PROPERTIES OF STEAM - AIR MIXTURES

by

Charles Richard Lucas

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INTRODUCTION

This thesis, as the title suggests, deals with certain properties of steam and air mixtures, and also, some of the properties of steam alone. At the present time, there appears to be no complete tables on steam-air mixtures; at least, there are none available for the public at large. It is for that reason that these tables have been compiled. There was no laboratory research work connected with this thesis, for it consisted entirely of calculations to determine values for the various properties of the mixture between certain limits.

It is the writer's wish to acknowledge the kind help and suggestions given him by Professor W. R. Woolrich, under whose direction this thesis was prepared.

GENERAL SURVEY OF THE FIELD

In general, there is very little available data concerning steam-air mixtures. The only usable material which the writer has been able to locate consists of a table of some of the properties of saturated steam by Mr. Gebhardt, another by Mr. Goodenough, and some Psychrometric Charts by Mr. W. H. Carrier.

The section of the thesis dealing with saturated steam is based upon the steam tables of Mr. Goodenough; however, the lower limiting value in the thesis was changed from 32° fahrenheit to 0° fahrenheit.

STATEMENT OF PURPOSE

The purpose of this thesis is of a dual nature. In the first place, it was devised in order that a set of values for properties of steam-air mixtures, which, up to the present are unavailable, might be made which would be of value to any one dealing with air condition problems. In the second place, the thesis was designed to set 0° fahrenheit as the base of tables instead of 32° fahrenheit.

GENERAL THEORY

As has been stated, this thesis had no laboratory research work connected with it. Instead, it consisted entirely of calculations designed to arrive at likely values for certain properties of steam-air mixtures. The tables compiled have been calculated for certain degrees of temperature; that is, the values have been found for the various properties between the limits of 0° and 205° fahrenheit at five degree intervals.

The mathematical calculations have been supplemented by increment curves so as to detect errors that might have been made by the writer in his calculations, and also, to act as a check upon the original data obtained from the tables of Mr. Goodenough and Mr. Gebhardt upon which the foundation of this thesis was laid.

STEAM-AIR MIXTURE TABLES

	1	2	3	4
Temperature	Latent Heat of one pound of vapor B.T.U.	Amount of vapor necessary to saturate one pound of air LBS.	Amount of moisture in one pound of mixture LBS.	Latent Heat in vapor necessary to saturate one pound of air B.T.U.
0	1090.0	0.000781	0.0007804	0.8513
5	1087.4	0.001016	0.001015	1.0047
10	1084.8	0.001309	0.001307	1.4275
15	1082.1	0.001682	0.001679	1.8210
20	1079.4	0.002144	0.002135	2.3045
25	1076.8	0.002725	0.002718	2.9345
30	1074.2	0.003444	0.003432	3.6999
32	1073.0	0.003782	0.0037772	4.0831
35	1071.0	0.004268	0.004250	4.5623
40	1068.8	0.005207	0.005175	5.5486
45	1066.1	0.00632	0.00628	6.7371
50	1063.5	0.00764	0.00758	8.1240
55	1060.8	0.00920	0.00911	9.7600
60	1058.1	0.01105	0.01092	11.6918
65	1055.5	0.01323	0.01305	13.9720
70	1052.8	0.01578	0.01553	16.6154
75	1050.1	0.01877	0.01842	19.7455
80	1047.4	0.02226	0.02177	23.3112
85	1044.7	0.02634	0.02566	27.5187
90	1042.0	0.03109	0.03015	32.4000
95	1039.3	0.03662	0.03532	38.0545

STEAM-AIR MIXTURE TABLES (CONTINUED)

	1	2	3	4
100	1036.6	0.04305	0.04127	44.6333
105	1033.9	0.05050	0.04807	52.2000
110	1031.1	0.0593	0.05598	61.1500
115	1028.4	0.0694	0.06480	71.3845
120	1025.6	0.0813	0.07519	83.5200
125	1022.8	0.0953	0.08700	97.4750
130	1020.0	0.1114	0.10020	113.6050
135	1017.2	0.1305	0.11543	132.6965
140	1014.4	0.1532	0.13284	155.3825
145	1011.5	0.1800	0.15254	183.9125
150	1008.7	0.2122	0.17505	214.9500
155	1005.8	0.2511	0.20070	252.5885
160	1002.9	0.2987	0.22999	299.2915
165	1000.0	0.3577	0.26348	357.7000
170	997.1	0.4324	0.30117	431.1000
175	994.2	0.5290	0.34507	526.0000
180	991.2	0.6577	0.39675	651.1667
185	988.2	0.8359	0.45530	826.0000
190	985.2	1.0985	0.52530	1082.0000
195	982.2	1.5000	0.60607	1470.0000
200	979.2	2.2953	0.70260	2224.7000
205	976.1	4.1900	0.81338	4089.8000

STEAM-AIR MIXTURE TABLES(CONTINUED)

	5	6	7	8
Temperature	Latent Heat in vapor necessary to make one pound of mixture B.T.U.	Heat in one pound of dry air B.T.U.	Air in one pound of mixture LBS.	Heat in air portion of one pound of mixture B.T.U.
0	0.8506	0	0.9992196	0
5	1.0027	1.205	0.999085	1.2379
10	1.4273	2.411	0.998693	2.4079
15	1.8178	3.616	0.998321	3.6099
20	2.2945	4.823	0.997865	4.8125
25	2.9270	6.028	0.997282	6.0116
30	3.5870	7.234	0.996568	7.2095
32	4.0527	7.7164	0.996241	7.6577
35	4.5430	8.44	0.995750	8.4000
40	5.5144	9.65	0.994825	9.6430
45	6.6955	10.86	0.99372	10.78
50	8.0616	12.07	0.99242	11.97
55	9.6633	13.28	0.99089	13.15
60	11.5526	14.48	0.98908	14.32
65	13.7907	15.69	0.98695	15.48
70	16.3500	16.90	0.98447	16.63
75	19.3408	18.11	0.98158	17.77
80	22.8527	19.32	0.97823	18.89
85	26.8118	20.53	0.97434	20.01
90	31.4214	21.74	0.96985	21.08
95	36.7000	22.95	0.96468	22.08

STEAM-AIR MIXTURE TABLES(CONTINUED)

	5	6	7	8
100	42.7900	24.16	0.95873	23.15
105	49.6777	25.37	0.95193	24.14
110	57.7143	26.58	0.94402	25.11
115	66.6500	27.79	0.93520	25.98
120	77.0845	29.00	0.92481	26.81
125	88.9800	30.21	0.91300	27.58
130	100.2000	31.42	0.89980	28.26
135	117.5120	32.63	0.88457	28.86
140	134.7190	33.85	0.86826	29.39
145	155.7860	35.06	0.84946	29.77
150	176.5599	36.27	0.82695	29.91
155	201.3640	37.48	0.80130	29.95
160	229.8890	38.69	0.77201	29.79
165	262.4800	39.91	0.73752	29.40
170	300.2670	41.12	0.69883	28.73
175	343.7695	42.33	0.65493	27.71
180	392.8180	43.55	0.60325	26.27
185	449.9000	44.76	0.54470	24.37
190	517.3750	45.97	0.47177	21.68
195	594.3200	47.19	0.40000	18.28
200.	684.0000	48.40	0.30347	14.08
205	787.9800	49.62	0.19268	8.98

STEAM-AIR MIXTURE TABLES(CONTINUED)

	9	10	11	12
Temperature	Heat of liquid in vapor to saturate one pound of mixture B.T.U.	Heat of liquid of vapor in one pound of mixture B.T.U.	Total Heat of one pound of air with moisture to saturate B.T.U.	Total Heat of one pound of mixture B.T.U.
0	0.11201	0.11192	0.963305	0.962425
5	0.14823	0.14708	2.333794	2.328037
10	0.19325	0.19296	4.031755	4.028159
15	0.25364	0.25319	5.690644	5.680892
20	0.32825	0.32687	7.455746	7.433868
25	0.42455	0.42346	9.387055	9.362061
30	0.54312	0.54123	11.477019	11.417726
33	0.59832	0.596100	12.39782	12.30650
35	0.68850	0.68593	13.69080	13.628930
40	0.86572	0.86234	16.06432	16.019740
45	1.08475	1.07800	19.68185	18.55350
50	1.34969	1.33845	21.54369	21.37005
55	1.67192	1.65538	24.71192	24.46868
60	2.06286	2.03856	28.23466	27.91116
65	2.53706	2.50167	32.19906	31.77237
70	3.10286	3.05357	36.61826	36.03357
75	3.78454	3.71454	41.64004	40.82534
80	4.59900	4.49900	47.23020	46.24170
85	5.57428	5.43000	53.62298	52.25180
90	6.73428	6.53142	60.87428	59.03282
95	8.11667	7.82667	69.12117	66.60667

STEAM-AIR MIXTURE TABLES(CONTINUED)

	9	10	11	12
100	9.75500	9.35200	78.54830	75.29200
105	11.69210	11.13086	89.26210	84.94856
110	14.02901	13.23946	101.75901	96.06376
115	16.76540	15.65360	115.93990	108.28360
120	20.04082	18.53046	132.56082	122.42496
125	23.96676	21.87890	151.65172	138.43890
130	28.56254	25.70000	173.58754	156.16000
135	34.11670	30.17140	199.44320	176.54340
140	40.82008	35.38356	230.05258	199.49256
145	48.87778	41.41000	267.85028	226.96600
150	58.67143	48.38889	309.89143	254.85879
155	70.68333	56.48555	360.75183	287.79955
160	85.56000	65.87143	423.54150	323.55043
165	104.25000	76.80000	501.86000	366.18000
170	128.20595	89.30000	600.42595	416.29700
175	159.51850	104.06000	727.84850	473.53950
180	201.45495	121.58350	896.17165	539.67150
185	260.37500	142.16680	1131.13500	616.43680
190	347.69250	165.19220	1475.66250	704.24720
195	482.29500	192.91800	2005.79500	804.11800
200	749.00000	224.36825	3022.10000	923.04825
205	1389.35555	264.66875	5488.77555	1065.19875

STEAM-AIR MIXTURE TABLES(CONTINUED)

Temperature	13 Volume of one pound of dry air Cu. Ft.	14 Volume of one pound of saturated mixture Cu. Ft.	15 Weight of one cubic foot of air LBS.	16 Weight of one cubic foot of saturated mixture LBS.
0	11.58	11.5809	0.08636	0.08634
5	11.70	11.71	0.08541	0.08544
10	11.83	11.84	0.08449	0.08445
15	11.96	11.97	0.08360	0.08346
20	12.09	12.10	0.08274	0.08256
25	12.21	12.24	0.08190	0.08167
30	12.34	12.36	0.08109	0.08078
33	12.39	12.43	0.08071	0.08040
35	12.47	12.49	0.08029	0.07988
40	12.59	12.63	0.07951	0.07901
45	12.72	12.76	0.07871	0.07824
50	12.84	12.90	0.07800	0.07748
55	12.97	13.03	0.07725	0.07662
60	13.10	13.18	0.07645	0.07576
65	13.22	13.31	0.07574	0.07508
70	13.35	13.47	0.07505	0.07424
75	13.48	13.62	0.07436	0.07340
80	13.60	13.78	0.07368	0.07256
85	13.73	13.94	0.07391	0.07173
90	13.86	14.11	0.07224	0.07086
95	13.98	14.27	0.07168	0.07003

STEAM-AIR MIXTURE TABLES(CONTINUED)

	13	14	15	16
100	14.11	14.52	0.07112	0.06916
105	14.24	14.63	0.07039	0.06834
110	14.36	14.85	0.06977	0.06724
115	14.49	15.05	0.06916	0.06632
120	14.62	15.27	0.06856	0.06536
125	14.75	15.51	0.06807	0.06437
130	14.88	15.77	0.06739	0.06333
135	15.00	16.04	0.06682	0.06225
140	15.13	16.35	0.06626	0.06112
145	15.26	16.64	0.06571	0.05995
150	15.39	16.99	0.06517	0.05873
155	15.52	17.37	0.06464	0.05745
160	15.64	17.77	0.06412	0.05611
165	15.77	18.22	0.06361	0.05477
170	15.90	18.75	0.06310	0.05337
175	16.03	19.32	0.06260	0.05170
180	16.16	19.92	0.06211	0.05013
185	16.28	20.63	0.06162	0.04845
190	16.41	21.42	0.06114	0.04712
195	16.54	22.30	0.06068	0.04480
200	16.67	23.43	0.06023	0.04267
205	16.74	24.50	0.05979	0.04081

STEAM-AIR MIXTURE TABLES(CONTINUED)

Temperature	17 Heat Content of one cubic foot of dry air B.T.U.	18 Heat Content of one cubic foot of saturated mixture including heat of liquid B.T.U.	19 Heat Content of one cubic foot of dry air with moisture to saturate including heat of liquid B.T.U.
0	0	0.08310	0.08318
5	0.1059	0.19877	0.20311
10	0.2084	0.34031	0.34079
15	0.3079	0.47433	0.47573
20	0.4040	0.61400	0.61660
25	0.4965	0.76500	0.76784
30	0.5881	0.92400	0.92952
32	0.6218	0.98950	1.00000
35	0.6786	1.09100	1.09772
40	0.7671	1.26705	1.26972
45	0.8536	1.45300	1.46475
50	0.9381	1.65654	1.67800
55	1.0222	1.87585	1.90535
60	1.1037	2.21585	2.15480
65	1.1845	2.47725	2.43500
70	1.2635	2.76662	2.74218
75	1.3411	3.08868	3.08964
80	1.4175	3.44764	3.47315
85	1.4824	3.84042	3.90509
90	1.5560	4.28125	4.39240
95	1.6281	4.77380	4.93288

STEAM-AIR MIXTURE TABLES(CONTINUED)

	17	18	19
100	1.6987	5.31575	5.56662
105	1.7683	5.91325	6.26842
110	1.8366	6.56680	7.06100
115	1.9035	7.28992	7.99800
120	1.9693	8.11158	9.06200
125	2.0343	8.94370	10.28139
130	2.0983	9.82170	11.66000
135	2.1614	10.85670	13.29333
140	2.2238	12.04070	15.20310
145	2.2855	13.25610	17.55125
150	2.3465	14.61506	20.13183
155	2.4065	16.16717	23.24333
160	2.4666	17.77527	27.08000
165	2.5150	19.61172	31.82214
170	2.5711	21.63172	37.76083
175	2.6263	23.94172	45.39500
180	2.6806	26.56292	55.43250
185	2.7336	29.50502	69.48000
190	2.7858	33.05472	89.88600
195	2.8371	37.46472	121.55500
200	2.8885	43.48120	181.29580
205	2.9395	59.25537	372.11666

STEAM TABLES

	20	21	22	23
Temperature	Heat of Liquid B.T.U.	Latent Heat of Fusion B.T.U.	Latent Heat of Vaporization B.T.U.	Total Heat of Vapor B.T.U.
0	0	143.4	1090.0	1233.4
5	2.5	143.4	1087.5	1233.4
10	5.0	143.4	1084.8	1233.2
15	7.4	143.4	1082.0	1232.8
20	9.7	143.4	1079.4	1232.5
25	12.4	143.4	1076.5	1232.3
30	14.3	143.4	1074.2	1231.9
32	158.6		1073.0	1231.6
35	161.62		1071.0	1233.02
40	166.65		1068.8	1235.45
45	171.67		1066.1	1237.77
50	176.68		1063.5	1240.18
55	181.68		1060.8	1242.48
60	186.68		1058.1	1244.78
65	191.68		1055.5	1247.18
70	196.67		1052.8	1249.47
75	201.66		1050.1	1251.67
80	206.65		1047.4	1253.05
85	211.64		1044.7	1256.34
90	216.63		1042.0	1258.63
95	221.61		1039.3	1260.91

STEAM TABLES(CONTINUED)

	20	21	22	23
100	226.60		1036.6	1263.20
105	231.58		1033.9	1265.48
110	236.57		1031.1	1267.67
115	241.55		1028.4	1269.95
120	246.54		1025.6	1272.14
125	251.52		1022.8	1274.32
130	256.51		1020.0	1276.51
135	261.50		1017.2	1278.70
140	266.49		1014.4	1280.89
145	271.49		1011.5	1282.99
150	276.48		1008.7	1285.18
155	281.48		1005.8	1287.28
160	286.48		1002.9	1289.38
165	291.48		1000.0	1291.48
170	296.48		997.1	1293.58
175	301.48		994.2	1295.68
180	306.49		991.2	1297.69
185	311.50		988.2	1299.70
190	316.51		985.2	1301.71
195	321.53		982.2	1303.73
200	326.55		979.2	1305.75
205	331.57		976.1	1307.67
210	336.59		973.0	1309.59
212	338.60		971.7	1310.30
215	341.60		969.9	1311.50

SAMPLE CALCULATIONS

Column one - The values for this column were obtained from Goodenough's Steam Tables; the values from 0° to 32° fahrenheit were found by exterpolation.

Column two - The values for this column were obtained from Goodenough's Tables for Mixtures of Air and Saturated Water Vapor.

Column three - The values for column three were obtained by a ratio. That is, the amount of vapor necessary to saturate one pound of air is to the unknown quantity as the sum of one pound of air plus the moisture to saturate it is to one.

$$\frac{0.000781}{X} = \frac{1.000781}{1}$$

Therefore $X = 0.0007804$ pounds

Column four - The values of this column were obtained by multiplying the latent heat of one pound of vapor by the amount of vapor necessary to saturate one pound of air.

$1090 \times 0.000781 = 0.8513$ B.T.U.'s

Column five - Values here were obtained by the product of the latent heat of one pound of vapor and the amount of moisture in one pound of mixture.

$1090 \times 0.0007804 = 0.8506$ B.T.U.'s

Column six - Values for this column were obtained from Gebhardt's Tables on Mixtures of Air Saturated with Water Vapor.

Column seven - These values were obtained by subtracting the amount of moisture in one pound of mixture from one.

Example: $1 - 0.0007804 = 0.9992196$ pounds.

Column eight - The values for this column are the products of the heat in one pound of dry air and the amount of air in one pound of mixture.

Example: $1.205 \times 0.999085 = 1.2379$ B.T.U.'s

Column nine - The values for column nine were obtained by multiplying the amount of vapor necessary to saturate one pound of air by the heat of the liquid of one pound of saturated steam added to the latent heat of fusion.

Example at 5° Fahrenheit:

$$(143.4 + 2.5) \times 0.001015 = 0.13374 \text{ B.T.U.'s}$$

Column ten - This column was obtained by multiplying the amount of moisture in one pound of mixture by the sum of the latent heat of fusion and the heat of liquid in one pound of saturated steam.

Example at 5° Fahrenheit:

$$(143.4 + 2.5) \times 0.001015 = 0.13774 \text{ B.T.U.'s}$$

Column eleven - The values for this column were found by adding the values for the latent heat in vapor necessary to saturate one pound of air, the heat in one pound of dry air, and the heat of liquid in the vapor necessary to saturate one pound of air.

Example at 0° Fahrenheit:

$$0.8513 + 0 + 0.11201 = 0.963305 \text{ B.T.U.'s}$$

Column twelve - The values in this column represent the sum of the latent heat in vapor necessary to make one pound of mixture, the heat in air portion of one pound of mixture, and the heat of liquid of vapor in one pound of mixture.

Example at 0° Fahrenheit:

$$0.8506 + 0 + 0.11192 = 0.962425 \text{ B.T.U.'s}$$

Column thirteen - These values were obtained from Goodenough's Tables on Mixtures of Air and Saturated Water Vapor.

Column fourteen - The values for this column were obtained by dividing the values for the volume of one pound of dry air plus the vapor to saturate it found in Goodenough's Air Mixture Tables by one plus the amount of vapor necessary

to saturate one pound of air.

Example at 0° Fahrenheit:

$$\frac{11.59}{1 + 0.000781} = 11.5809 \text{ cubic feet.}$$

Column fifteen - These values were found by dividing one by the volume of one pound of dry air.

Example at 0° Fahrenheit:

$$\frac{1}{11.58} = 0.08636 \text{ pounds.}$$

Column sixteen - Like column fifteen, these values were found by dividing one by the volume of one pound of saturated mixture.

Example at 0° Fahrenheit:

$$\frac{1}{11.5809} = 0.08634 \text{ pounds.}$$

Column seventeen - These values are the result of the products of the heat in one pound of dry air and the weight of one cubic foot of air.

Example at 5° Fahrenheit:

1.205 X 0.08541 = 0.1059 B.T.U.'s

Column eighteen - These values were found by multiplying the total heat of one pound of mixture by the weight of one cubic foot of mixture.

Example at 0° Fahrenheit:

0.962425 X 0.08634 = 0.08310 B.T.U.'s

Column nineteen - These values were obtained by multiplying the total heat of one pound of air with the moisture to saturate by the weight of one cubic foot of air.

Example at 0° Fahrenheit:

0.963305 X 0.08636 = 0.08320

Column twenty - The values from 32° Fahrenheit to 212° Fahrenheit represent the values found in Goodenough's Steam Tables plus the latent heat of fusion. The values below 32° Fahrenheit were obtained by exterpolation.

Example at 32° Fahrenheit:

$$15.2 + 143.4 = 158.6 \text{ B.T.U.'s}$$

Column twenty-one - This value represents the latent heat of fusion of water.

Column twenty-two - These values were obtained from Goodenough's Steam Tables with the values below 32° Fahrenheit being determined by exterpolation.

Column twenty-three - The values of this column represent the total of the heat of the liquid, the latent heat of fusion, and the latent heat of vaporization.

Example at 0° Fahrenheit:

$$0 + 143.4 + 1090 = 1233.4$$

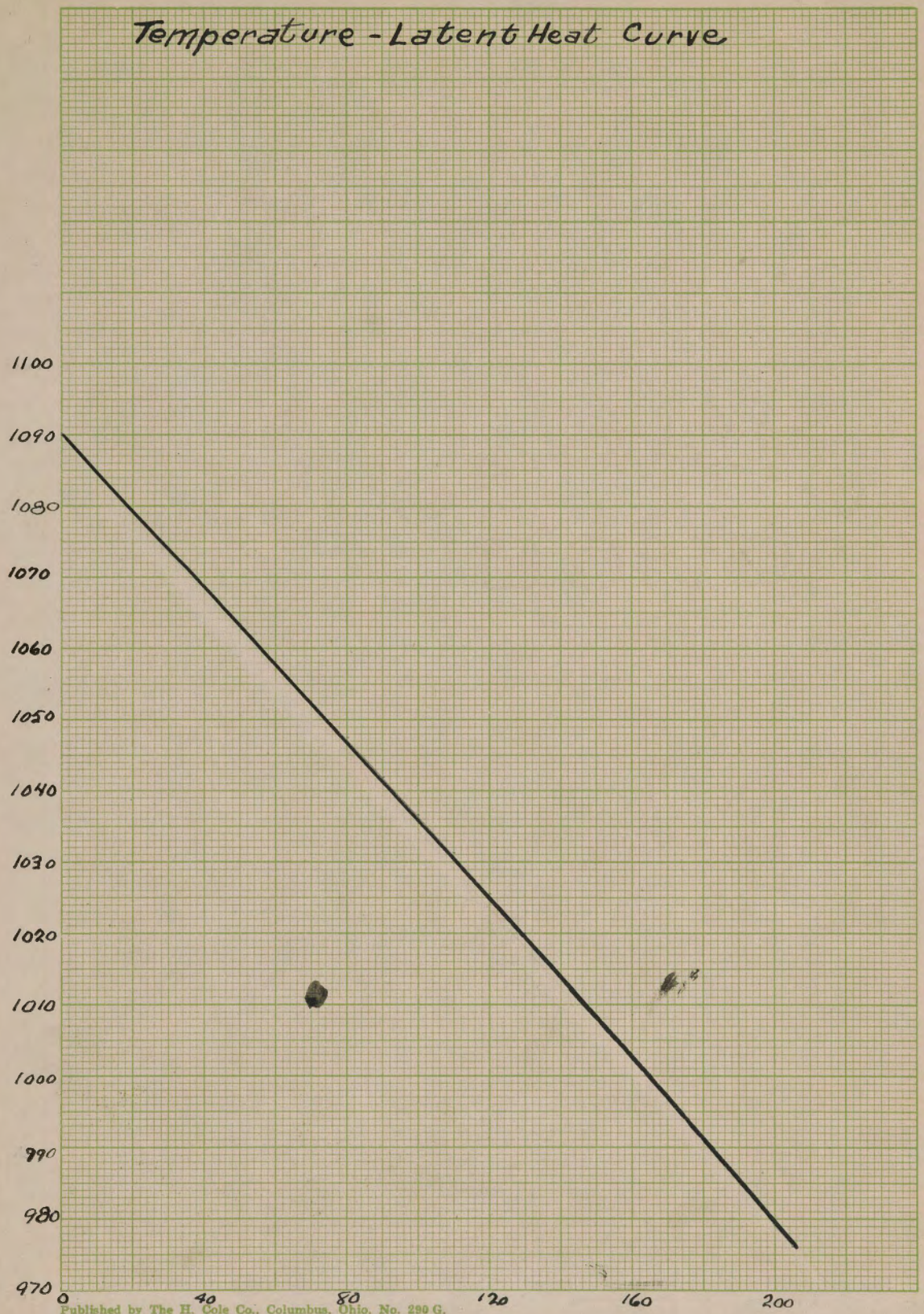
CURVES CORRESPONDING TO THE TABLES

On the following curves the temperatures were plotted on the horizontal scale, and the values taken from the tables were plotted on the vertical scale.

The numbers of the curves correspond to the column numbers of the tables.

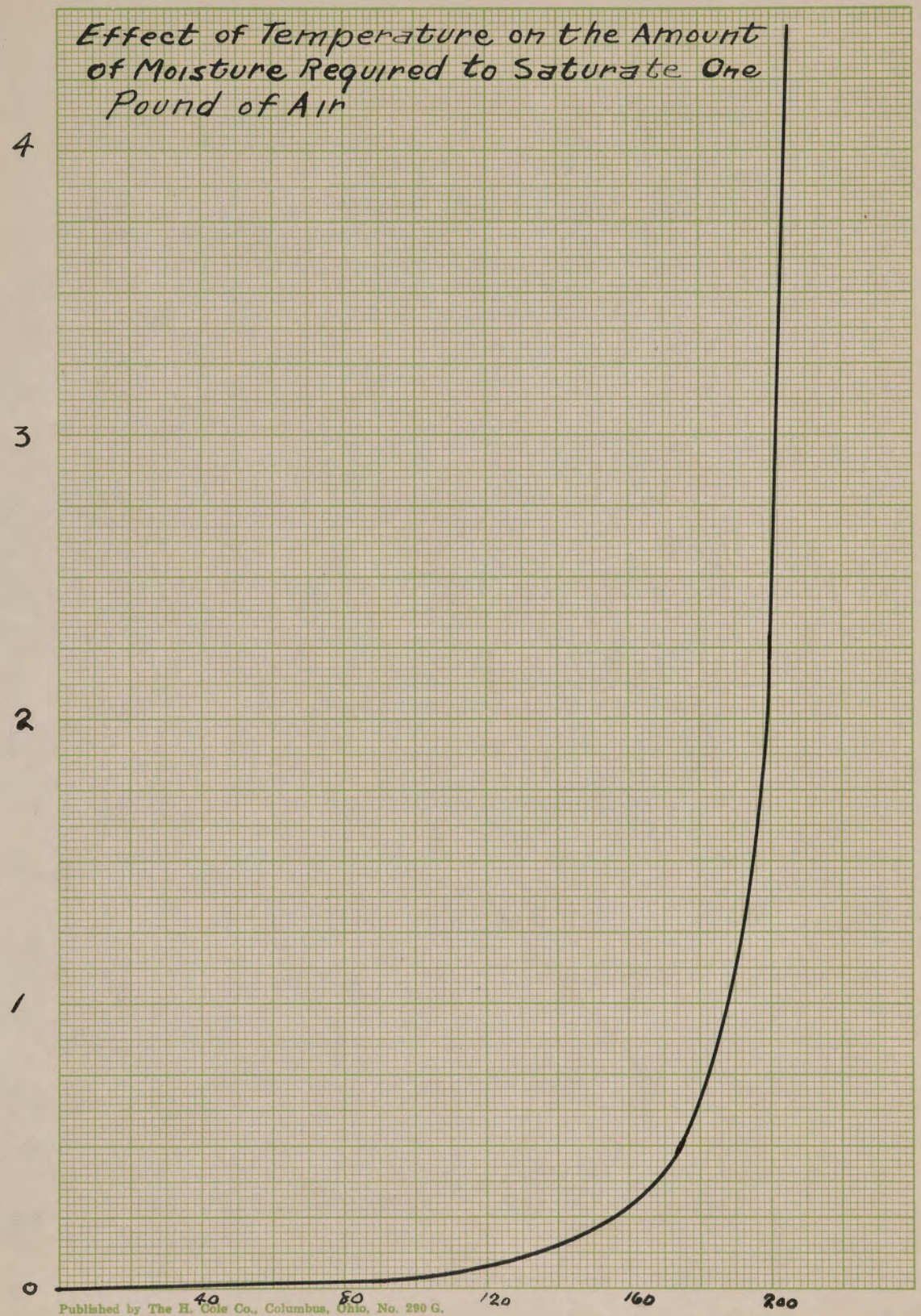
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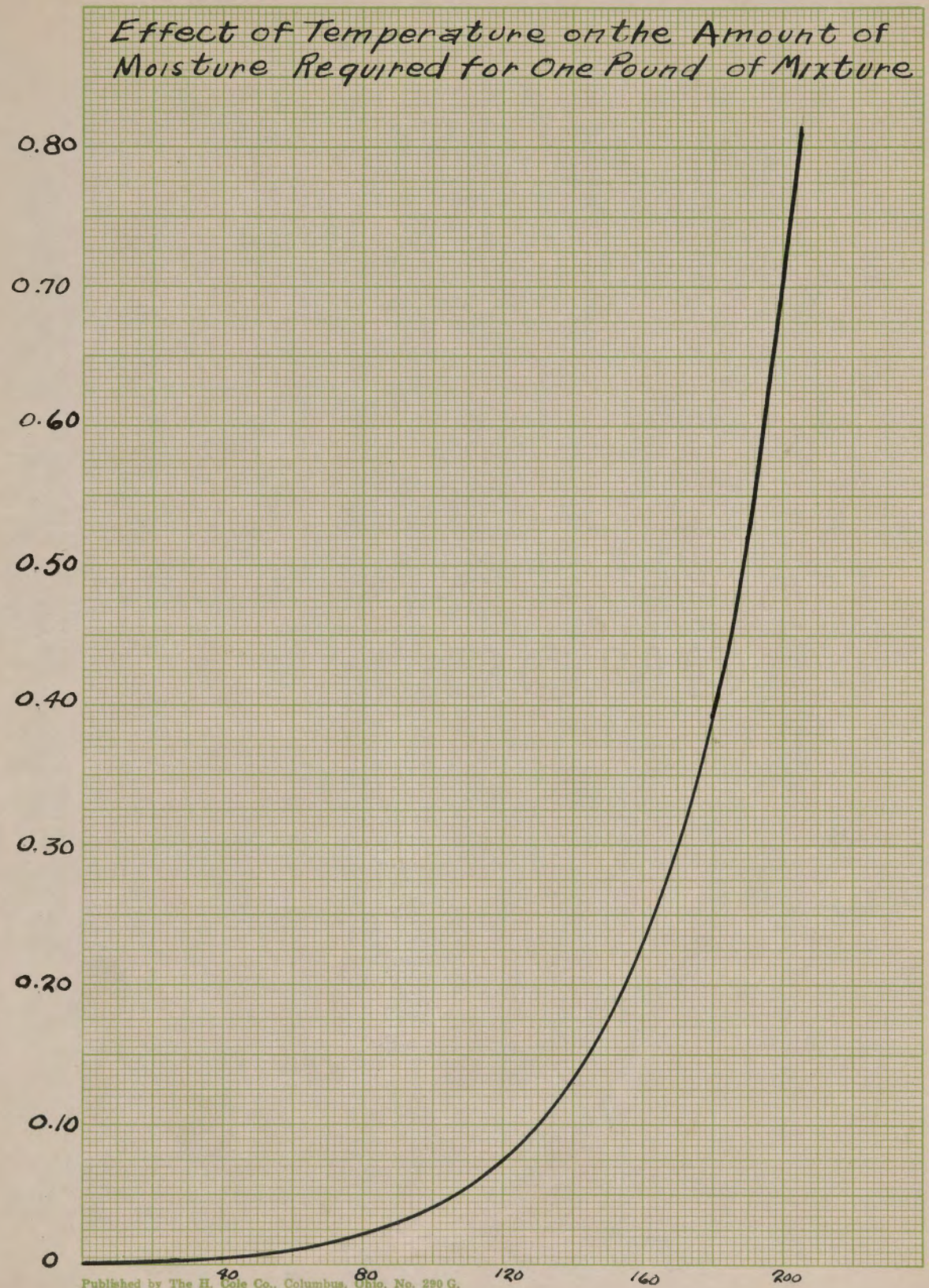
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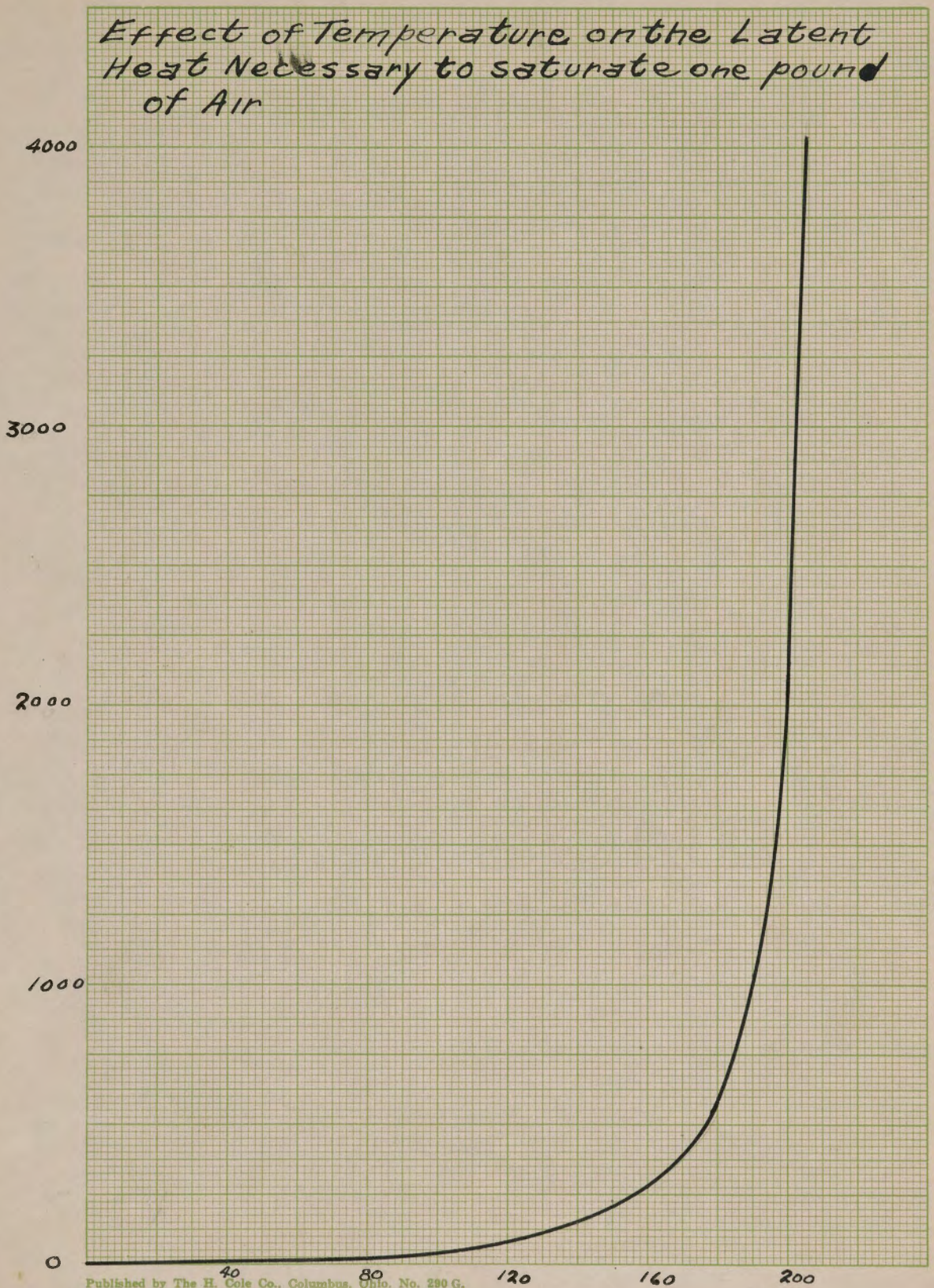


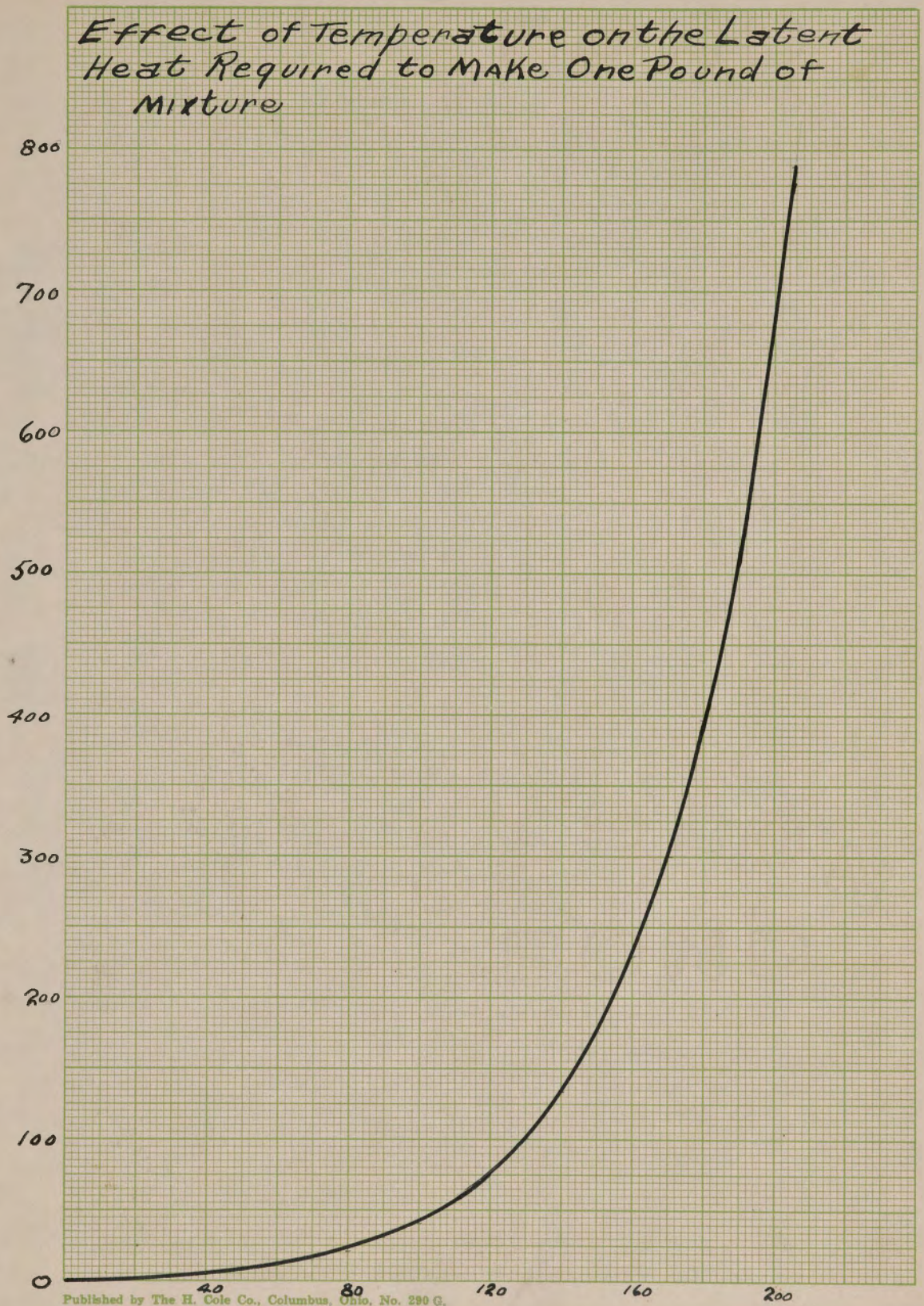
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2

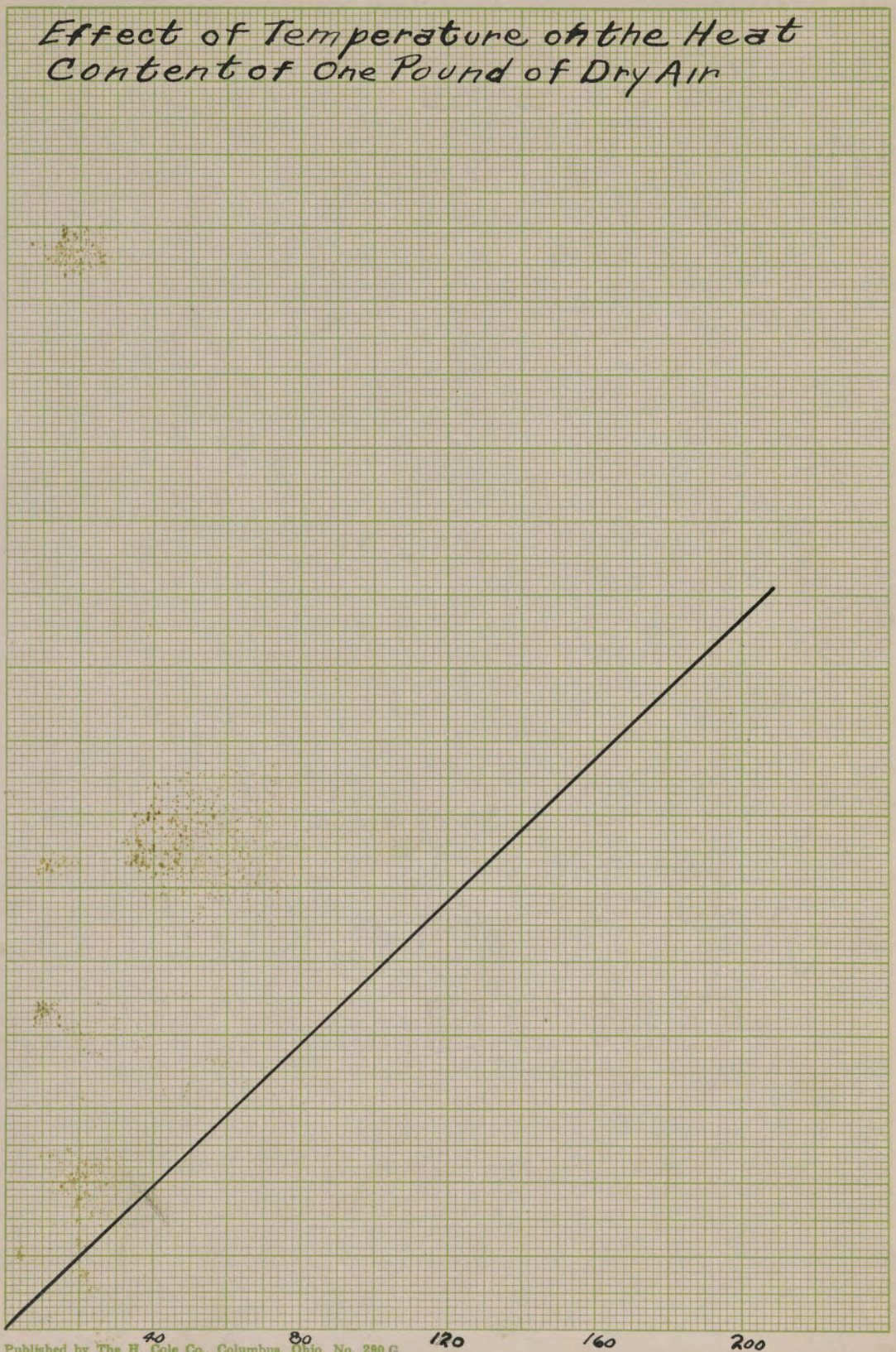

Effect of Temperature on the Amount of Moisture Required to Saturate One Pound of Air
4
3
2
1
0
40
80
120
160
200
Published by The H. Cole Co., Columbus, Ohio, No. 290 G.

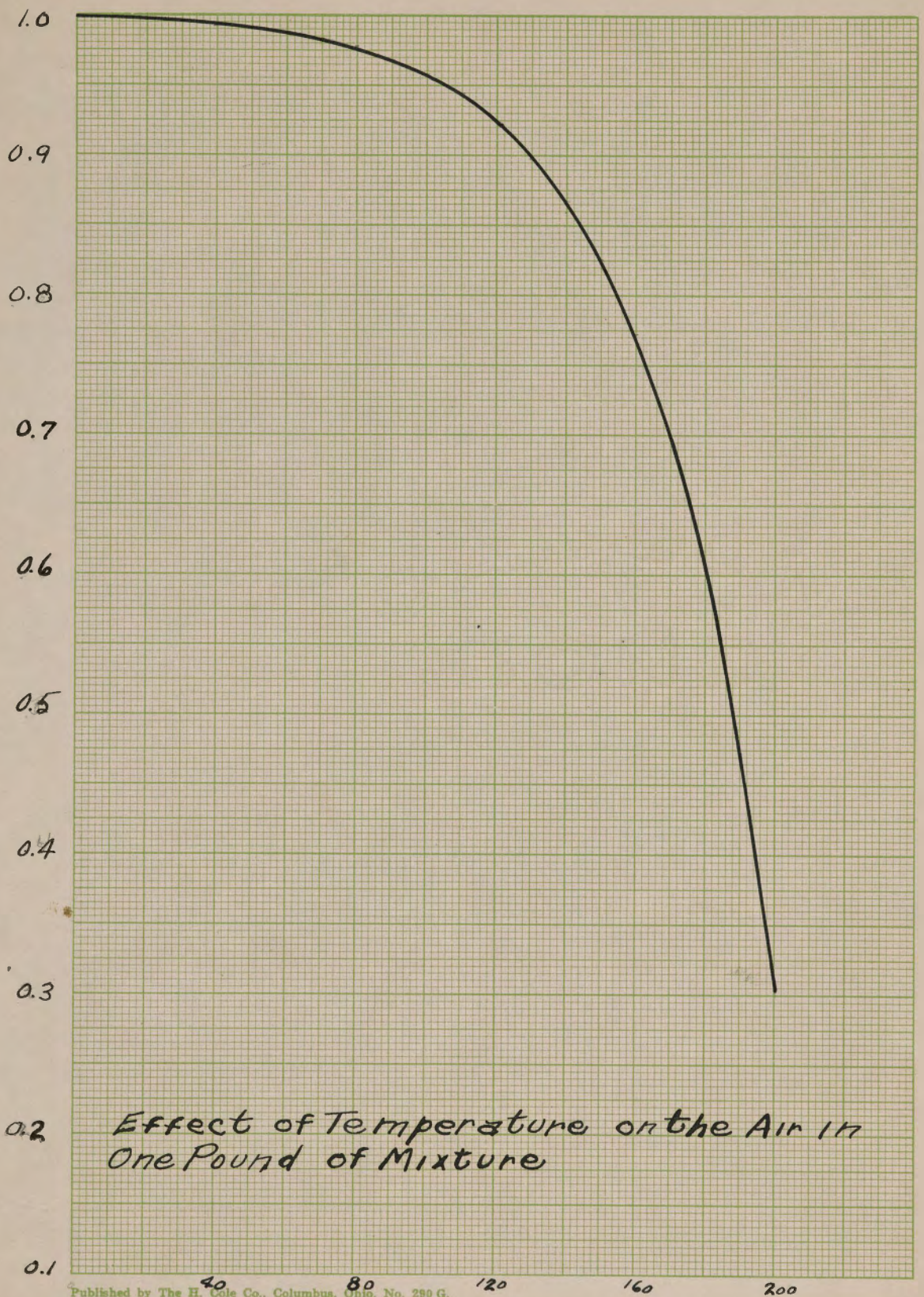

Effect of Temperature on the Amount of Moisture Required for One Pound of Mixture
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0
40
80
120
160
200
Published by The H. Cole Co., Columbus, Ohio, No. 290 G.


Effect of Temperature on the Latent Heat Necessary to saturate one pound of Air
4000
3000
2000
1000
0
40
80
120
160
200
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Effect of Temperature on the Latent Heat Required to Make One Pound of Mixture
800
700
600
500
400
300
200
100
0
40
80
120
160
200
Published by The H. Cole Co., Columbus, Ohio, No. 290 G.

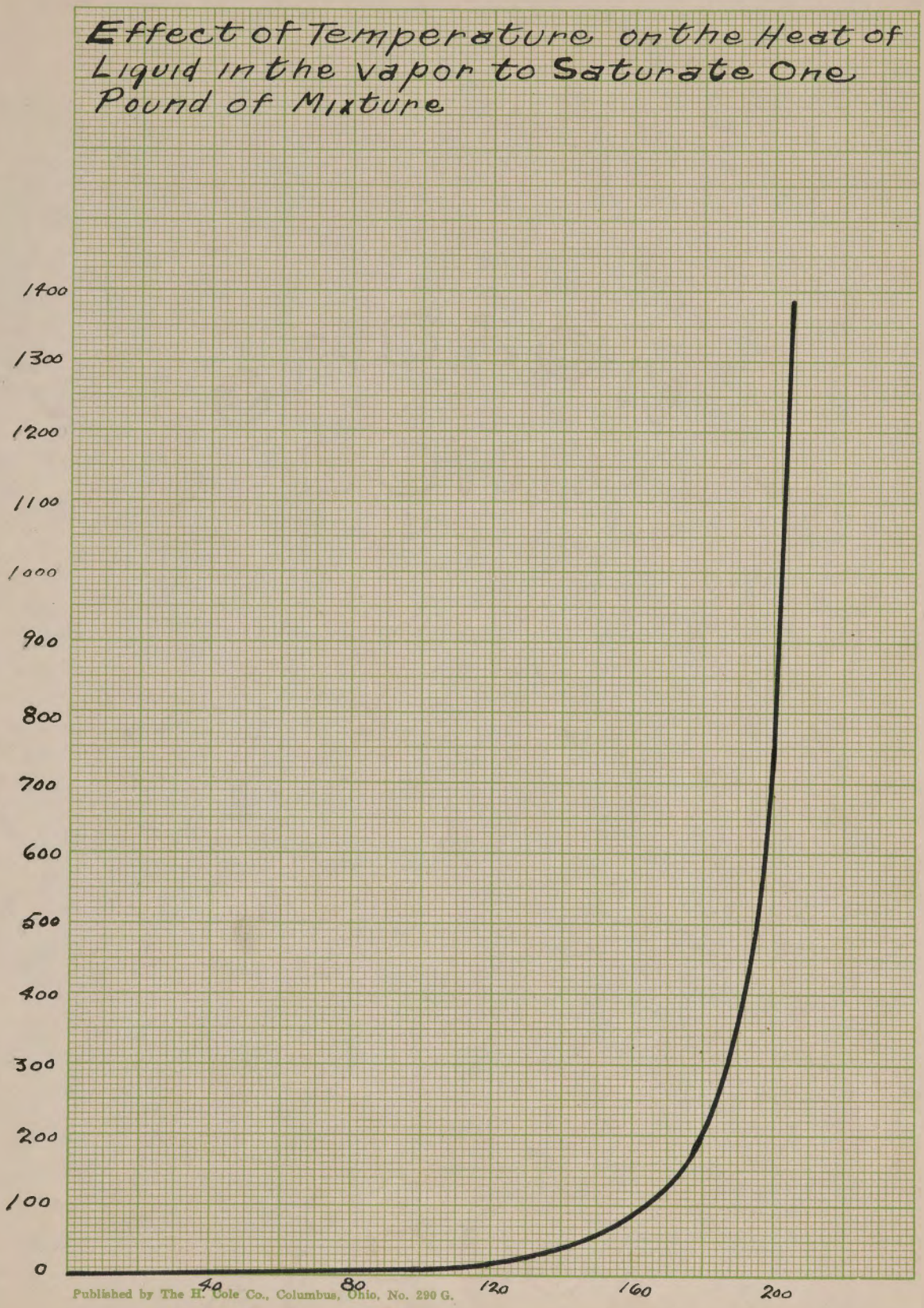
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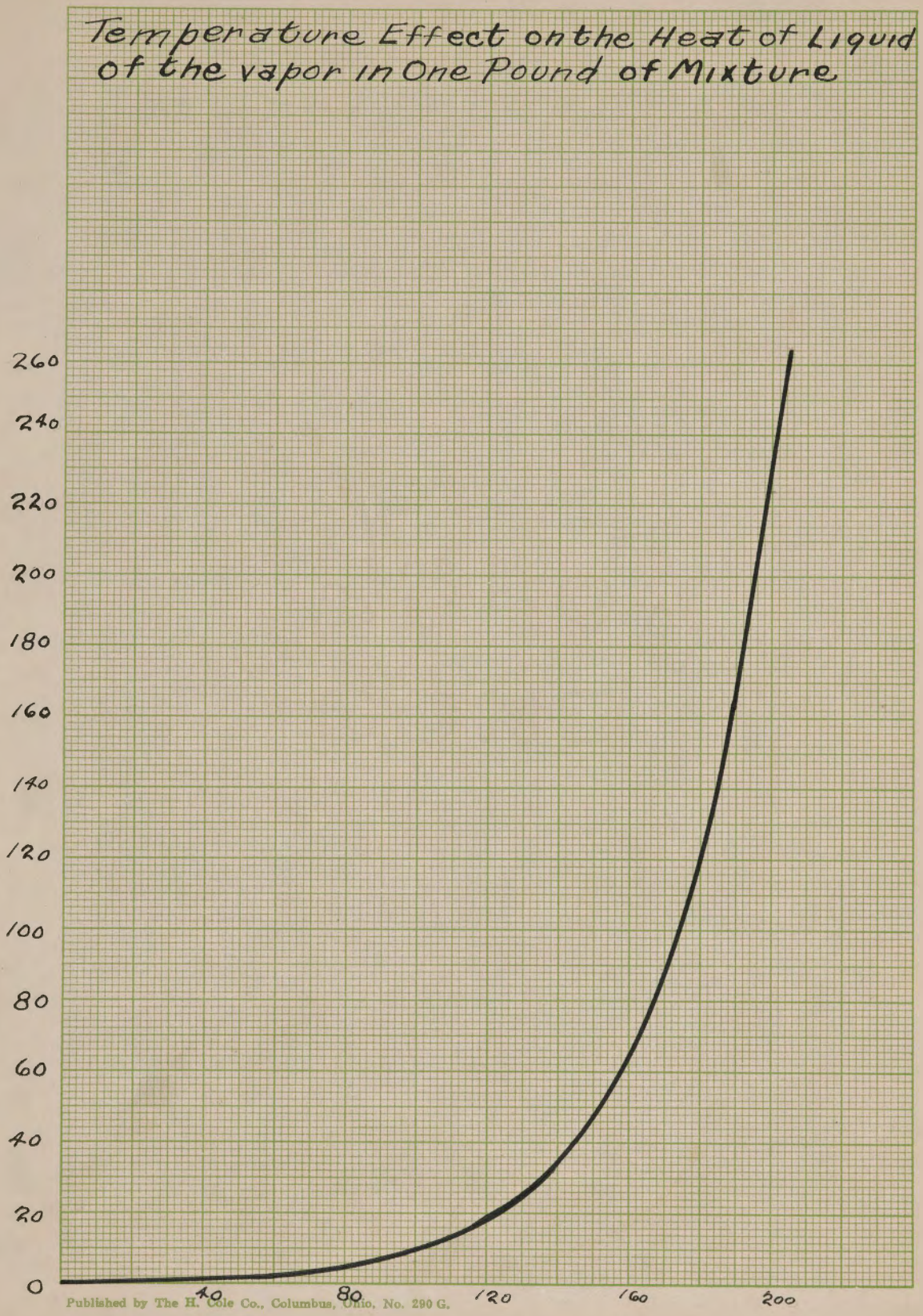

Effect of Temperature on the Heat Content of One Pound of Dry Air
50
40
30
20
10
0
40
80
120
160
200
Published by The H. Cole Co., Columbus, Ohio, No. 290 G.

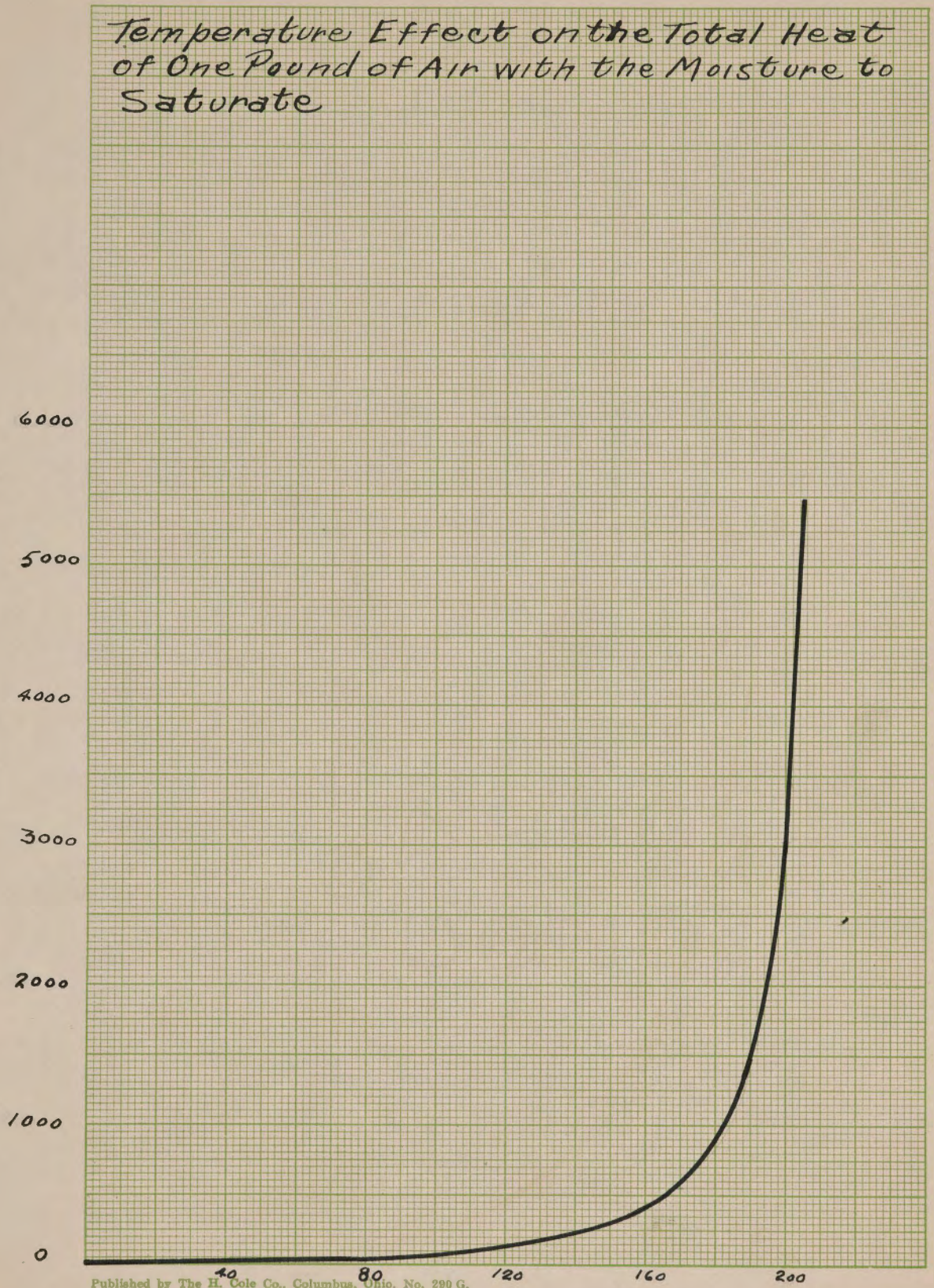


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Effect of Temperature on the Heat Content of the Air Portion of One Pound of Mixture
30
20
10
0
40
80
120
160
200
Published by The H. Cole Co., Columbus, Ohio, No. 290 G.

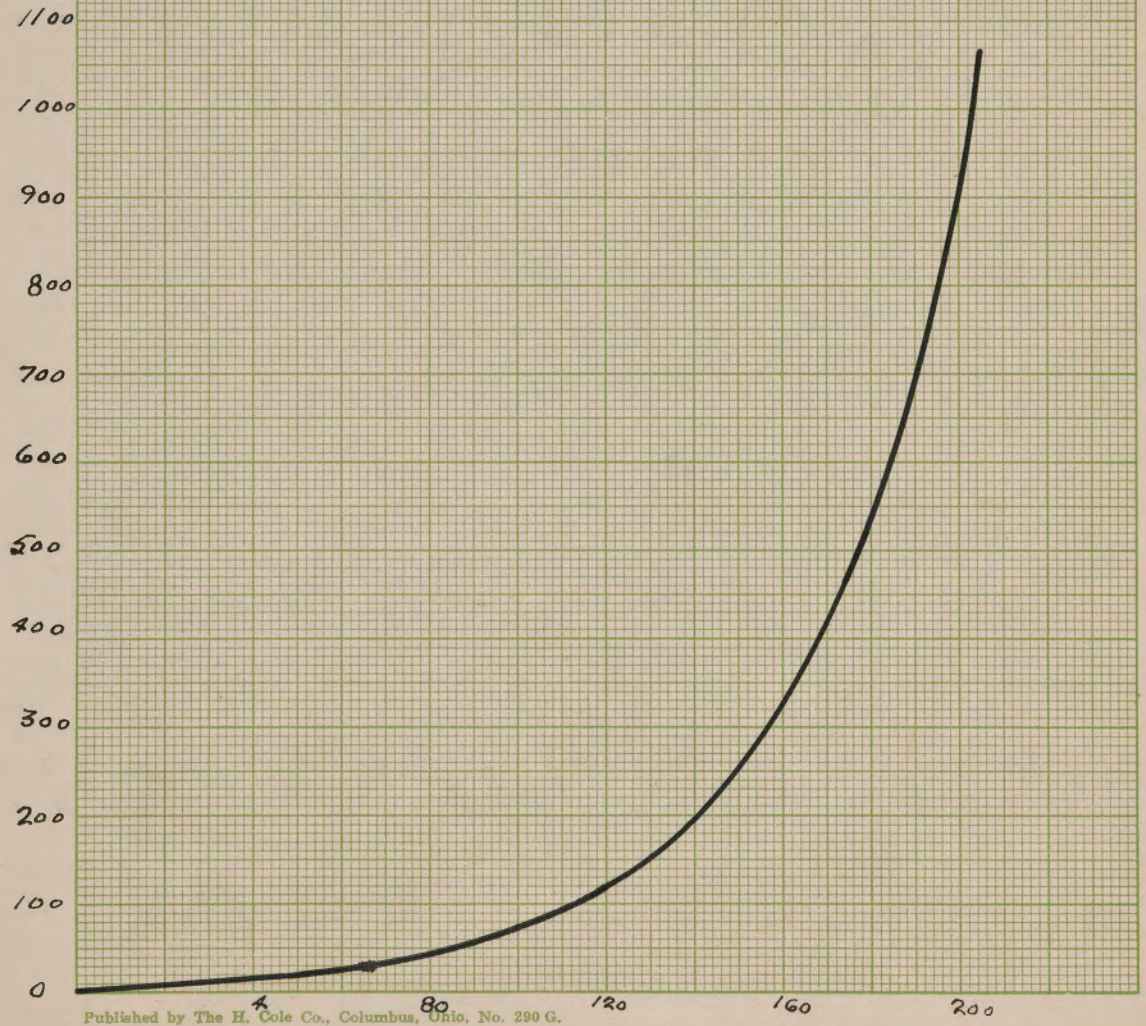

Effect of Temperature on the Heat of Liquid in the vapor to Saturate One Pound of Mixture
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
40
80
120
160
200
Published by The H. Cole Co., Columbus, Ohio, No. 290 G.


Temperature Effect on the Heat of Liquid of the vapor in One Pound of Mixture
260
240
220
200
180
160
140
120
100
80
60
40
20
0
40
80
120
160
200
Published by The H. Cole Co., Columbus, Ohio, No. 290 G.

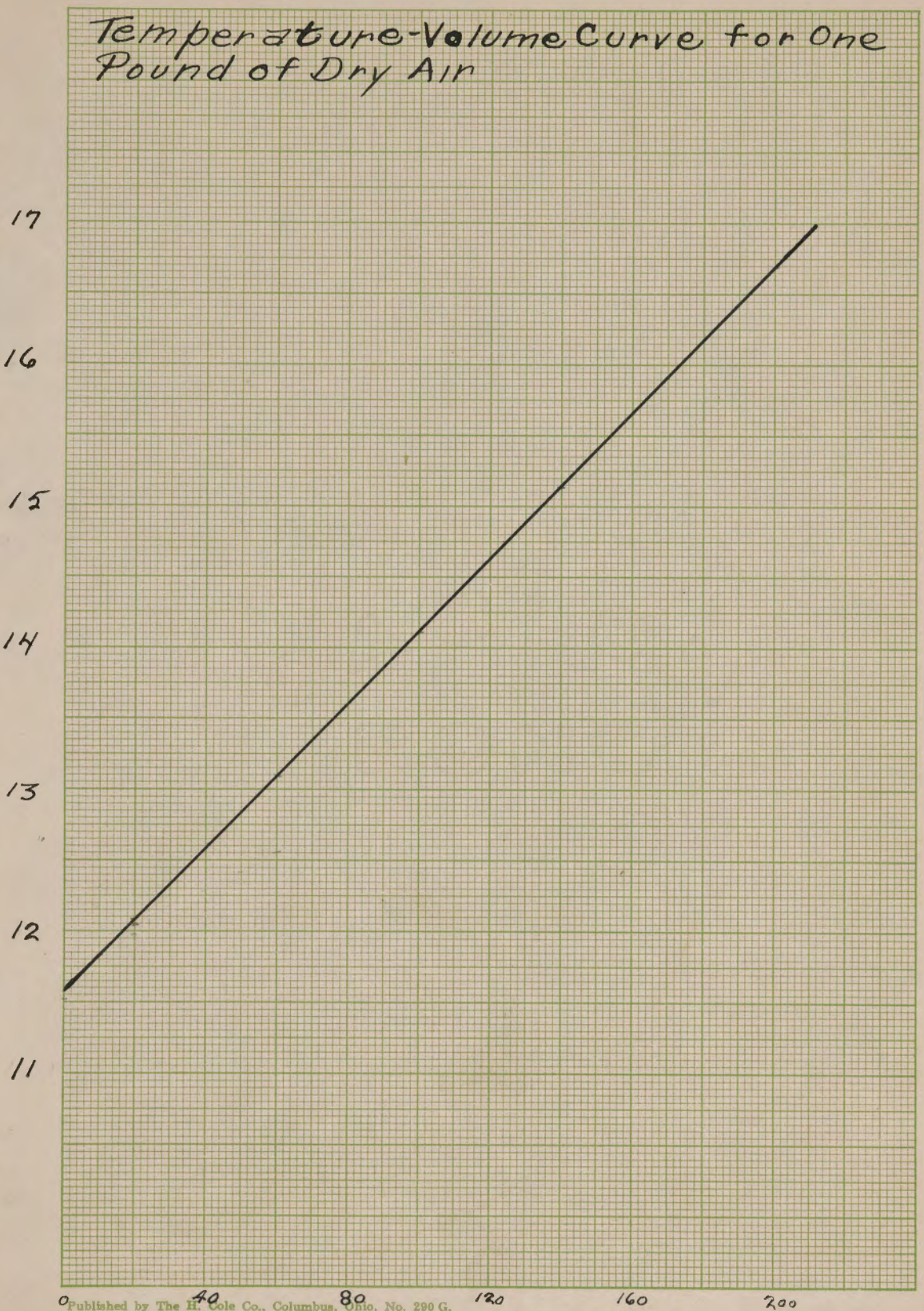


Published by The H. Cole Co., Columbus, Ohio. No. 290 G.

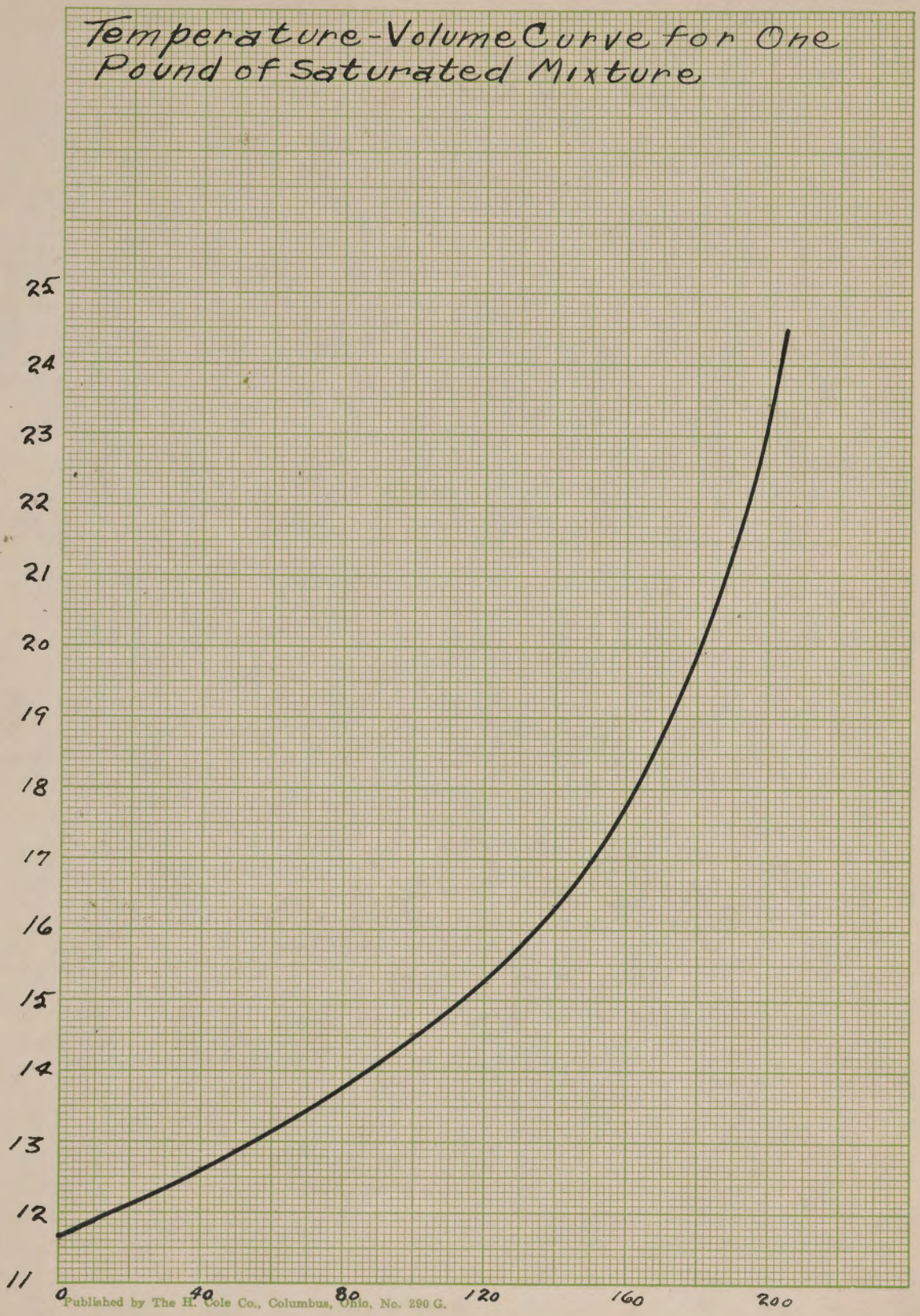
Temperature Effect on the Total Heat of One Pound of Mixture



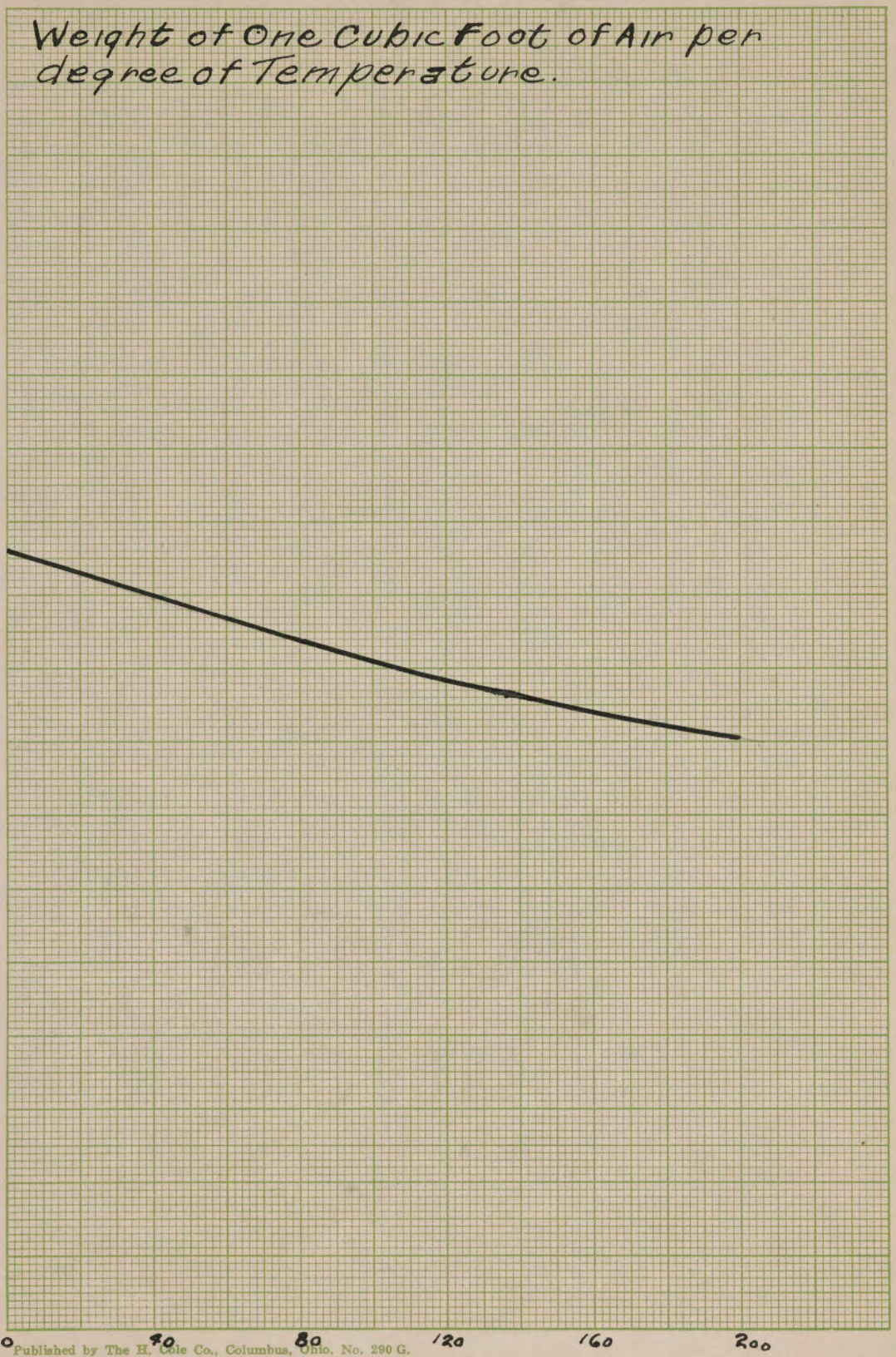
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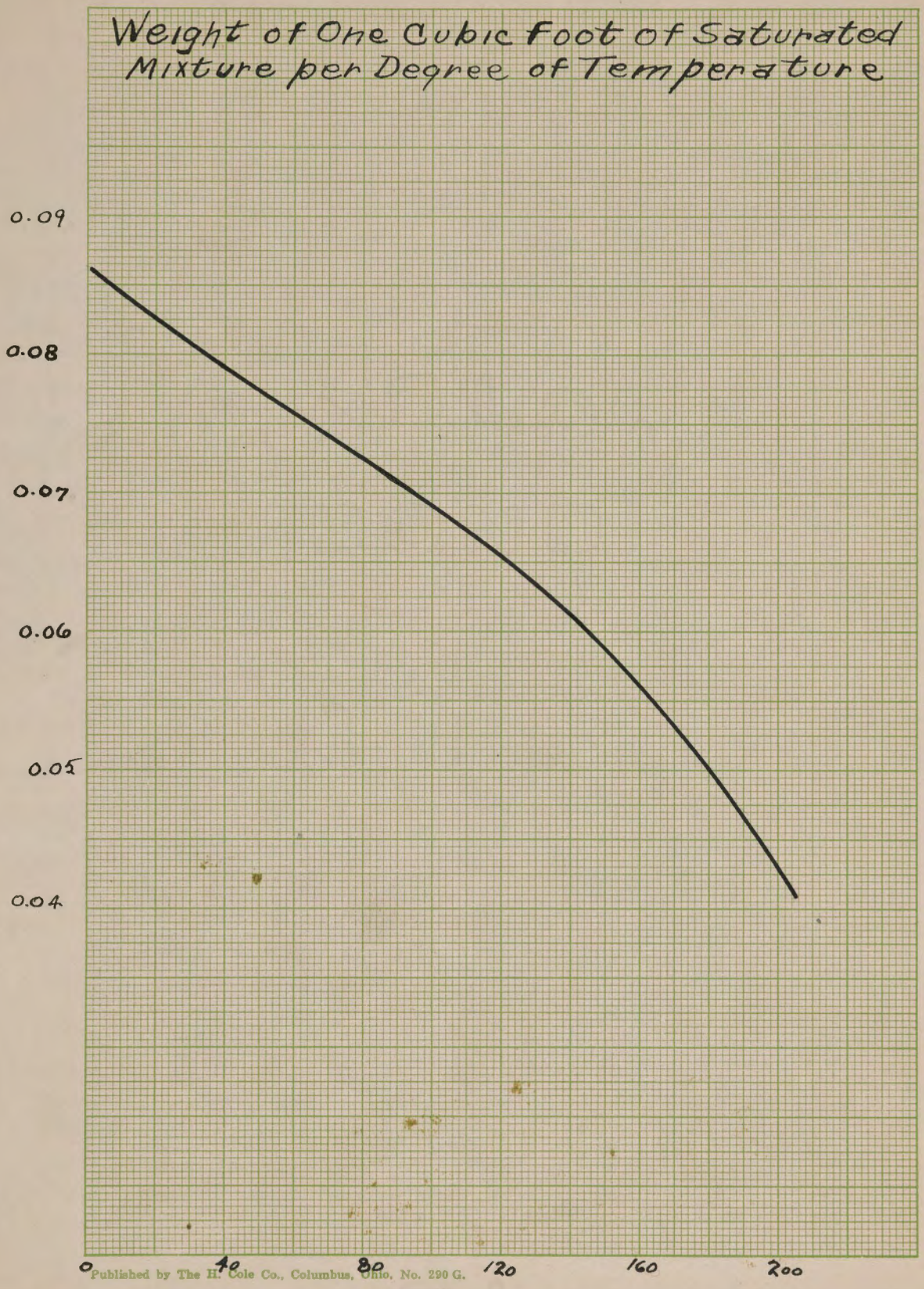
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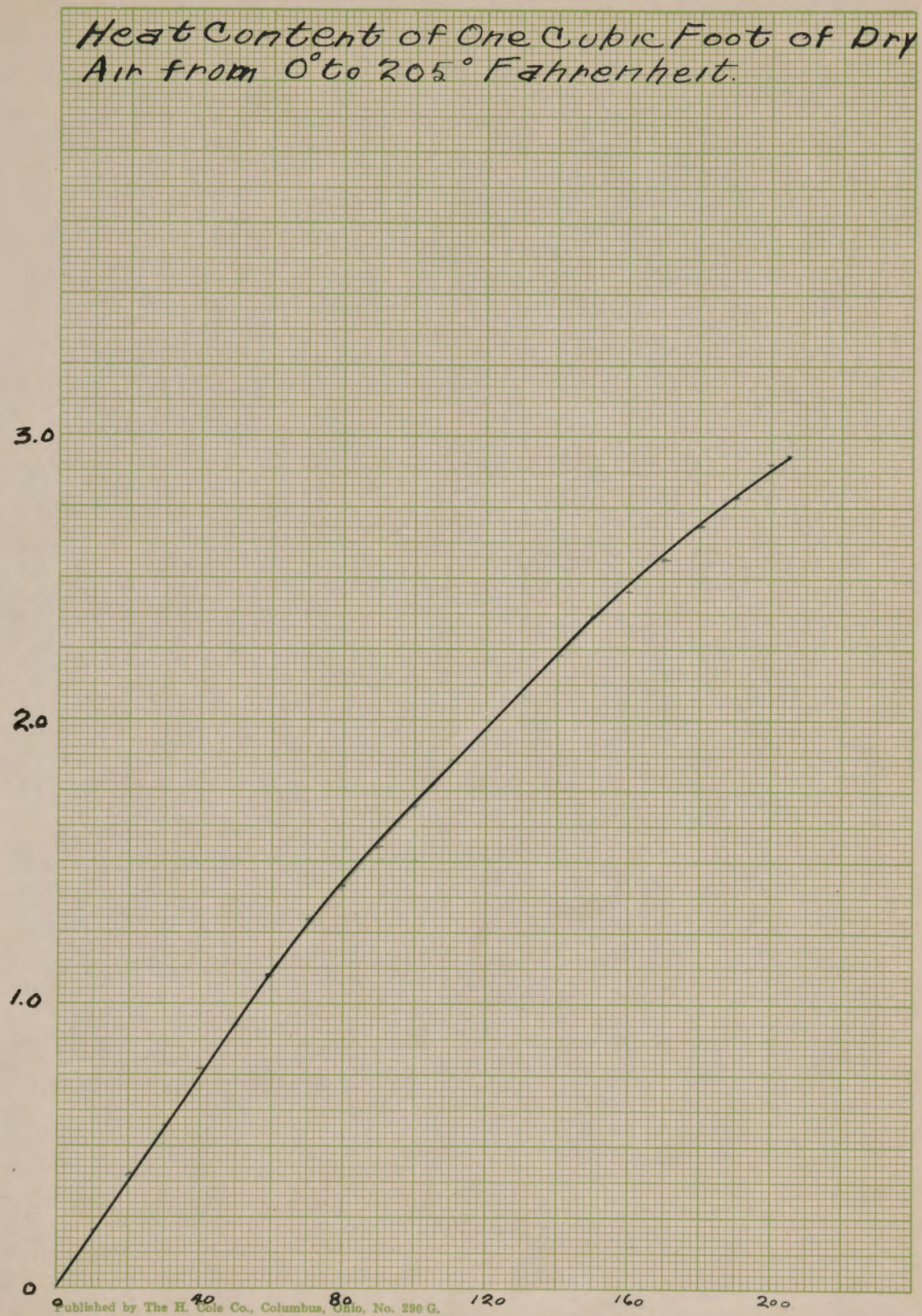


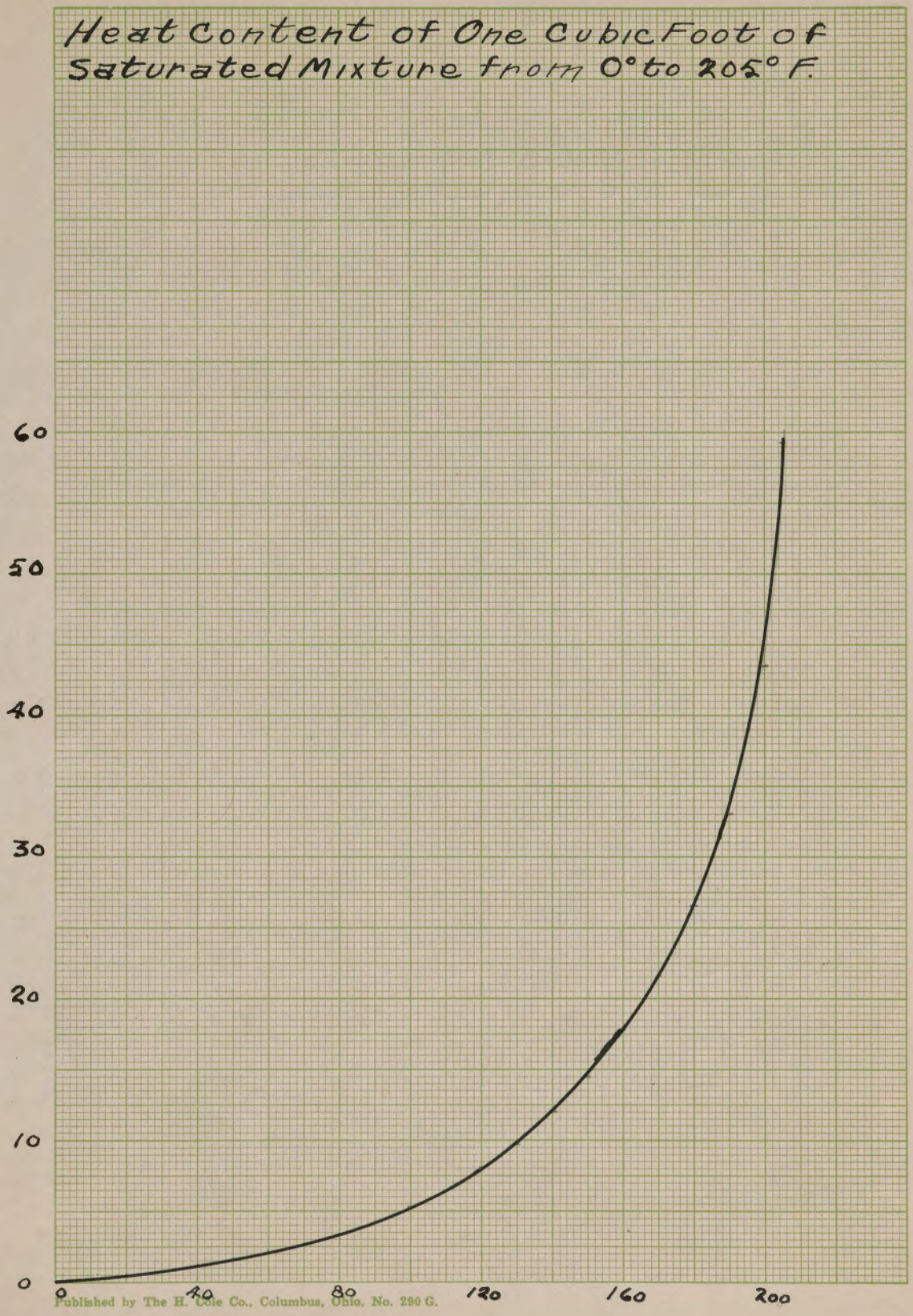
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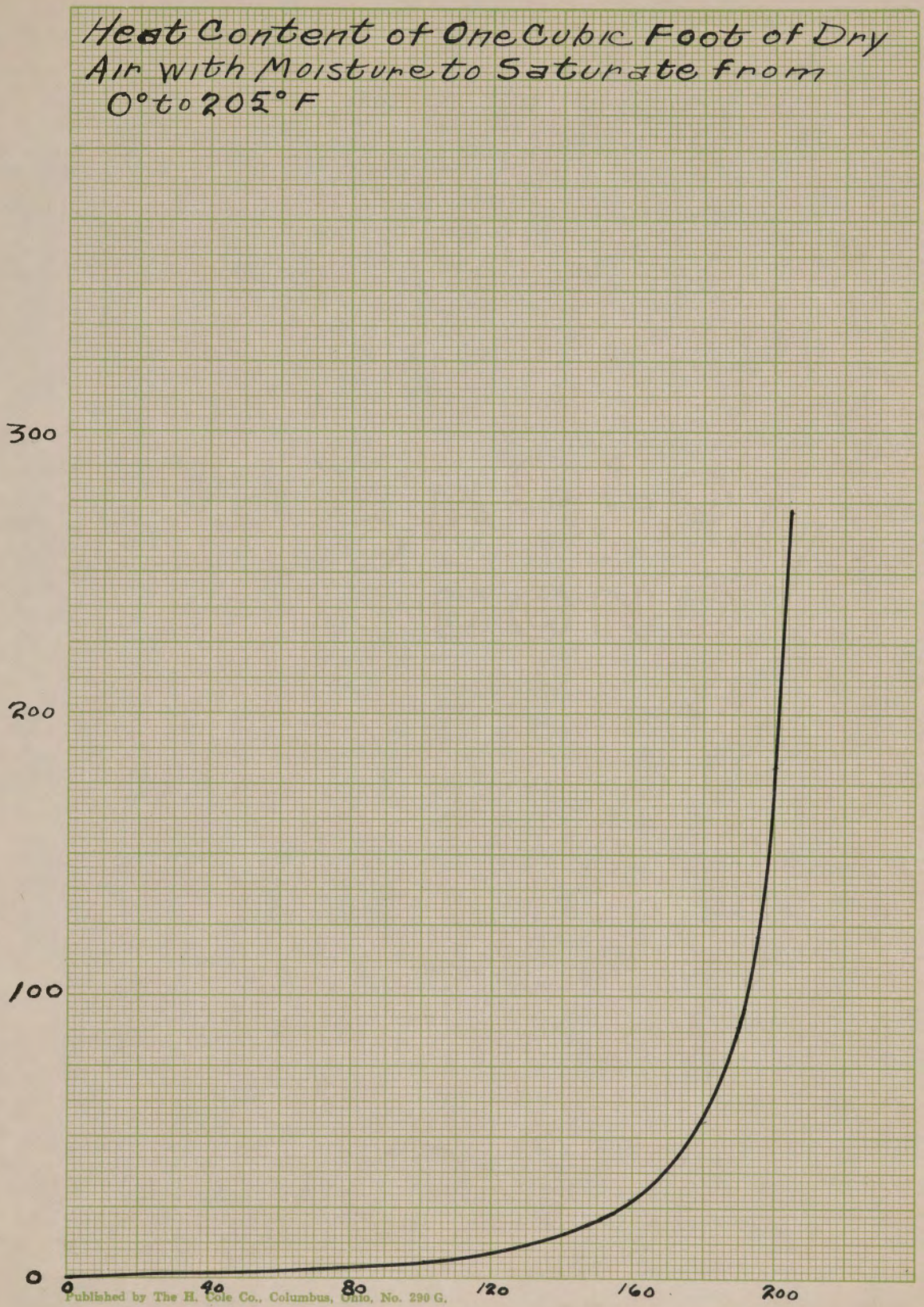


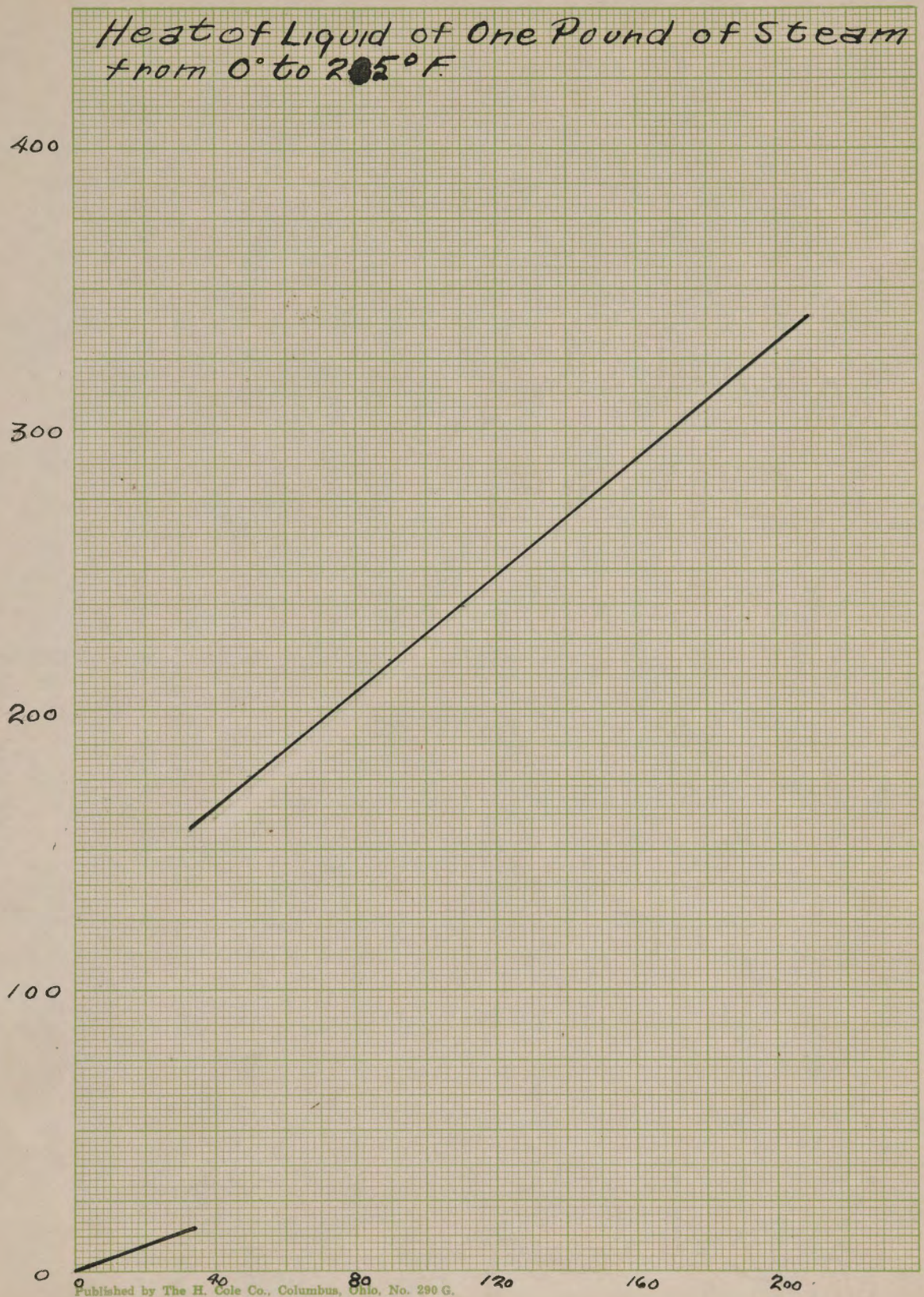
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Weight of One Cubic Foot of Saturated Mixture per Degree of Temperature
0.09
0.08
0.07
0.06
0.05
0.04
0
40
80
120
160
200
Published by The H. Cole Co., Columbus, Ohio. No. 290 G.

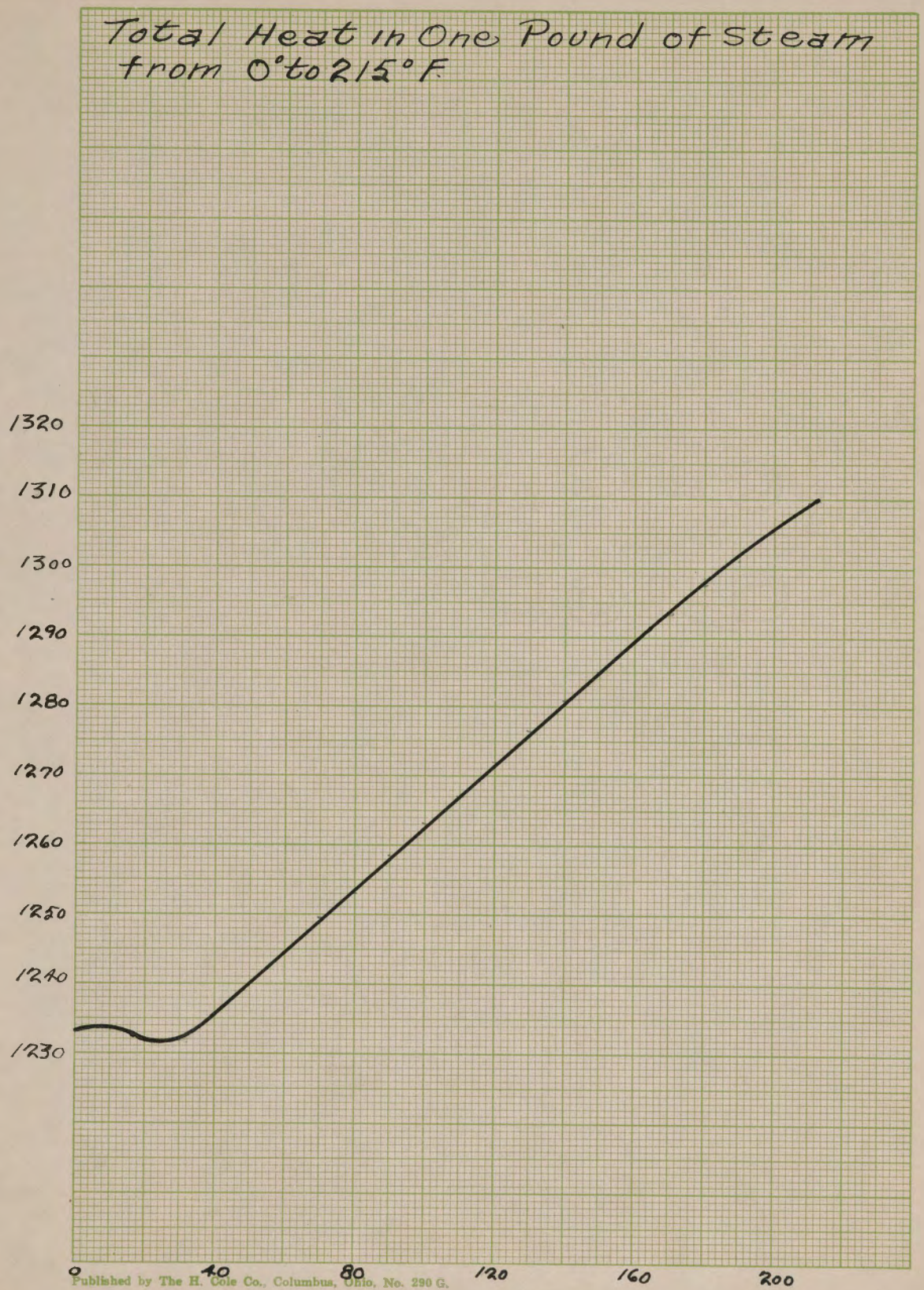

Heat Content of One Cubic Foot of Dry Air from 0° to 205° Fahrenheit.
3.0
2.0
1.0
0
0
40
80
120
160
200
Published by The H. Cole Co., Columbus, Ohio, No. 290 G.


Heat Content of One Cubic Foot of Saturated Mixture from 0° to 205° F.
60
50
40
30
20
10
0
0
40
80
120
160
200
Published by The H. Cole Co., Columbus, Ohio, No. 290 G.


Heat Content of One Cubic Foot of Dry Air with Moisture to Saturate from 0° to 205° F
300
200
100
0
0
40
80
120
160
200
Published by The H. Cole Co., Columbus, Ohio, No. 290 G.



Published by The H. Cole Co., Columbus, Ohio, No. 290 G.

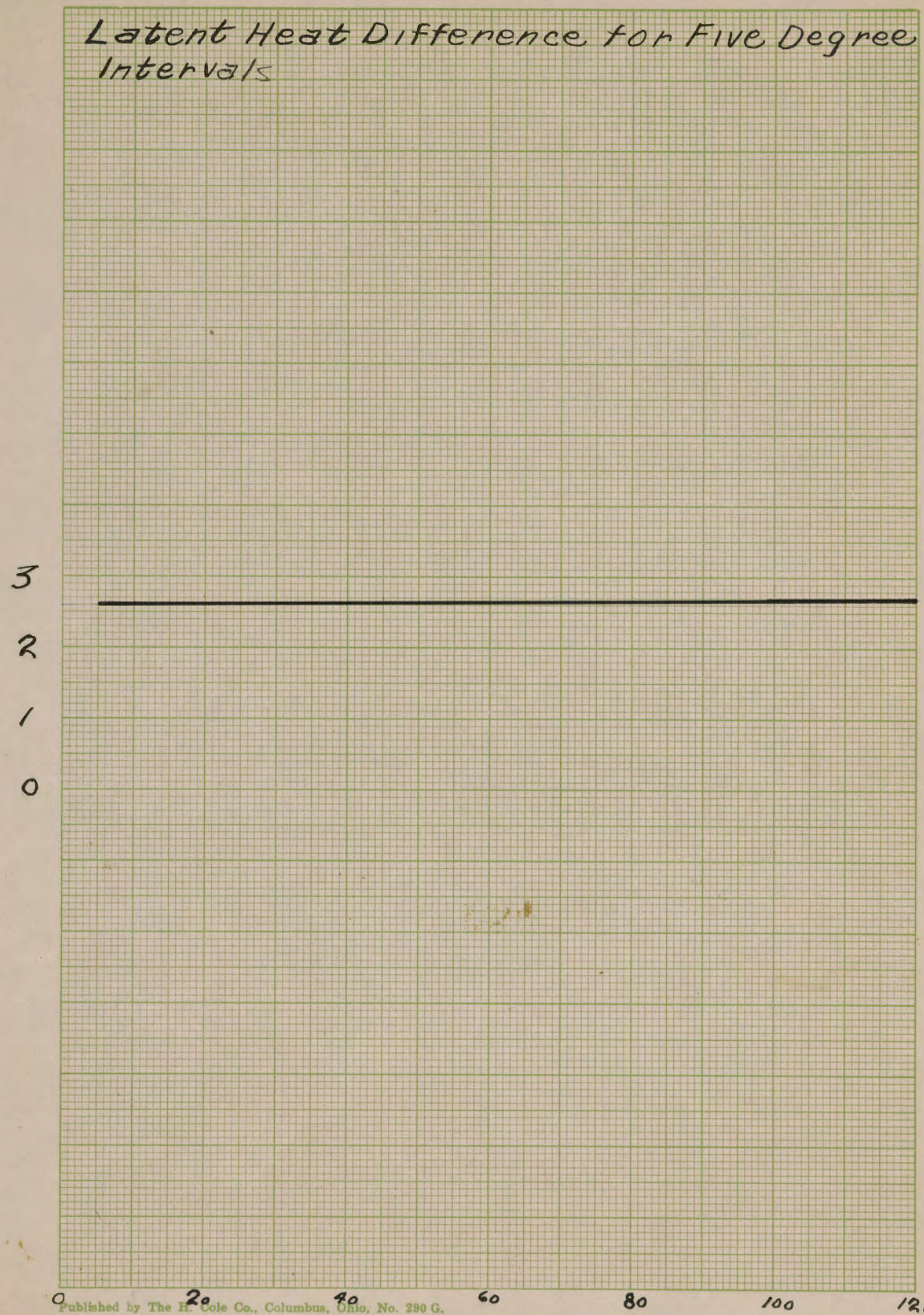


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INCREMENT CURVES

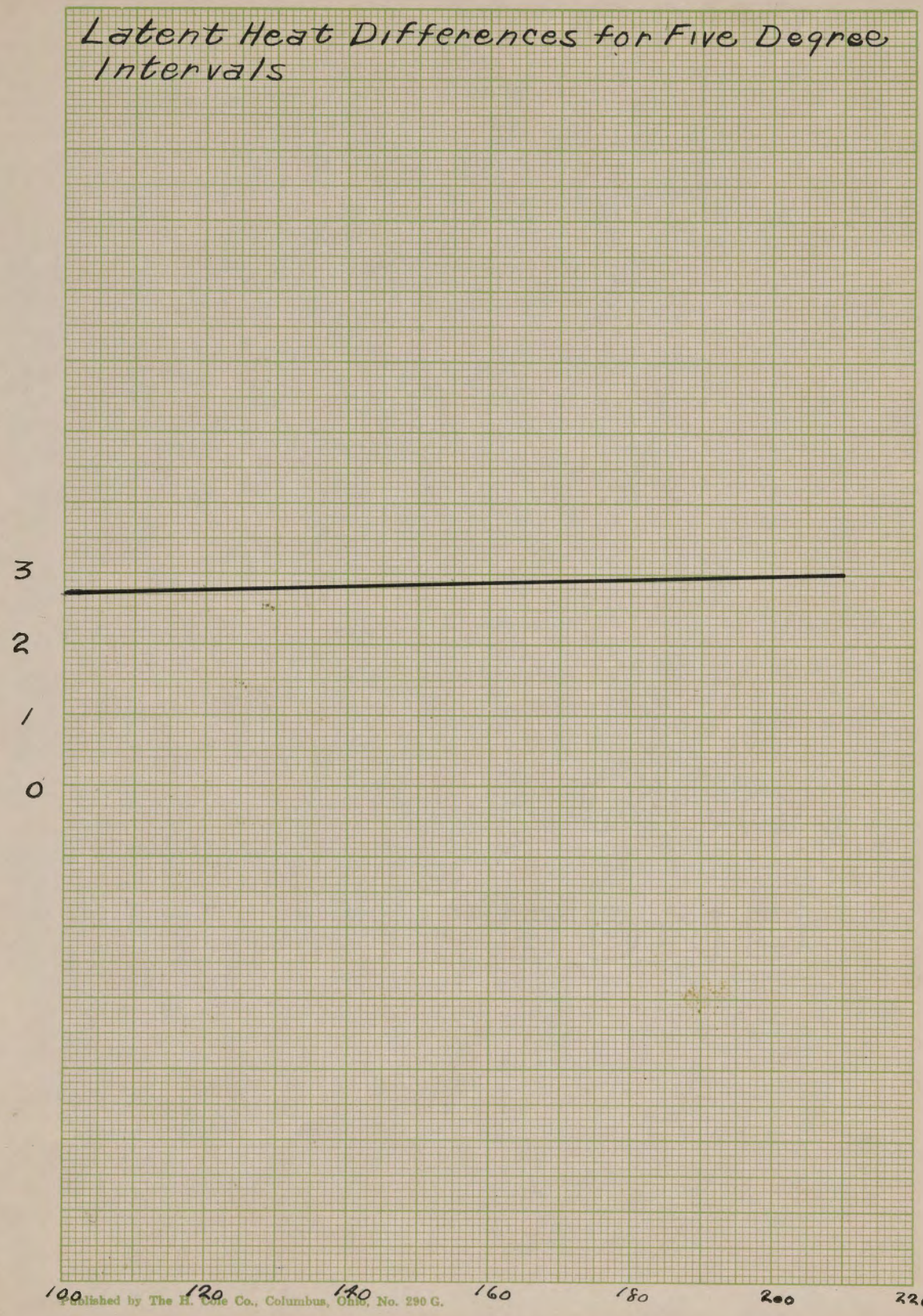
On the following curves the temperatures were plotted on the horizontal scale, while the increment differences for every five degrees of temperature were plotted on the vertical scale.

The curve numbers correspond to the column numbers of the tables.



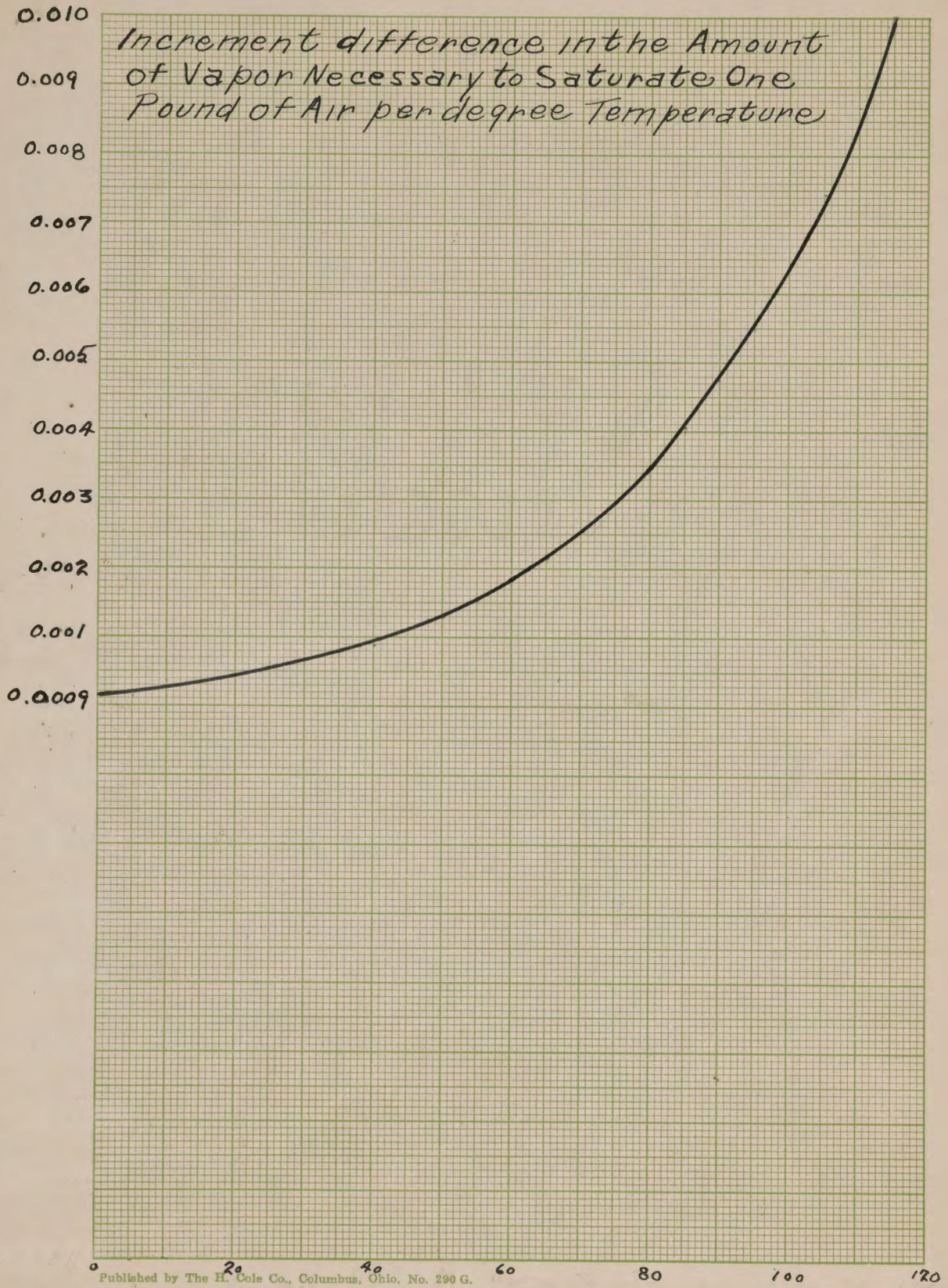
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1+22

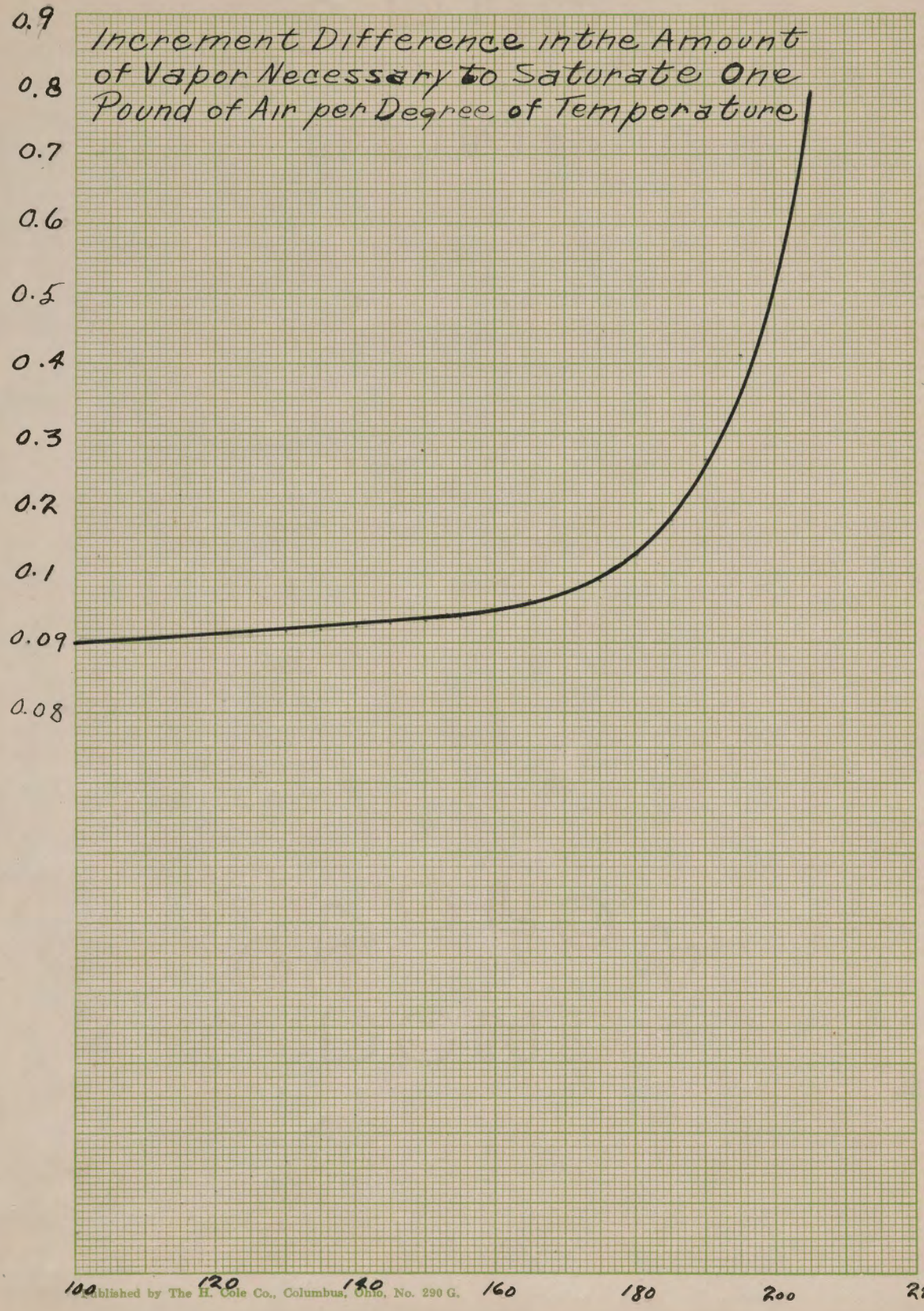


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2

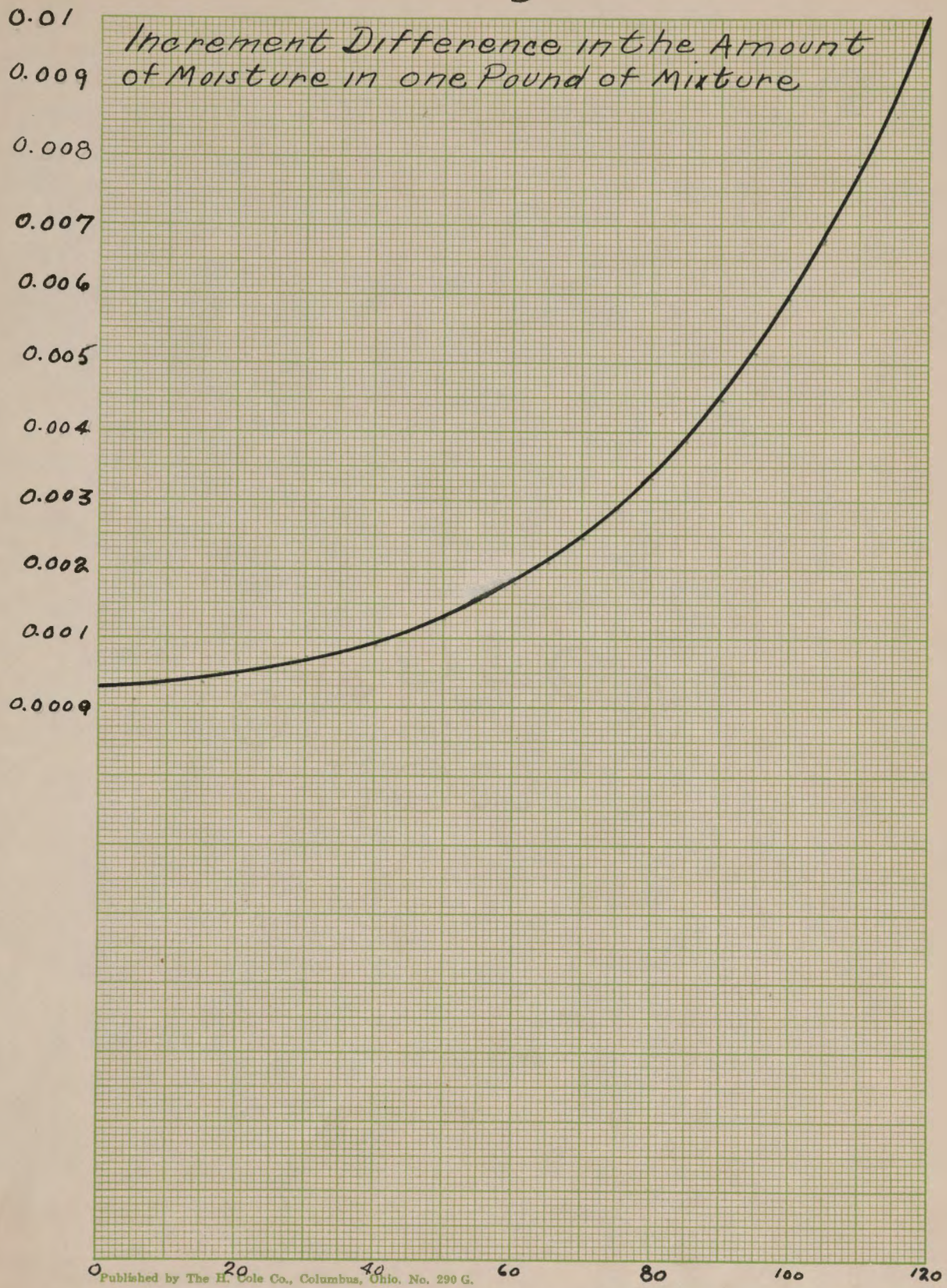


Published by The H. Cole Co., Columbus, Ohio, No. 290 G.



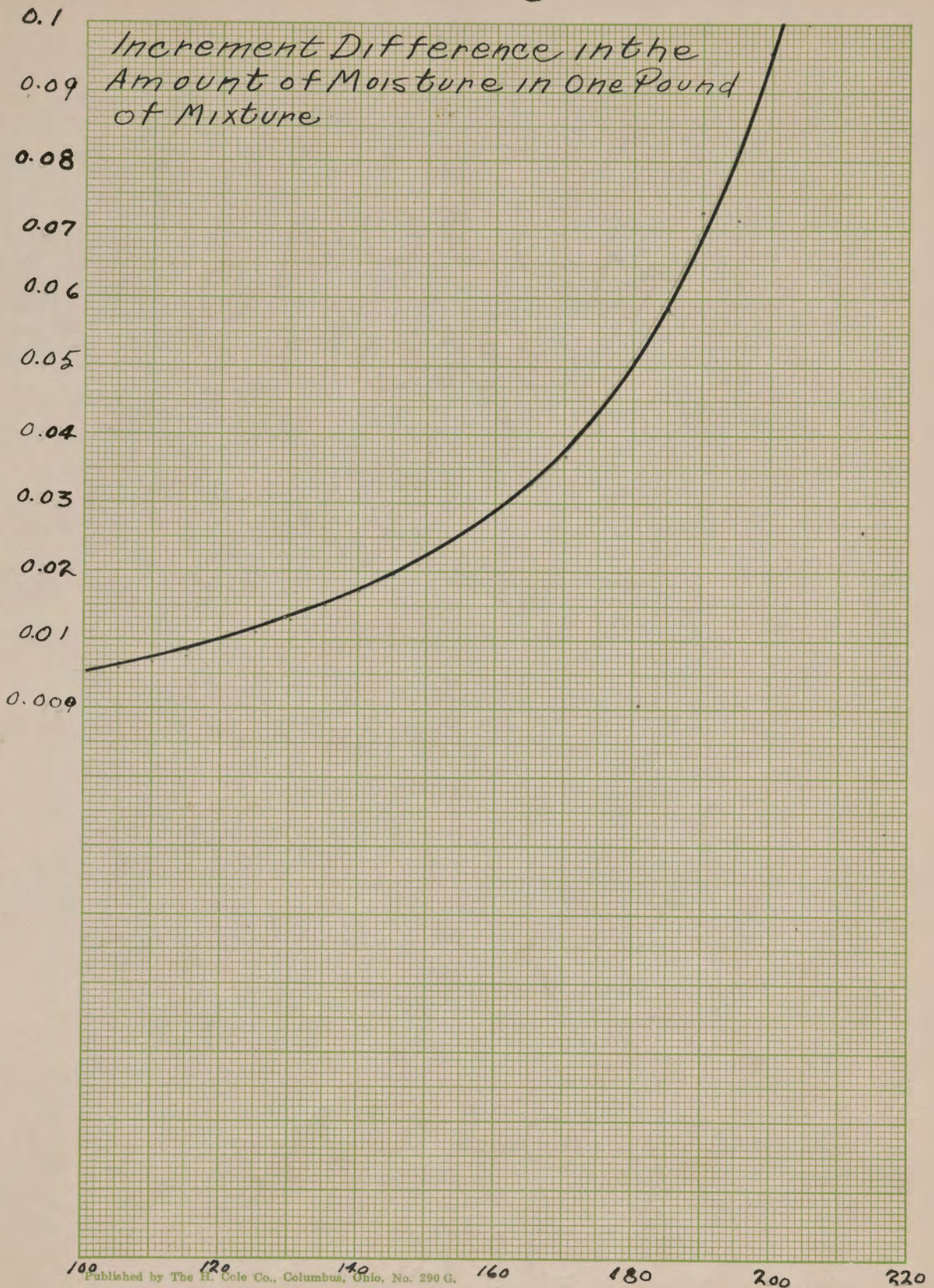
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3



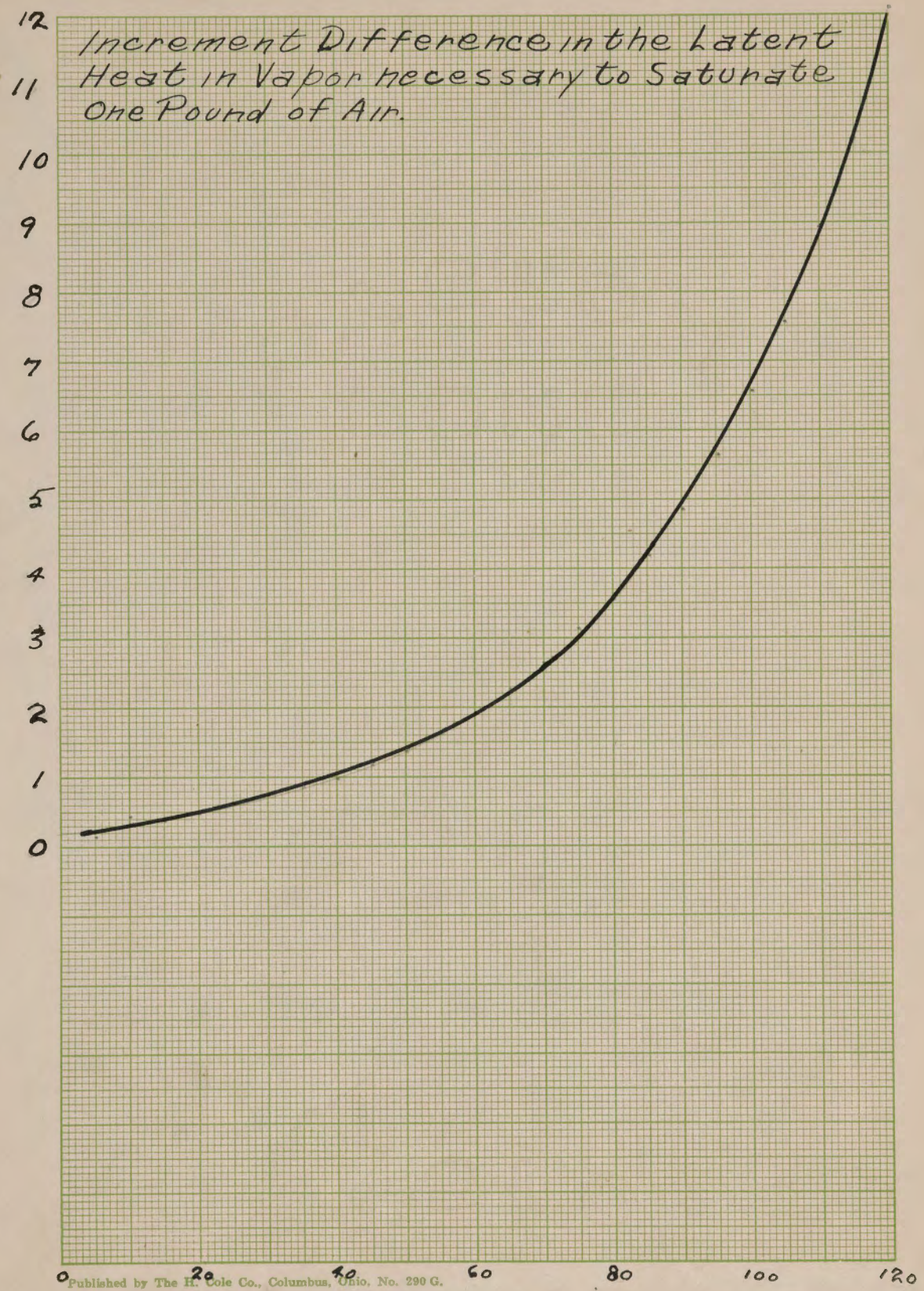
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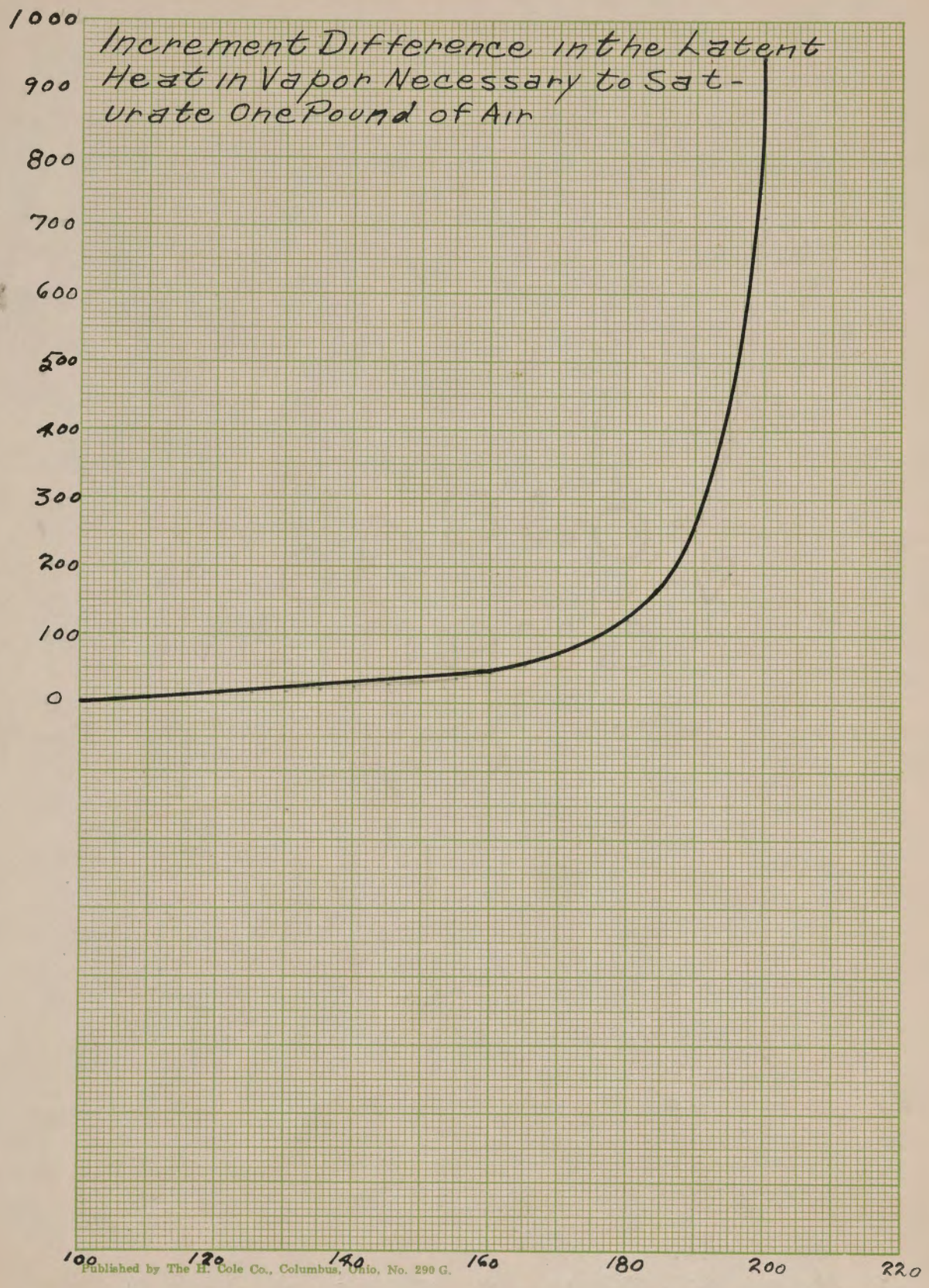
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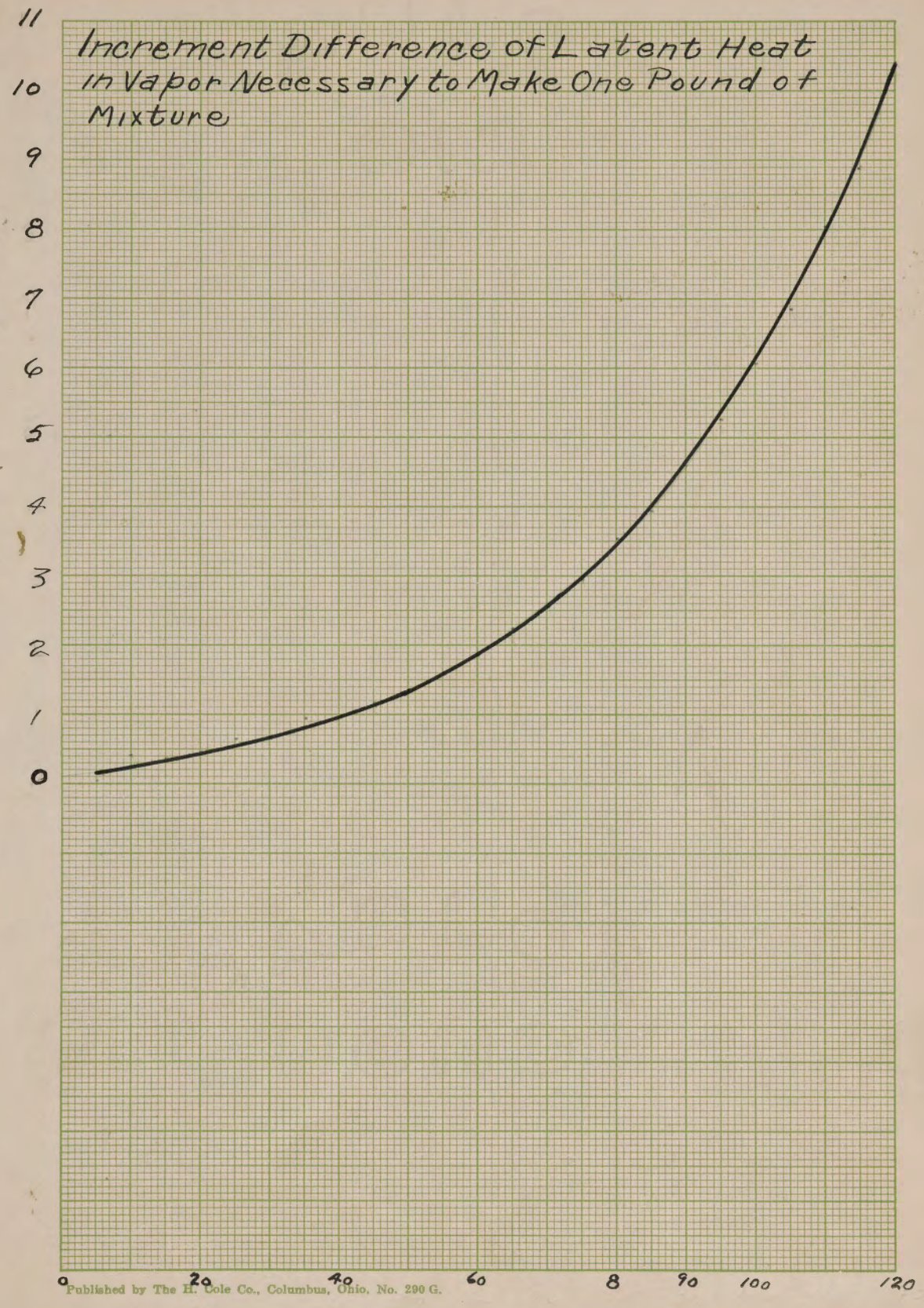
4


Increment Difference in the Latent Heat in Vapor necessary to Saturate One Pound of Air.
12
11
10
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
100
120
Published by The H. Cole Co., Columbus, Ohio. No. 290 G.



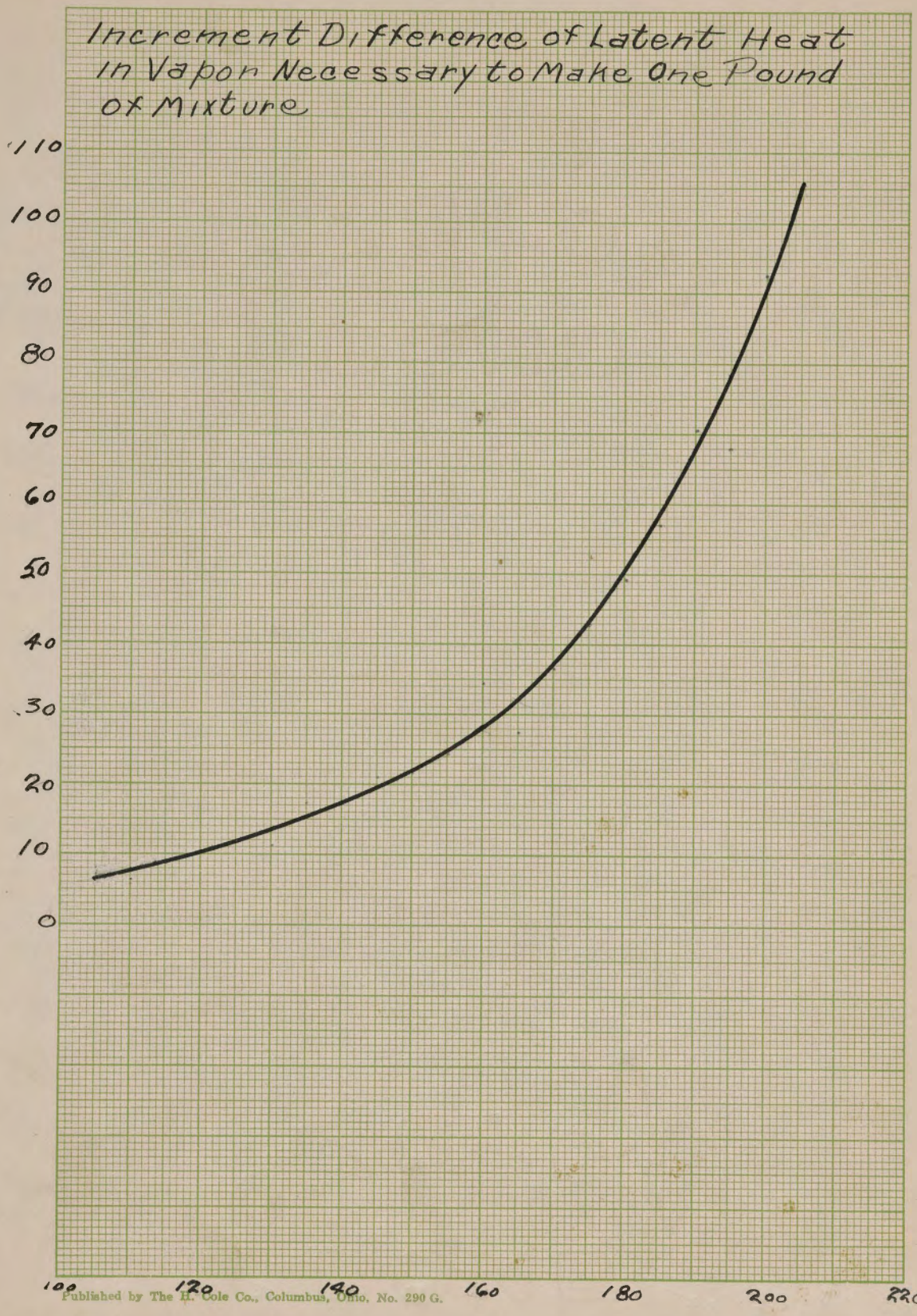
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5



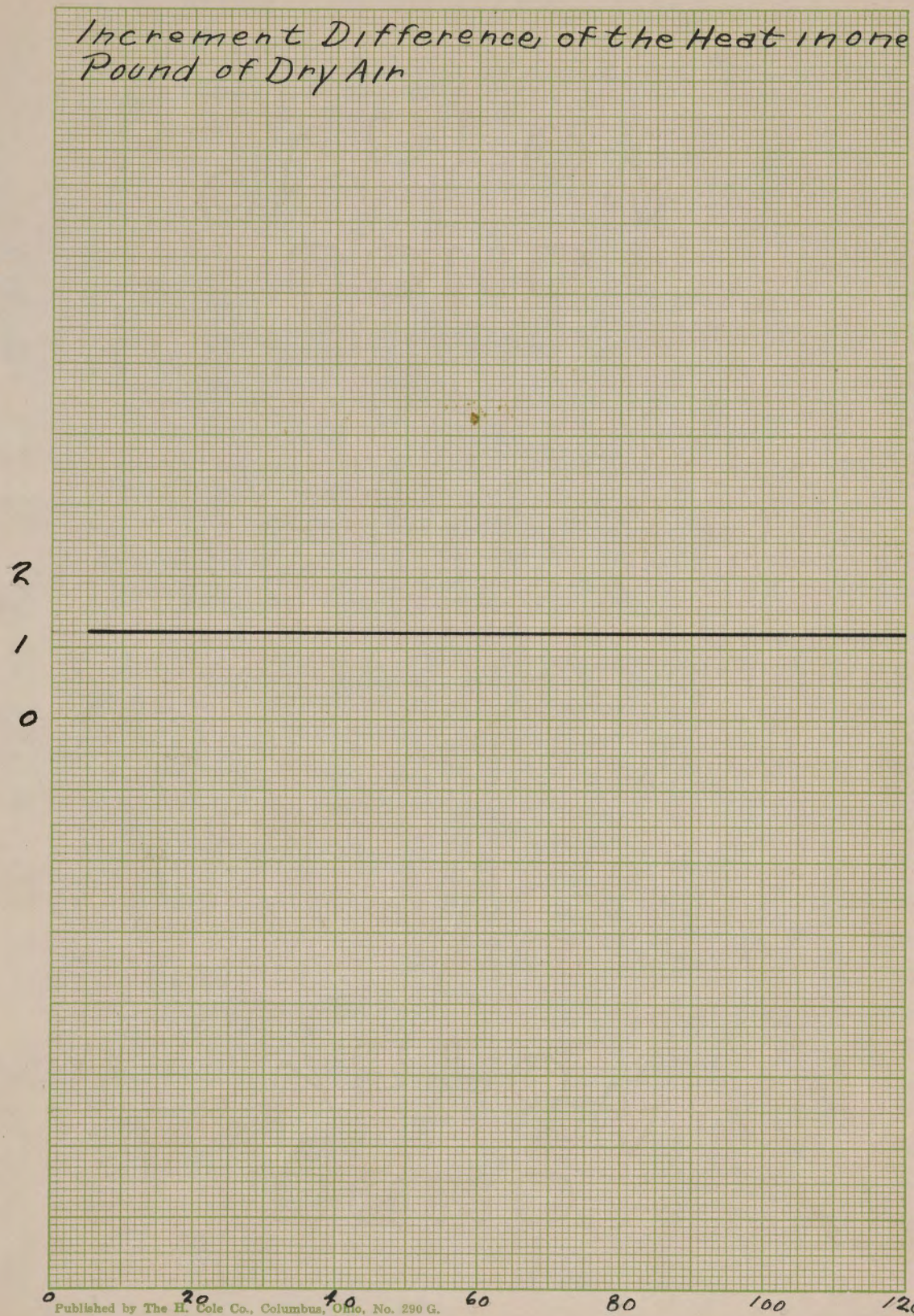
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5



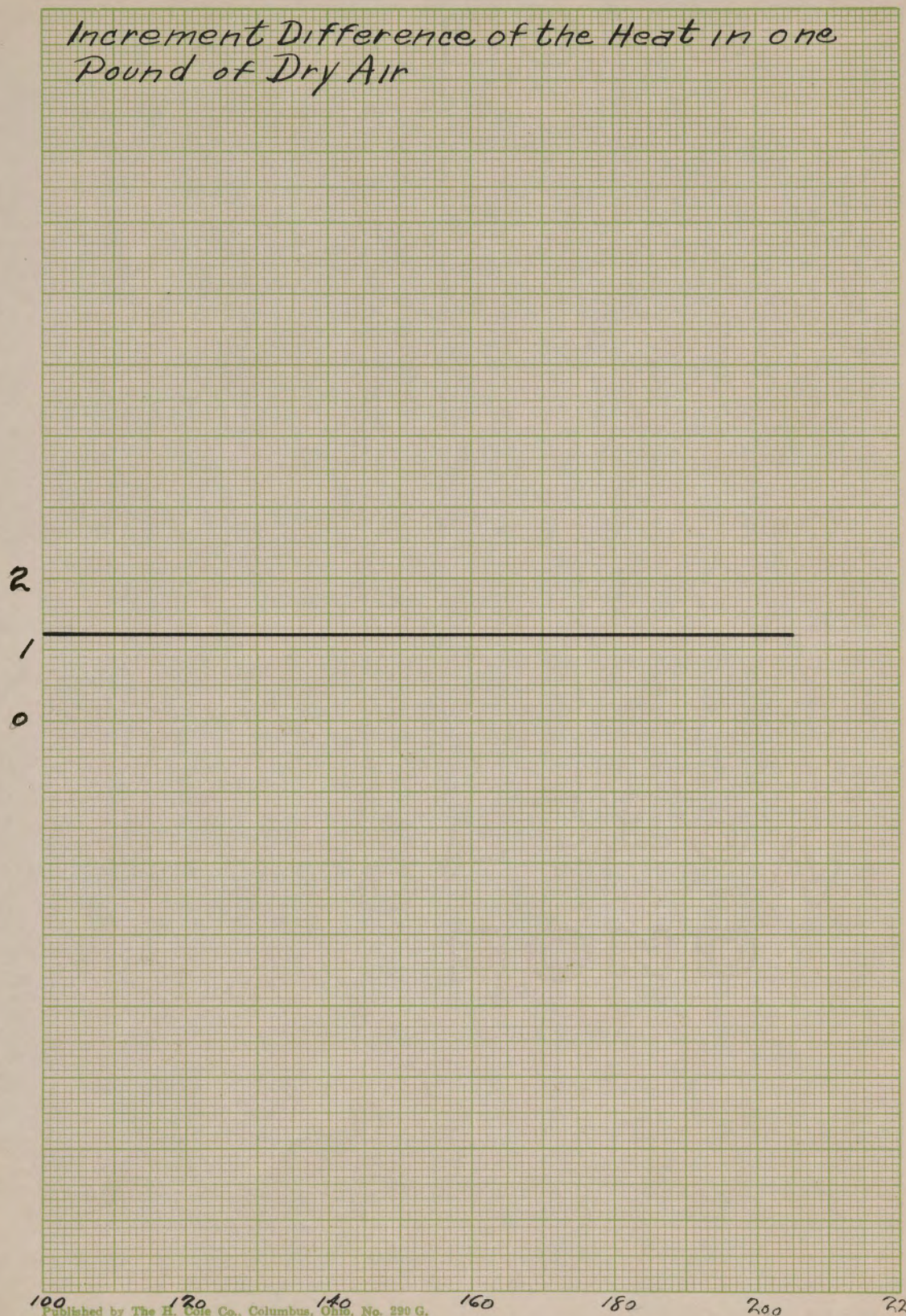
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6



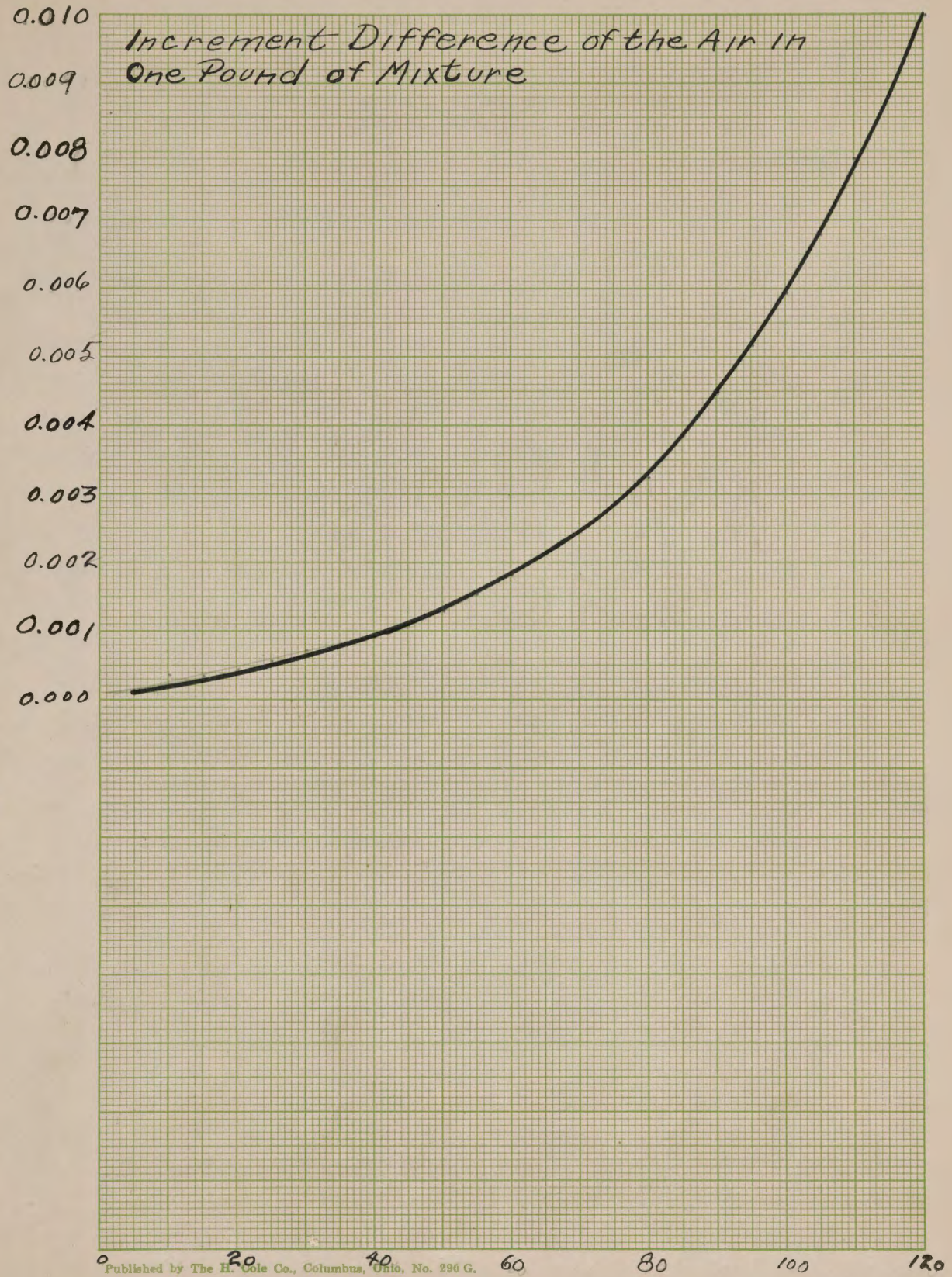
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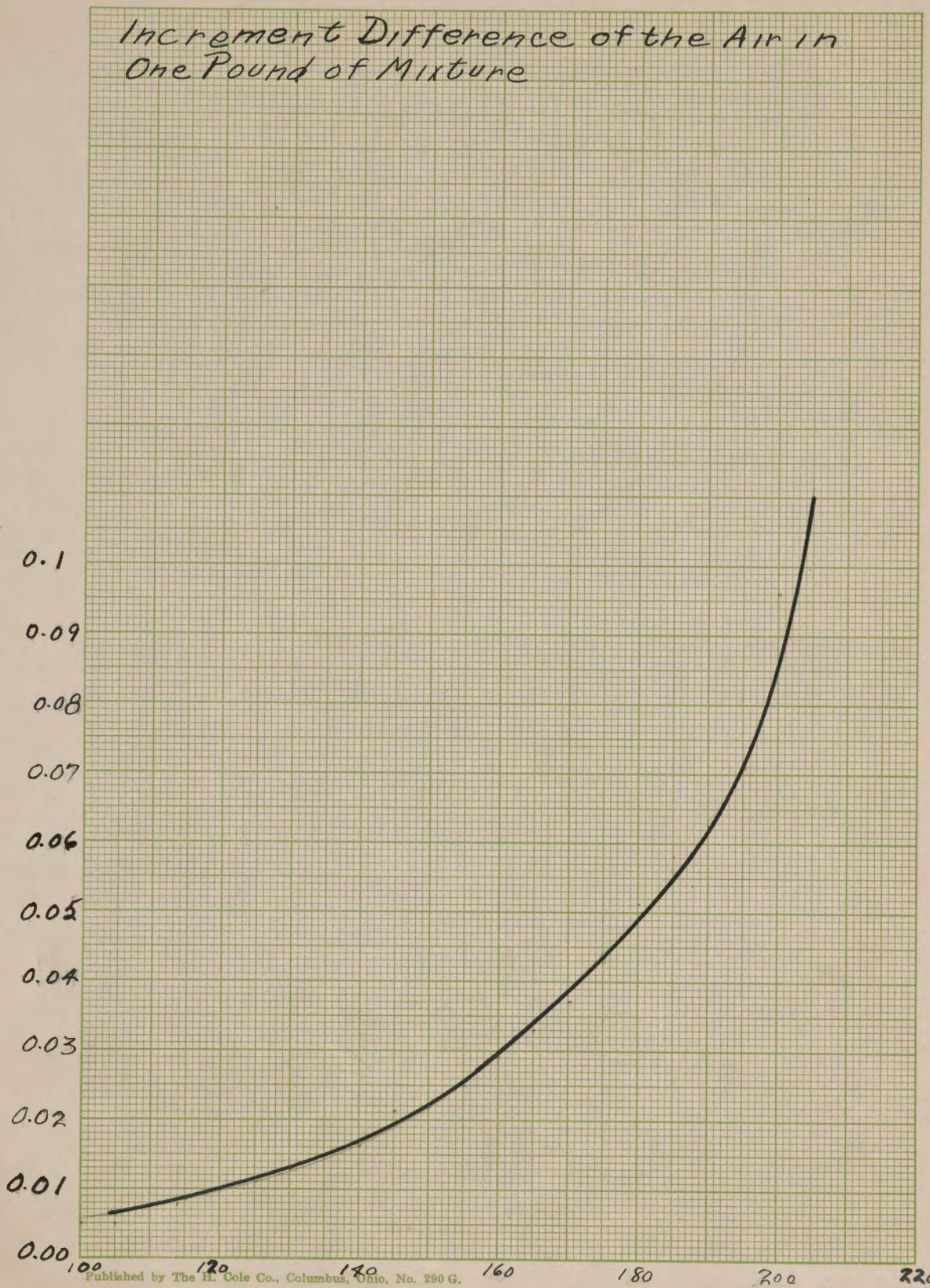


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7

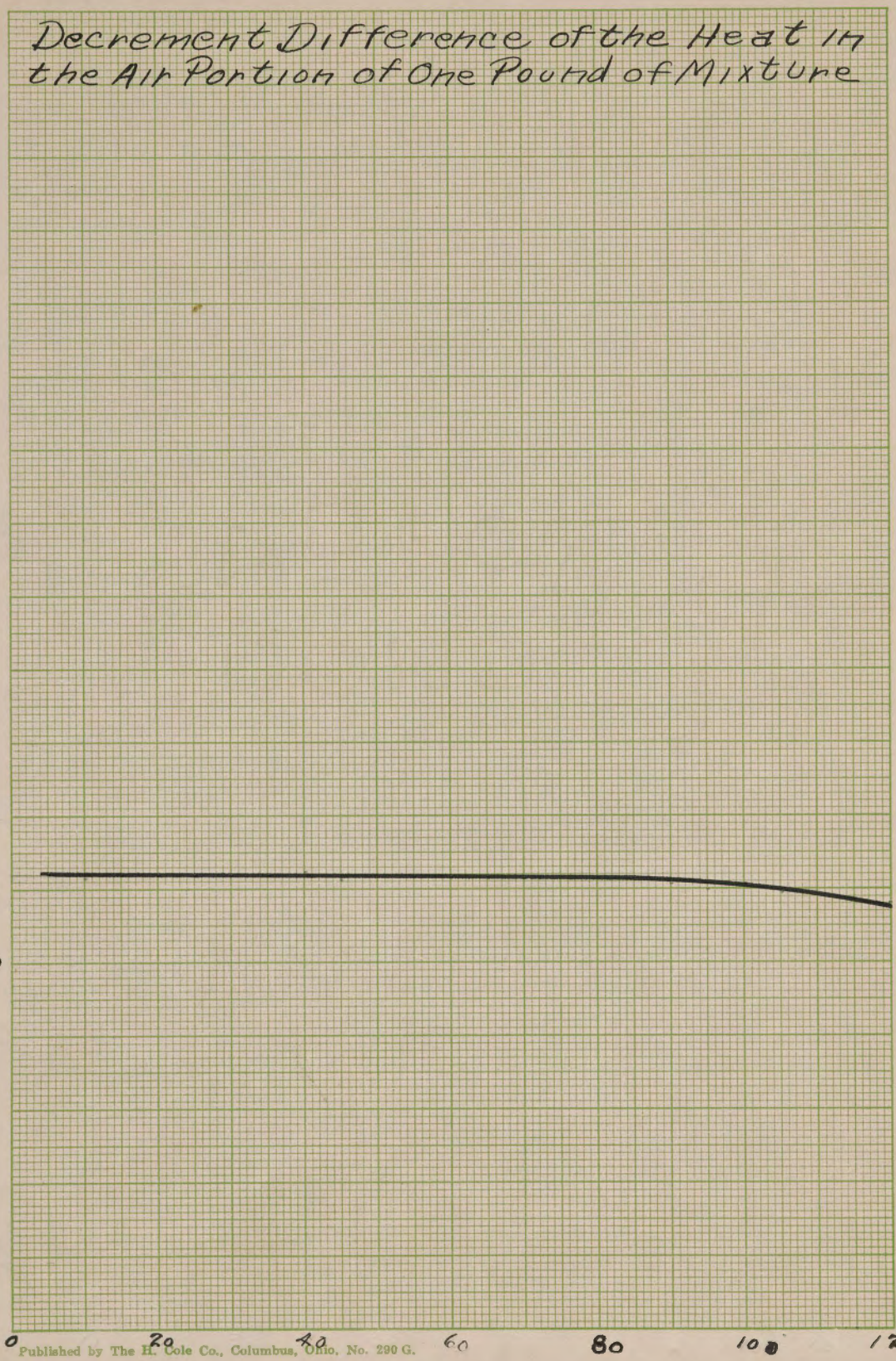


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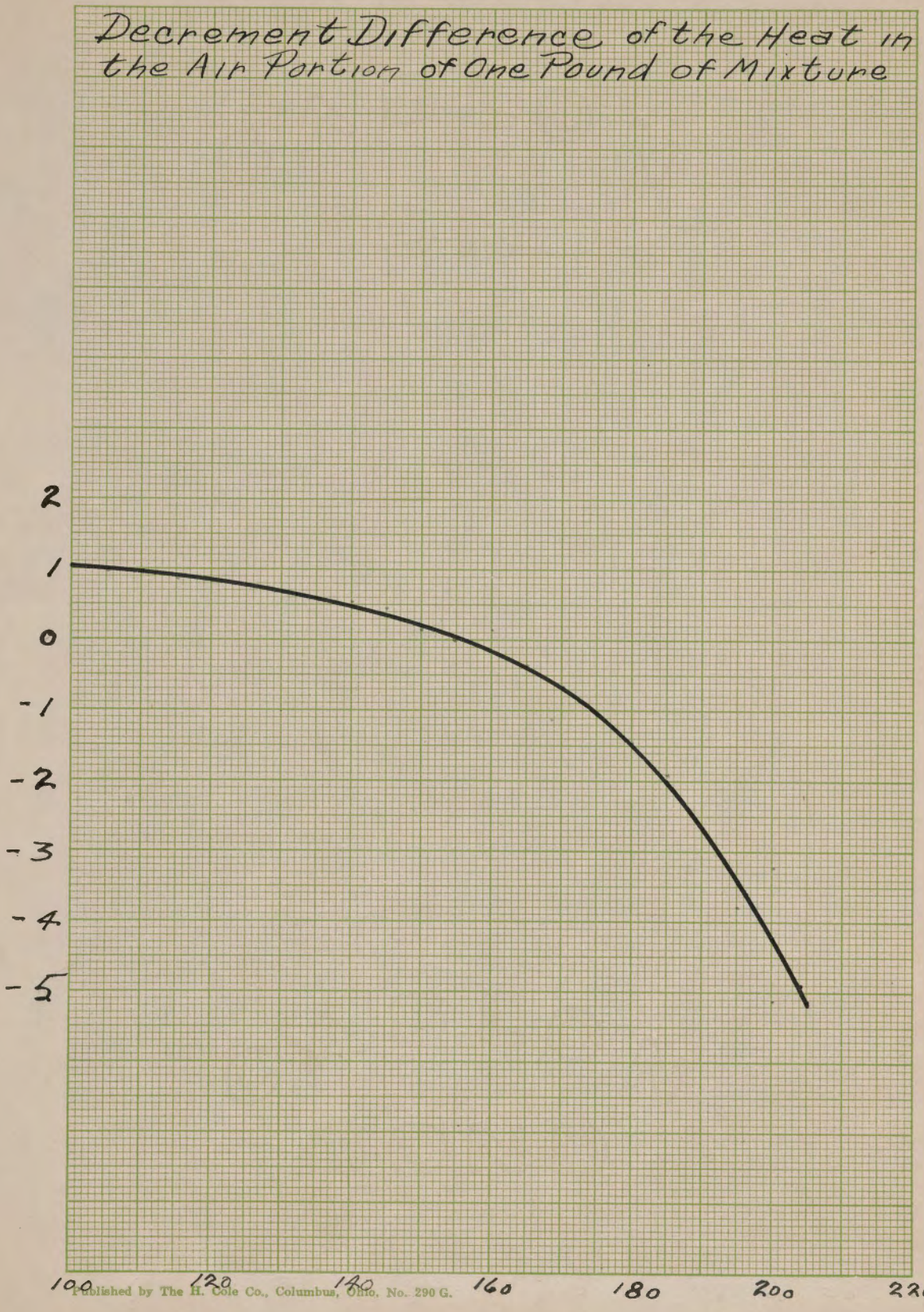
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8



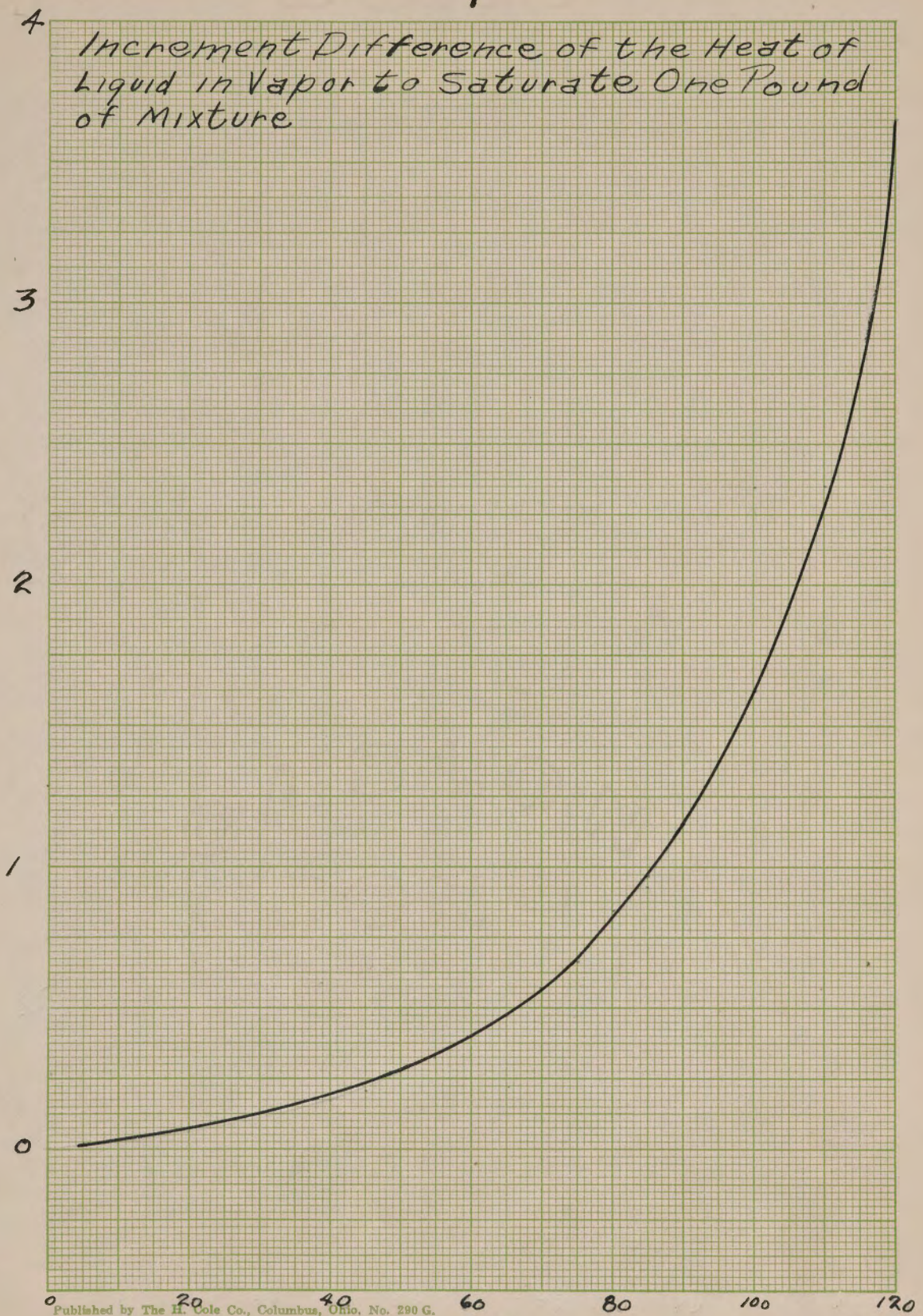
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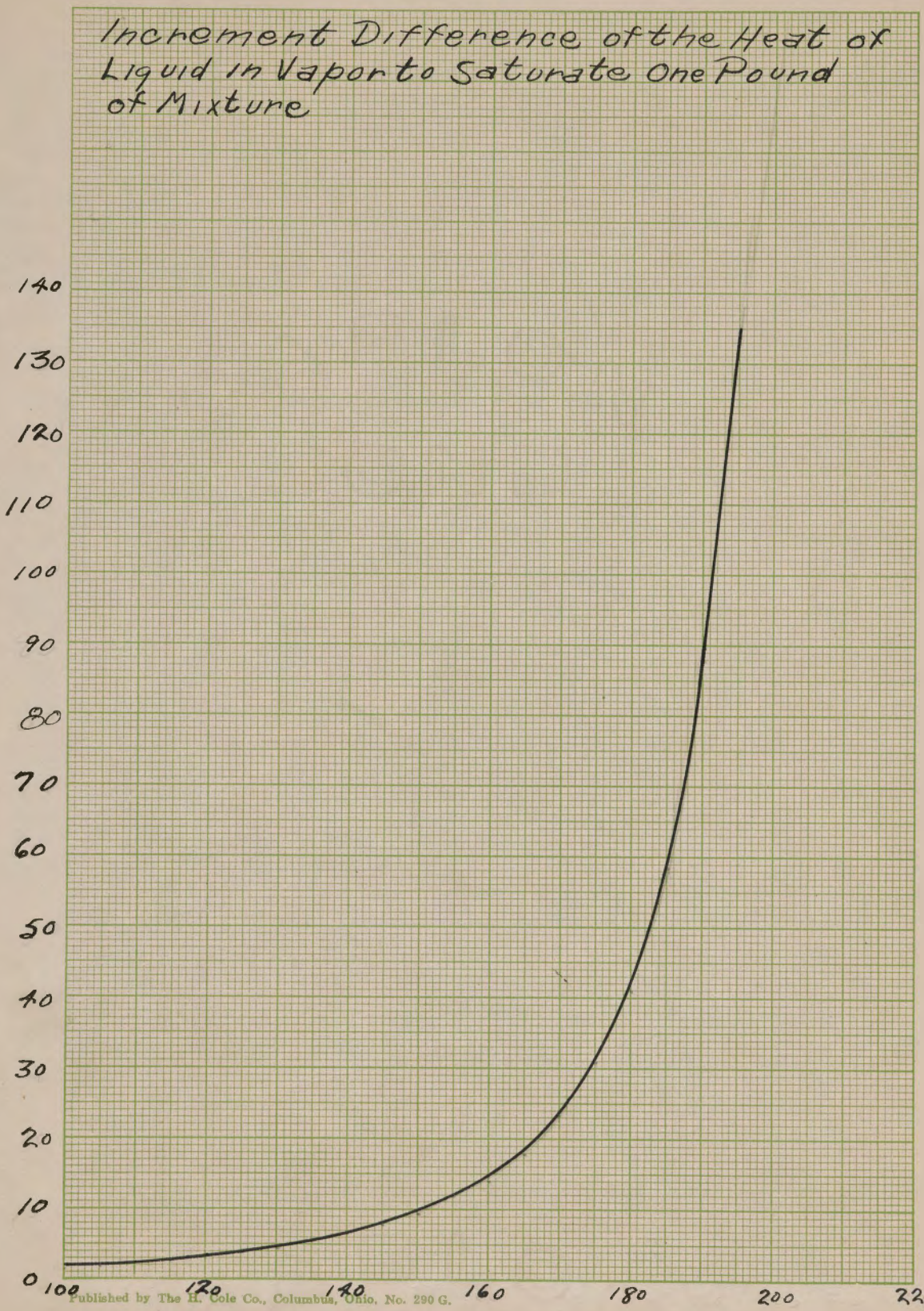


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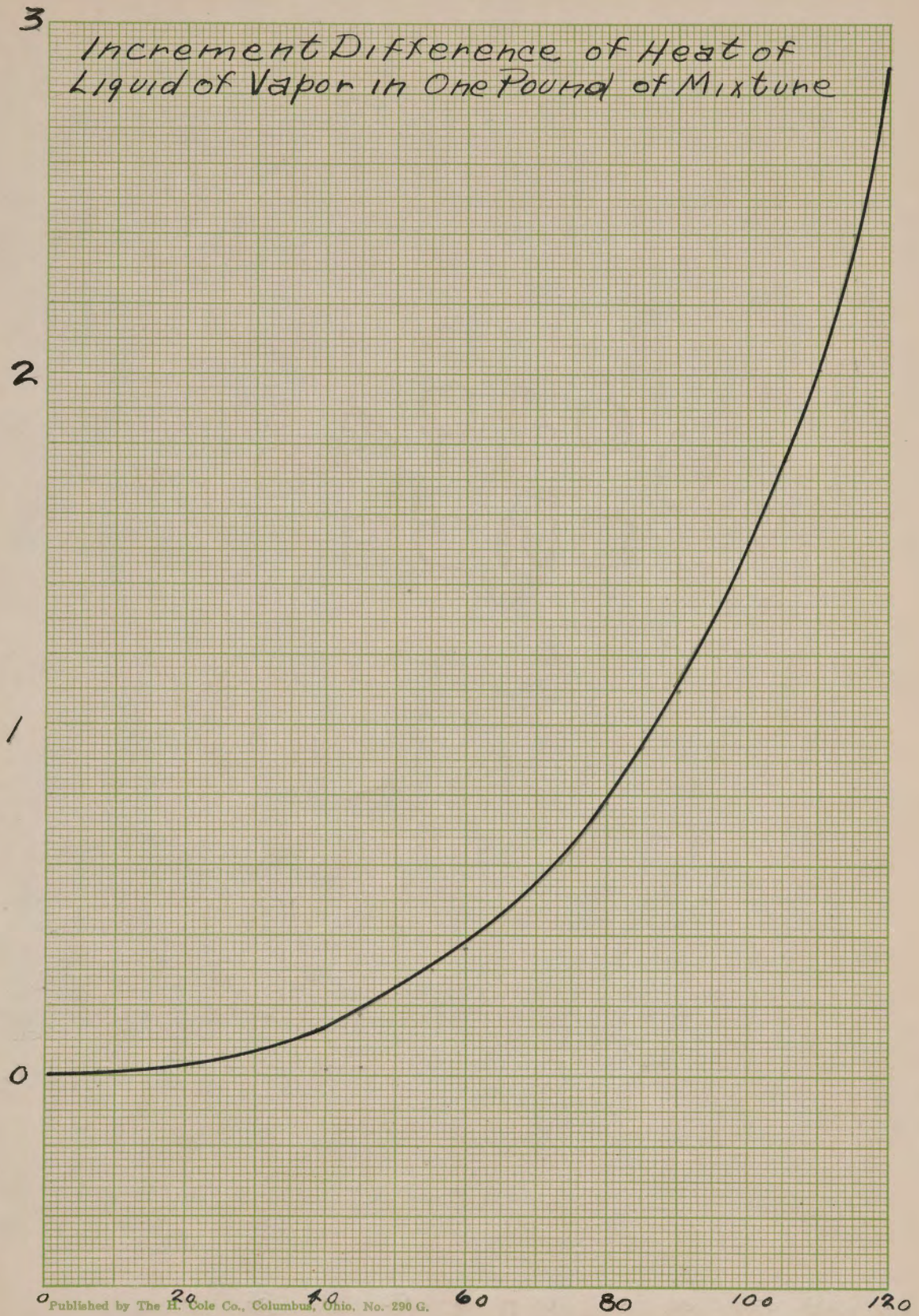
9


Increment Difference of the Heat of Liquid in Vapor to Saturate One Pound of Mixture
4
3
2
1
0
0
20
40
60
80
100
120
Published by The H. Cole Co., Columbus, Ohio, No. 290 G.

9

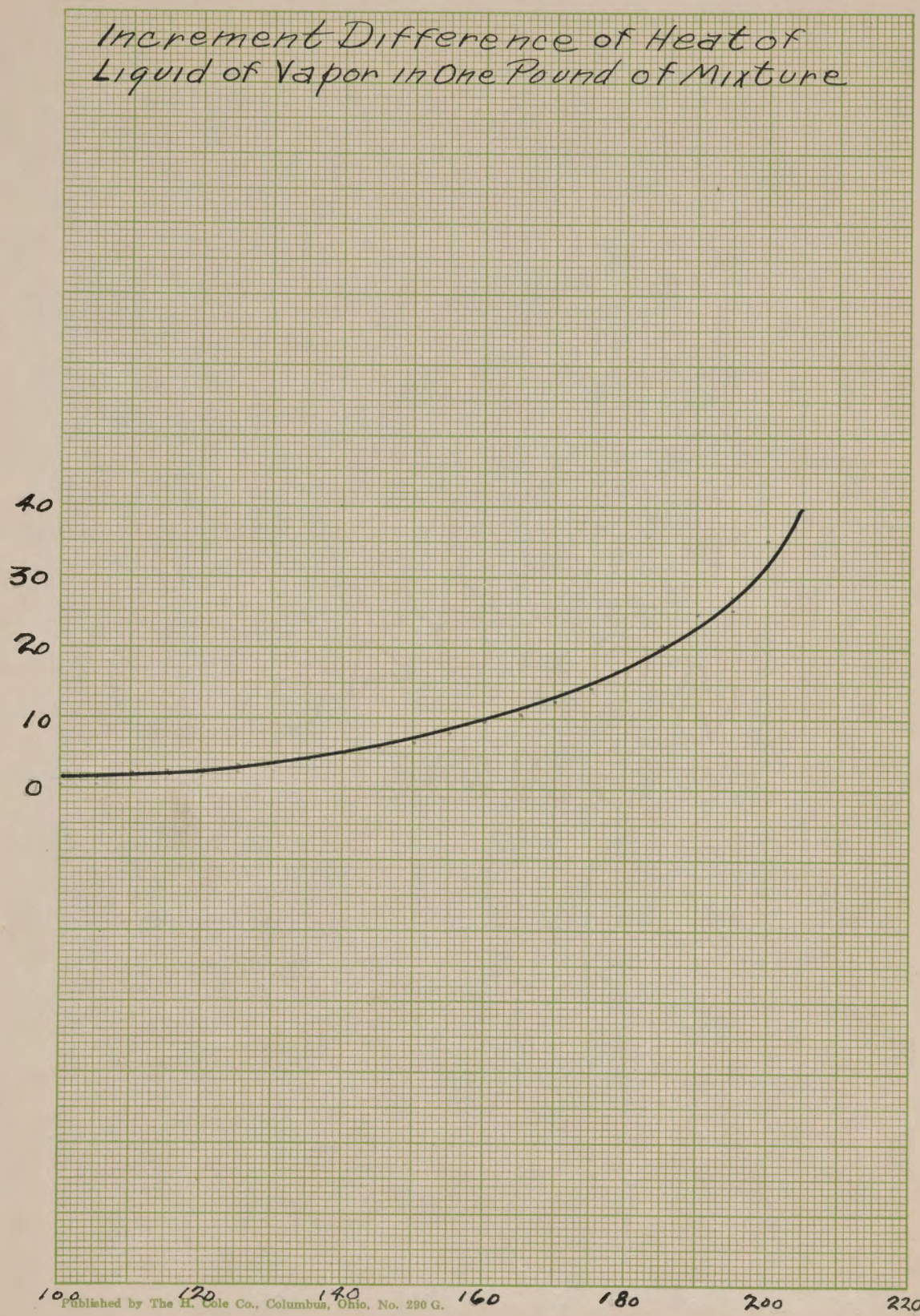

Increment Difference of the Heat of Liquid in Vapor to Saturate One Pound of Mixture
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
100
120
140
160
180
200
220
Published by The H. Cole Co., Columbus, Ohio. No. 290 G.

10



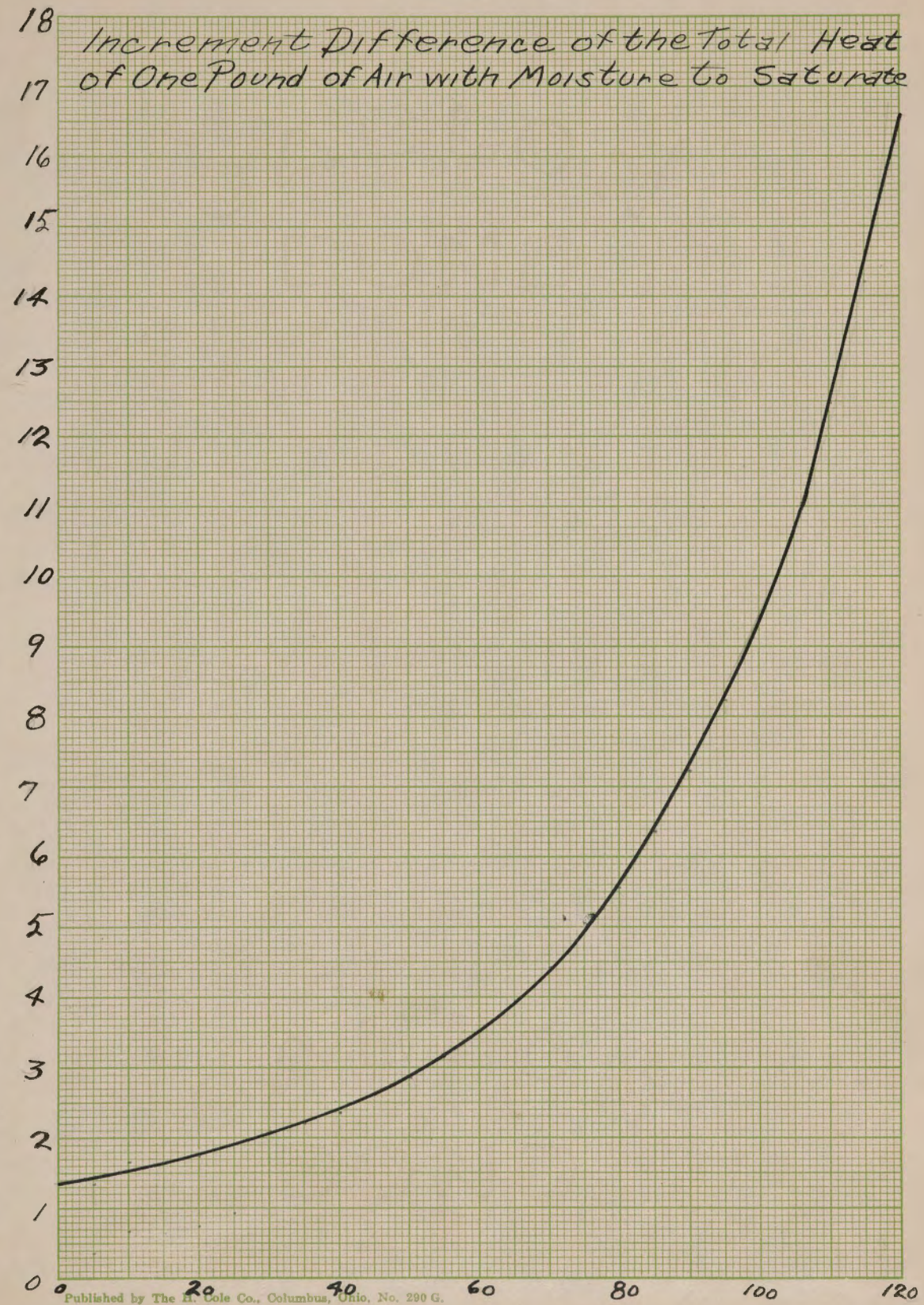
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10



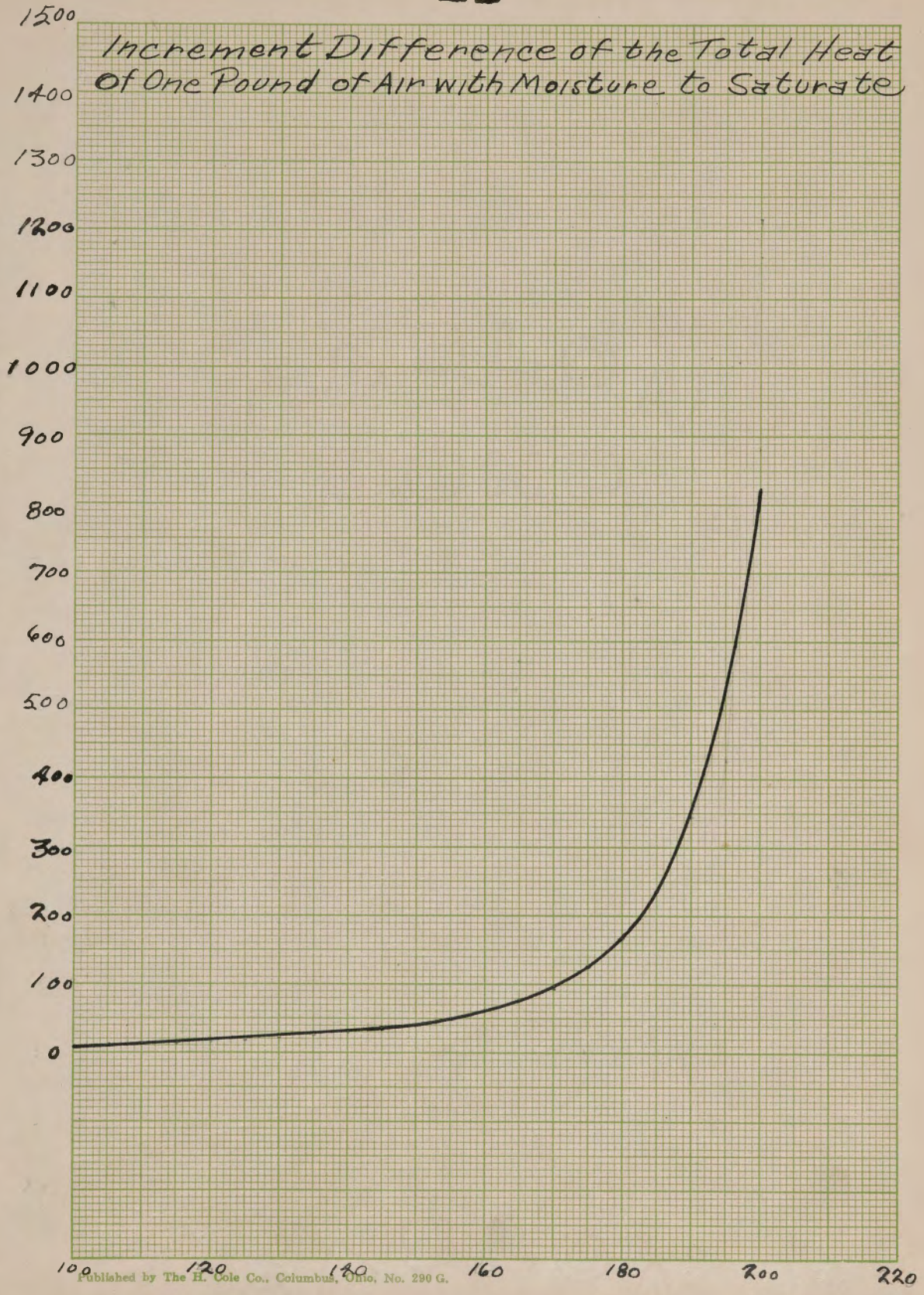
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11



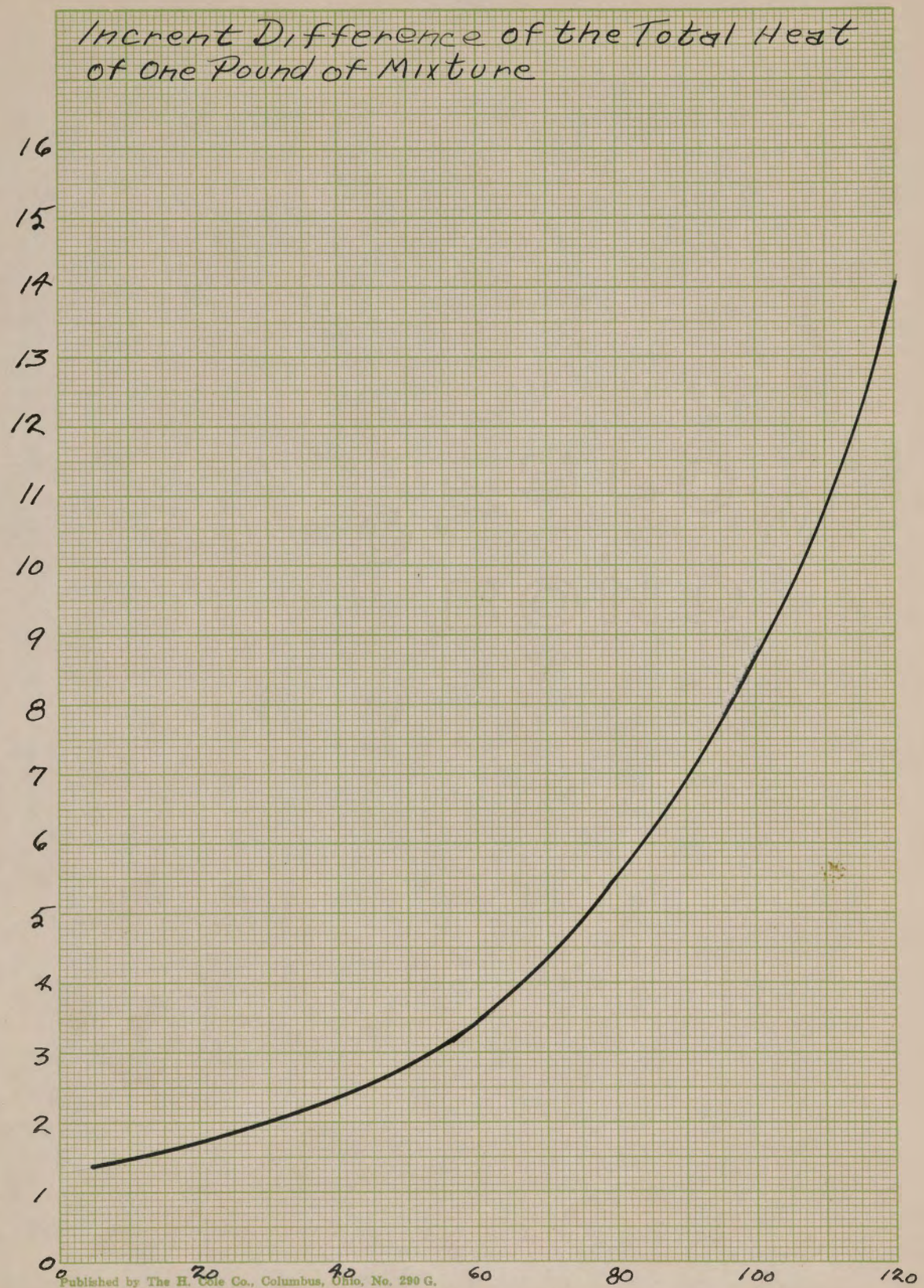
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11

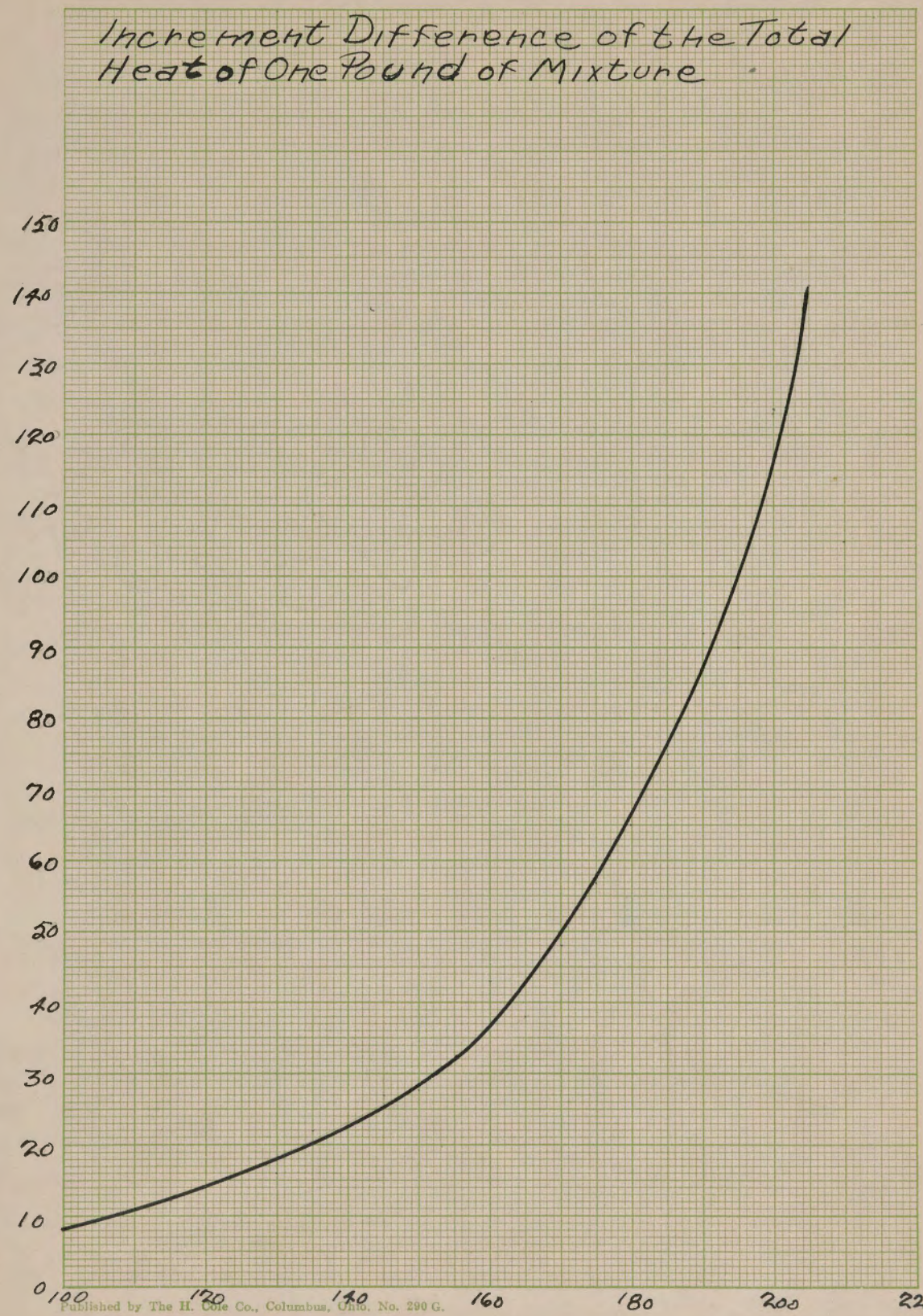


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12

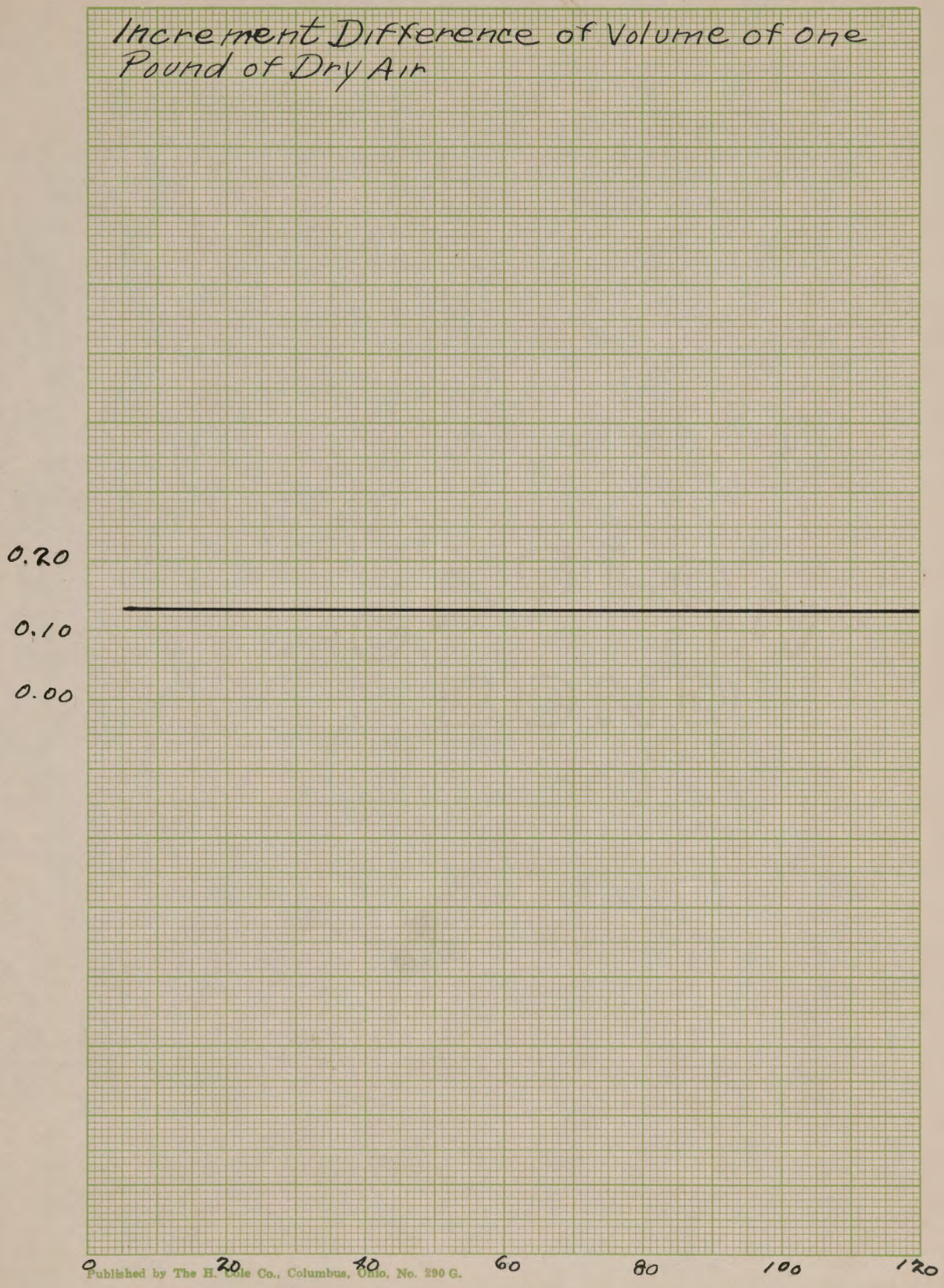


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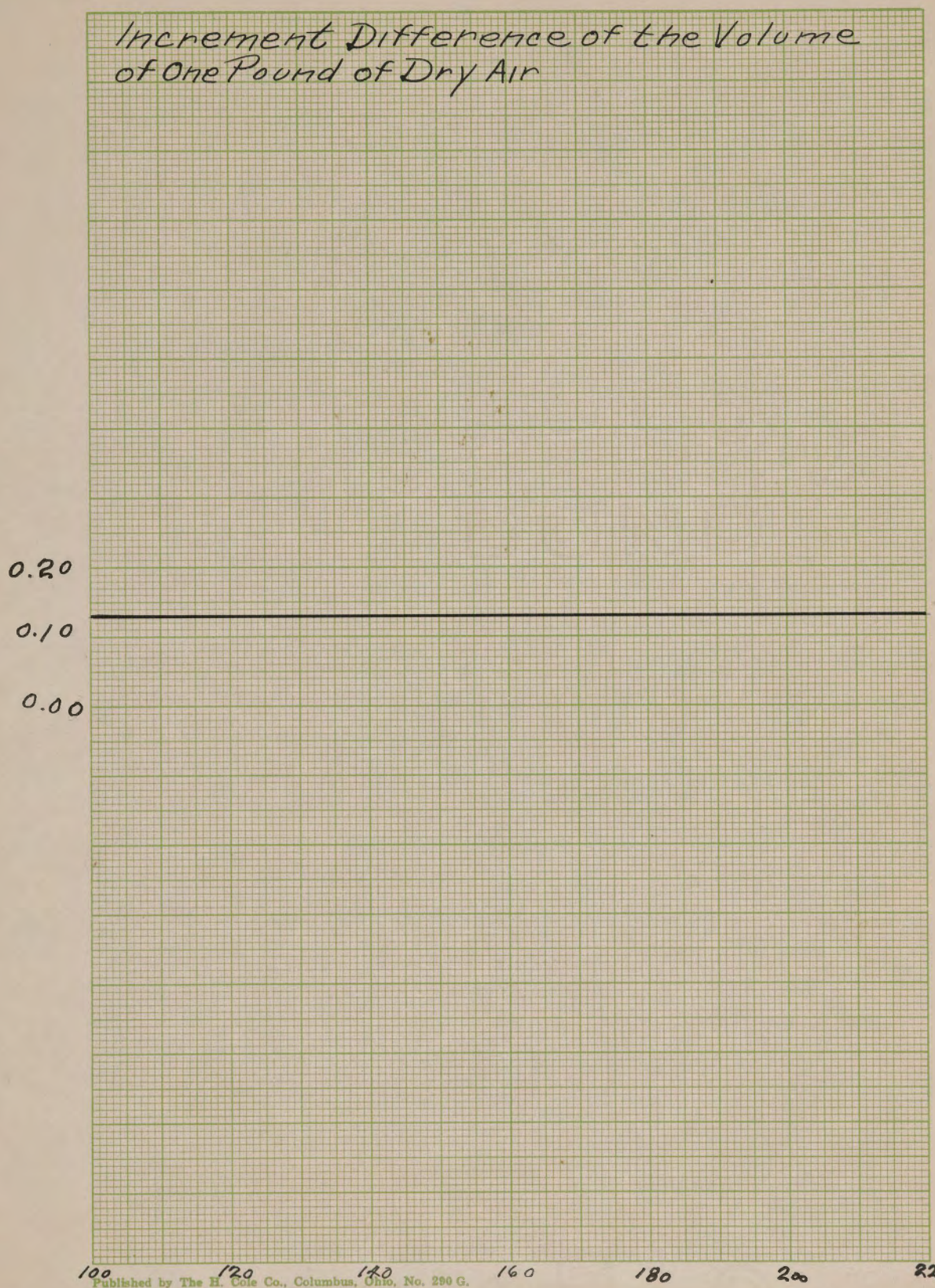
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13



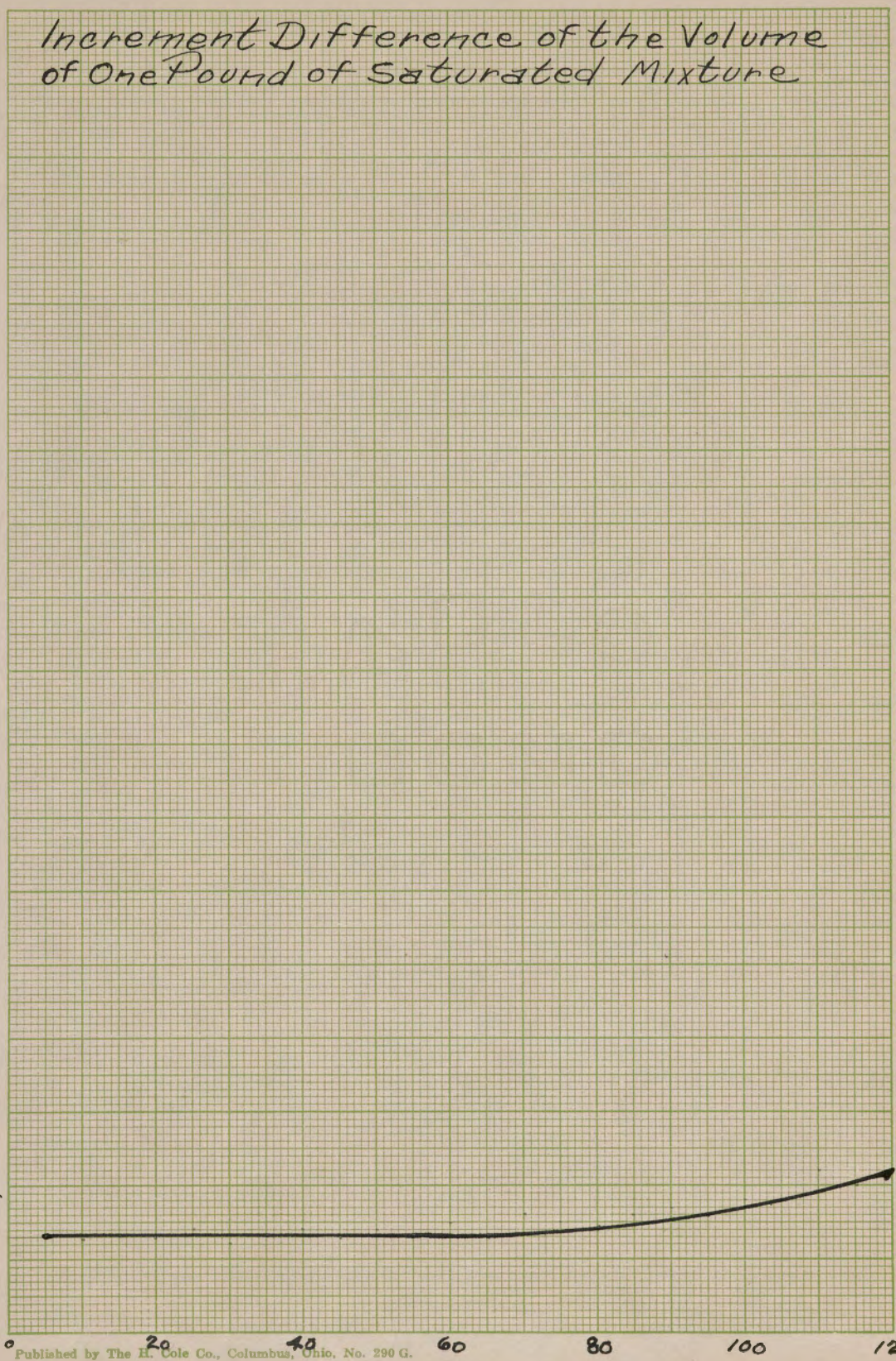
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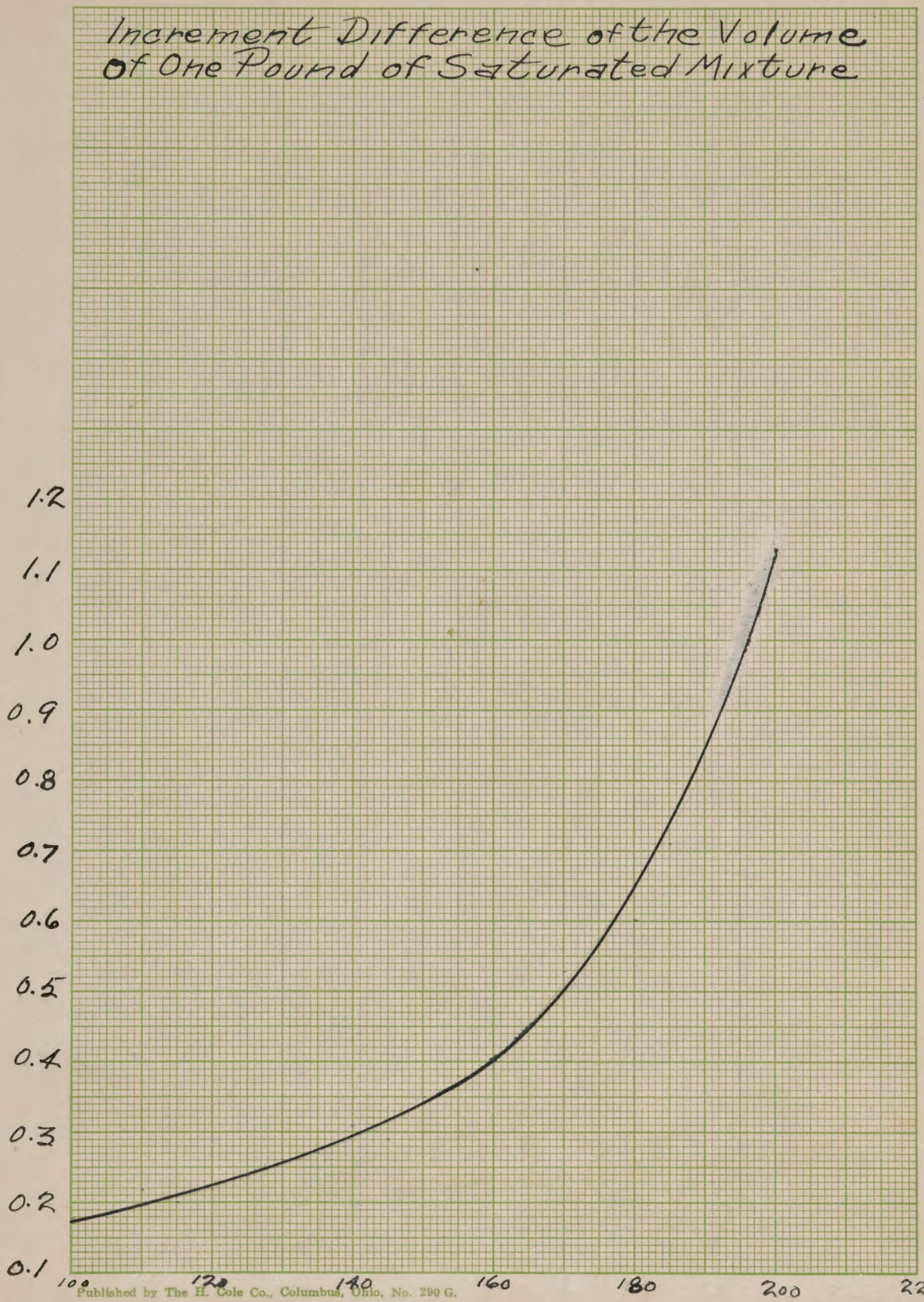


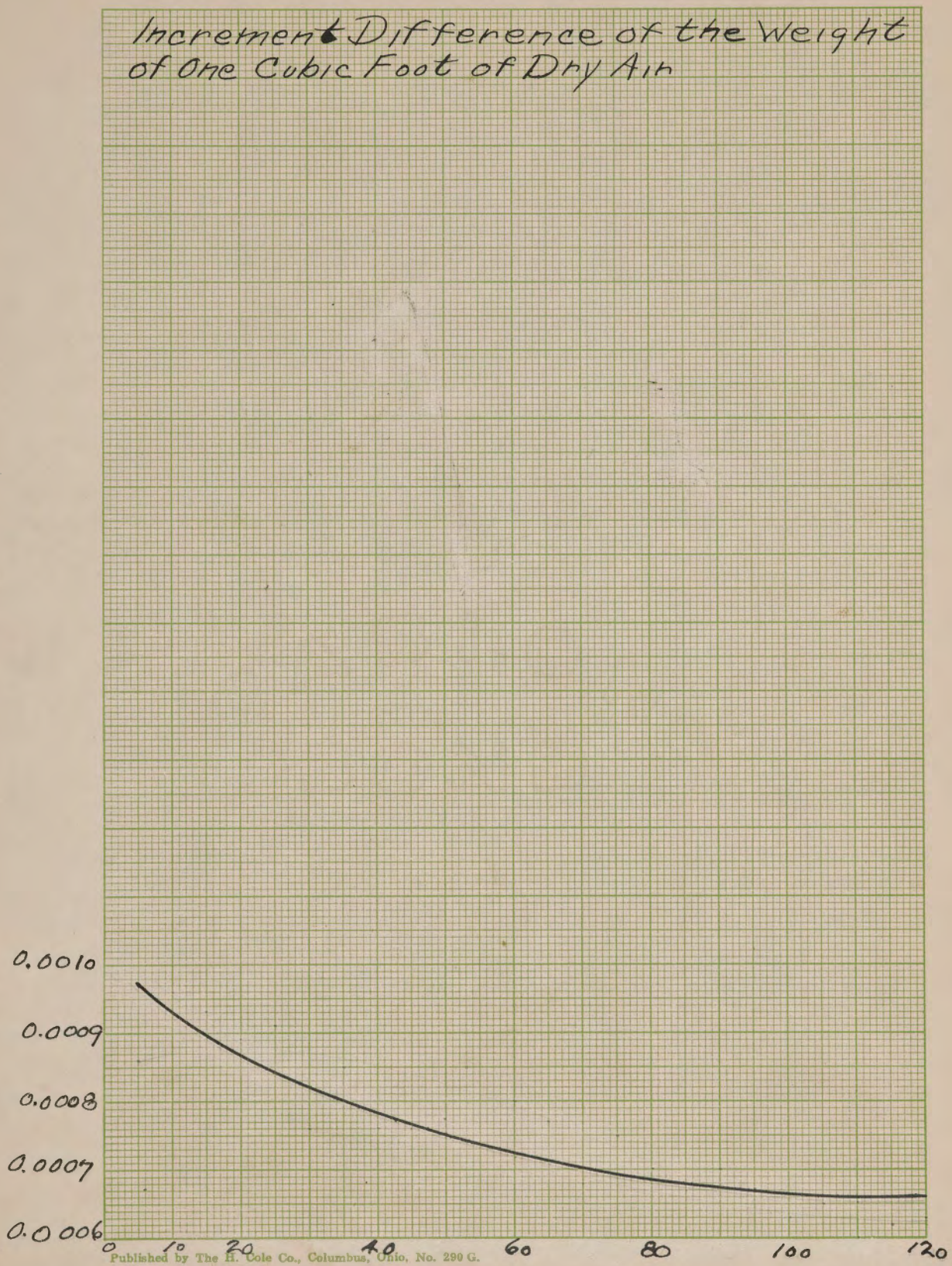
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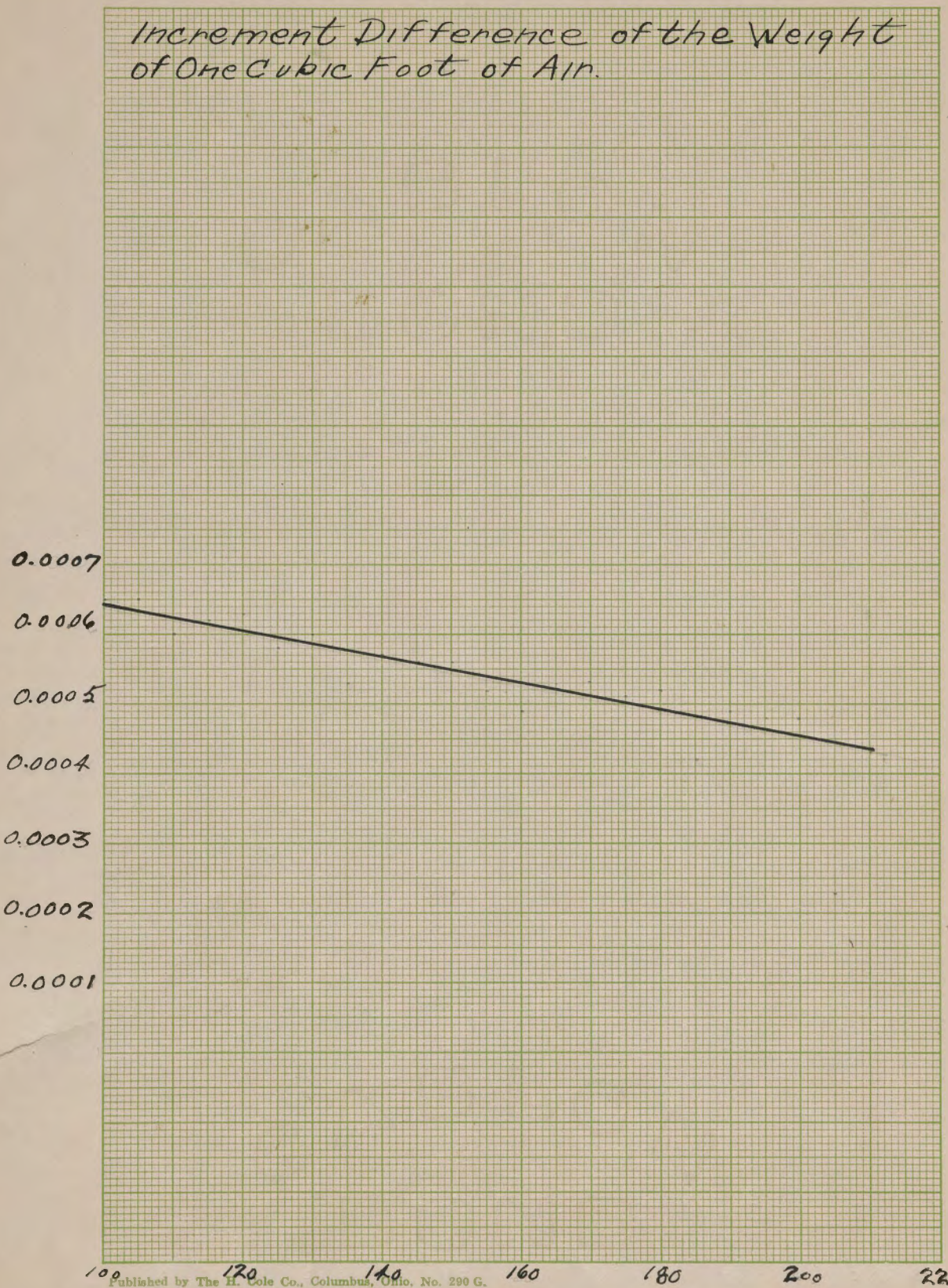
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Increment Difference of the Volume
of One Pound of Saturated Mixture
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
100
120
140
160
180
200
220
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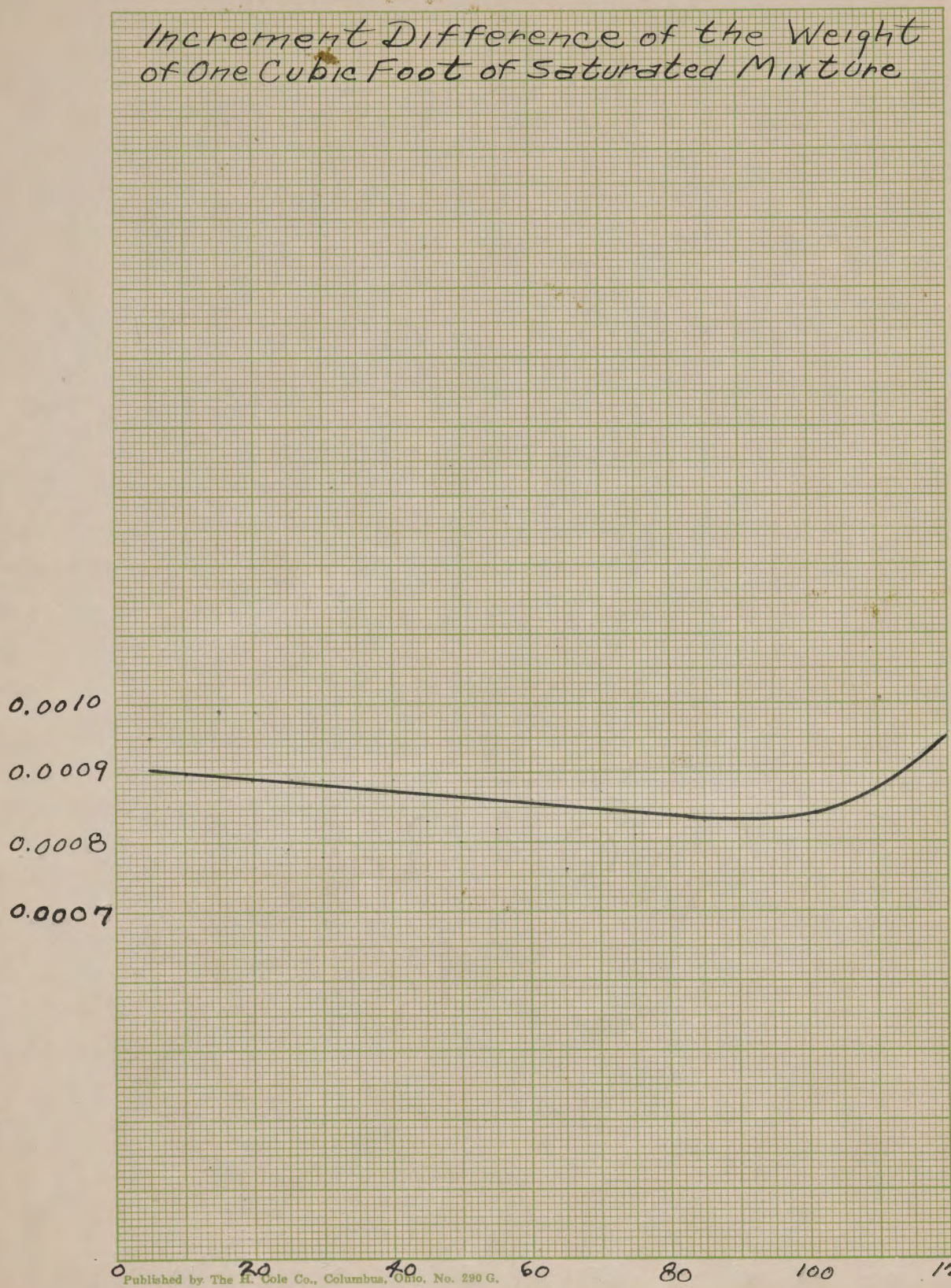
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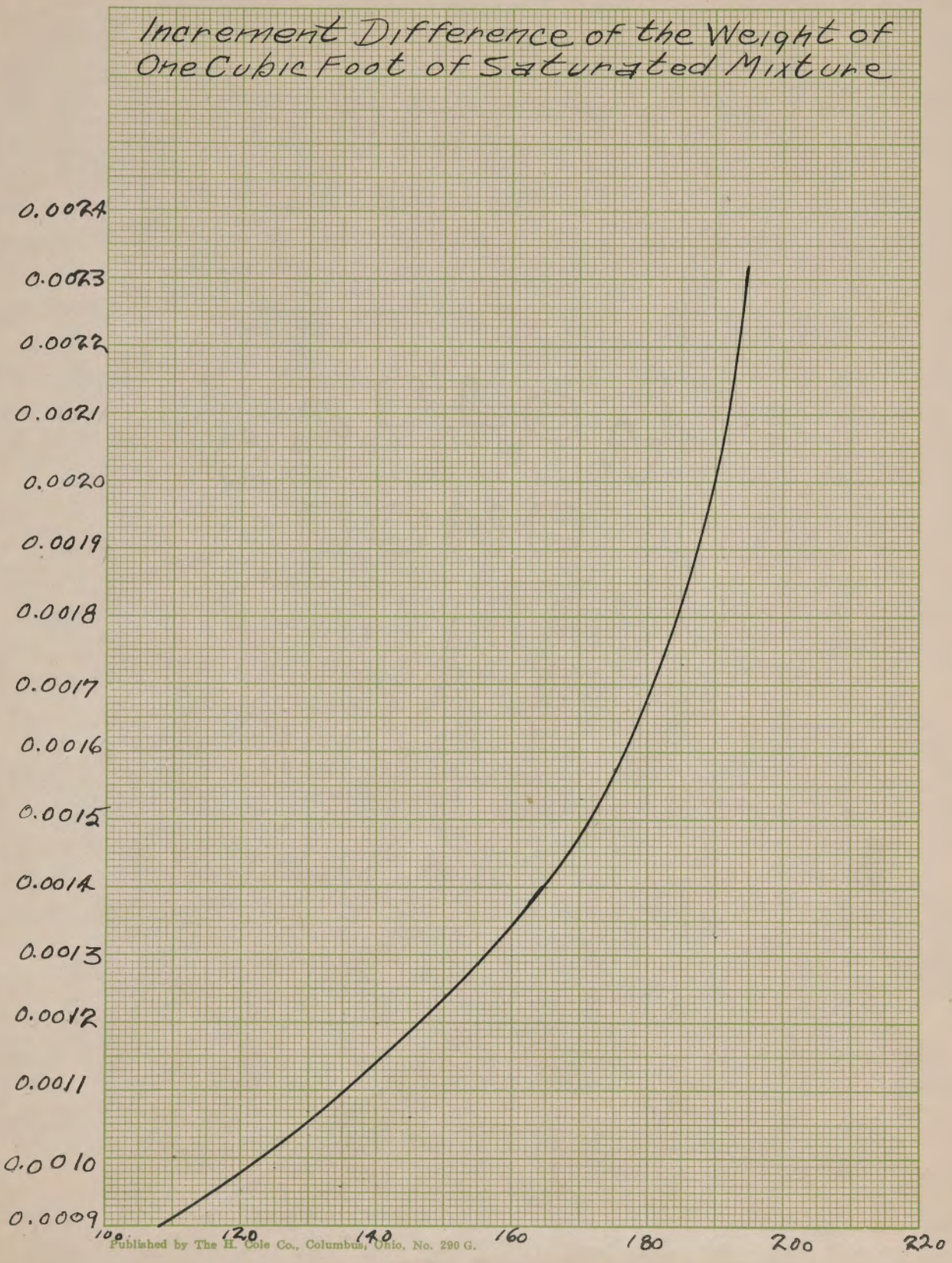
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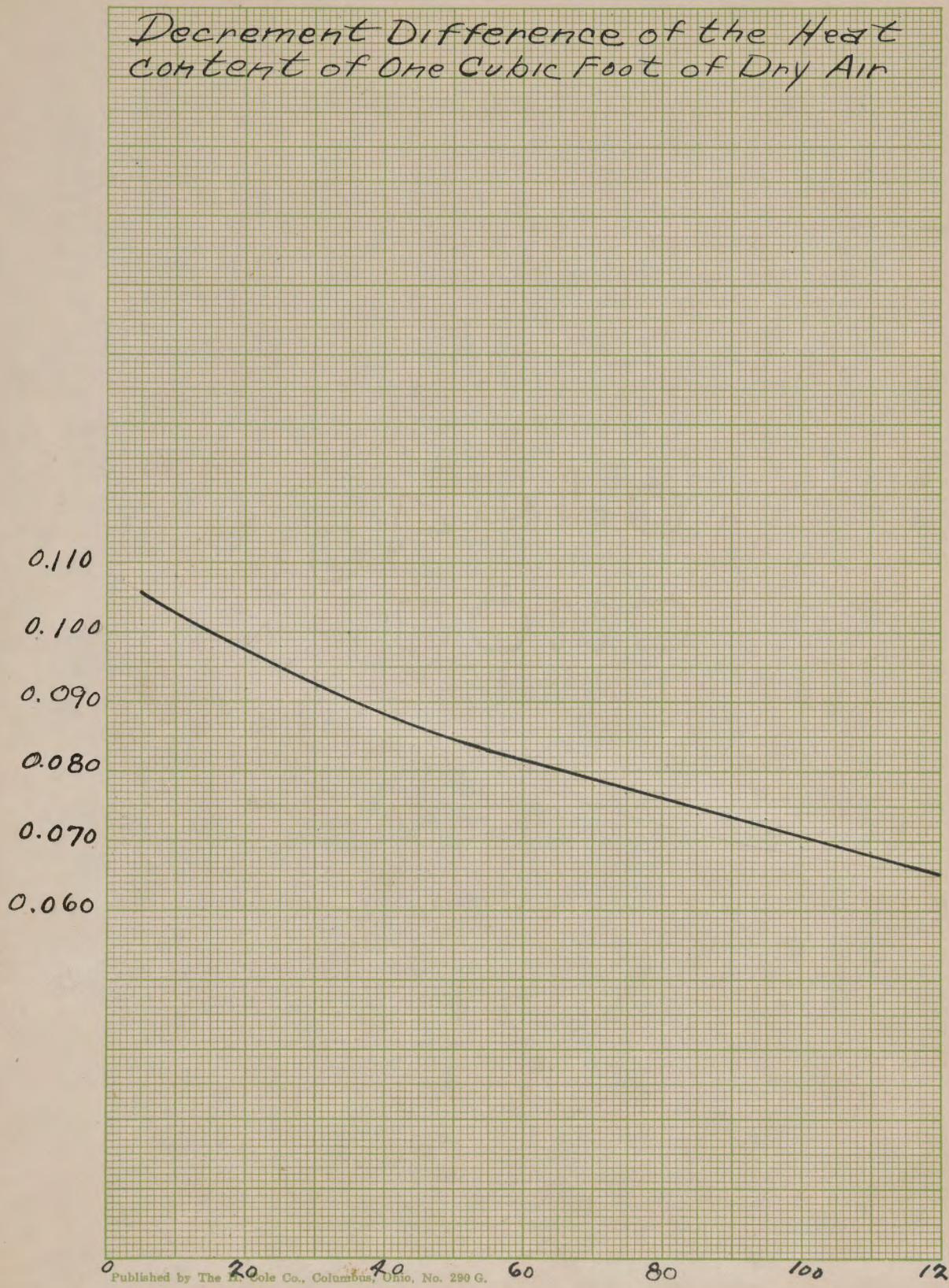
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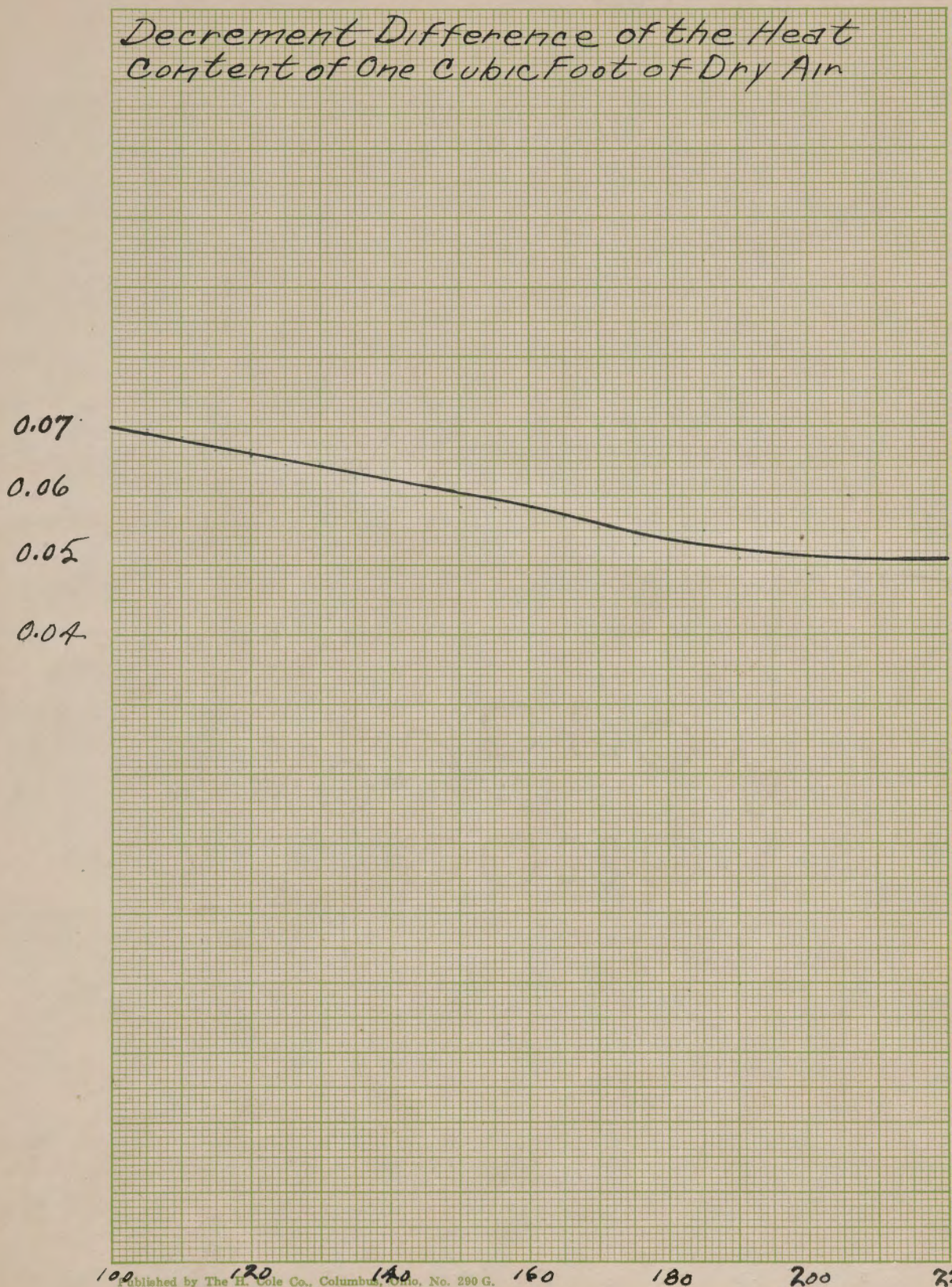
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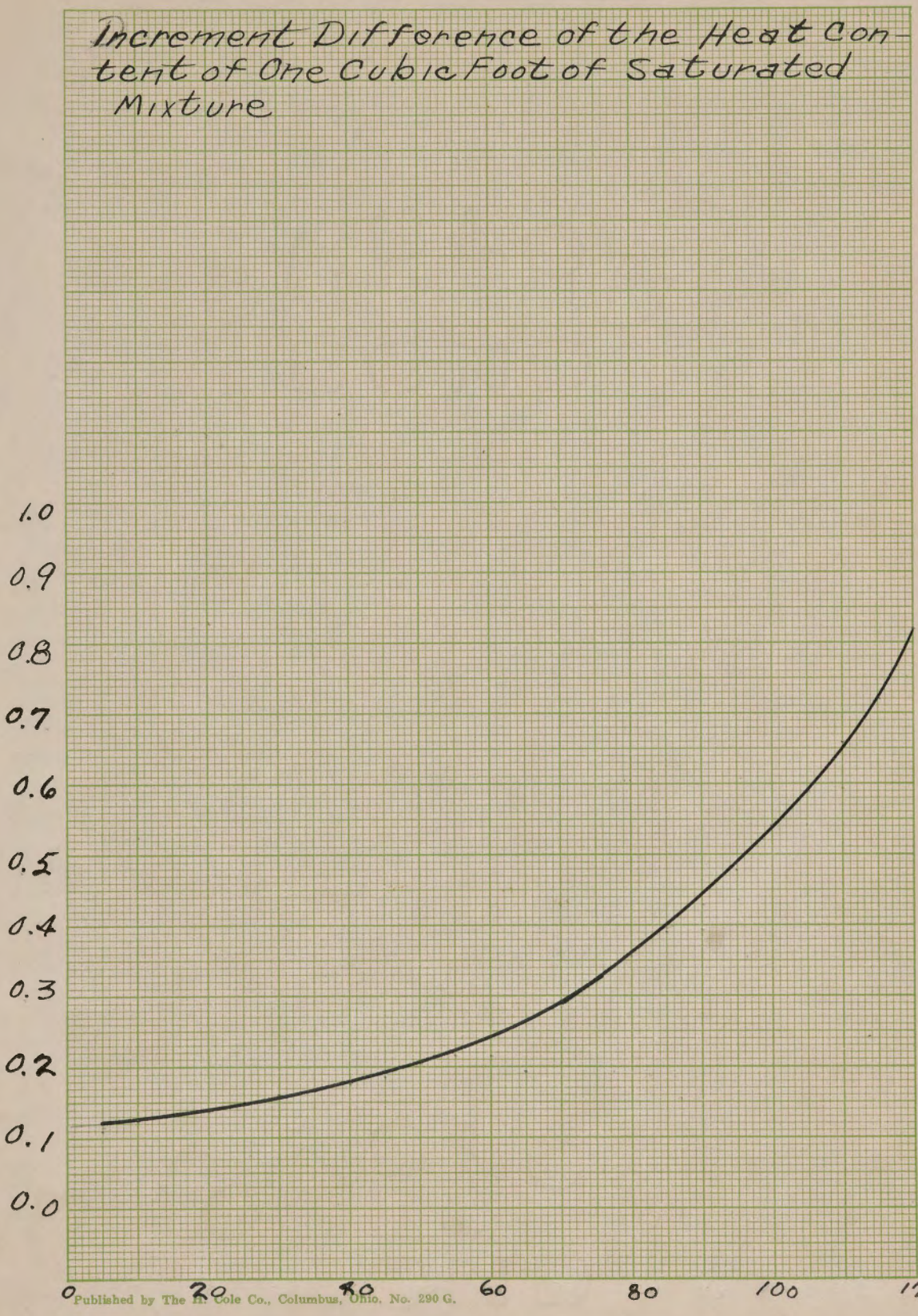
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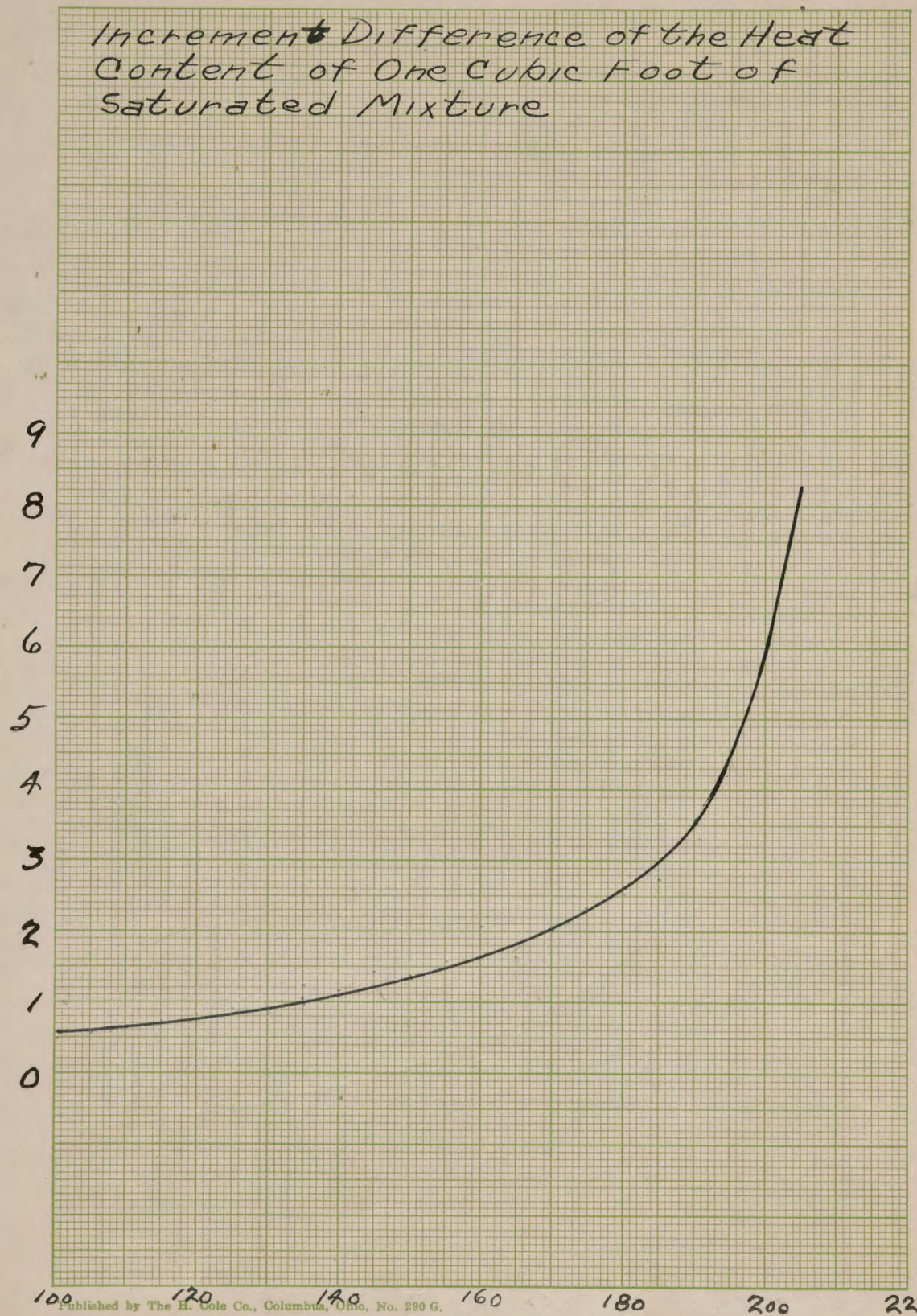
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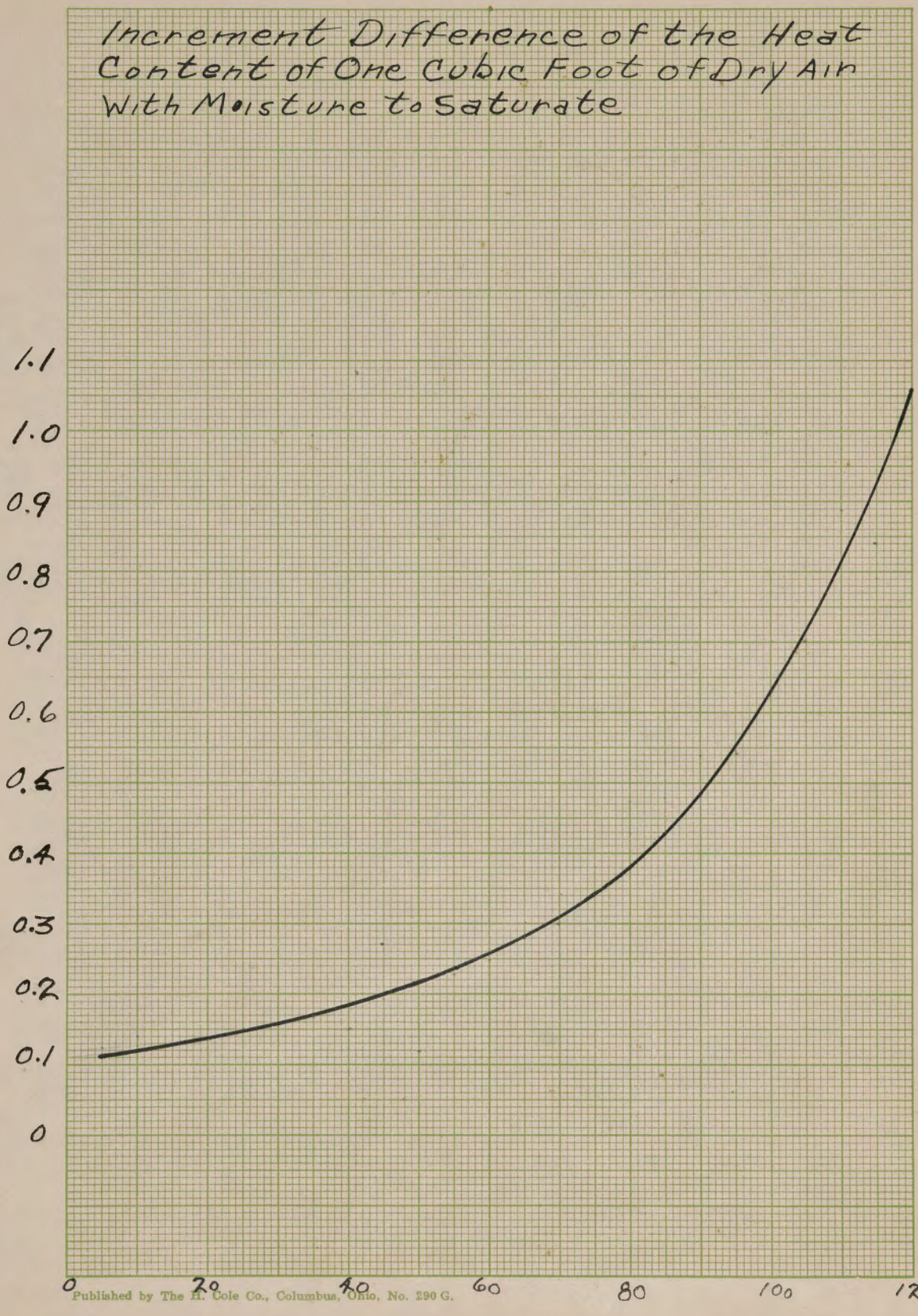
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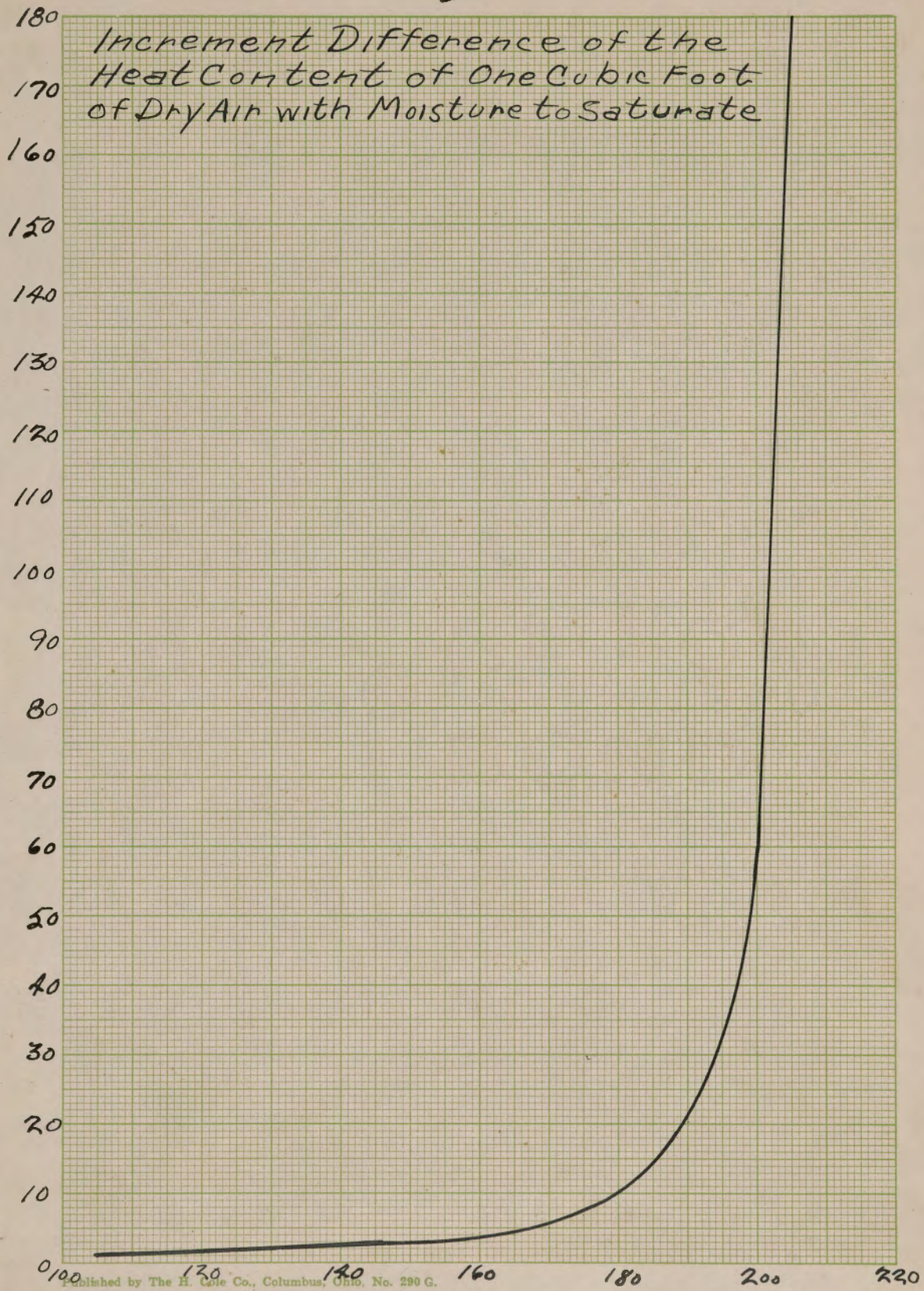


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19

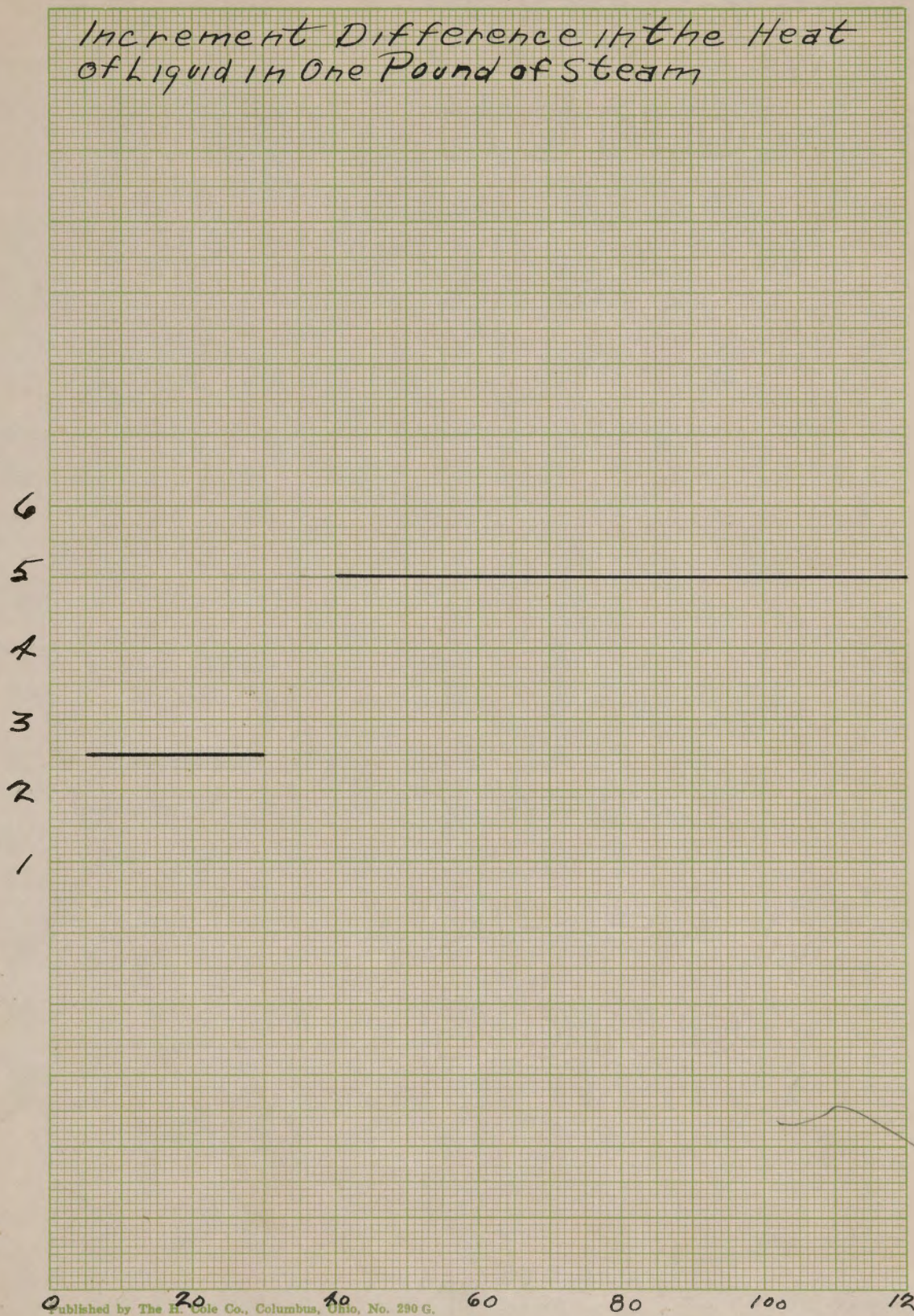

Increment Difference of the Heat Content of One Cubic Foot of Dry Air With Moisture to Saturate
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
120
Published by The H. Cole Co., Columbus, Ohio, No. 290 G.

19



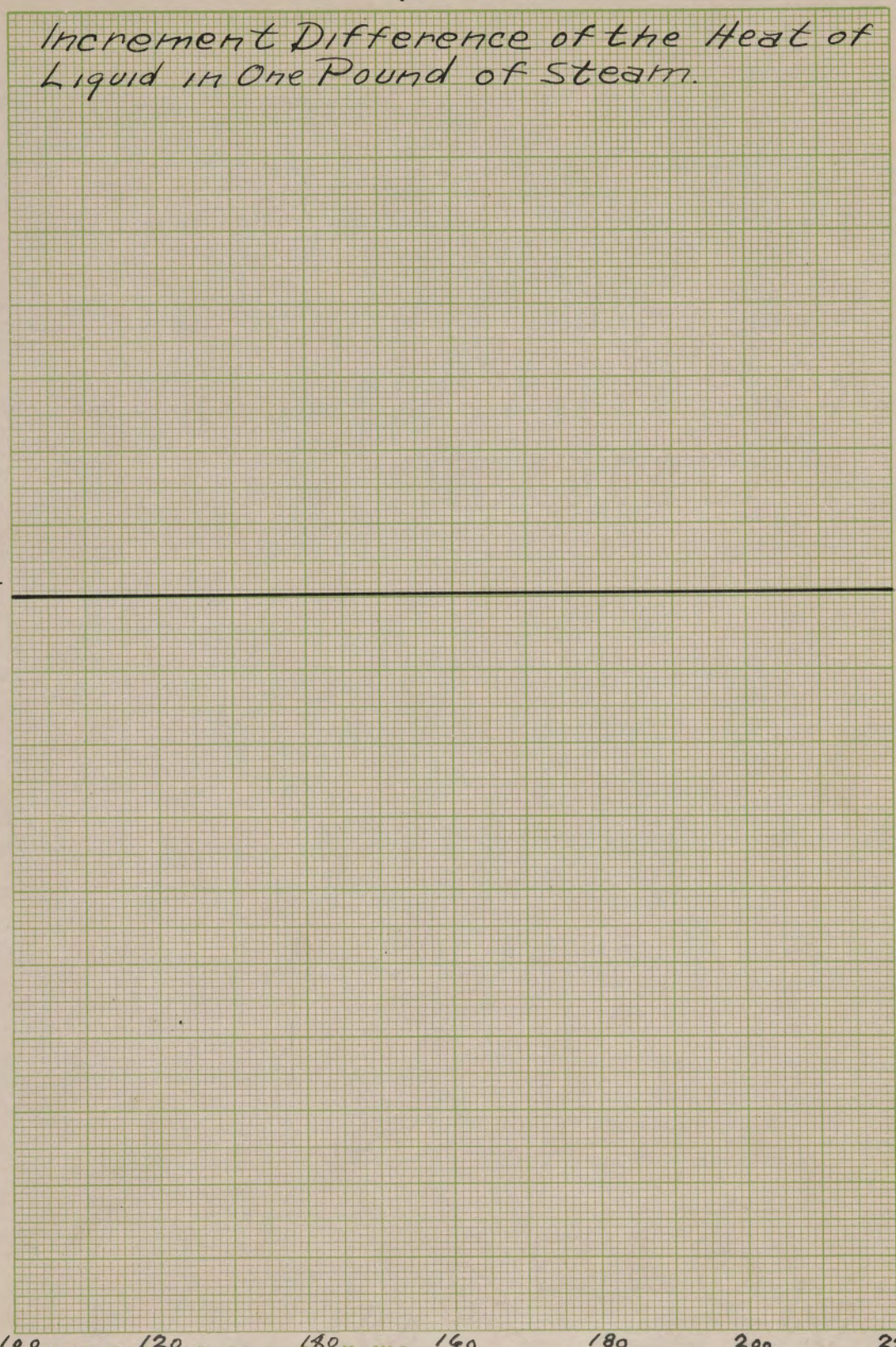
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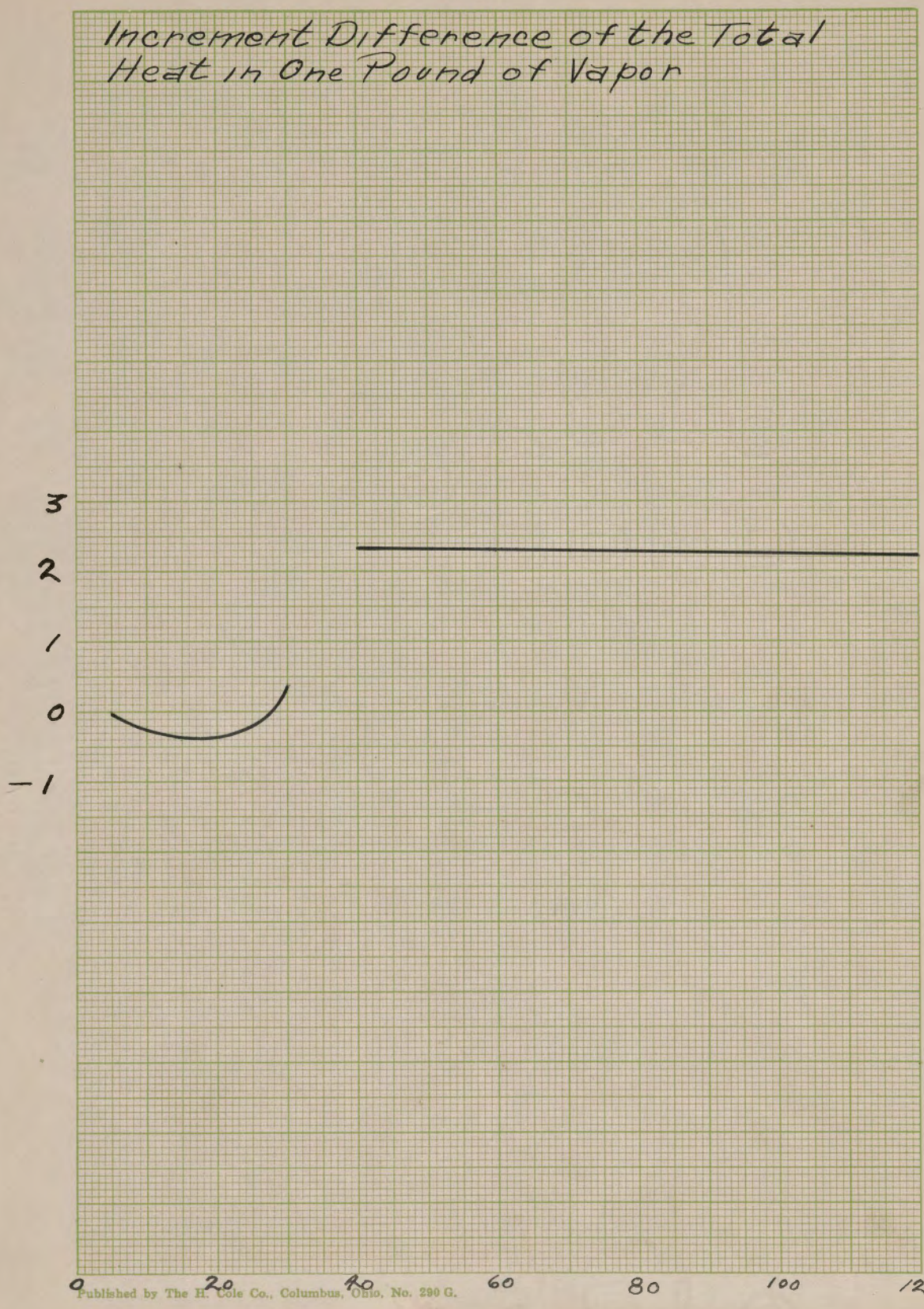
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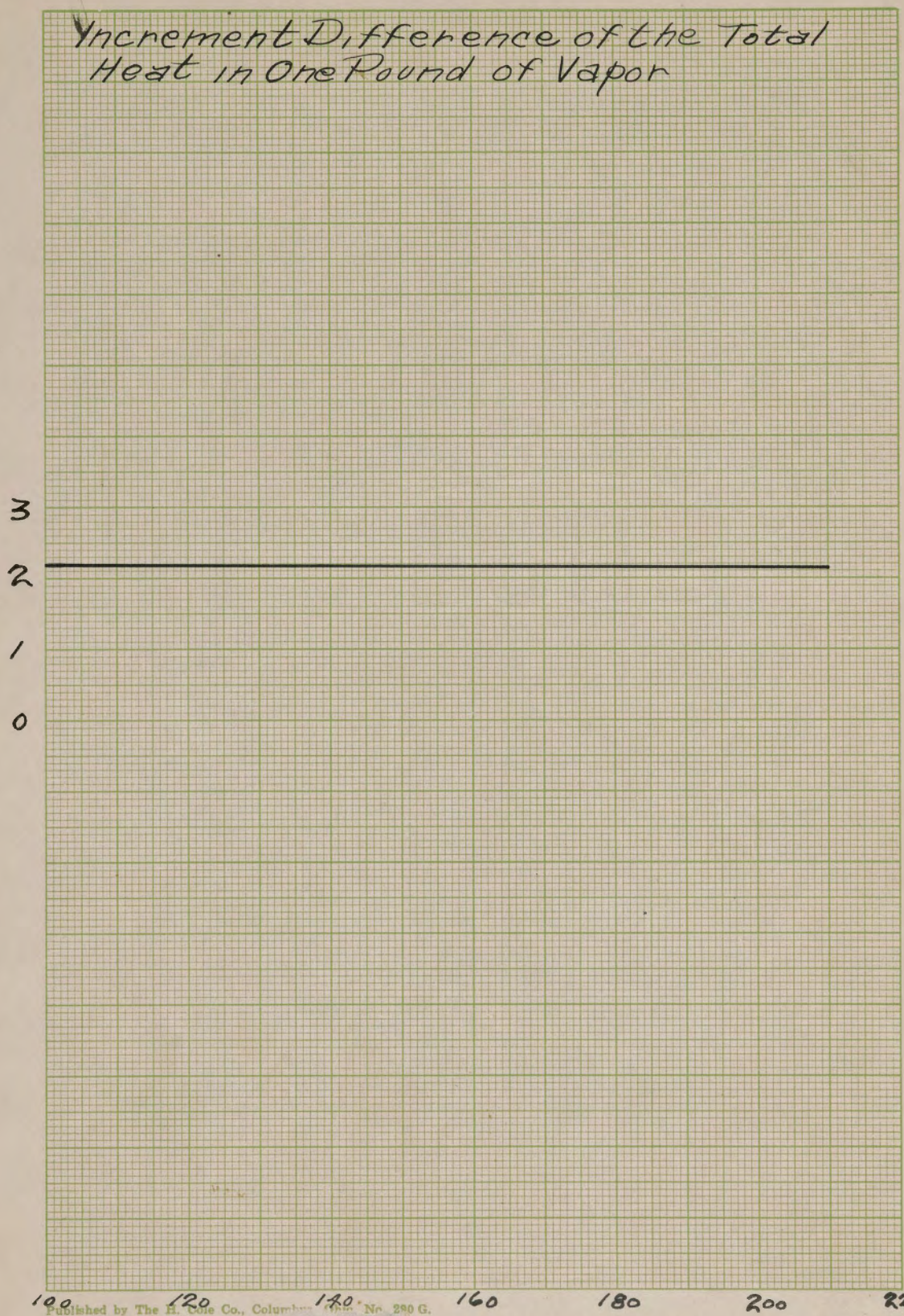
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CONCLUSION

In conclusion, it may be said that, for the most part, the values appear to be fairly accurate. In each case they follow rather closely the lines of a general curve which indicate that the values are probably accurate within certain limits.

It is the writer's hope that the values found here may be of value in the future, either for research work, or as a basis for computations of other properties of steam-air mixtures.

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APPROVAL

The foregoing thesis is hereby approved as a creditable study of an engineering subject, carried out and presented in a manner sufficiently satisfactory to warrent its acceptance as a prerequisite to the degree for which it has been submitted. It is understood that, by this approval, the undersigned does not necessarily endorse or approve any statement made, opinions expressed, or conclusions drawn therein, but approves the thesis only for the purpose for which it is submitted.

Name W. R. Woolrich

Title Prof. Mech. Eng.