containing 30 to 95% nitrogen will separate into two liquid phases having compositions of 27.5 and 95.5% nitrogen (points D and E), and a vapor phase containing 99.9% nitrogen (point F, Sec. A). If a mixture containing 95% nitrogen were cooled to —245°F at a pressure of 300 psia, it would exist as a liquid phase containing 24% nitrogen and a vapor phase containing 99.8% nitrogen (Sec. A). If the cooling were continued to a temperature of —248°F, the pressure being maintained at 300 psia, the liquid phase would cease to be homogeneous, and would separate into two liquid phases having compositions of 27.5 and 95.5% nitrogen, respectively. The vapor phase in equilibrium with the less dense liquid phase would have a composition of 99.9% nitrogen (V in Sec. A). Upon further cooling to a temperature of —250°F the vapor phase would have disappeared and the mixture would exist as two immiscible liquid phases (L_1 and L_2 in Sec. A). The three phases will coexist at 300 psia only at a temperature of —248°F; above —248°F there will be one liquid phase and a vapor phase, and below this temperature there will be two liquid phases and no vapor phase, the transition taking place at —248°F.

The composition of the equilibrium liquid and vapor phases at a given pressure and temperature can be read from the points at which the selected temperature line intersects the curves for the given pressure. For example, at —140°F and 100 psia the composition of the liquid phase (point B), is 97.8% ethane-2.2% nitrogen, while the equilibrium vapor phase at the same temperature and pressure (point C) is 11.5% ethane-88.5% nitrogen. Data obtained in this manner can be used to construct constant-pressure vapor composition-liquid composition (Y-X) diagrams. Y-X diagrams at 100, 300, 500 and 950 psia are shown in Fig. D. The 950 psia equilibrium curve intersects the Y = X line at the composition (85% ethane-15% nitrogen) which exhibits a critical point at this pressure. Since this pressure is greater than the critical for either component, separation into the pure components cannot be obtained under these conditions. The composition at the point of maximum obtainable separation (88% ethane-12% nitrogen) is that exhibiting a 950 psia cricondenbar.

Equilibrium vaporization ratios, K, for ethane and nitrogen in the binary system are also established from the compositions of the vapor and liquid in equilibrium as read from the temperature-composition diagram, Fig. C. As an illustration, at —140°F and 100 psia, the liquid composition (point B) is 97.8% ethane-2.2% nitrogen, and the equilibrium vapor (point C) is 11.5% ethane-88.5% nitrogen. The equilibrium vaporization ratio for ethane is 11.5/97.8 = 0.118, and for nitrogen, 88.5/2.2 = 40.2.

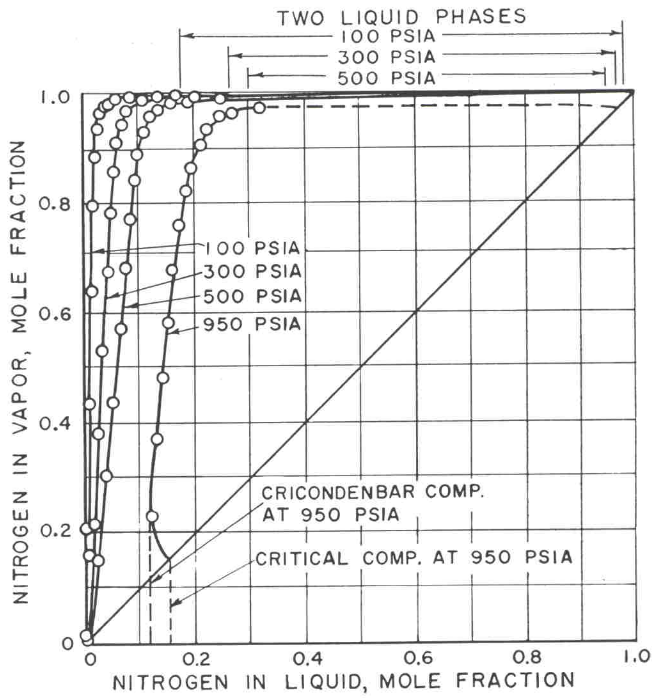

Fig. D.—Vapor Composition-Liquid Composition (Y-X) Diagrams for the Ethane-Nitrogen System at Selected Pressures

K values were calculated in this manner for ethane and nitrogen in the ethane-nitrogen system for selected values of temperature and pressure, and are given in Tables C and D. At the dew point temperature of the pure component for each pressure the K value is 1.000. The saturation (dew point) temperatures for the pure components are given at each pressure. For a pressure that exceeds the critical pressures of the pure components, the temperatures marked with daggers represent the critical temperatures of the system at that pressure, and the K values for ethane and nitrogen at each of these temperatures are also 1.000. The ethane equilibrium vaporization ratios are plotted as K versus pressure (Fig. E) isotherms, and the nitrogen equilibrium vaporization ratios as K versus temperature (Fig. F) isobars.

Table B.—SUMMARY OF DEW AND BUBBLE POINT

Pressure, Psia	95.02% C_2H_6 4.98% N_2		84.99% C_2H_6 15.01% N_2		79.98% C_2H_6 20.02% N_2	75.07% C_2H_6 24.93% N_2	68.31% C_2H_6 31.69% N_2		49.82% C_2H_6 50.18% N_2	30.00% C_2H_6 70.00% N_2
	D.P.	B.P.	D.P.	B.P.	B.P.	B.P.	D.P.	B.P.	D.P.	D.P.
100	—50.0†	—232.3†	—56.5	—278.2	—	—	—68.0	—	—88.7	—105.3
150	—27.7	—171.9	—35.0	—263.0	—268.8	—	—48.2	—	—69.1	— 89.7
200	— 9.8	—152.8	—18.8	—249.9	—257.4	—	—33.3	—	—56.1	— 78.9
250	+ 4.5	—111.3	— 5.5	—237.4	—247.4	—	—21.0	—	—45.4	— 70.1
300	16.8	— 75.6	+ 6.1	—225.1	—238.5	—241.1	—10.9	—	—36.3	— 62.8
350	27.4	— 48.0	16.2	—213.1	—229.8	—239.4	— 2.0	—	—28.6	— 56.7
400	36.8	— 26.5	25.1	—200.8	—221.5	—232.6	+ 5.5	—	—20.7	— 51.5
450	45.6	— 7.8	33.0	—187.6	—213.0	—225.9	12.1	—	—14.7	— 47.0
500	53.6	+ 8.4	40.0	—173.9	—204.2	—219.5	18.1	—	— 9.2	— 43.0
550	60.8	22.2	46.3	—159.4	—194.8	—212.9	23.7	—	— 3.9	— 39.6
600	67.3	34.5	51.9	—143.4	—185.0	—205.2	28.6	—219.9	— 0.1	— 36.5
650	73.0	45.8	56.9	—124.3	—173.9	—197.7	32.9	—214.3	+ 3.4	— 33.9
700	78.2	56.7	61.4	—102.8	—161.3	—190.4	36.7	—208.8	6.6	— 31.6
750	82.7	67.2	65.2	— 81.5	—147.8	—183.0	40.0	—203.3	9.4	— 29.7
800	—	76.2	68.4	— 59.9	—132.9	—174.3	42.9	—197.8	11.8	— 28.0
	—	82.1	—	—	—	—	—	—	—	—
850	—	—	70.4	— 37.2	—115.0	—165.3	45.2	—191.7	13.9	— 26.5
900	—	—	71.1	— 14.1	—	—154.9	47.1	—185.3	15.5	— 25.4
950	—	—	68.9*	+ 6.3	—	—142.6	48.5	—178.7	16.8	— 24.5
1000	—	—	—	28.7	—	—128.3	49.0	—171.8	17.9	— 23.9
	—	—	—	64.0	—	—	—	—	—	—
1050	—	—	—	—	—	—112.4	49.0	—163.7	18.7	— 23.5
1100	—	—	—	—	—	— 94.5	48.6*	—155.0	19.3	— 23.2
1150	—	—	—	—	—	— 75.0	47.3*	—144.9	19.5	— 23.1
	—	—	—	—	—	+ 50.8	—	—	—	—
1200	—	—	—	—	—	— 53.8	44.7*	—133.4	19.4*	— 23.0
	—	—	—	—	—	+ 45.6	—	—	—	—
1250	—	—	—	—	—	— 28.0	40.9*	—120.4	18.9*	— 23.1*
	—	—	—	—	—	+ 38.3	—	—	—	—
1300	—	—	—	—	—	—	35.9*	—106.0	17.7*	— 23.4*
1350	—	—	—	—	—	—	—	— 90.3	16.1*	— 23.9*
	—	—	—	—	—	—	—	+ 30.0	—	—
1400	—	—	—	—	—	—	—	— 71.6	14.1*	— 24.6*
	—	—	—	—	—	—	—	+ 22.7	—	—
1450	—	—	—	—	—	—	—	— 42.0	11.6*	— 25.6*
	—	—	—	—	—	—	—	+ 9.1	—	—
1500	—	—	—	—	—	—	—	—	9.0*	— 27.0*
1550	—	—	—	—	—	—	—	—	5.9*	— 28.6*
1600	—	—	—	—	—	—	—	—	+ 2.5*	— 30.4*
1650	—	—	—	—	—	—	—	—	— 1.3*	— 32.6*
1700	—	—	—	—	—	—	—	—	— 5.75*	— 35.4*
1750	—	—	—	—	—	—	—	—	—11.2*	— 39.4*
1800	—	—	—	—	—	—	—	—	—19.3*	— 44.9*
1850	—	—	—	—	—	—	—	—	—	— 53.2*

Table C.—"K" VALUES FOR ETHANE IN THE ETHANE-NITROGEN SYSTEM

Temp. °F.	Pressure, Psia 100	200	300	400	500	600	700	950	1200
*	—282.8	—263.7	—250.6	—240.3	—	—	—	—	—
—280	0.00120	—	—	—	—	—	—	—	—
—260	0.00218	0.00130	—	—	—	—	—	—	—
—240	0.00583	0.00284	0.00251	0.200	—	—	—	—	—
—220	0.0157	0.00659	0.00440	0.00373	0.00402	0.0308	—	—	—
—200	0.0217	0.0129	0.0107	0.00939	0.00988	0.0117	0.0194	—	—
—180	0.0356	0.0234	0.0198	0.0183	0.0178	0.0185	0.0200	0.0428	—
—160	0.0626	0.0391	0.0304	0.0269	0.0261	0.0264	0.0285	0.0455	—
—140	0.116	0.0692	0.0549	0.0487	0.0456	0.0440	0.0440	0.0531	0.0818
—120	0.205	0.118	0.0930	0.0794	0.0731	0.0717	0.0714	0.0816	0.103
—100	0.377	0.196	0.148	0.128	0.118	0.114	0.112	0.119	0.137
— 80	0.567	0.301	0.226	0.190	0.173	0.163	0.158	0.165	0.186
— 60	0.791	0.458	0.334	0.273	0.246	0.227	0.215	0.218	0.249
— 40	—	0.639	0.485	0.394	0.341	0.314	0.298	0.289	0.321
— 20	—	0.843	0.634	0.528	0.458	0.424	0.400	0.382	0.404
0	—	—	0.799	0.666	0.588	0.539	0.512	0.491	0.507
20	—	—	0.985	0.822	0.726	0.665	0.630	0.603	0.640
40	—	—	—	0.980	0.870	0.802	0.757	0.725	0.824
60	—	—	—	—	0.999	0.922	0.881	0.878	—
80	—	—	—	—	—	—	0.973	—	—
100	—	—	—	—	—	—	—	—	—
**	—46.0	—6.2	21.6	43.0	61.0	75.8	88.3	69.1†	45.5†

* Saturation temperature for nitrogen   ** Saturation temperature for ethane   † Critical temperature for the binary system