DEPARTMENT OF AGRICULTURE.
CHEMICAL DIVISION.
BULLETIN No. 5.

THE SUGAR INDUSTRY OF THE UNITED STATES.

INTRODUCTION.
PART I.—CANE SUGAR.
PART II.—BEET SUGAR.
PART III.—SORGHUM SUGAR.
PART IV.—MAPLE SUGAR.

BY

HARVEY W. WILEY.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1885.

13406 SUG

LETTER OF TRANSMITTAL.

DEPARTMENT OF AGRICULTURE, BUREAU OF CHEMISTRY,
Washington, D. C., March 2, 1885.

SIR: I have the honor to submit herewith the report of the investigations made by this Bureau on the Sugar Industry of the United States during the year 1884.

The report consists of an Introduction and four parts, viz, Cane Sugar, Beet Sugar, Sorghum Sugar, and Maple Sugar.

In Part II is incorporated the valuable report of Mr. G. L. Spencer on late improvements in machinery and methods for the manufacture of beet sugar. Part IV on maple sugar is not yet completed. A station for the chemical study of maple saps and sugars has been established at Lunenburg, Vermont, and it is hoped that the data obtained there will be ready for publication by the first of May this year.*

During the past year, instead of a merely local study of sugar chemistry in the laboratory here, stations have been established in various parts of the country. While this method of investigation requires more labor and is more expensive than that of local work, it is believed that it is far more practical, and the results it gives of much greater value. It is with such a belief that I submit the following pages for your approval.

Respectfully,

H. W. WILEY,
Chemist.

HON. GEO. B. LORING,
Commissioner.

---

*The manuscript of Part IV was delivered to the printer on May 16.

SUGAR INDUSTRY OF THE UNITED STATES.

INTRODUCTION.

INTRODUCTION.

The amount of sugar and molasses imported into the United States for the fiscal year ending June 30, 1884, with value at port of entry, is given in the following table:

[From the Annual Report on Commerce and Navigation of the United States for 1884.]

	Quantities.	Value.
DUTY FREE.		
Molasses ....gallons..	163, 347	$22, 963
Raw sugar ....pounds..	125, 158, 677	7, 108, 293
All other........		485
Sum		7, 131, 741
DUTIABLE.		
Molasses........ gallons..	33, 965, 293	5, 577, 722
Sugar: Not above No. 13 Dutch standard .... pounds..	2, 630, 352, 807	91, 080, 953
Above 13, not above No. 20........ do....	768, 832	61, 111
Above No. 20........ do....	136, 580	12, 251
Candy and confectionery........		20, 982
Sum		96, 753, 019
Total value of imports........		103, 884, 760

Domestic production for year ending June 30, 1884.

	Quantities.	Value.
Cane sugar at 5 cents a pound and molasses at 30 cents a gallon.		
Louisiana........pounds..	*287, 712, 230	$14, 385, 611 50
Other States (estimated)........do....	14, 000, 000	700, 000 00
Molasses (Louisiana) ....gallons..	15, 277, 316	4, 583, 194 80
Other States (estimated)........do....	750, 000	225, 000 00
Sum		19, 893, 805 30
Maple sugar at 10 cents a pound and molasses at 75 cents a gallon.		
Sugar (estimated)........pounds..	†36, 576, 061	3, 657, 606 10
Molasses (estimated) ....gallons..	1, 796, 048	1, 347, 036 00
Sum		5, 004, 642 10
Sorghum sugar at 5 cents a pound and molasses at 30 cents a gallon.		
Sugar........pounds..	‡726, 711	36, 335 55
Molasses (estimated) ....gallons..	30, 000, 000	9, 000, 000 00
Sum		9, 036, 335 55

* Bouchereau's Report, 1884.
† Census 1880.
‡ Bulletin Bureau of Chemistry United States Department of Agriculture, No 3.

Domestic production for year ending June 30, 1884—Continued.

	Quantities.	Value.
Beet sugar at 8 cents.		
Sugar .... pounds..	*1,277,826	$102,626 08
Glucose or starch sugar at 3 cents.		
Estimated production .... pounds..	300,000,000	9,000,000 00
Summary of value of domestic sugars and molasses.		
Cane		19,893,805 30
Maple		5,004,642 10
Sorghum		9,036,335 55
Beet		102,626 08
Glucose (starch sugar)		9,000,000 00
Total		43,037,409 03

* E. H. Dyer, Alvarado, Cal.

CANE SUGAR.

The yield of cane sugar is obtained by adding to the product of Louisiana, taken from Bouchereau's report for 1884, the estimated yield of the other Southern States. The average price received by the manufacturer is taken at 5 cents per pound for 1883–'84.

The molasses is estimated in the same way and the average price taken at 30 cents per gallon.

MAPLE.

The yield of maple sugar is taken from the census of 1880. For each period of ten years the product of maple sugar and molasses is almost a constant quantity, although the variations from year to year, depending on local causes, may be considerable.

In the absence of annual statistics the figures taken from the census returns are the most reliable. The first selling prices have been taken at 10 cents per pound for the sugar, and 75 cents per gallon for the molasses.†

SORGHUM.

The yield of sorghum sugar for the year ending June 30, 1884, was taken from Bulletin No. 3, this Bureau.

The census of 1880 gave the yield of molasses at 28,444,202 gallons. Allowing for a moderate increase in production, the yield for the last fiscal year is estimated at 30,000,000 gallons. The average selling price is fixed at 30 cents per gallon, which is more likely too large than too small a figure.

BEET SUGAR.

This was all made at Alvarado, Cal. (See Chem. Bul. No. 3.)

GLUCOSE.

"It is only about twelve years since the manufacture of glucose was introduced in the country, and now there are twenty large establish-

† Later information leads me to believe that 75 cents per gallon is less than the average price received by the maker for maple sirup.

ments located in seven different States, with an invested capital of over $10,000,000, and a capacity to consume 61,000 bushels of corn a day, giving employment to 4,575 workmen, paying annually $2,058,750 in wages, consuming $13,703,000 worth of materials, and yielding a product worth $18,270,000. These figures show an average profit of 15 per cent. on the capital invested. A bushel of corn will give 32 pounds of glucose; the twenty establishments, therefore, have a capacity for manufacturing 609,000,000 pounds of the article per annum."*

But owing to the depressed state of the trade these factories were not run to more than half of their capacity, and the total product is therefore fixed at the figure given in the table.

Total first cost of sugar for the year ending June 30, 1884.

Imported		$103,884,760
Domestic		43,037,409
Sum		146,922,169
During the same period there were exported—		
Sugar, molasses, confectionery, and candy valued at	$6,428,170	
Glucose valued at	212,628	
		6,640,798
Net first cost		140,281,371

Amount of duty collected.

Duty paid on sugar	$47,500,749 79
Confections	10,432 25
Molasses	1,412,283 16
Sugar cane	69 28
Sugar drainings	6,133 80
Total duty	48,929,668 28

Duty refunded for exported sugar, &c.

District.	Drawback.	Retention.	Paid.
Baltimore	$476 17	$4 76	$471 41
Boston	215,209 63	2,219 51	212,990 12
New Orleans	726 58	7 26	719 32
New York	1,357,037 52	13,570 37	1,343,467 15
Philadelphia	231 02	2 31	228 71
San Francisco	22,024 26	220 36	21,803 90
			1,579,680 61

Deducting this sum from the total duties paid gives net amount for duties, $47,349,987.67.

Cost to the consumer.

Value of sugar, &c., imported		$103,884,760
Domestic production		43,037,409
Sum		146,922,169
Less value sugar, &c., exported	$6,428,170	
And glucose valued at	212,628	
Gives net first cost		140,281,371

* Memorial of manufacturers of glucose to Congress.

Total duty paid	$48, 929, 668	
Total duty refunded	1, 579, 680	
Gives net duty collected		$47, 349, 988
Which, added to net first cost of sugar, gives total first cost before entering the market of		187, 631, 359

It would be impossible to give the exact cost to the consumer. The retail price varies greatly in different parts of the country, being, for instance, two cents a pound more for sugar in San Francisco than in New York. This variation is caused chiefly by cost of transportation. From a careful study of the cost to the consumer in various parts of the country, I believe that the profits of the refiners, dealers, and carriers are not less than 33.3 per cent. of the net first cost. This would give a total increase of cost, in round numbers, of $62,500,000, which, added to the first cost, gives total cost to consumers $250,131,359.

*Table showing amount of imported sugar entered for consumption and withdrawals from warehouses for consumption, duty received, consumption per capita, and duty per capita from 1867 to 1884, inclusive.**

BROWN AND ALL OTHER.

Year.	Duty free.	Dutiable.	Average rate of duty per pound.	Duty received.	Consumption per capita.	Duty per capita.
	Pounds.	*Pounds.*	*Cents.*		*Pounds.*	*Cents.*
1867		936. 786, 240	3. 04	$28, 497, 998	25. 87	78. 70
1868		997. 298, 331	3. 04	30, 359, 400	27. 10	82. 51
1869		1. 007, 625, 757	3. 04	30. 645. 235	26. 69	81. 17
1870		1, 183, 089, 146	3. 04	35, 986, 347	30. 68	93. 33
1871		1. 166, 394. 287	2. 54	29, 690. 522	29. 49	75. 06
1872		1. 346, 942. 550	2. 07	27, 876. 769	33. 17	68. 66
1873		1, 378. 498, 832	2. 05	28, 226, 309	33. 03	67. 68
1874		1. 511, 456, 915	2. 02	30. 492, 526	35. 27	71. 15
1875		1, 575, 893, 944	2. 12	33, 380, 643	35. 77	75. 76
1876		1. 561, 880. 545	2. 41	37, 625. 064	34. 47	83. 03
1877	30. 685, 142	1, 455, 387, 854	2. 36	34. 337, 350	31. 87	73. 65
1878	30, 368. 328	1, 552. 875, 112	2. 34	36, 387, 464	32. 99	75. 83
1879	41, 693, 069	1, 598. 461, 986	2. 33	37, 294, 197	33. 50	75. 50
1880	61, 556, 324	1, 592, 261, 958	2. 46	39, 107, 256	32. 98	77. 98
1881	76, 909, 207	1, 869. 173, 898	2. 46	45, 933. 045	37. 82	89. 26
1882	106, 181, 858	1. 913, 396, 455	2. 44	46, 711. 795	38. 25	88. 47
1883	114. 132. 670	1, 927, 685, 706	2. 31	44. 517. 851	37. 70	82. 19
1884	125. 148, 680	2, 437, 870,913	1. 95	47. 501, 750	46. 13	85. 51
MELADA.						
1867		2, 899, 768	2. 50	72, 494	0. 08	0. 20
1868		3, 542, 817	2. 50	88, 570	0. 10	0. 24
1869		11, 146, 867	2. 50	278, 672	0. 30	0. 74
1870		33, 307, 758	2. 50	832, 694	0. 86	2. 16
1871		65, 442. 264	1. 62	1. 060, 976	1. 65	2. 68
1872		65, 911, 871	1. 50	988, 678	1. 61	2. 43
1873		107, 084, 690	1. 50	1, 606. 270	2. 57	3. 85
1874		133, 252, 852	1. 50	1, 998, 793	3. 11	4. 66
1875		73. 145, 139	1. 74	1, 269, 442	1. 66	2. 88
1876		96, 751, 914	1. 87	1, 813, 354	2. 14	4. 00
1877		49, 650. 354	1. 87	930, 944	1. 07	2. 00
1878		36, 691, 376	1. 87	687, 963	0. 76	1. 43
1879		41, 152. 357	1. 87	771, 607	0. 83	1. 56
1880		33, 709, 344	1. 87	632, 050	0. 67	1. 26
1881		20, 534, 846	1. 87	385, 028	0. 40	0. 75
1882		14. 135, 435	1. 87	265, 039	0. 27	0. 50
1883		3. 925. 205	1. 87	73. 598	0. 07	0. 14

* Report on Commerce and Navigation of the United States, 1884, p. 791.

Table showing amount of imported sugar entered for consumption, &c.—Continued.

MOLASSES.

Year.	Duty free.	Dutiable.	Average rate of duty per gallon.	Duty received.	Consumption per capita.	Duty per capita.
	Gallons.	*Gallons.*	*Cents.*		*Gallons.*	*Cents.*
1867		50, 116, 513	8. 00	$4, 009, 321	1. 38	11. 07
1868		55, 006, 060	8. 00	4, 400, 405	1. 49	11. 96
1869		52, 111, 252	8 00	4, 168, 900	1. 38	11. 04
1870		47, 768, 267	8. 00	3, 821, 461	1. 25	9. 91
1871		47, 260, 021	5. 98	2, 826, 462	1. 19	7. 15
1872		42, 057, 924	5. 00	2, 102, 896	1. 04	5. 18
1873		44, 112, 413	5. 00	2, 205, 621	1. 06	5. 29
1874		47, 205, 641	5. 00	2, 360, 282	1. 10	5. 51
1875		43, 220, 697	5. 77	2, 495, 189	0. 98	5. 66
1876		39, 213, 804	6. 24	2, 447, 658	0. 87	5. 40
1877	138, 072	29, 000, 397	6. 25	1, 812, 525	0. 63	3. 89
1878	87, 534	26, 855, 764	6. 25	1 678, 485	0. 56	3. 50
1879	98, 112	35, 353, 586	6. 25	2, 209, 599	0. 71	4. 47
1880	111, 950	39, 433, 745	6. 25	2, 464, 609	0. 79	4. 91
1881	198, 987	26, 545, 026	6. 25	1, 659, 064	0. 52	3. 22
1882	152, 700	35, 543, 653	6. 25	2, 221, 478	0. 68	4. 21
1883	238, 773	28, 065, 366	5. 59	1, 569, 467	0. 52	2. 90
1884	163, 347	35, 305, 819	4. 00	1, 412, 283	0. 64	2. 54

Adding together the duty per capita for sugar and molasses for 1884 the total sum is found to be 88.05 cents. This really seems a small amount, and yet for a poor man with a large family the burden would be a considerable one. But the revenue derived from sugar is paid chiefly by the rich and those of moderate means. The consumption of sugar by these classes is vastly greater per capita than it is among the very poor. For this reason it is doubtful whether there is any better and more just way of raising a revenue than by the duty on sugar. It is not only a tax for protection but pre-eminently one also for revenue and should therefore have the undivided support of both protectionists and free-traders.

Table showing the population of the United States, the total consumption of sugar, and amount per capita, from 1867 *to* 1884, *inclusive.*

Year.	Population.	Total sugar consumed.*	Sugar consumption per capita.	Year.	Population.	Total sugar consumed.*	Sugar consumption per capita.
		Tons.†	*Pounds.*			*Tons.*†	*Pounds.*
1867	‡36, 211, 000	467, 268	28. 9	1877	‡46, 182, 000	745, 250	36. 2
1868	‡36, 973, 000	543, 033	32. 9	1878	‡47, 420, 000	773, 472	36. 0
1869	‡37, 756, 000	574, 399	34. 0	1879	‡48, 746, 000	831, 896	38. 3
1870	§38, 558, 371	606, 492	35. 3	1880	§50, 155, 783	922, 109	41. 2
1871	‡39, 505, 000	702, 314	39. 9	1881	‡51, 462, 000	1, 008, 932	43. 9
1872	‡40, 500, 000	720, 873	39. 9	1882	‡52, 799, 000	1, 077, 949	45. 7
1873	‡41, 642, 000	740, 525	39. 9	1883	‡54, 163, 000	1, 164, 391	48. 2
1874	‡42, 630, 000	801, 015	42. 1	1884	‡55, 554, 000	1, 265, 087	51. 4
1875	‡43, 766, 000	773, 002	39. 5	1885	‡56, 973, 000		
1876	‡45, 050, 000	745, 269	37. 1				

* New York Shipping and Commercial List, as copied in Bouchereau's Louisiana Reports.

† Ton = 2,240 pounds.

‡ Estimated by F. P. Elliott, actuary of the Treasury.

§ Census.

These figures differ in a few instances slightly from those given originally in the shipping list—as for example for 1880, where the original figures are 907,109. I do not know whether these differences are the result of later investigations or not, but since they do not materially affect the result I have not changed them.

Messrs. Willet and Hamlen* give the fol owing estimates of the total consumption of sugar in the United States during the past four years:

	1881.	1882.	1883.	1884.
Amount consumed..............tons..	993, 532	1, 061, 220	1, 170, 375	1, 252, 366
Increase per year in tons..............	....	67, 688	109, 155	81, 991
Per cent. of increase	....	6. 8	10. 3	7. 0
Consumption, per capita, in pounds	42. 8	45. 7	47. 6	51. 0

These figures are so nearly those of the preceding table that practically they may be considered identical.

They show that since 1867 the consumption of sugar per head in this country has almost doubled, and that with the exception of the very hard times that followed the financial disasters of 1873–1874, there has been a regular increase in the quantity of sugar used by each person.

The preceding figures show how erroneous are the tables of Goerz,† which give the following data concerning the consumption of sugar in the United States:

Year.	Population.	Total consumption.	Consumption per head.	Year.	Population.	Total consumption.	Consumption per head.
		Tons.	*Kilos.*†			*Tons.*	*Kilos.*†
1874..............	43, 555, 600	638, 960	14. 67	1879..............	49, 442, 600	673, 580	13. 62
1875..............	44, 713, 000	630, 520	14. 10	1880..............	50, 442, 066	761, 190	15. 09
1876..............	45, 970, 200	607, 660	13. 22	1881..............	51, 657, 400	850, 870	16. 57
1877..............	47, 127, 800	635, 590	13. 48	1882..............	52, 814, 800	898, 630	17. 01
1878..............	48, 285, 200	629, 260	13. 02				

† Kilo = 2. 2 pounds.

Counting each gallon of sugar cane, maple, and sorghum molasses as the equivalent of 5 pounds of sugar, it is found that the total consumption is increased by more than 4 pounds of sugar per head. This gives as the amount consumed per head for all kinds of sweets, excluding glucose and honey, nearly 56 pounds.

Comparing this with the consumption of other countries, the following table is obtained:

Consumption of sugar per head for various countries.

Countries.	Year.	Pounds.	Countries.	Year.	Pounds.
United States	1884	56	Holland	1881	18. 5
England	1884	67	Austria	1881	13. 0
France	1881	25	Russia	1881	7. 7
Germany	1881	18			

* La Sucrerie Indigène, Vol. 25, No. 6, p. 125.

† Handel und Statistik des Zuckers, p. 210.

*Table showing population of England, consumption of sugar, and amount consumed per capita, from 1876 to 1884, inclusive.**

Year.	Population.	Consumption, tons.	Consumption, per head.	Year.	Population.	Consumption, tons.	Consumption, per head.
			Pounds.				*Pounds.*
1876	33,093,000	880,000	59	1881	34,930,000	1,000,000	64
1877	33,447,000	847,000	56	1882	35,290,001	998,000	63
1878	33,799,000	939,000	62	1883	35,612,000	1,068,000	67
1879	34,155,000	953,000	62	1884	35,952,000	1,076,000	67
1880	34,468,000	956,000	62				

* La Sucrerie Indigène, Vol. 25, No. 6, p. 138.

From 1876 to 1885 the consumption of sugar in England rose from 59 to 67 pounds per head. During the same period in the United States the increase was from 37.1 to 50.4 pounds per head. At this rate in another decade the quantity of sugar required for each inhabitant will be as great in this country as in England, viz, about 75 pounds. But our population is increasing much more rapidly than that of England, and in ten years from this time it will be nearly 70,000,000, and the amount of sugar used in the country will be 5,000,000,000 pounds! This country will be the great sugar market of the world.

It is perhaps not too soon to recognize the fact that sugar has ceased to be a luxury, and has become a staple article of food. This fact should not be forgotten by our political economists.

The following account of the sugar trade of the United States for 1884 is taken from the New York Shipping and Commercial List, January 17, 1885:

ANNUAL STATEMENT OF THE SUGAR TRADE OF THE UNITED STATES.

The sugar industry throughout the world has reached a period in the history of its development that is likely to result in most important changes in the sources of supply as well as in the methods of manufacture. For centuries the saccharine product of the cane has supplied the human race with sugar; the cultivation of which and the manufacture of its product has formed one of the most important of the world's industries, as well as one of the most extensive branches of the world's commerce. It has had no rival or competitor in supplying this necessary food staple until the ingenuity and enterprise of the present generation discovered, utilized, and developed the saccharine properties of the beet-root. Quietly and gradually a new industry sprang into existence, and under the fostering care of Government aid it has steadily progressed, until to-day it challenges the supremacy of the cane product, and is contesting the privilege of controlling the sugar markets of the world. This has been the most potent factor in shaping the course of the sugar trade during the year 1884, and it is likely to continue the controlling influence for some time to come in regulating the value and consumption of raw sugar throughout the world. In addition to this, however, there have been other important influences which must be taken into consideration in reviewing the operations of the past year, and which combined have rendered it a singularly disastrous year to all who have been interested in either the production, manufacture, or trade in sugar. The production of cane sugar in almost every cane-growing country far exceeded the proportions of the previous year, and this combined with an enormous increase in the European beet crop, coming at a time when trade and commerce have been overshadowed by a heavy cloud of financial and commercial depression, seems to have resulted in a climax of events that could only result in disaster. The accumulation of supplies, shrinkage in values, and anxiety to realize have borne prices down until the market value of raw sugar has been down to, and in many instances below, the cost of production. This condition of affairs, very naturally, has been felt most severely in producing countries, and the heavy failures reported in Europe, the impoverished condition of Cuba planters, and the cry of financial distress wherever a crop of sugar has been gathered and marketed complete a record that it is to be hoped will not be again repeated during the present decade. Taking into consideration the improved methods of manufacture and the quality of the article consumed, it is safe to say that sugar has never before sold at the low prices that are current to-day, but it is equally true that the climax of shrinkage in value has been reached. Cane and beet root now stand arrayed against one another upon a basis that must force one or the other to yield, production can no longer be carried on at a fearful sacrifice of money irretrievably lost, and the year 1885 will probably witness the survival of the fittest.

Under these circumstances the refining interests of this country, as well as the importers of foreign sugar, have had to contend against heavy odds. They have had to face a steadily declining market throughout the year, and almost constantly stocks have been replaced from week to week and month to month at a lower cost. It is true that consumption has increased, and at times the full capacity of the refineries has been readily marketed, but this has in no measure compensated for the shrinkage in values that has scarcely experienced a noteworthy reaction. It is worthy of remark in this connection that the British refineries have been almost swamped by the flood of supplies that the payment of a Government bounty upon exports has made it possible for this country as well as Europe to divert thither.

The increased consumption of raw sugar of all descriptions during the year 1884, in comparison with 1883, has been 100,892 tons, or 8.66 per cent., which, on the basis of a population of 55,000,000, gives a per capita consumption of 51.70 pounds per annum, against 47½ pounds in 1883 and 45¼ pounds in 1882. It must not be supposed, however, that this represents the actual per capita consumption of refined sugar, for in the process of refining a certain percentage of the raw material, which is uncrystallizable, passes off in the shape of sirup, and there is a greater or smaller percentage of dirt or refuse. The large increase in consumption of raw material in 1884 is due, first, to increased population; second, to low prices, which have made it a cheaper article of food as well as for manufacturing purposes; and third, and perhaps most important, is the fact that a comparatively large percentage of the importations this year have consisted of low grades, of low saccharine value, and consequently yielding a very much smaller percentage of crystallizable sugar. In other words, the average test of the importations has been unusually low, so that the net result of melting up and refining a very much larger quantity of raw material has not given a proportionate increase of refined. The importations from Manila have comprised low-grade Taal; the cargoes received from Tuticorin, Swatow, and Formosa have been of the same description, testing as low as 75; there has been a very large proportion of low-grade Brazils received, and from many of the West India Islands the importations of these descriptions have been larger than usual. From these remarks it will be seen that the increased consumption of raw sugar has been proportionately very much greater than the actual consumption of refined product, and our figures are therefore scarcely so accurate a guide as they would be under ordinary circumstances in indicating the increased consumption of the country for the year. Still there has been a very considerable increase in the total consumption of the country even after making a liberal allowance for the conditions mentioned above, and there is no reason to doubt but that the country actually used up more crystallized sugar than it has ever done before.

An examination of the tables on the preceding page shows that with the exception of the Philippine Islands, nearly every sugar-producing country has contributed to the increased importations received. There has been no scarcity of supplies in any direction, and with the universal cry of "too much sugar," shippers have been sorely puzzled where to find the best market for their constantly depreciating cargoes. The most notable increase has been in the importations of European beet, which are nearly double what they were in 1883, and fully twelve-fold of what was imported in 1882. The next largest increase is in the importations from Brazil; but from Cuba, as well as all the West India Islands, the supply has far exceeded that of 1883. Exclusive of the Pacific coast the importations of foreign raw sugar into the United States for the year 1884 aggregate 1,082,340 tons, against 932,522 tons in 1883, an increase of 149,818 tons, while the consumption of foreign raw sugar during 1884, after deducting the exports of raw and refined, amount to 981,404 tons, against 908,717 tons in 1883, an increase of 72,687 tons, or 8 per cent. Adding to this the product of the domestic crop at the South, 135,443 tons, together with the quantity taken for consumption on the Pacific coast, and the sum represents the aggregate consumption of cane sugar throughout the country for the year, or 1,265,283 tons against 1,105,169 tons in 1883, an increase of 100,892 tons, or 8.66 per cent.

In order to arrive at the total consumption of raw sugar of all descriptions, there must also be added to the above total the products obtained from reboiling foreign molasses, an industry of very considerable proportions—the product of our maple groves or forests, which is of equal importance, and the yield obtained from the manufacture of domestic beet-root and sorghum. The quantity of so-called bastard or domestic molasses sugar obtained from the reboiling of foreign molasses is considerably larger than in 1883, owing to the larger supply of molasses available from the near-by West India Islands. Boiling establishments have been in operation at five coast ports, Portland, Boston, New York, Philadelphia, and Baltimore, and 190,000 hogsheads molasses have been used up, giving a product of sugar estimated at 50,000 tons. In comparison with other years, the production has been as follows:

Ports.	1884.	1883.	1882.	1881.	1880.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
New York	18,932	16,535	20,225	14,500	....
Philadelphia	24,304	17,212	36,200	20,457	....
Baltimore	1,830	2,840	2,837	2,380	....
Boston	3,327	2,459	2,770	2,174	....
Portland	1,607	1,676	2,424	438	....
Total	50,000	40,722	64,256	39,949	50,617

As compared with last year there has been an increase of 9,278 tons, but the product is not equal to that of 1882 or 1880.

There is no definite data upon which to base an estimate of the maple-sugar crop of this country, which is one of considerable importance. According to returns made to the Census Bureau in 1880, the product that year aggregated 50,944,475 pounds, and in the five years that have elapsed since then some increase has taken place by the planting of additional trees. The winter of 1884 was favorable for a full flow of sap, and competent authorities estimate the production at 25,000 tons. The largest supply comes from Vermont, but New York, Pennsylvania, and several Western States each produce upwards of 1,000,000 pounds annually.

The cultivation of the beet root in this country has made no substantial progress during the past year, and the only factory in successful operation is the Alvarado, in California, where there was produced, in 1884, 1,650,000 pounds sugar. Little or no progress has been made at the experimental factories and farms established in New Jersey several years ago, and thus far the efforts to develop the beet industry in this country have not gone beyond the experimental stage; certainly no practical results have yet been reached, nor has the effort to manufacture sugar from sorghum met with any better results. At the several factories operated last year not over 1,000,000 pounds of sugar was produced, which, in view of the annual consumption of the country, is of no commercial value, and comes only within the scope of those who are riding scientific hobbies.

The crop of cane-sugar produced in the Southern States during the crop year 1883–'84 shows a considerable falling off, as compared with that of the previous year. According to the accurate and valuable compilation of Mr. A. Bouchereau, of New Orleans, the yield in the State of Louisiana amounted to 221,515 hogsheads, or 128,443 tons, against 241,220 hogsheads, or 135,298 tons, for the crop grown and gathered during 1882–'83, a falling off of 19,705 hogsheads, or 6,855 tons, the total yield of the crop being about 20,000 hogsheads in excess of the estimates made at the beginning of 1884. In the remaining Southern States, where cane is grown, the product is estimated at about 7,000 tons, which, added to the yield of Louisiana, gives a total domestic crop of 135,443 tons. There were 172,420 acres of cane ground, which is 51,865 acres, or 43 per cent., more than the previous year. Planters using the vacuum pan obtained an average of 2,646 pounds of sugar per acre, or 126 pounds per ton of cane, and 21 tons of cane per acre, and those using other apparatus 1,290 pounds sugar per acre. Of the total crop, 105,812 hogsheads was refined sugar, which is the largest production of this description since the war, and the remaining 115,703 hogsheads was made by the old process.

The following statement shows the importations and deliveries of raw sugar for consumption at San Francisco for the year ending December 31:

Received from—	1884.	1883.	1882.
	Pounds.	*Pounds.*	*Pounds.*
Sandwich Islands	128, 859, 965	103, 842, 000	97, 920, 670
Manila	21, 392, 564	20, 598, 562	1, 528, 156
China	1, 197, 104	4, 157, 392	940, 946
Central America	1, 725, 862	1, 932, 296	1, 670, 437
Peru	....	600	....
Mexico	8, 115	43, 417	....
Domestic beet sugar	1, 650, 000	1, 200, 000	1, 000, 000
Total	154, 833, 610	131, 774, 267	103, 060, 209
Stock January 1	11, 524, 934	4, 792, 416	19, 218, 562
Total supply	166, 358, 544	136, 566, 683	122, 278, 771
Exports of raw and refined	2, 434, 018	3, 736, 935	4, 134, 936
	163, 924, 526	132, 829, 748	118, 143, 835
Stock December 31	1, 779, 391	11, 524, 934	4, 792, 416
Consumption	162, 145, 135	121, 304, 814	113, 351, 419

Taking the several sources from which supplies have been drawn, the consumption of raw sugar for the whole country, as compared with last year, has been as follows:

Consumption of raw sugar for the whole country as compared with last year.

	1884.	1883.
	Tons.	*Tons.*
Cane sugar consumed in the United States on the Atlantic	1,116,847	1,051,015
In the Pacific coast States	72,386	54,154
Of sugar made from molasses	50,000	40,722
Of maple sugar	25,000	18,500
Of domestic beet-root, sorghum, &c	1,050	....
Total	1,265,283	1,164,391
Increase in 1883-'4, 8.66 per cent., against an increase of 8.02 per cent. in 1883 and 6.84 per cent. in 1882	100,892	86,442

With respect to the importations of foreign raw sugar, an examination of the preceding tables shows that while Cuba and the West India Islands have been, as heretofore, the most important source of supply, the largest increase in the receipts of the year, in comparison with previous years, has been in European beet and Brazils. In 1880 this country imported about 2,350 tons European beet sugar; the next year this was a little more than doubled; in 1882 the quantity received was a trifle over 7,000 tons; in 1883 our importations suddenly increased to about 46,000 tons, and this year they have reached a total of 85,000 tons, or an increase over last year of nearly 50 per cent. The heavy crop gathered in Brazil last year necessarily increased the quantity sent hither, since this country usually absorbs the largest proportion of the supply available for export. A short crop in the Philippine Islands accounts for the falling off in the importations from that country, while the increased supplies received from Cuba, as well as the other West India Islands, has been largely due to the fact that this country has afforded the best market, as compared with Europe. Wherever these supplies have sought an outlet they have been brought face to face with the product of the beet, but perhaps the influence has been less potent in the markets of this country than in London or Europe, because of our greater distance from the sources of supply. In this connection it may be interesting to note the relative proportion of the importations received from each country. Taking the total importations of the whole United States for the year 1884 at 1,143,500 tons, about 45.87 per cent. was received from Cuba and Porto Rico together, 15 per cent. from all other West India Islands, 12.69 per cent. from Brazil, 8.44 per cent. from the Philippine Islands, $\frac{3}{4}$ per cent. was received from the other East Indies, 5.33 per cent. came from Hawaiian Islands, and 7.52 per cent. was beet root. The domestic crop of cane sugar manufactured and marketed during the crop year 1883-'84 formed 10.92 per cent. of the total consumption of the country of foreign cane sugar.

The relative volume of trade at the several ports, as compared with last year, shows some interesting changes. The receipts at New York are 108,512 tons in excess of last year, and the distribution is 53,041 tons greater than last year. The importations at Boston show a falling off, as compared with last year, while at Philadelphia there has been an increase of about 31,000 tons, and at New Orleans nearly 16,000 tons more have been imported last year than in 1883. At Baltimore the importations have been extremely meager.

The increased importations and consumption of the Pacific coast States has again been an important feature of the course of trade during the year under review. This has been due to the steady expansion of the sugar growing industry of the Sandwich Islands under the impetus of the reciprocity treaty with that Government, by which these sugars are admitted free of duty. As compared with last year, the importations from the Sandwich Islands have increased 10,294 tons, while the consumption is 18,232 tons larger than last year. Prohibitive overland railroad freights, or in other words, a discrimination against the product of Eastern refineries, has precluded the sale of any considerable quantity upon that market, only 2,191,260 pounds of eastern refined having been sold there. The chief source of supply is the Sandwich Islands, but a little more than 10,000 tons were drawn from the Philippine Islands and China, almost entirely low grades.

One of the most notable features of the operations of the year has been the large exports of refined, aggregating 63,643 tons, the bulk of which has been shipped away from the port of New York. The increase, comcompared with last year, which aggregates over 50,000 tons, has been mainly shipments made to Great Britain, where the product of our refineries has found ready sale, and successfully competed with the output of British refineries. This has been possible, however, solely in consequence of the drawback allowed to exporters under the present tariff law, which is tantamount to a bounty, and has given our refined product an advantage which it could not have obtained otherwise in a country where sugar is admitted free of duty. The exports of raw have been chiefly transshipments to Canada in bond. Up to the year 1879 the Canadian market was supplied with refined sugar entirely from this country, but the new tariff policy adopted that year by the Canadian Government caused a revival of the refining industry in Montreal and Halifax, and these supplies have gone to meet, in part, the requirements of the former city. The exports of refined from San Francisco have been absorbed by British Columbia.

The following statement shows the—

Deliveries of foreign and domestic sugar at this port for the past thirty-three years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1884	738, 715	1873	356, 110	1862	219, 330
1883	629, 796	1872	331, 025	1861	183, 855
1882	573, 003	1871	323, 785	1860	213, 325
1881	579, 050	1870	267, 265	1859	190, 135
1880	559, 652	1869	254, 579	1858	185, 801
1879	455, 473	1868	240, 555	1857	147, 811
1878	442, 910	1867	220, 437	1856	171, 611
1877	425, 732	1866	227, 134	1855	159, 325
1876	412, 208	1865	213, 568	1854	148, 028
1875	405, 338	1864	142, 047	1853	150, 880
1874	433, 155	1863	195, 164	1852	144, 439

The steady shrinkage in values throughout the year 1884 has brought the market value of raw sugar not only to a point absolutely below the cost of production, but to the lowest figure recorded during the past thirty-five years. The year opened with fair refining selling at $6\frac{11}{16}$ cents, and although during the month of August it had fallen to $4\frac{11}{16}$ cents, a decline of 2 cents, the best price afterward obtained was $4\frac{13}{16}$ cents, an advance of only one eighth of a cent, and the year closed with $4\frac{3}{4}$ cents, the best obtainable price. The average price for the year of fair refining was 5.04 cents, and of good 5.54 cents, or for the standard grade, fair to good refining, upon which quotations are usually based, 5.29 cents. This is the lowest average price since 1854, when our record shows 4.83 cents, and with the exception of the two preceding years, 1853 and 1852, the lowest average price in thirty-five years. That this value is below the cost of production can be readily ascertained without expert knowledge, for when the duty, freight, and charges are deducted there is little more than one cent per pound left from which Cuba planters have had to deduct export duty and land carriage before receiving the pittance that remained. The following statement shows the—

Yearly average price in currency of fair to good refining Cuba sugar for each of the past thirty-five years.

Year.	Price.	Year.	Price.	Year.	Price.
1884	\$5 29	1872	\$9 03	1860	\$6 88
1883	6 79	1871	9 33	1859	6 64
1882	7 29¼	1870	9 74	1858	6 60
1881	7 62	1869	11 64	1857	8 69
1880	7 87½	1868	11 32	1856	8 02
1879	6 93	1867	11 11	1855	6 04
1878	7 25	1866	11 03	1854	4 83
1877	8 89	1865	13 84	1853	4 96
1876	8 48	1864	17 22	1852	4 91
1875	7 97	1863	10 77	1851	5 45
1874	7 98	1862	7 92	1850	5 54
1873	8 05	1861	5 95		

SUGAR DUTIES, TAXES, AND BOUNTIES.

UNITED STATES.

Duties.

Sugar and molasses from the Sandwich Islands are admitted free of duty. From other countries the rates of duty are as follows:

MOLASSES.

On molasses testing by the polariscope not above 56 per cent. crystallizable sugar, 4 cents per gallon. Above 56 per cent., 8 cents per gallon.

RAW SUGARS.

Not above No. 13 Dutch standard of color, and not testing above 75 per cent. sugar by the polariscope, duty per pound, 1.40 cents. For each additional per cent. of sugar by the polariscope the duty is increased .04 cent.

Above No. 13 Dutch standard, sugar is dutiable according to that standard exclusively, viz:

	Cents.
Above 13 and not above 16 per pound	2¾
Above 16 and not above 20 per pound	3
Above 20 per pound	3½

Sugar candy (not colored) per pound, 5 cents; confectionery valued above 30 cents a pound, 50 per cent. ad valorem. Confectionery (colored) valued at 30 cents a pound or less, per pound 10 cents; sugar cane 10 per cent. ad valorem; sugar drainings, 20 per cent. ad valorem.

No national tax is laid on sugar of any kind produced in the United States.

France.

INDIGENOUS SUGAR.

The duty on sugar is laid on the unit of 100 kilograms of refined sugar, viz:

	Francs.
Sugar per 100 kilograms*	†50
Sugar candy per 100 kilograms	53.5

MOLASSES.

Molasses testing 50 per cent. or less not used for distillation, 15 francs per 100 kilograms; testing above 50 per cent. and not used for distillation, 32 francs per 100 kilograms.

Exceptions.—(1) Sugars raw or refined used to sweeten wines, ciders, and pear ciders before fermentation pay only 20 francs per 100 kilograms pure sugar; (2) the sugar of French colonies, imported directly into France, shall have the advantage of an allowance of 12 per cent. for waste in manufacture.

FOREIGN SUGARS.

All sugars from other European countries or ports pay duties equivalent to 7 francs per 100 kilograms in addition to those mentioned above. This tax is not returnable in case of the re-exportation of the sugar.

Progressive change in the method of taxation.

By collecting the tax on the product of sugar the French Government has not allowed that opportunity for the improvement of the beet and of the methods of manufacture which the German law has fostered.

There was little inducement to secure these results when it was known that they would only bring about increased taxation. The law of July 29, 1884, from which the above extracts are taken, also provides that after the 1st of September, 1887, the tax shall be levied on the weight

---

* Kilogram = 2.2 pounds. † Franc = 19.3 cents.

of beets entering into manufacture whatever be the method of extracting the juice. For the campaign of 1887–'88 the tax shall be at the rate of 6.25 kilograms of sugar per 100 kilograms of beets; for 1888–'89, 6.5 kilograms sugar per 100 kilograms of beets; for 1889–'90, 6.75 kilograms sugar per 100 kilograms of beets; for 1890–'91, 7 kilograms sugar per 100 kilograms of beets; and thereafter at the same rate. Before the campaign of 1887–'88 those manufacturers who so desire may enter into an agreement with the Government of the following kind:

Manufacturers working by diffusion may pay tax at the rate of 6 kilograms refined sugar per 100 kilograms of beets; those working by continuous or hydraulic presses, at the rate of 5 kilograms of refined sugar per 100 of beets; those manufacturers who do not enter into the agreement noted above will be allowed a rebate for waste amounting to 8 per cent. of their total product.

GERMANY.

Duties.

SUGAR.

	Marks.*
Refined sugar of all kinds, per 100 kilograms	30
Raw sugar of all kinds, per 100 kilograms	24

MOLASSES.

Per 100 kilograms	15

Tax.

The tax on the indigenous sugar is laid wholly on the beets prepared for manufacture. It amounts to 80 pfennige on each 50 kilograms of beets.

Bounties and drawback.

UNITED STATES.

No national bounty is given for the production of sugar. The State of New Jersey gives 1 cent per pound for sugar made from sorghum, and also $1 per ton for sorghum cane used in the manufacture of sugar. This bounty is for five years, and ceases in 1886.

Following is the law of Massachusetts relating to bounties for sugar production. Under this law only $16 bounty has been paid:

CHAP. 189.—An act granting a bounty for the production of sugar beets, or sorghum cane, for the purpose of manufacturing sugar.

Be it enacted, &c., as follows:

SECTION 1. The sum of one dollar per ton of two thousand pounds shall be paid from the treasury of the Commonwealth to any person who shall produce in this Commonwealth sugar beets or any variety of sorghum cane which shall be used in this Commonwealth in the manufacture of sugar.

* Mark = 23.8 cents.

SEC. 2. The sugar beets or sorghum cane produced for this purpose shall be weighed at the place of manufacture, by a sworn weigher appointed by the selectmen of the town or the mayor of the city in which the manufactory is located, and he shall be compensated for his services by the company or individual purchasing the same. Such company or individual shall keep a correct record of the name and residence of each person who delivers either of the above named products at its or his manufactory, with the time of delivery, and the quantity measured in tons.

SEC. 3. The weigher designated in section two of this act, shall from time to time, and before the first of January of each year, transmit to the secretary of the board of agriculture, correct lists of the persons with their residences who have produced and delivered at the factory of which he is the weigher, one or both of said products, with the number of tons produced and delivered by each person; and said secretary shall give to such persons his certificate directed to the auditor of the Commonwealth, certifying that such person has produced the stated number of tons of one or both of said products for the purpose of manufacturing sugar therefrom, and is entitled to receive from the treasury the sum of one dollar for each ton named therein.

SEC. 4. The secretary of the board of agriculture shall keep a correct record of the name and residence of each person to whom he issues said certificate, and the number of tons of either of the said crops grown by such person.

SEC. 5. This act shall take effect upon its passage, and continue in force until the first day of January in the year eighteen hundred and eighty-six.

Approved May 16, 1883.

Drawbacks equivalent to bounties.

FRANCE.

By the new French law the practice of giving bounties, which was virtually abandoned under the preceding law, has been restored. The tax being laid on the beet (from 1887, in and before that at the option of the manufacturer), beginning with an assumed yield of 6 per cent., and gradually increasing it (by 1891) to 7 per cent., permits all sugar obtained from the beet in excess of this amount to be sold duty free. It is well known that in Germany, under a similar system, the yield of sugar on the weight of the beet is fully 10 per cent. In France it will rapidly approach that figure. This will come from a rapid improvement in the quality of the beet produced, from the more general introduction of diffusion and other improved machinery, and from the more perfect extraction of the sugar from the molasses. On the exportation of the sugar, however, the excise is returned at the rate of 50 francs for every 100 kilograms of refined sugar. The manufacturer will pay 50 francs tax on 1,667 kilograms of beets, but he will easily obtain a yield of 8 per cent. from this quantity, which will amount to 122.4 kilograms. If this is sent out of the country he has a rebate of duty equivalent to 50 francs per 100 kilograms, or in all 61.2 francs. He thus receives a bounty of 11.2 francs on 122.4 kilograms of sugar, or 9.15 francs per 100 kilograms.

M. Deynaud, a member of the Chamber of Deputies, in discussing this bill, said:

"Under the new system the makers by diffusion would work off one-third of the beets grown in France, and produce 138,000,000 kilograms of sugar. The other makers would work the remaining two-thirds, and produce 240,000,000 kilograms of sugar. On this total of 378,000,000 kilograms the state would raise 189,000,000 francs of excise at 50 francs per 100 kilograms; 77,000,000 kilograms of imported French colonial sugar would add (at the new rate of 45 francs per 100 kilograms) 34,600,000 francs to the revenue in customs duty. Similarly, German and foreign colonial sugar would come in to the amount of 120,000,000 kilograms, and give 63,600,000 francs of customs revenue at 53 francs per 100 kilograms. But the total thus raised would not remain to the treasury. At present the maker of home sugar did not exhaust the molasses, because he had no interest in doing so. But as soon as the present law was established, and a hard and fast weight of beets made the basis of taxation, the sugar would all be taken from the molasses, and that sugar would be free of duty. He calculated that out of an annual yield of 250,000,000 kilograms of molasses, 35 per cent., or 87,000,000 kilograms, of sugar would be extracted. This quantity, added to 363,000,000 kilograms made directly, would raise the home supply to 450,000,000 kilograms, which, if added to that of colonial and foreign sugar, would make a total of 647,000,000 kilograms of sugar in the French market. The consumption of France being 353,000,000 kilograms, there would remain 294,000,000 kilograms for exports. On these the excise would be returned, leaving 140,000,000 francs only to the revenue or exactly less by 11,000,000 than the sum named by the minister of finance. But this was not all. The better the yield became under the new system the greater would be the loss to the revenue; at the same time prices would be necessarily enhanced and consumption reduced, as M. Tirard had stated, and all that to benefit, not the agriculturist who would have mere crumbs of profit, but the makers and refiners, whose pockets would receive substantial gains."

GERMANY.

The German method of taxation, on which the new French method has been modeled, grants a large bounty on exported sugar. Under the impulse of this bounty the German sugar industry has had a most remarkable development not only in the rapid increase of the amount of sugar made, but also in the quality of the beets grown and the perfection of the methods of manufacture employed. These methods will be fully discussed in the report of Mr. G. L. Spencer, to follow.

The tax on the beet in Germany is 1.6 mark per 100 kilograms.

By the law of 7th of July, 1883, the drawback on sugar is fixed as follows:

ARTICLE I.

"SECTION *a*. For raw sugar of at least 88 per cent. polarization, 9 marks per cwt.*

"SEC. *b*. For candied sugar and for sugar in white, full, hard loaves, weighing up to 12½ kilograms net (quarter of cwt. each), or broken up in the presence of the customs officials, 11.10 marks per cwt.

"SEC. *c*. For all other hard sugar as well as for all white dry sugar (not containing more than 1 per cent. of water) in crystal, powdered, or ground sugar of not less than 98 per cent. polarization, 10.40 marks per cwt."

ARTICLE II.

"The provisions of this law shall cease to have force on and after the 1st August, 1885. If, in the mean time, no other law of wider scope shall have been passed, the provisions of the law of 1869 shall again, at that date, come into force."

The drawback as given in the above law is lower by a uniform rate of 40 pfennigs than that allowed by the old law, which, however, will again come into force on August 1, 1885, unless some new law is passed before that time.

Since the yield of sugar in Germany is nearly 10 per cent. of the weight of the beets worked, it is easy to see that the tax and drawback as at present arranged give a bounty on exported sugar.

Allowing that 1,000 kilograms of beets will produce 100 kilograms of sugar we get the following data:

Tax on 1,000 kilograms of beets, at 1.60 marks per 100 kilograms, equals 16 marks; drawback allowed on 100 kilograms of sugar, section *c*, 20.80 marks; bounty per 100 kilograms equals 4.80 marks.

Thus although the drawback given under the provisional law is 80 pfennigs less per 100 kilograms than under the old law, which will now soon be in force again, it nevertheless amounts to a bounty of no inconsiderable amount. This bounty has enabled the German manufacturers to sell refined sugar in London at prices which are very near the actual cost of production less the tax. As an illustration of the enormous increase of the output of sugar in Germany under this artificial stimulus we give the following figures, showing the products of Germany for four years, in tons of 2,240 pounds:

	Tons.
1881–'82	644,775
1882–'83	848,124
1883–'84	986,403
1884–'85	1,150,000

UNITED STATES.

It has not been the policy of the Government of the United States to favor any industry, except by the application of a protective tariff.

*The cwt. = 50 kilos.

But in the attempt to enable our refiners of sugar to compete in a foreign market for the sale of their products it may be said that more duty has been refunded as a drawback than was paid on the raw sugar representing the refined sugar of commerce. It is only on this supposition that we can explain the remarkable fact that refiners of this country are able to enter the London market and compete with the bounty-fed sugar of Europe. Yet the statistics of the Treasury show that the increase of exports to England during the last two years has been one of great magnitude.

Since the price of sugar in the London market has been unprecedently low during this time, the secret of this remarkable increase in the export of sugar must be sought for in the more favorable terms of exportation which the new sugar tariff of 1883 offers to the refiners of this country. This view of the case is also held by the editors of the Shipping and Commercial List, as quoted in the annual statement of the sugar trade of the United States.

RATE OF DRAWBACK.

By an order of the Treasury Department, dated June 19, 1883, the drawbacks allowed for exported sugar and molasses were fixed at the following figures:

"*Rates of drawback on sugar and sirup from materials paying duty under old tariff.*—Sugar: Hard dried, 3.18 cents per pound; soft, above No. 20, 2.58 cents per pound; soft, No. 20 and below, 2.08 cents per pound. Sirup, 6¼ cents per gallon.

Provisional rates of drawback on sugar and sirup from materials paying duty under new tariff.—Sugar: Hard dried, 2.82 cents per pound; soft, above No. 20, 2.28 cents per pound; soft, No. 20 and below, 1.84 cents per pound. Sirup, 4 cents per gallon.

These rates are to remain in force until 1st September, 1883; meanwhile a commission will consider the subject of new permanent rates."

To place the rates of drawback under the old and new tariffs in the most favorable comparison for producing a bounty on export, I append a memorandum of the British sugar refiner's committee (13th July, 1883), as published in the parliamentary document on "Sugar bounties," ordered published August 12, 1884:

"(1) The reduction in the rates of drawback under the new provisional scale appear to be as follows:

Class of sugar.	Old rate.	New rate.	Reduction.
	Cents.	*Cents.*	*Cents.*
Hard dried .... per pound..	3.18	2.82	0.36
Soft, above No. 20 .... do ...	2.58	2.38	0.30
Soft, No. 20 and below .... do....	2.08	1.84	0.24
Average reduction	....	....	0.30

The reductions effected in the rates of duty by the new tariff are, on the following typical classes of sugar, as follows:

Class of sugar.	Polarizing, about—	Old duty, per pound.	New duty, per pound.	Reduction, per pound.
		Cents.	*Cents.*	*Cents.*
Unclayed Manilla and similar sugar	75	2.1875	1.40	0.7875
Clayed Manilla, low Brazil, &c	82	2.1875	1.68	0.5075
Brazil, superior Manilla, &c	84	2.1875 / 2.50	1.76	0.63
Brown muscovado, &c	87	2.50	1.88	0.62
Good muscovado, &c	90	2.50	2	0.50
Fine muscovado, &c	92	2.8125	2.08	0.7325
Java, Mauritius, &c., under No. 13	96	2.8125	2.24	0.5725
Average reduction				0.62

Therefore, while the average reduction in duty is 0.62, the average reduction in drawback is only 0.3.

(2) Again, taking the new rates of duty on the same by typical classes of sugar, it will be found that the new drawback on "hard dried" (*i. e.*, pure sugar) represents a proportion or yield of pure sugar very much less than that actually obtained; that is, that the drawback is too high in proportion to the duty. The proportions are as follows:

Class of raw sugar.	Polarizing, about—	New duty, per pound.	Equivalent yield of pure sugar, according to new drawback of 2.82, *i. e.*, proportion of duty on raw to drawback on hard dried, refined.
		Cents.	*Per cent.*
Unclayed Manilla, &c	75	1.40	49.64
Clayed Manilla, &c	82	1.68	59.58
Brazil, &c	84	1.76	62.41
Brown muscovado, &c	87	1.88	66.66
Good muscovado, &c	90	2	70.92
Fine muscovado, &c	92	2.08	73.76
Java, &c., under No. 13	96	2.24	79.43

These equivalent yields are very much below the reality, and consequently the drawback is to the same extent too high, the effect of which will be to give a bounty on the exportation of refined sugar at the expense of the tax-payer.

In a further memorandum we propose to examine the amount of this bounty, on the basis of figures given by the American refiners before the United States Treasury committee in 1875. At that time the drawback was fixed at 3.60 cents per pound, which we succeeded in showing to be nearly 0.50 too high, and the rate was subsequently (in 1877) reduced to 3.18 cents per pound.

The following table gives a comparison of the proportion of duty on raw to drawback on refined, as given by the admittedly excessive drawback of 3.60, the corrected drawback of 3.18, and the present provisional drawback of 2.82:

Class of raw sugar.	Proportion of duty on raw to drawback on refined.		
	With the excessive drawback of 3.60 (December, 1875).	With the corrected drawback of 3.18 (September, 1877).	With the new provisional drawback of 28.2 (June, 1813).
	Per cent.	*Per cent.*	*Per cent.*
Below No. 7	60.7	68.8	49.64 59.58 62.41
Nos. 7 to 10	69.4	78.6	66.66 70.92
Nos. 10 to 13	78.1	88.4	73.76 79.43

It therefore appears that the present drawbacks are more excessive than the drawbacks of December, 1875, which in the United States Treasury memorandum of 5th September, 1877, are spoken of as follows:

"I am entirely satisfied, by careful examination of the subject, especially of the reports made by commissions recently held in New York, Boston, and Baltimore, that the rates of drawback fixed by the regulations of 17th December, 1875, are too high and amount to more than the duty paid by importers on the raw sugar used in the manufacture of refined sugar, and now amount to a bounty and an actual loss to the Government of a very large sum."

The duty on raw sugar being now levied in proportion to its polarization, *i. e.*, to the quantity of pure sugar contained in it, the proper amount of drawback to be allowed on the exportation of pure sugar is easily ascertained, if it be intended merely to return the duty which has been paid.

The basis of the duty being 1.4 cents per pound for sugar polarizing 75, with an increase of .04 cent for every degree of polarization, the scale runs as follows:

Sugar containing 75 per cent. of pure sugar, 1.4 cents per pound; 80 per cent., 1.6 cents per pound; 85 per cent., 1.8 cents per pound; 90 per cent., 2 cents per pound; 95 per cent., 2.2 cents per pound; 100 per cent., 2.4 cents per pound.

The duty on raw sugar is, therefore, levied at the rate of 2.4 cents per pound of extractable pure sugar, and the yields of extractable pure sugar equivalent to each degree of polarization are, by calculation, according to this scale of duties, as follows:

Degree of polarization.	Yield of extractable pure sugar.
	Per cent.
76 equivalent to	60
79 equivalent to	65
82 equivalent to	70
85 equivalent to	75
88 equivalent to	80
91 equivalent to	85
94 equivalent to	90
97 equivalent to	95
100 equivalent to	100

These are fairly accurate for cane sugar, and it is evident that 2.4 cents per pound is the amount which should be returned as drawback on the exportation of pure sugar, and that no amount greater than 2.4 cents per pound could be correct, since it would be equivalent to a yield of more than 100 per cent. The present provisional drawback of 2.82 cents per pound is equivalent to a polarization of 110.5, and is, therefore, too high, to the extent of at least .42 cents per pound, or 42 cents per 100 pounds.

The drawbacks on soft sugars above and below No. 20, to be quite accurate, should vary with the polarization. The provisional drawbacks on soft sugars represent, however, a fair average, being equivalent to polarizations of 97 and 86, and therefore to the corresponding yields of 95 and 76.6 per cent. of extractable pure sugar.

It was stated in evidence before the committee appointed by the United States Treasury Department in 1875 to examine the question of drawbacks on sugar, that the yields obtained in refining were as follows:

(1.)

	Pounds.
Hard sugar, *i. e.*, pure sugar	60
Soft sugar, below No. 20	23.6
Sirup	11.5
Waste	4.9
	100

(2.)

	Pounds.
White coffee sugar, *i. e.*, soft sugar above No. 20	70
Soft sugar, below No. 20	13.5
Sirup	11.5
Waste	5
	100

Such yields may, of course, vary indefinitely, according to the kind of raw sugar used and the kind of refined sugar turned out, but the above figures, or any others that may be furnished, are sufficient material on which to illustrate the operation of the excessive drawback on hard sugar and the superfluous drawback on sirup.

Taking the yields of extractable pure sugar, already ascertained, to be equivalent to the drawbacks on white coffee sugar above No. 20 and soft sugar below No. 20, the following will be the total quantities of extractable pure sugar in each of the yields of raw sugar stated previously:

(1.)

	Per cent.
60 pounds hard sugar, equal to	60
23.6 pounds soft sugar	10.07
Total	78.07

(2.)

70 pounds white coffee sugar, equal to	66.5
13.5 pounds soft sugar	10.34
Total	76.84

These yields of 78.07 and 76.84 per cent. are equivalent to duties of 1.87 and 1.84 cents per pound on the raw sugar. The present provisional drawback on hard sugar will, therefore, give the following result:

60 pounds hard sugar, at drawback of 2.82 cents per pound	$1 69
23.6 pounds soft sugar, at drawback of 1.84 cents per pound	43
11.5 pounds sirup, at drawback of 4 cents per gallon (say)	04
	2 16
Duty paid on the raw sugar	1 87
Excess of drawback per 100 pounds of raw sugar	29
Excess of drawback per 100 pounds of hard sugar	48.3

The real excess of drawback on hard sugar has already been shown to be 42 cents per 100 pounds of hard sugar exported. The reason why the present illustration gives a larger excess is, that a drawback is also allowed on the residual sirup, an allowance to which the refiner can have no claim, as the following illustration will show:

Taking the correct drawback of 2.4 cents per pound on hard sugar, it will be found that the drawbacks on this yield of refined sugar exactly balance the duty paid on the raw sugar, as they should do, and presumably are intended to do.

60 pounds hard sugar, at drawback of 2.4 cents per pound	$ 144
23.6 pounds soft sugar, at drawback of 1.84 cents per pound	43
	1 87
Duty paid on the raw sugar	1 87
70 pounds white coffee sugar, at drawback of 2.28 cents per pound	1 59
13.5 pounds soft sugar, at drawback of 1.84 cents per pound	25
	1 84
Duty paid on the raw sugar	1 84"

It must be remembered that the above document was prepared by a committee in the interest of British refiners, and the argument is probably as strong as the most favorable construction of the facts could produce. But its figures are at least worth study, whatever may be thought of its conclusions.

The provisional rates were continued in force after the date mentioned above, in accordance with the instructions given in the following circular:

Rates of drawback on refined sugar and sirup.

TREASURY DEPARTMENT,
Washington, D. C., October 3, 1883.

To collectors of customs and others:

The provisional rates of drawback specified in the Department's circular of 9th June, 1883, No. 77, will continue in force until 1st January, 1884, unless sooner revoked.

CHAS. J. FOLGER,
Secretary.

The committee of experts appointed by the Treasury Department made a report on August 24, 1883, of which the following is the text:

OFFICE OF SPECIAL AGENT TREASURY DEPARTMENT,
New York, August 24, 1883.

SIR: The commission appointed under Department instructions of June 9, 1883, H. B. J., for the purpose of making investigation relative to the proper rate of drawback to be paid to exporters of refined sugars and sirup under the tariff act of March 3, 1883, has the honor to submit the following report:

The subject of drawback rates upon refined sugars, fairly proportioned to the amount of duties paid, has always been difficult for various reasons, particularly on account of the unsatisfactory mode of assessing duties on raw sugars under the former tariff. This embarrassment has been largely overcome, under the act of March 3, 1883, by the provisions of which the rate of duty, being graduated by the polariscopic test of the sugar, is thereby made proportionate to the value, and hence to the yield, of the imported raw product when applied to purposes of refining.

Your commission, after a meeting at New York and a general discussion of the subject, concluded that the most practicable method of inquiry would be to ascertain, if possible, the practical workings of the different refineries of the country and their out turn of refined sugars for given periods, which could then be compared with the raw materials used for the same periods and with the amount of duty paid. Upon endeavoring to obtain this information we found a reluctance upon the part of most of the refiners, owing, no doubt in great part, to business considerations, to give such facts and figures as were considered essential by your commission, and, indeed, those refiners who did furnish such information coupled it with a special request that it should not be made public.

One of the important features of our inquiry was to ascertain, as nearly as possible, the average test of imported sugars, and in this connection it may be stated that it is understood that the average test of all sugars imported during the year 1882 was 90°, while a careful calculation of the importations for June and July of the present year indicates very nearly the same test, which gives reasonable assurance that for the present the average rate of duty on sugar, under the new tariff, will be at least 2 cents per pound.

In the further prosecution of our inquiry samples of the refined product of all the different grades were obtained from most of the refineries and tested to ascertain the polariscopic strength of each with a view to enable us to reach a more intelligent judgment with respect to their arrangement in classes for drawback rates. The results showed that there were hardly two refineries in the country whose products were alike or did not vary from month to month as the state of the market or other circumstances might determine. The product of hard sugars, for instance, varied from 10 to 60 per cent. in different refineries, and soft sugars and sirup had a corresponding variation. The raw material going into the refineries varied from 74° to 97° in strength, and of course paid the various rates of duty, based upon such tests. It will be apparent that to establish rates of drawbacks, which should meet all these varying conditions was exceedingly difficult.

Having proceeded thus far with its investigations your commission again met, and having compared the results obtained from their various inquiries and from actual tests of sugars and samples, as before stated, it was considered that the present arrangement of grades for drawback, viz, one for hard and two for soft refined, would be better than a larger number. It was further considered, in view of all the circumstances to which reference has been made and with our present light upon the subject, that the only practicable method to adopt in establishing rates of drawback that should most nearly meet the practical refining operations of the country, was to take as a basis the average rate of duty paid upon all sugars imported, and in the application of this principle to the present provisional rates we were led strongly to the conclusion that they are practically correct.

As an illustration of the fairness of the provisional rates we submit examples, which we believe may be regarded as representative, of the results obtainable and now being obtained in the practical work of refining throughout the country, with the varying grades of the refined product named.

The following are understood to be the actual results in the work of a refinery making soft sugars only and would seem, therefore, to give strong assurance of the correctness of the provisional rates, as applied to soft sugars—400 pounds of raw sugar, four grades of 100 pounds each, testing respectively 80°, 85°, 90°, and 95°, or with an average test of 87½°, being about the average test of muscovadoes as now imported, pays a duty of $7.60, and gave the following yield :

277 pounds soft sugars, above No. 20, Dutch standard, at 2.28	$6 33
63 pounds soft sugars, not above No. 20, Dutch standard, at 1.84	1 16
38 pounds sirup	14
	$7 63

Showing a difference on 400 pounds in favor of the refiner, where soft sugars only are produced, of 3 cents, and indicating that the present provisional rates on these grades of the refined product are not too low. In other words, it would appear that the provisional rates of drawback are not excessive upon hard sugars to the prejudice of those upon soft refined. The following is an example of the practical working of certain refineries, during the months of June and July of the present year, producing both hard and soft sugars, with average tests and percentages as stated :

Average test of raw material 89.70, equal for duty 90°, equal duty		$2 00
Hard sugars produced, pounds 27.51, at 2.82	.7757	
Soft sugars produced above 20 Dutch standard, 20, at 2.28	.4560	
Soft sugars produced not above 20 Dutch standard, 41.77 at 1.84	.7685	
Sirup, 2.65, at .04	.0100	2 01
Difference in favor of refiner		.01

It will be observed that the average test of the sugars producing the above results corresponds practically with the average test of all sugars imported, as before stated.

From the best information that we have been able to obtain, we are of the opinion that the average of hard sugars produced at present throughout the country is about 10 per cent., and this, with an average test of 90° for the raw product, should, we think, give substantially the following results :

Average test of raw product, 90° ; duty		$2 00
Hards, 10 pounds, at $2.82	.2828	
Softs, above 20 Dutch standard, 25 pounds, at 2.82	1.1856	
Softs, not above 20 Dutch standard, 28 pounds, at 1.84	.5152	
Sirup, say 5½ pounds, at .04 a gallon	.0200	
		2 00

From these results, and after careful consideration of the entire subject, we recommend that the provisional rates now in force, viz, 2.82 cents per pound for hard sugar, 2.28 cents per pound for soft refined above No. 20 Dutch standard, and 1.84 cents per pound for soft refined not above No. 20 Dutch standard, with 4 cents per gallon for sirup produced from the refining of sugar imported, be made the rates of drawback to be paid under the tariff act of March 3, 1883.

We further recommend that the form of oath incident to the export of sugar under the present regulations be so changed that the exporter shall be required to swear only that the sugars intended for export are produced from imported raw material upon which duty has been paid, without reference to the particular mark or lot or importation, as is is now required.

We have the honor to be, very respectfully, your obedient servants,

JNO. AYER, Jr.
GEORGE KEYES.
JAMES BURT.

Hon. Charles J. Folger,
Secretary of the Treasury, Washington, D. C.

In harmony with the conclusions of this report the Secretary of the Treasury issued the following circular:

Drawback allowance—refined sugar and sirup.

Treasury Department, *February* 7, 1884.

The following rates of drawback on sugar and its products, established provisionally by the circular of June 9, 1883, are hereby declared to be permanent:

(1) On refined loaf, cut loaf, crushed, granulated, and powdered sugar, stove-dried or dried by other equally effective process, 2.82 cents per pound.

(2) On refined white coffee sugar, undried, and above No. 20 Dutch standard in color, 2.28 cents per pound.

(3) On all grades of refined coffee sugar, No. 20 Dutch standard and below in color, 1.84 cents per pound.

(4) On sirup resulting entirely from the refining of the above enumerated imported materials, 4 cents per gallon.

The allowance on sugars will be subject to the deduction of 1 per cent., and the allowance on sirup to the deduction of 10 per cent., as prescribed by law.

CHAS. J. FOLGER,
Secretary.

On comparing the data contained in the report of the Treasury commission, as given above, with those of the committee of British refiners, the points of difference are found to be many and striking.

The bias of self-interest which we must allow to have some influence in the British report is presumably absent in that of the Treasury commission. Yet I believe it will appear, on careful study, that the report of the commission is really in the interest of the American refiners. The difficulty which this commission experienced in getting reliable information of the yield of refined sugar is one of real magnitude. When it is further considered that refiners would naturally impart such information as would tend to their own interests it must be granted that the figures of the commission are open to serious criticism.

On account of the perfection to which the processes of refining have been carried in recent years, the output of refined sugar in proportion to the amount of raw sugar used has largely increased. The refiner, at will, can make either a large percentage of "hard dry sugar," or can turn the whole product into "white soft sugar."

The vicious system of selling sugar solely on its appearance, which obtains in this country, causes refiners to boil for a "soft white grain," which, although polarizing very low, will sell for a fair price.

By means of large vacuum strike pans, with the most perfect pumps and condensers, the sugar is made in a high vacuum at a temperature which sometimes falls as low as 110° F. The soft crystal made in this way incorporates a great deal of moisture, and even molasses, without suffering much in color. But if the refiner is making sugar for exportation, then a hard pure crystal is made for which the higher rate of rebate duty can be obtained.

For this reason I consider that it is quite impossible to fix an equitable rate of drawback for exported sugar from any commercial data. Long experience, however, has enabled the chemist to determine the total output of pure sugar obtainable from any kind of raw sugar. This output should be fixed, therefore, on the mean of numerous analyses of the raw sugar of commerce.

As an illustration of this principle the following examples are given.

A mean of thirty-nine analyses of raw cane sugar gives the following figures:

Sucrose	93.33
Glucose	1.78
Ash	.76
Moisture	2.16
Other solids	1.97
	100.00

If all the sugar (sucrose) could be obtained from such a sample the yield would be equivalent to 93.33 pounds for every 100 pounds of raw sugar. But such a yield cannot be obtained.

The losses are due to the following causes:

	Per cent.
Loss in process of refining	2
Loss due to ash (ash × 2)	1.52
Loss equivalent to glucose and other solids	3.75
Total loss	7.27

Deduct this from the total sucrose present and there is left, as actual *rendement*, 87.07 per cent.

Sugar of the kind mentioned above pays a duty of 2.16 cents per pound, or, for 100 pounds, $2.16.

To secure a rebate of the same amount on 87.07 pounds sugar, the rate per pound would be 2.16÷.87=2.49 cents.

It is evident therefore that the rate of drawback which should be paid on pure sugar exported is 2.49 cents per pound, and this rate should be diminished for less pure sugars *pari passu* with their decrease in saccharine strength as determined by the polariscope.

"The method of estimating the yield of raw in refined sugar which is used in France* is as follows:

(1) Deduct from total sucrose present four times the weight of the ash; (ash burned with addition of sulphuric acid, and one-fifth subtracted):

(2) Twice the glucose when the titre is 1 per cent. or above; the glucose multiplied by one when the titre is between 1 per cent. and one-half per cent.; when the titre is below one-half per cent. the glucose is neglected:

(3) One and one-half per cent. for waste in refining.

The method of coefficients described and used in France for the commercial valuation of raw sugars, though doubtless justified for certain beet and high-grade cane sugars, is open to serious objection. The results given by it necessarily vary a great deal, approaching near the truth for some, but falling far short for others, being generally too low."

It is conceded that this method gives results very nearly the truth for high-grade sugar, but very much too low for those of lower grades. In cane sugar (almost the only raw sugar imported into this country) the ash is a much less disturbing factor than in sugar from beets. In this latter case the ash is largely soluble and thus produces a maximum melassigenic action, while the ash of cane sugar is largely insoluble, and therefore excites a much less injurious effect.

For these reasons the method which I have given above appears to be as nearly just as present knowledge can decide.

If, therefore, a series of analyses of each grade of raw sugar should be made and the *rendement* calculated on the basis of the data given above, the mean of all these results would be the proper basis for fixing the amount of duty to be returned. Under the present regulations of the tariff this amount, I believe, would be found to be nearly 2.50 cents per pound of pure sugar.

---

* Tucker's Sugar Analysis, p. 238.

SUGAR INDUSTRY OF THE UNITED STATES.

Part I.—CANE SUGAR.

CANE SUGAR.

STATIONS.

In accordance with instructions from General E. A. Carman, Acting Commissioner of Agriculture, given below, an experimental station was established on the plantation of Governor H. C. Warmoth, Lawrence post-office, La., and also at Mr. John Dymond's plantation, Belair. La.

LETTER OF INSTRUCTION.

SIR: In order to secure for this Department accurate information concerning the sugar industry of Louisiana, it will be necessary to carry on a series of analyses of the sugar-cane and its products in that State.

For this purpose the Department will send from your bureau two of your assistants, Messrs. Spencer and Crampton to undertake this work.

I desire you to establish two experimental laboratories, one on the plantation of Governor H. C. Warmoth, and the other in connection with the World's Exposition, in New Orleans.

You will make the necessary arrangements for the fitting up of these laboratories, and give to your assistants named above the proper instructions for carrying on this work. I especially desire that the investigations should be made in such a manner as will prove of the greatest benefit to the sugar industry of the South. To this end all chemical methods and appliances should be thoroughly investigated, and as far possible put to a practical test.

I suggest, further, that you consult with the officers and members of the Louisiana Sugar Growers' Association respecting the character of the work which should be done.

You will, as far as possible, take personal supervision of this work and collect and preserve all valuable data to which it may give you access.

Respectfully,

E. A. CARMAN,
Acting Commissioner.

H. W. WILEY,
Chemist.

Governor Warmoth's Magnolia Plantation is situated on the right bank of the Mississippi River, 45 miles below New Orleans. It has a river front of about 2½ miles, and extends back to the brackish marsh of the Gulf of Mexico. The tillable land of the plantation is protected by levee in front from the waters of the river and by side and back levees from the waters of the Gulf, and from the overflow of the river above or below.

CHEMISTS IN CHARGE.

Mr. G. L. Spencer was appointed to take charge of the chemical work of the station. He was assisted until December 15 by Dr. C. A. Crampton. A laborer was also employed to help with the samples and apparatus.

The chemical work began on November 13, 1884, and ended January 13, 1885.

MACHINERY USED.

Experimental mill.

A small three-roll hand-mill, made by George L. Squier & Co., Buffalo, N. Y., was used for the experimental work on canes.

Sugar-house mill.

The cane was first passed through a shredder, (described on page 61). The pulp then passed through a three-roll mill of the following dimensions: Length of rolls, 5 feet 2 inches; diameter of rolls, 2 feet 4 inches. The bagasse then passed to a two-roll mill of the following dimensions: Length of rolls, 5 feet 6 inches; diameter of rolls, 2 feet 10 inches.

In the following tables, "first juice" indicates the product of the first or three-roll mill; "second juice" indicates the product of the second or two-roll mill; "mixed juice," that which was taken from the tank, the common receptacle of the juice from both mills.

Engine.

The two mills were driven by the same engine. Diameter of cylinder, 15 inches; stroke, 48 inches; steam pressure, 90 pounds; 14½ revolutions of fly-wheel were equal to one of the three-roll mill. Speed of rolls, three revolutions per minute. Total capacity of mill, 215 tons in 24 hours.

TRAM-CARS.

The cane is brought to the factory in tram-cars operated on a movable railroad. This method has great advantages over the ordinary one of transporting the cane in mule carts. Especially is this advantage apparent during a rainy season. The operations of cutting and loading the canes are shown in Figs. 3 and 4, reproduced from photographs.

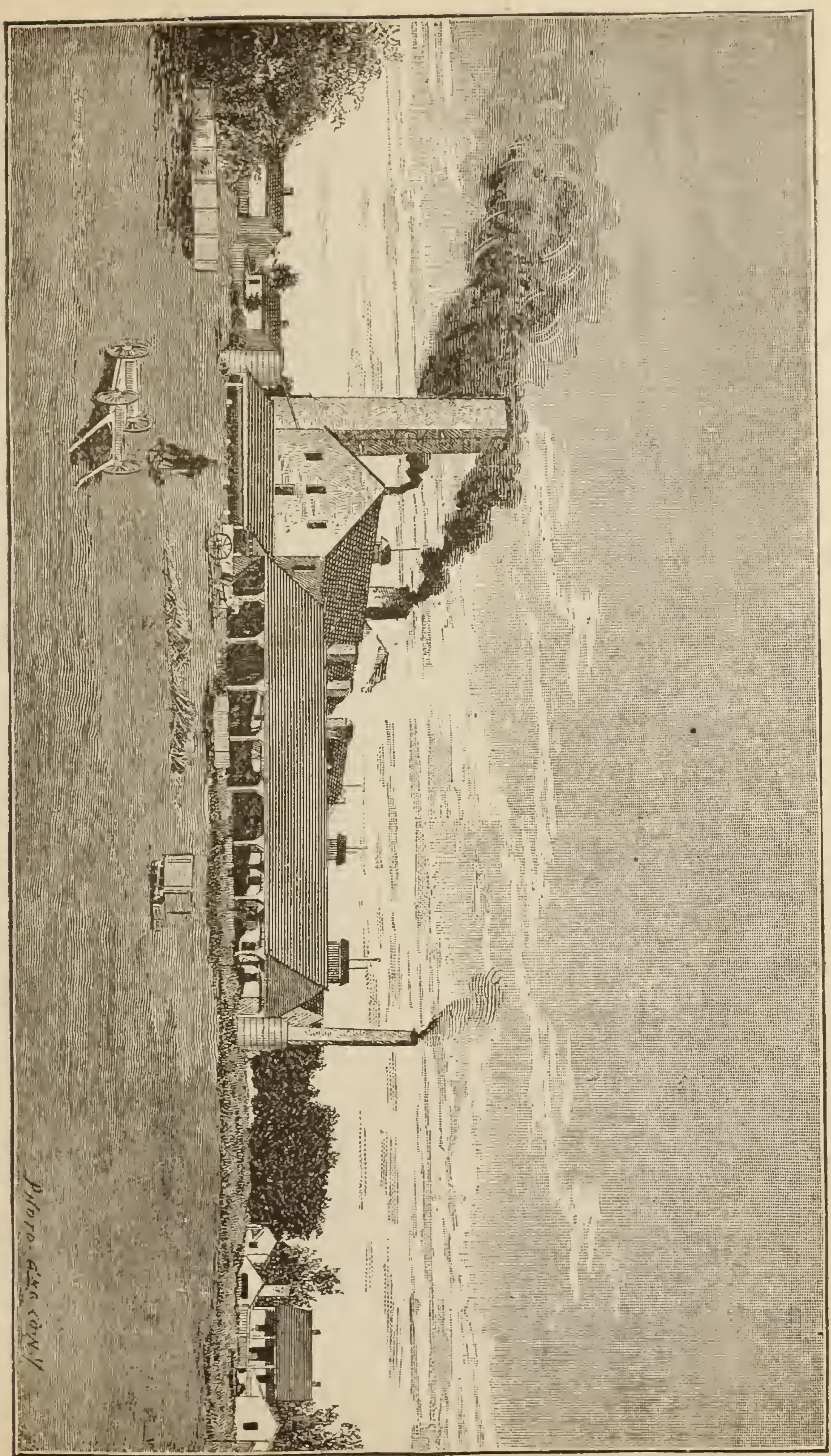


FIG. 1.—SUGAR FACTORY OF GOVERNOR H. C. WARMOTH, LAWRENCE, LA.

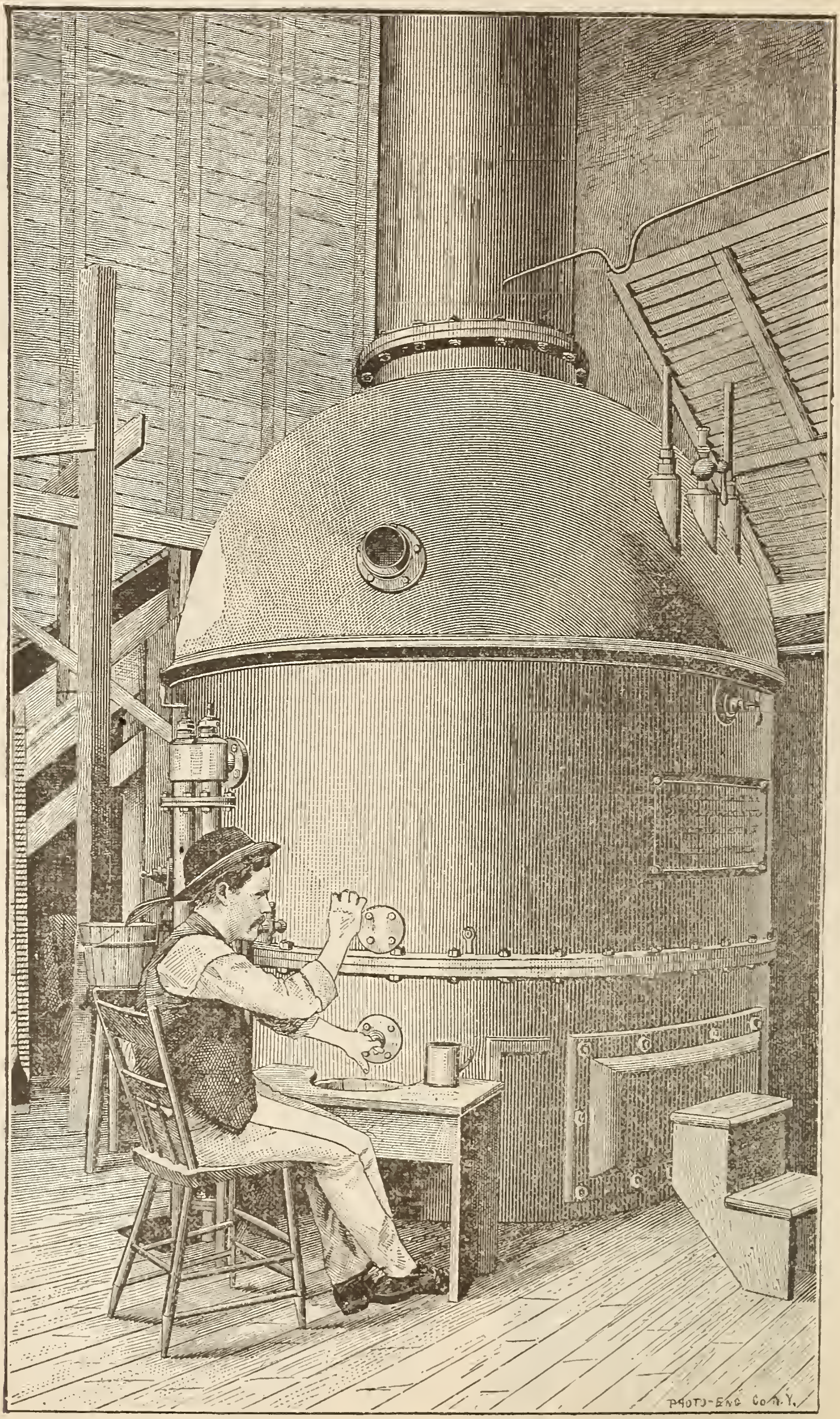


FIG. 2.—VACUUM STRIKE-PAN, LAWRENCE, LA.

Fig. 3.—Cutting Cane, Lawrence, La.

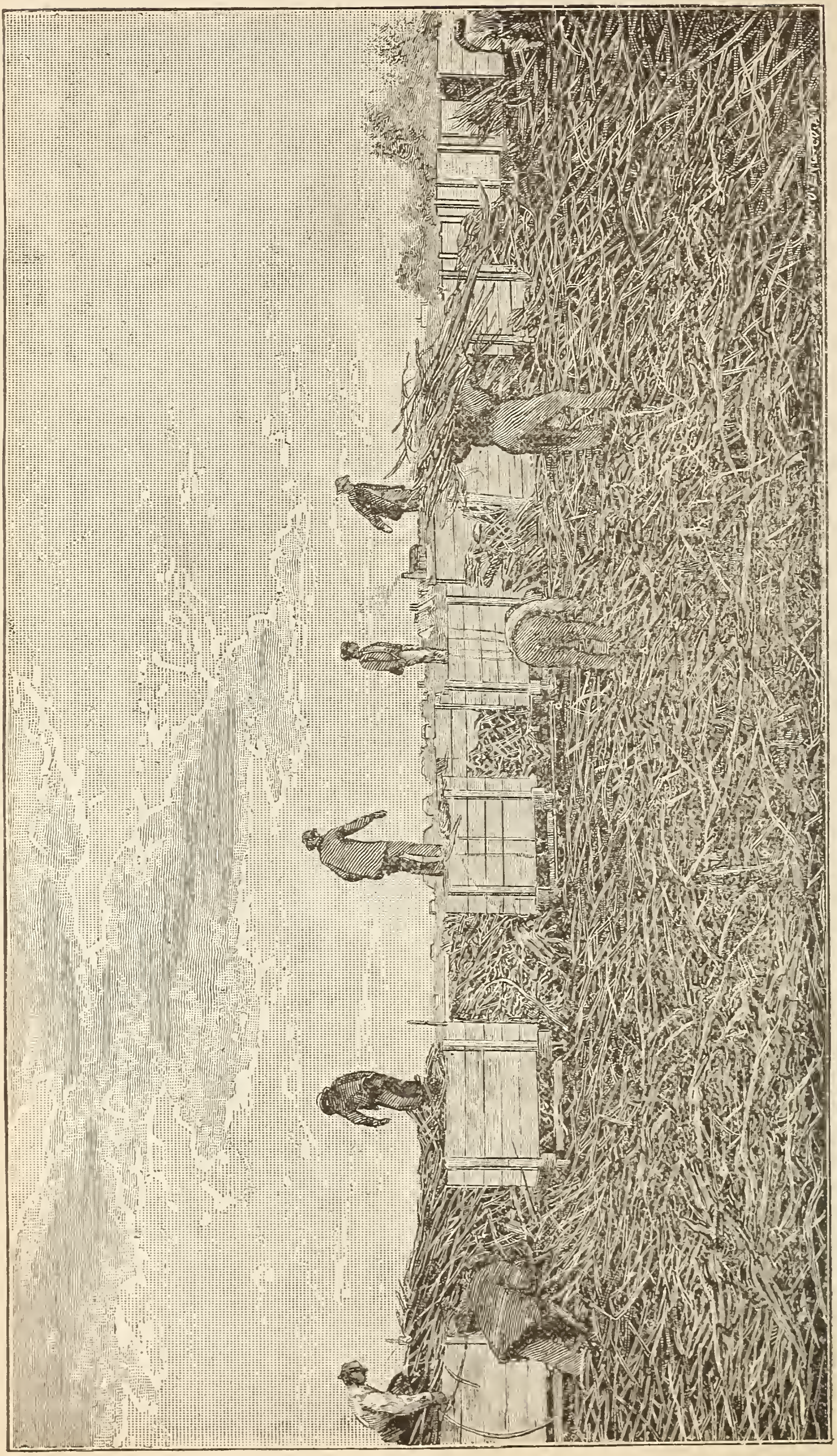


Fig. 4.—Loading Cane on Tram-Cars, Lawrence, La.

RESULTS OF THE ANALYSES.

In the following tables will be found the results of the analytical examination of the juices, sirups meladas, scums, sugars, canes and bagasses.

The analyses of the mill and clarified juices and sirups were made at the station. For albuminoid determinations the juices were evaporated to dryness in glass schaelchen and sent to Washington for ignition with soda lime. The meladas and sugars were likewise analyzed here.

The methods of analysis employed were the same as those described in previous bulletins of this Bureau.

TABLE I.—*Juice from first mill.*

Date.	Number of analysis.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Albuminoids.	Coefficient of purity.	Date.	Number of analysis.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Albuminoids.	Coefficient of purity.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*					*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	
Nov. 15	1	1.0739	17.9	13.82	1.07	......	77.20	Dec. 4	20	1.0621	15.2	11.77	.92	.1813	77.43
16	2	1.0695	16.9	12.71	1.79	......	75.21	5	21	1.0691	16.8	13.89	.54	.1125	82.68
17	3	1.0634	16.5	11.67	1.83	......	70.73	6	22	1.0665	16.2	13.50	.76	.1312	83.83
18	4	1.0717	17.4	13.51	1.15	.0500	77.64	7	23	1.0713	17.3	14.15	.59	......	81.79
19	5	1.0647	15.8	11.79	1.31	.1625	74.62	8	24	1.0691	16.8	13.79	.79	.1313	82.08
20	6	1.0656	16.0	12.86	1.21	.1000	80.37	9	25	1.0691	16.8	13.50	.87	.1938	80.36
21	7	1.0687	16.7	13.21	1.11	......	79.10	[1] 10	26	1.0691	16.8	13.98	.60	.2437	83.21
22	8	1.0687	16.7	13.35	.86	.0500	79.94	[2] 10	27	1.0669	16.3	12.89	.87	.2313	79.08
23	9	1.0687	16.7	13.60	.81	.0982	81.44	[3] 10	28	1.0753	18.2	15.50	.41	.....	85.16
24	10	1.0704	17.1	13.68	.72	.2437	80.00	11	29	1.0691	16.8	12.67	1.07	......	75.42
25	11	1.0656	16.0	12.86	.90	.1000	80.38	12	30	1.0609	14.9	11.24	.90	......	75.44
26	12	1.0678	16.5	13.47	.71	.1125	81.64	14	31	1.0626	15.3	11.47	.93	......	79.97
27	13	1.0695	16.9	14.17	.57	......	83.85	15	32	1.0617	15.1	11.73	.91	.2313	77.68
28	14	1.0704	17.1	14.16	.52	......	82.81	16	33	1.0600	14.7	11.16	.58	......	75.92
29	15	1.0649	15.8	12.23	.72	.....	76.77								
30	16	1.0652	15.9	12.37	.90	.1625	77.80	Mean ..	....	....	16.47	13.09	.87	.1544	79.47
Dec. 1	17	1.0717	17.4	14.93	.44	.2437	83.51	Max. ..	..	....	.....	15.50	1.83	.2437	85.16
2	18	1.0695	16.9	14.13	.58	......	83.61	Min....	....	....	....	11.16	.41	.0500	70.73
3	19	1.0652	15.9	12.52	.91	......	78.74								

[1] 9 a. m. [2] 2 p. m. [3] 6 p. m.

TABLE II.—*Juice from second mill.*

Date.	Number of analysis.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Albuminoids.	Coefficient of purity.	Date.	Number of analysis.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Albuminoids.	Coefficient of purity.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*					*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	
Nov. 15	1	1.0669	16.3	11.52	1.25	......	70.67	Dec. 4	20	1.0613	15.0	11.34	.74	.3313	75.60
16	2	1.0665	16.2	11.72	1.64	.2440	72.35	5	21	1.0652	15.9	12.23	.52	.2625	76.92
17	3	1.0617	15.1	10.55	1.69	......	69.87	6	22	1.0647	15.8	12.23	.67	......	77.41
18	4	1.0678	16.5	12.03	1.40	......	72.91	7	23	1.0655	16.0	12.60	.68	......	78.75
19	5	1.0605	14.8	10.31	1.06	.1313	69.66	8	24	1.0660	16.1	12.27	.77	.3125	76.21
20	6	1.0617	15.1	11.58	.95	.1625	76.69	9	25	1.0660	16.1	12.27	.64	......	76.21
21	7	1.0669	16.3	11 97	.85	.1969	73.45	[1] 10	26	1.0656	16.0	12.66	.54	.1625	79.13
22	8	1.0640	15.8	11.79	.78	.2125	74.62	[2] 10	27	1.0660	16.1	12.22	.65	.3281	75.90
23	9	1.0634	15.5	11.80	.71	.2500	76.13	[3] 10	28	1.0704	17.1	13.82	.42	......	80.82
24	10	1.0674	16.4	12.40	.65	.1313	75.61	11	29	1.0604	14.8	10.71	1.07	......	72.36
25	11	1.0634	15.5	12.00	.73	.2625	77.42	12	30	1.0591	14.5	10.57	.63	......	72.90
26	12	1.0647	15.8	12.28	.59	.2125	77.72	14	31	1.0600	14.7	10.81	.64	......	73.54
27	13	1.0691	16.8	12.38	.49	.2437	73.69	15	32	1.0578	14.2	10.34	.66	......	72.82
28	14	1.0647	15.8	12.53	.51	.2500	79.30	16	33	1.0561	13.8	10.11	.60	......	73.26
29	15	1.0634	15.5	11.81	.56	......	76.19								
30	16	1.0613	15.0	11.29	.69	......	75.33	Mean ..	....	....	15.66	11.82	.77	.2198	75.48
Dec. 1	17	1.0660	16.1	12.90	.48	.1313	80.12	Max. ..	....	....	.....	13.82	1.69	.3281	80.82
2	18	1.0665	16.2	12.67	.51	.....	78.21	Min....	....	....	....	10.11	.42	.1313	69.66
3	19	1.0652	15.9	12.28	.66	.1313	77.23								

[1] 9 a. m. [2] 2 p. m. [3] 6 p. m.

TABLE III.—*Mixed juices.*

Date.	Number of analysis.	Specific gravity.	Total solids.	Sucrose.	Reducing sugar.	Albuminoids.	Coefficient of purity.	Date.	Number of analysis.	Specific gravity.	Total solids.	Sucrose.	Reducing sugar.	Albuminoids.	Coefficient of purity.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*					*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	
Nov. 15	1	1.0647	15.8	12.04	1.71	......	76.20	3	19	1.0652	15.9	12.47	.88	.1625	78.43
16	2	1.0682	16.6	12.58	1.50	......	75.78	4	20	1.0630	15.4	11.76	.75	.2500	76.36
17	3	1.0634	15.5	11.76	1.53	......	75.87	5	21	1.0678	16.5	13.56	.57	.1625	82.18
18	4	1.0704	17.1	12.48	1.28	......	72.98	6	22	1.0656	16.0	13.05	.77	......	81.56
19	5	1.0639	15.6	11.31	1.16	.1625	72.50	7	23	1.0682	16.6	13.46	.71	......	81.08
20	6	1.0626	15.3	12.16	1.34	.1313	79.47	8	24	1.0687	16.7	13.06	.76	.1625	78.20
21	7	1.0665	16.2	12.65	.90	.0987	79.08	9	25	1.0687	16.7	13.21	.78	.1938	79.10
22	8	1.0656	16.0	12.71	.95	......	79.44	[1] 10	26	1.0652	15.9	13.06	.68	.2437	82.14
23	9	1.0647	15.8	12.81	.91	.1625	81.08	[2] 10	27	1.0682	16.6	12.29	.75	.2125	74.04
24	10	1.0691	16.8	13.40	.73	......	79.76	11	28	1.0647	15.8	11.69	1.17	......	73.98
25	11	1.0682	16.6	12.97	.87	.1313	78.13	12	29	1.0617	15.1	11.63	.81	......	77.02
26	12	1.0682	16.6	13.56	.64	.1125	81.69	14	30	1.0639	15.6	11.99	.78	......	76.86
27	13	1.0691	16.8	13.55	.57	......	80.65	15	31	1.0626	15.3	11.47	.77	.2500	74.97
28	14	1.0691	16.8	13.45	.58	......	80.06	16	32	1.0639	15.6	10.82	.59	......	69.36
29	15	1.0647	15.8	12.14	.78	.1813	76.83								
30	16	1.0652	15.9	12.62	.76	......	79.37	Mean..	....	......	16.15	12.62	.87	.1726	78.14
Dec. 1	17	1.0700	17.0	14.17	.46	.1438	83.35	Max...	....	......	.....	14.93	1.71	.2500	83.35
2	18	1.0687	16.7	13.84	.61	......	82.87	Min....	....	......	.....	10.15	.42	.0987	66.77

[1] 9 a. m. [2] 2 p. m.

NOTES ON TABLES I, II, AND III.

The difference in the composition of the juice from the first mill and that from the second is not so great as the appearance of the two would indicate.

The juice expressed by the first mill is of a comparatively bright color, while that from the second is a dirty brown and seems hardly worth saving.

It was estimated that of the total juice expressed about 85 per cent. was extracted by the first mill and 15 per cent. by the second.

Since the total extraction on the weight of cane (see summary of results for the season) was 74.58, the percentage of juice extracted by the first mill is $74.58 \times .85 = 63.39$ and by the second mill $74.58 \times .15 = 11.19$.

Comparing the sucrose in the juices, the following data are obtained:

Per cent. sucrose, first-mill juice	13.09
Per cent. sucrose, second-mill juice	11.82
Per cent. mixed juices	12.68

Then $63.39 \times .1309 = 8.297751$ and $11.19 \times .1182 = 1.322658$; sum, 9.620409.

Therefore $9.620409 \times 100 \div 74.58$ gives $12.89 =$ theoretical content of juice in sucrose on supposition of relative extraction given above.

Theoretical per cent. sucrose	12.89
Actual per cent. sucrose	12.68
Difference	.21

Percentage of juice extracted by each mill, calculated from the analyses.

Let x = percentage of juice extracted by first mill; then $74.58 - x$ = percentage extracted by second mill. Then

$$x \times .1309 = .1309x$$
$$74.58 - x \times .1182 = 8.795356 - .1182x$$
$$\text{Sum} = 8.795356 + .0127x$$

Then

$$\frac{8.795356 + .0127x}{74.58} = 12.68$$

And

$$8.795356 + .0127x = 9.456744$$
$$.0127x = .661388$$
$$x = 52.08$$

Then

$$74.58 - 52.08 = 22.50$$

Hence of the 74.58 per cent. of juice expressed the first mill gave 52.08 per cent. and the second gave 22.50 per cent.

Comparison of relative yield of the two mills with the theoretical yield calculated from the mean content of sucrose in juices from first and second mills and the mixed juice.

Estimated yield of first mill	63.39
Theoretical yield of first mill	52.08
Difference	11.31
Estimated yield second mill	11.19
Theoretical yield second mill	22.50
Difference	11.31

CAUSES OF DIFFERENCE IN ABOVE RESULTS.

It is not surprising that the theoretical computation of the percentage of juice expressed by each mill from the relative percentage of sucrose in the mill and mixed juices should be somewhat fallacious. It would become more exact as the percentage of sucrose in the mill juices differed. As they come nearer together the limit of error in the computation becomes rapidly greater until should the two percentages become identical, the limit of error would be infinite; for it is at once evident that if the two mill juices should have the same content of sucrose its estimation in the mixed juices could give no clue whatever as to how much of the whole was derived from either of the mills.

Difference in juices, first and second mills.

TOTAL SOLIDS.

From the appearance of the juices from the two mills it would be expected that that from the second mill was heavier. But much of the muddiness of the second mill juice is caused by fragments of cane that quickly subside when the juice is allowed to stand.

The percentage of total solids was not determined directly by evaporation of a sample of the juice, but taken from the tables for specific gravity of saccharine liquids. The numbers given therefore should not be accorded the same value as if they had been obtained by direct determination.

The total solids from the first mill mean of 33 determinations	16.47
From second mill	15.66
Difference	0.81

SUCROSE.

The most remarkable result of the comparison of the two juices is seen in the percentage of sucrose.

In the juice of the first mill the sucrose amounts to 13.09 per cent.; in that of the second to 11.82 per cent.; difference, 1.27 per cent.

From this it appears that by heavier pressure a juice is extracted from the canes less rich in sucrose than that which is removed by a lighter pressure. This may be accounted for by remembering that the juice in the interior of the cane contains more sugar than that of the periphery. The pulp of the cane yields its juice more readily to pressure than the bark. Hence in the second and heavier pressure the juice from the bark of the canes less rich in sugar is expressed, and this mixing with the rest tends to diminish the content of sucrose.

REDUCING SUGAR.

The same reason assigned above for the decrease in sucrose explains the fall in reducing sugars from .87 per cent. in the juice of the first mill to .77 per cent. in that of the second.

ALBUMINOIDS.

For the determination of nitrogenous compounds 10 cc. of the juice were evaporated to dryness in glass-schälchen and sent here for combustion. Many of these delicate dishes were broken in transit, and this accounts for the missing data in the table.

The percentage of albuminoids in first-mill juices (mean of 18 analyses) was .1544; in second mill juices (mean of 18 analyses) it was .2198; in the mixed juices (mean of 17 analyses) it amounted .1726.

Mean composition of the expressed juices (mixed) for the whole campaign of 1884–'85 (*November* 14, 1884, *to January* 14, 1885).

Total number of analyses		72
MEANS.		
Specific gravity of juice		1.0680
Sucrose	per cent.	13.05
Reducing sugar	do	.67
Ash (22 analyses)	do	.512
Albuminoids (28 analyses)	do	.1862
Total solids	do	16.54
Purity coefficient		78.97

MINIMA.

Sucrose	per cent..	9.80
Reducing sugar	do....	.27
Ash	do....	.409
Albuminoids	do....	.0987
Purity coefficient		66.77

MAXIMA.

Sucrose	per cent..	15.48
Reducing sugar	do....	1.71
Ash	do....	.691
Albuminoids	do....	.3625
Purity coefficient		85.14

TABLE IV.—*Clarified juice.*

Date.	Number of analysis.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Albuminoids.	Co-efficient of purity.	Date.	Number of analysis.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Albuminoids.	Coefficient of purity.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*					*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	
Nov. 15	1	1.0726	17.6	13.98	1.37	.0625	79.43	Dec. 3	19	1.0700	17.0	13.68	.83	.1000	80.47
16	2	1.0704	17.1	13.39	1.60	......	78.30	4	20	1.0669	16.3	12.40	.95	......	76.07
17	3	1.0713	17.3	12.76	1.83	.0652	73.76	5	21	1.0726	17.6	14.72	.58	.0813	83.63
18	4	1.0717	17.4	12.73	1.64	.1000	73.16	6	22	1.0726	17.6	14.47	.65	.1313	82.22
19	5	1.0682	16.6	12.29	1.23	.0652	74.04	7	23	1.0709	17.2	14.21	.88	.0818	82.61
20	6	1.0647	15.8	12.87	1.28	.0652	81.45	8	24	1.0722	17.5	14.33	.69	......	81.89
21	7	1.0693	16.8	13.89	.74	.1625	82.67	9	25	1.0726	17.6	14.28	.70	.0625	81.13
22	8	1.0691	16.8	13.40	.83	.0656	79.76	10[1]	26	1.0717	17.4	13.17	.93	.1312	75.69
23	9	1.0695	16.9	13.54	.83	.0819	80.12	10[2]	27	1.0713	17.3	14.15	.68	......	81.79
24	10	1.0713	17.3	14.15	.73	.1000	81.79	11	28	1.0665	16.2	12.11	1.13	.2313	74.75
25	11	1.0722	17.5	14.15	.82	.0813	80.85	12	29	1.0682	16.6	13.02	.78	......	78.43
26	12	1.0687	16.7	14.69	.59	.0813	87.96	14	30	1.0643	15.7	12.38	.75	......	78.85
27	13	1.0711	17.2	14.21	.55	.0813	82.61	15	31	1.0639	15.6	12.34	.82	.2125	78.97
28	14	1.0717	17.4	14.49	.65	......	83.27	16	32	1.0609	14.9	11.49	.74	......	77.11
29	15	1.0665	16.2	12.70	.82	......	78.39								
30	16	1.0687	16.7	12.77	.94	......	76.47	Mean..	....	....	16.8	13.49	.90	.1011	79.82
Dec. 1	17	1.0709	17.2	14.55	.66	.1000	84.59	Max. ..	....	....	.....	14.72	1.83	......	84.59
2	18	1.0726	17.6	14.47	.62	.0813	82.22	Min. ...	....	....	.....	11.49	.55	......	73.16

[1] 9 a. m. [2] 2 p. m.

TABLE V.—*Filtered juice.*

Date.	Number of analysis.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Albuminoids.	Coefficient of purity.	Date.	Number of analysis.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Albuminoids.	Coefficient of purity.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*					*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	
Nov. 17	1	1.0735	17.8	13.16	1.95	......	76.40	Dec. 4	18	1.0709	17.2	13.18	.82	.1438	76.63
18	2	1.0722	17.5	12.67	1.55	......	72.40	5	19	1.0713	17.3	14.49	.62	......	83.76
19	3	1.0775	18.7	13.92	1.56	.0500	74.44	6	20	1.0691	16.8	11.74	.67	.1000	69.88
20	4	1.0850	20.4	15.12	1.88	.0615	74.11	7	21	1.0730	17.7	14.42	.83	.1125	81.47
21	5	1.0761	18.4	14.33	1.10	......	77.88	8	22	1.0730	17.7	14.27	.79	.1625	80.62
22	6	1.0660	16.1	12.66	.88	......	78.63	9	23	1.0639	15.6	12.83	.62	.1375	82.30
23	7	1.0656	16.0	13.01	.92	.0813	81.32	10[1]	24	1.0748	18.1	14.01	.74	.1125	77.40
24	8	1.0722	17.5	13.80	.95	.0625	78.85	10[2]	25	1.0613	15.0	12.32	.73	.1125	82.13
25	9	1.0744	18.0	14.55	.87	.0625	80.83	11	26	1.0540	13.3	10.28	.72	.1662	77.29
26	10	1.0739	17.9	14.60	.88	.0813	81.56	12	27	1.0735	17.8	14.12	.67	......	79.32
27	11	1.0750	18.1	15.08	.49	.0813	83.31	15	28	1.0674	16.4	12.69	.75	......	77.38
28	12	1.0726	17.6	13.74	.83	......	78.06	16	29	1.0682	16.6	12.92	.97	......	77.83
29	13	1.0695	16.9	13.30	.71	.1000	78.69								
30	14	1.0748	18.1	13.76	.96	......	76.02	Mean..	....	1.0717	17.39	13.61	.91	.1049	78.36
Dec. 1	15	1.0687	16.7	13.10	.78	......	78.44	Max....	....	....	.....	15.71	1.95	......	84.01
2	16	1.0775	18.7	15.71	.41	.1438	84.01	Min. ...	....	....	.....	10.28	.41	......	71.72
3	17	1.0846	20.3	14.56	.87	.1125	71.72								

[1] 9 a. m. [2] 2 p. m.

NOTES ON TABLES IV AND V.

The mixed juices were clarified by adding to them thick cream of lime until the acid reaction nearly disappeared. The juice was then raised nearly to the boiling point, a thick blanket of scum rising to the top. After five minutes the scum was removed, and the juice then boiled for a few minutes, until another covering or crop of scum was produced. This process was repeated until the green or dirty scum ceased to be formed.

The steam was then shut off, the heavier particles allowed to settle, and the juice gradually drawn off.

Comparing the analyses of the clarified juice with those of the raw mixed juices, the following data are obtained:

	Sucrose.	Glucose.	Total solids.	Albuminoids.	Coefficient of purity.
Raw juice	12.62	.87	16.15	.1726	78.14
Clarified	13.49	.90	16.8	.1011	79.82

As was to be expected, the principal change produced by clarification is seen in the diminished percentage of nitrogenous matter, nearly half of which is removed with the scum. The slight increase in the percentages of the two sugars is due solely to the concentration of the juice, since, as will be seen by the analyses of the scums (p. 58), the loss of sugar in them is practically the same as if an equal quantity of the juice should be removed. A little over one-half of the albuminous matter present is either not coagulated by the lime and heat, or else remains suspended in the juice. By the process of clarification, also, the purity coefficient is raised nearly two units.

The clarified juices were filtered through bone-black, and in this process all suspended matter in them was removed and the coloring matters destroyed.

It will be interesting to compare the composition of the filtered with that of the raw and clarified juices:

	Sucrose.	Glucose.	Total solids.	Albuminoids.	Purity coefficient.
Raw juice	12.62	.87	16.15	.1726	78.14
Clarified juice	13.49	.90	16.08	.1011	79.82
Filtered juice	13.61	.91	17.39	.1049	78.36

The only remarkable change produced by filtering through bone-black aside from the decolorization of the juice is in the increase in total solids, which increase must be in the ash, as it is not shown to any considerable extent in the organic bodies present. I am unable to account for this increase, unless it should be ascribed to imperfect burning and washing of the char. It seems remarkable that a liquor colorless, clear, like the filtered juice, should differ so little in its composition from the turbid and dirty juices of the mill. The chemical study of these processes of clarification has shown that cane juice contains much less of substances injurious to crystallization (aside from glucose) than the juices of the sugar beet; otherwise it would not be possible to make such excellent sugar in a manner as simple as that generally practiced in Louisiana. But, although this is true, it is also probable that the best and most scientific methods of preparing the juice for the evaporating pans would produce results which would more than justify their employment.

TABLE VI.—*Masses cuites.*

Date.	Number.	I. Sucrose.	I. Reducing sugars.	II. Sucrose.	II. Reducing sugars.	III. Sucrose.	III. Reducing sugars.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Nov. 16	1	72.80	11.04	......	......	......	......
17	2	......	......	64.10	15.19	......	......
22	3	......	......	*67.07	16.40	......	......
26	4	75.80	7.51	......	......	......	......
28	6	......	......	64.60	12.82	......	......
30	7	......	......	*68.88	14.70	......	......
Dec. 1	8	*77.73	7.46	*66.41	15.25	*49.72	18.38
4	9	*75.00	6.02	*58.10	11.05	......	......
5	10	*73.34	8.69	......	......	40.60	12.02
6	11	......	......	*67.02	14.18	......	......
7	12	*74.12	7.04	......	......	......	......
8	13	......	......	*72.01	11.45	......	......
10	14	81.13	5.46	......	......	......	......

Date.	Number.	I. Sucrose.	I. Reducing sugars.	II. Sucrose.	II. Reducing sugars.	III. Sucrose.	III. Reducing sugars.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Dec. 11	15	......	......	*68.76	12.70	......	......
13	16	*79.92	6.54	......	......	......	......
16	17	......	......	59.05	11.36	......	......
17	18	*76.78	6.99	......	......	......	......
18	19	*75.81	7.81	......	......	......	......
20	20	......	......	*63.62	12.60	......	......
22	21	......	......	*62.05	12.20	......	......
Jan. 3	22	*78.29	4.93	62.12	11.50	......	......
Mean	..	76.43	7.23	64.91	13.18	45.16	15.20
Max.	..	81.13	11.04	72.01	16.40	49.72	18.38
Min.	..	72.80	4.93	58.10	11.05	40.60	12.02

Per cents sucrose marked with * were determined by double polarization.
The numbers I, II, and III refer to the strikes from the first boiling, and from reboiling the molasses from first and second sugars respectively.

TABLE VII.—*Sugars.*

Date.	Number.	I. Sucrose.	I. Reducing sugars.	II. Sucrose.	II. Reducing sugars.	III. Sucrose.	III. Reducing sugars.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Nov. 18	1	98.60	Trace.	98.40	Trace	......	......
22	2	99.10	Trace.	......	......	......	......
Dec. 6	3	......	......	......	......	84.70	7.96
11	4	......	......	......	......	91.00	8.05

Date.	Number.	I. Sucrose.	I. Reducing sugars.	II. Sucrose.	II. Reducing sugars.	III. Sucrose.	III. Reducing sugars.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Dec. 22	5	......	......	95.37	.51	......	......
Jan. 2	6	97.70	Trace.	......	......	......	......
7	7	*95.88	.29	......	......	......	......

Per cents sucrose marked with * were determined by double polarization.
I, II, and III refer to first, second, and third sugars respectively. The second sugars are nearly as pure as the first.

TABLE VIII.—*Showing the composition of molasses from first, second, and third sugars.*

MOLASSES.

Date.	Number.	II. Sucrose.	II. Reducing sugars.	III. Sucrose.	III. Reducing sugars.	IV. Sucrose.	IV. Reducing sugars.	Date.	Number.	II. Sucrose.	II. Reducing sugars.	III. Sucrose.	III. Reducing sugars.	IV. Sucrose.	IV. Reducing sugars.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*			*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Nov. 22	1	43.80	14.70	32.00	11.16	......	......	Dec. 11	13	......	......	*39.02	14.10	20.60	25.93
24	2	38.20	13.26	......	......	......	......	13	14	28.29	5.87	......	......	......	......
26	3	......	......	39.80	24.61	......	......	16	15	......	......	41.20	18.16	......	......
26	4	......	......	36.80	19.23	......	......	20	16	......	......	*45.00	18.50	......	......
28	5	......	......	37.40	16.23	......	......	22	17	......	......	*43.35	18.50	......	......
30	6	......	......	*45.52	25.51	......	......	25	18	36.90	4.32	......	......	......	......
Dec. 1	7	29.80	7.98	*50.32	22.62	......	......	26	19	37.30	4.28	......	......	24.80	19.52
4	8	*66.74	12.80	*43.32	21.01	......	......								
5	9	33.80	7.27	......	......	20.20	17.73	Mean .	..	37.97	8.13	41.23	18.82	21.87	21.06
7	10	33.80	6.15	......	......	......	......	Max...	..	66.74	14.70	50.32	25.51	24.80	25.93
8	11	34.40	6.61	*40.98	16.20	......	......	Min. ..	..	28.29	4.28	32.00	11.16	20.20	17.73
10	12	34.60	6.18	......	......	......	......								

Per cents sucrose marked * were determined by double polarization. The molasses from first sugar is generally called "second molasses," and therefore the numbers II, III, and IV are used to indicate the product from first, second, and third sugars. By a study of the difference between direct and double polarization in the table to follow it will be seen that where large quantities of glucose are present the direct polarization is uniformly too low. This may account for the statement that has been made, that molasses has been produced in which the sucrose was less than the glucose.

TABLE IX.—*Showing the difference between single and double polarization in masses cuites molasses, and sugars.*

	Masses cuites. I. Sucrose, direct.	Masses cuites. I. Sucrose, double polarization.	Masses cuites. II. Sucrose, direct.	Masses cuites. II. Sucrose, double polarization.	Masses cuites. III. Sucrose, direct.	Masses cuites. III. Sucrose, double polarization.	Molasses. II. Sucrose, direct.	Molasses. II. Sucrose, double polarization.	Molasses. III. Sucrose, direct.	Molasses. III. Sucrose, double polarization.	Sugar. I. Sucrose, direct.	Sugar. I. Sucrose, double polarization.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
	75.80	77.73	62.20	67.07	41.00	49.72	61.10	66.74	37.50	45.52	95.50	95.88
	77.00	75.00	64.40	68.88	......	......	......	......	39.20	50.32	......	......
	76.60	73.34	59.20	66.41	......	......	......	......	32.50	43.32	......	......
	68.40	74.12	57.70	58.10	......	......	......	......	34.00	40.98	......	......
	75.30	79.92	62.50	67.02	......	......	......	......	32.10	39.02	......	......
	72.70	76.78	65.60	72.01	......	......	......	......	35.80	45.00	......	......
	71.10	75.81	61.80	68.76	......	......	......	......	33.80	43.35	......	......
	74.90	78.29	56.10	63.62	......	......	......	......	......	......	......	......
	......	......	55.70	62.05	......	......	......	......	......	......	......	......
Mean	73.97	76.37	60.58	65.99	41.00	49.72	61.10	66.74	34.98	43.93	95.50	95.88

REMARKS ON TABLE IX.

The direct polarization of a sugar solution will give an accurate result for sucrose provided no other optically active bodies are present. If such bodies be present, however, whether they be dextro or levogyratory, the results of a single polarization are not reliable. In such cases the analyst must resort to double polarization, *i. e.*, an ordinary direct polarization followed by inversion of the solution and a repolarization. In *masses cuites*, molasses and raw sugars made from cane, the disturbing element is chiefly the reducing sugar present formed either in the plant or during the process of manufacture. This sugar is levogyratory, and the more so as the temperature is low. By reason of the presence of this sugar the direct reading for sucrose is too low by the amount of left handed sugar present. After inversion the rotation is to the left, and by observing the temperature (in degrees centigrade) the real percentage of sucrose which was present in the solution is determined by the usual formula, *i. e.*, divide the algebraic difference of the direct and invert readings by 144, minus half the number expressing the temperature at which the reading is made. The mean percentage of glucose in first *masses cuites* (Table VI) is 7.23.

The difference in sucrose between direct and double polarization is 76.37−73.97=2.40 per cent. In second *masses cuites* the mean content of glucose 13.18 per cent. The difference in sucrose is 65.97−60.58=5.41 per cent.

Collecting all the data of this kind we have the following results:

TABLE X.—*Showing error of single polarization.*

	Masses cuites, first.	Masses cuites, second.	Molasses, third.
Mean per cent. glucose	7. 23	13. 18	18. 82
Increase by double polarization	2. 40	5. 41	8. 95
Ratio of increase to glucose	3. 01	2. 44	2. 11

Mean ratio of increase equals 2. 52.

From this it follows that in order to get a correct expression for sucrose in such substances either double polarization must be practiced or the percentage obtained by direct polarization must be increased by the quotient of the number expressing percentage of glucose divided by 2.5.

Applying this formula to the results of No. IV, molasses, Table VIII, it is seen that the percentage of sucrose, which appears to be 21.87 by single polarization, is entirely too low, and to represent the actual sucrose present should be increased by the number expressing glucose, viz, 21.06, divided by 2.5, or 8.42. The total mean percentage of sucrose which was present, therefore, in such molasses was 30.29 instead of 21.87. This discrepancy becomes a matter of commercial as well as of scientific importance when it is remembered that low-grade sugar and molasses are valued by the polariscope both for sale and the payment of duties. A molasses, for example, which polarizes 55 per cent. by the present method of polarization employed by the custom-house, would be admitted at 4 cents per gallon duty, when it really contains more than 60 per cent. crystallizable sugar and should pay 8 cents per gallon.

TABLE XI.—*Showing composition of filtered sirup.*

Date.	Number of analysis.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Coefficient of purity.	Date.	Number of analysis.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Coefficient of purity.
			P. ct.	*P. ct.*	*P. ct.*					*P. ct.*	*P. ct.*	*P.ct.*	
Nov. 19	1	1.2234	48.3	33.34	5.56	69.03	Dec. 5	17	1.2003	44.0	35.42	3.02	80.50
20	2	1.2372	50.8	37.87	5.74	74.54	6	18	1.2083	45.5	36.56	2.67	80.35
21	3	1.2280	49.1	38.52	4.67	78.45	7	19	1.2136	46.5	36.75	3.43	79.01
22	4	1.2478	52.7	41.38	4.11	78.52	8	20	1.1987	43.7	37.20	2.43	85.17
23	5	1.2256	48.7	38.26	5.21	78.56	9	21	1.1882	41.7	34.90	2.68	83.69
24	6	1.2377	50.9	39.79	4.47	78.17	[1]10	22	1.2250	48.6	35.64	2.40	73.33
25	7	1.2283	49.2	38.81	4.38	78.88	[2]10	23	1.1820	40.5	33.85	2.63	83.58
26	8	1.2405	51.4	40.86	3.96	79.49	11	24	1.2169	47.1	39.09	2.54	82.99
27	9	1.2294	49.4	39.96	3.48	80.89	12	25	1.2110	46.0	36.91	3.40	80.24
28	10	1.2333	50.1	39.96	3.59	78.04	15	27	1.1940	42.8	33.07	3.35	77.27
29	11	1.2077	45.4	37.01	3.54	81.52	16	28	1.2120	46.2	38.63	2.75	83.61
30	12	1.2083	45.5	35.71	3.57	78.48							
Dec. 1	13	1.2051	44.9	34.80	3.20	77.51	Mean	......	1.2153	46.8	37.19	3.53	79.47
2	14	1.1998	43.9	35.60	2.80	81.09	Max	......	....	......	41.38	5.74	85.17
3	15	1.2185	47.4	39.17	2.85	82.64	Min	......	....	......	33.07	2.40	69.03
4	16	1.1987	43.7	35.12	2.91	80.37							

[1] 9 a. m. [2] 2 p. m.

It will be observed that the constituents of the sirup maintain the same relative ratios as in the juice, showing little change produced by the process of evaporation. The coefficient of purity is sensibly the same as in the raw and clarified juices.

It is the custom in some factories to submit the sirup from the double effect to a reskimming in an open pan. The boiling and skimming are continued from fifteen to twenty minutes.

Under A of Table XII will be found analyses of sirups directly from the double effect; under B analyses of the same sirup after boiling and skimming. In the first case the quantity of glucose per 100 of sucrose is 7.04. In the second instance, it has risen to 9.53. This increase of 2.49 represents the parts of sugar per hundred that are lost by this process. This loss is out of all proportion to the good accomplished, and therefore the process should be abandoned.

On the other hand it is shown under C and D that merely heating the sirup to the boiling point preparatory to filtration does not have any appreciable deleterious effect.

TABLE XII.—*Showing the effect of boiling and skimming sirups.*

Date.	[1]A.						[2]B.						
	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Reducing sugars per 100 sucrose.	Coefficient of purity.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Reducing sugars per 100 sucrose.	Increase percentage of reducing sugars.	Coefficient of purity.
		P. ct.	*P. ct.*	*P. ct.*				*P. ct.*	*P. ct.*	*P. ct.*			
Nov. 25	1.1866	41 4	33.45	2.67	7.98	80.80	1.2191	47.5	37.22	3.94	10.58	2.60	78.36
26	1.2147	46.7	38.21	4.00	10.46	81.82	1.2394	51.2	41.15	5.00	12.15	1.69	80.37
27	1.2126	46.3	37.72	2.56	6.78	81.47	1.2366	50.7	40.99	3.50	8.54	1.76	80.85
28	1.1722	38.6	32.31	1.10	3.40	83.70	1.2207	47.8	39.65	2.76	6.96	3.56	82.95
29	1.1919	42.4	34.01	2.91	6.61	80.21	1.2131	46.4	36.84	3.48	9.44	2.83	79.40
Mean..	....	43.1	35.14	2.65	7.04	81.61	....	48.7	39.17	3.74	9.53	2.49	80.38

[1] Before boiling and skimming.
[2] After boiling and skimming.

Date.	[3]C.						[4]D.					
	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Reducing sugars per 100 sucrose.	Coefficient of purity.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Reducing sugars per 100 sucrose.	Coefficient of purity.
		P. ct.	*P. ct.*	*P. ct.*				*P. ct.*	*P. ct.*	*P. ct.*		
Dec. 3	1.2447	46.7	39.63	1.40	3.53	84.86	1.2207	47.8	39.77	1.42	3.57	83.20
4	1.2256	48.7	38.35	3.18	8.29	85.32	1.2283	49.2	38.93	3.24	8.32	79.13
5	1.2153	46.8	37.38	2.89	7.73	79.87	1.2051	44.9	37.87	3.05	8.05	84.35
6	1.2185	47.4	37.73	3.02	7.79	79.60	1.2256	48 7	39.53	3.03	7.66	81.14
Mean..	....	47.4	38.29	2.62	6.83	82.41	....	47.6	39.02	2.68	6.90	81.95

[3] Sample direct from double effect.
[4] Heated to 100° C. (212° F.) preparatory to filtration.

A few experiments were also made to trace the development of the sucrose in the cane left standing and its decrease when the cane was cut and stored. The results are given in Tables XIII, XIV, XV, and XVI.

Although these analyses were made with as much care as possible, yet in all cases the results appear negative. In other words, it does not appear from the tables that there was any marked increase of sucrose in the standing cane after the middle of November, nor was there any notable decrease of it in those canes that were cut and stored under shelter.

The cause of this unsatisfactory result is not difficult to find. Only a few canes could be taken for each analysis, and thus a fair basis of estimation could not be secured. Single canes differ so greatly from each other in content of sugar that only when they are taken by the hundred can we assume that a fair sample has been selected.

The analyses at least show, however, that cane can be cut and put in sheds without endangering its sugar-making qualities; also that it can be left standing when there is no danger of freezing.

I see no reason for doubting the possibility of extending the rolling season far into the winter by properly storing the cane. If this should prove practicable, the cost of sugar production can be greatly lessened by establishing larger central factories, where, by reason of a longer working season and better forms of apparatus, the process of manufacture could be made less expensive.

EXPERIMENTS TO SHOW DEVELOPMENT OF THE CANE.

TABLE XIII.—*Purple cane.*

Date.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Coefficient of purity.	Juice.	Date.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Coefficient of purity.	Juice.
		P. ct.	*P. ct.*	*P. ct.*		*P. ct.*			*P. ct.*	*P. ct.*	*P. ct.*		*P. ct.*
Nov. 13	1.0722	17.5	14.22	.64	81.26	64.6	Dec. 4	1.0753	18.2	15.99	.22	87.86	55.1
14	....	......	....	......	....	59.2	6	1.0713	17.3	13.76	.47	79.54	55.2
15	1.0713	17.3	14.13	.70	81.68	65.6	8	1.0748	18.1	15.41	.33	85.14	58.1
17	1.0665	16.2	12.45	1.09	76.84	......	13	1.0726	17.6	14.67	.45	83.35	57.0
19	1.0682	16.6	13.21	.85	79.58	57.3	20	1.0682	16.6	13.00	.53	78.31	65.7
20	1.0753	18.2	15.17	.55	82.35	59.0	26	1.0720	17.5	14.80	.22	84.57	66.6
21	1.0691	16.8	13.30	.75	79.17	59.0	Jan. 1	1.0709	17.2	14.39	.30	83.66	65.2
22	1.0744	18.0	15.03	.53	83.50	58.6	3	1.0674	16.4	12.99	.55	79.27	65.4
24	1.0722	17.5	14.48	.59	82.74	56.4	7	1.0660	16.1	13.10	.33	81.82	71.6
25	1.0704	17.1	14.16	.52	82.81	57.0							
27	1.0735	17.8	14.85	.43	83.43	58.7	Mean .	....	17.3	14.29	.52	82.60	......
28	1.0739	17.9	14.89	.76	83.18	58.5	Max. .	....	......	15.99	1.09	87.86	......
29	1.0753	18.2	15.41	.26	84.73	57.8	Min. ..	....	......	12.45	.22	76.84	......
Dec. 2	1.0730	17.7	15.15	.36	85.59	57.3							

TABLE XIV.—*Ribbon cane.*

Date.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Coefficient of purity.	Juice.	Date.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Coefficient of purity.	Juice.
		P. ct.	*P. ct.*	*P. ct.*		*P. ct.*			*P. ct.*	*P. ct.*	*P. ct.*		*P. ct.*
Nov. 13	1.0744	18.0	15.33	.62	85.16	63.8	Dec. 2	1.0669	16.3	13.33	1.01	81.78	59.6
14	1.0674	16.4	13.42	.97	81.83	63.3	4	1.0674	16.4	13.03	.95	79.45	59.4
15	1.0691	16.8	13.01	1.21	77.44	69.1	6	1.0674	16.4	13.28	.85	80.98	59.5
17	1.0652	15.9	12.64	1.08	95.50	63.5	8	1.0677	16.7	13.70	.85	82.04	57.8
18	1.0709	17.2	13.94	.87	81.05	59.1	13	1.0713	17.3	13.85	.66	80.06	60.6
19	1.0695	16.9	13.35	.77	78.99	57.8	20	1.0682	16.6	12.96	.61	78.07	66.8
20	1.0647	15.8	12.58	1.25	79.43	58.1	26	1.0693	16.9	13.78	.47	81.54	65.9
21	1.0687	16.7	12.87	1.05	77.07	60.6	Jan. 1	1.0709	17.2	13.98	.42	81.28	66.2
22	1.0682	16.6	13.27	.91	79.94	58.0	3	1.0704	17.1	13.92	.51	81.40	66.1
24	1.0695	16.9	13.78	.83	81.54	58.2	7	1.0660	16.1	12.95	.67	80.43	68.1
25	1.0722	17.5	14.15	.91	80.86	59.3							
27	1.0709	17.2	14.29	.75	83.08	58.3	Mean..	....	16.8	13.64	.80	81.78	......
28	1.0726	17.6	14.76	.61	83.86	56.4	Max. ..	....	......	15.33	1.25	85.16	......
29	1.0735	17.8	15.04	.43	84.49	57.4	Min. ..	....	......	12.58	.42	77.07	......

EXPERIMENTS IN THE STORAGE OF CANE.

TABLE XV.—*Purple cane cut and stored under cover November 14.*

Date.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Coefficient of purity.	Reducing sugars per 100 sucrose.	Juices extracted from cane.	Date.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Coefficient of purity.	Reducing sugars per 100 sucrose.	Juices extracted from cane.
		P. ct.	*P. ct.*	*P. ct.*			*P. ct.*			*P. ct.*	*P. ct.*	*P. ct.*			*P. ct.*
Nov. 18	1.0634	15.5	10.34	2.55	66.71	24.66	57.0	Jan. 3	1.0735	17.8	12.22	2.39	68.60	19.55	61.8
25	1.0713	17.3	12.06	1.19	69.71	9.86	56.5	7	1.0744	18.0	11.88	2.51	66.00	21.13	56.5
Dec. 2	1.0730	17.7	12.96	1.53	73.22	11.80	58.8								
9	1.0744	18.0	12.46	2.37	69.22	19.02	57.0	Mean.	....	17.7	12.26	2.12	69.27	17.46	....
13	1.0753	18.2	13.27	2.07	62.91	15.59	56.8	Max.	....	.....	13.27	2.55	73.22	......	.....
20	1.0761	18.4	12.91	1.98	70.16	15.34	66.2	Min.	....	.....	10.34	1.19	62.91	......	.....
27	1.0761	18.4	12.31	2.49	66.90	20.23	62.5								

TABLE XVI.—*Ribbon cane cut November 16, stored under cover November 20.*

Date.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Coefficient of purity.	Reducing sugars per 100 sucrose.	Juices extracted from cane.	Date.	Specific gravity.	Total solids.	Sucrose.	Reducing sugars.	Coefficient of purity.	Reducing sugars per 100 sucrose.	Juices extracted from cane.
		P. ct.	*P. ct.*	*P. ct.*			*P. ct.*			*P. ct.*	*P. ct.*	*P. ct.*			*P. ct.*
Nov. 22	1.0695	16.9	12.02	1.04	71.12	8.65	59.3	Jan. 3	1.0722	17.5	12.38	1.79	70.74	13.97	62.6
29	1.0735	17.8	14.46	.86	79.75	5.94	56.8	7	1.0682	16.6	11.13	1.73	67.05	15.54	56.5
Dec. 6	1.0691	16.8	12.57	1.17	74.82	9.30	57.0								
13	1.0744	18.0	14.35	1.08	79.72	7.52	57.8	Mean.	....	17.25	12.70	1.27	73.34	10.11	.....
20	1.0722	17.5	12.86	1.02	73.49	7.93	67.0	Max.	....	.....	14.46	1.79	79.75	......	.....
27	1.0695	16.9	11.84	1.42	70.06	11.99	64.2	Min.	....	.....	11.13	.86	67.05	......	.....

SCUMS.

That there is a great waste of sugar in the scums has long been recognized by many observing sugar boilers. On the other hand the scums have been treated as if worthy of no more attention than was necessary to get them decently out of the way. Subjected to analysis, however, the scums are found to contain about the same per cent. of sugar as the juices themselves. As the process of concentration goes on the richness of the scums in sugar progresses with that of the sirup. In a business, therefore, which requires at the present time the strictest economy and the most careful supervision, it is well to endeavor to recover the vast quantities of sugar which are annually thrown away in the scums. The only practical way in which this can be done with our present knowledge is by the use of the filter press. Even the first scums, "the blanket," can be profitably washed through a filter press, and with the subsequent skimmings the operation is still more useful.

TABLE XVII.—*Showing composition of blanket, secondary, and sirup scums.*

Date.	Description.	Sucrose.	Reducing sugars.	Albumen.
		Per cent.	*Per cent.*	*Per cent.*
Nov. 14	From skimming box	12.98	.93	1.1563
15	......do	14.10	1.09	....
18	......do	12.10	1.26	1.175
19	Blanket	11.80	.90	1.263
20	From skimming box	12.70	1.31	.7875
21	......do	11.40	1.01	1.263
22	......do	13.90	.67	1.263
23	......do	12.40	.72	1.263
24	Blanket	12.20	.10	.8375
25	From skimming box	12.60	.38	1.3625
25	From sirup	40.75	3.54	1.100
25	From skimming box	10.80	.31	2.400
26	From sirup	44.50	5.38	.710
26	From skimming box	13.50	.82	....
27	......do	13.70	.13	....
29	......do	13.00	.48	1.100
30	......do	17.00	1.10	.4563
Dec. 3	......do	13.20	Trace.	1.0875
4	From third sirup	46.60	11.85	....
7	From skimming box	12.60	.54	....
8	......do	12.70	.41	1.188
8	......do	11.60	.58	....

Summary of preceding table.

MEAN.

Sucrose in "blanket"	12.00
Glucose in "blanket"	.50
Sucrose scums from tank	12.96
Glucose from tank	.69
Sucrose (sirup)	42.62
Glucose (sirup)	4.46
Sucrose (third sirup)	46.60
Glucose (third sirup)	11.85

The following figures will show the loss in sugar in working a crop of 9,063 tons.

In all 2,851 clarifiers of juice, weighing 4,742 pounds each were obtained.

The average weight of "blanket" skimmings for each clarifier was 266 pounds, or for 2,851 clarifiers, 758,366 pounds.

The mean total sugar in these scums was 12.50 per cent. Then $758,366 \times .125 = 94,545.75$ pounds.

After the "blanket" has been removed the subsequent skimmings are run into a tank where, after settling, the clear juice is drawn off from above and the sediment is run into the sewer. This tank was filled one hundred and eighteen times during the season.

The particles of impurities in these scums are so nearly of the same specific gravity as the juice in which they float that they subside very slowly and imperfectly.

There remains therefore always a large quantity of juice which is thrown away. The average quantity thus wasted is estimated at 200 gallons for each clarifier, or 23,600 gallons for the campaign, giving a total weight of about 188,800 pounds.

The mean percentage of both sugars in these scums was 13.65. Then $188,800 \times .1365 = 25,771.2$ pounds.

SUMMARY.

	Pounds.
Loss of sugar in "blanket" scums	94,545.75
Loss of sugar in subsequent scums	25,771.20
Total loss of sugar in scums	120,316.95

This does not include the waste in scums from sirups in which the average percentage of both sugars, as is seen from the table, is nearly 50. But these scums are not great in amount, and the loss arising from them may be neglected.

By simply passing these scums through a filter press as indicated by the work in the subjacent table done in the small press, more than 80 per cent. of their weight is obtained as a perfectly clear limpid juice. By washing the residue with a little warm water practically the whole of the sugar can be recovered.

TABLE XVIII.—*Results of experimental work with "blanket" scums.*

Date.	Weight of scums.	Weight of juice.	Per cent. of juice.	Date.	Weight of scums.	Weight of juice.	Per cent. of juice.
1885.	*Pounds.*	*Pounds.*		1885.	*Pounds.*	*Pounds.*	
January 2	44.75	35.13	78.49	January 5	55.00	44.45	80.79
3	46.13	36.94	80.08	10	53.50	43.31	80.95
4	57.41	46.75	80.00				

SUMMARY OF DATA COLLECTED AT THE MAGNOLIA STATION; PLANTATION OF GOVERNOR H. C. WARMOTH.

TABLE XIX.—*Date of working, description of field, number of acres, age of cane, amount of fertilizers used.—Total yield and yield per acre for the campaign of* 1884–'85.

Date.	Strip.	Acres.	Cane.	Fertilizer. Cotton seed meal per acre.	Fertilizer. Superphosphates per acre.	Total weight.	Weight per acre.
				Pounds.	*Pounds.*	*Tons.*	*Tons.*
Nov. 10–11	"48 acres"	10.69	First stubble	900	....	170.79	15.97
Nov. 12–15	"Upper front"	21.05	Second stubble	500	....	288.46	13.70
Nov. 16–17	"Jeff's Garden"	14.79	Second stubble	535	265	181.64	12.28
Nov. 18–19	"Murphy patch"	15.44	First stubble	535	265	225.48	14.60
Nov. 20–27	"Railroad"	67.18	First stubble	666	334	1,270.28	18.91
Nov. 28	"Magnolia"	9.56	First stubble	535	265	119.24	12.47
Nov. 29–30	......do	15.61	Fall plant	666	334	427.12	27.36
Dec. 1	"New land"	5.61	Second stubble	400	200	73.12	13.03
Dec. 2	......do	12.52	First stubble	666	334	263.63	21.05
Dec. 3–4	......do	10.42	Fall plant	666	334	233.42	22.79
Dec. 5–6	"Magnolia"	30.92	First stubble	600	300	478.19	15.46
Dec. 7–9	"Stable"	27.54	First stubble	1,000	....	501.32	18.20
Dec. 9–19	"Polly Garden"*	42.30	14 acres spring plant; rest fall plant.	900	....	1,027.76	24.29
Dec. 20–24	"Pond"	44.07	Spring plant	700	500	918.10	20.83
Dec. 25	"Church"	22.51	....do	700	500	337.60	14.98
Dec. 26	Swinging Oak and cypress.	32.00	.. do	No	fert.	632.59	19.77
Jan. 1	Swinging Oak	13.63	First stubble	535	265	276.44	20.28
Jan. 2–4	"Pasture"	26.00	Fall plant	700	500	443.75	17.06
Jan. 4–13	"Lower front	58.60	Spring plant	500	....	1,194.41	20.38
	Total	480.44		....	....	9,063.34	*Mean.* 18.86

* Fall plant cane, 746 tons 1,195 pounds; spring plant cane, 303 tons 10 pounds.

*Table showing number tons caneworked, weight juice extracted, per cent. of extraction, weight of all sugars per ton of cane, for the four periods of time into which the season was divided.**

	First period.	Second period.	Third period.	Fourth period.	Total.
Cane worked ....tons..	4, 885. 34	2, 031.5	1194. 00	952. 5	9, 063. 34
Juice extracted ....pounds..	6, 918, 575	3, 134, 462	1, 896, 800	1, 569, 602	13, 519, 442
Per cent. of extraction	70. 81	77. 14	78. 17	82. 34	74. 58
Sugar per ton (exclusive of molasses) .pounds..	138. 84	177. 11	174. 11	194. 75	158. 42

* These divisions were arbitrary and were made when bad weather or accident permitted a thorough cleaning of the sugar house.

Per cent. of yield (sugars)	7. 92
Pounds of first sugar (polarization 98.5 per cent.) per ton of cane (61.73 per cent. of the whole).	94. 46
Pounds of second sugar (polarization 98.5 per cent.) per ton of cane (19.86 per cent. of the whole).	42. 93
Pounds of third sugar (polarization 87.8 per cent.) per ton of cane (18.41 per cent. of the whole).	21. 03
Yield of molasses, per ton ....pounds..	58. 25
Molasses, made ....pounds..	528, 000

TABLE XX.—*Bagasse analyses and theoretical extraction.*

Date.	Sucrose.	Reducing sugars.	Moisture.	Total sugars, mixed juice.	Total sugars, second mill juice.	Bagasse.	Juice.	Date.	Sucrose.	Reducing sugars.	Moisture.	Total sugars, mixed juice.	Total sugars, second mill juice.	Bagasse.	Juice.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*		*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Dec. 4	6. 08	.70	......	......	12. 08	22. 76	77. 24	Dec. 16	4. 09	.49	......	......	10. 71	17. 47	82. 53
5	5. 67	.44	......	......	12. 75	19. 19	80. 81	31	5. 09	.53	51. 78	12. 54	......	......	......
6	4. 60	.53	......	......	12. 90	16. 60	83. 40	Jan. 2	6. 66	.30	44. 22	15. 26	......	......	......
7	6. 08	.67	......	......	13. 28	23. 33	76. 67	3	5. 63	.38	......	13. 17	......	......	......
9	7 04	.52	......	......	12. 91	24. 15	75. 85	6	4. 45	.60	......	14. 78	......	......	......
10	6. 67	.43	......	......	13. 20	21. 62	78. 38	8	6. 34	.41	......	14. 62	......	......	......
12	7. 26	.59	......	......	11. 20	33. 44	66. 56	9	6. 67	.26	......	15. 34	......	......	......
15	5. 62	.55	......	......	11. 00	22. 77	77. 23	10	7. 23	.26	......	15. 42	......	......	......

REMARKS.

The weight of the juice was estimated in the following manner: The volume of a clarifier was determined by filling it with water, then running the water into a square tank and measuring it. The clarifiers were always filled to the same point. The weight of a gallon of juice was calculated from the average specific gravity.

CANE SHREDDER.

The cane shredder (Fig. 5) used on the Magnolia plantation was manufactured by the Newall Universal Mill Company of New York. The two cylinders (teeth shown in the cut) revolve in opposite directions and at different rates of speed. The cylinder on the right turns at one hundred and thirty-eight revolutions per minute and the one on the left at three hundred. The canes falling into the hopper from the carrier are caught by the teeth of the cylinders and crushed and torn into a pulp. From the bottom of the apparatus this pulp falls onto the carrier, which conveys it to the rolls. In this state of pulp a more even distribution of the material is secured, and the working of the mill thereby made more uniform and effective.

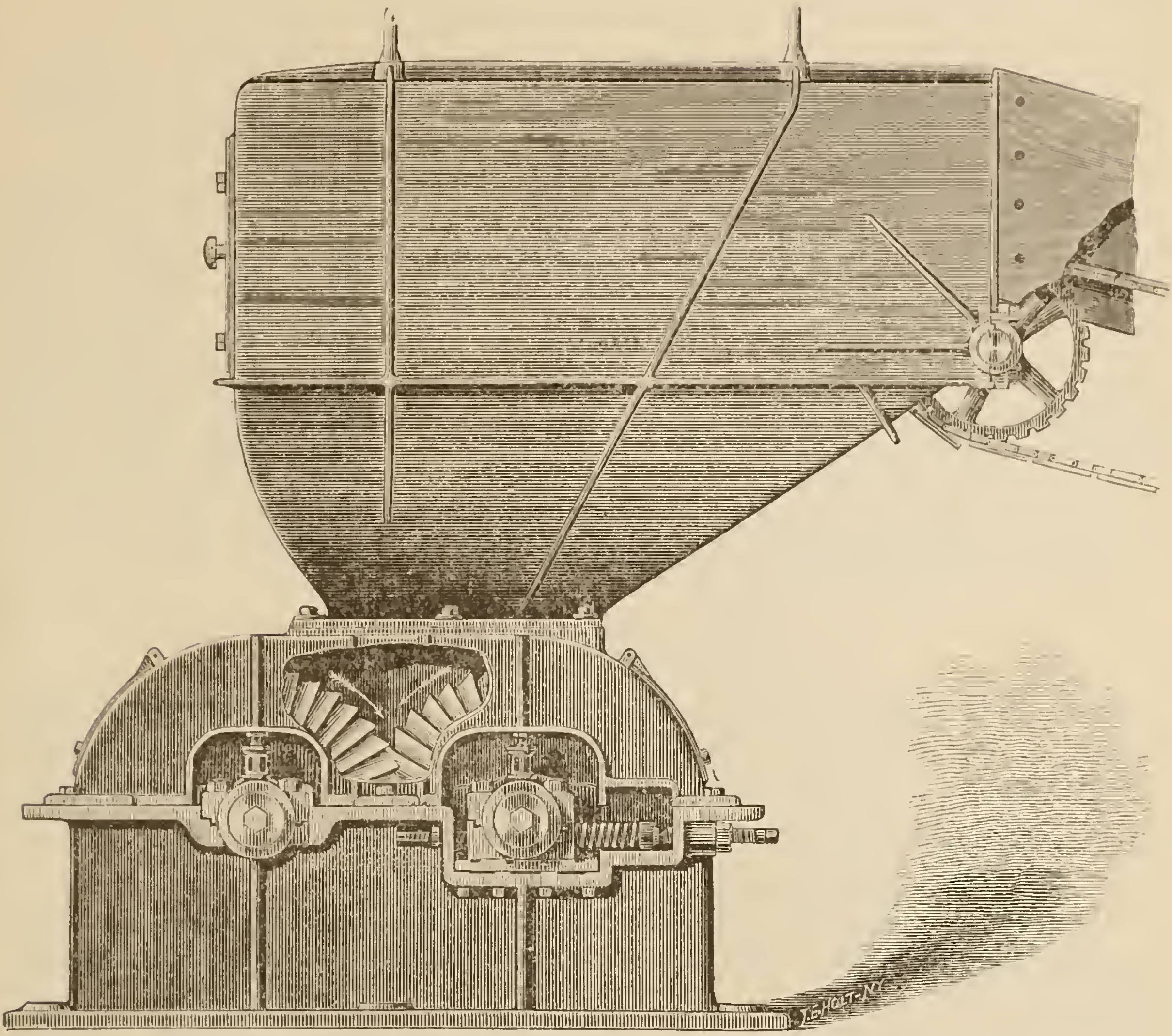


FIG. 5.—Cane shredder.

FILTER PRESS.

Press manufactured by Riedel, of Halle, in Saxony.
Filtering surface equals 200 square feet.
Cloths equal heavy twilled goods.
Mud left in press dry and compact; juice clear and bright.

DIMENSIONS OF EXPERIMENTAL FILTER PRESS.

Johnson's hydraulic press.—Filtering surface, 8.8 feet; pressure, 150 pounds; obtained results given in table.

Statement showing the monthly maximum, minimum, and mean temperature, and the precipitation, at New Orleans, La., for the year 1884.

[Compiled from the records on file at the office of the Chief Signal Officer of the Army.]

Months.	Temperature.			Precipitation.
	Maximum.	Minimum.	Mean.	
	°	°	°	*Inches.*
January	72.0	22.5	47.1	4.35
February	77.1	32.7	60.7	3.16
March	80.5	40.9	64.8	8.24
April	82.0	50.0	68.2	6.48
May	86.2	61.7	76.4	4.33
June	90.9	68.5	79.4	8.60
July	94.7	71.4	85.4	4.12
August	93.4	65.5	82.3	0.87
September	92.3	70.2	80.9	3.12
October	90.0	49.0	74.4	5.60
November	75.6	42.2	59.7	3.13
December	76.5	28.8	58.7	8.01

SIGNAL OFFICE, WAR DEPARTMENT,
Washington, February 10, 1885.

OPERATIONS AT BELAIR, LA.

Mr. J. I. Donohue, through the courtesy of Mr. John Dymond, was allowed to devote one month to analyses for the Department at Belair.

The Belair plantation of Mr. Dymond is 30 miles below New Orleans, on the left bank of the river. During the past season, on this plantation, 1,200 acres were cultivated in cane.

The amount ground was 20,532 tons and the quantity used for seed (estimated) 2,400 tons. The average yield per acre was therefore nearly 20 tons.

The largest yield per acre was 33.5 tons of "crystalline" cane; the smallest 13 tons "ribbon" cane.

Boiling began on 13th of October. The cane at first yielded poorly, being too green. The summer was dry, and September rains gave the cane a second growth.

The yield of sugar per ton increased up to the tenth week, when it reached 132 pounds per ton.

The cane was severely frozen on January 1, 1885, except that part of it which was windrowed.

The cost of a ton of cane at Belair was as follows:

Seeding and cultivation	$2 50
Shipping and cutting	30
Loading	14
Hauling	45
	3 39

Two hundred and forty pounds of coal were used for each ton of cane. Add to this the other expenses of manufacture and the total cost of the sugar from a ton of cane will not be less than $4.50.

Following are the results of the analyses:

CRYSTALLINE CANE.

TABLE XXI.—*Mill juice.*

Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.	Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*				*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	
Nov. 28....	1.0548	13.51	9.20	1.32	10.52	68.1	Dec. 18....	1.0548	13.51	9.00	.....	......	66.6
29....	1.0531	13.00	8.30	.....	......	63.1	19....	1.0510	12.60	9.00	1.79	10.79	71.1
30....	......	......	......	.....	......	......	20....	1.0548	13.51	9.60	1.56	11.16	71.0
Dec. 3....	1.0548	13.51	9.60	.....	......	71.1	28....	1.0578	14.24	10.60	1.28	11.88	75.8
3....	1.0557	14.69	9.40	.....	......	64.0	29 ...	1.0604	14.78	10.40	1.59	11.99	73.0
5....	1.0566	13.87	10.00	.....	......	72.1	31....	1.0557	13.69	10.00	1.19	11.19	72.3
6....	1.0548	13.51	10.40	.....	......	74.0	Jan. 2....	1.0570	14.04	10.00	1.43	11.43	71.0
13....	1.0548	13.51	10.56	.....	......	78.6							
14....	1.0587	14.42	10.56	.....	......	73.0	Mean......	1.0556	13.80	9.81	1.52	11.41	71.1
16....	1.0604	14.78	10.00	1.67	11.67	67.7	Maximum .	1.0604	14.78	10.60	1.85	12.05	78.6
17....	1.0548	13.51	10.20	1.85	12.05	75.5	Minimum .	1.0510	12.60	8.30	1.19	10.52	63.1

TABLE XXII.—*Clarified juice.*

Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.	Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.
		P. ct	*P. ct.*	*P. ct.*	*P. ct.*				*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	
Nov. 30....	1.0519	12.77	8.90	.....	......	69.0	Dec. 18....	1.0566	13.87	9.40	1.67	11.07	67.7
Dec. 3....	1.0531	13.19	9.60	.....	......	72.7	19....	......	......	......	....	......	......
3....	......	......	......	.....	......	......	20....	1.0540	13.35	10.00	1.92	11.92	74.7
5 ...	......	......	......	.....	......	......	28....	1.0604	14.78	11.20	1.35	11.55	75.8
6 ...	1.0531	13.19	10.00	.....	......	78.8	29....	1.0570	14.04	10.70	.....	......	70.3
13....	......	......	......	.....	......	......							
14....	......	......	......	.....	......	......	Mean......	1.0557	13.74	10.08	1.66	11.76	72.9
16....	1.0587	14.42	10.30	1.56	11.86	71.4	Maximum .	1.0604	14.78	11.20	1.92	12.42	78.8
17....	1.0570	14.04	10.60	1.82	12.42	75.7	Minimum .	1.0519	12.77	8.90	1.35	11.07	67.7

TABLE XXIII.—*Sirup.*

Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.	Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*				*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	
Dec. 16....	1.2411	51.55	36.30	.....	......	70.7	Dec. 29....	1.2433	51.81	34.00	6.67	40.67	65.6
17....	1.2411	51.55	36.86	.....	......	70.3							
18....	1.2411	51.55	34.00	.....	......	66.6	Mean	1.2462	52.41	35.42	6.46	41.66	67.5
19....	1.2523	53.47	37.40	.....	......	70.1	Maximum.	1.2523	53.47	37.40	6.67	42.65	70.7
20....	1.2523	53.47	36.40	6.25	42.65	68.2	Minimum .	1.2411	51.55	33.00	6.25	40.67	61.2
28....	1.2523	53.47	33.00	.....	......	61.2							

JAVA CANE.

TABLE XXIV.—*Mill juice.*

Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.	Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*				*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	
Nov. 21....	1.0527	13.00	9.20	......	......	70.7	Jan. 14....	1.0566	13.87	11.00	1.06	12.00	79.3
21....	1.0510	12.61	8.80	......	......	60.9	14....	1.0510	12.61	9.80	1.39	11.19	77.8
28....	1.0609	15.00	10.78	......	......	71.8	15....	1.0570	14.05	10.20	1.19	11.39	73.5
28....	1.0609	15.00	11.00	......	......	73.3	15....	1.0587	14.42	10.30	1.12	11.42	71.4
Dec. 1....	1.0548	13.51	9.50	......	......	70.3	16....	1.0587	14.42	10.50	1.08	11.58	73.6
3....	1.0548	13.51	9.60	......	......	72.0	16....	1.0587	14.42	10.20	1.01	11.21	70.7
12....	1.0587	14.42	9.50	1.92	11.42	65.8							
29....	1.0566	13.86	10.20	1.26	11.46	73.6	Mean.......	1.0572	14.07	10.12	1.23	11.51	71.7
31....	1.0587	14.42	10.00	1.08	11.08	71.4	Maximum.	1.0643	15.68	11.40	1.92	12.36	79.3
31....	1.0587	14.42	10.00	1.43	11.43	69.3	Minimum.	1.0510	12.61	8.80	.96	11.08	60.9
Jan. 1....	1.0643	15.68	11.40	.96	12.36	72.7							

TABLE XXV.—*Clarified juice.*

Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.	Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*				*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	
Dec. 1....	1.0540	13.30	9.50	......	......	71.4	Jan. 16....	1.0604	14.78	10.20	1.54	11.74	69.0
3....	1.0531	13.19	9.60	......	......	72.7							
31....	1.0587	14.42	9.20	1.48	10.68	63.9	Mean......	1.0573	14.09	9.88	1.43	11.48	70.2
Jan. 14....	1.0587	14.42	10.20	1.54	11.74	70.7	Maximum.	1.0604	14.78	10.60	1.54	11.78	73.5
15....	1.0587	14.42	10.60	1.18	11.78	73.5	Minimum	1.0531	13.19	9.20	1.18	10.68	63.9

TABLE XXVI.—*Sirup.*

Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.	Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*				*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	
Nov. 21....	1.2201	47.73	32.00	......	......	67.0	Jan. 15 ...	1.2411	51.55	32.00	6.91	38.91	62.9
Dec. 12....	1.2631	55.47	38.00	......	......	68.7							
31....	1.2523	53.47	37.40	......	......	69.9	Mean......	1.2405	51.41	34.23	6.65	39.31	66.5
Jan. 14....	1.2361	50.59	36.00	5.95	41.95	69.8	Maximum.	1.2631	55.47	38.00	7.08	41.95	69.9
14....	1.2305	49.63	30.00	7.08	37.08	60.5	Minimum.	1.2201	47.73	30.00	5.95	37.08	60.5

RIBBON CANE.

TABLE XXVII.—*Mill juice.*

Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.
		P. ct.	P. ct.	P. ct.	P. ct.	
Nov. 15	1.0548	13.51	11.00	.....	.....	85.0
16	1.0548	13.51	11.50	.....	.....	85.0
16	......			.....	.....	......
17	1.0548	13.51	11.50	.....	.....	85.0
18	......	......	......	.....	.....	......
19	......	......	......	.....	.....	......
23	1.0626	15.32	11.00	.....	.....	71.9
24	1.0626	15.32	11.00	.....	.....	71.9
25	1.0587	14.42	11.00	.....	.....	76.0
26	1.0570	14.20	10.10	.....	.....	71.1
27	1.0626	15.30	11.00	.....	.....	71.9
28	......	......	......	.....	.....	......
30	......	......	......	.....	.....	......
Dec. 2	1.0587	14.42	12.00	.....	.....	83.0
25	1.0609	14.92	11.40	1.19	12.59	76.3
26	1.0604	14.78	11.40	1.19	12.59	77.1
27	1.0566	13.86	11.40	1.43	12.83	82.2
28	......	......	......	.....	.....	......
29	......	......	......	.....	.....	......

Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.
		P. ct.	P. ct.	P. ct.	P. ct.	
Jan. 1	1.0626	15.32	11.80	1.02	12.82	79.5
2	......	......	......	.....	.....	......
3	1.0617	15.14	11.00	1.25	12.25	73.3
3	1.0604	14.78	11.00	1.14	12.14	74.4
4	1.0617	15.14	11.00	1.23	12.23	73.3
5	1.0604	14.90	11.60	1.11	12.71	77.8
6	......	......	......	.....	.....	......
7	1.0609	14.96	10.30	1.58	11.88	68.8
8	1.0566	13.87	9.50	1.47	10.97	68.5
9	1.0609	14.96	10.56	1.67	12.23	70.4
10	1.0548	13.51	9.10	1.64	10.74	67.3
11	1.0548	13.51	10.20	1.67	11.87	70.9
12	1.0548	13.51	11.00	1.51	12.51	81.4
13	1.0523	13.00	9.80	1.57	11.37	75.3
Mean	1.0611	14.40	10.88	1.38	12.12	75.7
Maximum	1.0626	15.32	12.00	1.67	12.83	85.0
Minimum	1.0523	13.00	9.10	1.02	10.74	67.3

TABLE XXVIII.—*Clarified juice.*

Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.
		P. ct.	P. ct.	P. ct.	P. ct.	
Dec. 2	1.0578	14.24	12.10	.....	.....	84.3
25	1.0626	15.32	11.50	1.25	12.75	75.0
26	......	......	......	.....	.....	......
27	1.0609	15.00	12.00	1.35	13.35	80.0
28	......	......	......	.....	.....	......
29	......	......	......	.....	.....	......
Jan. 1	1.0567	14.42	10.10	1.32	11.42	70.0
2	......	......	......	.....	.....	......
3	1.0604	14.78	11.00	1.28	12.28	74.4
3	......	......	......	.....	.....	......
4	......	......	......	.....	.....	......
5	1.0647	15.54	12.00	1.26	13.26	75.7

Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.
		P. ct.	P. ct.	P. ct.	P. ct.	
Jan. 6	......	......	......	.....	.....	......
7	1.0604	14.78	10.40	1.56	11.96	73.0
8	......	......	......	.....	.....	......
9	1.0587	14.42	9.80	1.75	11.55	67.7
10	1.0587	14.42	9.20	2.08	11.28	63.8
11	1.0531	13.15	10.00	1.61	11.61	74.1
12	1.0540	13.33	10.80	1.67	11.47	75.5
13	1.0566	13.87	10.00	1.67	11.67	72.0
Mean	1.0589	14.44	10.75	1.53	12.05	73.8
Maximum	1.0647	15.54	12.10	2.08	13.35	84.3
Minimum	1.0531	13.15	9.20	1.25	11.28	63.8

TABLE XXIX.—*Sirup.*

Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.	Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.
		P. ct.	P. ct.	P. ct.	P. ct.				P. ct.	P. ct.	P. ct.	P. ct.	
Nov. 16 ..	1.2631	55.47	37.00	....	......	66.7	Dec. 28....	1.2523	53.47	33.00	....	......	61.1
16....	1.2305	49.63	36.00	.....	......	72.5	29 ...	1.2433	51.81	34.00	6.67	40.67	65.6
18....	1.2234	48.00	30.50	.....	......	58.3	Jan. 2....	1.2631	55.47	39.82	5.71	45.53	71.8
19....	1.2411	51.55	33.20	.....	......	64.3	4 ...	1.3089	63.22	42.90	5.70	48.60	69.0
23....	1.2467	52.51	35.60	.....	......	67.7	5....	1.2467	52.51	37.00	5.26	42.26	70.8
24....	1.2411	51.55	36.88	.....	......	74.1	6 ...	1.2799	58.34	37.00	7.14	44.14	63.4
25....	1.2523	53.47	35.86	.....	......	67.0	7....	1.2361	50.59	32.00	7.69	39.69	63.2
26 ...	1.2523	53.47	36.75	....	......	68.7	8....	1.1998	43.94	25.30	8.33	33.63	60.0
27....	1.2411	51.55	37.46	....	......	71.7	11....	1.2256	48.68	32.00	5.57	37.57	65.7
28 ..	1.2411	51.55	37.46	.....	......	72.5	13 ...	1.2305	49.63	34.00	5.88	39.88	68.5
30 ...	1.2683	56.37	37.00	.....	......	65.6							
Dec. 25....	1.2361	50.59	37.00	4.34	41.34	73.1	Mean......	1.2467	52.47	35.61	6.01	41.68	67.8
26....	1.2523	53.47	37.40	4.74	42.14	70.0	Maximum.	1.3089	63.22	42.90	8.33	48.60	75.4
27....	1.2467	52.51	39.60	5.13	44.73	75.4	Minimum .	1.1998	43.94	25.30	4.34	33.63	58.3

RED OR PURPLE CANE.

TABLE XXX.—*Mill juice.*

Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.	Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.
		P. ct.	P. ct.	P. ct.	P. ct.				P. ct.	P. ct.	P. ct.	P. ct.	
Nov. 19 ...	1.0570	14.05	12.00	.....	......	82.2	Dec. 24....	1.0626	15.32	12.00	1.14	13.14	78.6
20....	1.0626	15.32	11.66	.....	......	76.6	30 ...	1.0626	15.32	11.00	...	......	72.2
Dec. 2....	1.0626	15.32	12.00	.....	......	78.4	7 ..	1.0587	14.42	11.00	1.43	12.43	76.2
9....	1.0617	15.18	12.10	.....	......	79.7							
21....	1.0643	15.68	12.10	2.04	14.14	77.2	Mean	1.0611	15.22	11.69	1.30	13.00	76.7
22....	1.0665	16.23	12.00	1.23	13.23	73.9	Maximum	1.0665	16.23	12.10	2.04	14.14	82.2
23....	1.0626	15.32	11.00	1.04	12.04	71.8	Minimum .	1.0570	14.05	11.00	1.04	12.04	71.8

TABLE XXXI.—*Clarified juice.*

Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.	Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.
		P. ct.	P. ct.	P. ct.	P. ct.				P. ct.	P. ct.	P. ct.	P. ct.	
Dec. 21....	1.0570	14.00	11.20	.....	.....	82.0	Mean......	1.0609	14.90	11.48	1.18	13.08	77.4
22 ...	1.0604	14.78	11.00	.....	.....	74.4	Maximum.	1.0626	15.32	12.00	1.22	13.14	82.0
23 ...	1.0617	15.10	11.80	1.22	13.02	77.0	Minimum .	1.0570	14.00	11.00	1.14	13.02	74.4
24....	1.0626	15.32	12.00	1.14	13.14	78.6							
30 .	1.0626	15.32	11.49	.....	.....	74.9							

TABLE XXXII.—*Sirup.*

Date.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Total sugars.	Purity coefficient.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	
Dec. 9	1.2099	43.83	35.64	....	......	77.7
21	1.2411	51.55	37.40	5.88	43.28	70.0
22	1.2523	53.47	38.00	4.88	42.88	70.0
23	1.2631	55.47	40.00	4.56	44.56	72.1
24	1.2467	52.51	38.05	4.17	42.67	73.3
30	1.2467	52.51	33.00	....	......	62.8
Jan. 6	1.2740	57.34	37.00	7.14	44.14	64.5
Mean	1.2477	52.38	37.01	5.33	43.49	70.1
Maximum	1.2740	57.34	40.00	7.14	44.56	77.7
Minimum	1.2099	43.83	33.00	4.17	42.67	62.8

TABLE XXXIII.—*Molasses from first sugar.*

Number of analysis.	Specific gravity.	Total solids.	Sucrose.	Purity coefficient.
		P. ct.	*P. ct.*	
1	1.4119	79.39	34.98	44.0
2	1.4052	78.35	31.46	40.1
3	1.3953	76.79	28.60	37.2
4	1.4119	79.39	30.80	38.8
5	1.4119	79.39	33.22	41.7
6	1.4052	78.35	34.98	44.6
Mean	1.4069	78.61	32.34	41.1

TABLE XXXIV.—*Molasses from second sugar.*

Number of analysis.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Purity coefficient.
		P. ct.	*P. ct.*	*P. ct.*	
1	1.2631	55.47	26.40	....	44.6
2	1.4052	78.35	37.40	....	47.7
3	1.2223	48.00	19.80	....	41.2
4	1.4179	80.40	27.30	....	33.8
5	1.3783	74.30	27.00	....	39.9
6	1.3848	75.29	30.00	....	39.9
7	1.3979	77.32	30.00	21.00	38.8
8	1.3719	73.23	29.50	19.00	39.9
Mean	1.3552	70.29	28.42	20.00	40.6
Maximum	1.4179	80.40	37.40	21.00	47.7
Minimum	1.2223	48.00	19.80	19.00	33.8

TABLE XXXV.—*Molasses from third sugar.*

Number of analysis.	Specific gravity.	Total solids.	Sucrose.	Glucose.	Purity coefficient.
		Per cent.	*Per cent.*	*Per cent.*	
1	1.4259	81.47	22.00	28.13	27.0
2	1.3848	75.27	19.50	21.00	26.0
Mean	1.4053	78.37	20.75	24.56	26.5

TABLE XXXVI.—*Third sugars.*

Number of analysis.	Sucrose.	Glucose.
	Per cent.	*Per cent.*
1	72.00	....
2	73.00	9.50
Mean	72.50	....

REMARKS ON PRECEDING TABLES.

Table XXI.—While the crystalline variety of cane yields a heavy tonnage it shows a low percentage of sugar, being fully two units below some of the other varieties grown on the same plantation. The percentage of available sugar in these juices is only 5.82 and the maximum yield per ton, if all the juice could be extracted and worked without loss, would be only 116 pounds. As a result of the analyses Mr. Dymond has decided to abandon the further cultivation of this variety of cane.

Table XXIII.—The number of sirup analyses is so much smaller than that of the juices that a fair comparison of the mean composition of the two can hardly be made. The sirup made from December 16 to 29 was, however, obtained from the juices of Table XXI of same dates. In only two instances does the purity coefficient of these juices fall below 70. In the sirup, however, more than half of them have a coefficient less than 70, and in no case does it reach 71. It is plain, therefore, that there has been a partial inversion of the sugar during the processes of clarification and evaporation.

Table XXIV.—The Java canes are better than the crystalline but are not up to the mark for good varieties. The mean percentage of sucrose in the raw juice is only 10.12.

Table XXVI.—Again the sirups show marks of deterioration as compared with the raw and clarified juices. The purity coefficient has fallen to 66.5.

Table XXVII.—The ribbon cane shows a much richer juice than the crystalline or Java varieties. Twenty-four analyses show a mean sucrose percentage of 10.88 and a coefficient of 75.7.

Table XXIX.—The sirup again shows a falling off in its percentage of crystallizable sugar. But it must be remembered that in all these sirups the sucrose was determined by a single polarization and for this reason the coefficient must be uniformly a little too low.

Table XXX.—The purple cane gave the best results of all the varieties cultivated by Mr. Dymond. But it would be unwise from a single series of experiments to proclaim any one variety better than all others. Vigor of growth, hardiness, largeness of yield, are some of the factors that must be studied in connection with the content of sugar.

Table XXXII.—The same remarks are applicable here that have been made on the preceding sirup tables.

Table XXXV.—This is an illustration of the origin of the statement that molasses may have a larger content of glucose than sucrose. The explanation of this has already been made.

GENERAL REVIEW.

The production of sugar and molasses in Louisiana has almost ceased to be profitable. Damage from overflow, unfavorable seasons and depression of prices have been the causes which have rendered the cultivation of the sugar-cane a precarious undertaking. It would be useless to discuss further here the causes which have forced the price of sugar down to less than the cost of its production. Yet in spite of rapidly increasing consumption the amount of sugar made has been so enormous that a fair price for it could not be maintained. In fact the progress of agriculture is more rapid than the increase of population; and more food per capita is grown now than ever before.

Since we cannot hope for any marked decrease in the sugar product of the world the only remaining way to save the indigenous industry of this country is to make its processes more economical.

The sum of all the analyses shows that the percentage of sucrose in sugar-cane in this country is neither as large as in the tropics nor as it has generally been regarded.

I had expected to find the mean percentage of sucrose in the juices of cane at least fourteen and was not a little surprised to find it greatly less.

One of the great problems to which the sugar-cane grower should seriously address himself is to secure the production of a cane richer in sugar. Careful and systematic selection of seed, and a constant practice of a most favorable system of fertilizing and cultivation will surely result in such an improvement. No such scientific attempts have been made in this country to improve the cane as have been attended with such signal success with the sugar beet in Europe. Yet what would be the condition of this industry to-day if the beet-growers of Germany were to use the same kind of seed they planted fifty years ago? It may be true that the sugar-cane would not lend itself to improvement as rapidly as the beet has done, but the natural law of selection still holds good, and a certain improvement must follow its application.

The best way to accomplish this result would be the establishment by the State of an experiment station where a principal object of the work would be the improvement of the quality of the cane. The results thus obtained in a small way could be made of the greatest possible advantage on the plantations.

Having secured the best development of the cane and established the most favorable conditions of culture, the process of manufacture would next receive attention. As this is now generally carried on it is neither scientific nor economical.

The history of the development of the sugar industry shows that only in central factories, where the operations can be carried on on a large scale, the most economic methods can be applied.

With the exception of the manufacture of sugar and molasses for domestic use the small mill and open kettle must be abandoned.

The method of extracting the sugar by diffusion is also worthy of a trial, and should it succeed, will effect a large saving of sugar.

Improved methods of clarification are also to be tested, and that process which gives a juice of the greatest purity without too great an expense, brought generally into use.

It is doubtful whether the method so successfully employed with beet juices would succeed as well with the juices of the cane.

The excess of lime which would be employed would act vigorously on the uncrystallizable sugar, and the products of this reaction may prove a serious hindrance to the subsequent operations. Nevertheless the trial should be made at first in a small way. It is the intention of the Commissioner of Agriculture to make the above mentioned experiments with diffusion and clarification during the coming season.

With a wise protection against too great an influx of foreign sugars, and a careful trial of all improvements in the culture and manufacture of the cane it is reasonable to hope that the depression of the indigenous sugar industry of the country will pass away.

SUGAR INDUSTRY OF THE UNITED STATES.

Part II.—BEET SUGAR.

BEET SUGAR.

THE SUGAR BEET.

Three varieties of sugar beet were grown by the Department.

The area planted in each variety was very small and no estimate of yield per acre was made. The fertilizing and cultivation were the same as described for sorghum.

The analyses show that the hot, dry summers of this locality are not favorable to the production of sugar in the beet.

The results of the work give emphasis to the fact pointed out in Bulletin No. 3, and illustrated in chart No. 10, that the sugar beet will not prosper south of the isotherm of 70° mean temperature for the summer months.

The data of the analyses will be found in the following table.

In each case five beets were taken, the total weight of which, as well as weight after removal of neck, are given. After the removal of the neck the beets were cut longitudinally into quarters and one quarter taken from each beet. These samples were then reduced to pulp and the juice expressed.

The percentages of sucrose and reducing sugar are given for the juice and not on weight of the beet.

Analyses of beet-juices from beets grown by the Department.

Number.	Total weight.	Weight without collar.	Juice expressed.	Specific gravity.	Sucrose direct.	Reducing sugar.	Total solids.	Solids not sugar.	Purity coefficient.
	Grams.	*Grams.*	*Per cent.*		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
1	5,305	4,018	59.26	1.053	8.88	.17	13.06	4.01	68.00
2	9,490	6,845	72.81	1.040	5.92	.40	9.97	3.65	59.38
3	6,740	5,305	71.14	1.048	8.34	.32	11.87	3.21	70.26
4	8,970	6,279	71.11	1.050	8.56	.21	12.35	3.58	69.80
5	7,455	4,890	66.69	1.046	7.49	.53	11.39	3.34	65.76
6	9,448	6,738	63.01	1.042	7.09	.24	10.44	3.11	66.95
7	10,272	8,319	68.64	1.047	7.79	.44	11.63	3.40	66.98
8	10,730	7,570	67.44	1.047	7.86	.13	11.63	3.64	67.58
9*	9,090	6,316	72.78	1.046	7.06	.41	11.39	3.92	51.98
10	8,825	6,347	68.67	1.052	9.48	.21	12.82	3.13	73.95
11	11,230	8,615	70.25	1.049	7.53	.46	12.11	4.12	72.09
12	9,655	6,782	74.99	1.046	7.68	.33	11.39	3.38	67.43
13	10,312	7,242	71.96	1.051	8.78	.33	12.58	3.47	69.79
14	7,950	5,855	71.94	1.048	8.00	.46	11.87	3.41	67.45

Analyses of beet-juices from beets grown by the Department—Continued.

Number.	Total weight.	Weight without collar.	Juice expressed.	Specific gravity.	Sucrose direct.	Reducing sugar.	Total solids.	Solids not sugar.	Purity coefficient.
	Grams.	*Grams.*	*Per cent.*		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
15	9, 715	6, 455	71. 82	1. 048	7. 62	. 37	11. 87	3. 88	64. 20
16	9, 039	6, 557	71. 88	1. 049	7. 50	. 33	12. 11	4. 28	61. 93
17	7, 925	6, 180	67. 48	1. 051	9. 43	. 29	12. 58	2. 86	74. 97
18	8, 949	6, 759	70. 52	1. 047	7. 30	. 36	11. 63	3. 97	62. 77
19	9, 889	7, 033	71. 07	1. 046	7. 05	. 31	11. 39	4. 03	61. 90
20	7, 997	5, 190	66. 58	1. 052	8. 57	. 76	12. 82	4. 09	66. 85
21	10, 710	7, 025	66. 67	1. 051	8. 29	. 32	12. 58	3. 97	65. 90
22	8, 448	5, 520	62. 70	1. 054	8. 63	. 20	13. 30	4. 47	64. 88
23	8, 250	6, 107	72. 09	1. 045	7. 06	. 39	11. 16	3. 71	63. 26
24	8, 288	6, 287	74. 68	1. 045	7. 28	. 42	11. 16	3. 45	65. 05
25	10, 663	7, 845	78. 89	1. 041	6. 13	. 50	10. 21	3. 58	60. 04
26	9, 605	8, 066	75. 37	1. 041	6. 43	. 33	10. 21	3. 45	62. 98
27	8, 340	6, 410	75. 43	1. 042	6. 12	. 74	10. 44	3. 58	58. 62
28	10, 242	7, 904	75. 08	1. 038	5. 87	. 35	9. 49	3. 27	61. 85
29	8, 858	6, 865	71. 84	1. 048	7. 72	. 60	11. 87	3. 55	65. 04
30	9, 152	6, 550	77. 35	1. 042	6. 31	. 44	10. 44	3. 69	60. 44
31	8, 783	6, 990	72. 11	1. 043	6. 61	. 75	10. 68	3. 32	61. 89
32	14, 292	9, 087	73. 21	1. 049	8. 55	. 27	12. 11	3. 29	70. 60
33	10, 882	7, 795	75. 06	1. 043	6. 39	. 54	10. 68	3. 75	59. 84
34	9, 675	7, 322	76. 06	1. 046	7. 61	. 41	10. 39	3. 37	66. 81
35	8, 419	6, 550	74. 53	1. 043	6. 30	. 46	10. 68	3. 92	58. 99
36	11, 970	9, 705	77. 49	1. 045	6. 44	. 25	11. 16	4. 47	57. 71
37	7, 749	6, 807	73. 48	1. 042	6. 47	. 42	10. 44	3. 55	61. 97
38	9, 702	7, 137	73. 52	1. 043	6. 30	. 67	10 68	3. 71	58. 99
39	8, 910	6, 928	74. 42	1. 045	6. 41	. 40	11. 16	4. 35	57. 44
40	9, 207	6, 975	75. 96	1. 045	6. 97	. 37	11. 16	3. 82	62. 46
41	10, 055	7, 635	72. 91	1. 043	6. 27	. 51	10. 68	3. 90	58. 71
42	9, 045	6, 905	73. 77	1. 041	6. 35	. 17	10. 21	3. 69	62. 19
43	11, 020	7, 710	77. 51	1. 041	6. 19	. 43	10. 21	3. 59	60. 63
44	10, 343	6, 641	78. 04	1. 046	7. 00	. 54	11. 39	3. 85	61. 37
45	8, 250	5, 180	67. 53	1. 052	9. 51	. 19	12. 82	3. 12	74. 18
46	8, 680	7, 147	73. 66	1. 050	8. 98	. 29	12. 35	3. 08	72. 71
47	8, 500	6, 880	76. 14	1. 044	7. 45	. 48	10. 92	2. 99	68. 22
48	11, 065	9, 945	76. 93	1. 042	5. 60	. 32	10. 44	4. 52	53. 64
49	7, 594	5, 964	77. 61	1. 041	6. 47	. 72	10. 21	3. 02	63. 37
50	8, 170	6, 260	72. 42	1. 051	8. 41	. 29	12. 58	3. 78	66. 85
51	9, 561	7, 446	73. 35	1. 050	8. 05	. 46	12. 35	3. 84	45. 18
52	8, 695	6, 465	76. 31	1. 047	8. 43	. 18	11. 63	3. 02	72. 49
53	8, 837	6, 435	78. 48	1. 044	6. 93	. 54	10. 92	3. 45	63. 46
54	10, 990	6, 760	68. 53	1. 054	7. 87	. 37	13. 30	5. 06	59. 17
55	9, 367	7, 612	76. 41	1. 050	7. 71	. 38	12. 35	4. 26	62. 91
56	7, 748	5, 583	71. 18	1. 051	8. 60	. 48	12. 58	3. 58	68. 36
57	7, 247	5, 842	77. 72	1. 048	8. 22	. 37	11. 87	3. 28	69. 25
58	9, 092	6, 822	74. 96	1. 051	8. 50	. 42	12. 58	3. 66	67. 57
59	8, 258	5, 796	76. 60	1. 053	8. 64	. 78	13. 06	3. 64	66. 16
60	7, 038	5, 703	74. 36	1. 051	8. 42	. 53	12. 58	3. 53	66. 93
61	7, 494	5, 669	68. 51	1. 053	8. 64	. 36	13. 06	4. 06	66. 16
62	8, 232	6, 296	73. 88	1. 051	8. 57	. 57	12. 58	3. 44	68. 12
63	8, 120	5, 942	71. 91	1. 052	8. 76	. 33	12. 88	3. 73	68. 33
64	7, 142	5, 079	75. 15	1. 055	9. 12	. 21	13. 53	4. 20	67. 41
65	8, 940	7, 467	72. 04	1. 056	9. 84	. 15	13. 77	3. 78	71. 46
66	9, 507	6, 265	73. 21	1. 051	8. 13	. 52	12. 58	3. 93	64. 63

It is interesting to compare the results of these analyses with those published in Bulletin No. 3, p. 26, and with those of California beets, given further along.

Washington beets, mean sucrose	7. 61
York, Pa., beets, mean sucrose	7. 64
Oswego, N. Y., beets, mean sucrose	13. 13

As a practical deduction from these results it will be found useless to try to introduce the sugar-beet culture in localities south of the isotherm already mentioned. But north of that line there is left abundant acreage to raise a crop of beets which would render this country largely independent of a foreign sugar supply.

NOTES.

It is evident that it would prove unprofitable to try to manufacture sugar from beets of the poor quality represented above.

The average percentage of sucrose in all the samples examined was 7.61.

In every case reducing sugar (glucose) was found, the mean percentage being .39. In good sugar beets, grown in a suitable climate and soil, there is at most only a trace of reducing sugar.

The percentage of solids not sugar is also very high, viz, 3.78 (mean of all the analyses).

The average weight of the beets (necks off) was 1,344 grammes (2.9 pounds).

THE SUGAR BEET IN CALIFORNIA.

The Alvarado, Cal., beet-sugar factory, situated on the east side of the bay, 24 miles from San Francisco, is still the only one in operation in the United States.

The climate of Alvarado is a peculiar one, and, as experience has shown, very suitable to the development of a first-class sugar beet.

The winters are mild. Planting begins in February and can be continued up to the middle of May. The early planting matures in the summer and the factory can be started by the middle of August. From this time until December there is a consecutive maturity of beets. The summers and falls are dry, and there is little danger of the beets taking a second growth by reason of early rains.

When harvested the beets do not require to be siloed, but are kept in heaps either with no covering at all or at most a little straw.

In the middle of December, 1884, the company had nearly twenty thousand tons of beets on hand.

In Fig. 7 is seen this immense pile of beets, covering over two acres of surface and of eight feet mean depth.

The land on which these beets are grown is level, the soil sandy and fertile, stretching from the bay eastward to the hills, a breadth of from five to ten miles.

The character of this soil and its extent in the State will be more easily seen from the following maps and description prepared by Prof. E. W. Hilgard, and taken from the reports of the tenth census.

The appearance of the valley lands of the Coast Range, in cultivation for beets, is seen in Fig. 4, taken from a photograph of a beet field near Alvarado.

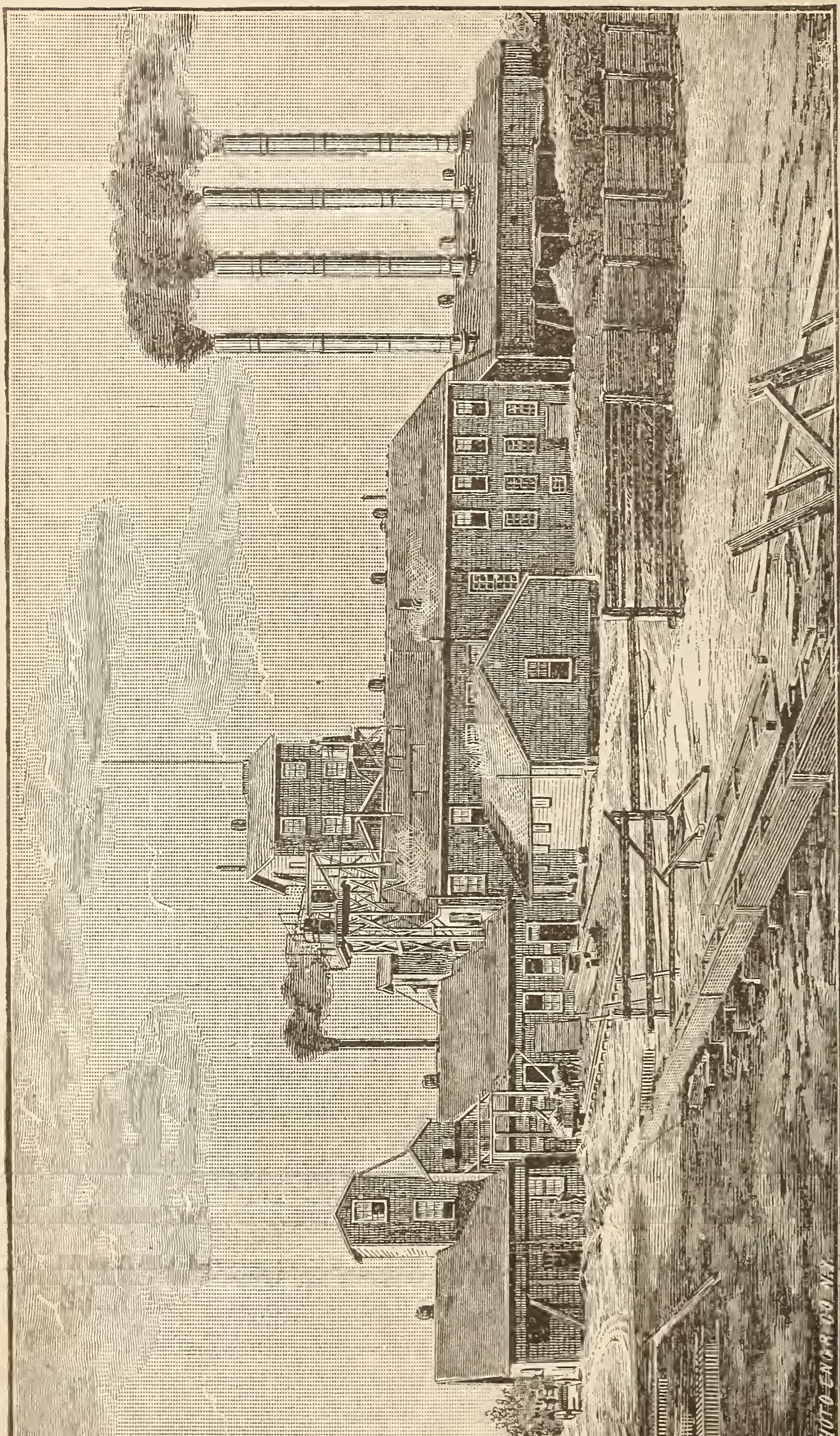


Fig. 6.—Beet Sugar Factory, Alvarado, Cal.

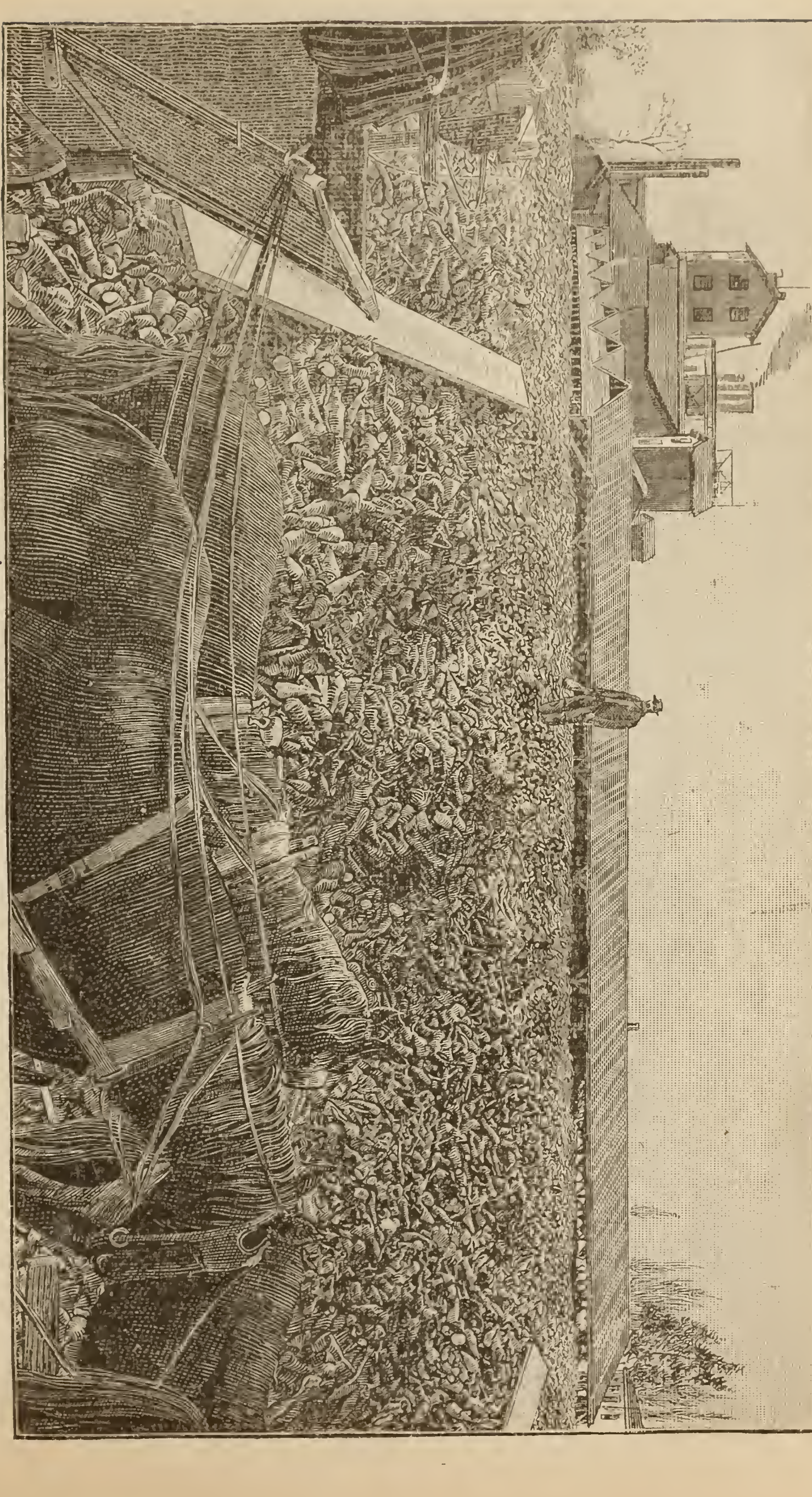


FIG. 7.—SUGAR BEETS (NEARLY 20,000 TONS), ALVARADO, CAL.

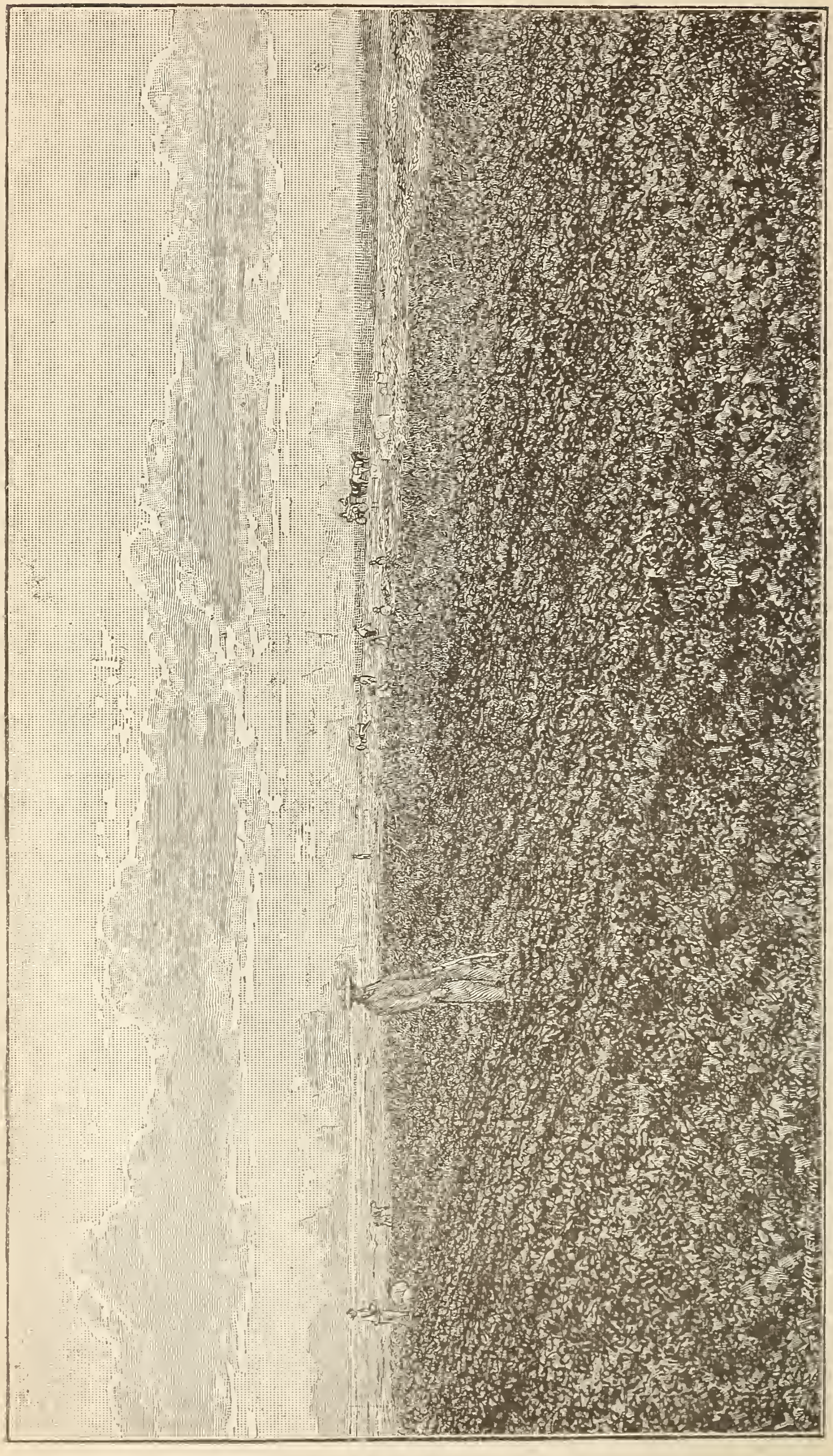


Fig. 8.—A Field of Sugar Beets near Alvarado, Cal.

The following tables prepared at my request by Mr. E. Dyer, superintendent of factory, exhibit the data collected from twelve different fields representing a fair average of all the land in cultivation for beets in 1884.

The analyses represent a fair sample of beets taken from all the wagons during each day the beets were brought to the factory. The kind of seed used is also indicated in the tables.

Formerly all the seed planted was imported, but the company is now raising its own seed and with the most encouraging results.

The expression "first and second year" indicates that the seed was native and one or two years from the imported seed.

In all the analyses made at Alvarado the sucrose is calculated on the weight of the beet and not of the juice.

FIELD OF JOHN LOWRIE.

Date.	Kind of seed used.	Total solids.	Sucrose.	Other solids.	Coefficient of purity.	Remarks.
1884.		*P. ct.*	*P. ct.*	*P. ct.*		
Sept. 10	Native red first year	15.9	13.4	2.5	84.2	Planted 315 acres; not all harvested yet; will average between 15 to 20 tons per acre.
15	Native white second year	16.9	13.9	3.	82.2	
20	Native red first year	17.3	14.9	2.4	86.1	
25	......do	17.9	15.6	2.3	85.7	
30	......do	17.2	15.1	2.1	87.7	
Oct. 1	......do	18.5	15.7	2.1	84.8	
5	.... do	17.7	14.7	3.	83.	
10	.....do	17.8	15.5	2.3	87.6	
15	......do	17.	14.4	2.6	84.7	
20	.... do	16.6	14.	2.6	84.	
24	.....do	13.7	12.6	3.1	80.	
28	......do	17.4	14.3	3.1	82.1	
Nov. 9	...do	16.5	13.5	3.	81.2	
13	......do	14.8	11.5	3.3	77.1	
16	......do	14.5	12.5	2.	86.2	
18	......do	13.	10.4	2.6	80.	
22	Native white second year	17.	14.9	2.4	87.6	
24	Native red first year	16.2	13.7	2.5	84.5	
Dec. 5	......do	15.4	13.2	2.2	85.7	
10	......do	15.6	13.2	2.4	84.4	

FIELD OF B. AZEVADA.

Date.	Kind of seed used.	Total solids.	Sucrose.	Other solids.	Coefficient of purity.	Remarks.
Nov. 5	Native white second year	17.	14.	3.	82.9	Planted 10 acres; had 153.8 tons; yield per acre, 15.3 tons.
6	Native red first year	16.2	13.8	2.4	85.1	
9	.....do	16.8	14.3	2.3	86.3	
13	Native white second year	17.4	15.4	2.	88.5	

FIELD OF JAMES NARCISSO.

Date.	Kind of seed used.	Total solids.	Sucrose.	Other solids.	Coefficient of purity.	Remarks.
Oct. 23	Native white second year	16.1	13.1	3.	81.3	Planted 10 acres; had 237 tons; yield per acre, 23.7 tons.
Nov. 5	......do	16.5	13.6	2.9	82.4	
7	......do	15.2	13.	2.2	85.1	
13	.....do	15.2	12.3	2.9	80.9	
20	.....do	16.9	13.5	3.4	79.8	
23	......do	17.1	14.3	3.8	83.6	
24	......do	15.6	12.8	2.	82.	

FIELD OF J. G. VANDEPEER.

Date.		Kind of seed used.	Total solids.	Sucrose.	Other solids.	Coefficient of purity.	Remarks.
1884.			*P. ct.*	*P. ct.*	*P. ct.*		
Oct.	21	Native white second year	16.8	13.9	3.1	82.7	Planted 20 acres; had 360 tons; yield per acre, 18 tons.
	24	do	17.9	15.	2.9	83.2	
Nov.	1	do	15.6	13.5	2.1	86.5	
	3	do	17.8	15.1	2.7	84.4	
	4	do	15.2	12.5	2.7	82.2	
	6	Native red first year	14.3	12.	2.3	83.9	
	7	do	14.2	12.	2.2	84.	
	13	Native white second year	17.2	14.3	2.9	83.1	
	15	Native red first year	14.2	12.	2.2	84.5	
	17	Native white second year	18.[illegible]	16.1	2.4	87.5	
	24	do	17.	14.	3.1	82.3	
	26	do	16.3	14.	2.3	85.9	

FIELD OF FRANK MUNYAR.

Date.		Kind of seed used.	Total solids.	Sucrose.	Other solids.	Coefficient of purity.	Remarks.
Nov.	1	Native white second year	16.2	13.9	2.3	85.	Planted 12 acres; had 246 tons; yield per acre, 20.5 tons.
	6	do	15.6	13.	2.6	83.3	
	9	Native red first year	16.8	14.	2.8	83.3	
	11	do	16.9	14.2	2.7	84.	
	19	do	15.2	12.6	2.6	80.7	

FIELD OF M. BAIN.

Date.		Kind of seed used.	Total solids.	Sucrose.	Other solids.	Coefficient of purity.	Remarks.
Oct.	24	Native red, first year	17.3	14.5	2.8	83	Planted 18 acres: had 414 tons; yield per acre, 23 tons.
	24	Native white, second year	18.4	15.8	2.6	85.9	
	31	Native red, first year	15.2	12	3.2	78.9	
	31	do	16.2	14	2.2	86.4	
Nov.	2	do	16.8	14.7	2.1	86.3	
	5	do	16.9	14.7	2.2	86	
	6	Native white, second year	16.9	14.2	2.7	83.7	
	7	Native red, first year	15	12.4	2.6	82	
	10	do	17.2	14.5	2.7	84.3	
	15	do	17.2	15	2.2	87.2	
	18	do	16.7	14.5	2.2	86.8	

FIELD OF A. GEORGE.

Date.		Kind of seed used.	Total solids.	Sucrose.	Other solids.	Coefficient of purity.	Remarks.
Oct.	21	Native white, second year	15.2	12	3.2	79	Planted 10 acres; had 153.8 tons; yield per acre, 15.3 tons.
	29	Native red, first year	14.6	12.1	2.5	82.8	
	1	do	14.5	11.5	3	79.3	
	9	do	14.6	12	2.9	82.1	
	16	Native white, second year	16.1	14	2.1	86.9	
	18	do	16.7	13.1	3.6	78.4	

FIELD OF A. P. MACHADE.

Date.		Kind of seed used.	Total solids.	Sucrose.	Other solids.	Coefficient of purity.	Remarks.
Oct.	24	Native white, second year	16.3	13.7	2.6	84.6	Planted 8 acres; had 152 tons; yield per acre, 19 tons.
	28	do	17.4	14.7	2.7	84.6	
Nov.	1	do	17.4	15.3	1.9	89.6	
	5	do	16.2	14	2.2	86.4	
	10	do	14	11.6	2.4	82.5	
	13	do	14.6	12.5	2.1	85.6	

FIELD OF FRANK GEORGE.

Date.		Kind of seed used.	Total solids.	Sucrose.	Other solids.	Coefficient of purity.	Remarks.
Oct.	21	Imported white Imperial	18.3	15.5	2.8	84.7	Planted 10 acres; had 175 tons; yield per acre, 17.5 tons.
	23	do	16.8	13	3.8	77.3	
Nov.	2	do	16.2	12.9	3.3	79.6	
	5	do	15.9	13	2.9	81.6	
	10	do	15.5	13	2.5	83.8	

FIELD OF A. GASPER.

Date.		Kind of seed used.	Total solids.	Sucrose.	Other solids.	Coefficient of purity.	Remarks.
Oct.	21	Imported white Imperial	16.6	13	3.6	78.3	Planted 7 acres; had 105 tons; yield per acre, 15 tons.
	28	do	16.2	13.8	2.4	85	
Nov.	10	do	15.7	13	2.7	82.8	
	14	do	16.4	14.5	1.9	88.4	

FIELD OF JAMES FIRERA.

Date.	Remarks.	Total solids.	Sugar.	Other solids.	Co-efficiency of purity.	Remarks.
1884		P. ct.	P. ct.	P. ct.		
Oct. 24	Imported white from Fred. Knauer, Germany.	15.3	12.5	3	80.1	Planted 5 acres; had 130 tons; yield per acre, 26 tons.
24	......do	15.2	11.5	2.7	75.5	
Nov. 4	......do	16.4	12.8	3	78	
11	......do	15.6	12.3	2.1	80.1	
13	......do	16.5	13.3	3.2	80.6	
19	......do	14.2	10.2	4	91.8	
20	......do	13.7	9.1	4.8	66.4	

FIELD OF FRANK P. ROSE.

Date.	Remarks.	Total solids.	Sugar.	Other solids.	Co-efficiency of purity.	Remarks.
Oct. 24	Native red, first year	19.2	17	2.2	88.5	Planted 20 acres; had 474 tons; yield per acre, 23.7 tons.
24	Imported white	16	13.6	2.4	85	
25	......do	17.3	13.2	3.5	78	
30	Native red, first year	16.5	13.8	2.7	83.6	
Nov. 15	......do	17.6	15.3	2.3	86.9	
16	......do	17.3	15	2.3	86.6	
19	......do	16.5	13.8	2.7	83.6	
24	......do	16.3	13	3.3	79.8	

Tables of work at factory for each week from September 16 *to November* 11.

Mr. E. F. Dyer also kindly furnished me with the following data illustrating the workings of the factory in detail for nine consecutive weeks.

These tables contain a large amount of most practical information as well as valuable scientific data.

EXPLANATION OF TABLES.

The analyses were made daily, and these are given as well as the mean for the week. The column headed "Diffusions" gives the number of diffusion cells filled each day. The degree Brix represents the per cent. total solids in the juice. The polarization gives the percentage of sucrose in the juice. This subtracted from the total solids gives the *difference* or solids not sucrose.

The percentage of sucrose divided by the percentage of total solids gives the "quotient" or coefficient of purity.

The columns under "Filtration" show the density and alkalinity of the juice and semi-sirup as they come from the filter presses.

The loss of sugar in the pulps and waste waters is also given.

The percentage of lime carbonate in the animal charcoal when it is taken out for washing and reburning is also given. Last of all are the analyses of the melada as it comes from the strike pan on its way to the centrifugal. The summary gives the tons of beets worked per week and the yield of pure granulated sugar in percentages of the beets worked.

Record of working of Standard Sugar Refinery.

WEEK ENDING SEPTEMBER 16, 1884.

Date.	Diffusions.	Cossettes per 100 of juice. Deg. Brix.	Cossettes per 100 of juice. Sucrose.	Cossettes per 100 of juice. Diff.	Cossettes per 100 of juice. Quot.	Diffusion juice. Deg. Brix.	Diffusion juice. Sucrose.	Diffusion juice. Quot.	Saturation. I. Alkalinity.	Saturation. II. Alkalinity.	Filtration. First. Deg. Brix.	Filtration. First. Alk.	Filtration. Second. Unfiltered. Deg. Brix.	Filtration. Second. Unfiltered. Alk.	Filtration. Second. Filtered. Deg. Brix.	Filtration. Second. Filtered. Alk.	Loss per 100. Pulp.	Loss per 100. Waste water.	Loss per 100. Slime.	Char. Ca CO_3. First.	Char. Ca CO_3. Second.	Melada. Sucrose.	Melada. Buckets.
			Per ct.						*Per ct.*	*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		
10	71	15.9	13.4	2.5	84.2	12.8	10.4	81.1	0.168	0.123	9.7	0.084	43.7	0.226	41.8	0.151	0.4	1.4	......	14.6	......	......	......
11	69	16.6	13.3	3.3	80.1	12.9	10.3	79.8	0.210	0.182	15.9	0.092	48.5	0.159	47.6	0.106	0.2	1.2	......	......	11.55	83	......
12	67	17	14.6	2.4	84.3	12.8	10.2	80.7	0.182	0.082	13.4	0.070	47.5	0.200	45.0	0.095	0.15	0.1	......	15.5	......	......	......
13	67	16.8	13.6	3.2	82.6	13.2	10.5	82.6	0.173	0.143	13.5	0.080	49.5	0.168	47.8	0.077	0.1	1.6	......	9.6	9.6	......	......
14	69	16.9	14.1	2.8	83.4	12.7	10.5	82.2	0.200	0.196	13.1	0.098	49	0.126	40.2	0.070	0.1	1.7	......	......	......	......	......
15	75	16.9	13.9	3	82.2	13.2	10.3	78.0	0.184	0.142	11.8	0.075	51	0.250	49.3	0.159	0.3	......	......	......	12.9	82	......
16	74	17.6	15.2	2.2	86.3	12.4	10	80.6	0.187	0.176	11.6	0.061	49.1	0.215	44.8	0.097	0.1	1.3	......	......	......	......	......
Average	......	16.7	14.0	2.7	83.2	12.8	10.3	80.7	0.186	0.152	12.7	0.080	48.3	0.192	45.2	0.107	0.19	1.2	......	14.8	11.35	82.5	......

Tons of beets worked, 565. Per cent. of first product obtained, 9.5.

Record of working of Standard Sugar Refinery—Continued.

WEEK ENDING SEPTEMBER 23, 1884.

Date.	Diffusions.	Cossettes per 100 of juice. Deg. Brix.	Cossettes per 100 of juice. Sucrose.	Cossettes per 100 of juice. Diff.	Cossettes per 100 of juice. Quot.	Diffusion juice. Deg. Brix.	Diffusion juice. Sucrose.	Diffusion juice. Quot.	Saturation. I. Alkalinity.	Saturation. II. Alkalinity.	Filtration. First. Deg. Brix.	Filtration. First. Alk.	Filtration. Second. Unfiltered. Deg. Brix.	Filtration. Second. Unfiltered. Alk.	Filtration. Second. Filtered. Deg. Brix.	Filtration. Second. Filtered. Alk.	Loss per 100. Pulp.	Loss per 100. Waste water.	Loss per 100. Slime.	Char. Ca CO3. First.	Char. Ca CO3. Second.	Melada. Sucrose.
									Per ct.	Per ct.		Per ct.		Per ct.		Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	
17	70	17.4	14.9	2.5	85.6	11.9	9.7	81.5	0.201	0.187	10.9	0.084	48.9	0.187	46.2	0.071	0.15	0.55	......	14	12.2	....
18	75	17.1	14.1	2.7	84.2	12.8	10.5	82	0.224	0.196	11.8	0.067	50.9	0.226	47.9	0.148	0.15	0.75	......	......	......	....
19	69	16.7	14	2.7	83.2	12.7	9.7	76.3	0.204	0.177	13.1	0.096	47.9	0.220	46	0.129	0.2	1.6	2.8	14.9	9.4	....
20	72	17.3	14.9	2.4	86.1	12.3	9.9	80.4	0.239	0.198	......	0.082	.....	0.250	43.7	0.100	0.2	1.5	7.03	......	......	....
21	71	17.6	15.5	2.1	81	13.4	11.2	83.8	0.223	0.190	15.2	0.071	......	0.198	43.7	0.118	0.3	1.7	......	......	......	83.5
22	71	17.2	14.9	2.3	86.6	13.7	11.4	85.1	0.259	0.218	15.7	0.091	47.3	0.165	45.1	5.150	0.3	1.5	......	15.2	11.7	....
23	72	17.7	15.3	2.4	86.4	13.3	11.1	83.4	0.220	0.179	15.4	0.124	50.7	0.124	48.3	0.193	1.2	1.5	12.2	......	......	....
Average	......	17.2	14.8	2.4	85.5	12.8	10.5	81.7	0.224	0.192	13.6	0.087	49.1	0.195	46.2	0.129	0.34	1.30	7.34	14.7	11.1	83.5

Tons of beets worked, 565. Per cent. of first product obtained, 9.64.

WEEK ENDING SEPTEMBER 30, 1884.

Date.	Diffusions.	Cossettes per 100 of juice. Deg. Brix.	Cossettes per 100 of juice. Sucrose.	Cossettes per 100 of juice. Diff.	Cossettes per 100 of juice. Quot.	Diffusion juice. Deg. Brix.	Diffusion juice. Sucrose.	Diffusion juice. Quot.	Saturation. I. Alkalinity.	Saturation. II. Alkalinity.	Filtration. First. Deg. Brix.	Filtration. First. Alk.	Filtration. Second. Unfiltered. Deg. Brix.	Filtration. Second. Unfiltered. Alk.	Filtration. Second. Filtered. Deg. Brix.	Filtration. Second. Filtered. Alk.	Loss per 100. Pulp.	Loss per 100. Waste water.	Loss per 100. Slime.	Char. Ca CO3. First.	Char. Ca CO3. Second.	Melada. Sucrose.
																				Per ct.	Per ct.	
24	78	16.2	14.0	2.2	86.4	13.4	10.6	79.1	0.212	0.187	15.1	0.091	46.8	0.220	44.3	0.128	0.6	1.7	......	13.3	11.4	83.5
25	73	17.9	15 6	2.3	85.7	13.6	11.0	80.9	0.234	0.179	15.8	0.138	46.4	0.223	43.1	0.149	0.2	1.5	8.44	......	......	....
26	64	17.4	15.1	2.3	84.7	13.0	11.3	86.1	0.182	0.231	16.2	0.091	47.1	0.242	45.2	0.165	0.5	1.8	......	14.7	11.4	....
27	78	16.6	14.5	2.1	87.3	14.2	12.0	84.4	0.262	0.220	16.0	0.124	......	0.265	......	0.138	0.5	1.2	8.74	......	......	....
28	68	17.9	15.9	2.0	88.8	13.4	11.8	87.1	0.234	0.176	15.2	0.102	47.3	0.303	44.0	0.160	0.7	1.1	......	......	......	81.7
29	73	17.6	15.4	2.2	87.5	12.8	10.7	83.5	0.158	0.138	14.9	0.082	48.9	0.234	46.8	0.171	0.9	1.6	......	15.63	12.59	....
30	72	17.2	15.1	2.1	87.5	13.5	11.1	82.2	0.248	0.176	......	0.091	......	0.135	......	0.165	....	1.4	......	......	......	81.0
Average	.....	17.2	15.0	2.1	86.8	13.4	11.2	83.3	0.218	0.186	15.5	0.102	47.3	0.231	44.6	0.155	0.5	1.4	8.59	14.54	11.79	82.06

Tons of beets worked, 566.72. Per cent. of first product obtained, 9.54.

Record of working of Standard Sugar Refinery—Continued.

WEEK ENDING OCTOBER 7, 1884.

Date.	Diffusions.	Cossettes per 100 of juice.				Diffusion juice.			Saturation.		Filtration.						Loss per 100.			Char.		Melada.
											First.		Second.							Ca Co_3.		
													Unfiltered.		Filtered.							
		Deg. Brix.	Sucrose.	Diff.	Quot.	Deg. Brix.	Sucrose.	Quot.	I. Alkalinity.	II. Alkalinity.	Deg. Brix.	Alk.	Deg. Brix.	Alk.	Deg. Brix.	Alk.	Pulp.	Waste water.	Slime.	First.	Second.	Sucrose.
			Per ct.			*Per ct.*			*Per ct.*	*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
1	62	18.5	15.7	2.1	84.8	14.5	12.2	83.7	0.248	0.175	13.6	0.091	50.8	0.256	48.7	0.151	0.10	1.2	10.69	15.21	12.96	82.8
2	65	17.0	14.6	2.4	85.8	14.3	11.5	80.4	0.242	0.165	13.6	0.088	50.8	0.251	47.3	0.171	0.30	0.5	9.06	13.16		....
3	74	18.1	15.0	3.1	83.4	14.3	12.2	85.3	0.171	0.096	14.6	0.0828	48.9	0.181	47.5	0.171	0.15	0.10	......	......	12.2	83.
4	68	17.7	15.2	2.5	85.8	13.9	11.9	83.6	0.194	0.160	14.6	0.102	50.0	0.187	45.0	0.170	0.6	0.8	9.63	......	......	....
5	72	17.7	14.7	3.0	83.0	14.1	11.6	82.2	0.234	0.160	15.3	0.082	47.2	0.151	44.9	0.123	0.3	0.7	......	......	......	....
6	64	17.9	15.2	2.7	84.8	14.7	12.2	85.6	0.198	0.165	17.0	0.096	44.5	0.160	44.5	0.151	0.3	0.35	......	12.23	14.42	83.
7	61	16.6	14.4	2.2	86.8	14.1	11.1	78.7	0.234	0.123	15.1	0.089	45.3	0.124	40.8	0.082	0.2	0.10	9.52	......	......	....
Average	......	17.6	14.9	2.7	84.0	14.3	11.8	81.8	0.217	0.149	14.8	0.0786	48.2	0.187	45.5	0.144	0.27	0.67	9.72	13.68	13.09	82.9

Tons of beets worked, 521.92. Per cent. of first product obtained, 9.7.

WEEK ENDING OCTOBER 14, 1884.

Date.	Diffusions.	Cossettes Deg. Brix.	Cossettes Sucrose.	Cossettes Diff.	Cossettes Quot.	Diffusion juice Deg. Brix.	Diffusion juice Sucrose.	Diffusion juice Quot.	I. Alkalinity.	II. Alkalinity.	First Deg. Brix.	First Alk.	Unfiltered Deg. Brix.	Unfiltered Alk.	Filtered Deg. Brix.	Filtered Alk.	Pulp.	Waste water.	Slime.	Ca Co_3 First.	Ca Co_3 Second.	Melada Sucrose.
																				Per ct.	*Per ct.*	
8	70	17.0	14.4	2.6	84.7	14.3	12.0	83.2	0.220	0.209	15.2	0.199	44.9	0.157	44.8	0.110	0.10	0.3	......	......	1.03	....
9	66	17.9	15.3	2.4	86.7	13.4	11.5	85.8	0.195	0.187	15.8	0.110	44.9	0.219	41.0	0.124	0.15	0.1	9.06	12.0	......	83.1
10	57	17.8	15.5	2.3	87.6	13.8	11.4	85.2	0.251	0.165	17.0	0.138	44.0	0.201	44.3	0.138	0.15	0.3	......	12.3	8.6	83.3
11	26	18.4	16.6	1.8	90.1	13.5	10.7	79.2	......	......	......	0.096	......	......	......	......	......	0.1	......	......	......	....
12	71	......	......	......	......	13.3	11.4	85.7	0.193	0.165	14.2	0.110	46.7	0.193	39.	0.140	0.17	0.1	......	......	......	....
13	62	17.8	15.2	2.4	86.5	13.5	10.7	79.2	0.201	0.146	15.1	......	45.5	0.182	41.1	0.124	0.30	0.2	......	14.8	......	....
14	72	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	....
Average	......	17.8	15.4	2.4	86.5	13.5	11.3	83.7	0.172	0.174	15.4	0.130	45.2	0.190	42.0	0.127	0.17	0.185	9.06	13.0	4.81	83.2

Tons of beets worked, 476. Per cent. of first product obtained, 11.1.

WEEK ENDING OCTOBER 21, 1884.

15	74	17.0	14.4	2.6	84.7	13.7	11.0	80.2	0.229	0.170	15.2	0.140	46.7	......	39.3	0.138	0.30	0.3	7.12	13.12	......	......
16	64	16.4	13.8	2.6	84.1	13.7	11.0	80.3	0.182	0.150	15.8	0.124	47.8	0.27	43.5	0.173	0.25	0.1	......	......	......	......
17	63	16.9	14.1	2.8	83.1	13.8	9.1	76.5	0.176	0.096	15.0	0.096	47.1	0.242	41.8	0.157	0.10	1.2	7.57	......	......	82.3
18	71	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
19	80	17.3	14.7	2.6	84.9	13.0	9.5	73.0	0.182	0.178	14.6	0.126	44.5	0.303	45.3	0.178	0.15	0.5	......	......	......	......
20	75	16.6	14.0	2.6	84.0	12.6	9.5	78.1	0.212	0.176	14.1	0.138	47.2	0.317	46.1	0.202	0.60	0.9	......	16.	12.6	81.6
21	77	16.4	13.3	3.1	81.0	12.9	10.5	81.5	0.176	0.138	14.7	0.121	47.5	0.317	46.	0.173	0.35	1.1	8.2	......	......	......
Average	......	16.8	14.0	2.8	83.3	13.3	78.27	75.9	0.191	0.151	14.7	0.124	46.8	0.207	43.6	0.170	0.29	0.68	7.63	14.56	12.6	81.9

Tons of beets worked, 564.4. Per cent. of first product obtained, 9.9.

WEEK ENDING OCTOBER 28, 1884.

22	74	16.0	12.9	3.1	80.6	12.2	9.0	73.7	0.176	0.138	14.7	0.121	47.5	0.317	41.8	0.173	0.50	0.6	......	14.5	13.	......
23	69	14.8	11.7	3.1	79.0	12.2	8.8	72.1	0.168	0.138	14.9	0.090	47.	0.276	44.	0.171	0.10	0.5	6.35	......	......	......
24	69	14.8	12.3	2.5	83.0	11.7	9.4	80.3	0.165	0.149	16.	0.108	46.9	0.240	42.5	0.151	0.20	0.8	......	12.6	11.5	......
25	76	14.1	11.6	3.0	82.2	12.8	9.4	73.4	0.171	0.156	13.8	0.085	47.3	0.251	44.3	0.154	0.20	0.9	10.8	......	......	84.
26	73	15.9	12.9	2.9	81.1	12.2	9.2	75.4	0.182	0.138	13.8	0.082	47.3	0.201	38.9	0.126	0.15	0.7	....	......	......	......
27	74	16.5	13.6	2.5	82.4	11.8	9.0	76.2	0.160	0.121	14.	0.080	45.9	0.204	40.7	0.126	0.15	1.0	......	13.2	10.4	......
28	80	15.4	12.8	2.6	83.1	11.2	8.2	73.2	0.193	0.153	14.	0.069	46.8	0.208	41.	0.114	0.30	0.7	6.82	......	......	83.5
Average	......	15.4	12.5	2.9	81.1	12.0	9.0	75.0	0.173	0.146	14.3	0 091	47.0	0.242	42.2	0.145	0.23	0.74	7.99	13.4	11.6	83.7

Tons of beets worked, 576.8. Per cent. of first product obtained, 9.3.

WEEK ENDING NOVEMBER 4, 1884.

29	73	13.9	11.9	2.0	83.1	12.8	9.1	71.0	0.209	0.151	13.6	0.074	47.1	0.179	42.2	0.129	0.5	0.8	......	15.5	13.2	82.
30	76	12.3	10.7	1.6	86.9	11.4	8.6	73.5	0.220	0.118	14.7	0.077	47.4	0.179	43.5	0.118	0.2	0.6	8.3	...	......	......
31	75	12.4	9.7	2.7	78.2	11.4	8.4	73.3	0.193	0.124	14.6	0.096	46.5	0.220	43.8	0.121	0.2	0.7	......	15.0	13.2	81.
1	74	16.0	13.0	2.6	83.7	11.9	9.2	77.3	0.207	0.118	13.7	0.079	43.1	0.207	42.1	0.151	0.1	0.7	7.1	......	......	......
2	69	14.1	12.1	2.0	85.8	11.0	8.1	73.3	0.179	0.151	13.7	0.113	43.6	0 179	42.2	0.113	0.2	0.6	......	......	......	82.2
3	69	15.4	12.8	2.6	83.1	11.9	9.6	80.6	0.171	0.138	14.4	0.120	45.0	0.252	42.3	0.165	0.2	0.5	......	......	14.2	......
4	71	16.0	12.9	3.1	80.6	11.9	9.2	77.3	0.219	0.185	13.9	0.118	47.9	0.262	44.0	0.152	0.5	0.5	....	....	......	......
Average	......	14.3	11.9	2.4	83.2	11.8	8.8	74 5	0.199	0.132	14.1	0.096	45.8	0.211	42.9	0.136	0.27	0.63	7.7	15.25	13.5	81.7

Tons of beets worked, 567.84. Per cent. of first product obtained, 8.4.

Record of working of Standard Sugar Refinery.

WEEK ENDING NOVEMBER 11, 1884.

Date.	Diffusions.	Cossettes per 100 of juices.				Diffusion juice.			Saturation.		Filtration.						Loss per 100.			Char.		Melada.
											First.		Second.							Ca CO_3.		
													Unfiltered.		Filtered.							
		Deg. Brix.	Sucrose.	Diff.	Quot.	Deg. Brix.	Sucrose.	Quot.	I. Alkalinity.	II. Alkalinity.	Deg. Brix.	Alk.	Deg. Brix.	Alk.	Deg. Brix.	Alk.	Pulp.	Waste water.	Slime.	First.	Second.	Sucrose.
			Per ct				Per ct		Per ct.	Per ct.		Per ct.		Per ct.		Per ct.	Per ct	Per ct.	Per ct	Per ct.	Per ct.	Per ct.
5	75	15.9	13.6	2.3	85.5	11.7	9.2	78.4	0.189	0.143	14.7	0.110	43.2	0.231	38.3	0.082	0.30	0.5	7.5	16.1	13.6	82.5
6	55	15.1	12.4	2.7	82.1	11.3	8.6	76.1	0.204	0.165	13.6	0.112	45.7	0.207	44.6	0.151	0.30	0.7	......	......	......	......
7	14	......	......	......	......	12.7	10.2	80.3	......	......	......	......	......	......	......	......	......	0.8	......	......	......	83.
8	79	13.2	10.5	2.7	79.6	13.1	10.6	80.9	0.197	0.151	12.6	0.074	46.2	0.138	40.8	0.110	0.10	0.7	10.5	......	13.3	......
9	77	14.8	12.4	2.4	83.7	11.7	9.0	76.8	0.201	0.193	13.2	0.096	44.2	0.234	45.4	0.129	0.40	1.0	......	......	......	......
10	78	14.3	11.6	2.7	81.1	11.4	8.5	74.5	0.187	0.151	14.0	0.099	......	0.234	40.5	0.138	0.15	0.3	......	......	11.5	82.3
11	76	16.6	14.2	2.4	85.5	12.0	9.0	75.0	0.183	0.180	14.2	0.082	43.9	0.220	39.9	0.138	0.20	0.4	7.74	......	......	......
Average	......	14.9	12.4	2.5	82.9	11.9	9.3	76.0	0.196	0.163	13.7	0.095	44.6	0.210	41.5	0.124	0.24	0.62	8.85	16.1	12.8	82.9

Tons of beets worked, 503.4. Per cent. of first product obtained, 9.5.

Analysis of California beets made by the Bureau of Chemistry at Washington.

In order to render the results of the analyses made by Mr. E. H. Dyer more emphatic, I selected ten samples of beets, some from wagons as they were unloading, and some from the large pile of beets on hand, and sent them to Washington for examination.

The results of the analyses of these beets are given in the following table:

Analyses of California beets.

Variety.	Number.	Number of beets.	Weight in grammes.	Per cent. of juice extracted.	Specific gravity.	In juice. Per cent. of reducing sugar.	In juice. Per cent. of sucrose.	Total solids calculated.	Total solids weighed.	Per cent. ash.	Coefficient calculated.	Coefficient found.
Imperial Rose	1	8	4,237	51.80	1.071	.190	14.46	17.23	17.41	1.136	83.9	83.1
Imperial White	2	7	4,350	65.61	1.068	.084	13.59	16.53	16.23	.930	83.2	83.7
Imperial or White Silesian	3	7	4,565	59.08	1.070	.082	14.69	17.01	17.13	1.134	86.4	85.8
White Silesian	4	8	3,555	58.41	1.074	.057	15.85	17.92	18.29	.822	88.5	86.7
Imperial	5	8	2,902	64.13	1.063	.069	14.92	15.39	17.40	.844	96.9	85.7
Improved Imperial Red	6	6	3,490	65.07	1.069	.061	13.59	16.77	17.60	.956	81.0	77.2
White Imperial	7	6	3,285	62.34	1.075	.129	15.19	18.14	18.40	1.009	83.7	82.6
Imperial Rose	8	7	3,585	66.63	1.063	.075	13.65	15.39	15.62	1.233	88.7	87.3
White Imperial	9	6	3,253	62.68	1.062	.109	12.71	15.16	15.29	.928	83.8	83.1
White Imperial	10	8	3,530	58.06	1.067	.050	15.19	16.30	18.58	.950	93.2	82.1
			38,752	61.38	......	1.091	14.38	16.58	17.20	.994	86.9	83.7

REMARKS.—No. 1, Imperial Rose; in sheds from October 15 to November 20. No. 2, Imperial White; native seed, two years; wagon. No. 3, Imperial or White Silesian; in sheds from October 15. No. 4, White Silesian; native seed, two years; wagon. No. 5, Imperial; native seed, one year. No. 6, Improved Imperial Red; native seed, one year; wagon. No. 7, White Imperial; native seed, two years; wagon. No. 8, Imperial Rose; native seed, one year; wagon. No. 9, White Imperial; native seed, two years; wagon. No. 10, White Imperial; wagon.

REMARKS ON PRECEDING TABLES.

The richness of the beets worked during the nine weeks is fully equal to the average European standard.

Thirteen per cent. of sucrose indicates a kind of beet that can be successfully manufactured.

The yield of pure granulated sugar, designated as "first product," is for the nine weeks nearly 9.5 per cent., or 190 pounds of sugar per ton of beets. This large yield is obtained by remelting the second sugars and working the solution with the fresh juices. This method gives a maximum of "first product," no second product at all, and scarcely any in sugar of "thirds," or molasses. Indeed the quantity of molasses made by the Alvarado factory is quite insignificant.

Placing the yield in beets per acre at 15 tons, the lowest average, it is found that the total yield of sugar per acre is $190 \times 15 = 2{,}850$ pounds. The actual yield, however, in all except a few poorly cultivated fields, has been nearly 4,000 pounds, or two tons, per acre.

Later in the season, *i. e.*, during late winter and early spring, the content of sucrose in the beets will slowly decrease, and by May 1 it is expected that it will be so low that the further manufacture of sugar will not be profitable. But even by that time the company will have still several thousands tons of beets on hand, on which it now seems probable they will suffer financial loss.

This excess of beets came about in this way: In former seasons the difficulty has been to get the farmers interested in beet-raising to grow enough to secure a liberal supply. The company, therefore, had urged farmers to plant, and agreed to take all the beets offered at a stipulated price.

During the campaign of 1883–'84 the farmers clearly saw that beet-raising was far more profitable than the culture of wheat or any of the usual crops. They therefore gave much more land and labor to beet-culture for the campaign of 1884–'85 than they had ever done before. The result has already been stated.

In a letter dated January 31, 1885, Mr. Dyer says:

"Our total receipts of beets this campaign were 20,358 tons (2,000 lbs.). The total amount of refined sugar manufactured and sold this campaign to date is 1,819,266 pounds."

Under date of March 9, 1885, he writes:

"We have beets to last through April. They keep well, and still show a coefficient of purity of over 75."

If the yield continues, as expected, through April, the total output of refined sugar will exceed 3,000,000 pounds.

The study of the preceding tables is a most encouraging one for the farmer. These soils are easily cultivated. In no case was any fertilizer employed, and yet the yield and quality of the roots are fully up to the standard of the forced and expensive cultivation of Germany.

Although the price of labor in California is so much greater than in Germany, I doubt very much whether the cost of the beets per ton is greater. The largest item of expense to the beet farmer in these valleys of the Coast Range is rent. As much as $20 per acre is paid annually for beet land.

Lands of equal fertility and adaptation for beets farther from San Francisco could doubtless be obtained on better terms.

YIELD PER ACRE.

The large differences in yield per acre shown in the preceding tables are not so much due to variation in the fertility of the soil as to methods of cultivation.

The experience of six years has shown that the average yield of beets per acre has steadily increased, and this increase has been due to improved agriculture alone.

At first the farmers (the company does not grow beets) were largely ignorant of the correct method of beet culture, and as this ignorance disappears the results are seen in an increase of the crops.

But the farmers of these rich valleys must not be deceived by this prosperity. The time will soon come when the best methods of tillage will no longer result in heavier harvests. It is far better and cheaper to maintain the fertility of the soil than to restore it. It is a wise policy to use fertilizers on rich soils. The voluntary use of these soil-foods will prevent the necessity for them which an unwise agriculture always produces.

The following extract is from "Wood's History of Alameda County," California, published in 1883:

"BEET-ROOT SUGAR INDUSTRY AT ALVARADO.

"No history of Alameda County would be complete without some mention of the rise and progress of this promising industry, which, so far as California and the Pacific coast are concerned, had its origin at Alvarado—its failure and its final success.

"The first attempt to manufacture beet-root sugar in California was made at Alvarado in 1869. Messrs. Bonesteel, Otto & Co., who were engaged in a small way in the business at Fond du Lac, Wisconsin, opened a correspondence upon the subject with General C. I. Hutchinson, E. H. Dyer, and others on this coast. The matter was pushed with zeal, and the 'California Beet Sugar Company' was organized with a capital stock of $250,000. The stockholders were: General C. I. Hutchinson, Flint, Bixby & Co., T. G. Phelps, E. H. Dyer, E. R. Carpentier, E. Dyer, W. B. Carr, W. T. Garratt, and E. G. Rollins, all well known capitalists and enterprising business men of California; and A. D. Bonesteel, A. Otto, and Ewald Klinean, of Wisconsin. The eastern parties, who were to assume the technical management of the business, arrived in California in the spring of 1870, and arrangements were immediately made for the erection of a factory. The location chosen was the farm of E. H. Dyer, at Alvarado. The work was pushed with such energy that the building was completed by the contractor, B. F. Ingalls, esq., in November of the same year.

"It is unnecessary to follow minutely the history of this company. It is sufficient to say that, after running four years at Alvarado, through the incompetency of the technical managers, it proved a financial failure. Messrs. Bonesteel and Otto contended that the location at Alvarado, not being a suitable place for the business, was the cause of the failure, and succeeded, by their plausible representations, in organizing a new company, which purchased the Alvarado machinery and removed it to Soquel, Santa Cruz County, where, after operating a few years, subjecting its stockholders to a heavy annual loss, the enterprise was abandoned.

"E. H. Dyer, who had bought the buildings and a portion of the land owned by the old company at Alvarado, still had faith in the business, believing that with good management it could be made to pay at that place. He found it very difficult, however, in the face of so many failures, to induce capitalists to invest a sufficient amount to give the business another trial, and it was not until 1879 that the Standard Sugar

Manufacturing Company was incorporated. The company consisted of A. E. Davis, O. F. Giffin, E. H. Dyer, Prescott, Scott & Co., J. P. Dyer, and Robert N. Graves, with a capital of $100,000. It was soon ascertained that more capital was needed, and the company reincorporated under the name of the Standard Sugar Refinery, with a capital stock of $200,000. The officers are: O. F. Giffin, president; J. P. Dyer, vice-president; E. H. Dyer, general superintendent; W. F. Ingalls, secretary; trustees, O. F. Giffin, R. N. Graves, J. P. Dyer, G. H. Waggoner, and E. H. Dyer. This company has made a success of the business from the start. It earned 33 per cent. on the capital invested the last or third campaign, and is now just commencing on its fourth campaign with very flattering prospects. The success of this important home industry is greatly due to the general management of Mr. Dyer, who owns one-fourth of the stock, and who, profiting by former experience, is able to avoid many mistakes which have caused the failures of other establishments of the kind. The present factory has been enlarged and improved until it now has a capacity of about 100 tons per day; employs at the factory 125 men, to say nothing of the great amount of labor necessary to produce the beets, harvest and haul them to the factory. One, to obtain an adequate idea of the business of this company and the great good it is doing in the way of using the products of the farmers and keeping employed so many of our people, should see the works in operation during the months of September, October, and November, when beets are being received.

"There are frequently lines of teams, all heavily laden with beets, from a quarter to sometimes half a mile in length, pushing along in line to reach the company's scales and deliver their loads. It is a scene of great activity. From fifteen to twenty thousand tons of beets are used each campaign, which require for their production ten to fifteen hundred acres of land. The company disburses among its workmen and the farmers nearly $150,000 a year for labor and material used; all produced in Alameda County. They have turned out each campaign one and a half million pounds of pure white sugar. No low grades or yellow sugars are put on the market by them."

The climate and soils of California in relation to beet culture.

The soils and climate of California have been carefully studied by Prof. E. W. Hilgard in his report on "Cotton Production in California," published in Vol. VI, Tenth Census, pp. 665 *et seq.*

The following table contains data of thermal observations. It will be seen at once that the summer temperature of the interior valley of the western or coast division is entirely too high for successful sugar beet culture.

In the interior and eastern divisions only the high Sierra regions have a temperature low enough for beets, and in this locality there is no land adapted to beet culture. The beet region of California therefore, is confined to the coast region.

WESTERN OR COAST DIVISION (from vol vi, Tenth Census, p. 668).

Station.	County.	Elevation.	Years of observation.	Temperature, Fahrenheit.						
				General average.			Monthly extremes.			
							Summer.		Winter.	
				Summer.	Winter.	Year.	Maximum.	Year.	Minimum.	Year.
Coast region, north.		*Feet.*		°	°	°	°		°	
Camp Lincoln	Del Norte	.....	2	59.5	47.2	53.9	......	...	......	...
Fort Humboldt	Humboldt	50	16	58.2	47.0	52.9	......	....	......	...
Camp Wright	Mendocino	.....	6	74.7	58.8	57.8	......	....	......	....
Coast region, middle.										
Napa	Napa	95	5	70.3	49.3	59.9	......	....	......	....
San Francisco	San Francisco	130	11	58.0	50.1	55.2	......	....	......	....
Oakland	Alameda	14	5	67.8	52.2	57.7	72.6	1879	49.1	1880
Martinez	Contra Costa	.....	4	70.1	48.9	60.3	74.5	1878	41.9	1880
San José	Santa Clara	91	7	66.7	49.5	56.8	76.0	1879	42.2	1876
Santa Cruz	Santa Cruz	2,500	4	62.9	50.5	59.2	66.8	1881	46.2	1880
Coast region, south.										
Monterey	Monterey	140	12	59.7	50.2	55.5	......	....	......	....
Salinas	...do	...	6	60.6	50.8	55.6	65.1	1877	43.9	1882
Soledad (interior)	...do	3,213	6	66.9	48.8	57.8	77.3	1876	41.8	1877
Santa Barbara	Santa Barbara	20	7	67.9	54.1	61.4	70.0	1874, 1876, 1877	50.4	1875
Los Angeles	Los Angeles	265	7	73.2	55.6	64.9	83.3	1876	49.9	1882
Interior valley.										
Riverside (Rio de Jurupa)	San Bernardino	1,000	1½	74.2	53.2	63.7	......	...	......	....
Colton	... do	965	4	80.1	50.2	65.1	86.1	1879	44.9	1882
San Diego	San Diego	64	20	69.7	54.1	62.1	......	....	......	....

INTERIOR AND EASTERN DIVISION.

Station.	County.	Elevation.	Years of observation.	Summer.	Winter.	Year.	Maximum.	Year.	Minimum.	Year.
Northern Sierra and Lava Beds.										
Fort Jones	Siskiyou	2,570	5	71.1	34.1	52.3	......	....	......	....
Fort Bidwell	Modoc	4,680	5	71.1	32.3	50.8	......	....	......	....
Great Valley (Sacramento Division).										
Redding	Shasta	556	7	81.6	47.3	63.4	87.2	1879	42.5	1880
Red Bluff	Tehama	308	10	89.8	47.5	63.7	88.9	1875	39.9	1879
Marysville	Yuba	67	10	78.7	49.5	64.4	83.9	1871	44.4	1880
Sacramento	Sacramento	30	10	71.8	48.2	60.8	76.9	1876	43.0	1880
Foot-hills of the Sierra.										
Auburn	Placer	1,360	11	74.1	45.4	58 6	80.5	1875	39.8	1882
High Sierra.										
Cisco	Placer	5,934	11	60.9	32.7	45.2	73.1	1871	26.3	1880
Truckee	Nevada	5,819	11	61.1	27.7	43.3	70.3	1871	21.7	1874, 1880
Great Valley (San Joaquin Division).										
Stockton	San Joaquin	23	10	72.5	48.2	60.8	77.7	1872, 1874	44.0	1879
Modesto	Stanislaus	91	8	78.2	47.8	63.2	85.3	1879	40.4	1881
Merced	Merced	171	9	79.1	49.0	63.4	85.1	1874	43.2	1876
Fresno	Fresno	292	5	84.1	51.3	67.6	90.0	1878	43.9	1882
Tulare	Tulare	282	6	83.8	45.9	64.4	95.2	1874	39.1	1874
Sumner	Kern	415	7	86.2	48.7	67.3	93.0	1875	41.9	1878

Following is Professer Hilgard's description of the climate of California:

"As to the change in temperature in ascending the Sierra from the valley, the following statement is made by Mr. B. B. Redding in a paper read before the California Academy of Sciences in 1878:

"It has been found that the foot-hills of the Sierra up to the height of about 2,500 feet have approximately the same temperature as places in the valley lying in the same latitude. It has also been found that with the increased elevation there is an increase of rainfall over those places in the valley having the same latitude, as, for instance, Sacramento, with an elevation above the sea of 30 feet, has an annual mean temperature of 60.5°, and an average rainfall of 18.8 inches, while Colfax, with an elevation of 2,421 feet, has an annual mean temperature of 60.1° and an annual rainfall of 42.7 inches. This uniformity of temperature and increase of rainfall appears to be the law throughout the whole extent of the foot-hills of the Sierra, with this variation as relates to temperature, viz, that as the latitude decreases the temperature of the valley is continued to a greater elevation. To illustrate, approximately, if the temperature of Redding, at the northern end of the valley, is continued to the height of 2,000 feet, then the temperature of Sacramento, in the center of the valley, would be continued up to 2,500 feet, and that of Sumner, at the extreme southern end of the valley, to 3,000 feet."

It is curious to note that, as appears from Mr. Redding's statement, the lowest temperature thus far observed at the two opposite ends of the valley, Redding and Sumner, are the same, viz, 27°

It will be noted that in the southern region the difference between the summer means or between winter means, as well as between the annual means, is quite small when Santa Barbara and San Diego, both lying immediately on the coast, are compared. At Los Angeles, 20 miles inland, all these means are notably higher; still farther inland, and with increasing elevation, the summer mean rises, while the winter mean falls at Riverside, as well as more strikingly at Colton, although at the latter point the annual mean is almost the same as at Los Angeles.

To convey an easily intelligible idea of some of the climatic differences indicated in the table, it may be stated that while in the great valley a few inches of snow cover the ground for a short time nearly every winter as far south as Sacramento, and snow flurries are occasionally seen even at the upper end of the San Joaquin Valley, snow has fallen in the streets of San Francisco only once since the American occupation to such a depth as to allow of snowballing (which during a few hours created a state of anarchy), and only a few times has enough fallen to whiten the ground for a few minutes or hours. Hence the heliotrope, fuschia, calla lily, and similar plants endure year after year in the open air, while at a corresponding latitude in the interior they require some winter protection. Lemon and orange trees never suffer from frost on the bay, but their fruit also rarely ripens save in favored localities. In the interior these trees more frequently suffer from frost, but the high summer temperature matures the fruit some weeks earlier than even in the southern coast region. Cotton would, as a rule, be frost-killed in the great valley in November, while on the coast it might endure through several mild winters; but within reach of the summer fogs of the coast it fails to attain a greater height than eight or ten inches the first season, and sometimes can scarcely succeed in coming to bloom before October. Subtropical trees, which in the cotton stages grow rapidly and luxuriantly, such as the crape myrtle, paulownia, catalpa, mimosa (Julibrissin), and others, either grow very slowly or remain mere shrubs in the coast climate, while in the interior they develop as in the Gulf States. The vine flourishes near San Francisco, but fails to mature its fruit, yet it yields abundant and choice crops near San José, where the immediate access of the coast fogs is intercepted by a range of hills. It is thus obvious that, with the varying topography, the change in the direction of a valley or a mountain range, the occurrence of a gap or of a high peak in the same permitting or intercepting communication with the coast on the one hand or with the interior on the other, there exist innumerable local climates, "thermal belts," sheltered nooks, and exposed locations, each of which has its peculiar adaptations apart from soil, and the recognition and utilization of these adaptations require knowledge and good judgment, and count heavily in the scale for or against success in agriculture in California.

Rainfall.—As regards the rainfall, the prominent peculiarity throughout the State is the practically rainless summer. While it is true that rain has been known to fall in every month in the year, the average amount of precipitation during the three summer months is less than 1 inch in the greater portion of the State, and less than 2 inches even in the most favored part, viz, the counties just north of San Francisco Bay. Frequently not a drop of rain falls in the interior valley and the southern region from the middle of May to November, and as the agricultural system of California is based upon the expectation of this dry weather, summer rains are not even desired by the farmers at large. Northward, in the mountainous and plateau regions adjoining Oregon, the season of drought becomes shorter, as is also the case in the high Sierras, and thus there is a gradual transition toward the familiar régime of summer rains and occasional thunder-storms which prevail in Oregon and Washington west of the Cascade Range.

Since the growing season, in the case of unirrigated lands at least, thus practically lies between November and June, and each harvest is essentially governed by the rains occurring within these limits, it is the universal and unconscious practice to count the rainfall by "seasons" instead of by calendar years; hence the current estimate of local rainfall averages in California differs not immaterially from that of the usual meteorological tables, in which the paramount distinction between the *agriculturally* "dry" and "wet" seasons is more or less obliterated. The data hereinafter given are therefore, as a rule, "seasonal" and not "annual," and are largely those of the observations conducted along its lines by the Central and Southern Pacific Railroad.

The mean annual rainfall of the greater (middle and southern) part of the State is less than 20 inches, the northern limit of that region lying between Sacramento and Marysville, in the great valley; while on the Sierras the region of rainfall between 20 and 26 inches extends as far south as the heads of King's and Kern Rivers, furnishing the waters upon which depends the irrigation of the San Joaquin Valley; thence southward the rain gauge rapidly descends to 8 and 4 inches, and less in the Kern Valley, the Mojave Desert, and the basin of Nevada.

A rapid decrease of rainfall is observed in the great interior valley. From 42 inches at Redding, at the northern end of the valley, and 24 inches at Red Bluff, 24 miles to the southward, the annual mean falls to about 19 inches at Sacramento and to 16 at Stockton. Thence southward the rainfall descends to a mean of only 10 inches at Merced, 7 at Fresno, and 4 at Bakersfield, near the southern end of the San Joaquin Valley, separated only by the Tehachapi Mountains from the western margin of the Mojave Desert, in which the rainfall is still less.

Along the coast proper Cape Mendocino bears the reputation of a kind of weather divide. Mariners expect a change of weather whenever they round this cape, and on land it marks the region where the character of vegetation begins to change rapidly from that of Southern or Middle California toward that of Oregon. At and immediately north of the cape the rainfall reaches an annual mean of 40 inches. A short distance southward, at Point Arenas, the annual fall is 26 inches; and from 23 to 21 inches in the region of San Francisco; it falls to 16 inches at Monterey and Santa Barbara, 12 at Los Angeles, and 9 at San Diego.

Northward of Cape Mendocino the rainfall increases rapidly, rising to over 70 inches in the northwestern corner of the State. Inland from the coast the increase is less rapid, but the rainfall rises at points in the Shasta region to as much as 108 inches in some years. Southward the region of rainfall exceeding 20 inches extends in the coast range slightly farther south than in the great valley, so as to include all but the most southerly portions of the counties of Sonoma, Napa, and Marin. Southward of San Francisco again a region of more abundant rainfall includes the western Santa Clara Valley, Santa Cruz Mountains, Monterey Bay, and the lower Salinas Valley, where from 13 to 16 inches fall annually.

Ascending the Sierra from the great valley there is a rapid increase of rainfall, which, from data furnished by the records of the railroad, may be estimated at 1 inch for every 100 to 150 feet of ascent.

The following tables show more in detail the rainfall averages for representative points, the data being derived mainly from the observation made under the auspices of the Central and Southern Pacific Railroad, and given for "seasons" reaching from July to June inclusive.

WESTERN OR COAST DIVISION.

Station.	County.	Elevation.	Years of observation.	Average.	Maximum.	Year.	Minimum.	Year.
Coast Range, north.		*Feet.*		*In.*	*In.*		*In.*	
Camp Lincoln	Del Norte	......	2	73.4	......	......	......	......
Fort Humboldt	Humboldt	50	16	35.9	......	......	......	......
Camp Wright	Mendocino	......	6	43.9	......	......	......	......
Coast Range, middle.								
Napa	Napa	95	5	26.6	34.7	1877–'78	17.1	1881–'82
San Francisco	San Francisco	130	10	20.7	32.1	1877–'78	8.8	1876–'77
Oakland	Alameda	14	5	20.6	29.3	1877–'78	9.6	1881–'82
Martinez	Contra Costa	......	4	16.1	19.7	1880–'81	12.9	1881–'82
San José	Santa Clara	91	8	11.4	19.3	1877–'78	5.0	1876–'77
Santa Cruz	Santa Cruz	2,500	5	26.4	39.2	1877–'78	22.0	1878–'79
Coast Range, south.								
Monterey	Monterey	140	12	15.7	......	......	......	......
Salinas	do	......	9	12.8	23.7	1877–'78	3.9	1876–'77
Soledad (interior)	do	3,213	8	7.9	15.3	1875–'76	2.7	1876–'77
Santa Barbara	Santa Barbara	20	11	16.2	31.5	1877–'78	4.5	1876–'77
Los Angeles	Los Angeles	265	7	12.0	21.9	1875–'76	4.6	1876–'77
Interior Valley.								
Riverside (R. de Jurupa)	San Bernardino	1,000	1½	13.6	......	......	......	......
Colton	do	965	6	8.2	14.5	1877–'78	5.9	1876–'77
San Diego	San Diego	64	20	9.3	......	......	......	......

INTERIOR AND EASTERN DIVISION.

Station.	County.	Elevation.	Years of observation.	Average.	Maximum.	Year.	Minimum.	Year.
Northern Sierra and Lava Beds.								
Fort Jones	Siskiyou	2,570	5	21.7	......	......	......	......
Fort Bidwell	Modoc	4,680	5	20.2	......	......	......	......
Great Valley (Sacramento Division).								
Redding	Shasta	556	7	42.1	60.0	1877–'78	25.4	1881–'82
Red Bluff	Tehama	308	10	24.0	52.7	1877–'78	13.6	1874–'75
Marysville	Yuba	67	11	17.8	26.9	1873–'74	12.2	1876–'77
Sacramento	Sacramento	30	32	18.7	25.5	1875–'76	9.2	1876–'77
Foot-hills of the Sierra.								
Auburn	Placer	1,360	11	34.0	44.3	1875–'76	18.9	1876–'77
High Sierra.								
Cisco	Placer	5,934	11	60.8	82.7	1880–'81	34.1	1876–'77
Truckee	Nevada	5,819	11	34.1	44.0	1871–'72	18.0	1876–'77
Great Valley (San Joaquin Division).								
Stockton	San Joaquin	23	32	15.8	20.6	1871–'72	7.2	1876–'77
Modesto	Stanislaus	91	11	9.6	13.4	1875–'76	4.3	1876–'77
Merced	Merced	171	10	9.7	12.7	1875–'76	3.2	1876–'77
Fresno	Fresno	292	5	7.0	8.9	1877–'78	4.9	1878–'79
Tulare	Tulare	282	8	6.2	10.0	1880–'81	3.1	1878–'79
Sumner	Kern	415	7	4.2	8.0	1877–'78	1.3	1878–'79

Were the rainfalls of 20 inches and less distributed over the whole or even the greater part of an ordinary season of the temperate zone, it would be altogether inadequate for the growing of cereal or other usual crops of that zone; but since in California nearly the whole of it usually falls within six months (November and April inclusive), and by far the greater part within the three winter months, during which a "growing temperature" for all the hardier crops commonly prevails, it becomes perfectly feasible to mature grain and other field crops before the setting in of the rainless summer, provided only that the aggregate of moisture has been adequate and its distribution reasonably favorable. The grain sown into the dust of a summer-fallowed field begins to sprout with the first rain, and thenceforward grows more or less slowly, but continuously, through the winter. It is ready to head at the first setting in of warm weather, from the end of March to May, according to latitude, and becomes ready for the reaper from the end of May to the end of June. Once harvested, the grain may be left in the field for several months, thrashed or unthrashed, without fear of rain or thunder storms. As a matter of course, the grain-grower may also at his option sow his grain at any time after the beginning of the rains, and good crops are sometimes obtained from sowings made late in February. Usually, however, the late-sown grain is cut for hay when in the milk, in April and May, for, since meadows can form no part of the agricultural system, except where irrigation is feasible, the hay grasses commonly grown in the Eastern States are available only to a limited extent, and wheat, barley, and oats take their place. Again, there is no strict distinction or limit between fall and spring grain, since the sowing season extends from October to February. Thus the winter months are a very busy season for the farmer in California, as he has to watch his opportunity for putting in his crops between rains. The time between laying by and harvest is nearly filled up by gardening and haying operations. The latter are occasionally interrupted by one or two light showers, rarely enough to injure the quality of the hay. Protracted rainy spells or thunder-storms, calling for hasty gathering of the cut grain into shocks, are unknown in harvest time, as are also sprouted or spoiled grain, except when the sacked grain is left out in the fields so late as to catch the first autumn rains. It will thus be seen that midsummer finds the California grain-grower comparatively at leisure.

But while the culture of hardy plants of rapid development was the first and most obvious expedient resorted to by the American settlers in order to utilize the fertile soils of the region of rainless summers, that of selecting culture plants adapted to arid climates was the one naturally suggesting itself to the missionary padres, who brought with them from the Mediterranean region of Europe the vine, the fig, the olive, the citrus fruits, as well as from adjacent portions of Mexico the culture of cotton, to which, however, but little attention was given by them, the growing of wool being better adapted to the temper of their native laborers. And as they relied largely on irrigation for the success of their annual crops, it was only in very extreme cases that a deficient rainfall so affected their interests as to give the fact a place in their records.

Variation and periodicity of rainfall.—While the means of rainfall given above will not vary widely when any large numbers of years are taken together, the variations from one year to another are often sufficiently great to tempt many to invest heavily in putting in crops on the chances of a favorable season, which would bring a fortune at one venture, but sometimes results in a total loss, and consequent ruin to investor. Such cases of agricultural gambling were at one time not uncommon in the San Joaquin Valley especially, the turning point of profit or loss being a single light shower at the critical time or the occurrence of a norther for a day or two. More ingenuity has been spent in trying to forecast the weather for the season in time to determine the chances of success, but it will generally be found that the oldest citizen, if he is candid, will be far more reserved in his opinions than later comers.

However steady and reliable the summer climate may be, that of a California winter is most difficult to forecast from day to day and from week to week, and while there are certain rules that are ordinarily counted upon, the cases where "all signs fail" are very frequent, and surprises are abundant. A discussion of the observations made from 1849 to 1877, by Dr. G. F. Becker, late of the University of California, and now of the United States Geological Survey, seems to indicate as probable a cycle of thirteen years between extreme minima or drought years, and some data I have since obtained from the records of the missions seem to confirm still further this conclusion. The first minimum within the time of the American occupation of California occurred in the season of 1850–'51, when the rainfall at San Francisco was 10.1 inches, and the third was the season of 1876–'77, with 10 inches. The next succeeding season of minimum would be that of 1889–'90.

Chemical analyses of California soils and

Number.	Soil title.	Locality.	Depth.	Vegetation.	Insoluble residue.
	COAST RANGE REGION.				
	South of San Pablo Bay.				
168	Valley soil	Santa Paula, Ventura County	12		85.664
182	Reddish mountain soil	do	12	Grass, herbs	74.930
170	Bench-land subsoil ..	Hollister's ranch, Santa Barbara County.	12–18	Oaks	83.065
600	Upland soil	Poverty Hill, San Benito County	12	Cultivated 12 years	85.596
606	Upland loam soil	Soquel ranch, Santa Cruz County	12	Cultivated	80.426
702	Chaparral soil	Two miles northeast of Saratoga, Santa Clara County.	12		57.449
37	Valley soil	Pescadero, San Mateo County	.....	Redwood, pine, oak, alder, buckeye, and madrone.	78.084
680	Sandstone soil	San Francisco, San Francisco County.	8	Scrubby live-oak	78.135
682	Sandstone subsoil	do	8–18		70.224
643	Black waxy adobe soil.	Cobton ranch, Contra Costa County.	12	Sunflower	50.960
692	Dark soil, rolling uplands.	Livermore Valley, Alameda County	6	Scattering white-oak and poison-oak.	80.262
693	Dark subsoil, rolling uplands.	do	6–18	do	80.658
694	Red gravelly soil, rolling uplands.	do	8	do	81.941
649	Sediment soil	Arroyo del Valley, Livermore Valley, Alameda County.	.....	Shrubs, herbs, and some sycamores.	71.156
1	Black adobe soil	University grounds, Alameda County.	12–22	Live-oaks, large	......
2	Subsoil No. 1	do	22–30	do	......
4	Adobe ridge subsoil	do	10–20	Scattered live-oak, small.	......
	North of San Pablo Bay.				
185	Valley soil	G. F. Hooper's vineyard, Sonoma County.	12	Oaks and grapevines	76.089
188	Red mountain soil	do	12	Oaks, manzanita chaparral.	34.392
207	Eel River bottom soil	Three miles east of Ferndale, Humboldt County.	12		65.346
205	Subsoil of No. 207	do	12–25		69.373
676	Red volcanic soil	Flat on Clear Lake, Lake County	12	Not known	49.604
672	Gray valley soil	Two miles south of Saint Helena, Napa County.	12	Large white oak	77.017

subsoils. (Vol. VI, 10th Census, p. 738.)

Silica soluble in Na_2CO_3.	Total insoluble residue and silicia.	Potash.	Soda.	Lime.	Magnesia.	Brown oxide of manganese.	Ferric oxide.	Alumina.	Phosphoric acid.	Sulphuric acid.	Carbonic acid.	Water and organic matter.	Total.	Hygroscopic moisture.	Temperature of absorption °C.	Analyst.
1. 847	87. 511	0. 634	0. 070	0. 759	0. 593	0. 025	3. 350	3. 099	0. 200	0. 003	.....	3. 132	99. 372	5. 49	15. 0	Jappa.
7. 912	82. 842	0. 621	0. 164	0. 952	0. 955	0. 036	5. 070	5. 936	0. 127	0. 039	......	2. 669	99. 414	6. 59	15. 0	Do.
4. 678	87. 743	0. 506	0. 058	0. 561	0. 666	0. 055	3. 116	2. 995	0. 223	0. 094	......	3. 854	99. 871	5. 98	15. 0	Do.
2. 567	88. 163	0. 333	0. 109	0. 676	0. 526	0. 048	2. 856	4. 214	0 027	0. 015	......	3. 476	100. 443	5. 22	12. 5	Do.
3. 028	83. 454	0. 343	0. 126	0. 502	0. 390	0. 014	3. 928	5. 711	0. 053	0. 009	......	4. 955	99. 485	5. 60	15. 0	Do.
5. 114	62. 563	0. 859	0. 260	1. 987	2. 428	0. 098	10. 019	9. 516	0. 139	0. 063	......	11. 921	99. 853	12. 09	15. 0	Do.
3. 237	81. 321	0. 541	0. 231	0. 925	0. 820	0. 039	4. 934	4. 821	0. 084	0. 027	.....	6. 757	100. 500	7. 38	15. 0	Do.
3. 458	81. 593	0. 675	0. 080	0. 846	0. 788	0. 053	5. 682	5. 162	0. 031	0. 053	......	5. 404	100. 359	6. 02	15. 0	Morse.
5. 532	75. 756	0. 590	0. 172	0. 399	1. 221	0. 059	7. 268	9. 737	0. 011	0. 022	.	4. 900	100. 135	9. 41	15. 0	Do.
9. 020	59. 980	0. 192	0. 741	2. 471	0. 890	0. 065	11. 090	15. 689	0. 057	0. 045	Trace	8. 304	99. 524	13. 51	15. 0	Do.
5. 023	85. 285	0. 299	0. 108	0. 813	0. 647	0. 065	3. 584	4. 933	0. 066	0. 010	......	4. 047	99. 857	5. 67	15. 0	Jappa.
5. 157	85. 815	0. 357	0. 121	0. 693	0. 666	0. 025	3. 647	5. 329	0. 062	0. 008	......	3. 435	100. 158	6. 12	15. 0	Do.
3. 756	85. 697	0. 323	0. 081	0. 720	0. 563	0. 030	3. 620	5. 540	0. 061	0. 008	......	3. 550	100. 193	4. 53	15. 0	Do.
4. 938	76. 094	1. 143	0. 123	2. 049	3. 046	0. 044	5. 648	7. 153	0. 117	0. 101	1. 004	3. 679	100. 201	5. 67	15. 0	Do.
......	77. 844	0. 452	0. 074	1. 050	1. 211	0. 078	4. 675	7. 788	0. 231	0. 077	......	5. 718	99. 198	.....	15. 0	Sutton.
......	69. 563	0. 348	0. 109	0. 998	1. 913	0. 093	7. 208	13. 970	0. 116	0. 028	.....	6. 600	100. 946	...	....	Do.
......	86. 002	0. 189	0. 154	0. 484	0. 452	0. 038	4. 013	5. 532	0. 057	0. 021	......	4. 051	100. 993	.....	....	Do.
6. 839	82. 928	0. 435	0. 123	0. 744	0. 578	0. 025	5. 793	5. 092	0. 187	0. 171	......	3. 715	99. 791	4. 98	15. 0	Jappa.
14. 110	48. 502	0. 319	0. 058	0. 670	0. 712	0. 146	25. 955	12. 160	0. 166	0. 274	......	11. 640	100. 602	13. 71	15. 0	Do.
6. 896	72. 242	1. 127	0. 282	0. 105	3. 329	0. 117	6. 986	10. 236	0. 167	0. 020	......	5. 629	100. 240	7. 87	15. 0	Do.
3. 588	72. 961	1. 134	0. 120	0. 101	3. 239	0. 054	7. 307	9. 758	0. 141	0. 026	......	4. 665	99. 506	6. 21	15. 0	Do.
5. 934	55. 538	0. 452	0. 170	0. 658	0. 610	0. 051	10. 477	22. 585	0. 031	0. 033	......	9. 654	100. 259	11. 11	15. 0	Morse.
3. 340	80. 357	0. 746	0. 477	0. 600	1. 331	0. 041	5. 656	5. 671	0. 101	0. 050	......	5. 252	100. 282	4. 50	15. 0	Do.

Soils of the southern region.

Constituents.	Los Angeles County.			San Diego County.	
	Soil of San Gabriel Valley.	Pomona Colony. Low mesa soil.	Pomona Colony. Subsoil.	Soil of mesa land.	Bottom soil Colorado River.
	No. 130.	No. 382.	No. 381.	No. 48.	No. 506.
Insoluble matter / Soluble silica	81.12	72.519 / 5.121 = 77.640	75.304 / 3.872 = 79.176	86.21	58.574 / 5.327 = 63.901
Potash	0.21	0.839	0.962	0.48	1.177
Soda	0.17	0.296	0.301	0.14	0.162
Lime	0.68	2.354	2.052	0.36	8.671
Magnesia	1.77	2.225	2.154	0.54	2.966
Brown oxide of manganese	0.10	0.039	0.043	0.10	0.025
Peroxide of iron	6.30	8.097	7.342	3.69	4.139
Alumina	6.79	5.974	5.835	5.12	8.379
Phosphoric acid	0.16	0.018	0.049	0.23	0.133
Sulphuric acid	0.07	0.022	0.020	0.03	0.145
Carbonic acid	....	....	....	....	7.818
Water and organic matter	3.07	2.550	2.546	2.60	3.344
Total	100.50	100.054	100.480	99.50	100.860
Humus	....	0.324	....	0.555	0.752
Available inorganic	....	0.263	....	1.439	1.151
Available phosphoric acid	....	....	....	....	0.133
Hygroscopic moisture	2.30	3.460	2.370	2.340	9.204
Absorbed at	15° C.	15° C.	15° C.	15° C.	15° C.

The accompanying map will show the area adapted to the growing of sugar beets.

The yellow areas marked in the legend "chief valleys of the Coast Range," &c., show the localities where the soil is suitable for beet culture. The following table gives the areas of this soil in regions where the climate will permit beet culture. The areas for each county are as follows:

The area of soil suitable for beet cultivation by counties.

	Square miles.
Los Angeles	1,480
San Bernardino	465
San Mateo	50
Contra Costa	70
Alameda	225
Santa Clara	405
Monterey	700
San Benito	115
San Luis Obispo	1,090
Santa Barbara	300
Ventura	170
Sonoma	350
Napa	145
Other valleys	40
Lake	100
Mendocino	125
Sum	5,830

This gives a total area in acres of 3,731,200. Granting that two-thirds of this area are unfit for beet culture for lack of moisture and local causes, there remains over a million and a quarter acres on which beets could be grown. Of this area not less than half a million acres could be cultivated annually. From the data of yield of beets per acre and sugar per ton of beets, already given, the average may be put at fifteen tons and 9 per cent., respectively, or 2,700 pounds of sugar per acre. For 500,000 acres this would give 1,250,000,000 pounds.

THE SUGAR BEET IN OREGON AND WASHINGTON TERRITORY.

I was anxious to extend my investigations of the possibilities of beet culture into Oregon and Washington Territory, but the limited time at my command prevented this design from being carried into execution.

Having learned that Mr. E. Meeker, of Puyallup, Wash., had been engaged in the cultivation of beets, I addressed him a letter making inquiries concerning the matter.

In answer I received the following communication. I regret to say the samples of beets which Mr. Meeker hoped to be able to forward for analysis have not been received.

Mr. Meeker says: "I am in receipt of your favor of 21st ultimo from San Francisco, and herewith inclose an article to answer your question with reference to growing sugar beets in Oregon and Washington.

"I will send you samples of beets grown by myself, and from others if I can obtain them. T. M. Alvord, White River P. O., Wash., takes great interest in this question, also J. W. Sprague, Tacoma, Wash., and James McNaught, Seattle, Wash. I would also suggest to send to the secretaries of the chambers of commerce of both Seattle and Tacoma.

"I send you paper containing an article of mine giving the cost in detail of our present year's crop.

"My article refers only to the Puget Sound country, or what is here known as Western Washington. I am not fully advised as to the valley lands of Oregon, but I think their heavy clay wheat lands unsuitable. I also think the prairie, or in fact any lands of Eastern Oregon or Washington are unsuited from the excess of alkali contained in the soil, also from scarcity of fuel.

"The climate of Western Washington is mild and equable, neither very cold in winter nor hot in summer, and seems to be exactly suited to growing the sugar beets to perfection.

"There is always an abundant rainfall in summer, so that we never have a failure of crops; the autumns are free from heavy frosts or freezing weather (at this writing, December 1, there has as yet been no freezing weather), but usually there is considerable rain.

"We do not irrigate; in fact the soil is loose and favorable, so that our crops grow well the whole season, and remain green even during a 'dry spell,' which, however, seldom occurs of sufficient duration to endanger crops. The growing season is very long, and all hardy vegetables are produced in great abundance and perfection.

"Soil suitable for producing the sugar beet is in the alluvial bottoms adjacent to various rivers flowing from the Cascade range of mountains towards salt water.

"These rivers are not large nor the valleys wide, but are numerous; in the Puget Sound Basin there are eleven or more situated north of the Columbia River and south of our northern boundary. I should say the area of land in each of these valleys suitable for beet culture would average sixty sections of land, or say about 40,000 acres each. This is nearly all timber land and requires clearing, is a deep alluvial sandy loam, very rich, and produces an abundant and certain crop.

"Fuel is abundant, and is widely distributed. The coal is under the table-land or foot-hills of the Cascade range of mountains, and is reached by short lines of railroads. The aggregate monthly output of the mines opened is, I think, about 30,000 tons. It can be increased indefinitely, as the coal area is large, the veins numerous and heavy (thick).

"So far, our sugar beets have been not only rich but also singularly pure. This is probably to be accounted for from our heavy rainfall and agreeable climate. The actual cost of raising per ton for a period of five years has been less than $2.50 per ton, and the present year $2.25 per ton. We have grown them for cattle, and could utilize the pulp to great advantage in stall-feeding beef.

"Our winters will admit of working sugar beets nearly the whole time, the weather seldom being cold enough to interfere with harvesting the beets. Locations can be had where transportation is cheap, where fuel is cheap, where land is cheap, and where the market for sugar is good. It would seem to be difficult to find better conditions for the successful inauguration of this business than here exist, and we firmly rest in the conviction that sooner or later the capital will be found to develop these favorable conditions, and that the day is not far distant when we shall see numerous beet-sugar factories producing not only enough for the immediate home consumption, but also for the great interior country of this continent."

Following are the results of culture mentioned in the foregoing letter:

"I raised the present year sixty-five tons of beautiful sugar beets from two acres of land. There was no guess-work; it was sixty-five tons of 2,240 pounds from the two measured acres. These cost me $2.25 per ton, and I will give this in detail that your farmers may ponder this question and see that I do not understate the cost:

Plowing and subsoiling two acres	$20 00
Harrowing and clod mashing	6 00
Rolling	4 00
Planting	2 00

Seed	$4 00
Cultivating (machine work)	16 25
Hand weeding	20 00
Harvesting	21 50
Housing, 50 cents per ton	32 50
Rent of land	20 00
Total	146 25

"My neighbor, Mr. T. M. Alvord, of White River, has for five years raised an average of 100 tons a year at an average cost of less than $2.50 per ton and an average yield of twenty tons per acre. We *know* that the beets can be raised; that the crop is certain; that the quality is good, pure, rich—in a word, everything desired to make this industry profitable, and now shall we throw this opportunity away, encourage the importation of foreign sugar made by cheap, servile labor, or shall we encourage home production and all the benefits that follow?"

The following account of the topography, climate, and soils of the Chehalis Valley is taken from an article printed in Gray's Harbor News, Chehalis County, Washington Territory, April 19 1884:

"TOPOGRAPHICAL FEATURES.

"Western Washington is a name given to that portion of country lying between the Pacific Ocean and the Cascade Mountains, the Columbia River and British America. On its eastern border the Cascade Range, an unbroken chain containing the highest peaks in the United States, stands like a lofty wall, shutting out and hiding the beautiful and fertile country west from the rest of the world. West of this lofty range lies a strip of country about one-half the size of the State of New York, about 110 miles wide and from 200 to 250 miles long. In the southwestern portion of this country, lying near the Pacific and jutting close upon the Columbia River, is a cluster of high hills, and in the northwestern portion, on the peninsula formed by Puget Sound and the Pacific, is the Olympic Mountains, another cluster rising to the height of 8,000 feet. In the north is Puget Sound, perhaps the most beautiful inland sea in the world, with its lofty wooded shores, its innumerable windings and islands, and its deep clear water. The shores of this sound are high and rocky. But few streams flow into it, and these chiefly on its eastern side. In the southeastern part the Cowlitz River flows along the base of the Cascades in a southerly direction and empties into the Columbia. But in the central part, rising among the hills in the southwestern corner and flowing first east then north, so that the Kalama Branch of the Northern Pacific passes along it, and then west, is a magnificent stream, the Chehalis River, emptying into Gray's Harbor and so into the Pacific Ocean. This is the largest river in Western Washington. It is the only river of any size not subject to summer floods caused by the melting of mountain snows. This river with its tributaries, and including Gray's Harbor, drains a basin of some 3,500 square miles; (the map shows sixty townships, and a greater amount may fairly be reckoned as part of this river valley). As will be seen, Chehalis County is the very heart of Western Washington, and it is the heart in a very true sense, in that all that is desirable in Western Washington is centered here in its best condition, and here are the means, the forces that are to give life and growth to all the rest.

"CLIMATE.

"From October 13 to November 13, thirteen rainy days, thirteen fair days, and five clear days; from November 13 to December 13, twelve rainy days, thirteen fair, and four rain and shine; from December 13 to January 13, one day snow, six rain, three rain and shine, fourteen fair, and eight clear days; from January 13 to February 13, three days snow, four rain, two rain and shine, ten fair, and twelve clear days; from February 13 to March 13, five days snow, three rain, one rain and shine, sixteen fair, and four clear days; total for the winter, nine days of snow, thirty-eight rain, ten rain and shine, sixty-six fair, and thirty clear days. Days are called clear when not a cloud appears. During this time the range of the thermometer was: First month—lowest 40°, highest 65°, and the average $53\frac{1}{2}$°; second month—lowest 34°, highest 55°, average $41\frac{5}{8}$°; third month—lowest 28°, highest 50°, average $37\frac{1}{2}$°; fourth month—lowest 9°, highest 45°, average $23\frac{1}{6}$°; fifth month—lowest 27°, highest 42°, average $36\frac{3}{8}$°. The record of 9° above was the lowest point reached during the last seven years. There was one fall of snow that reached a depth of 6 inches. The record of lowest thermometer for the last seven years is: For 1876–'77, 22°; for 1877–78, 20°; for 1878–79, 10°; for 1879–'80, 10°; 1880–'81, 28°; 1881–'82, 20°; 1883, 9°.

"THE SOIL.

"The soil of the uplands, or hills, is loamy—in places gravelly. It is quick, warm, but not strong land as a rule. In some localities where upland clearings have been made reports are given of large crops. It is better adapted to fruit and general gardening. Some of the hills are doubtless good land. It all grades off into bottom-land. It is difficult to clear for the immense growth of timber. But in this climate most of these hills will be profitably farmed. Indeed, almost anywhere clover and timothy grass will flourish luxuriantly. But it is the *bottom land* that is chiefly valuable at present for farming. Thus far the most part is easily cleared, and is as good land as can be found anywhere. It will produce good crops of almost anything, and its fertility is inexhaustible. One piece that has been cultivated almost continuously for twenty years, with no manuring, is to-day as rich as when first plowed. This land is all made land. It is a mixture of alluvial wash and vegetable and animal matter. It is more like garden than field land. A few acres will yield more than a quarter-section of much of the land East.

"These bottom-lands in general are subject to winter overflow. Though some of them rarely, if ever, are covered. They are apt to be broken by channels which this overflow has made and by sloughs and streams which flow through.

"There is much of this bottom-land. Along each of the principal streams there are wide stretches of it, and along each stream in this whole Chehalis country there is more or less. But as there are few quarter-sections across which some stream does not flow, so there are few which do not possess some of this bottom-land.

"These bottom-lands that lie down toward the sea are subject to periodical overflow by the tide, and there is a large amount of this about Gray's Harbor and the streams that empty into it. These are in places largely open and covered with a rank growth of wild grass. They are used now principally for pasture. But a dike from 1 to 3 feet high would keep out this tide, and when so diked they are equal to the best of bottom-land. No better land can be found."

In view of the preceding description I am inclined to believe that in Washington Territory and Oregon soil and climate are very favorable to the growth of a sugar beet of high saccharine strength.

The mildness of the winter is, though to a less degree than in California, favorable to the season of manufacture. With a wise and careful encouragement of the industry I have no hesitation in saying that the prospects for the development of an indigenous sugar industry in the extreme northwestern part of our country are decidedly bright. It is a field worthy the attention both of experimenters and capitalists.

INDIRECT ENCOURAGEMENT OF THE BEET SUGAR INDUSTRY.

A few years ago machinery to be used exclusively for the manufacture of beet sugar was admitted free of duty. Now, that such machinery can be made here almost as cheap as abroad, the same necessity for its free entry does not exist. Nevertheless it might be wise to continue the free admission of such machinery until our own manufacturers have learned the art of making it. This would be especially true of the machinery used in separating the sugar from the beet molasses, none of which has ever been made in this country. Since beet molasses can be used only for distillation and the alcohol therefrom is never used as a beverage, it would be a great encouragement to the industry to permit the manufacture of the alcohol for use in the arts free of tax. If such an arrangement could be made without unduly complicating our internal revenue system it would render the molasses a most valuable by-product of beet sugar production.

REPORT UPON RECENT IMPROVEMENTS IN MACHINERY AND PROCESSES FOR THE MANUFACTURE OF BEET SUGAR.

By GUILFORD L. SPENCER, *Assistant Chemist.*

DEPARTMENT OF AGRICULTURE,
Washington, D. C., March 2, 1885.

SIR: I have the honor to submit the following report of my visit to Europe, to examine recent improvements in machinery and processes for the manufacture of beet sugar.

I wish to thank Messrs. Vilmorin & Posth, of the firm Vilmorin, Andrieux et Cie., Paris, and Mr. Dupont, Francières, for their kindness in supplying me with letters of introduction. Also, Messrs. Riedel, Roediger, & Ganzer, of Halle, for many favors.

Respectfully,

GUILFORD L. SPENCER,
Assistant Chemist.

Dr. H. W. WILEY,
Chemist.

The European sugar industry is at present attracting considerable attention. This industry is now struggling against a financial crisis which threatens to seriously retard its extension. Never before in the history of sugar manufacture has this staple brought a lower price in the market. Sugar is now being sold in London, in many instances for less than it costs on the continent to manufacture it.

At the time of the discovery of the existence of sugar in beets attempts were made to discourage its extraction, lest it should prove a too powerful competitor for the tropical sugar. Bribery was even resorted to, but fortunately without success. These fears were soon allayed, as the impure beet juice was far from being as manageable as the purer juice of the cane. Again, the cane growing on the rich soils of the South under the rays of a tropical sun, required little skill in agriculture, and furnished a juice so pure that the simplest processes served to extract the sugar. Not so with the beet. Skill and patience were necessary to bring it up from a root yielding but little sugar to one rivaling even the richest sugar cane of the tropics. It required study and perseverance to devise methods for the treatment of its impure juice. As soon as experiment proved that sugar could be successfully extracted from the beet, wise legislation and generous bounties encouraged the new industry, until now it has attained an enormous development. The production of cereals is gradually yielding to the demands for more land for the cultivation of the beet. Non-beet-producing countries can grow cereals more economically. So gradually the beet-sugar industry has been extending, almost unobserved by the cane planter, until now he finds himself on the verge of financial ruin, brought about by overproduction in this industry, against whose competition he once felt so secure. This crisis may serve to stimulate him to improve his processes of manufacture, to enable him to compete with the European producer. It is a noticeable fact in the history of the manufacture of beet sugar that each time the Governments have imposed additional burdens in the shape of taxes, the producer has been compelled to improve his processes and often to devise new ones.

The laws imposing excise taxes on beet sugar have also had a marked influence in the development of the sugar industry. As soon as the extraction of sugar from the beet was an assured success, the Governments which at one time liberally encouraged the industry began to compel it to assist in raising the public revenues. France levied a tax directly on the quantity of sugar extracted, consequently the manufacturer did not attempt to extract all the sugar from the beet, but stopped at a certain limit. This limit was reached as soon as the cost of manufacture and the tax amounted to as much as the value of the sugar.

On the other hand, the German Government assessed the tax on the weight of the beet, assuming that it would contain on an average a certain per cent. of sugar. This law has stimulated the German manufacturer to extract the greatest possible amount of sugar from his beets. As a result of the workings of this law, Germany is far ahead of France as regards perfection of processes. A similar law has also placed Austro-Hungary in advance. But now, within a year, France has so modified her laws controlling the manufacture and exportation of beet sugar that her manufacturers will soon work under more favorable conditions.

In his report on the "Sugar Beet"* Dr. McMurtrie has given so complete a history of the growth and development of the beet-sugar industry that it is unnecessary for me to repeat it here. Like other industries, this one has had its struggles, but after many years it is too firmly established to be hurt by competition with the cane sugar of the South. The troublous times through which the industry is now passing seem to incite scientific men to new discoveries and to the perfecting of manufacturing processes. There is little doubt but the United States could grow beet sugar and successfully compete with Europe. We have a range of climatic and soil conditions that can be found in no other country. The policy of our Government in not taxing such industries, but protecting them, is a marked advantage over European producers. Under the present political conditions they cannot well do away with the revenue raised by taxing the sugar industry.

EXTRACTION OF THE JUICE.

The most usual method for extracting the juice from the beet is by diffusion. This process has been so successful that now but comparatively few sugar houses employ presses, either hydraulic or continuous.

---

* "Culture of the sugar beet," United States Department of Agriculture, 1878.

Diffusion batteries may be divided into two classes:

(1) The ordinary, consisting of a number of cells.

(2) The continuous, having but one cell. The first may be divided into (1) battery in line, (2) circular battery.

The ordinary diffusion battery is composed of several cells, usually twelve in number. They are so arranged that as soon as one cell or diffuser is charged with beet cuttings it is closed and warm water forced into it. The water takes up a portion of the sugar and then enters a second diffuser charged with fresh cuttings or *cossettes*.* This operation is repeated, until the juice from the first diffuser, having passed through a certain number of cells, leaves the last heavily charged with sugar.

In working a diffusion battery, one diffuser is being charged and a second emptied while the rest of the battery is under pressure.

The arrangement of a battery, whether in a line, a double line, or a circle, depends quite often upon the space at the disposal of the sugar manufacturer. The circular arrangement requires a higher building owing to the position of the slicing machines, but nevertheless it is usually considered preferable to a line battery. Among the special advantages of a circular battery is the economy of labor. Another advantage, and quite an important one, is that all the diffusers are under the immediate control of the workman in charge. The beet slicer is placed above the battery, a swinging funnel conducting the cossettes into the diffusers. The exhausted cossettes, or pulp as they are termed, are dropped into a channel below and thence carried to the continuous presses by a chain and bucket elevator.

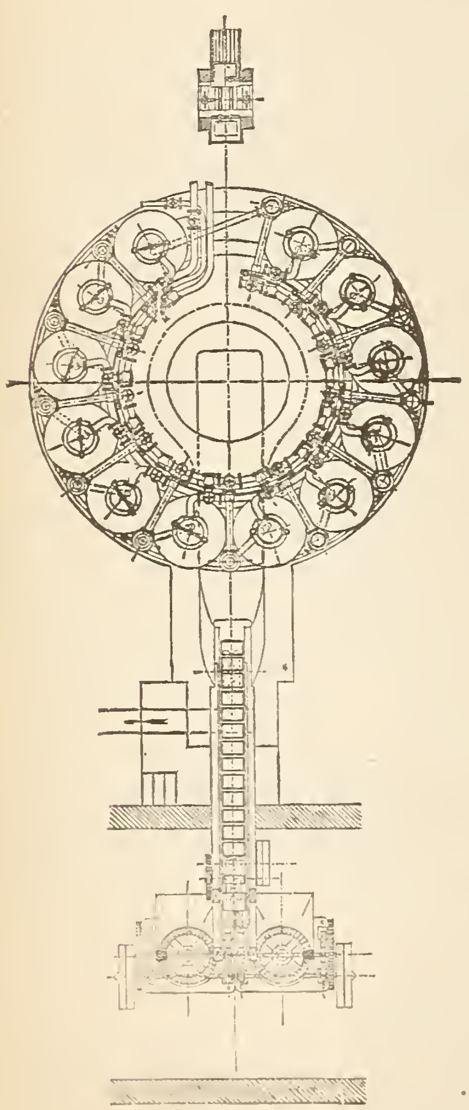


FIG. 9.

As I have indicated, the line battery differs from the circular only in the arrangement of the diffusers and the carrier necessary to charge them.

Plate 1 and Fig. 9 illustrate a circular battery, Riedel's system, constructed by the Hallesche Maschinenfabrik, Halle a. S.

THE CONTINUOUS DIFFUSER.

Since the invention of what is termed the German diffusion process, by Robert, it has been a favorite idea to devise a continuous diffuser. Robert himself attempted this, but without success. About six years ago

* Cossettes in French, Schnitzel in German.

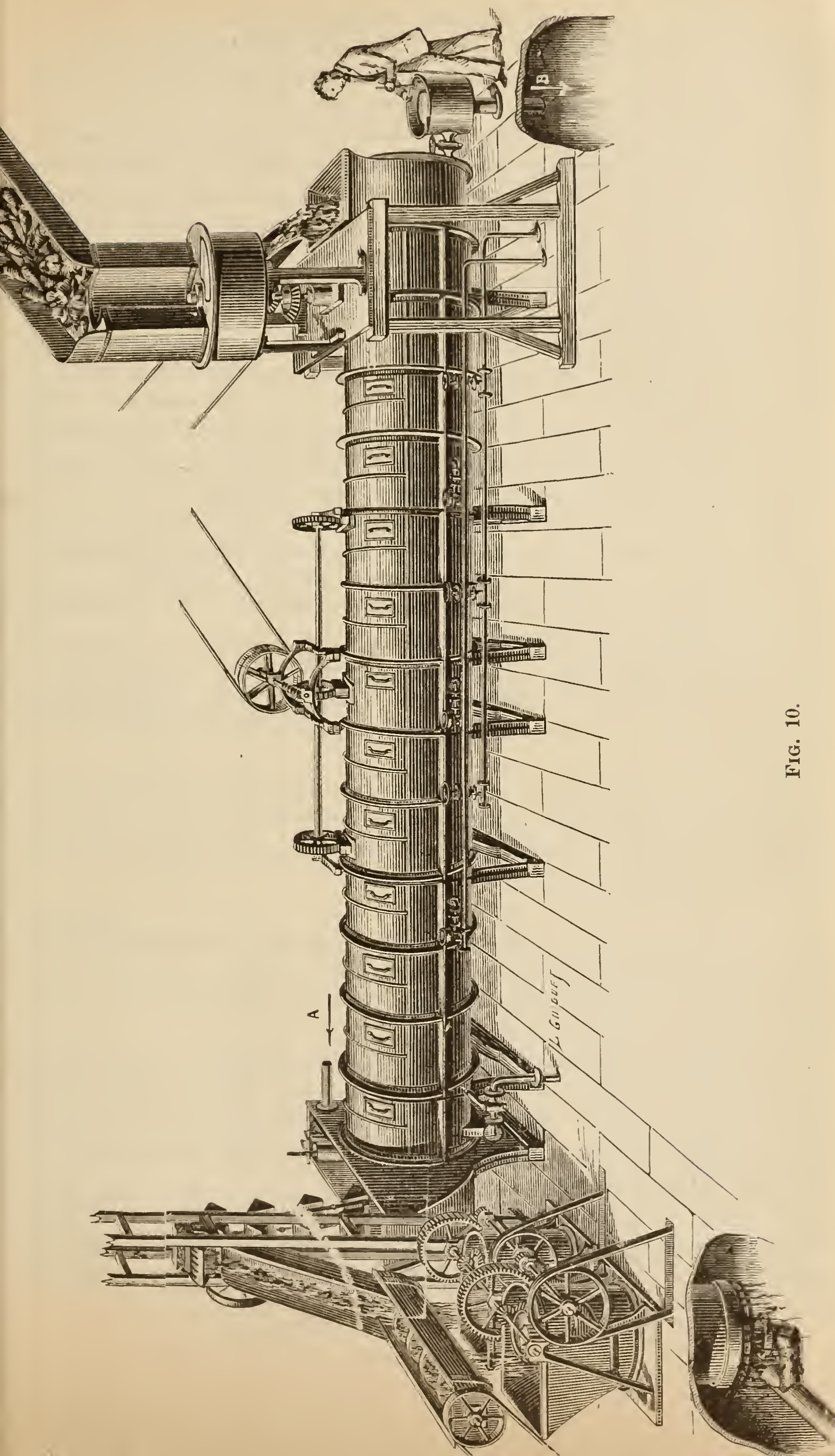


FIG. 10.

Mr. Charles invented a continuous diffuser, which was afterwards successfully modified by Mr. Peret, of Roye, France. The following description of the continuous diffuser has been taken from the "Bulletin de la Société Industrielle d'Amiens, 1882:"

"The continuous diffuser (Fig. 10) consists of an iron cell, cylindrical in form, resting horizontally upon a foundation of masonry. Within this cell is a perforated iron cylinder, 1.30 meters (4.26 feet) in diameter and 11.20 meters (36.74 feet) in length. The axis is formed by a smaller cylinder. Between these two cylinders is a helix, pitch 70 centimeters (2.3 feet). The inner cylinder is revolved by a suitable connection with a shaft The speed of revolution is so adjusted that it requires 60 minutes for the beet cuttings to traverse the length of the helix. The cossettes are continually immersed in water. The water enters the cell at the end where the exhausted cossettes are expelled. An automatic arrangement controls the amount of water admitted and keeps it at a certain level. The water gradually becomes charged with sugar and finally leaves the cell at the end where the fresh cossettes enter it.

The conditions for a good diffusion are fulfilled when the cossettes and water move in opposite directions, the juice becoming more and more concentrated as it passes cossettes richer, and richer in sugar.

The water enters at a temperature of 30° C. (86° F.). It is heated as it passes the coils placed between the fixed cell and the revolving cylinder, and its temperature is gradually increased to 75° C. or 80° C. (167° or 176° F.), and then, as it strikes fresh cossettes, it gradually becomes colder and leaves the diffuser at a temperature of 50° C. to 60° C. (122° to 140° F.).

Three small vertical test cylinders are placed at equal distances from one another and serve for determining the specific gravity and the temperature of the juice. These observations are made at regular intervals and the results are entered in a note-book.

* * * * * *

In the ordinary form of diffusion battery the ten or twelve diffusers demand the constant attention of a skilled workman. He must open and close the various valves from six to seven hundred times in the twelve hours he is on duty.

The continuous diffuser requires but little attention after one has regulated (1) the speed of the slicer, (2) the speed of the elevator which removes the exhausted cossettes, (3) the speed of rotating cylinder, (4) the pressure of steam on the coils, (5) the exit of the juice which controls the entrance of the water.

It is only necessary to note the temperature at intervals and regulate the pressure on the coils. The temperature and the quality of the beets are the only variables. One man and a boy are sufficient to conduct the diffuser, beet slicer, and pulp presses."

The following certificate will explain itself:

Complete machinery for working 2,000 hectoliters (44,000 gallons) of juice in twenty-four hours, including engines, beet slicer, the diffuser (with elevator for exhausted cossettes), Klusemann pulp presses, and transmission of power, &c.; total cost, 50,000 francs ($10,000); cost of repairs per season, 500 to 700 francs ($100 to $140).

Labor per ton of beets worked, not including washing the beets, 16 centimes (3.2 cents).

Results obtained.

Mean density of 2,000 hectoliters of juice	*1.036
Beets, per 100 liters, and each degree of density ......kilograms..	21.00
Masse cuite per 100 kilograms of beets ......liters..	6.63
Masse cuite per hectoliter of juice ......do...	1.45
First sugar, white, per 100 kilograms of beets ......kilograms..	4.492
Sugar per 100 liters of masse cuite ......do...	68.
Second molasses per 100 kilograms of beets ......liters..	4.06
Second molasses per 100 liters of first masse cuite ......do...	61.
Second sugar per hectoliter of masse cuite ......do...	44.
Molasses per 100 kilograms of masse cuite ......do...	44.
Beets, per 100 kilograms of masse cuite ......kilograms..	†1,000
Pulp per 100 kilograms of beets ......do...	40.
Sugar per 100 kilograms of pulp ......do...	0.41

ROUSSEAU,
Chef de fabrication à Frayieres.

The following table shows the results obtained in the sugar house at Roye (Somme), France:

Table showing the extraction—Roye sugar house (France), 1881 and 1882.

Date.	Specific gravity of the beet.	Specific gravity of the juice.	Temperature.	Juice.	Sugar left in cossettes.
1881.			° C.	*Hectoliters.*	*Per cent.*
September 28	....	1.023	66	900	....
September 29	1.050	1.026	66	1325	....
September 30	....	1.028	66	1495	0.82
Averages	1.050	1.026	66	1217	0.82
October 1	1.053	1.0295	70	1275	0.57
October 2	....	1.029	69	300	....
October 3	1.0515	1.029	69	1500	0.58
October 4	1.0535	1.0339	66	1725	0.55
October 5	1.0541	1.0333	60	1575	0.47
October 6	1.0521	1.030	66	1700	0.45
October 7	1.0555	1.032	63	1725	0.40
October 8	1.053	1.030	66	1575	0.45
October 9	1.0525	1.0355	78	1000	0.44
October 10	1.0525	1.036	75	1825	0.37
October 11	1.0535	1.032	73	1650	0.51
October 12	1.0525	1.033	73	1750	0.45
October 13	1.052	1.034	73	1750	0.42
October 14	1.0545	1.034	73	1750	0.48
October 15	1.054	1.036	73	1725	0.57
October 16	1.054	1.033	73	2000	....
October 17	1.0555	1.035	71	1775	0.45
October 18	1.054	1.0345	72	2000	0.44
October 19	1.057	1.035	72	1700	0.55

* Or 3°.6. †2,200 pounds.

Table showing the extraction, &c.—Continued.

Date.	Specific gravity of the beet.	Specific gravity of the juice.	Temperature.	Juice.	Sugar left in cossettes.
1881.			°C.	*Hectoliters.*	*Per cent.*
October 20	1. 0535	1. 032	70	1675	0. 50
October 21	1. 055	1. 033	66	1600	0. 57
October 22	1. 0548	1. 033	69	1200	0. 60
October 23	1. 055	....	76	300	0. 45
October 24	1. 0535	1. 030	77	1700	0. 48
October 25	....	1. 030	78	1800	....
October 26	1. 055	1. 0347	78	1800	0. 52
October 27	1. 049	1. 0349	78	1850	0. 40
October 28	1. 051	1. 035	78	1900	0. 38
October 29	1. 055	1. 0353	77	1975	0. 39
October 30	1. 055	1. 0377	78	2000	0. 40
October 31	1. 054	1. 0378	78	1875	0. 41
Averages	1. 0549	1. 0339	71	1725	0. 51
November 1	1. 0525	1. 0367	78	1950	0. 40
November 2	1. 054	1. 0367	79	1950	0. 39
November 3	1. 053	1. 0364	79	1925	0. 39
November 4	1. 051	1. 0369	79	2025	0. 40
November 5	1. 054	1. 0378	79	1975	0. 43
November 6	1. 055	1. 0366	79	1450	0. 44
November 7	1. 054	1. 0365	79	1875	0. 54
November 8	1. 0518	1. 0365	80	1900	0. 44
November 9	1. 053	1. 0365	80	2000	0. 44
November 10	1. 053	1. 0363	80	1825	0. 37
November 11	1. 0525	1. 0368	80	1625	0. 44
November 14	1. 052	1. 0381	80	1275	0. 36
November 15	1. 052	1. 0372	72	1925	0. 40
November 16	1. 0565	1. 0372	75	2000	0. 39
November 17	1. 056	1. 0366	76	2000	0. 39
November 18	1. 0555	1. 0363	75	1925	0. 40
November 19	1. 052	1. 0358	78	1950	0. 44
November 20	....	1. 0357	78	1400	....
November 21	1. 055	1. 0357	72	1775	0. 40
November 22	1. 055	1. 0357	74	2025	0. 32
November 23	1. 051	1. 0351	76	2000	0. 34
November 24	1. 055	1. 0357	77	2000	0. 36
November 25	1. 053	1. 0357	78	2000	0. 25
November 26	1. 053	1. 0349	78	2000	0. 30
November 28	....	1. 0348	78	575	....
November 29	1. 0575	1. 0348	77	1950	0. 50
November 30	1. 0525	1. 0346	77	2025	0. 48
Averages	1. 0535	1. 0361	77. 5	1940	0. 40
December 1	1. 0525	1. 0351	78	2000	0. 43
December 2	1. 054	1. 036	78	2025	0. 33
December 3	1. 052	1. 0365	79	1950	0. 36
December 4	1. 051	1. 0353	83	1900	0. 38
December 5	1. 0505	1. 0352	86	2000	0. 37
December 6	1. 050	1. 0356	84	1975	0. 38
December 7	1. 051	1. 0350	84	2000	0. 39
December 8	1. 053	1. 0358	86	1975	0. 35
December 9	1. 049	1. 0369	86	2000	0. 48
December 10	1. 0505	1. 0357	85	1950	0. 39
December 11	1. 050	1. 0364	85	825	0. 36
December 12	1. 051	1. 0355	82	2000	0. 32
December 13	1. 050	1. 0361	81	2000	0. 35
December 14	1. 0477	1. 0359	80	2000	0. 42
December 15	1. 0495	1. 0363	80	2000	0. 37
December 16	1. 0495	1. 0357	80	2000	0. 37
December 17	1. 0485	1. 0356	86	2000	0. 44
December 18	1. 050	1. 0352	82	1375	0. 44
December 19	....	1. 0326	85	450	....
December 20	1. 0525	1. 038	82	2000	0. 65
December 21	1. 053	1. 041	87	2050	0. 79
December 22	1. 0508	1. 0403	87	2050	0. 88
December 23	....	1. 0392	88	2000	....
December 24	1. 0461	1. 0380	86	1575	....
December 26	1. 054	1. 0387	87	1400	0. 52
December 27	1. 050	1. 0383	89	2000	0. 51
December 28	1. 050	1. 041	90	2000	0. 52
December 29	1. 0448	1. 039	90	2000	0. 46
December 30	1. 0455	1. 0395	90	2000	0. 45
December 31	1. 046	1. 0396	91	2050	0. 48
Averages	1. 050	1. 038	84. 5	2000	0. 44

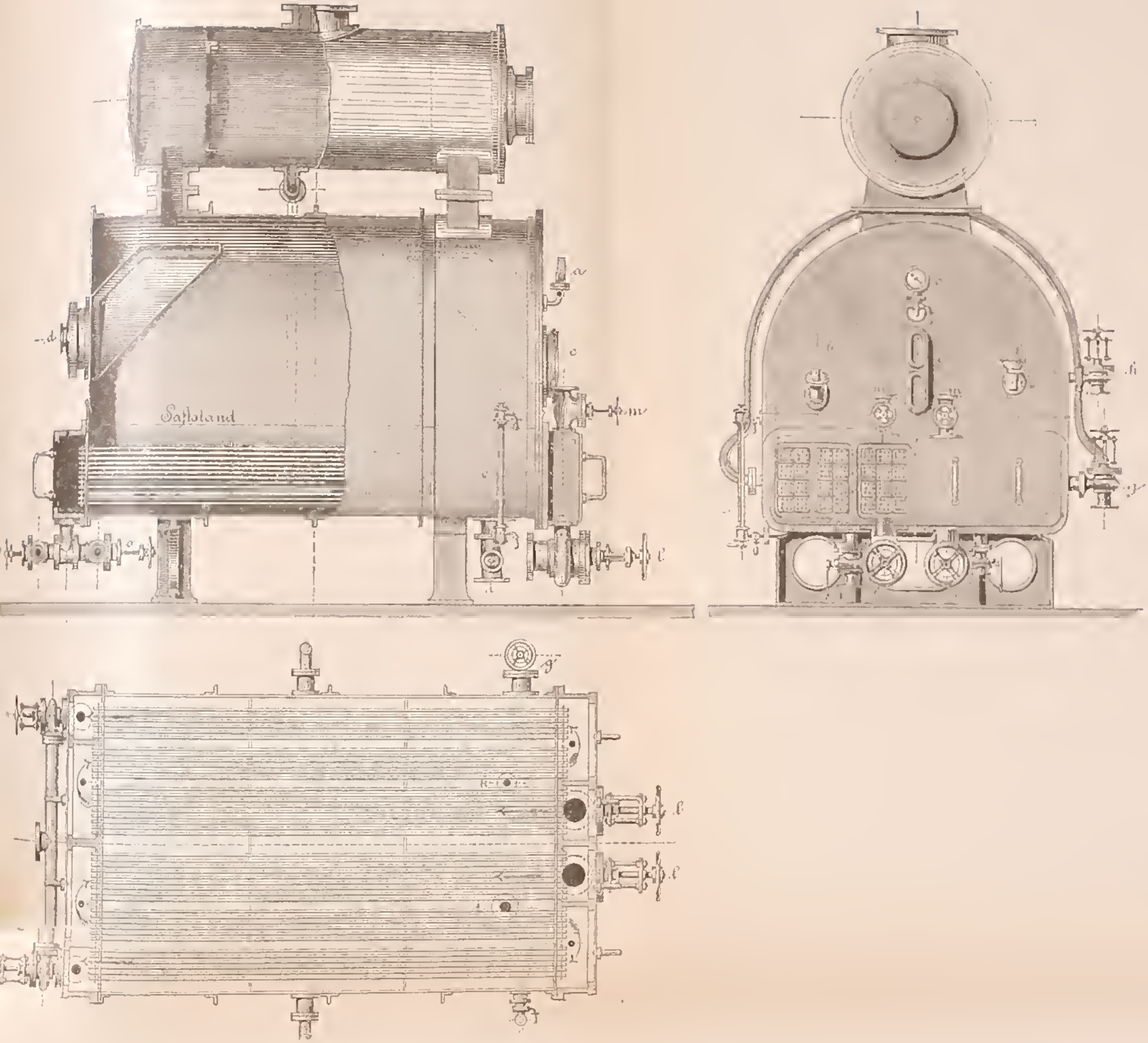


Fig. 11.—Apparatus for Rapid Evaporation.

Welner Jelinek System.

(Hallesche Maschinen-fabrik builders).

a. Vacuum gauge.
b. Thermometer.
c. Sight-glass.
d. Manhole-plate and sight-glass.
e. Juice gauge.
f. Grease cup.
g. Valve to admit juice.
h. Steam valve.
i. Exit for juice.
k. Exit for wash-water.
Saftstand = juice level.
l. Valve to admit exhaust steam from engines.
m. Valve to admit direct steam.
n. Valve connecting with exhaust steam-receiver.
o. Valve for exit of condensed water.

13406 SUG——face p. 114

Table showing the extraction, &c.—Continued.

Date.	Specific gravity of the beet.	Specific gravity of the juice.	Temperature.	Juice.	Sugar left in cossettes.
1882.			°*C.*	*Hectoliters.*	*Per cent.*
January 2	....	1.0376	88	1425	....
January 3	....	1.038	89	2000	....
January 4	1.053	1.041	89	1975	0.57
January 5	1.0509	1.0374	88	2000	0.55
January 6	1.0505	1.039	88	2000	0.54
January 7	1.0495	1.0375	88	2000	0.57
January 8	....	1.039	87	1500	....
January 9	1.048	1.0375	88	1575	0.57
January 20	1.052	1.0386	90	1250	0.55
January 21	1.051	1.038	90	1900	0.50
Averages	1.0513	1.038	88.5	1980	0.56

It may be safely stated that in Germany and Austro-Hungary not less than 90 per cent. of the sugar houses employ the diffusion process for extracting the juice. The proportion in France is much smaller, owing to the tax being based upon the sugar actually extracted. Since the passage of the new law, levying the tax as in Germany, many French sugar houses have adopted this process. I believe that in a few years the diffusion will be the only process employed for extraction, except in a few districts where local conditions prevent its adoption.

EVAPORATION.

The economical evaporation of the juice is one of the most important problems with which the sugar manufacturer has to deal.

The hydraulic presses yield 100 pounds of dilute juice per 100 pounds of beets. With the diffusion process this proportion is considerably larger, being 120 pounds dilute juice per 100 pounds of beets. It is evident from the above statements that a beet-sugar house employing the diffusion process must be supplied with evaporating facilities at least one-fifth greater than one employing hydraulic presses. Inventors have not been backward in their efforts to meet this demand for improvements in the apparatus for rapid and economical evaporation.

One of the most recent and important improvements in multiple-effect apparatus is known as the Welner-Jelinek system.

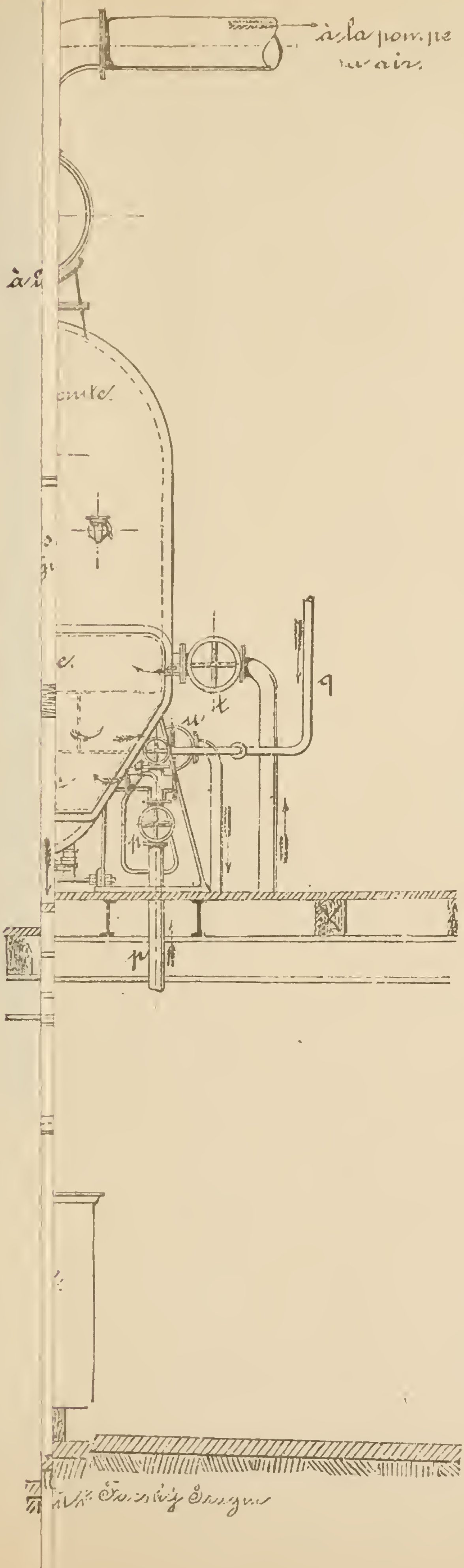
In this system the pans are arranged horizontally (see Fig. 11), and the heating space is divided into two chambers—an upper and lower This division into chambers permits the passage of the vapors from the upper to the lower, facilitating the discharge of the water of condensation, and increases the heating surface. These chambers are each subdivided into two others of unequal size. The shape of the pan reduces the danger of loss through particles of the juice becoming entangled with the disengaged vapors. In addition there is also the usual arrangement for diminishing this loss.

The following illustrations (Figs. 12, 13, and 14) were taken from a recent publication * by the two well-known Belgian chemists, Messrs. F. Sachs and Armand Le Docte.

* Revue Universelle des Progrés de la Fabrication du Sucre. François Sachs et Armand Le Docte. E. Guyot, publisher, Brussels, 1884.

Translation of terms, Figs. 12, 13, and 14.

Aux filtres, au lait de chaux, à la salle du noir.	Pipe leading to the filters, to the boxes for slacking lime, and to the bone black room.
Automate central à tension de vapeur directe.	Central receiving trap.
A la carbonatation.	To the carbonatation pour.
Automate sous tension de la vapeur directe.	Receiving trap for direct steam.
A la pompe alimentaire.	Pipe leading to the feed-pumps.
A la pompe à air.	To the vacuum pump.
Aux filtres.	To the filters.
Appareil de cuire.	Vacuum strike pan.
Boîte pour les eaux ammoniacales (1^{e} et 2^{e}).	1st and 2d tanks for ammoniacal water.
Chaudière d'alimentation.	Water heater.
1^{e} caisse, 2^{e} caisse, 3^{e} caisse.	1st, 2d, and 3d pans.
Condenseur.	Condenser.
Calorisateur à contre courant.	Calorisator for heating the juice.
Cuite des sirops.	Evaporation of the sirup.
Cuite préalable.	Preparatory pan.
Eau alimentaire.	Water for the boilers.
Eau de condensation des pompes à air, à 40° C. temp.	Condensed water from vacuum pumps; temperature, 40° C. (104° F.).
Jus de diffusion.	Diffusion juice.
Jus filtré faible.	Filtered juice.
Jus faible.	Thin juice.
Jus demi-concentré et filtré.	Juice half concentrated, filtered.
Pompe d'eau ammoniacale.	Pump for ammoniacal water.
Pompe à air.	Vacuum pump.
Pompes à jus.	Juice pumps.
Réservoirs pour l'eau ammoniacale de la 2^{e} caisse.	Reservoirs for ammoniacal waters from the 2d pan.
Réservoirs pour l'eau ammoniacale de la 3^{e} caisse.	Reservoirs for ammoniacal waters from the 3d pan.
Retour d'eau.	Receiving trap.
Réservoir de l'eau de diffusion.	Reservoir for water for the diffusion battery.
Retour d'eau sous tension de la vapeur de retour.	Receiving trap for condensed water from exhaust steam pipes.
Réservoir de jus faible.	Reservoir for thin juice.
Réservoir de jus demi-concentré.	Reservoir for half-concentrated juice.
Réservoir de jus concentré.	Reservoir for concentrated juice.
Soupape de sûreté.	Safety valve.
Trop plein.	Overflow pipe.
Tuyau de refoulement.	Pipe connecting with pump.
Tuyau de réserve pour l'eau ammoniacale.	Reserve pipe for ammoniacal water.
Tuyau de l'eau de retour allant directement dans les chaudières à vapeur.	Return water pipe, connecting directly with the boilers.
Vapeur directe.	Direct steam.
Vase pour recueillir le jus concentré.	Collecting tank for conceutrated juice.



à la pompe
à air
q
t

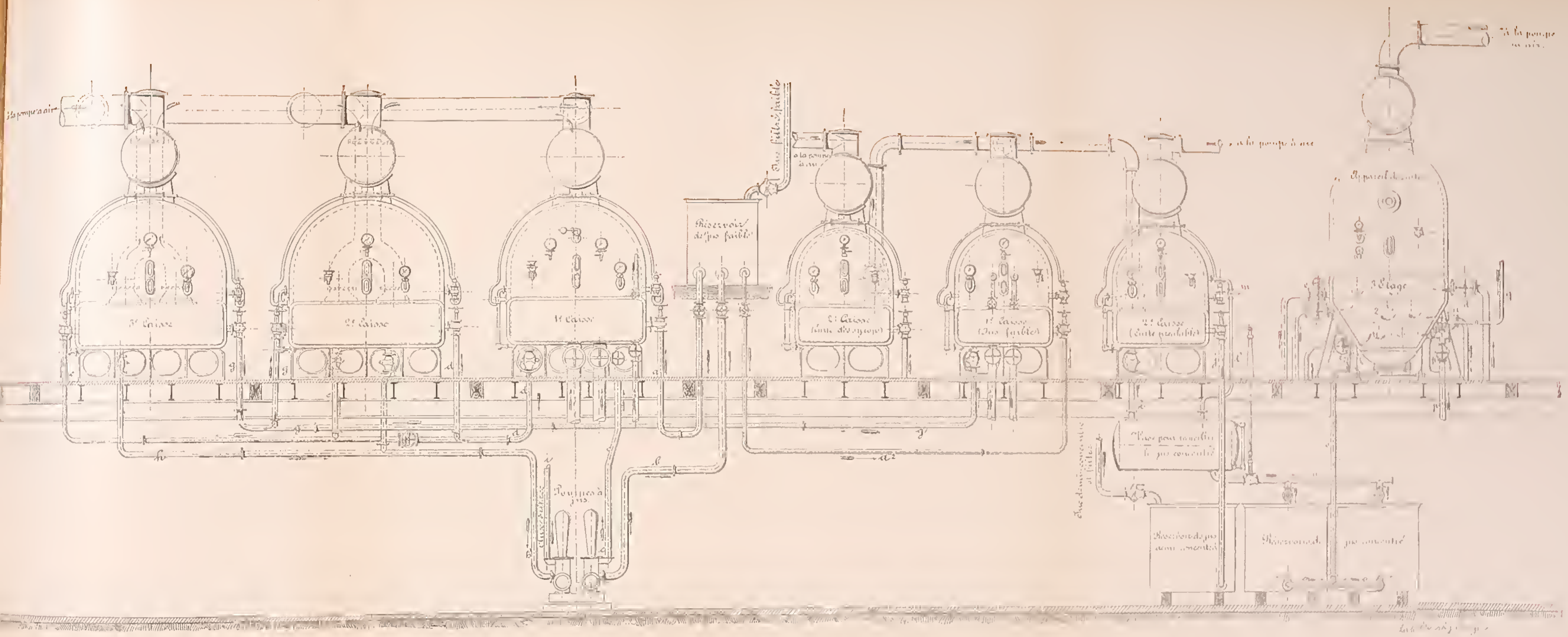
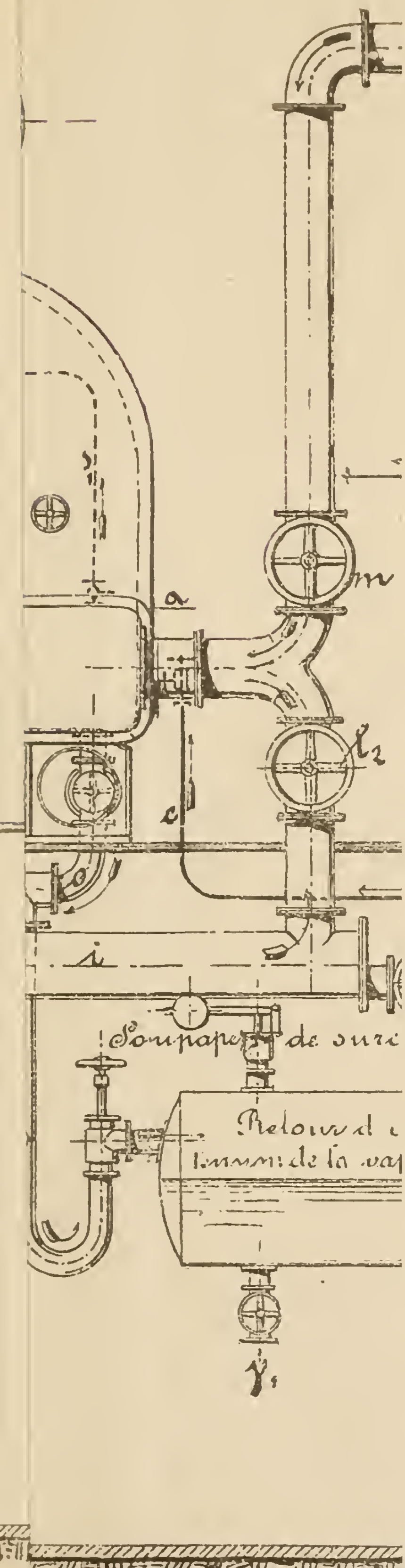


FIG. 13.



m
a
c
i
Soupapes de sûre
Retour d
de la vap

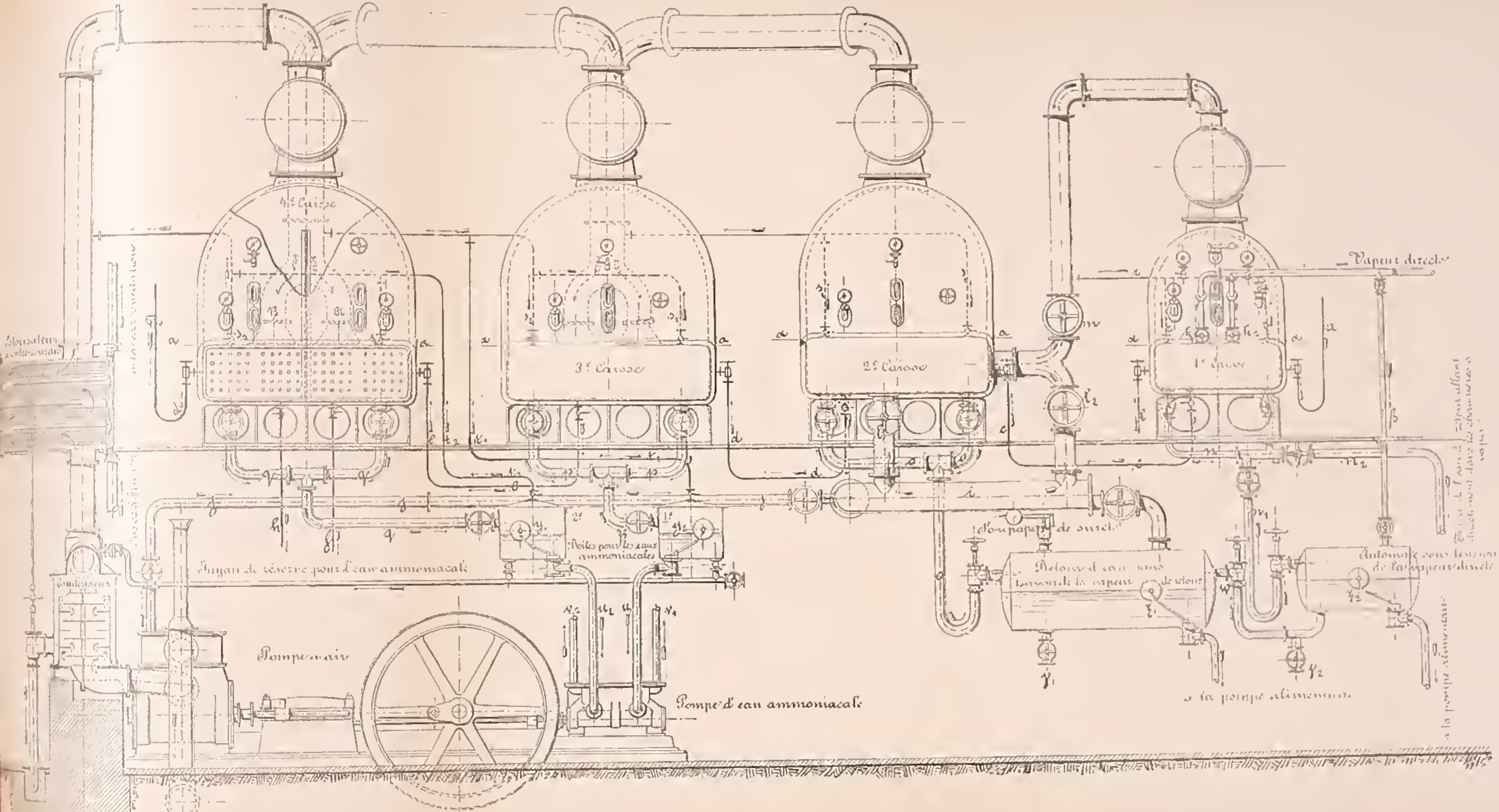
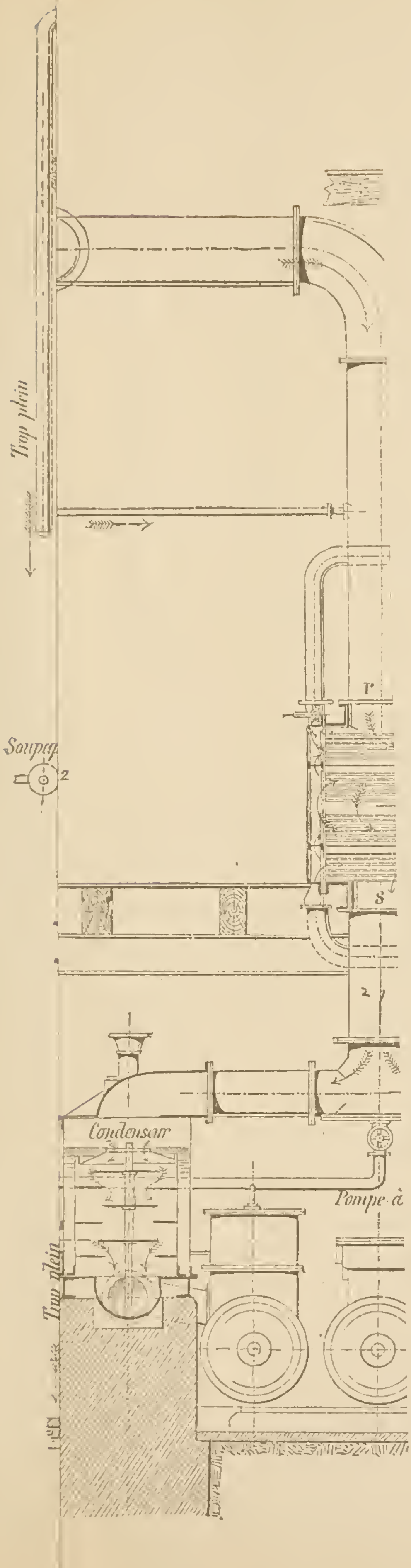

4e Caisse
3e Caisse
2e Caisse
Vapeur directe
Soupape de sûreté
Boîtes pour les eaux ammoniacales
Tuyau de réserve pour l'eau ammoniacale
Pompe à air
Pompe d'eau ammoniacale

FIG. 14.


Trop plein
Soupap
Condenseur
Pompe à
Trop plein

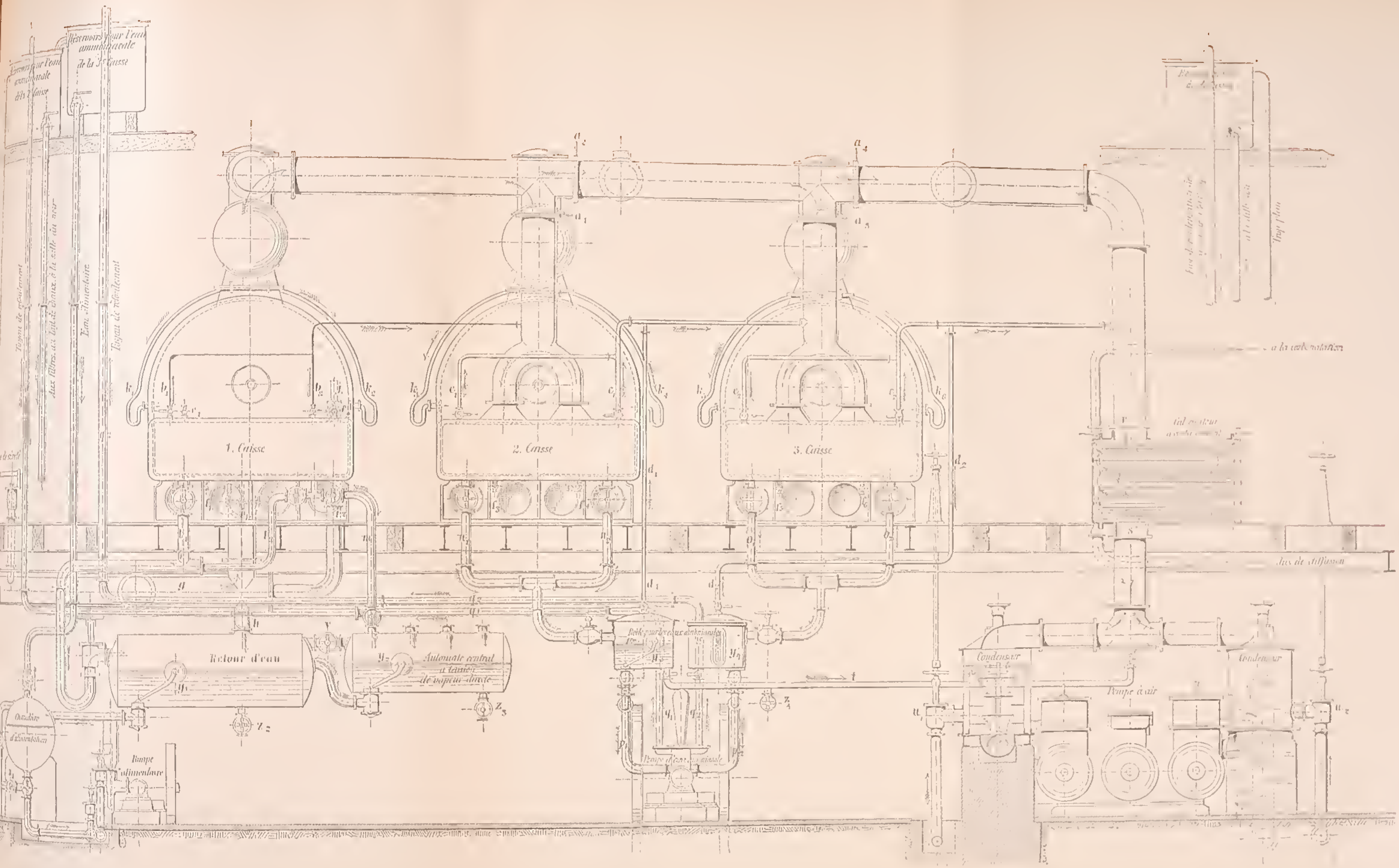

1. Caisse
2. Caisse
3. Caisse
Retour d'eau
Automate central à tension de vapeur diluée
Condenseur
Condenseur
Pompe à air
Pompe alimentaire
Jus de diffusion

Fig. 12.

GENERAL DISPOSITION OF MACHINERY FOR EVAPORATION IN A TRIPLE EFFECT.

I.—*Illustration of the Welner Jelinek system.*

(FIG. 12.)

a_1 a_4. Valves and connections to convert the triple effect into a double effect by cutting off communication with the second or third pan.

b_1 b_2. Tubes for the escape of air from the heating chamber of the first pan.

c_1 c_2. Tubes for the escape of ammonia and non-condensed vapors from the second and third pans.

d_1 d_2. Pipes for the escape of the air, ammonia, and non-condensed vapors from the ammoniacal water-tanks.

e_1 e_2. Air-valves.

f_1 f_2. Valve to take sample for determination of the density of the sirup.

g_1 g_2. Escape pipes for exhaust steam.

h. Pipe connecting return steam pipe and pipe *g*.

i_1 i_2. Valves to admit exhaust steam to the heating chamber of the first pan.

j. Valve to admit direct steam to the heating chamber of the first pan.

k_1 k_6. Return pipe for particles of juice entrained by the escaping steam.

l_1 l_2. Pipes leading to condensed-water tanks.

m. Pipe to drain direct steam pipe.

n_1 n_2. Pipe for condensed water from the heating chamber of the second pan, connecting with the second tank for ammoniacal water.

p_1 p_2. Pipe connecting with ammoniacal water pump.

q q. Pipe connecting with ammoniacal water pump.

r. Outlet into calorisator for steam generated in third pan.

S. Outlet for vapors set free in calorisator.

t. Reserve pipe to conduct ammoniacal water into the condensers.

u_1 u_2. Injectors to throw water into condensers.

v. Valve to increase the pressure of the exhaust steam (usually left closed).

y_1 y_2, Ball valves.

z_1 z_2. Discharge valves.

II.—*Illustration of the manipulations necessary to evaporate beet juice in multiple-effect apparatus.*

(FIG. 13.)

a_1 a_2. Pipe connecting with juice reservoirs.

b. Suction pipe, for filtered juice, when necessary to employ a pump for first pan.

c. Pipe connecting the pump with the pan.

d. Juice pipe connecting first and second pans.

e. Juice pipe connecting second and third pans.

f. Valve for establishing communication between first and third pan when necessary to clean the second pan.

g. Pipe connecting first pan of double effect with the second or third of the triple effect.

h. Pipe connecting third pan with the pump.

i. Pipe to conduct the the half-concentrated sirup to the filters.

j, Pipe connecting with concentrating pan.

k. Pipe connecting the concentrating pan with the receiving vessel for sirup.

l. Pipe connecting the concentrating pan with the receiving vessel to produce a vacuum in the latter.

m. Two-way valve to connect either with the pan or with the open air.

n. Pipe to conduct the sirup into the reservoir.

o. Pipe connecting the sirup reservoir with the vacuum strike pan.

p. Valve admitting exhaust steam from the engines to the first heating chamber of the strike pan.

q. Valve connecting the same chamber with the direct steam pipe.

r. Discharge valve for condensed water from first chamber of vacuum pan.

s. Valve connecting second heating chamber with the exhaust steam reservoir.

t. Valve connecting third heating chamber with the exhaust steam reservoir.

u. Valve for condensed water from second chamber of the vacuum pan.

v. Valve for condensed water from third chamber of the vacuum pan.

III.—Illustration of the use of multiple effects in a sugar-house employing economical arrangements for steam power. (Fig. 14.)

a. Suction-pipe.

b. Suction-pipe first pan, when the apparatus is charged by means of a suction pump.

c. Pipe to conduct the juice from first to second pan.

d. Pipe to conduct the juice from second to third pan.

e. Pipe to conduct the juice from the third pan to section A of the fourth pan.

f. Pipe to conduct the sirup at 25° B. from section A fourth pan to the filters.

g. Pipe conducting filtered sirup (25° B.) to section B, fourth pan.

h. Pipe to conduct the concentrated sirup (37° B.) from the fourth pan to the vacuum strike pan.

i. Feed-pipe for exhaust steam.

j. Connection for exhaust from vacuum-pump engine.

k_1 k_2. Valves to admit direct steam into the heating chamber of the first pan.

l_1 l_2. Valves to admit exhaust steam into the heating chamber of the second pan.

m. Valves to admit steam from evaporating juices into the heating chamber of the second pan.

n. Pipe to drain direct steam pipe.

o. Pipe to drain heating chambers of second pan.

p. Pipe to conduct ammoniacal waters into the first receiver.

q. Pipe to conduct ammoniacal waters into the second receiver.

r. Escape valve for air from heating chambers of first pan.

s_1 s_2 s_3. Escape valve for ammonia and non-condensed vapors from second, third, and fourth pans.

t_1 t_2. Escape valve for ammonia and non-condensed vapors from first and second receivers for ammoniacal waters.

u_1 u_2. Pipe connecting receivers for ammoniacal waters with the pump.

w. Valve (usually closed) communicating with steam trap.

x. Water injector.

y_1 y_2 z_1 z_2. Ball valves.

$\alpha\alpha$. Juice level in the pans.

γ_1 γ_2. Discharge valves.

TREATMENT OF THE JUICE.

Preliminary to describing a few of the more important processes employed in the manufacture of sugar from the beet, it may be well to indicate briefly the usual method for treating beet juices.

Unfortunately, the simple process employed for clarifying cane juices is not at all successful with the beet. Beet juice contains but slight traces, if any, of glucose or reducing sugar, whereas the cane juice usually carries a notable quantity of this substance. It is a well-known fact that glucose unites with the lime and forms combinations, which are decomposed on heating and yield very highly-colored products. Hence the care which is taken not to add an excess of lime in defecating cane juices. Enough lime only is added to combine with the acids in the juice and with other impurities.

In treating beet juices a large excess of lime is added, usually from 2½ to 3 per cent. Carbonic acid gas is then forced through the juice, and the excess of lime is precipitated in the form of a carbonate, and carries down with it mechanically many of the impurities. This operation is terminated when the lime precipitate becomes granular and settles readily. At this point there still remains about a gram and a half of lime (CaO) per liter of juice. After having been passed through filter-presses the juice is treated, boiling hot, with ½ per cent. of lime, and carbonic acid is passed through it, until all the lime is precipitated. This operation is termed the *saturation*, the former the *first carbonatation.* The juice is again filtered through presses. Its further treatment is very similar to that of the cane.

Experiments have been made by Dr. Wiley * which indicate that a modification of this process could be successfully employed with cane juices. This method would be especially applicable in the manufacture of sugar from sorghum or in the treatment of very dilute diffusion juices.

The vacuum pans employed in boiling beet sugar are usually very high in proportion to their diameter, in order to enable the panman to build up large crystals.

As a rule, in Germany, the first sugars are not washed, and polarize 96 per cent. In France, on the contrary, those houses having facilities for making white sugar usually do so, and turn out an article polarizing 99 per cent.

STOEBNITZ SUGAR HOUSE.

This sugar house is located about 15 miles distant from Halle. The works were erected by a stock company. The stock is divided into 150 shares of 6,000 marks ($1,500). Each shareholder binds himself to furnish the beets from a certain number of acres of land, for which he receives 22 marks ($5.17) per 1,000 kilograms (2,200 pounds), and, in addition, the pulp from his beets. Other farmers are paid 25 marks ($5.87) per ton of 1,000 kilograms, and receive no pulp; but, if they prefer it, they are paid in the same way as the shareholders. This insures a plentiful supply of beets and is the plan generally adopted by German sugar houses.

The soil of the surrounding country tributary to Stoebnitz is rather a light clay, easily worked, and capable of producing an excellent beet. The sugar house furnishes the seed to the farmers. Selected samples from the field have polarized as high as 22 per cent. sucrose. Glucose

* Bulletin No. 3, Chemical Division, United States Department Agriculture, 1884.

is only present in immature beets, or in those which have sprouted in the silos.

The Stoebnitz sugar house is located in the center of a great depression, the neighboring hills sloping gradually to it. It is readily accessible by good country roads radiating in all directions. Its location possesses many advantages and but one serious disadvantage. This latter is its distance from rail communication.

The greater part of the machinery has been constructed by the Hallesche Maschinenfabrik. Mr. Roediger, a mechanical engineer connected with this establishment, kindly accompanied me on my visit to Stoebnitz.

As the acreage tributary to Stoebnitz has increased from time to time, the works have gradually reached their present magnitude through successive enlargements; hence, as one would naturally expect, the arrangement of the buildings and machinery is not such as would give the greatest economy of labor. Old walls, constructed for a smaller sugar-house, have imposed many restrictions upon the manager in the disposition of his machinery. Notwithstanding the disadvantages under which he labored, he has succeeded in building up a model sugar house.

The carts and wagons are driven directly into the beet shed and discharge their loads through trap doors into the receiving room below. Here a large force, composed mostly of women, throw the beets upon the carrier, which transports them to the washers, two in number. The washed beets are then carried by an elevator to an upper story and dumped into cars, to be weighed by the excise officer. The weighed beets are then sliced and conveyed to the two diffusion batteries. These batteries are arranged in a double line, twelve diffusers in each line. They have an united capacity of 600 tons of 2,200 pounds, in twenty-four hours. The batteries are of the Riedel type, constructed some years since. Between the two lines is a large trough to receive the exhausted cossettes, whence they are conveyed to six continuous pulp presses, four of the type known as Klusmann and the other two Bergreen.

The pressed pulps still contain from 75 to 85 per cent. of water, and in this moist condition are 40 per cent. of the weight of the beets worked. This pulp is very valuable as cattle food and sells for about $1.70 per ton. The relative values of diffusion and the old hydraulic press pulps is still a much debated question in some sugar countries. The juice from the diffusers is conducted to a calorisator, where it is heated to about 90° C. (194° F.) and is then treated with lime.

By the use of calorisators (Fig. 15) it is claimed that the heat expended in the process of diffusion is not lost, and that subsequent operations are carried on much more rapidly than by the old method. Generally in France the juice is conducted into tanks, whence it is drawn off as needed for the carbonatation pans. Consequently it loses much of its heat, and the first carbonatation demands a longer time. This

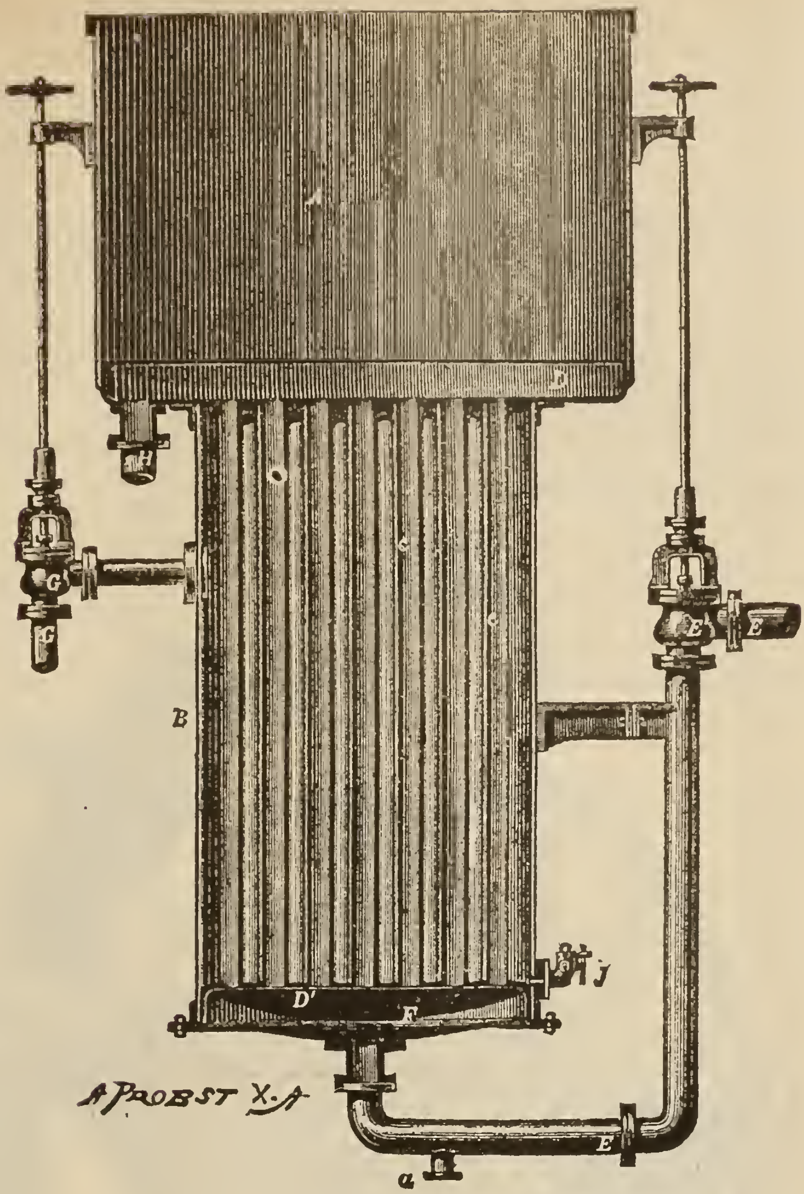


FIG. 15.

entails a much larger number of carbonatation pans. As at Stoebnitz, also generally in Germany, the carbonatation pans are covered and the foam is kept down by a jet of live steam. In many French sugar-houses, where large open pans are employed, the foam is beaten down by an arrangement of paddles, driven by machinery, and often in addition by a jet of steam.

The French manufacturer usually commences his first carbonatation at a low temperature, 40° C. (104 F.), which he gradually increases as the carbonatation progresses. By this means he claims that he avoids dangerous combinations between the lime, carbonic acid, and the sugar.

At Stoebnitz about 2½ per cent. (of the weight of the beets) of lime is employed in the defecation, and the usual quantity, about 1½ grams per liter, is left in the juice after the first treatment with carbonic acid.

The carbonated juice, including the suspended precipitate, is sent to the filter presses. The precipitate is washed with hot water and the washings are added to the filtrate. The filtered juice is treated with a second portion of lime, one-fourth of one per cent. of the weight of the beets; the lime is again precipitated by carbonic acid and the juice is passed through the filter presses; a third portion, about a liter and a half of cream of lime, is then added and afterwards saturated with sulphurous acid. After passing the filter presses, the juice is concentrated to 23° B.

This sirup is treated with a final and very small portion of lime, which is precipitated by carbonic acid, and the sirup after filtration is boiled to grain.

This sugar house has two double effects, one of the ordinary type, and the second the Welner-Jelinek system.

The vacuum pans have a capacity, one of 60,000 pounds dry sugar, and the other 25,000 pounds.

FIG. 16.

The masse cuite is dropped into small coolers, each of about one hectoliter capacity. These coolers are shaped like the frustrum of a pyramid, and can be readily transported by means of a small two-wheeled carriage. (See Fig. 16.)

It requires but little more time to fill these coolers than to drop the masse cuite into the larger mixers common in Louisiana. The masse cuite is expelled from the cooler by compressed air. The cooler itself weighs about 50 pounds, and when filled with masse cuite, 400 pounds.

The manager of the Stoebnitz sugar house stated that he obtains from 4 to 6 per cent. (of the weight of the masse cuite) more sugar by allowing it to become perfectly cold before swinging out.

The next portion of these works that deserves more than this passing notice is the chemical laboratory. It is evident, from the fact that a very large proportion of sugar houses employ chemists, that the German manufacturers fully appreciate the advantage of a chemical control of the work. Most of the important improvements in processes have had their origin in the laboratory.

The Stoebnitz works have an excellent laboratory. It is located on the second floor, and occupies two large, well lighted and ventilated rooms. The chemist and his assistant keep a chemical control of all the processes. The juice and diffusion pulps are examined at frequent intervals. Samples of the beets from each lot brought to the sugar-house are also analyzed. The laboratory is one of the busiest parts of the sugar house.

Stoebnitz has unsurpassed advantages for the economical generation of steam. Within 600 yards of the sugar house there is an inexhaustible mine of lignite or brown coal. This lignite is mined very extensively, and transported upon a tramway to the works, and is dumped into large bins above the boilers. By an automatic arrangement it is fed directly upon the fires.

Lignite furnishes an excellent fuel, but yields only about a third as much heat as bituminous coal. The ash amounts to about 14 per cent. The cost of lignite delivered at the machine works in Halle is less than $1 per ton. Good bituminous coal costs in the same locality from $3.75 to $4.50 per ton.

CAMBURG SUGAR HOUSE.

The sugar factory at Camburg is situated on the river Saale, about 25 miles from Halle. The buildings are located about 100 yards from the river, from which the works derive an unfailing supply of water.

Comparatively few beet-sugar houses have equal water advantages. In most factories the vapors from the evaporating juices are condensed and the water is used again and again. This necessitates a special arrangement for cooling the water. This consists of a frame-work, supporting bundles of willow twigs, over which the water passes, falling from one bundle to another, until it finally reaches the reservoir which supplies the factory.

A branch railway has been constructed, connecting with the main line, and beets are brought in and dumped directly into the carriers. These latter consist of a system of narrow cement-lined trenches, through which a constant stream of water is flowing.

The rapidly flowing current propels the beets and finally drops, them into a box, from which they are carried by an elevator to the washers, two in number.

This hydraulic carrier, as it is termed, is a very convenient and economical method for transporting beets, and for factories having a good water supply can be highly recommended. The trenches are easily constructed, and are so arranged that they admit of ready access for repairs. The condensing water furnishes the supply for the conduits.

The washed beets fall upon a perforated plate, which is rapidly shaken by machinery in order to throw off the water and dry them as much as practicable. This is evidently very important, as an excise tax is levied on the washed beets. The water so thrown off amounts to at least 2 per cent. of the weight of the beets.

The diffusion battery is of the Hallesche Machinenfabrik construction and has all the latest improvements.

The diffusers are arranged in a circle and discharge the pulp into a central basin, whence it is lifted to the presses by a chain and bucket elevator. The helix form of elevator for pulp is no longer used with Riedel's battery, as it will not work satisfactorily at so great an angle as 45°.

The presses are of the Bergreen type. It will be noticed that two presses only are required to do the same work as three at Stoebnitz. The process employed at Camburg for extracting the sugar from the juice does not differ materially from that in vogue in most of the sugar houses of France. The only difference is in the reheating of the juice coming from the diffusers, before carbonatation, this is accomplished by two calorisators, in one of which the temperature is raised to a certain degree by exhaust steam and in the other to 90° C. by direct steam. I would again call attention to this idea of conducting the first carbonatation at a high temperature.

Not having been able to secure analyses of the juice, I cannot say whether the results are better than by the old process or not. This method certainly has the advantage of hurrying the precipitation, and by diminishing the time required, a few pans will do the work of several working in the old way, and there is still another advantage. Since the precipitation is accomplished so much more rapidly, it is evident that the carbonic acid is better utilized and that the waste is reduced to a minimum.

A series of montes jus are employed to force the juice to any part of the sugar house. Instead of steam pressure, compressed air is employed. As soon as a monte jus is emptied, the air pump is connected with it and the air is forced into another. By this method the power expended in compressing the air is economized. The use of compressed air instead of high pressure steam is not only much more economical, but in addition possesses the advantage of not injuring the juice.

The quantities of lime, Ca O. employed are as follows: 1st. Carbonatation 2.25 to 2.5 per cent. of the weight of the beets. Saturation, .25

per cent. 1.0 to 1.5 grams lime per liter of juice is left after the first carbonatation; after the saturation .03 to .04 gram.

The lime is placed in wire baskets, which are lowered into the carbonatation pans. This plan is considered preferable to adding slacked lime.

The lime precipitate, usually termed scum or mud, is washed in the filter press by a stream of water. This precipitate amounts to about 6 per cent. of the weight of the beets worked.

While on this subject it may be well to speak of two of the more important processes for the recovery of the sugar left in the scums.

The proper treatment of the scums is of very great importance. Unwashed scums contain about 4 per cent. sugar, and amount to at least 9 or 10 pounds per hundred pounds of beets. This corresponds to a loss of .36 to .40 per cent. sugar, or 7.9 to 8.8 pounds of sugar per long ton of beets.

By means of an ingenious device for washing, Mr. Charles Gallois has succeeded in reducing the loss of sugar to from .20 to .40 per cent. of the scums.

This device consists of a three-way valve, so arranged that the filter press can be placed in communication with either the monte jus containing the scums, a mixture of scum and hot water, or boiling water. This simple device can be attached to any filter press.

To operate the press: Open wide the valve connecting with the scums. The press soon fills. When the volume of juice flowing from the press diminishes perceptibly, change the valve and admit scums diluted with water. The density of the juice will now rapidly diminish. Open the water valve and pass boiling water through the press until the density indicates that but little juice is being extracted. The last portions of dilute juice are employed to slack lime for the defecation.

Another successful method is as follows: The scums are pressed in an ordinary filter; the residue, or precipitate, is removed from the filter, thoroughly mixed with water, and is again pressed. This results in a very decided decrease in the weight of the scums, showing that a large proportion of the sugar has been extracted. It is claimed that this method reduces the danger of redissolving the impurities contained in the lime precipitate.

When this factory was constructed two years since the process for treating the juice with sulphurous acid and entirely suppressing the use of bone-black was not yet an assured success, consequently, rather than risk a new and still uncertain process, the new works were supplied with a battery of closed filters and a Langen-Schatten bone-coal kiln. Since this time the sulphurous acid process has advanced very much in favor with sugar manufacturers, and now many sugar houses entirely suppress the use of bone-black.

For evaporation this house has one triple effect, and for boiling to grain, one vacuum pan. The barometric vacuum pump is used.

TREATMENT OF THE MASSE CUITE.

The masse cuite is dropped into small coolers similar to those at Stoebnitz (Fig. 16) 2 feet 6 inches deep, 10 inches long, 1 foot 6 inches wide at top, and 1 foot at the bottom. Capacity approximately 1.4 hectoliters.

After remaining 12 hours in the cooling room the masse cuite is expelled from the cooler by compressed air, and is dropped into the mixer bel w. It is claimed that by the use of these coolers the yield of first sugar is largely increased.

Dr. Prella, superintendent of the Camburg works, made an experiment two or three years since, to determine if this is really the case. He took equal volumes of the masse cuite, then swung out the sugar from one immediately after dropping it from the pan; the yield was 62 per cent. sugar. The second portion he set aside 12 hours, until it was perfectly cold; this yielded 68 per cent. sugar, a gain of 6 per cent. He now invariably allows the masse cuite to become cold before swinging out. The following are a few percentages taken from Dr. Prella's notebook and show the amount of sugar obtained several days in succession last season: 75 per cent., 74 per cent., 74.2 per cent., 77 per cent., 71 per cent., 72 per cent., 76 per cent.

The Camburg sugar house has not yet finished its second campaign. Its first year's work was remarkably successful. The house being supplied with every facility for good work, and having an exceptionally good harvest of beets, both as regards quantity and quality, yielded a very large profit to the owners. The cost of the sugar house was about $225,000. Its capacity is 300 long tons per 24 hours, or 30,000 tons for the campaign. This establishment at Camburg is in every respect a model sugar house.

Through the kindness of Mr. Riedel, of the Hallesche Maschinenfabrik, I succeeded in obtaining copies of the original drawings for the construction of the buildings and disposition of the machinery (Plates 2, 3, 4, 5, 6, 7, and 8).

For convenience in examining these plates a translation of the German terms accompanies them.

Detailed statements of the workings of seventeen German sugar houses.

In order to determine a basis for taxing the beet-sugar industry, the German Government selects certain sugar houses and requires them to make detailed reports. In these reports each sugar house is designated by a letter of the alphabet. Care is taken to select only those factories which are fair representatives of the districts in which they are located.

The copy of these tables for 1882 and 1883, which accompanies this report, is given to show as briefly as possible statistics of the yield and expenses in the manufacture of beet sugar.

Campaign of 1882 and 1883.

Designation of sugar house	A.	B.	C.	D.	E.	F.	G.	H.	I.	K.	L.	M.	N.	O.	P.	Q.	R.
Polarization calculated on weight of beet	10.72	11.44	11.86	10.83	10.85	10.90	10.50	10.90	10.05	11.20	10.47	9.66	10.44	10.53	10.09	11.47	10.90
Non-sugar calculated on weight of beet	2.65	2.62	2.77	2.66	2.95	2.82	2.60	2.68	2.87	2.54	2.59	2.94	2.45	2.86	2.89	3.93	2.50
Coefficient of purity	80.21	81.36	81.07	80.28	78.62	79.46	80.15	80.24	77.80	81.50	80.14	76.66	30.99	78.64	77.73	74.40	81.37
Available sugar	8.70	9.31	9.60	8.69	8.53	8.76	8.42	8.77	7.82	9.13	8.39	7.40	8.44	8.28	7.84	8.53	8.86
Masse cuite	12.19	12.27	12.06	11.53	11.92	11.89	11.11	10.84	13.73	11.99	11.36	11.38	13.32	10.63	10.86	11.65	11.36
Polarization of masse cuite	84.90	87.60	84.34	85.73	84.40	85.37	85.60	86.94	84.70	85.58	84.43	83.04	85.48	84.10	85.27	83.90	84.46
Sugar obtained from the masse cuite	83.76	80.25	77.89	76.54	75.29	76.87	76.69	80.67	73.42	75.70	73.77	76.97	75.25	82.68	72.83	76.53	81.82
Sirup obtained from the masse cuite	7.92	20.29	21.68	23.42	24.61	21.16	25.74	12.88	14.22	23.92	26.23	19.68	10.85	17.15	30.08	23.52	9.98
Sugar obtained	10.21	9.85	9.40	8.82	8.97	9.14	8.51	8.75	10.05	9.07	8.38	8.77	10.02	8.77	7.90	8.94	9.30
Sirup obtained	0.97	2.50	2.61	2.70	2.93	2.51	2.86	1.39	2.14	2.87	2.78	2.24	1.45	1.82	3.26	2.74	1.13
Polarization of the first products	95.89	95.67	95.40	95.70	95.60	96.03	95.60	96.66	94.14	95.63	96.40	94.42	94.98	95.35	96.90	94.22	95.14
Valuation of the sugar in dollars per 100 lbs. (German = 110 lbs.)	$6 80	$6 87	$6 73	$6 80	$6 93	$6 98	$7 00	$6 95	$6 75	$6 76	$7 03	$6 56	$6 65	$6 86	$7 49	$6 55	$6 84
Cost of sugar in dollars per 100 lbs. (German = 110 lbs.)	$5 52	$5 73	$5 65	$5 86	$6 02	$6 09	$6 10	$6 13	$6 17	$6 17	$6 45	$6 02	$6 22	$6 50	$7 12	$6 35	$6 89
Beets worked per hectoliter of brown coal ... lbs.	196.9	233.2	178.2	277.2	198.0	242.0	407.0	372.9	209.0	200.2	195.8	172.7	213.4	320.1	200.2	234.3	232.1
Receipts per ton (2,200 lbs.) of beet roots	$14 16	$14 14	$12 92	$12 75	$13 18	$13 30	$12 64	$12 40	$13 06	$12 96	$12 62	$12 10	$13 52	$12 36	$12 70	$12 13	$12 98
Expenses, not including mortgages, etc	11 56	11 92	10 88	11 08	11 52	11 68	11 10	10 96	12 10	11 88	11 64	11 04	12 68	11 72	12 12	11 98	13 06
Gross profit per ton (2,200 lbs.) of beets	2 60	2 22	2 04	1 64	1 64	1 60	1 52	1 42	1 14	1 06	0 98	0 94	0 82	0 62	0 58	0 34	....
Gross loss per 100 lbs. of beets	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0 10

A.—EXPENSES FOR BEETS AND TAXES PER TON (2,200 LBS.) OF BEETS.

	A.	B.	C.	D.	E.	F.	G.	H.	I.	K.	L.	M.	N.	O.	P.	Q.	R.
Beets	$4 94	$5 58	$5 02	$5 08	$5 58	$5 32	$4 86	$5 08	$5 48	$4 94	$5 42	$4 84	$5 48	$6 10	$5 36	$5 32	$6 42
Taxes	3 76	3 76	3 76	3 76	3 76	3 76	3 76	3 76	3 76	3 76	3 76	3 76	3 76	3 76	3 76	3 76	3 76
Totals	8 70	9 34	8 78	8 84	9 34	9 08	8 62	8 84	9 24	8 70	9 18	8 60	9 24	9 86	9 12	9 08	10 18

Campaign of 1882 *and* 1883—Continued.

B.—MANUFACTURING EXPENSES PER TON (2,200 LBS.) OF BEETS.

Designation of sugar house	A.	B.	C.	D.	E.	F.	G.	H.	I.	K.	L.	M.	N.	O.	P.	Q.	R.
Fuel	$0 90	$0 80	$0 80	$0 62	$0 67	$0 82	$0 68	$0 63	$0 86	$0 86	$0 87	$0 80	$1 00	$0 61	$1 05	$0 76	$0 81
Light	04	02	04	02	07	02	01	01	03	02	03	03	04	02	03	04	07
Freight	04	04	04	04	......	12	09	07	......	16	03	04	05	......	09	01	......
Sacking sugar	02	04	02	06	......	02	03	02	06	04	03	02	03	02	05	01	07
Buildings and repairs	06	06	08	04	03	01	02	05	02	03	01	02	03	02	14	06	05
Bone-coal	10	12	12	06	09	11	09	08	11	10	05	07	09	08	07	12	05
Wages	62	62	40	44	65	43	44	37	61	69	59	58	62	38	45	63	66
Machinery and repairs	20	22	28	24	13	17	18	22	17	18	13	19	37	18	21	29	12
Provisions	10	08	06	08	......	07	06	07	07	07	07	06	11	06	09	07	06
Oil for vacuum pans	02	02	02	02	01	......	......	01	01	01	01	01	05	01	01	03	01
Machines, oil, and grease	02	02	02	02	02	01	01	......	02	02	02	02	01	01	01	01	01
Muriatic acid	02	02	02	02	02	01	04	03	02	03	01	02	01	02	01	06	04
Minor apparatus	02	02	02	......	......	01	......	02	02	03	......	01	......	01	04	05	01
Lime	06	04	04	08	10	10	06	05	11	07	01	04	24	07	06	......	05
Canvas and linen	06	04	02	06	05	04	05	02	02	05	04	03	18	04	02	06	04
Wood, coal, and coke	04	04	02	02	03	02	01	05	05	05	05	05	11	04	08	03	03
Spirits, osmose paper	02	......	......	02	......	01	......	......	04	01	......	01	......	......	......	......	02
Totals	2 34	2 20	2 00	1 84	1 87	1 97	1 77	1 70	2 22	2 42	1 95	2 00	2 94	1 57	2 41	2 23	2 10

C.—OTHER EXPENSES PER TON (2,200 LBS.) OF BEETS.

Designation of sugar house	A.	B.	C.	D.	E.	F.	G.	H.	I.	K.	L.	M.	N.	O.	P.	Q.	R.
Insurance	$0 04	$0 04	$0 03	$0 05	$0 04	$0 04	$0 02	$0 03	$0 06	$0 04	$0 05	$0 03	$0 06	$0 03	$0 06	$0 04	$0 07
Interest and discount	23	20	......	22	10	36	51	23	33	44	28	36	31	17	31	39	49
Salary	14	16	08	09	12	08	08	11	11	14	10	10	09	08	16	12	14
Various expenses	10	08	04	11	07	08	08	05	14	14	09	06	05	07	09	12	09
Totals	51	48	15	47	33	56	69	42	64	76	52	55	51	35	62	67	79

THE EXTRACTION OF THE SUGAR FROM THE MOLASSES.

It has long been a problem with sugar manufacturers to devise a method for extracting the sugar from the molasses. The importance of this problem is such that it has led many of the most noted inventors in the field of sugar manufacture to investigate it. It is stated that in France 15 per cent. of the sugar in the beet remains in the molasses. This corresponds to a loss of about 1½ per cent. on the weight of the beet. This loss is even more important in the beet than the cane sugar manufacture. The beet molasses is very highly colored and has an extremely disagreeable taste. In fact, it can only be utilized for the manufacture of vinegar or for distilling purposes.

Quite a number of processes have been proposed for the extraction of the sugar from molasses, a few of which have been successful. From a chemical point of view this is a comparatively easy problem, but commercially or mechanically speaking it is an extremely difficult one.

It is a well-known fact among manufacturers that all the sugar can be readily separated by precipitation as a barium saccharate, but the cost of the barium salt precludes its use. Again, the processes known as "elution," depending upon the precipitation of a lime saccharate and subsequent washing of this precipitate with dilute alcohol, are both chemically and mechanically successful. The elution processes, however, can only be employed in those countries where alcohol either pays a very low excise tax, or is entirely free from tax when used for manufacturing purposes. These brief statements merely indicate the difficulties which the chemist and manufacturer have been compelled to face. In many instances, after a long series of experiments in his laboratory, the chemist has been compelled to yield to difficulties not always chemical, but often of a purely mechanical nature.

For example, he has succeeded in producing a saccharate of lime, containing all the sugar in the molasses; but the saccharate would contain many impurities which could only be eliminated by careful washing. On attempting to wash this combination between the lime and sugar the filter-press would soon clog and refuse to do the work. Had the precipitated saccharate been granular this would not have been the result. Notwithstanding these difficulties and failures two successful processes have been devised. In the more recent, the Steffen separation process, the inventor has succeeded in readily producing a granular precipitate of tribasic saccharate of lime. The other process is termed the Strontium Process. Not having had an opportunity to visit works employing strontium, I shall only describe the Steffen process.

CHEMISTRY OF THE SEPARATION PROCESS.

Very complete investigations have been made of the lime saccharates, with the especial object of utilizing their properties in the separation of sugar. The lime saccharates are three in number:

Monobasic, $(C_{12}H_{22}O_{11})$ CaO.
Dibasic, $(C_{12}H_{22}O_{11})$ 2 CaO.
Tribasic, $(C_{12}H_{22}O_{11})$ 3 CaO.

Some chemists claim the existence of a fourth, the tetrabasic.

If a portion of finely-powdered pure quicklime be added to a 6 to 12 per cent. sugar solution, in the proportion of one molecule of lime for each molecule of sugar, the temperature of the solution being kept below 30° C. (86° F.), the monobasic saccharate of lime will be formed. This saccharate is perfectly soluble in water. It is necessary for the success of this experiment that the quicklime be recently calcined and finely powdered.

If this solution of monobasic saccharate be heated it will be decomposed and the tribasic saccharate precipitated. To form the dibasic saccharate it is necessary to add an additional molecule of lime, under the same physical conditions as before. The dibasic saccharate may be separated by crystallization in the cold.

The tribasic saccharate is much more important from a commercial point of view than the others. It is with difficulty soluble in 200 parts of water, but insoluble in a saturated water solution of the tribasic salt itself. When precipitated under certain well-defined conditions it is granular. Sugar can be completely precipitated in this combination from a dilute solution. This precipitate being crystalline can readily be washed in a filter.

To form the tribasic saccharate proceed as follows: Dissolve a certain quantity of sugar in water, making a 6 to 12 per cent. solution. By means of some suitable arrangement keep this solution at a temperature below 30° C. (86° F.). For every molecule of sugar add three molecules of very finely-powdered and freshly-burned lime. The lime must be added in small portions, the solution being stirred constantly. The tribasic saccharate of lime will be precipitated.

The following analyses show the composition of the saccharate obtained by the above method:

	By analysis.*	Calculation.
Carbon (C)	25.30	25.53
Hydrogen (H)	5.14	4.96
Oxygen (O)	38.12	48.23
Calcium (Ca)	21.44	21.28

This saccharate is readily soluble in a sugar solution.

The tribasic saccharate of lime cannot be preserved any great length of time. Even at the end of two or three weeks the proportion of sugar

* De la Diffusion. Par Jules Cartuyvels, p. 263.

decreases. The sugar decomposes and forms organic salts with the lime.

The crystals of sugar obtained by the separation process resemble a confused mass of needles. If these crystals be dissolved in water and recrystallized they will assume the normal form.

THE SEPARATION PROCESS.

I visited the sugar house at Elsdorf, near Cologne, Germany, to examine into the practical workings of this process. The Elsdorf sugar house was the first, I believe, to adopt it, and experiment upon a large scale. I afterwards visited the works of Mr. Max Le Docte, at Gembloux, Belgium, and examined the machinery, as adopted by Mr. Steffen after a year's experience in the practical application of his separation process. Plates Nos. 9, 10, 11, and 12 are from drawings kindly furnished me by Mr. Gèrard Oyens, of Paris.

Before describing the separation process it may be well to speak of the

COMPOSITION OF BEET MOLASSES.

The averages of a large number of analyses of beet molasses show its composition to be about as follows:

	Per cent.
Sucrose	47.5
Reducing sugars	.5
Ash	9.3
Water	20.5
Organic matters	22.2
	100.0

The percentage of reducing sugars as given above is rather high, as beet molasses does not usually contain more than a trace.

The ash consists principally of salts of potassium, sodium, and magnesium. Phosphate of potassium is one of the principal constituents. The recovery of these mineral substances forms quite an industry in connection with the distillation of the molasses. One hundred pounds of molasses yield ten pounds of black ash.

The Steffen separation process depends upon the precipitation in the cold of the tribasic lime saccharate, sparingly soluble and of a granular structure.

The freshly burned quicklime is first broken into small pieces by an ore crusher such as is used in the mining regions of this country. The broken lime is carried by an elevator to a mill where it is ground to a very fine powder. This mill resembles in every respect an ordinary flouring mill. Special precautions are taken to prevent the lime powder from being inhaled by the workmen.

The powdered lime is next conveyed by an elevator to another room, where it is passed through a fine wire gauze sieve. It is extremely important in this process that the lime be reduced as nearly as possible to an impalpable powder. Precautions are taken to remove any particles of iron from the powder by means of magnets. The powdered lime falls into a box holding a certain quantity, and is divided automatically into equal portions. From this box the portions are dropped at intervals into the mixer containing the diluted molasses. It is necessary that the temperature in this mixer should not rise above 30° C. (86 F.). The lower the temperature the quicker the lime will combine with the sugar.

The mixer consists of a large closed iron cylinder placed in a vertical position. Within this cylinder is a system of tubes arranged similarly to those in a pan of an ordinary double effect. Cold water (below 15° C., 59° F.) circulates about these tubes, entering below and discharging from above. The dilute molasses circulates through and above this system of tubes; a helix revolved by suitable machinery keeps the mixture in constant motion that it may be quickly cooled.

The operations for the production of the tribasic lime saccharate are conducted as follows:

A certain quantity of molasses is accurately measured. Water is added to it until the density of the solution is 12° Brix (6.6° B.), the percentage of sugar being from 7 to 8. This solution is cooled down to 15° C. (59° F.); small portions of the powdered lime are then added at intervals of about a minute. The temperature increases a little after each addition of lime. Before adding more lime it must be again reduced to 15° C. This operation continues until lime has been added from ten to thirteen times, when the sugar is all precipitated. The workman determines this point by the density of a "proof" filtered from the mixture. The density of this filtrate should not be greater than 6° to 6½° Brix (3.5° B). The total quantity of lime added is 93.4 pounds lime per 100 pounds of sugar in the molasses. When this process was first invented much larger quantities of lime were employed, often as much as 150 pounds per 100 pounds of sugar. The chemist at Elsdorf informed me that 93.4 pounds is sufficient.

The unwashed lime saccharate resembles a dirty milk of lime. After leaving the mixer it is pumped to the filter presses. The filters are fitted for washing the saccharate in the press. The mother liquor containing all the impurities of the molasses is used as a fertilizer. The water for washing the saccharate is carefully measured, and the same quantity per press is always employed. The wash water is afterwards used to dilute the molasses. By this means losses due to the slight solubility of the saccharate are avoided.

It is important that the pressure on the filter presses should not exceed two and one-half atmospheres. An excess of pressure over this limit will cause the saccharate to cake in the presses and it will be impossible to wash it.

The filter-cloths require washing every four or five days. The cloths from one press per day are replaced by clean ones.

The coefficient of purity of the saccharate, *i. e.*, the percentage of pure saccharate in the crude, ranges from 97.5 to 98.5, and will average about 98.

If one wishes to simply extract the sugar from the molasses, having obtained the tribasic saccharate, it is only necessary to decompose it with hot water, remove the lime by precipitation and filtration, and evaporate the filtrate. But the greater number of establishments employing the Steffen substitution process work it in connection with beet sugar houses. In this case the saccharate of lime replaces the lime for defecation.

It is not sufficient to simply treat the saccharate with water to form a lime paste suitable for defecating. The objection is that the saccharate is in a granular state and is not readily acted upon by the carbonic acid. To produce a perfectly smooth milk of lime, free from grains, the saccharate is decomposed by hot juice. An average of 92 per cent. of the sugar contained in the molasses is extracted by this process.

EXPENSES FOR LABOR.

The extreme simplicity of this process is quite noticeable. There are no operations requiring skilled labor aside from the control exercised by the chemist. There is not an operation that cannot be performed by a common laborer.

At Elsdorf the workmen at the mixers receive one mark and a half per day (about 36 cents); at the filter presses, one and a quarter marks (30 cents). These wages are about the average for the entire sugar house.

TREATMENT OF CANE MOLASSES BY STEFFEN'S PROCESS.

Shortly after the announcement of the successful working of the separation process on a large scale, certain London refineries employed a chemical expert to examine the process and report to them. As a successful application of this process would be of great importance to our cane planters, I obtained a copy of this report and shall give those portions not already included in my description.

After speaking of the complete success of the Steffen process in the treatment of beet molasses, Mr. Gill, the expert mentioned above, says:

"How far the same thing can be said in regard to its application to the molasses obtained in the manufacture or refining of sugar from the cane depends on a variety of considerations, of which the following are some of the most important:

"First. Is the sugar separated as pure as that obtained from the beet molasses, and is any of the glucose (altered and uncrystallizable sugar), which is always present in large quantities, precipitated along with the true cane sugar and then again set free when the lime compound is decomposed by the carbonic acid, and if so how far the fact will interfere with the economy and utility of the process?

"The answers to these questions are not clear in the present state of the evidence. I am informed by Mr. Langen and his chemist that some glucose is precipitated, but that they do not know in how large a proportion. This would, therefore, have to be determined by experiment. I may say with certainty that if all or most of the glucose be precipitated with the sugar, and then again set free along with the sugar by the subsequent treatment with carbonic acid, that very little or no useful effect will be obtained, because glucose when present in solution with sugar greatly hinders, if it does not altogether prevent, the crystallization of an equal weight of the latter on evaporation.

"That the evil indicated may attain large dimensions is shown by the fact that second sirups obtained in the manufacture of Mauritius sugar contain, according to Dr. Icery, from 22 to 43 per cent. of glucose out of 100 total sugars.

"Second. Will the mother liquid drain away completely through the cloth of the filter presses from the precipitated sugar lime when molasses obtained from cane juice in the usual rough manner is the original material operated upon?

"Here again direct experience is practically wanting. In one experiment which I witnessed, and which was performed on a cane molasses of unknown origin, but believed to be from a refinery, the filtration proceeded quite readily and without any difficulty. I should remark that solutions of ordinary raw cane sugar can not be filtered through a filter press, since the gummy matters choke the pores of the cloth, and almost immediately.

"If the above two points can be settled in a favorable manner then the process will be as great a success in a chemical and mechanical sense as it is with beet molasses."

Mr. Gill then discusses the commercial conditions requisite for success. But as these conditions are so different in this country from those in London I shall not repeat them.

In conclusion, he says, "I cannot advise your clients to incur the expense of adopting this process until they have satisfied themselves by experiment that it is as applicable to the molasses of cane sugar as that of the beet.

"I may add that sufficiently extended experiments could be made on a laboratory scale at an expense which would not exceed, say, £40, and which might be less."

C. HAUGHTON GILL.

To Messrs. MATHESON & GRANT,
32 Walbrook, London, E. C.

Not having made any laboratory experiments on the treatment of cane molasses by Steffens process I cannot add anything to the above report.

Estimate for the establishment of works for the treatment of 10,000 *to* 15,000 *kilograms* (22,000 *to* 33,000 *pounds*) *of molasses per day.*

1 reservoir for molasses, 318 cubic feet capacity, fitted with valves	$182 50
1 reservoir for water, 212 cubic feet capacity	132 50
1 measuring tank, with valve	112 50
1 scale, for weighing molasses	37 50
2 mixers, with connections, at $1,500	3,000 00
2 automatic measuring apparatus for lime, at $162.50	325 00
1 horizontal steam pump, for the lime saccharate. Cylinder, 12.8 inches diameter; pump, 7.9 inches diameter; stroke, 15.8 inches	1,250 00
1 safety valve	37 50
1 gauge	10 00
6 filter presses, at $675	4,050 00
6 iron funnels, at $43.75	262 50
1 double trough, 34.5 feet long	105 00
1 reservoir; capacity, 88.3 cubic feet (for wash water)	87 50
1 Archimedean screw, 37.4 feet long	440 00
1 saccharate mill	750 00
1 pump; 2 plungers, 5.9 inches diameter, stroke, 7.9 inches, including transmission of power	475 00
1 saccharate pump; 2 plungers, 3.9 inches diameter, stroke, 7.9 inches	375 00
1 engine; cylinder, 13.8 inches diameter, stroke, 27.6 inches	1,125 00
1 transmission of power (approximate)	725 00
1 ore crusher, for lime	537 50
1 mill, to grind the lime	1,212 50
2 elevators (iron), at $300	600 00
1 rotary sieve	660 00
1 hopper, for powdered lime	225 00
1 aspirator	437 50
Total	17,155 00

The value of the franc in the above estimates is taken at 20 cents.

In addition to the cost of the machinery a royalty must be paid, depending upon the size of the plant and the length of the working season.

If the Steffen process is worked in connection with a sugar house, the royalty is $7,500 for works having a capacity to treat 22,000 pounds of molasses per day, or $10,000 if 33,000 pounds are treated. To these sums $2,500 and $3,750, respectively, must be added, if the Steffen process is to be employed after the regular campaign of the sugar house is finished.

If the plant is to be employed the entire year, only for the extraction of the sugar from molasses obtained by purchase, the royalty is $10,000 for a daily capacity of 22,000 pounds; $13,750 for a daily capacity of 33,000 pounds. For larger plants, the royalty is fixed by special contract.

This process has already been adopted by a number of German sugar houses, and by 11 this season in Belgium. When I left France in October, the great central sugar house at Cambrai was about to contract for the installation of the Steffen separation process.

Plates Nos. 9, 10, 11, and 12 show the disposition of the machinery for working the Steffen process in connection with an ordinary sugar factory.

NOTE.—Mr. François Sachs, chemist of the Max le Docte Sugar-house, Gembloux, Belgium, has kindly given me the results of his experiments last season with the Steffen process.

He says: "The separation process for the extraction of the sugar from the molasses yields less sugar in actual practice when molasses alone is treated, than was expected. In fact it is necessary to add sugar in order to obtain a good crystallization.

"Taking 100 kilograms of molasses containing 50 per cent. sugar, we have added 24 kilograms of raw sugar (polarizing 89 to 90 degrees) with the following losses based on the weight of the molasses:

	Per cent.
(1) In the mother liquor * (reheated)	1.50
(2) In the filter press deposits	3.20
(3) In the scums from the carbonatation	0.64
Total	5.34

"Then 50 kilograms of sugar in the molasses, minus 5.34 loss, leaves 44.66 kilograms in the masse cuite. The masse cuite gave 52.52 per cent. first sugar, or 23.45 per cent. of second molasses. There then remained 24.12 per cent. of second molasses (the weight of raw sugar added not being taken into account). The second molasses yielded 25.52 per cent. sugar, or 6.03 per cent. of the molasses originally taken. The total amount of first and second sugars extracted is 23.48, plus 6.03, and equals 29.48 per cent. The proportion of third sugar has not yet been determined."

* The mother liquor dissolves a small portion of the saccharate, which is reprecipitated on heating the liquor, and is mostly recovered in the filter process.

Description of plates 2, 3, 4, 5, 6, 7, *and* 8.

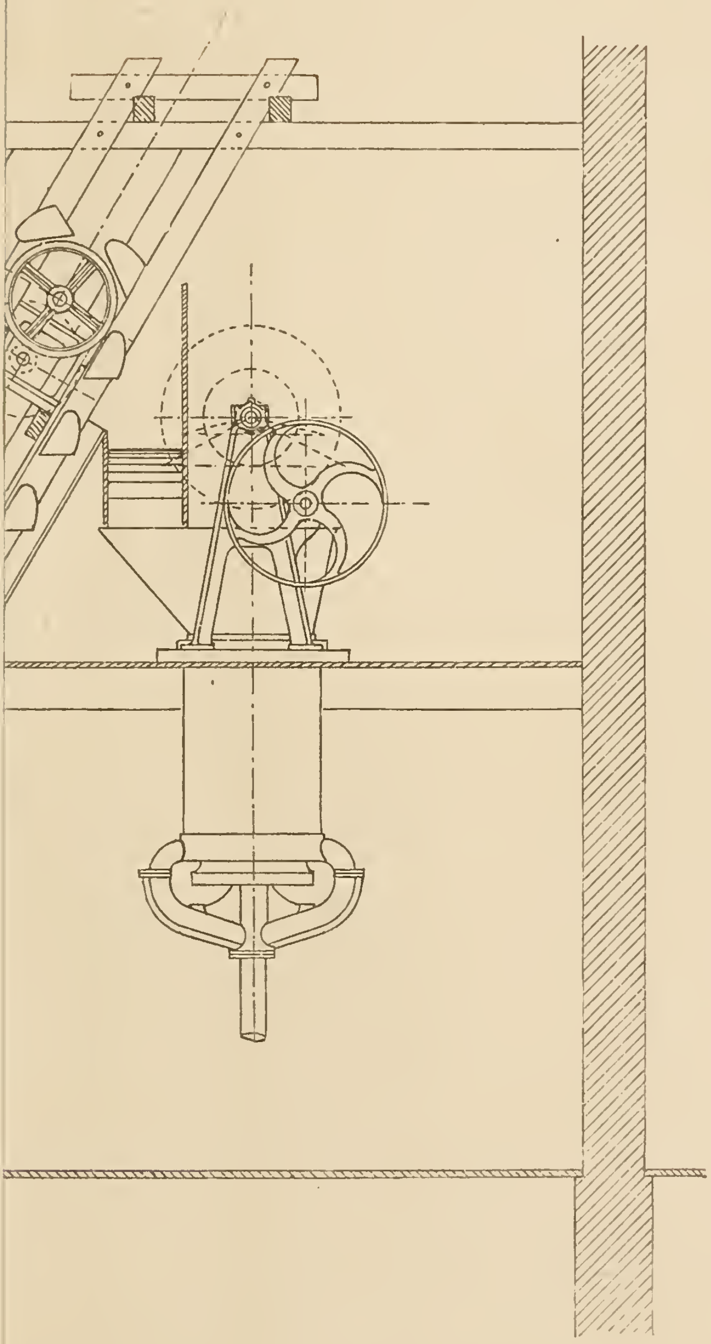
No. 1. Arrangement for dumping beets into the receiving room.
2. Hydraulic beet-carrier.
3. Beet elevator.
4. Beet washers.
5. Apparatus to drain the wash water from the beets.
6. Beet elevator.
7. Receptacle for washed beets.
8. Turn-table.
9. Beet cars.
10. Scales for use of revenue officers.
11. Beet slicer.
12. Funnel.
13. Diffusion battery.
14. Elevator to remove the pulp.
15. Pulp presses.
16. Exit for pulp.
17. Engine.
18. Carbonatation pans.
19. Calorisators for diffusion juice.
20, 21. Apparatus for preparing milk of lime.
22. Pump for compressing air.
23. Lime-kiln.

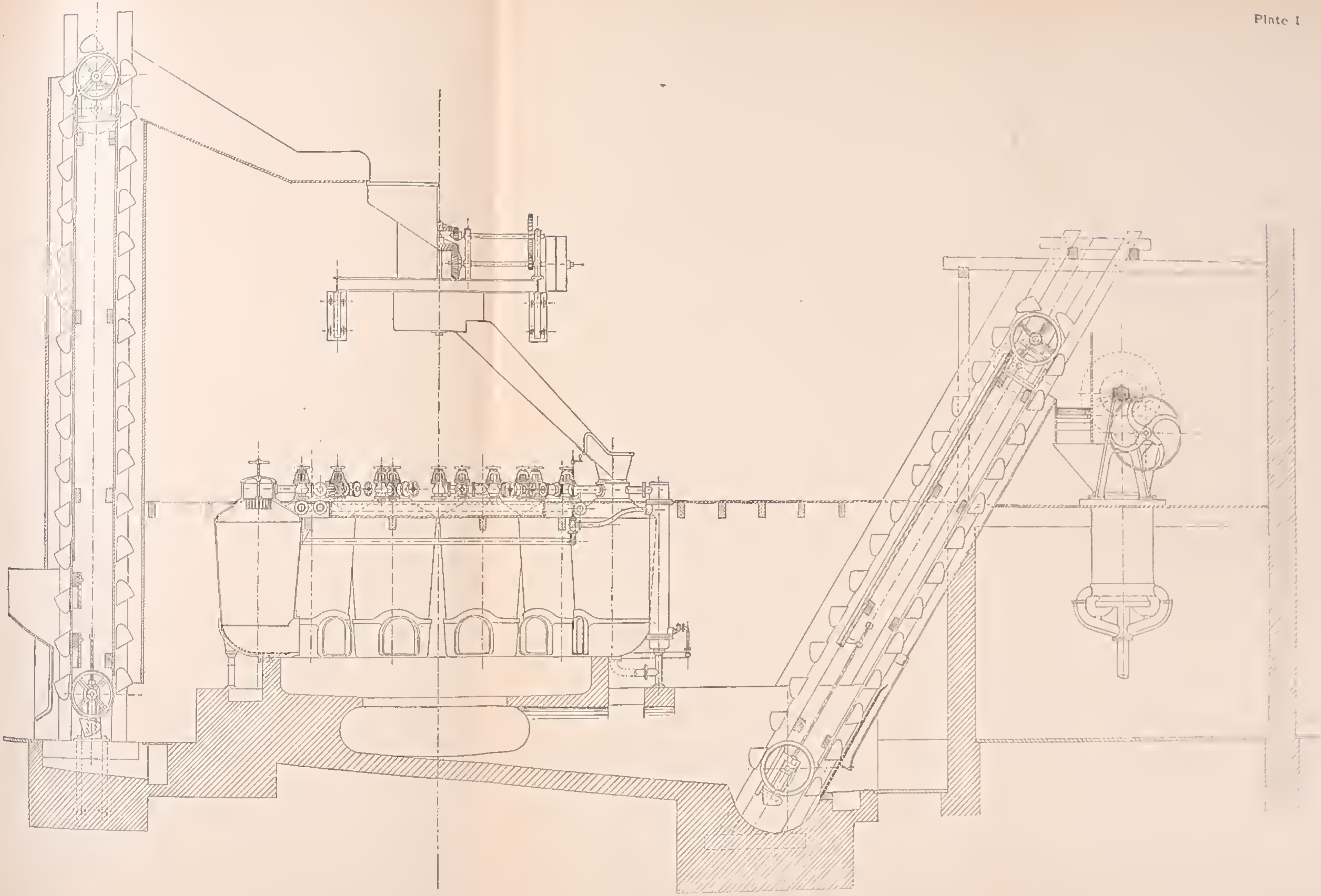
No. 28. Monte juice.
29. Water pump.
30. Filter presses.
31. Bone-black filters.
32, 33, 34, 35, 36. Treatment of the bone-black; washing, revivifications, &c.
37. Elevator for bone-black.
38. Elevator.
39. Elevator for bone-black.
40. Tramway.
41. Triple-effect.
42. Vacuum pans.
43. Water tanks.
44. Vacuum and water pumps.
45. Pump.
46. Engine for centrifugals.
48. Centrifugals.
49. Elevator for sugar, &c.
50. Boilers.
51. Pumps.
52 and 53. Crystallizing tanks for 2d and 3d products.
54. Tank.
55. Tanks.

Translation of German terms employed in the description of plates 2, 3, 4, 5, 6, 7, *and* 8.

Bodenraum	Garret.
Comptoir	Office.
Coaks schuppen	Coke shed.
Eisenbahn-Rübenhaus	House for beets brought in by rail.
Fabrik sohle	Ground level.
Grundriss der I ten Etage	Plan of 1st floor.
Grundriss der II ten Etage	Plan of 2d floor.
Grundriss des Parterre	Ground plan.
Hierunter Keller	Cellar below.
Kesselhaus	Boiler-house.
Küche	Kitchen.
Kammer	Bed-chamber.
Laboratorium	Laboratory.
Land-Rübenhaus	House for beets brought in by carts.
Niederlage	Storehouse.
Steuer Stube	Revenue officer's room.
Schlamm Absatz Bassins	Settling tanks.
Sammel Brunnen	Cisterns.
Schlamm bahn	Tramway for removal of scums.
Schnitt	Section.
Vorder Ansicht	Front elevation.
Versammlungs Zimmer	Director's room.
Werkstätte	Workshop.
Zimmer	Room.

Plate I.



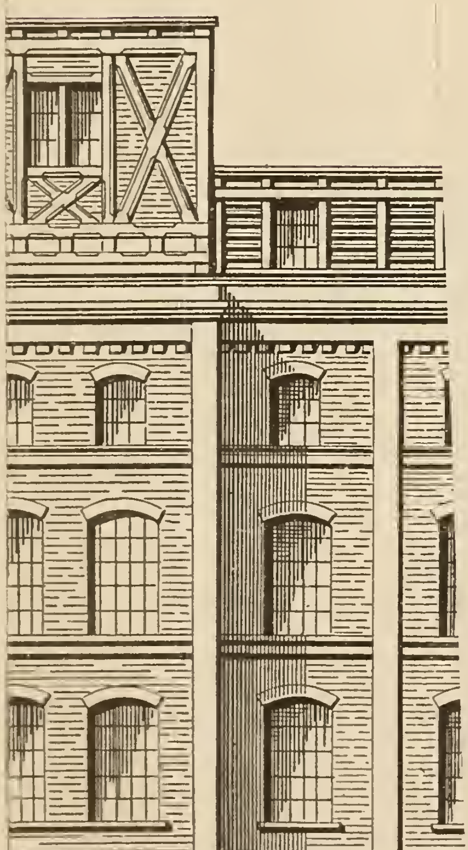


CIRCULAR DIFFUSION BATTERY. (RIEDEL'S SYSTEM.)

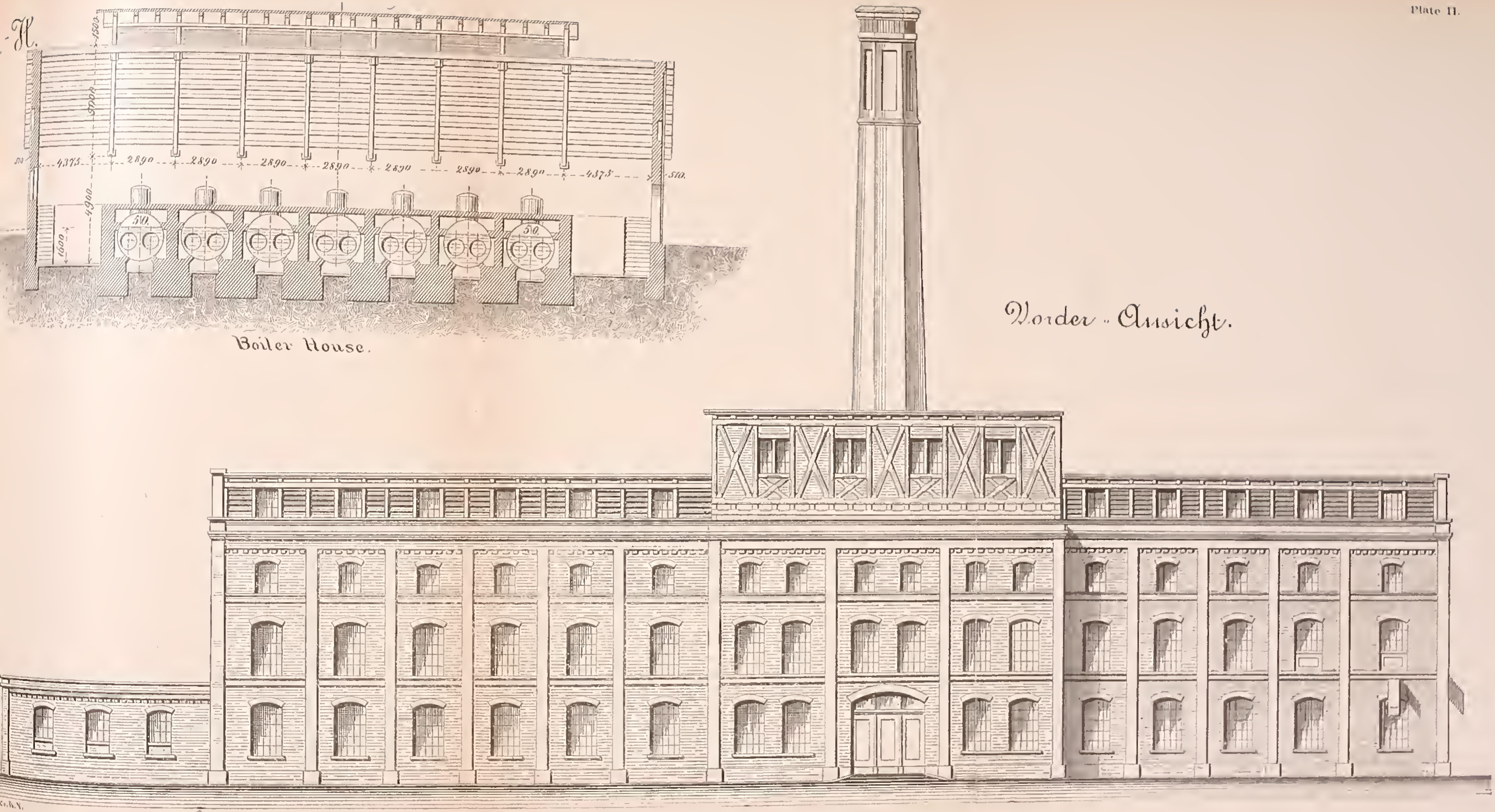
Hallesche Maschinen-fabrik, builders. Scale: 1 to 75.

G.

Vorder - A



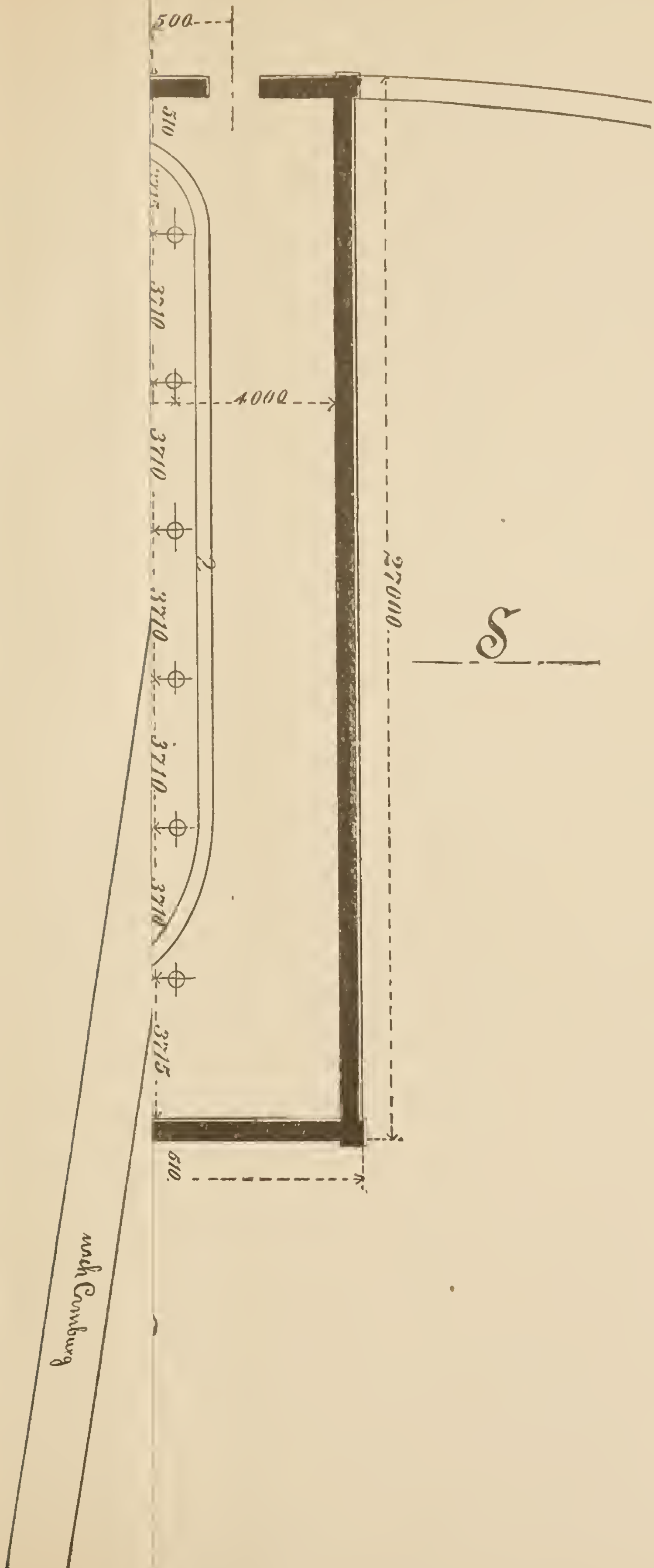
o'Eng.

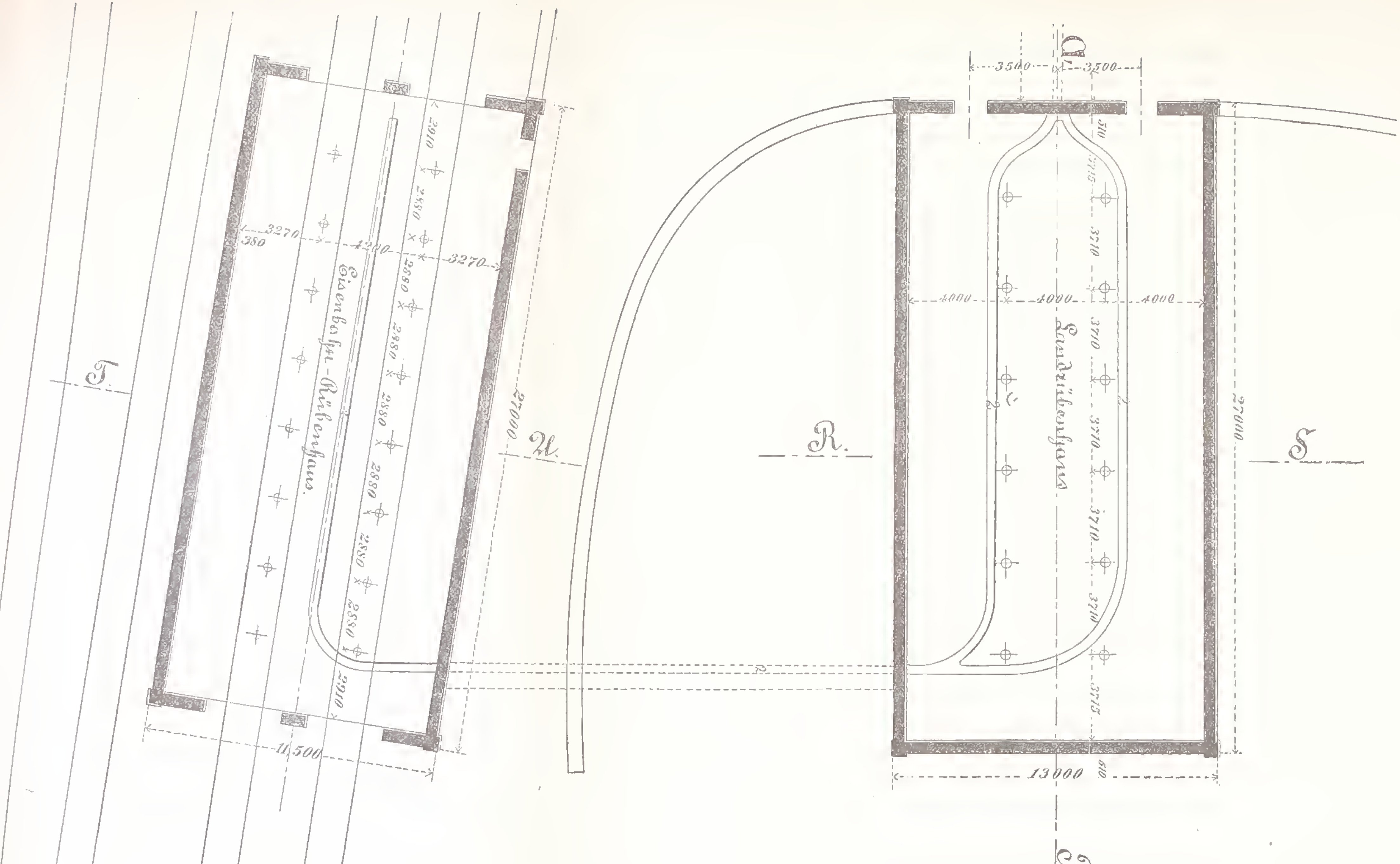


CAMBURG SUGAR HOUSE—FRONT ELEVATION.

Hallesche Maschinen-fabrik, builders. Scale: 1 to 210.

Plate III.

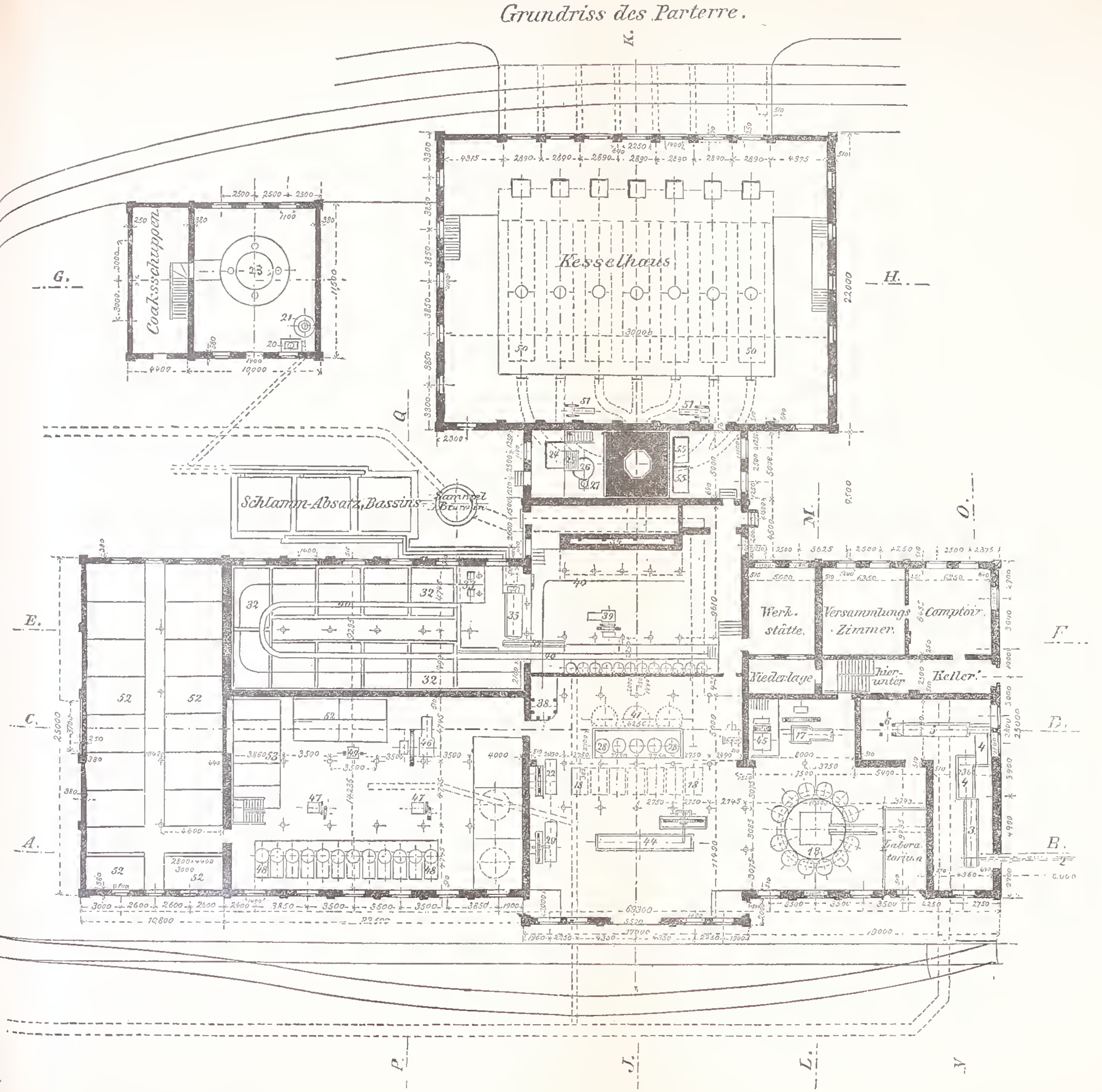




Camburg Sugar House.

Hallesche Maschinen-fabrik-Builders.

Ground Plan. — Scale 1 to 235.



CAMBURG SUGAR HOUSE—PLAN OF GROUND FLOOR.

Hallesche Maschinen-fabrik, builders. Scale: 1 to 450.

Plate V.

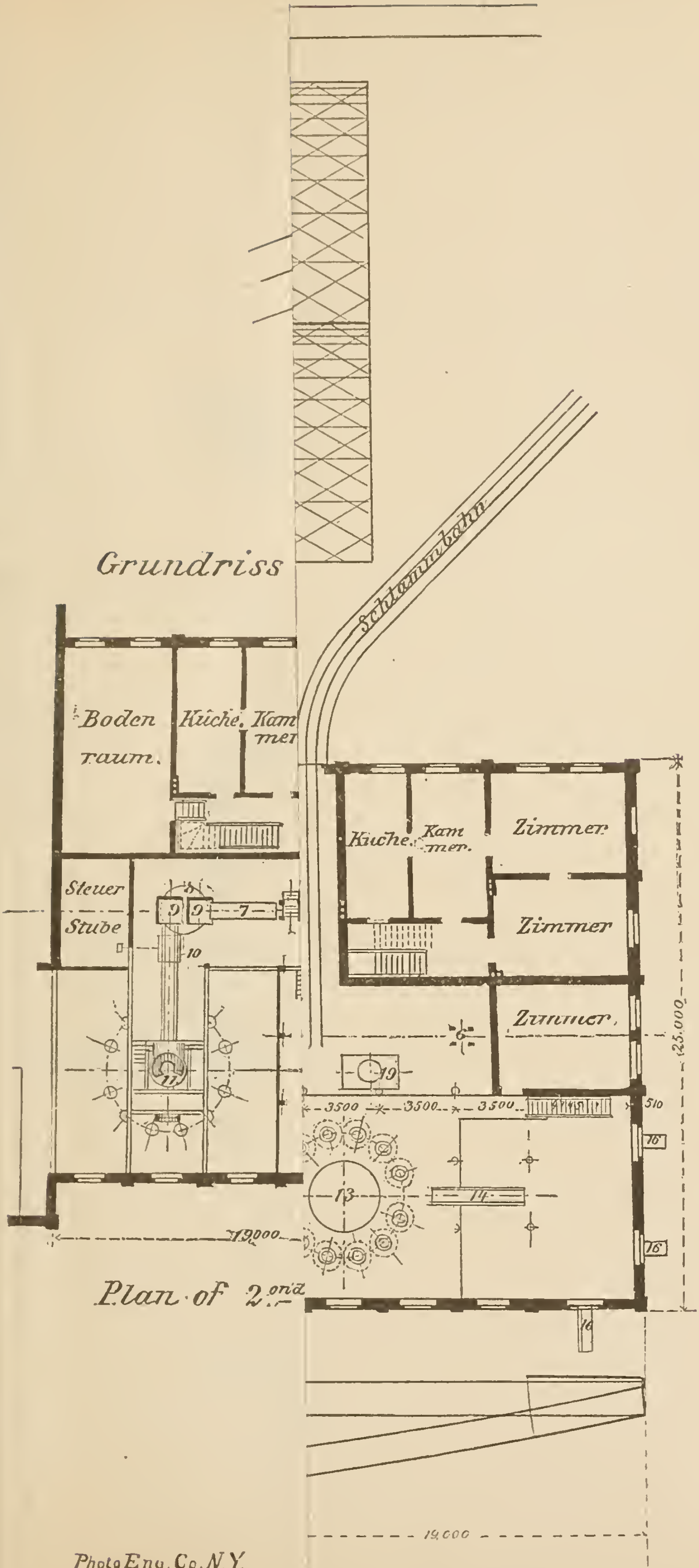
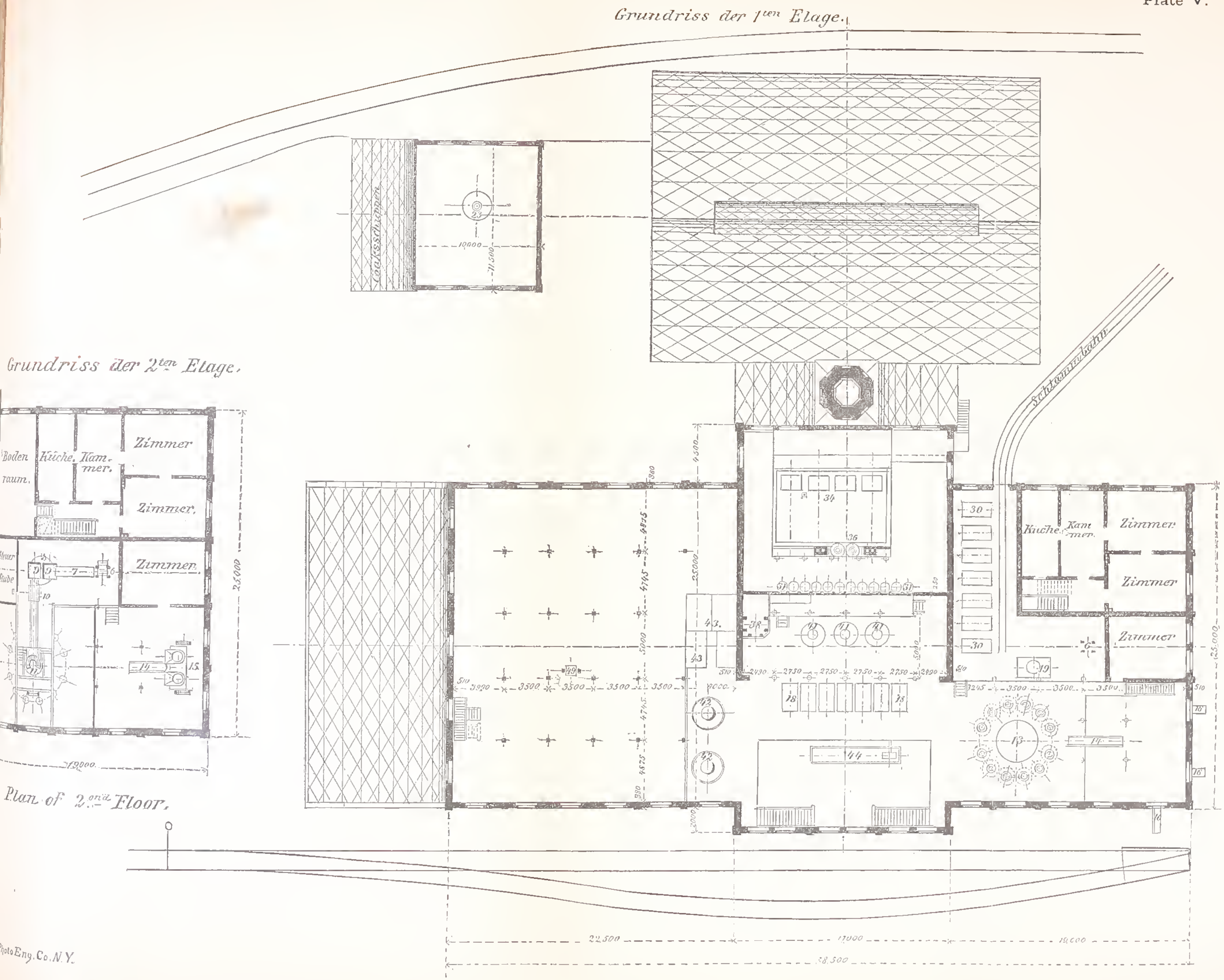


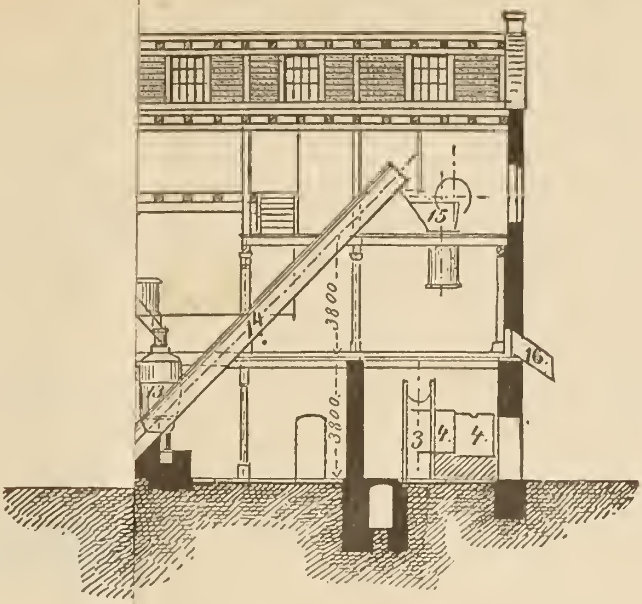
Photo Eng. Co. N.Y.



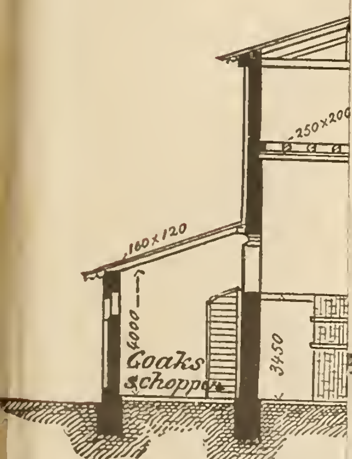
CAMBURG SUGAR HOUSE—PLAN OF FIRST FLOOR.

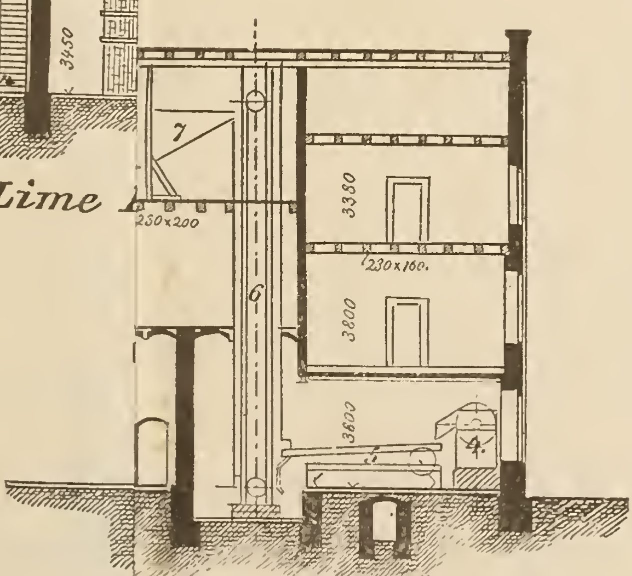
Hallesche Maschinen-fabrik, builders. Scale: 1 to 480.

Plate



Section

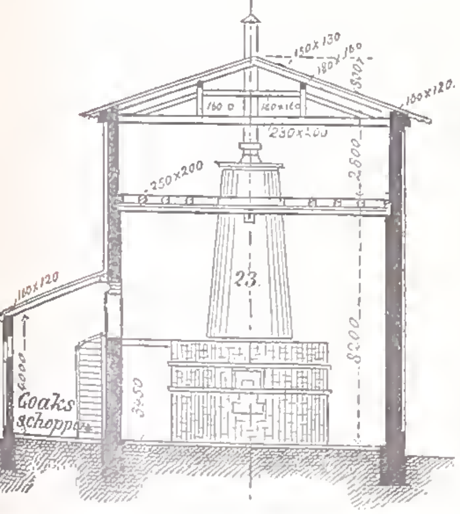




Lime

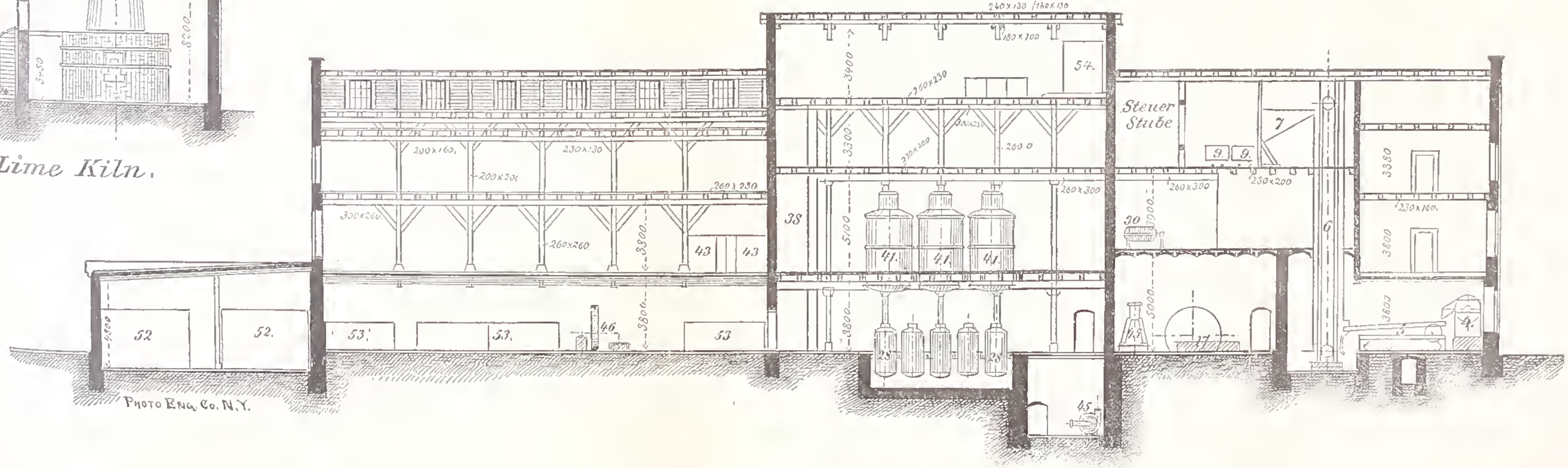
Section through A-B.

Section through G.-H.



Lime Kiln.

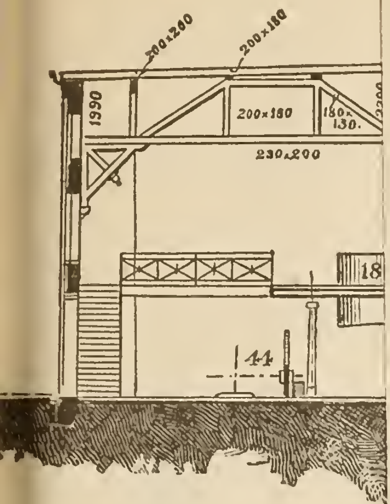
Section through C.-D.



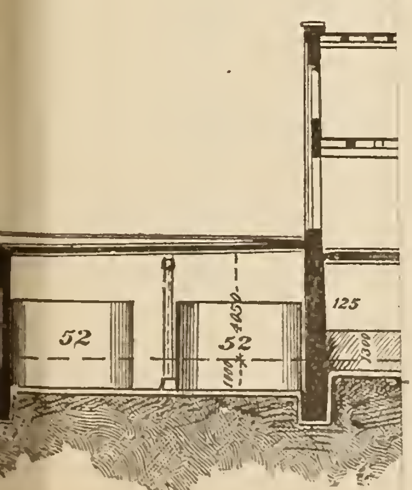
CAMBURG SUGAR HOUSE.

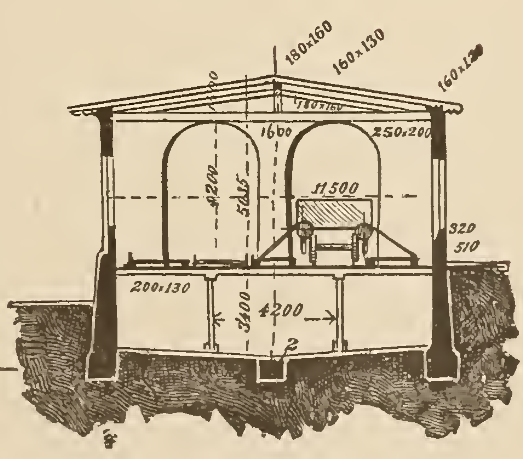
Halleschе Maschinen-fabrik, builders. Scale: 1 to 340.

Plate VII.

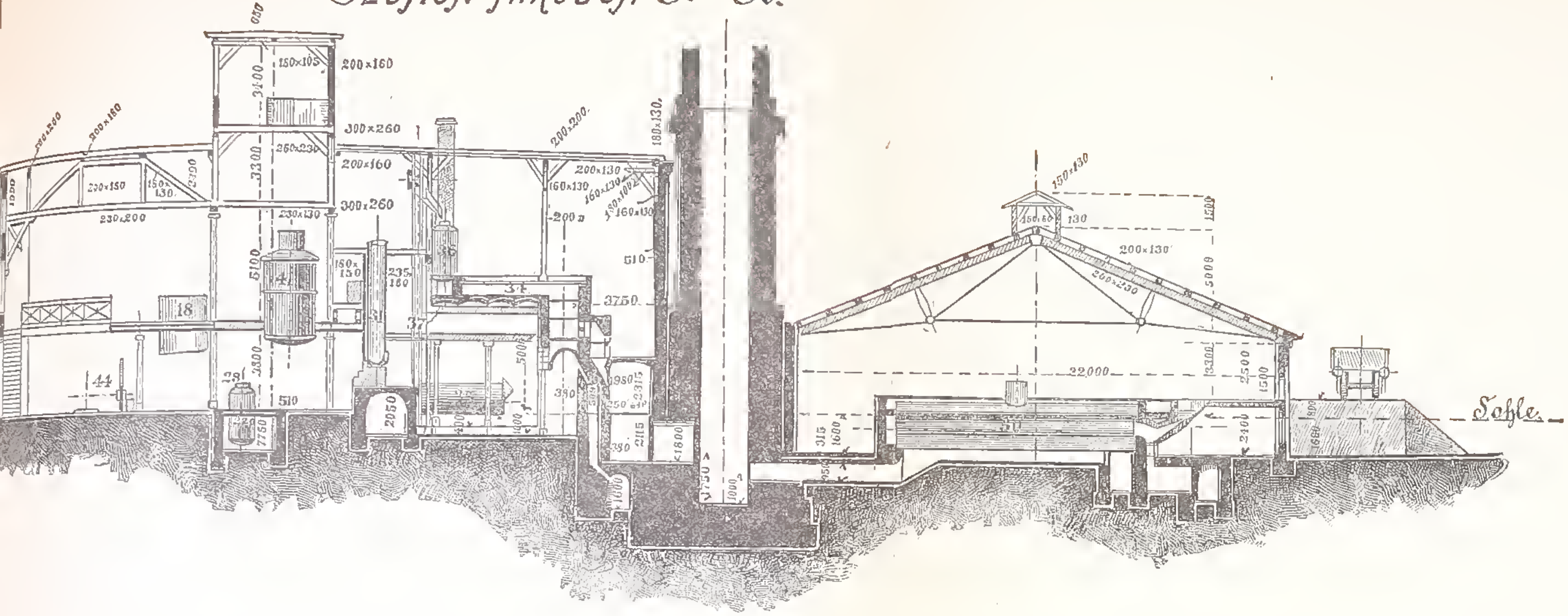


CTION THROUGH T-U.

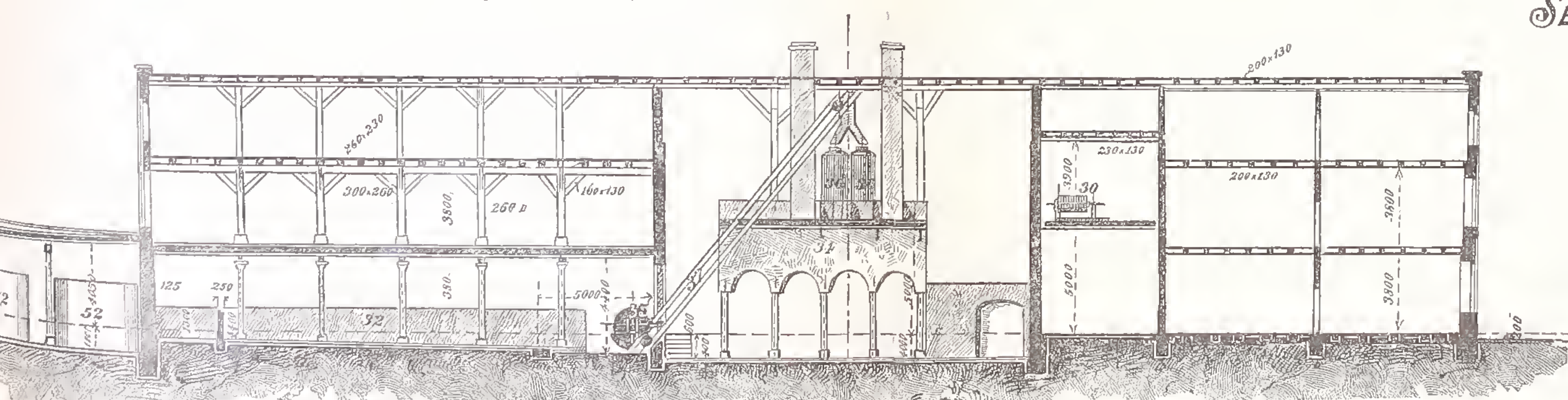




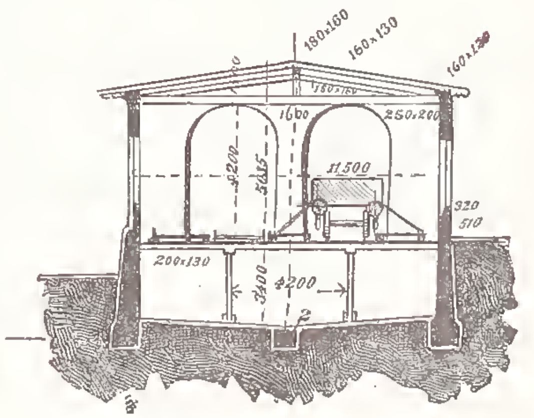
Section through J.-K.



Section through E-F.



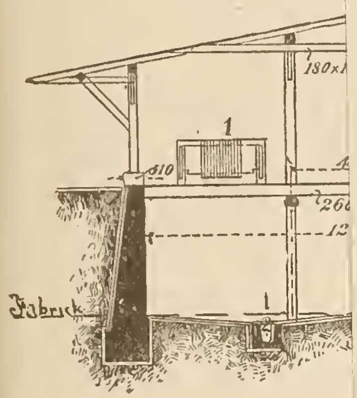
Section through T-U.



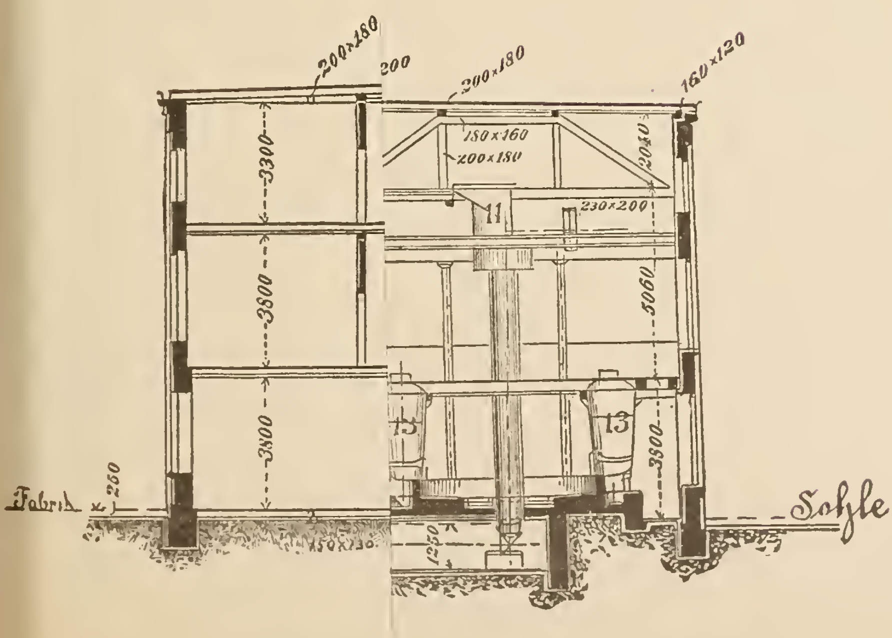
Camburg Sugar House.
Hallesche Maschinen-fabrik-Builders.
Scale 1 to 370

Plate VIII.

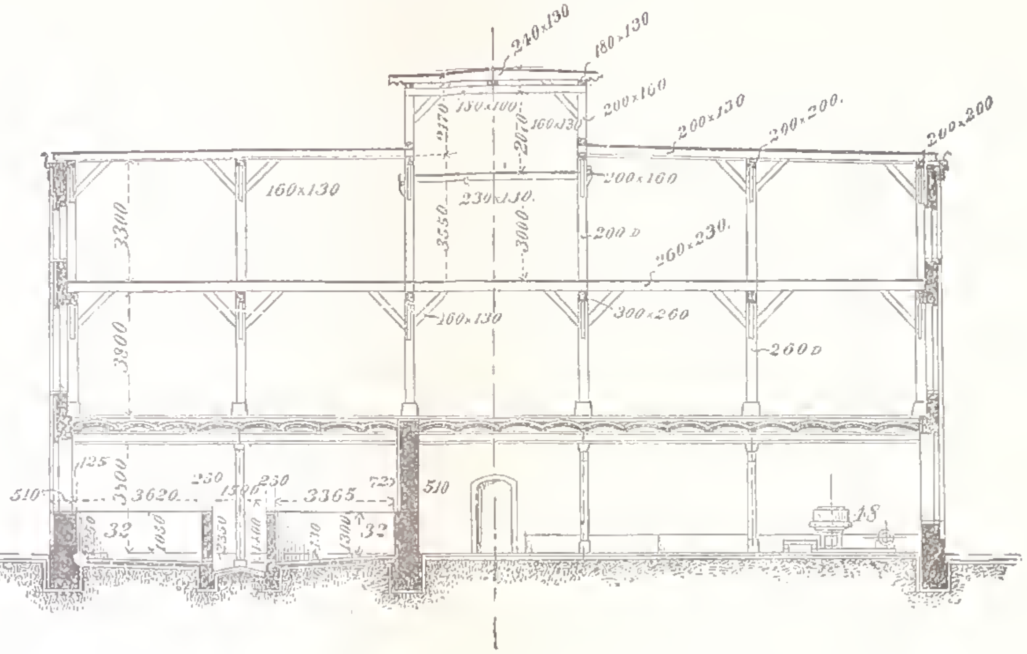
SECTION THROUGH



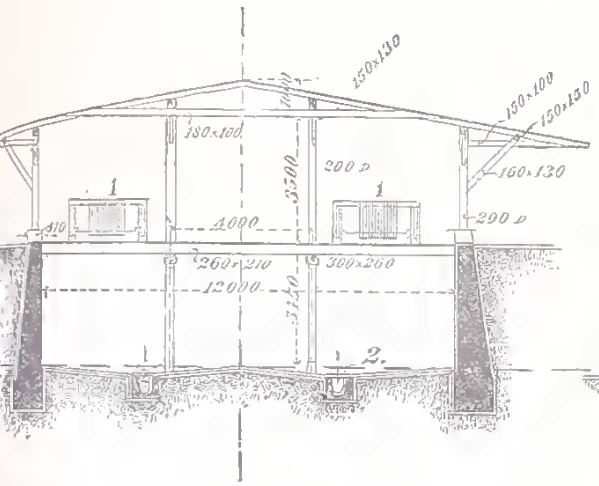
SECTION M.



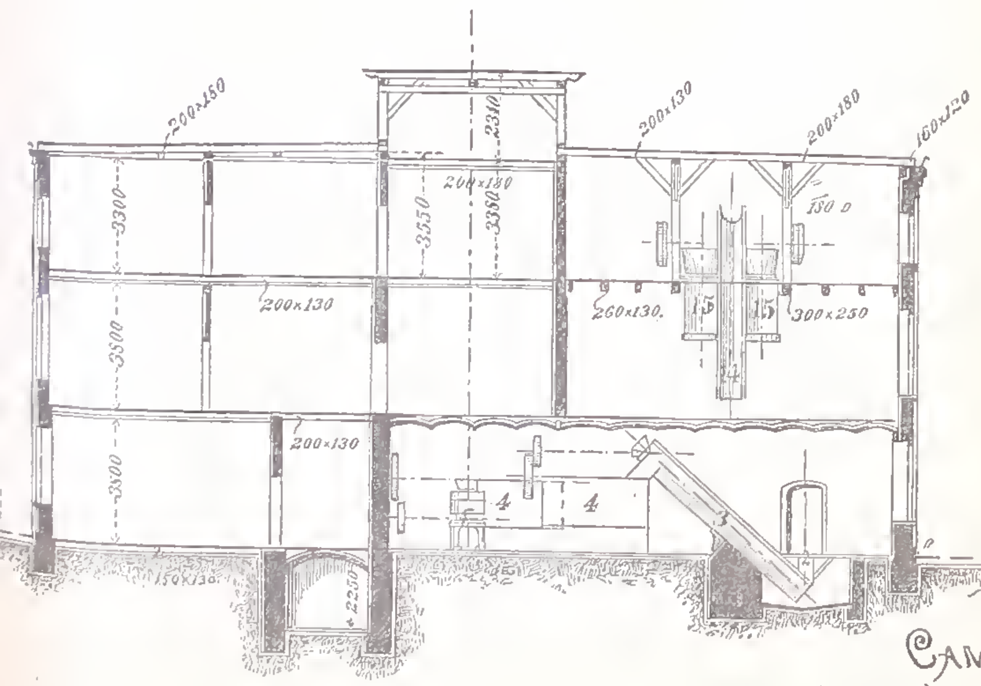
SECTION THROUGH P-Q.



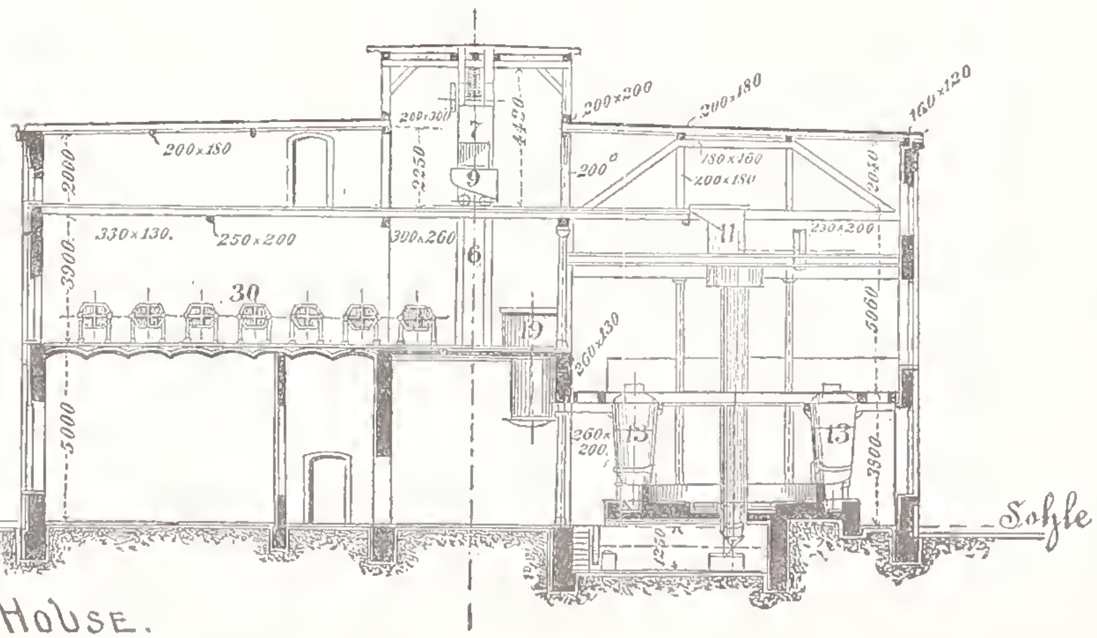
...ON THROUGH R-S.



SECTION THROUGH N-O.



SECTION THROUGH L-M.



CAMBURG SUGAR HOUSE.
Hallesche Maschinen-fabrik Builders
Scale —1 to 285.

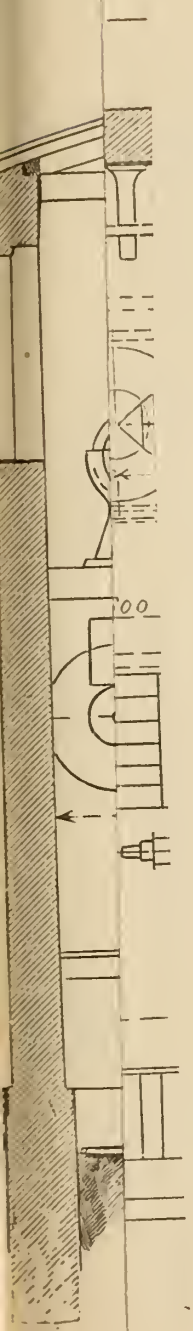
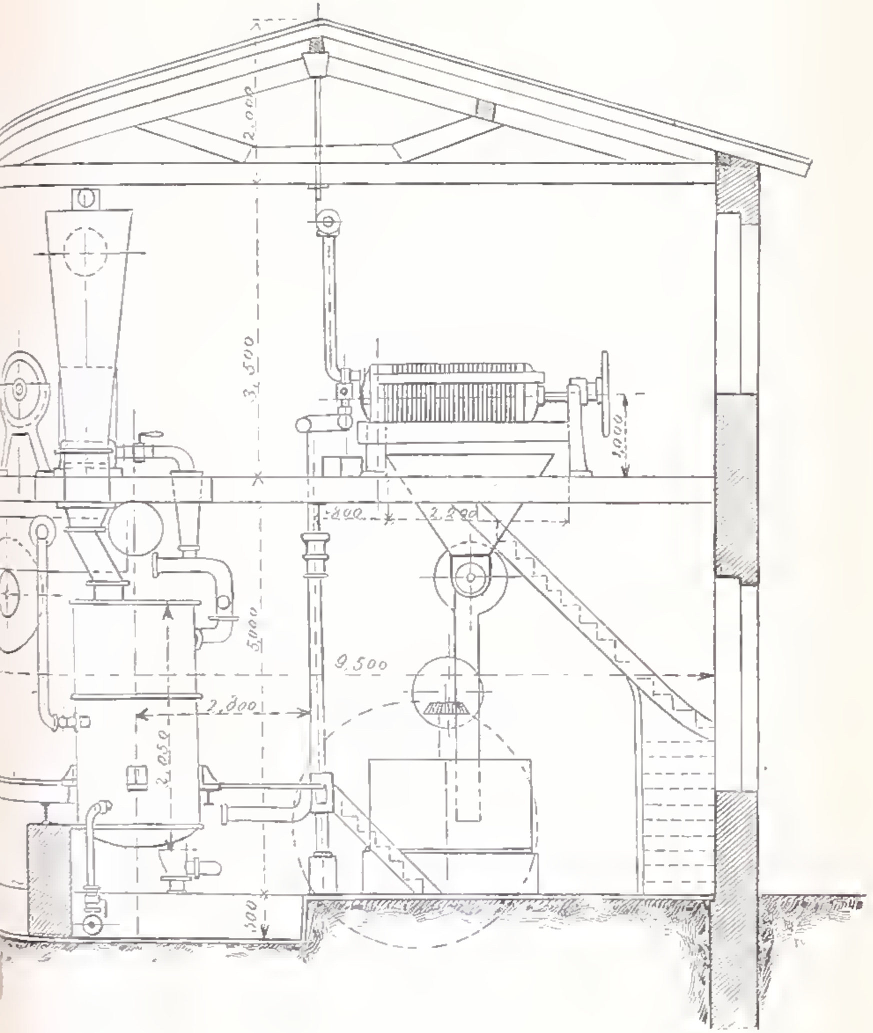
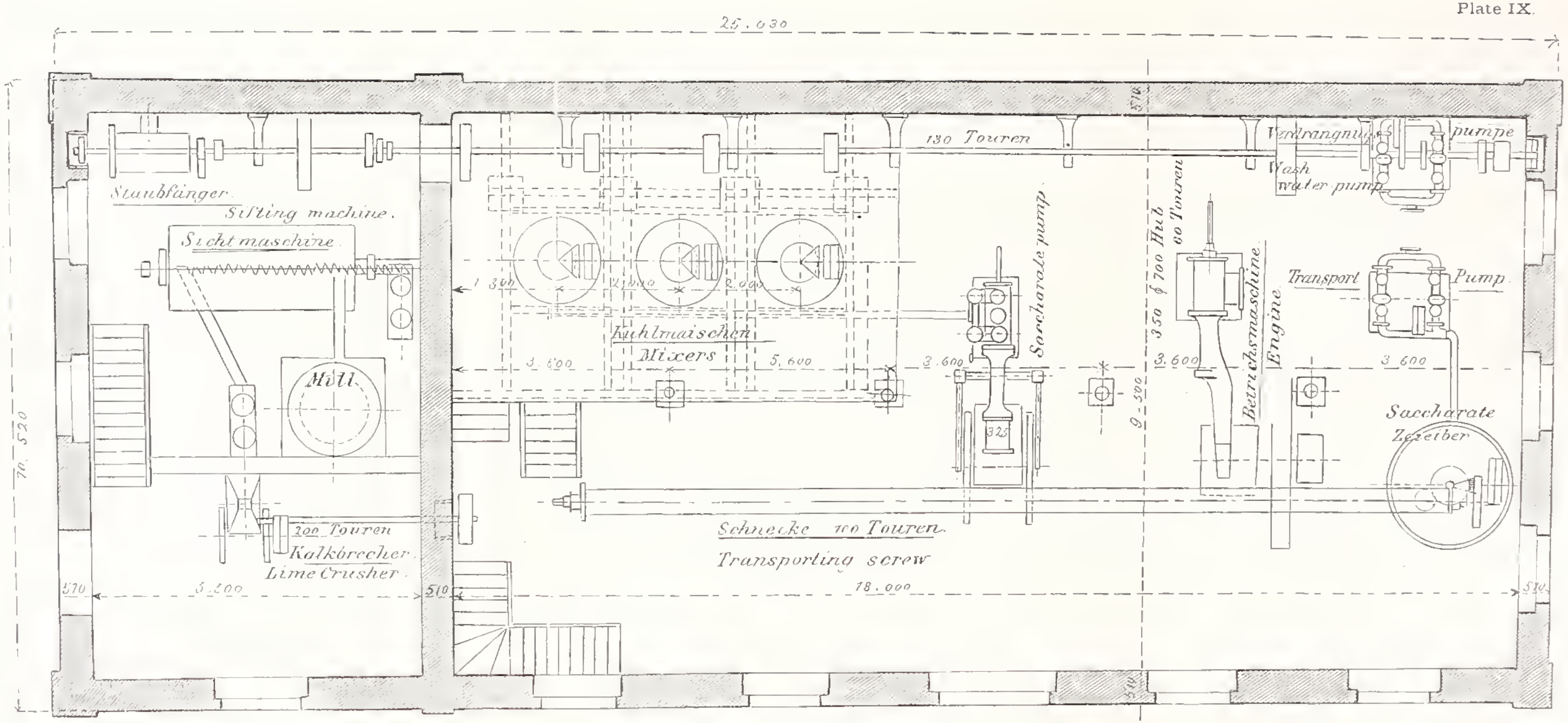


Plate IX.



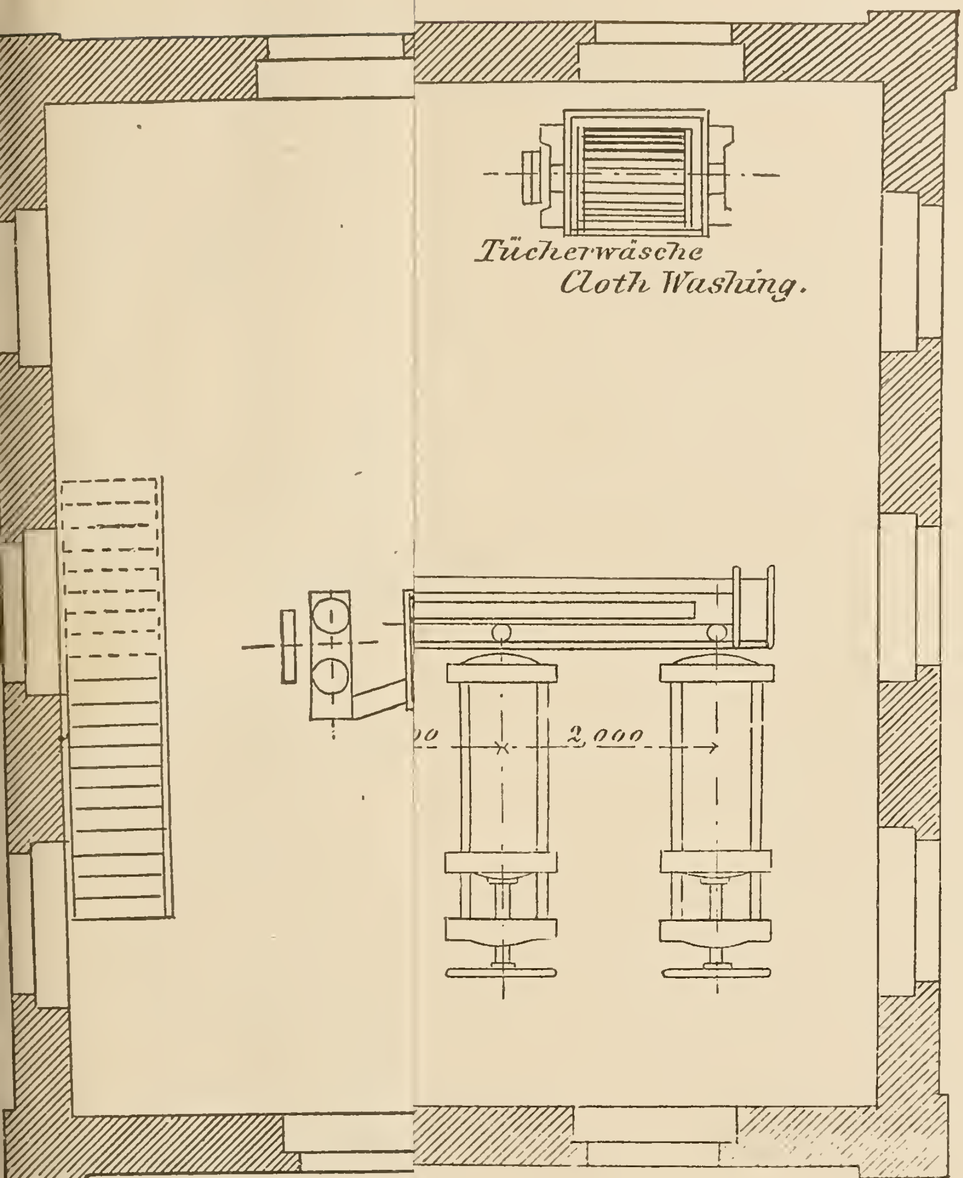
END VIEW.

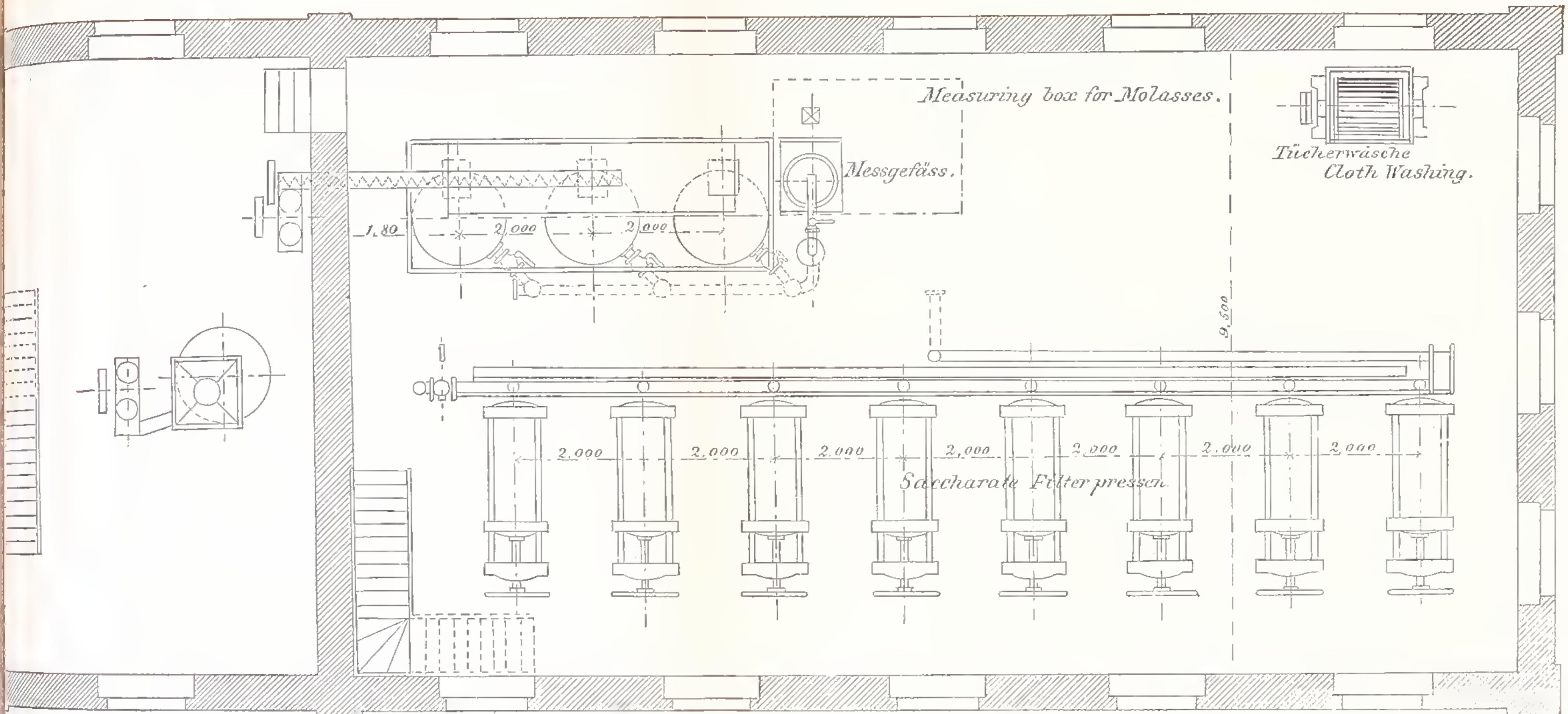


STEFFEN'S PROCESS.—PLAN OF FIRST FLOOR.

Scale: 1 to 100.

Plate X.

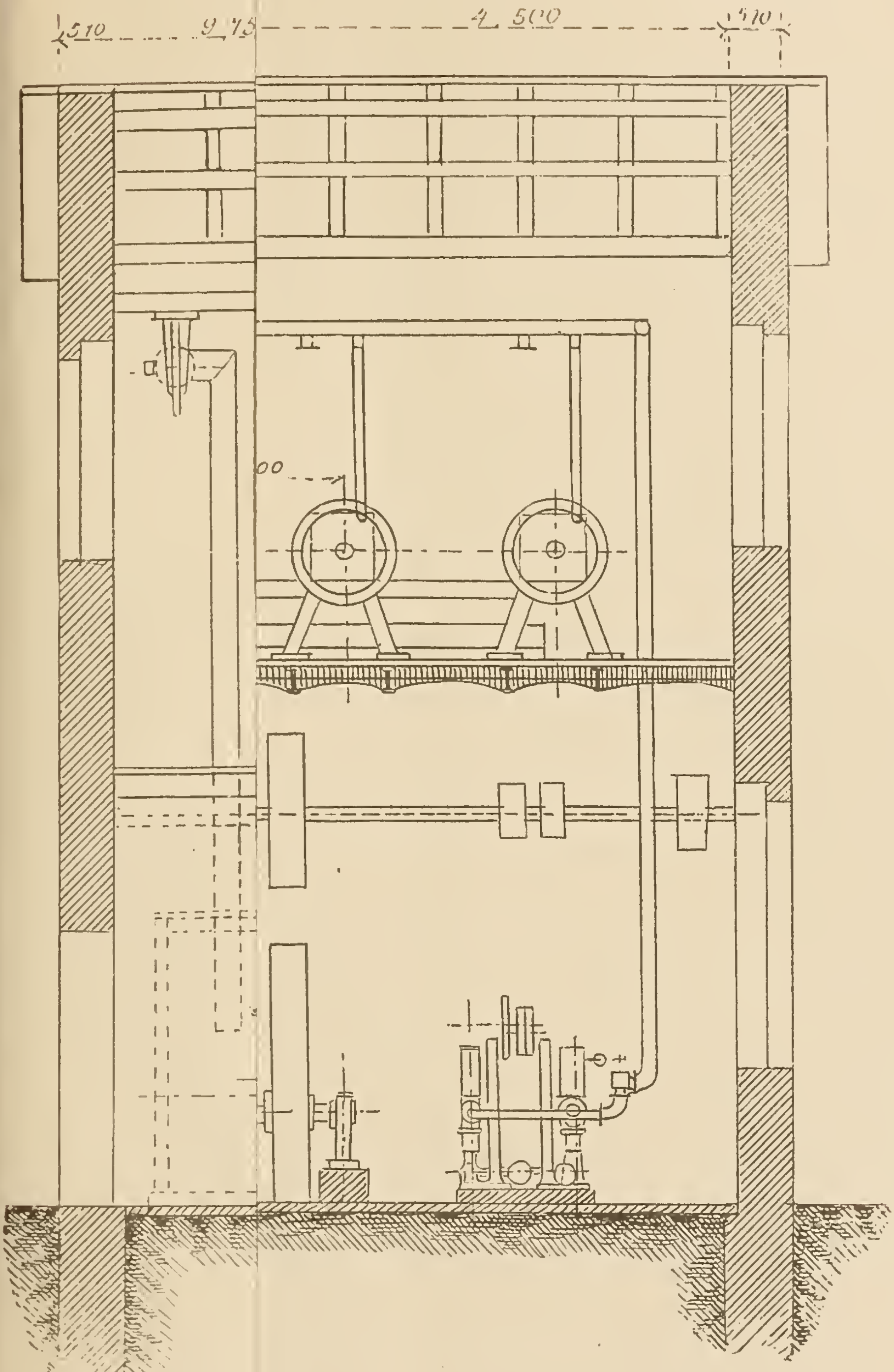


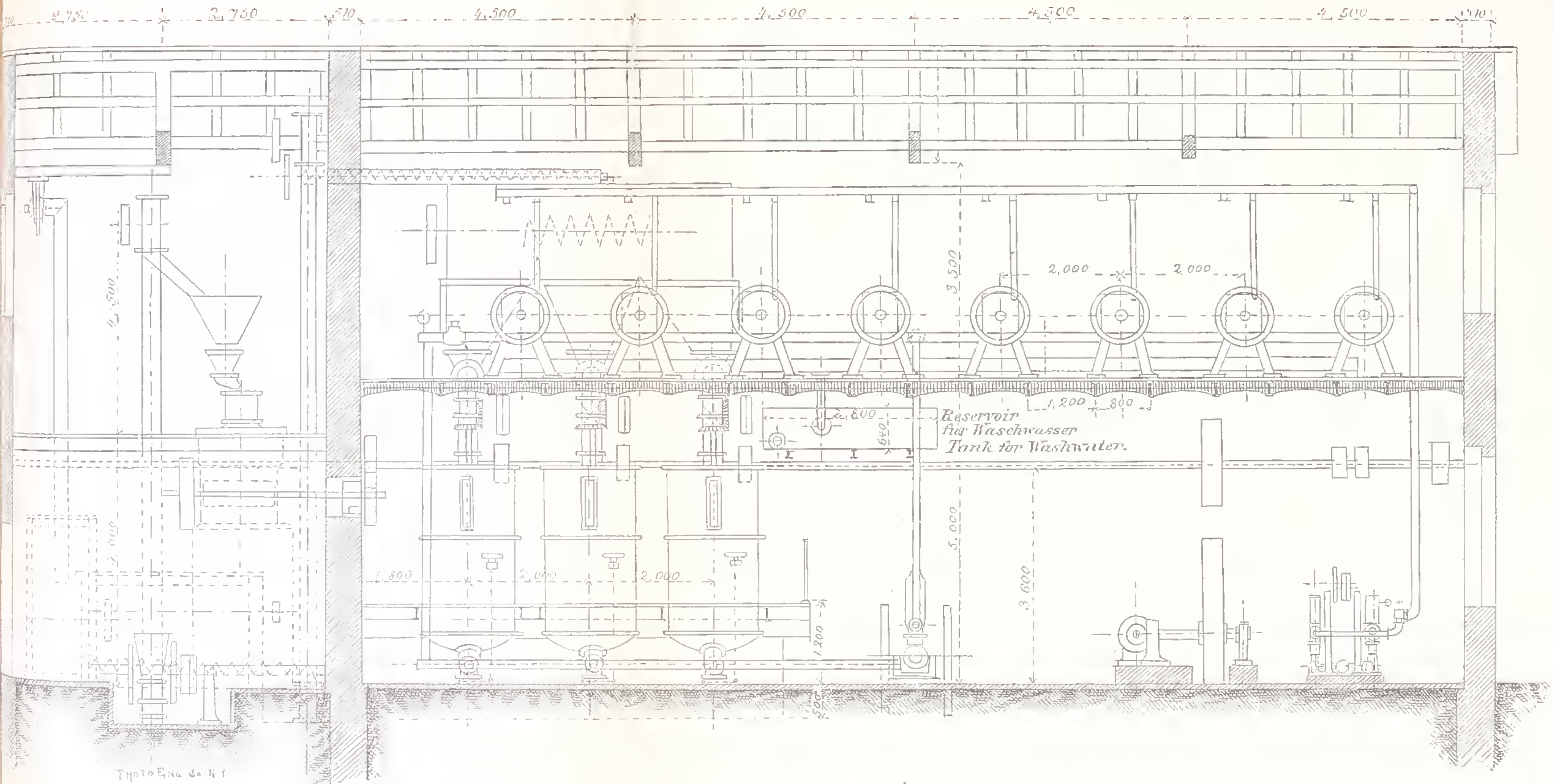


STEFFEN'S PROCESS.—PLAN OF SECOND FLOOR.

Scale: 1 to 100.

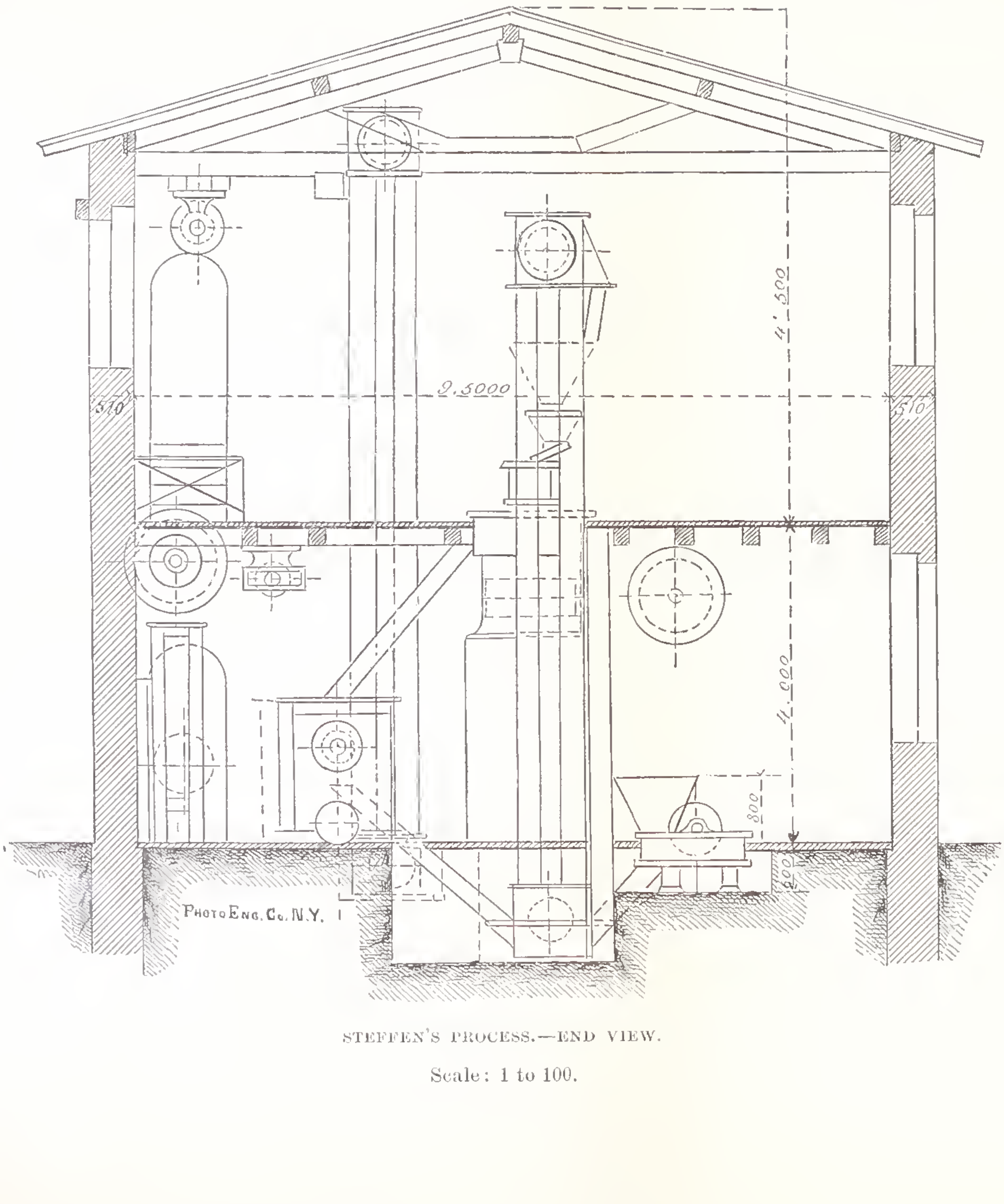
Plate XI.





STEFFEN'S PROCESS.—SIDE VIEW, SHOWING DISPOSITION OF THE MACHINERY.

Scale: 1 to 100.



STEFFEN'S PROCESS.—END VIEW.

Scale: 1 to 100.

THE SUGAR INDUSTRY OF THE UNITED STATES.

Part III.—SORGHUM.

SORGHUM.

EXPERIMENTS MADE BY DEPARTMENT OF AGRICULTURE IN 1884.

The discouraging results of the experiments with sorghum in 1883 (see Bulletin No. 3) deterred the Department from any extensive cultural experiments during the season just passed.

Small plats of the best approved varieties of sorghum, viz: Early Amber, Early Orange, Link's Hybrid, and Honduras, were planted on the grounds of the Department. These plats had a dressing of well-decomposed stable manure and an application of superphosphate equivalent to about 400 pounds per acre. The crop received the ordinary cultivation. The season was favorable, as is indicated by the following statement taken from the official reports of the U. S. Signal Office:

Statement showing the precipitation, in inches and hundreths, and the mean temperature, at Washington City, from May to October, 1884, inclusive. Copied from the records on file at the office of the Chief Signal Officer of the Army.

Nature of data.	1884.					
	May.	June.	July.	August.	September.	October.
Precipitation inches	3.09	6.95	7.39	1.01	0.14	1.73
Mean temperature, F°......	64.4	72.5	74.2	74.2	71.7	59.6

EFFECT OF REMOVING SEED HEADS.

It was first suggested by Prof. H. A. Weber, of Columbus, Ohio, that the formation of the starch of the seed took place at the expense of the sucrose in the juice. Following out this idea he made a few investigations which corroborated the truth of his theory.

To give a further trial of this theory the following experiments were made:

The seed heads, as they appeared, were cut off of a large number of canes at intervals along the row. A like number of canes was left to mature in the usual way. To protect the forming seeds of these against the depredations of the English sparrows, they were covered with a cap of tarlatan. But in spite of this precaution the seeds did not mature. The hungry birds would hang upon the netting and gradually pick them off. To this extent the object of the trial was defeated. But the results show that the removal of the seed either before or after flowering does apparently increase the percentage of sucrose in the juice. This is shown from the fact that the percentage of sucrose in canes deprived by the birds of their seed is much greater in the juices analyzed in 1884 than in those of 1883 when the seeds matured. On the other hand, it does not appear that the removal of the panicle immediately on its appearance tends to give a materially greater percentage of sucrose than is obtained by allowing the birds to remove the seeds after they have begun to form.

In Table I are given the results of the analyses of canes whose panicles were cut as soon as they could be seen. These canes were stripped and pressed in a small mill. The percentage of juice expressed was noted. The bagasse was now passed a second time through the mill, and the percentage of second juice calculated on the first weight of the cane. The object of this second milling was to compare the character of the juice expressed at first with that which remained in the bagasse. The sucrose was determined by direct and double polarization, and the reducing sugar by titration with Fehling's solution. The methods of analysis were those employed in the investigations published in Bulletins Nos. 2 and 3. The albuminoids were determined by evaporating 10 c. c. of the juice to dryness and ignition of the residue with soda lime. The total solids were generally calculated from the specific gravity of the juice; in other cases by evaporation of 2 c. c. in a capsule with sand.

In Table II are found analyses of canes whose seed had been protected by caps, as already described. The corresponding numbers of the two tables represent canes cut at the same time and as nearly as possible alike. The juices obtained by the two methods of culture are thus directly compared.

TABLE I.—*Canes in which seed-heads were cut when shown.*

A.

Date.		Number.	Serial number.	Variety.	No. of canes.	Weight of canes.	Weight after stripping.	Blades, &c.	Weight of first juice.	First juice.	Weight of second juice.	Second juice.
						Gram.	*Gram.*	*Per ct.*	*Gram.*	*Per ct.*	*G'm.*	*P. ct.*
Sept.	12	1	3	Early Amber	6	5955	4216	29.21	1561	37.03	883	20.94
	13	2	7	....do	6	5007	3545	30.00	1575	44.43	345	9.73
	15	3	11	Link's Hybrid	6	7090	5250	25.95	2358	44.91	592	11.27
	16	4	15	Honduras	4	4572	3149	31.15	1639	52.05	305	9.68
	17	5	19	Early Orange	6	4800	3645	24.06	1677	46 01	500	13.72
	18	6	23	Wabaunsee*	6	5655	3875	31.48	1827	47.15	522	13.47
	19	7	27	Early Amber	4	3551	2617	26.30	1064	40.66	360	13.76
	20	8	31	Link's Hybrid	4	3792	2788	28,59	1256	45.05	412	14.78
	22	9	35	Honduras	4	3853	2877	25.33	1375	47.79	378	13.14
	24	10	38	Early Orange	3	3148	2308	26.68	893	38.69	.....	.....
	25	11	40	Wabaunsee*	4	3557	2116	40.51	817	38.61	.....	.....
	26	12	42	Early Amber	4	3535	2366	33.07	784	33.14	.....	.....
	27	13	45	Link's Hybrid	5	4503	3495	22.38	1705	48.78	360	10.30
	29		49	White Mammoth	5	5322	4390	17.51	2117	48.22	492	11.21

TABLE I.—*Canes in which seed-heads were cut when shown*—Continued.

A.

Date.	Number.	Serial number.	Variety.	No. of canes.	Weight of canes.	Weight after stripping.	Blades, &c.	Weight of first juice.	First juice.	Weight of second juice.	Second juice.
					Gram.	*Gram.*	*Per ct.*	*Gram.*	*Per ct.*	*G'm.*	*P. ct.*
Oct. 1	15	53	Honduras	5	5050	3764	25.47	1835	48.75	405	10.76
2	16	57	Early Orange	5	4442	3162	28.82	1350	42.69	385	12.18
3	17	61	Wabaunsee*	5	5735	3700	35.48	1740	47.03	442	11.95
4	18	65	Early Amber	5	4207	2773	34.09	1214	43.78	380	13.70
6	19	69	Link's Hybrid	5	5562	4167	25.08	1923	46.15	549	13.17
7	20	73	White Mammoth	5	5513	4502	18.37	2046	45.45	571	12.68
8	21	77	Honduras	5	5325	3957	25.69	1890	47.76	419	10.59
9	22	81	Early Orange	6	5475	3997	27.00	1755	43.88	406	10.06
10	23	85	Wabaunsee*	5	6320	3886	38.51	1671	43.00	451	11.61
11	24	89	Early Amber	6	5319	3177	40.37	1265	39.82	409	12.87
13	25	95	Link's Hybrid	5	4856	3627	25.31	1691	46.62	430	11.86
14	26	99	Honduras	5	5270	3858	26.79	1754	45.46	454	11.77
15	27	103	White Mammoth	5	4885	4033	17.44	1816	45.03	553	13.72
16	28	107	Early Orange	6	4175	3045	27.05	1188	39.01	357	11.72
17	29	111	Wabaunsee*	6	5964	4317	27.06	1848	42.81	425	9.84
Mean							28.07		44.13		12.33

B.—ANALYSES FIRST JUICE.

Date.	Number.	Serial number.	Variety.	No. of canes.	Specific gravity.	Sucrose direct.	Sucrose by inversion.	Reducing sugars.	Albuminoids.	Total solids.	Solids not sugar.	Purity coefficient.
						Per ct.	*Per ct.*	*P. ct.*	*Per ct.*	*Per ct.*	*P. ct.*	
Sept. 12	1	3	Early Amber	6	1.084	15.51	15.46	.77	......	20.26	4.03	76.38
13	2	7	......do	6	1.070	11.29	11.46	1.79	.781	17.14	3 89	66.86
15	3	11	Link's Hybrid	6	1.090	16.02	16.00	1.33	1.250	21.69	4.36	73.77
16	4	15	Honduras	4	1.874	12.51	12.80	2.12	.650	18.05	3.13	70.91
17	5	19	Early Orange	6	1.083	13.76	13.89	3.12	.631	19.83	2.82	70.05
18	6	23	Wabaunsee*	6	1.082	14.61	14.61	1.24	.787	19.63	3.78	74.43
19	7	27	Early Amber	4	1.091	15.82	15.77	.86	.975	21.69	5.06	72.25
20	8	31	Link's Hybrid	4	1.089	16.03	15.82	.59	1.168	21.23	4.82	74.52
22	9	35	Honduras	4	1.073	12.35	12.65	2.74	.637	17.59	2.20	71.91
24	10	38	Early Orange	3	1.081	14.20	14.54	2 89	.644	19.50	2.07	74.56
25	11	40	Wabaunsee*	4	1.072	13.69	13.72	.57	.762	17.59	3.30	78.00
26	12	42	Early Amber	4	1.081	14.17	14.24	.97	.819	19.23	4.02	74.05
27	13	45	Link's Hybrid	5	1.094	17.05	17.14	.73	1.276	22.41	4.51	76.62
29	14	49	White Mammoth	5	1.088	15.06	15.13	1.01	1.044	21.23	5.09	71.27
Oct. 1	15	53	Honduras	5	1.080	14.31	14.56	1.94	.794	19.03	2.53	76.51
2	16	57	Early Orange	5	1.087	15.58	15.71	1.89	.881	20.78	3.18	75.60
3	17	61	Wabaunsee*	5	1.076	13.64	13.70	.81	.894	18.50	3.99	74.05
4	18	65	Early Amber	5	1.082	13.77	13.96	.76	.869	19.63	4.91	71.12
6	19	69	Link's Hybrid	5	1.090	17.27	17.29	.36	1.319	21.69	4.76	79.71
7	20	73	White Mammoth	5	1.085	15.20	15.13	1.30	1.031	20.39	3.96	74.20
8	21	77	Honduras	5	1.081	13.54	13.74	1.04	.969	19.50	4.72	70.46
9	22	81	Early Orange	6	1.091	16.39	16.33	1.26	.944	21.69	4.10	75.24
10	23	85	Wabaunsee*	5	1.078	14.10	14.02	.88	.900	17.72	2.82	79.12
11	24	89	Early Amber	6	1.082	13.80	13.90	.73	.844	18.73	4.10	74.21
13	25	95	Link's Hybrid	5	1.095	17.72	17.53	.34	1.363	21.33	3.46	82.18
14	26	99	Honduras	5	1.088	14.32	14.43	2.39	1.025	19.72	2.90	73.17
15	27	103	White Mammoth	5	1.092	15.93	15.90	1.21	1.169	19.78	2.67	80.38
16	28	107	Early Orange	6	1.095	16.06	16.16	1.79	1.069	21.37	3.42	75.62
17	29	111	Wabaunsee*	6	1.090	16.37	16.46	.60	1.006	20.11	3.05	81.85
Average						14.87	14.90	1.32	.947	19.90	3.71	74.80

C.—ANALYSES SECOND JUICE.

Date.	Number.	Serial number.	Variety.	No. of canes.	Specific gravity.	Sucrose direct.	Sucrose by inversion.	Reducing sugars.	Albuminoids.	Total solids.	Solids not sugar.	Purity coefficient.
						Per ct.	Per ct.	P. ct.	Per ct.	Per ct.	P. ct.	
Sept. 12	1	3	Early Amber........	6	1.086	15.27	15.17	.75	....	20.55	4.63	73.82
13	2	7	Early Amber.........	6	1.074	11.58	12.00	1.71	....	18.05	4.28	66.48
15	3	11	Link's Hybrid.........	6	1.094	15.99	15.79	1.08	1.468	22.41	5.54	70.46
16	4	15	Honduras	4	1.077	12.24	12.49	2.07	.956	18.73	4.17	66.68
17	5	19	Early Orange..........	6	1.088	13.90	14.01	2.61	.881	21.23	4.61	65.99
18	6	23	Wabaunsee*..........	6	1.085	14.45	14.43	1.09	1.043	20.39	4.87	70.77
19	7	27	Early Amber..........	4	1.094	15.93	15.93	.91	1.325	22.41	6.11	71.08
20	8	31	Link's Hybrid.........	4	1.089	15.32	15.11	.60	1.456	21.23	5.52	71.17
22	9	35	Honduras	4	1.078	12.02	12.29	2.64	.969	18.73	3.80	65.62
27	13	45	Link's Hybrid.........	5	1.095	16.51	16.38	.72	1.731	22.60	5.50	72.48
29	14	49	White Mammoth	5	1.092	15.16	15.30	1.02	1.263	21.91	5.59	69.83
Oct. 1	15	53	Honduras	5	1.084	13.98	13.87	1.92	1.113	20.26	4.47	68.46
2	16	57	Early Orange	5	1.093	15.59	15.61	1.80	1.263	21.94	4.53	71.15
3	17	61	Wabaunsee*..........	5	1.078	13.31	13.34	.83	1.069	18.73	4.56	71.22
4	18	65	Early Amber.........	5	1.085	14.09	14.08	.77	1.238	20.39	5.54	69.05
6	19	69	Link's Hybrid.........	5	1.095	17.04	16.86	.37	1.513	22.60	5.37	74.00
7	20	73	White Mammoth	5	1.092	15.81	15.64	1.33	1.213	21.91	4.94	71.39
8	21	77	Honduras	5	1.089	13.33	13.37	1.08	1.313	21.23	6.78	62.98
9	22	81	Early Orange.........	6	1.100	16.76	16.49	1.21	Lost.	23.75	6.05	69.43
10	23	85	Wabaunsee*...........	5	1.082	13.35	13.37	.89	1.131	18.02	3.76	74.20
11	24	89	Early Amber	6	1.088	14.20	14.13	.74	1.206	20.11	5.24	70.26
13	25	95	Link's Hybrid.......	5	1.097	17.69	17.36	.34	1.600	22.11	4.41	78.52
14	26	99	Honduras...............	5	1.099	13.67	13.77	2.46	1.319	20.07	3.84	68.69
15	27	103	White Mammoth......	5	1.094	15.70	15.48	1.20	1.419	21.14	4.46	73.22
16	28	107	Early Orange	6	1.099	16.21	16.05	1.77	1.444	23.37	5.55	68.68
17	29	111	Wabaunsee*...........	6	1.092	16.10	16.15	.61	1.294	21.03	4.27	76.79
Average ...	....		....	....	....	14.82	14.83	1.25	1.219	20.96	4.94	70.50

*Seed from C. M. Schwarz, Edwardsville, Ill.

TABLE II.—*Analyses of sorghum juices from canes in which seeds were allowed to ripen.*

A.

Date.	Number.	Serial number.	Variety.	Number of canes.	Weight of canes.	Weight after stripping.	Blades, &c.	Weight of first juice.	First juice.	Weight of second juice.	Second juice.
					Gram.	Gram.	Pr. ct.	Gram.	Pr. ct.	Grm.	Pr. ct.
Sept. 12	1	1	Early Amber.................	6	4475	3500	21.79	....	40.51	870	16.29
13	2	5	....do.........................	6	5650	4345	23.08	1820	41.89	614	14.13
15	3	9	Links Hybrid	6	4810	3952	17.84	1900	48.08	442	11.18
16	4	13	Honduras	4	3925	3200	18.47	1672	52.25	402	12.63
17	5	17	Early Orange	6	4193	3422	18.39	1684	49.21	533	15.58
18	6	21	Wabaunsee	6	3932	3254	17.24	1625	49.90	375	11.52
19	7	25	Early Amber..................	4	2935	2311	21.26	984	42.58	305	13.20
20	8	29	Links Hybrid	4	3556	2855	19.71	1378	48.27	484	16.95
22	9	33	Honduras	4	3384	2643	21.89	1137	43.02	405	15.32
24	10	37	Early Amber..................	3	2276	1989	12.61	825	41.49	......	......
25	11	39	Wabaunsee	4	2500	2082	16.72	797	38.28	......	......
26	12	41	Early Amber..................	4	3096	2412	22.09	745	30.89	......	.....
27	13	43	Links Hybrid	5	4160	3472	16.54	1791	51.58	301	8.67
29	14	47	White Mammoth	5	4602	3980	13.52	2065	51.38	382	9.60
Oct. 1	15	51	Honduras	5	4515	3677	18.56	1790	48.68	366	9.95
2	16	55	Early Orange	5	3449	2828	18.01	1485	52.51	230	8.13
3	17	59	Wabaunsee	5	4320	3184	26.30	1552	48.74	325	10.21
4	18	63	Early Amber	5	4755	2667	43.91	1194	44.77	372	13.95
6	19	67	Links Hybrid	5	4800	3777	21.31	1787	47.31	442	11.71
7	20	71	White Mammoth............	5	4820	4065	15.66	1855	45.63	347	8.54
8	21	75	Honduras	5	4130	3527	14.60	1739	49.30	383	10.86

TABLE II.—*Analysis of sorghum juices from canes, &c.*—Continued.

A.

Date.	Number.	Serial number.	Variety.	Number of canes.	Weight of canes.	Weight after stripping.	Blades, &c.	Weight of first juice.	First juice.	Weight of second juice.	Second juice.
					Gram.	*Gram.*	*Pr. ct.*	*Gram.*	*Pr. ct.*	*Grm.*	*Pr. ct.*
9	22	79	Early Orange	6	4560	3751	17.74	1728	46.07	472	12.58
10	23	83	Wabaunsee	5	4940	3579	27.55	1758	49.12	......	....
11	24	87	Early Amber	6	5497	3440	37.42	1449	41.83	389	11.31
13	25	93	Links Hybrid	5	5885	3906	33.63	1842	47.16	452	11.57
14	26	97	Honduras	5	4340	3674	15.35	1771	48.20	430	11.70
15	27	101	White Mammoth	5	4540	3888	14.36	1795	46.17	507	13.04
16	28	105	Early Orange	6	3530	2935	16.86	1237	42.15	286	9.79
17	29	109	Wabaunsee	6	5445	3892	28.52	1725	44.32	318	8.17
Mean	....	....	....	....	....	....	21.06	....	45.91	......	11.86

B.—ANALYSES OF FIRST JUICES.

Date.	Number.	Serial number.	Variety.	Number of canes.	Specific gravity.	Sucrose direct.	Sucrose by inversion.	Reducing sugars.	Albuminoids.	Total solids.	Solids not sugar.	Purity coefficient.
						Pr. ct.	*Pr. ct.*	*P. ct.*	*Pr. ct.*	*Pr. ct.*	*P. ct.*	
Sept. 12	1	1	Early Amber	6	1.083	15.31	15.38	1.03	....	19.83	3.42	77.55
13	2	5	......do	6	1.083	15.08	15.25	.77	.562	19.83	3.81	76.90
15	3	9	Links Hybrid	6	1.073	13.28	13.45	.75	.787	17.59	3.39	76.46
16	4	13	Honduras	4	1.078	13.07	13.44	2.39	.568	18.73	1.84	71.80
17	5	17	Early Orange	6	1.061	8.79	9.17	2.58	.300	14.87	2.06	61.67
18	6	21	Wabaunsee	6	1.077	14.50	14.23	1.09	.387	18.73	3.41	75.97
19	7	25	Early Amber	4	1.091	16.30	16.50	.90	.656	21.69	4.29	76.07
20	8	29	Links Hybrid	4	1.079	14.44	14.44	.58	.856	19.18	4.16	75.28
22	9	33	Honduras	4	1.084	14.07	14.48	2.20	.612	20.26	3.58	71.47
24	10	37	Early Amber	3	1.069	10.70	11.15	3.20	.294	16.68	2.33	66.84
25	11	39	Wabaunsee	4	1.084	14.97	15.15	.88	.450	19.63	3.60	77.17
26	12	41	Early Amber	4	1.093	16.72	16.85	.57	.800	21.94	4.52	76.75
27	13	43	Links Hybrid	5	1.087	15.67	15.80	.52	.800	20.78	4.46	76.03
29	14	47	White Mammoth	5	1.080	13.71	13.95	1.07	.794	19.03	4.01	73.35
Oct. 1	15	51	Honduras	5	1.084	15.09	15.35	1.50	.756	20.26	3.41	75.86
2	16	55	Early Orange	5	1.083	14.30	14.64	1.65	.431	19.83	3.54	73.82
3	17	59	Wabaunsee	5	1.078	14.00	14.34	.70	.631	18.73	3.69	76.56
4	18	63	Early Amber	5	1.082	14.07	14.37	.94	.781	19.63	4.32	73.20
6	19	67	Links Hybrid	5	1.087	16.63	16.75	.37	1.050	20.78	3.66	80.60
7	20	71	White Mammoth	5	1.086	14.62	14.66	1.36	.962	20.55	4.53	71.33
8	21	75	Honduras	5	1.083	14.12	14.50	.56	.725	19.83	4.77	73.12
9	22	79	Early Orange	6	1.087	15.23	15.35	1.60	.481	20.78	3.83	73.86
10	23	83	Wabaunsee	5	1.079	13.51	13.69	.86	.631	18.15	3.60	75.42
11	24	87	Early Amber	6	1.086	15.48	15.58	.76	1.044	20.06	3.72	77.66
13	25	93	Links Hybrid	5	1.092	17.23	17.11	.35	1.038	20.97	3.51	81.59
14	26	97	Honduras	5	1.085	13.44	13.80	2.25	.675	19.22	3.17	71.80
15	27	101	White Mammoth	5	1.090	15.60	15.69	1.03	.969	19.93	3.21	78.72
16	28	105	Early Orange	6	1.094	16.25	16.40	1.79	.625	21.20	3.01	77.36
17	29	109	Wabaunsee	6	1.086	15.24	15.35	1.08	.687	19.46	3.03	78.88
Mean	....	....	....	....	....	14.53	14.72	1.22	.691	19.59	3.58	74.93

C.—ANALYSES OF SECOND JUICES.

Date.	Number.	Serial number.	Variety.	Number of canes.	Specific gravity.	Sucrose direct.	Sucrose by inversion.	Reducing sugars.	Albuminoids.	Total solids.	Solids not sugar.	Purity coefficient.
						Pr. ct.	Pr. ct.	P. ct.	Pr. ct.	Pr. ct.	P. ct.	
Sept. 12	1	1	Early Amber	6	1.087	15.41	15.35	1.04	......	20.78	4.39	73.62
13	2	5	....do	6	1.088	15.48	15.58	1.15	.787	21.23	4.50	73.38
15	3	9	Links Hybrid	6	1.074	13.21	13.14	.72	.975	18.05	4.19	72.76
16	4	13	Honduras	4	1.084	13.21	13.60	2.35	.950	20.26	4.31	67.12
17	5	17	Early Orange	6	1.061	8.83	9.22	2.56	.425	14.87	3.09	62.00
18	6	21	Wabaunsee	6	1.081	13.81	13.79	1.09	.423	19.50	4.62	70.70
19	7	25	Early Amber	4	1.098	16.34	16.57	.86	1.031	23.26	5.83	71.23
20	8	29	Links Hybrid	4	1.082	14.08	13.93	.49	1.056	19.63	5.21	70.25
22	9	33	Honduras	4	1.086	13.53	13.81	2.06	.869	20.55	4.68	67.20
27	13	43	Links Hybrid	5	1.093	15.85	16.00	.51	1.169	21.94	5.43	72.92
29	14	47	White Mammoth	5	1.082	13.23	13.27	1.10	1.031	19.63	5.26	67.60
Oct. 1	15	51	Honduras	5	1.090	12.90	12.92	1.55	1.038	21.69	7.22	59.56
2	16	55	Early Orange	5	1.086	14.26	14.47	1.72	.675	20.55	4.36	70.41
3	17	59	Wabaunsee	5	1.083	14.28	14.21	.71	.887	19.83	4.91	71.65
4	18	63	Early Amber	5	1.087	14.16	14.18	.90	1.045	20.78	5.70	68.23
6	19	67	Links Hybrid	5	1.090	16.43	16.47	.39	1.300	21.69	4.73	75.93
7	20	71	White Mammoth	5	1.092	15.09	15.19	1.41	1.150	21.91	5.31	69.32
8	21	75	Honduras	5	1.087	14.51	14.71	.56	1.063	20.78	2.51	70.98
9	22	79	Early Orange	5	1.091	15.80	15.79	1.56	.850	21.69	4.34	72.75
10	23	83	Wabaunsee	5	1.085	14.03	14.04	.89	1.000	19.36	4.43	73.03
11	24	87	Early Amber	6	1.092	16.14	16.07	.71	1.344	23.45	6.67	68.59
13	25	93	Links Hybrid	5	1.097	17.28	17.07	.35	1.288	21.70	4.28	78.66
14	26	97	Honduras	5	1.087	12.78	13.05	2.14	.944	19.69	4.50	67.81
15	27	101	White Mammoth	5	1.092	15.66	15.58	1.05	1.169	21.20	4.57	73.48
16	28	105	Early Orange	6	1.097	16.39	16.32	1.82	1.019	22.38	4.24	72.92
17	29	109	Wabaunsee	6	1.088	15.27	15.28	1.07	.944	21.14	4.79	72.28
Mean						14.54	14.60	1.18	.986	20.67	4.77	70.54

REMARKS.

In Table I, the total sucrose of first juices by direct polarization, 29 analyses, is 14.87 per cent.; by polarization after inversion, 14.90. The percentage of reducing sugar is 1.32. The near agreement of the two sucrose determinations shows that the reducing sugar present was optically inactive, *i. e.*, anoptose. Analyses worthy of special note are 13, 19, and 25, in which the sucrose rises above 17 per cent., and 1, 7, 8, 11, 12, 13, 17, 18, 19, 23, 24, 25, and 28, in which the reducing sugar is less than 1 per cent.

In the second juices of Table I, the sucrose, by direct polarization, is 14.82 per cent., and by inversion 14.83 per cent. The reducing sugar is 1.25 per cent. As far as sugar is concerned, therefore, the two juices are practically identical. But the analyses show a great increase in solids not sugar. The albuminoids rise from .947 per cent. to 1.219, and the total solids not sugar from 3.71 to 4.94.

In Table II, the sucrose direct of the first juices is 14.53 per cent., and by inversion 14.72 per cent. The analyses of second juice shows the same general results as in Table I. In only one instance in this series of analyses, viz. No. 25, does the sucrose rise above 17 per cent., while in fourteen cases the reducing sugar is less than 1 per cent. The effect of cutting off the young heads in increasing the per cent. of sucrose was not as marked as had been expected, being a little less than .3 per cent.

On the other hand, it is certain that cutting the tops produces a great increase of suckering. From nearly every joint of the topped cane a sucker grew. No attempt was made to remove these suckers. Their growth, however, evidently had no effect whatever on the sucrose in the juice of the cane, a fact which is contrary to the generally accredited belief. The removal of the seed by the sparrows also produces an exuberant growth of suckers. Trials of previous years have shown that the mean percentage of blades to weight of cane is 10. In the canes from which the panicle had been removed the percentage of blades and suckers was 28.07; hence percentage of suckers was 18.07. In Table II the total percentage of blades and suckers is 21.06; hence percentage of suckers is 11.06. The topping of the canes, therefore, nearly doubled the quantity of suckers. From a scientific point of view it is desirable that these experiments should be tried on a larger scale in a locality where English sparrows are unknown.

Practically it is doubtful whether topping the cane would prove profitable. The great labor which it would require, the increase in suckering which it would produce, the loss in seed which it would entail, would, in my opinion, be insuperable objections to its use. Aside from this the question in physiological chemistry which it raises is one of considerable importance. The development of starch at the expense of sucrose is worthy of careful investigation at the hands of vegetable physiologists.

EXPERIMENTS IN TOPPING CANE, BY PROF. H. A. WEBER.

"The first experiment in topping cane was made in the season of 1882. It was suggested by the theory that the starch, which forms about 63 per cent. of the weight of the seed, could, by removing the top in time, be retained in the stalk in the form of cane sugar. The experiments in this direction fully proved the correctness of this theory. In the first experiment a portion of the heads were removed from a plat of amber cane soon after they made their appearance and before there was any visible formation of seed. When the remaining cane had reached the hard-dough stage comparative analyses were made, with the following results:

	Topped.	Untopped.
Density, Baumé	9.5	8.1
Cane sugar	12.62	7.80
Grape sugar	2.58	4.80

"In the season of 1883 two more experiments were made in this direction. In the first one a field of Kansas orange cane was chosen. Two rows lying side by side and of uniform growth were selected. One was topped as soon as the heads appeared. The first comparative analyses were made on September 19, when the upper half of the seed heads was in the hardening dough. The results are as follows:

	Topped.	Untopped.
Density Baumé	10.8	9.8
Cane sugar	14.4	11.83
Grape sugar	4.01	3.89

"Two more comparative analyses of the same rows were made on October 2, after the seed was fully ripe.

"The following table shows the results:

	Topped.	Untopped.
Density, Baumé	11.3	9.4
Cane sugar	14.82	11.53
Grape sugar	2.82	3.53

"The last test was made with a plat of Indian cane. The topping was done August 23, three days after the heads began to appear.

"The comparative analyses were made October 6. At this date the seeds were perfectly ripe, and would drop from the head when shaken.

"The results are given in the following table:

	Topped.	Untopped.
Density, Baumé	10.2	8.3
Cane sugar	13.04	10.06
Grape sugar	1.54	2.46

"These results show an increase of over 4 per cent. of cane sugar in favor of the topped cane."

COMPARISON OF JUICES OBTAINED BY FIRST AND SECOND PRESSURE.

Already in the remarks on Tables I and II, some comparisons have been made between the juice obtained by passing the canes through the mill and that got by immediately remilling the bagasse. As has already been shown, these two sets of juice are almost identical, as far as their content of the two sugars is concerned. The specific gravity and total solids of the juice from the second milling are, however, quite different from those of the first. The mean percentage of juice obtained by the first milling (Table No. I) was 44.13 per cent; by the second milling 12.33 per cent. In Table No. II the percentages were 45.91 and 11.86, respectively. The juices of the second milling show a marked decrease in the coefficient of purity and of course in the percentage of available sugar. In the first juices of Table I this is 9.85, while in the second juices it is only 8.63. In Table No. II the percentage of available sugar in the first juices is 9.77, and in the second juices 8.62. From this it is seen that the juice obtained by high pressure yields less available crystallizable sugar than the juice from low pressure.

It follows, therefore, that there is a limit beyond which a strong pressure could cease to be profitable. There is, however, not much danger of reaching that limit with mills as they are now constructed. The chief loss will continue to be in the sugar left in the bagasse, and not in the impurities forced into the juice. The results of the above experiments furnish additional reasons for prosecuting experiments looking to the extraction of sugar by other methods.

EFFECT OF GRINDING CANES WITHOUT STRIPPING.

A few experiments were also made to determine what effect grinding the canes unstripped would have on the juice. In Table III are found the results of this trial with canes whose panicles had been cut, and in Table IV those with canes whose seed had been allowed to ripen.

TABLE III.—*Comparison of juices*

CANES IN WHICH

Date.	Number.	Serial number.	Variety.	Condition.	Number of canes.	Total weight.	Weight after stripping.	Per cent. of blades, &c.	Weight of juice.	Per cent. of juice.	
										Stripped.	Unstripped.
October 18...	1	113	Early Amber	Stripped	5	4, 380	2, 927	33. 17	1, 206	41. 20	......
October 18...	2	115	Early Amber	Unstripped .	5	4, 217	......	......	1, 401	......	33. 22
October 20...	3	117	Link's Hybrid	Stripped	5	4, 160	3, 235	22. 23	1, 453	44. 91	......
October 20...	4	119	Link's Hybrid	Unstripped .	5	4, 524	......	....	1, 722	......	38. 06
October 21...	5	121	White Mammoth .	Stripped	5	4, 430	3, 635	17. 94	1, 629	44. 81	......
October 21...	6	123	White Mammoth .	Unstripped .	5	4, 330	......	......	1, 715	......	39. 60
October 22...	7	126	Honduras	Stripped	5	4, 680	3, 652	21. 96	1, 651	45. 20	......
October 22 ..	8	128	Honduras	Unstripped .	5	5, 014	......	......	2, 036	......	40. 60
October 23...	9	130	Early Orange......	Stripped	5	3, 825	2, 473	35. 34	1, 074	43. 42	......
October 23 ..	10	132	Early Orange......	Unstripped	5	3, 336	......	......	1, 139	......	34. 14
October 24...	11	134	Warbaunsee.......	Stripped	5	3, 965	2, 626	33. 77	1, 050	40. 02	......
October 24...	12	136	Warbaunsee.......	Unstripped .	5	5, 488	......	......	1, 803	......	32. 85
Average ...	....	.....	....	....	....	......	......	27. 40	......	43. 26	36. 41

TABLE IV.—*Comparison of juices from*

CANES IN WHICH THE

Date.	Number.	Serial number.	Variety.	Condition.	Number of canes.	Total weight.	Weight after stripping.	Per cent. of blades, &c.	Weight of juice.	Per cent. of juice.	
										Stripped.	Unstripped.
October 18...	1	114	Early Amber	Stripped	5	3, 860	2, 502	35. 19	1, 009	40. 32	......
October 18 ..	2	116	Early Amber	Unstripped .	5	4, 182	......	.	1, 333	......	31. 87
October 20...	3	118	Link's Hybrid	Stripped	5	4, 309	3, 372	21. 72	1, 492	44. 24	......
October 20...	4	120	Link's Hybrid	Unstripped .	5	4, 024	......	......	1, 588	......	39. 46
October 21...	5	122	White Mammoth..	Stripped	5	5, 230	3, 973	24. 03	1, 809	45. 53	......
October 21...	6	124	White Mammoth..	Unstripped .	5	4, 835	......	......	1, 947	......	40. 26
October 22...	7	127	Honduras..........	Stripped	5	3, 844	3, 379	12. 87	1, 630	48. 24	......
October 22...	8	129	Honduras..........	Unstripped .	5	4, 387	......	......	1, 908	......	43. 42
October 23...	9	131	Early Orange	Stripped	5	3, 129	2, 609	16. 61	1, 112	42. 62	......
October 23...	10	133	Early Orange	Unstripped .	5	2, 892	......	......	1, 073	......	37. 10
October 24 ..	11	135	Warbunsee	Stripped	5	3, 321	2, 531	23. 57	1, 117	43. 97	......
October 24...	12	137	Warbunsee	Unstripped .	5	3, 849	....	......	1, 539		39. 98
Average ..	....	......	....	....	....	......	......	22. 33	......	44. 15	38. 68

from stripped and unstripped canes.

SEED-HEADS WERE CUT.

Specific gravity.		Sucrose direct.		Sucrose, inversion.		Reducing sugars.		Albuminoids.		Total solids.		Solids not sugar.		Purity coefficient.	
Stripped.	Unstripped.	Stripped.	Unstripped.	Stripped.	Unstripped.	Stripped.	Unstripped.	Stripped.	Unstripped.	Stripped.	Unstripped.	Stripped.	Unstripped.	Stripped.	Unstripped.
1.086	......	15.42	......	15.53	......	1.20	......	.900	......	20.51	....	3.78	......	75.71	......
......	1.082	......	13.62	......	13.69	......	1.02	......	1.019	......	18.92	......	4.21	......	72.35
1.097	......	18.19	......	18.12	...	.70	.....	1.350	.....	22.70	......	3.88	......	79.82	.....
......	1.098	......	17.58	......	17.42	......	.63	......	1.475	......	22.09	...	4.04	......	78.85
1.090	......	16.14	......	16.11	......	1.18	......	1.200	......	21.39	.....	4.10	......	75.31	......
......	1.095	......	16.33	......	15.86	......	1.29	......	1.438	......	20.94	......	3.79	......	75.74
1.084	.. .	12.97	......	13.51	......	3.32	.....	.850	......	19.22	......	2.39	......	70.29	......
......	1.081	.. .	12.14	......	12.58	..	4.93	......	.888	......	18.34	......	.83	...	68.59
1.092	......	15.78	......	15.91	......	1.79	......	1.169	......	21.01	......	3.31	......	75.72	......
......	1.087	......	14.25	......	14.12	......	2.09	...	1.069	......	19.57	......	3.36	......	72.15
1.080	......	15.06	......	15.21	......	1.23	......	.744	.....	19.23	......	2.79	......	79.09	......
......	1.074	......	12.25	.....	13.19	......	2.00	......	.975	......	16.60	....	.81	......	79.45
1.088	1.086	15.59	14.36	15.73	14.48	1.57	1.99	1.035	1.144	20.68	19.41	3.37	2.84	75.99	74.52

stripped and unstripped canes.

SEED-HEADS WERE NOT CUT.

Specific gravity.		Sucrose direct.		Sucrose by inversion.		Reducing sugars.		Albuminoids.		Total solids.		Solids not sugar.		Purity coefficient.	
Stripped.	Unstripped.	Stripped.	Unstripped.	Stripped.	Unstripped.	Stripped.	Unstripped.	Stripped.	Unstripped.	Stripped.	Unstripped.	Stripped.	Unstripped.	Stripped.	Unstripped.
1.094	......	16.67	......	16.68	......	1.02	......	.975	......	20.85	......	3.15	......	80.00	......
......	1.092	......	15.19	......	15.20	......	1.24	......	1.069	......	20.18	......	3.74	......	75.32
1.098	.	17.85	......	17.80	......	.36	......	1.163	......	22.30	....	4.14	......	79.82	......
......	1.097	......	17.27	......	17.20	......	.47	......	1.069	......	21.88	......	4.21	......	78.61
1.096	..	16.64	......	16.45	.....	.99	......	1.469	......	21.57	......	4.13	......	76.26	......
......	1.096	......	16.09	......	15.67	......	1.17	......	1.400	......	21.23	......	4.39	.... .	73.81
1.082	......	12.57	......	13.05	.....	3.27	......	.769	......	18.72	......	2.40	......	69.18	......
......	1.082	......	12.93	......	13.30	......	5.00	......	.662	......	18.95	......	.65	......	70.18
1.092	......	15.54	......	15.71	......	1.77	......	.669	......	20.76	......	3.28	......	75.67	......
......	1.089	......	15.26	......	15.20	......	2.42	......	.656	......	20.20	....	2.58	......	75.24
1.079	......	15.55	......	15.66	......	.78	......	.644	......	19.28	......	2.84	......	81.22	......
.....	1.073	......	13.76	......	13.72	......	1.66	......	Lost.	......	17.55	.....	1.17	......	78.17
1.090	1.088	15.80	15.08	15.89	15.05	1.36	1.99	.948	.971	20.58	20.00	3.32	2.79	77.02	75.22

In all cases it will be seen that grinding with the blades and suckers produced a juice inferior in every respect to that obtained from the clean canes. In Table III it will be seen that the percentage of sucrose was diminished by more than 1.3, while that of reducing sugars was raised nearly .5. The same is true also of the results in Table IV. The albuminoids are also increased in blade juice while the coefficient of purity is lowered. In view of these facts it might be well to consider whether it is not advisable to carefully clean the canes before milling. This is done with the sugar-cane, and it ought to be done with sorghum. The only question is, "Will it pay?" But that is still a question with the whole sorghum industry, and the only way to answer it will be by continued experiments.

In sirup-making I have no doubt of the advisability of stripping the canes. Such a preparation gives a juice easier to clarify and a sirup of lighter color and superior flavor. It is true that sorghum canes are smaller and more difficult to clean than sugar-canes. But if better results can be obtained by stripping them it ought to be done. In case diffusion should come into use the canes should always be cleaned. The blades and young suckers contain bitter and coloring matter easily extracted by warm water, and which afterward it would be difficult to remove.

JUICES OF 1884 COMPARED WITH THOSE OF 1883.

The most surprising result of the experimental work as exhibited in the tables given is the great difference which it shows between the composition of juices analyzed and those analyzed during 1883:

	*1883.	1884.
Mean percentage sucrose	8.38	14.72
Mean percentage reducing sugars	4.09	1.24
Mean percentage albuminoids	.1544	.961

* See Chemical Bul., No. 3, p. 47.

The chief points of interest in this comparison are the increase in sucrose, the decrease in reducing sugars, and the increase in albuminoids. It is difficult to explain why the same varieties of cane grown in the same locality, with the same kind of culture and fertilizing, and in seasons not markedly different, should yield juice of such different composition. Sorghum is one of the most capricious of plants, and the above comparison brings some of its moods into strong contrast.

In percentage of sucrose and reducing sugars, the sorghum juices in Tables I and II compare favorably with those of sugar cane. Their inferiority consists in the large amount of solids not sugar, and especially of albuminoids. It is only by a long process of careful selection that a sorghum cane can be produced which shall contain a maximum of sucrose and a minimum of other substances. The hope of sorghum as a sugar producer lies in the line of such a selection and the location of the areas best suited to its growth and manufacture. The climatic and geographic data of this nature are given tentatively in Chemical Bulletin No. 3.

LABORATORY AT HELENA, WIS.

In order to carry out as fully as possible the purpose of Congress in making an appropriation for the investigation of sugar-producing plants, a laboratory was established at Helena, Wis. Mr. J. I. Donohue was placed in charge of this station, and the results of his analyses give the most extensive knowledge of the character of sorghum in the Northwest which has heretofore been obtained. The station was established on the farm of Messrs. Williams & Flynn.

The character of the soil, the cost of production, the work at the mill, &c., are to be found in the following letter from the proprietors of the farm:

"HELENA, WIS., *November* 17, 1884.

"DEAR SIR: Your letter of inquiry, dated the 12th, is received. We will reply to your inquiries as follows:

"First. Five hundred acres of sorghum.

"Second. Variety, amber cane, except 20 acres Link's Hybrid. There was some Honduras mixed with our seed, which grew considerably larger than the amber, was about two weeks later in ripening, but ripened two weeks before the frost. The Link's Hybrid did not ripen, and is not suitable for this latitude. It came near maturity this year.

"Third. The average yield estimated at 6 tons per acre unstripped cane, tops taken off. The soil upon which the cane was planted is a light sandy soil, too sandy to be profitably cultivated in corn; without fertilizing, corn on the same land yields 12 bushels to the acre. A portion of this same field upon which we grew the cane this year was planted to cane last year, and the first upon which the bagasse was spread; the cane yielded this season 15 tons to the acre, and this cane thus fertilized ripened two weeks earlier than the unfertilized canes. From this experiment we were satisfied that by spreading the bagasse over the land the product can be materially increased every year; in fact, equal to plowing in a crop of clover every year.

"Fourth. Yield of molasses per ton of cane, 4 gallons.

"The mill used was manufactured by J. A. Field & Co., Saint Louis, Star Mill No. 6. Parts of the mill were not sufficiently strong to have a pressure required. Hence from necessity it has to be run at light pressure, as there was not time enough to procure another mill. It is estimated that not 30 per cent. of the juice was obtained.

"Fifth. Cost of cultivation per acre, $3.

"Sixth. Cost of hauling to the mill and cutting per ton, 50 cents.

"Seventh and eighth. The average per cent. of sucrose and glucose, about 15 per cent., sucrose being from 10 to 14 per cent. when first cut. In this connection we refer you to the analyses made by J. I. Donohue, the chemist furnished by the Department of Agriculture, whose report is doubtless now filed in your Department.

"Tenth. The molasses is not yet marketed, but 40 cents is the estimated price per gallon. We have made no effort to make sugar, though the analyses of Mr. Donohue showed the canes to be very rich in crystallizable sugar.

"First frost, October 12, though not sufficient to touch the leaves of the cane.

"First freeze, October 22.

"The cane, except the Link's Hybrid, was ripe as early as the 20th of September, and as early as the 10th contained between 9 and 10 per cent. of sucrose.

"We wish to call your attention particularly to the report of Mr. Donohue, above referred to, with regard to the analysis made by him of our cane after freezing. The remarkable fact appeared that the freezing of ripe cane does not diminish the quantity of crystallizable sugar or deteriorate its quality for molasses. As his report is already in your Department, we will not refer to it further than to suggest careful consideration on this point.

"In the fall of 1883, the canes in this section were killed by frost before the seed was sufficiently ripe to germinate. Though cane has been grown in this section for twenty years, the fall of 1883 was the only one when the cane has not ripened. Our crop of sorghum suffered the common lot and was useless for molasses, as the product was simply "black strap" and would not pay for making. Ten days after the canes were frozen, and we had become satisfied that it could not be made profitably into molasses, we secured the services of Professor Armsby, chemist of the Agricultural College of Wisconsin, to analyze some samples of the juice. Two analyses were made—one from cane which had been cut after it was frozen and piled for a week previous to making the analysis, and the second from cane of the same quality cut just previous to crushing. There was very little difference in the quality of the two tests, showing in each case 8 per cent. of crystallizable sugar and 4½ per cent. of uncrystallizable sugar. These results, as shown by Professor Armsby's analyses, go to show that freezing of green canes as well as ripe cane stops the conversion of the crystallizable sugar in the canes, and in case of the frozen cane, which was not mature, in 1883, it is possible that it could have been profitably worked for sugar when it was valueless for molasses. These facts raise this question for future investigation. If the frozen cane, though frequently thawed, retains without change the crystallizable sugar, whether the sugar-making season in Wisconsin may not be continued throughout the fall and even through the winter, and possibly even short seasons be more favorable for making sugar from sorghum on that account, as it is for making sugar from the beet.

"Yours, truly,

"WILLIAMS & FLYNN.

"Hon. E. A. CARMAN,

"*Acting Commissioner, Agricultural Department,*

"*Washington, D. C.*"

Following is the report of Mr. J. I. Donohue, chemist of the Helena station:

HELENA, WIS., *October* 10, 1884.

Prof. H. W. WILEY,

Chemist Department of Agriculture, Washington, D. C.:

DEAR SIR: I forward to you this day a report of the analyses I have made of sorghum at the factory of Williams & Flynn, Helena, Wis. As you know, this land lies on the left bank of the Wisconsin River, thirty-five miles, by the Chicago, Milwaukee and Saint Paul Railroad, west of Madison, Wis. The soil is sandy, and has not been cultivated before.

The cane, the greater part of which was Early Amber, was grown from seed raised in Kansas. The seed was planted about May 15, 1884, in drills. The cane was too thick in the rows, and the growth was not as large as it would have been if planted in hills, like corn.

Williams & Flynn started their mill September 15, 1884; the cane seed was in the dough, some being quite hard. The mill used expressed only 35 per cent. of the weight of the cane. The juice, as you will see from the analyses, was quite rich in "*total sugars*," the highest being about 16 per cent. and the lowest, from Link's Hybrid, a little over 10 per cent.

The first frost of the season was on the night of October 12, 1884, which in places killed the leaves but did no other damage. The first severe frost of the season was on the night of October 22, 1884—severe enough to form ice one-half inch thick in water in exposed parts. This frost froze the upper joints of the cane and the envelop of the lower ones. October 24 and 25 were freezing nights, and by October 26 the cane was frozen through from top to bottom. In the morning the cane would not crush well, and crushing was delayed until about 10 a. m. The weather at noon generally indicated about 50° F., thawing the cane. The nights were cool, the thermometer standing at 32° F. and a little lower. The juice from the frozen cane was brighter than that from the unfrozen, and quite an amount of the suspended matter would settle out in the receiving tank, which was not the case with the juice from unfrozen cane. I was somewhat surprised at the first results I obtained, giving as high, and in cases higher, per cent. of sucrose in the juice from frozen cane than in the juice from unfrozen cane. Yet except in one or two analyses I have found the juice practically unaltered by freezing.

Crushing was finished on the evening of November 3, and you will see from the analyses of that day that the above is true; however, I will not say that the temperature did not rise at most above 55° F. The sirups, as you will see, are not as light in color as they might be. The first sirup made was quite dark, as you will see from the sample I forward you. This was due to the prolonged heating, the steam-coils used having a common head, and thus the juice would boil at one end of the pan and be quiet at the other. After the mill was run for about three weeks Williams & Flynn put in continuous coils, and were able to reduce the juice in less than one-third of the time it took with the first coils.

We were troubled somewhat with getting a clear juice from defecation; there was a fine suspended matter that would settle about one-half to the bottom of the settling tank and there remain. It was so fine that it would pass through filter paper. I do not know whether this was due to an ingredient of the soil or not. But I think by using "filter presses or bag filters" this could be easily removed.

We used lime and bisulphite of lime in defecating, putting in the bisulphite and then the lime. We boiled to 36° B. and then turned off the steam, 600 gallons of juice making about 110 gallons of sirup. You will see that the juice yielded as well practically as it did by analysis.

TABLE V.—*Raw juices analyzed at the factory of Williams & Flynn.*

Date.	Number.	Specific gravity.	Sucrose.	Reducing sugar.	Date.	Number.	Specific gravity.	Sucrose.	Reducing sugar.
			Per cent.	*Per cent.*				*Per cent.*	*Per cent.*
Sept. 12	1	1.066	8.66	3.20	Oct. 15	24	1.062	9.16	3.40
15	2	1.085	.33	12.22	16	25	1.063	8.66	3.81
17	4	1.072	....	....	17	26	1.052	6.43	....
19	5	1.078	6.18	6.20	18	27	1.059	9.13	3.88
19	6	1.068	11.00	3.86	20	28	1.065	7.73	3.73
22	8	1.068	8.15	4.25	21	29	1.063	7.63	5.00
22	8	1.068	8.15	4.25	*22	30	1.067	9.83	3.61
23	9	1.060	9.12	4.32	25	31	1.073	11.33	3.34
24	10	1.068	7.03	7.09	25	32	1.069	10.66	3.20
27	11	1.076	5.14	9.60	27	33	1.066	1.00	3.56
29	12	1.068	5.40	8.23	27	34	1.060	1.04	3.08
30	13	1.076	2.77	11.95	27	35	1.065	9.60	3 46
Oct. 1	14	1.078	2.94	13.00	28	36	1.060	9.37	3.37
2	15	1.068	3.78	10.20	29	37	1.066	11.65	3.48
3	16	1.058	6.51	6.49	30	38	1.063	8.84	4.46
6	17	1.084	12.52	4.22	31	39	1.069	10.95	3.51
7	18	1.058	7.91	2.67	Nov. 1	40	1.066	11.10	3.88
8	19	1.054	5.90	3.72	1	41	1.065	12.17	3.28
9	20	1.068	8.50	3.38	3	42	1.061	9.66	4.61
10	21	1.064	8.43	3.91	3	43	1.060	9.33	3.25
11	22	1.068	10.27	4.13	3	44	1.062	9.88	4.00
13	22½	1.068	5.13	7.52	4	45	1.079	....	....
14	23	1.066	9.00	3.98					

* Hard freeze. All analyses following were of frozen canes.

TABLE VI.—*Clarified juices, factory of Williams & Flynn.*

Date.	Number.	Specific gravity.	Sucrose.	Reducing sugar.	Date.	Number.	Specific gravity.	Sucrose.	Reducing sugar.
			Per cent.	*Per cent.*				*Per cent.*	*Per cent.*
Sept. 17	4	1.068	7.78	3.77	Oct. 11	22	1.068	11.01	4.11
20	6	1.076	9.66	4.83	13	22½	1.060	9.80	4.65
20	7	1.065	8.87	4.35	14	27	1.059	8.73	3.88
23	9	1.065	9.35	4.25	15	24	1.064	8.93	4.13
24	10	1.063	7.46	....	16	25	1.062	9.05	3.19
27	11	1.068	....	....	17	26	1.066	9.20	3.53
30	13	1.070	2.60	11.86	18	27	1.061	9.43	3.86
Oct. 1	14	1.077	5.60	9.70	20	28	1.058	8.50	4.83
2	15	1.065	5.74	9.07	22	30	1.061	9.99	4.22
3	16	1.063	5.90	7.14	28	36	1.062	9.43	3.41
6	17	1.060	8.81	4.42	29	37	1.063	10.96	3.58
7	18	1.067	8.60	3.44	30	38	1.062	8.70	4.59
8	19	1.046	5.78	3.76	31	39	1.065	Not determined.	3.32
9	20	1.068	9.33	3.48					
10	21	1.062	7.66	3.37	Nov. 3	44	1.063	9.24	4.17

TABLE VII.—*Semi-sirups and sirups from factory of Williams & Flynn.*

Name.	Date.	Number.	Specific gravity.		Sucrose.	Reducing sugar.	Sirups corresponding to preceding.	Serial No.	Ash.	Water.	Reducing sugar.	Sucrose.
			B.°	Density.								
					P. ct.	*P. ct.*			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Semi-sirup.	Sept. 18	4	27.0	1.230	30.5	14.33		2884	1.69	25.01	28.94	31.12
Do.....	Sept. 20	6	29.6	1.266	28.0	13.84	No sample..	(2886)	......	......	......	......
Do.....	Sept. 23	9	....	....	20.33	28.60		2889	1.50	28.58	35.71	27.02
Do.....	Sept. 29	12	17.4	1.138	13.35	12.00		2892	1.52	27.59	44.32	17.65
Do.....	Sept. 30	13	28.2	1.240	8.74	32.80		2893	2.51	26.40	42.61	18.54
Do.....	Oct. 1	14	22.0	1.183	7.91	27.19		2894	1.69	27.05	33.83	23.44
Do.....	Oct. 2	15	24.5	1.208	13.00	21.12		2895	1.80	31.84	28.52	28.81
Do.....	Oct. 4	16	15.4	1.118	3.51	16.70	No sample..	(2896)	......	......	......	......
Do.....	Oct. 6	17	22.3	1.187	19.74	10.50		2897	2.00	26.85	27.54	30.03
Do.....	Oct. 7	18	20.6	1.168	......	12.80	No sample..	(2898)	......	......	......	......
Do.....	Oct. 8	19	14.0	1.108	12.40	5.49		2899	1.79	30.41	14.80	44.68
Do	Oct. 9	20	15.0	1.120	15.60	6.71		2900	1.68	27.90	15.36	44.91
Do. ..	Oct. 10	21	17.4	1.141	19.20	7.57		3901	2.03	24.57	17.16	47.74
Do.....	Oct. 11	22	17.4	1.139	21.66	8.40		3902	1.60	22.44	9.86	54.12
Do.....	Oct. 14	23	16.9	1.132	17.30	8.20		3903	1.42	26.83	23.57	43.15
Do	Oct. 16	25	16.8	1.132	18.40	3.95		3905	1.74	25.38	16.37	49.77
Do.....	Oct. 17	26	17.5	1.141	19.40	7.09		3906	1.49	28.07	14.92	49.55
Do.....	Oct. 18	27	21.7	1.177	21.00	9.90		3907	1.84	31.02	20.07	42.78
Do.....	Oct. 21	29	17.0	1.135	16.57	8.85		3909	1.97	28.80	17.71	50.40
Do.....	Oct. 28	36	27.0	1.233	32.00	11.11		3908	1.98	31.28	14.82	41.31
Do.....	Oct. 30	38	22.7	1.189	23.98	11.80		3910	2.25	26.81	21.16	40.11

NOTES ON PRECEDING TABLES.

Analysis No. 2. Cane cut for three days. Weather warm. Nearly all the sucrose inverted.

Analysis 13. September 30. Juice from canes cut and left in piles for five days. Temperature average 70° F., with foggy nights.

Analysis 14. Part of this cane cut September 24 and part September 26. Rain had fallen twice on this cane, which had been piled together in half ton lots.

(15.) Canes cut September 26 and 27. Weather warm and rainy.

The disastrous effects of cutting cane several days before crushing are exhibited in the above analyses.

(17.) Canes cut October 4. Weather cool, dry, and nights very cool. The state of the weather and the temperature are the active helpers of sucrose inversion. Below 50° F. even sorghum canes can be kept a long time without injury.

(19.) The cane from which this juice was extracted grew on a low piece of land and was late coming up. The seed, however, appeared hard. It was cut on the date of the analysis.

October 22. On this night a hard freeze, followed by severe frosts on the 23d, 24th, and 25th. Temperature at noon did not rise above 50° F.

November 3. The analyses of the juices of canes frozen on the 22d of October and repeatedly thereafter, show but little inversion of the sucrose. As is seen in the foregoing letters of Messrs. Williams & Flynn and Donohue, these observers conclude that freezing does not injure the canes for sugar making. But they have overlooked a very important factor in coming to this conclusion. The freeze of October 22 was not followed by warm or rainy weather. The nights continued cold and the warmest temperature of the day did not rise above 50° F. The keeping of the juices of the cane without loss by inversion or fermentation was due solely to these meteorological conditions. If the warm Indian summer weather, which nearly always follows a late October frost, had supervened, the whole of the cane would have been lost. The only salvation for sorghum cane after a freeze is in a continuation of the cold weather.

The observation that the juices of frozen cane when worked before fermentation sets in are purer and easier to work than those from the unfrozen stalks is in harmony with common experience. Much of the albuminous and coloring matter of the juice is rendered harmless by congelation. In fact, freezing is a better process of depuration for cane juices than boiling, at least for some of the impurities.

In spite of the conviction of Messrs. Williams & Flynn that sorghum sugar can be made profitably in Wisconsin, I am far from being convinced of the justness of that expectation unless, indeed, it be in some small way. In view of the disasters that have overtaken attempts at sorghum sugar making further South I think it would be unwise to encourage like enterprises in regions where at best not more than four weeks of an average milling season can be expected.

SORGHUM IN NEW ENGLAND.

Within a few years much attention has been given to the culture of sorghum in the New England States. In Connecticut, according to the proceedings of the State Board of Agriculture, farmers are finding it profitable to change tobacco for sorghum. At the last meeting of the Connecticut Board of Agriculture Mr. Ellsworth, of Windham, made the following statement: "After growing tobacco for years became disgusted, gave it up, and devoted the land to sorghum growing. I manufactured sirup from the cane, and made 160 gallons per acre last year, which sold readily at 65 cents; cost of manufacture 25 cents. The bagasse makes excellent bedding. I got 25 bushels of seed per acre, which makes capital buckwheat cakes—better than genuine. I am well pleased with this new crop; raise the Amber cane."

In Massachusetts Mr. B. P. Ware was awarded a premium by the New England Agricultural Society for the best acre of sorghum. Following is his description of the growth and yield of the crop:

"I herewith submit a statement of a crop of sorghum entered for the premium offered by your society for the largest crop grown upon an acre of land, cost of production to be considered, the acre entered being a part of a lot containing $1\frac{1}{5}$ acres devoted to this crop. The land having been in grass for the last six years was badly run out, yielding last year less than one ton of hay. In March last three cords of good stable manure was spread on with a Kemp's manure spreader.

"May 26, plowed under the sod and manure seven inches deep, the land having a gravelly subsoil, and such as would be considered good corn land.

"May 30, harrowed it thoroughly and then dragged it smooth, then sowed with a machine, in drills three feet apart, 21.2 quarts of Early Amber sorghum seed, obtained from the Agricultural Department at Washington.

"June 2, applied on the drills 750 pounds Ames animal fertilizer.

"June 13, cultivated between the rows.

"June 27, cultivated the second time.

"July 5, finished hoeing carefully.

"July 8, cultivated the third time.

"July 23, cultivated the fourth time.

"August 12, pulled weeds from the drills, which finished the cultivation of the crop.

"October 13, commenced preparing the crop for the sugar-mill by trimming off the leaves; cutting off the seed tassels; cutting down and bundling up, and loading the carts. The crop for the last six weeks has presented a very beautiful appearance, attracting the attention and admiration of the numerous visitors. Standing on an average ten feet high, showing different shades of green of the stalks and leaves, capped by the rich brown of the seed tassels, waving gracefully in the passing breeze, was a scene of beauty long to be remembered."

Cost of production.

3 cords of stable manure, at $7	$21 00
Spreading the same	1 50
750 pounds of Ames animal fertilizer, at $2	15 00
Applying the same, half day, one man	75
Plowing, with pair horses and one man	4 00
Harrowing thoroughly and dragging, half day	2 25
Sowing seed, 3 hours' work	45

Cultivating 4 times, half day each time, man and horse		$6 00
Hoeing required 4 days' work		6 00
Pulling weeds from rows in August		1 50
Total cost of cultivation of whole lot		58 45
Deduct the proportion of one-fifth of an acre		9 74
Cost of cultivation of the acre		48 71

($1.50 per day is allowed for man and horse.)

The acre of land entered for premium measured 100 feet by 435.6.

		Tons.
The gross product of which was		17.329
Weight of seed-tops	1.375	
Weight of stripped leaves	1.164	
		2.539
Net weight of stripped canes		14.790

SORGHUM IN INDIANA.

The area cultivated in sorghum in Indiana is gradually increasing. No sugar is made in this State except incidentally in sirup making. The quality of the sirup made is improving very rapidly. Lime and sulphur are now used for clarifying the juice to a much larger extent than they were a few years ago.

The local markets for brands of an established reputation continue good, and the profits of such manufacturers are satisfactory.

The general market, however, is unsatisfactory, as indeed it is everywhere. Consumers have grown suspicious of every kind of table sirup, and are willing to pay only such prices as centrifugal molasses and adulterated articles are worth.

Following are analyses of a number of sirups collected for the Department by Mr. A. Chapman, of Madison, Ind.

[From Colfax, Ind., 3914–3921, inclusive.]

Maker.	No.	Ash.	Water.	Reducing sugar.	Sucrose.	Other solids, not sugar.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
W. B. Clark	3914	2.82	27.04	16.84	47.87	5.40
Do	3915	1.68	18.51	11.58	66.81	1.42
Do	3916	2.30	28.55	17.93	46.91	4.31
Do	3917	3.33	27.29	24.93	38.07	4.38
Do	3918	2.62	29.10	15.41	44.76	8.11
Do	3919	2.48	27.93	24.93	35.17	9.49
Do	3920	3.13	24.12	26.49	37.13	9.13
Do	3921	2.48	28.30	21.43	40.91	6.88
George Schneider	3922	1.66	24.37	23.54	43.14	7.29
Frank Lay	3923	2.88	24.48	28.68	35.59	8.37
L. Lowry	3924	3.88	24.67	31.80	30.70	8.95
Henry Porter	3925	1.85	23.62	22.71	43.00	8.84
Do	3926	2.53	22.32	22.41	45.96	6.78
I. Hammer	3927	2.21	24.40	27.32	38.04	9.03
Do	3928	2.27	26.04	24.57	32.70	14.42
James Lyle	3929	3.54	25.72	33.04	26.42	11.28
Do	3930	3.14	20.62	30.43	42.51	3.30
N. B Nickols	3931	2.65	27.07	30.72	28.10	11.46
Do	3932	2.89	30.55	35.67	25.98	4.91
Henry Philips	3933	2.91	21.79	36.57	25.45	13.28

3914. Grown by Jackson Wolf. Black level soil near a slough. Amber cane. Planted June 18, manufactured October 8. Used lime in cold juice until nearly neutral. Manufactured by W. B. Clark. All the samples below from Mr. Clark were clarified with lime.

3915 and 3916. Amber cane. Made by W. B. Clark, Colfax, Ind. Dark gravelly loam soil. Planted

27th May, manufactured September 15. This sample was almost all melada when it reached Washington. 3915 is this melada, and 3916 the molasses on top of it.

3917, 3918, 3920, and 3921 are from barrels of sirup made by Mr. Clark during the grinding season of 1884.

3922. Made by George Schneider, Jefferson County, Ind. Average cane. Manufactured same day cane was cut in continuous pan. No chemicals used. Density of cane juice, 9° B.

3923. Made by Frank Lay, Wirt, Ind. Red Top cane. White flat upland; 162 gallons per acre. Nine heads of seed weighed 3 pounds. Think it a valuable crop for the seed.

3924. Made by L. Lowry, North Madison, Ind. Honduras cane. Grown in limestone soil. No chemicals used. Yield, 122 gallons per acre.

3929 and 3930. Amber; grown and manufactured by James Lyle, Holman, Ind. Flat, wet land. Used lime. Cane poorer this year than usual.

3931. A mixture of several varieties; Oomseana, Imphee, White seed, &c.; such as is grown in this section; all grown on upland.

3932. An Imphee, with short, compact head, grown on old up-clay land, lightly treated with barnyard manure.

OPERATIONS AT LAFAYETTE, IND.

The Lafayette Sugar Company, W. T. Barbee president, C. B. Phelps, secretary and treasurer, and E. W. Deming superintendent, have kindly furnished the Department with the following information:

Arrangements were partially made to secure a complete set of analyses of the products of this company, but unfortunately the chemist engaged for the work was compelled by other duties to resign before much more than a beginning had been made. In the few analyses which were made the average percentage was as follows:

	Raw juice.	Clarified juice.	Semi-sirup.	Sirup.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Sucrose	7.42	7.15	31.82	54.53
Reducing sugar	5.55	3.31	12.18	19.59

OFFICE OF THE LAFAYETTE SUGAR COMPANY,
Lafayette, Ind., December 15, 1884.

DEAR SIR: In obedience to your request for a detailed statement of our work of the past season, the following is placed at your disposal. Total acres of sorghum planted 205, as follows: Early Amber, 181; Link's Hybrid, 15; Honduras, 5; Stewart's Hybrid, 4. Total acres lost by freezing, 62. The early part of the season was quite favorable, but the excessive drought of July, August, and early part of September hastened the maturity of the canes at the expense of the full development of stalk and the saccharine quality. The following table shows the field work, the weights being for topped, unstripped canes:

Fields.	Total acres.	Yield.	Yield per acre.	Total yield of seed.	Yield of seed per acre.
		Tons.		*Bush.*	*Bush.*
Amber, main field	79	558.3	8.45	1,580	20
Amber, small field	45	287.2	6.38	900	20
Honduras field	5	50.0	10.00	177	35.4
Stewart's Hybrid	4	28.0	7.00	72	18
Link's Hybrid	10	67.5	6.75	131	13.1
	143	1,091.0	7.70	2,860	20

Owing to a very favorable fall for growth, the Link's Hybrid did not fully mature. Rainy weather at time of thrashing and imperfect machinery reduced the above average yield of seed 5 bushels per acre. The following table is an itemized account of expenditurés on the 143 acres, leaving entirely out of the account the 62 acres not worked.

Items.	Total cost 143 acres.	Cost per acre.	Cost per ton.	Cost per gallon in cents.	Actual cost for work.*	Actual cost for manufacturing.
	Col. A.	Col. B.	Col. C.	Col. D.	Col. E.	Col. F.
General expense	$120 90	$0. 846	$0. 111	. 0756	....	....
Fertilizer	136 13	. 952	. 125	. 8503	....	....
Plowing:						
Manual labor	×159 30	1. 114	. 146	. 9950	$109 15	....
Teams	×41 61	. 291	. 039	. 2600	27 06	....
Planting:						
Manual labor	×34 60	. 245	. 034	. 2160	22 80	....
Teams	×12 72	. 089	. 012	. 0790	12 27	....
Hoeing	×244 10	1. 708	. 220	1. 5250	167 40	....
Cultivating:						
Manual labor	×187 61	1. 312	. 172	1. 1721	125 66	....
Teams	×104 96	. 734	. 097	. 6560	69 56	....
Harvesting:						
Manual labor	×1, 312 89	9. 181	1. 204	8. 6050	1, 017 89	....
Teams	×101 60	. 710	. 093	. 6350	78 00	....
Manufacturing	×944 99	6. 609	. 866	5. 9060	....	$729 39
Rent	572 00	4. 000	. 525	3. 5750	572 00	....
Fuel	414 21	2. 897	. 379	2. 5780	....	414 21
Seed	73 21	. 502	. 067	. 4570	73 21	....
Barrel	259 50	1. 815	. 238	1. 6210	....	259 50
Total	4, 720 40	33. 000	4. 328	29. 8860	2, 275 00	1, 403 10

*Not including $826 for salaries.

To amounts marked thus × in column A have been added their proportion of $826, salaries of officers during the period of that work. In column E and F the proportions of the above amount have been omitted and the actual cash separated into two accounts. Farm work and manufacturing, which, if carried out as preceding figures, would be: Total farm work, $2,275; per acre, $15.91; per ton, $2.08.5; per gallon, 14.218 cents. Total manufacturing, $1,403.10; per acre, $9.812; per ton, $1.286; per gallon, 8.769 cents. Total actual cost farming and manufacturing, $3,678.10; per acre, $25.722; per ton, $3.371; per gallon, 22.987 cents.

Made no sugar; method of manufacture same as in Louisiana, using lime and sulphur; density of juice, 6.5 to 8 Baumé; yield of sirup, 14.8 gallons per ton, or 118.4 gallons per acre; selling price of molasses, 30 to 35 cents; length of working season, six weeks; first frost, October 7—no damage done; first freeze, October 13, destroying the standing canes. The item "manufacturing" includes hauling the bagasse into the fields, where it is immediately burned. Owing to cane being badly lodged, expense of harvesting was increased one-third at least. It is the intention to work up at least a small portion of our seed into flour, that shall be used as a substitute for buckwheat. The Lafayette Sugar Company is a stock company of $20,000 invested capital, devoted as yet exclusively to the manufacture of molasses, raising their own crop, and fitted with all the appliances common to Louisiana plantations.

Very respectfully, yours,

E. W. DEMING,
Superintendent.

E. A. CARMAN,
Acting Commissioner of Agriculture,
Washington, D. C.

The foregoing is a most valuable contribution to sorghum literature. In no other case have I been able to secure so full and accurate a statement of expenses connected with sorghum raising.

Having made a personal inspection of the cultivation and manufacture of sorghum by the Lafayette Company, I can say that it is accomplished at as little expense as in any other portion of the country. Yet it is seen that with every economy of labor the actual cost of making the sirup is nearly 30 cents a gallon.

This is more than the sirup would bring if forced on the market. Since receiving Mr. Deming's letter I have learned that the company has sold a part of its seed for 60 cents per bushel. With the help of this it appears that the season's work will be attended with no financial loss if the sirup brings 30 cents per gallon.

The excellent method which the company follows of keeping itemized accounts of every expense is to be commended to sugar growers the country over.

Only by such methods can we hope soon to reach a true economic solution of the sugar problem.

SORGHUM IN WISCONSIN, MINNESOTA, IOWA, AND TENNESSEE.

Report of A. J. Decker, Special Agent Department of Agriculture.

Hon. GEO. B. LORING,
Commissioner of Agriculture:

I hereby submit a report of my visit of inspection of sorghum factories, made in compliance to your instructions of August last, to visit those factories to which the awards were paid. Also, a subsequent order, to visit certain other factories and make a careful investigation of the sorghum sugar industry.

It being several weeks past the usual time of beginning work in the more southern localities where the factories were located, I started September 1, 1884. My first call was at Champaign, Ill.; next, to Edwardsville, Ill., but neither of these factories had started, and I went to Kansas.

HUTCHINSON SUGAR WORKS.

This factory is one of the best equipped in the country, and under the management of one of the most successful operators in producing sorghum sugar, and the measure of success attained would seem to be a fair estimate of the present success of the sugar industry from the most favorable conditions.

The buildings are of stone and brick, with solid foundations, and built in the best manner, calculated to stand the strain of heavy work.

The machinery is complete, and of the most approved patterns. An 8-foot vacuum pan, 8 char filters, char kiln, 4 defecators, each holding 600 gallons; 2 large copper evaporators, and 1 filter press for utilizing the skimmings.

The graining room is well finished, and heated by steam, and supplied with 40 sugar wagons holding each 1 ton of melada.

The mill will supply 5 tons of juice per hour, and capacity of steam power to do the evaporating readily.

In a separate building there is an oven for superheating the steam and a large vacuum evaporator built of brick.

This factory was built and operated by a learned chemist, having high scholarly attainments, and his calculations gave the exact amount of sugar that would be produced. But his calculations were at fault somewhere, for the season closed without developing a single pound of sugar.

The next season, 1883, the services of Prof. Magnus Swenson, of the Wisconsin University, was secured as superintendent, he having been very successful in his work of producing sugar from sorghum, having produced 997 pounds from a single acre of ground, the largest amount having been produced by any one, and having received one of the awards for experiments in producing sugar from sorghum. The success of this factory was awaited with considerable interest.

The result of this season's work was 200,000 pounds of sugar.

This was heralded by Kansas speculators as the solution of the sugar question and the great future of Kansas as a great sugar State. The railroads of Kansas sent samples of the sugar in every direction as an advertising medium.

But the facts were that the cost of production was far in advance of the amounts received for the sugar, and the obligations of the company not being met, the company became bankrupt, and Professor Swenson having become a member of the company, placing all his savings up to this time in the concern, and not having drawn his salary, found himself without a dollar.

The property not being suitable for other purposes, another effort was decided upon, and Professor Swenson placed in the position of superintendent for the season of 1884.

That season has now passed, and the result shows 250,000 pounds of sugar, but again at a heavy loss in cost of production, and this factory will probably not be run again for making sugar from sorghum.

THE KANSAS SUGAR COMPANY.

Their works are located at Sterling, Kans.

This mill was built and operated by an experienced southern boiler, but without success in producing any quantity of sugar.

In 1883 a new company was formed, with Professor Scovell, of the Champaign Sugar Company. His work shows great skill in reducing the cost of production at every possible point, yet the company has met with a heavy loss for the season's operations. One hundred and seventy-five thousand pounds of sugar was made; much of the cane was not worked for sugar, but for a light sirup. Much of this sirup has been sold with more satisfactory returns than that worked for sugar. The complete returns cannot now be given, as much of the product is yet on hand, but Professor Scovell says the loss will be heavy, largely owing to the extremely low price of sugar, and that the factory cannot run again unless the market improves greatly.

The Champaign Sugar Company is composed of members who also constitute the Kansas Sugar Company, and their loss here has been much greater than at Sterling.

At the office of the president of the company I was told that they had made 100,000 pounds of sugar, but would never make any more—that they had sunk all the money that they put into it, and had no more to sink.

William Fraser, located at Esofea, Vernon County, Wis., has a good mill of a capacity of 400 gallons of sirup per day. He has no machinery especially adapted for sugar making except a small centrifugal, but is a careful operator and has succeeded in producing about 1,000 pounds of sugar the past season. This has been done by gathering the granulation from the bottoms of his sirup tanks. He has made about 5,000 gallons of sirup, which he has sold to the home market for 40 cents per gallon. This makes his factory pay a fair profit on the investment.

Joseph Porter, of Red Wing, Minn., has a model factory for neatness and ingenuity of its machinery and its arrangements; he works entirely by steam, and runs his juice in a thin stream over pipes filled with live steam and has had some fair crystallization in his tanks. He has made 2,500 pounds of sugar the past season and 6,000 gallons of sirup; 2,000 pounds of his sugar was sent to New Orleans Exposition as an exhibit of Minnesota sugar product. He says his mill is a paying investment, getting from 35 to 50 cents per gallon for his sirup.

Clinton Bozarth & Sons, Cedar Falls, Iowa, have one of the best sorghum factories in the country. He has been in the business for many years and has made considerable sugar, one season making 15,000 pounds, but for two years past has worked to avoid crystallization; he says there is money in sirup making, but none in sugar making; he has made 28,000 gallons of sirup for the season of 1884, and has sold 14,000 gallons of it at an average of 40 cents per gallon. He says it is a good business and pays a good profit.

John Stuart, Traer, Iowa, has for years been trying to invent some process by which evaporation could be produced artificially by the same principle that natural evaporation is produced. His conclusions were that the earth becoming heated the moisture was drawn to the surface, and the air being colder was brought in contact with the earth and immediately becoming heated and expanded, and the expansion absorbed the moisture, which was carried off in the form of vapor with the rarefied air. To accomplish this he has made a reel having four arms at either end; attached to these arms extending from one end to the other is a bucket having a row of small holes in the bottom, and when the wheel is turned the bucket strikes the juice inverted, and the pressure of the bucket being forced into the juice forces the air through the small holes, which becoming expanded absorbs the moisture and rises to the surface, where it escapes, carrying the moisture with it.

By this plan he reduces the temperature of the juice to 150° F., and still evaporation continues equally as fast. This he claims takes the place of the vacuum pan and is of trifling expense. The result of his work this season was made from seven acres of cane, producing seven tons of cane per acre, from which he produced 4,900 pounds of sugar. This sugar was good, large, even crystals, but not well cleansed, and would probably lose one-fourth in proper work in making it dry.

This result may be an exception and prove nothing, yet I suggest that it may be worthy of further notice.

DRUMMOND BROTHERS, WARRENSBURG, MO.

They have made sirup successfully, but lost money at every attempt to make sugar. They have sold their old mill and fixtures, and are preparing to build a better mill, but will not try to make sugar.

BELCHER AND SWARTZ, EDWARDSVILLE, ILL.

This firm stands among the first in fine ability as operators, having attained the highest point of success in both sugar and sirup, though no effort has been made for several years to make sugar. They have made the past season eleven thousand gallons of a very fine grade of sirup which brings them fifty cents per gallon in kegs. They say it pays to make good sirup, but have poor hopes that making sugar from sorghum can be made a paying business.

FRANKLIN SUGAR COMPANY, FRANKLIN, TENN.

This company shows a record of the most glaring blunders and mismanagement and is now in the hands of a receiver.

Having the finest natural advantages in the growing of cane, by proper selection of varieties they have a long season to run. The richness of the cane was from 8° to 13° Baumé, and the amount per acre from 8 to 17 tons. The superintendent told me he had a single stalk of orange cane that weighed, with the leaves and seed taken off, 9 pounds.

The capital stock of the company was fifty thousand dollars, twenty thousand being in auxiliaries located in different localities on the line of the railroads, and thirty thousand in the central factory. The machinery was placed in the factory and the estimate of the capacity of the makers depended upon without further investigation. The result was that it would not reach one-half the capacity claimed and the cane immediately became piled in stacks round the factory awaiting the mill. Contracts had been made with parties to bring to the mill a certain amount of cane each day, and the auxiliaries began sending in semi-sirup that could not be taken care of.

The only man capable of making sugar or sirup was C. C. Barnes, a young chemist from Champaign University. His first run gave good evidence of his ability, as sugar was boiled to grain in the vacuum pan, producing large crystals and good quantity, but each day the sugar became less until at the end of one week no trace of sugar could be found, and in mortification he left without notice and has not yet been heard from.

The rest of the season was spent trying to make sirup, but no record of the work could be obtained.

Nelson Maltby, Geneva, Ohio. His mill has been rebuilt and in good shape; makes sirup for his patrons, but makes no effort to make sugar. He made six thousand gallons of sirup the past season, mostly for the farmers. In connection with his sirup making he has a cider mill and makes apple jelly after his grinding season.

Jefferson Sugar Company, Jefferson, Ohio, has done but little work the past season, and is moving its works to Tennessee.

The amount of sugar made from sorghum may be safely based upon this report:

Hutchinson Sugar Company, Kans	250,000
Kansas Sugar Company, Kans	175,000
Champaign, Ill	100,000
John Stuart, Traer, Iowa	4,900
Joseph Porter, Red Wing, Minn	2,500
William Fraser, Esofea, Wis	1,000
Daniel Root, Hudson, Mich	3,000
Rio Grande (reported)	385,000

At Ottawa, Kans., a few thousand pounds of sugar were, made but the amount not reported, and in a number of other places small amounts were made; so I think the total crop may be safely placed at one million pounds.

Respectfully submitted.

A. J. DECKER,
Special Agent.

HUTCHINSON, KANS.

In response to inquiries from the Commissioner of Agriculture, Prof. M. Swenson, superintendent of the Hutchinson Sugar Works, sent the following letter:

Further information concerning this company will be found in Mr. Decker's report, p. —. Also in the report of Mr. Cowgill, p. —.

HUTCHINSON, KANS., *December* 12, 1884.

The Hon. COMMISSIONER OF AGRICULTURE, *Washington, D. C.:*

In response to your letter of the 12th ultimo, addressed to Sorghum Sugar Company of this place, we reply as follows:

1. Acres of cane planted, 900; of amber and orange each 375; Link's hybrid, 150.

2. Yield per acre, varieties not separated, 7 tons of topped cane.

3. Yield of sirup per ton of cane previous to September 5, 12 gallons. After September 5 the yield was of sugar 47 pounds per ton, and of molasses 7 gallons.

4. Used one three-roll crusher.

5. Cost of planting and cultivation per acre, $5.

6. Cost of harvesting and delivering per ton, 75 cents.

7. Average density of juice, 8.50° Baumé.

8. Average per cent. of sucrose estimated between 10 and 10.5; the analyses not being made uniformly throughout the season.

9. Average per cent. of glucose, 4.1.

10. } 11. } Good, not on market, on account of low prices.

12. Length of season, 11 weeks.

13. First frost, October 21.

14. First freeze, October 23.

We would call your attention to the fact that from this limited amount of ground we have produced over a quarter of a million pounds of sugar, a sample of which accompanies this letter, and about 45,000 gallons of sirup; furnishing employment to 20 men and teams for an average of 140 days, and to 50 men for an average of 80 days. Under the present low prices the sorghum sugar industry is barely able to hold its own, but if under favorable legislation prices can be advanced from ½ cent to one cent per pound, or if State or national aid to a like amount can be obtained for a limited time, till the best machinery can be procured and the methods of manufacture perfected, under these conditions we may safely hope to see the sorghum sugar industry established on a sound basis, and adding very materially to the wealth and prosperity of the country. We hope the influence of your department will be used with Congress to prevent any further fall in the price of sugar by unfavorable legislation.

Any assistance or information that we can render will be cheerfully given.

Yours, respectfully,

M. SWENSON,
Superintendent Hutchinson Sugar Works.

SORGHUM IN KANSAS.

In addition to the reports of Mr. A. J. Decker and Prof. M. Swenson, Mr. E. B. Cowgill, special agent of the department for collecting statistics of the sorghum industry in Kansas, has furnished some valuable data. From these the following items have been selected:

SORGHUM FOR FORAGE IN WESTERN KANSAS.

Investigation of the subject of sorghum as feed for stock discloses the fact that there is considerable difference of opinion among stock men as to the advantage of its use. Some find that all animals thrive upon it, and estimate its value to exceed that of the best meadow hay; they find no deleterious effects from feeding it, but that it keeps the animals in fine physical condition, and that it is an excellent fat-producing feed. Others report that it injures animals to which it is fed freely, and condemn it as an unwholesome feed.

An able discussion of the subject by several prominent stock men was published in the Kansas Cowboy, a stock journal now published at Dodge City. This discussion clearly establishes the fact that the amber cane, when properly cured, constitutes the most valuable winter feed that can be produced in Western Kansas for cattle, sheep, and horses, and that the deleterious effects noted by some feeders resulted from badly handled and soured cane.

That experience has proven the value of this as a forage crop is also attested by the fact that in the western third of the State the acreage has increased largely. The most important fact, however, which has been clearly demonstrated by the experience of those who produce sorghum for forage purposes, is that it is a sure crop in the most arid portions of the State. In all the discussion of the subject this is undisputed, and is either claimed or admitted by every writer or feeder.

In the Far West two methods of sowing are pursued. The first is to sow, as for the production of cane for the mill, in rows about three and a half feet apart, putting the seed from four to eight inches apart in the row. The ground is then cultivated as when planted in corn. The second method is to sow broadcast, or with a wheat drill, and omit all subsequent cultivation. The cane in either case is cut just before the seed becomes ripe. The large cane grown in rows is better if shocked like corn, and may be fed safely at least until the first of January. Later in the season the juice sometimes sours to such an extent as to require care in feeding. The cane sown broadcast is cut and cured like hay, and is fed safely at any time. That cultivated in rows endures drought better than that sown broadcast.

The successful cultivation of sorghum for forage on the semi-arid lands points to the probable extension of the sugar industry over those lands which are now used almost exclusively as ranges for cattle.

TEMPERATURE.

The growing season of Kansas opens early in April. The rise in temperature with the opening spring is accompanied by the increasing rainfall. The light soils are quickly warmed, and seeds, if sound when planted, are almost sure to germinate and grow rapidly. The difference of mean temperature in the cereal portions of the State is not great. In the south central region, the season opens a little earlier and closes a little later than in the northern and western parts. The summer heats are much the same all over the State.

The mean temperatures for each month for the four stations located respectively at Leavenworth, on the Missouri River, Holton, Wellington, and Dodge City, represent very fairly the mean of the State except in the northwestern portions, where no records are available. They show a good growing season of sufficient length to mature most varieties of sorghum, and give a working season of considerable length.

The maximum temperatures run high, but no injury to sorghum cane has ever been observed on account of these high temperatures.

The minimum temperatures of the months in which the growth of sorghum takes place are sufficiently high to sustain a rapid growth.

The most important consideration is, however, the record of minimum temperature of the working season. Cane may be produced in many localities in the country with great facility and in perfection, and could be made profitable, were not the working season cut short, by the early freezing of the cane.

In Kansas the freezing point is scarcely ever reached during September, but generally comes in October, while hard freezing occurs first in November, except in very unusual seasons.

Tables of minimum temperatures for each day in October and November, during the seasons of 1880 to 1884 inclusive, are presented. Less difference than might be expected exists in the time at which freezing weather commences at the several stations. The station at Dodge City, in the southwestern part of the State, has a much greater altitude than that at Leavenworth, while the latter station is considerably farther north. Freezing weather occurs rather earlier at Dodge City than at Leavenworth. It might have been expected that Wellington, situated at a medium altitude near the southern boundary of the State, would enjoy a longer immunity from frost than the station at Holton, in the second tier of counties from the northern boundary. But the records fail to show such advantage. The want of records in the northwestern part of the State renders it impossible to include that section in this discussion.

So far as appears from observations thus far recorded, no portion of the State has an advantage over another in the favorableness of its temperature, although it is a point of common observation that crops mature earlier in the southern than in the northern counties.

Other conditions, therefore, than those of temperature thus far observed must determine the part of the State best adapted to the sorghum-sugar industry.

NORTHERN LIMITS OF THE CANE BELT.

Reports from growers in all parts of the State assert that the several varieties mature wherever planted. The northern limit of the cane belt is therefore north of the northern boundary of Kansas. The southern boundary of the cane belt is quite as surely south of the southern boundary of the State.

After cane has matured a light frost does it no harm. It is uninjured until the temperature goes so low as to freeze through the outer shell and burst the cells containing the juice. A lower temperature is required to injure the large late varieties than the early amber. This results from the thick shell and the heavy protecting sheath of the large varieties.

PART OF KANSAS BEST ADAPTED TO GROWING CANE.

This depends upon the several considerations of soil, rainfall, and temperature, and it may be found to have also a relation to the facility with which irrigation may be effected.

The central portion of the State has thus far been selected by those who have erected large works, and the Arkansas River bottom lands have had the preference. These lands have a loose, sandy soil underlaid at a depth of a few feet by gravelly subsoil. The content of vegetable matter is small. The content of such soluble mineral salts as are taken up by cane is so large as to perceptibly increase the amount of settlings in defecation over those from canes grown on Illinois soils.

The tonnage of cane grown on these Arkansas valley soils increases and its quality improves after a series of crops have been produced on a given field.

Other portions of Kansas may be found equally well adapted to the growth of cane, and it is probable that most localities in the eastern two-thirds of the State will be found to possess the requisite advantages for profitable prosecution of the sugar industry. There is, however, ample room in the central region, where favorable conditions are known to exist, for an immense development.

Table showing number of acres cultivated in sorghum, winter wheat, and corn in counties of Kansas traversed by meridians 95, 96, 97, 98, 99, 100, *and* 101, *respectively; also averages per Congressional township on said meridians in* 1883.

	102°	101°	100°	99°	98°	97°	96°	95°
Sorghum, total	......	793	21, 649	24, 599	16, 150	5, 009	3, 368	3, 295
Sorghum, township average	......	3. 10	97. 96	126. 15	62. 09	34. 51	24. 23	26. 36
Winter wheat, total	......	1, 333	13, 170	162, 022	172, 092	146, 831	71, 144	165, 382
Winter wheat, township average	......	5. 29	59. 55	830. 88	915. 55	1, 012. 63	511. 80	132. 25
Corn, total	......	2, 792	38, 625	216, 116	439, 642	495, 905	612, 694	602, 016
Corn, township average	......	11. 10	174. 77	1, 057. 00	2, 363. 67	3, 420. 04	4, 407. 88	4, 816. 26

Meteorology of Kansas—precipitation.

LEAVENWORTH.

[About Lat. 39° 20′, Long. 95°.]

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Averages	1. 35	1. 60	2. 39	3. 56	5. 07	5. 89	4. 79	3. 20	3. 10	3. 36	2. 57	1. 74	38. 49
1883	0. 75	2. 92	1. 05	0. 97	7. 33	10. 84	3. 58	1. 95	1. 57	8. 31	2. 02	0. 65	41. 94

EMPORIA.

[About Lat. 38° 28′, Long. 96° 17′.]

Averages	......	......	......	......	......	......	......	......	......	......	......	......	33. 69
1883	0. 18	0. 89	1. 90	1. 62	8. 90	6. 29	3. 73	2. 14	1. 25	6. 74	0. 30	1. 42	35. 40

WELLINGTON.

[About Lat. 37° 41′, Long. 97° 30′.]

Averages	0. 53	2. 00	1. 61	2. 10	7. 70	4. 05	4. 70	2. 01	5. 26	4. 00	1. 13	.72	35. 81
1883	0. 37	3. 73	1. 14	2. 06	6. 53	5. 34	6. 64	3. 51	4. 65	4. 94	0. 18	1. 40	40. 49

DODGE CITY.

[About Lat. 37° 45′, Long. 100°.]

Averages	0. 28	0. 58	0. 70	1. 25	4. 33	2. 55	3. 06	3. 30	1. 16	1. 33	0. 64	0. 68	20. 09
1883	0. 44	1. 42	0. 42	2. 40	5. 41	4. 31	2. 61	5. 66	1. 32	3. 32	0. 12	1. 07	28. 50

There is no serious diminution of moisture between the eastern line and the center of the State, longitude 98° 30′. As shown by the accompanying table, the precipitation at Wellington, longitude 97° 30′, is only 2.68 inches less than at Leavenworth, and is 2.12 inches greater than at Emporia, longitude 36° 17′.

The rainfall of 1883 in all parts of the State was above the mean.

It should be observed that most of the precipitation of the year occurs during the six growing months.

At Leavenworth the sum of the means for May, June, July, August, September, and October is 25.41 inches, nearly two-thirds of the annual mean. At Wellington the sum of the means for the six growing months is 27.72 inches, being 2.31 inches greater than for the same months at Leavenworth and more than three-fourths of the annual mean for Wellington. At Dodge City the sum of the means for the six growing months is 16.73 inches, or more than three-fourths of the total annual mean for that place.

In the eastern half of Kansas the moisture of the growing months is ample for most cultivated crops. It is abundant for sorghum over a considerable but not well-defined area west of the center. It is claimed by those who have cultivated sorghum as far west as the one hundredth meridian that the rainfall is there ample. It is true that large amounts of sorghum have been produced in the western frontier settlements, but whether the saccharine qualities of the cane were well developed so far out on the dry plains has never been determined by either experience or analysis:

Maximum temperature for each month—Years in which they occurred.

Month.	Leavenworth.		Holton.		Wellington.		Dodge City.	
	Year.	Temperature.	Year.	Temperature.	Year.	Temperature.	Year.	Temperature.
		°		°		°		°
January	1876	65	1882	60	1882	60	1876	70
February	1876	73	1882	71	1882	70	1876	78
March	1879	84	1882	79	1881	82	1879	89
April	1883	86.5	1883	93	1881	91	1880	92
May	1874, 1875	94	1883	88	1881	89	1880	98
June	1875	99	1882	99	1882	99	1880	102
July	1874	104	1881	104	1881	104	1876	108
August	1874	107	1881	110	1881	105	1881	101.6
September	1882	101	1882	104	1882	101	1881	99.3
October	1874	89	1881	88	1881	95	1883	90
November	1874	77	1882	80	1882	79	1875	83
December	1875	72	1881	65	1880	67	1875	73

Minimum temperature for each month—Years in which they occurred.

Month.	Leavenworth.		Holton.		Wellington.		Dodge City.	
	Year.	Temperature.	Year.	Temperature.	Year.	Temperature.	Year.	Temperature.
		°		°		°		°
January	1873	−29	1881, 1882	−18	1881	−14	1883	−20
February	1883	−12	1883	−20	1883	−15.5	1883	−20
March	1876	− 2	1881	10	1882	12	1880	− 8
April	1881	13	1881	13	1881	15	1881	13
May	1875	31	1882	42	1882	34	1877	34
June	1882	45	1883	48	1882	47	1879	40
July	1882	53.5	1882	50	1882	51	1877	50
August	1879	52	1883	46	1880	47	1880	50
September	1873	38	1883	37	1881	31	1876	30
October	1873	19	1880	21	1880	22	1878	10
November	1872	Zero.	1880	2	1880	−10	1875	− 1
December	1872	−13	1880	−20	1880	−12	1876	−15

Mean temperatures.

Place.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual mean.
Leavenworth	26.5	32.8	40.8	53.5	65.1	74.0	77.9	96.6	66.8	55.5	39.7	30.7	53.4
Holton	21.5	27.0	39.4	55.0	62.8	74.3	76.2	77.2	67.0	54.5	37.2	29.9	51.8
Wellington	25.1	33.0	42.0	55.1	62.5	71.1	76.1	78.0	67.5	55.5	38.0	32.1	53.0
Dodge City	26 7	33.8	42.1	53.2	63.4	73.1	77.4	75.4	66.9	55.0	38.5	31.6	53.0
Mean	24.95	31.65	41.17	54.2	63.4	73.1	76.9	81.8	67.0	55.1	38.35	31.1	52.8

Minimum temperatures—October.

Day of month.	Leavenworth.				Holton.				Wellington.				Dodge City.			
	1880.	1881.	1882.	1883.	1880.	1881.	1882.	1883.	1880.	1881.	1882.	1883.	1880.	1881.	1882.	1883.
1	58	51	62	51	60	44	65	59	59	55	63	63	50	38	54	54
2	59	64	62	46	64	65	62	48	63	66	58	48	56	59	61	46
3	45	70	62	45	39	74	68	47	43	71	63	50	44	67	62	46
4	39	57	62	48	35	60	65	44	32	68	61	67	36	51	62	46
5	43	52	65	50	50	51	65	49	37	58	64	57	39	49	60	51
6	46	57	66	49	53	58	62	50	43	65	62	47	42	58	57	50
7	48	66	64	61	48	68	60	63	43	70	58	60	49	66	57	60
8	53	63	54	66	53	63	58	70	51	70	55	64	55	54	53	60
9	60	57	48	56	61	54	46	50	53	60	50	58	60	55	47	41
10	60	56	50	54	58	56	51	41	59	60	44	44	46	63	38	43
11	53	62	48	46	49	60	50	48	48	64	50	48	39	65	48	37
12	50	48	57	41	51	48	56	40	45	68	64	42	39	40	49	36
13	52	41	48	44	54	38	50	41	63	42	37	43	49	34	46	38
14	50	45	54	35	50	45	55	28	44	46	47	31	40	38	50	33
15	39	44	56.5	40	35	43	56	40	38	48	61	42	32	38	50	46
16	34	45	45	39	34	44	42	42	29	50	43	48	28	43	36	48
17	31	46	41.5	51	28	46	38	48	25	50	34	55	28	41	34	55
18	30	42	42	45	26	37	44	34	31	40	40	43	28	31	34	40
19	35	39	35	43.5	26	36	32	40	29	32	31	43	32	38	29	39
20	42	40	39.5	34	45	34	41	27	39	37	33	33	42	35	35	32
21	39	52	44	32.5	36	49	47	40	43	52	42	47	36	54	45	42
22	32	53	42	43	29	54	39	40	28	52	42	19	27	46	35	42
23	36	41	39	40.5	35	40	40	40	31	43	37	44	32	36	37	35
24	38	40	40	35	40	37	42	30	43	32	43	44	43	29	43	33
25	50	44	50	35.5	53	44	47	30	56	45	49	31	45	43	39	26
26	42	50	42	34	40	42	40	32	46	51	39	39	38	41	32	36
27	43	59	43	45	42	59	49	44	41	58	41	46	30	48	36	46
28	40	56	49	52	34	56	48	51	24	48	55	57	35	46	43	38
29	36	50	36	48	26	50	34	38	29	42	35	41	42	42	33	34
30	39	46	53	42	37	43	58	34	29	42	63	41	37	33	41	34
31	32	46	44	39.5	21	44	34	31	22	48	44	33	30	43	33	34

THE SUGAR INDUSTRY IN KANSAS IN 1884.

In Kansas the manufacture of sugar from sorghum was carried on during the season of 1884 in factories at Sterling, Hutchinson, and Ottawa.

The factory at Dundee, which made a small amount of sugar in 1883, was not operated this year.

The factory at Sterling was improved since last year by the addition of another crusher of large size and the necessary attachments for submitting the same to a second crushing; by the construction of a railroad in the mill yard and placing cars thereon to receive cane from the farmers' wagons and move it to the side of the carrier; and by various minor modifications for the reduction of the labor of operating the works.

The factory at Hutchinson changed financial management and was greatly improved in this respect. Very little change was made in the plant.

The factory at Ottawa was thoroughly overhauled and made into a well-equipped sugar factory, and placed under efficient management.

REPORT OF THE STERLING WORKS.

Prof. M. A. Scovell, superintendent of the Kansas Sugar Works at Sterling, reports as follows:

1. Acres of cane manufactured about	1,000
2. Tons of cane manufactured	7,106
3. Price paid for cane delivered ... per ton	$2 00
4. Cost of producing cane by the company, not estimating the value of seed in the computation ... per ton	$1 57
5. Seed not yet gathered, but will yield 15 to 30 bushels per acre.	
6. Amount of sugar made ... *pounds	169,000
7. Amount of sirup made ... *gallons	75,000
8. Value of manufacturing plant	$80,000
9. Number of hands employed in manufacturing	50 to 60
10. Wages paid per hour ... cents	15
11. Cost per ton of manufacturing sorghum cane into sugar and sirup	$1 10
12. Amount of juice expressed ... per cent	50 to 60
13. Percentage of feed furnished by bagasse ... per cent	66⅔
14. Date of commencement of milling	Sept. 1
15. Date of close	Oct. 31
16. Working capital required	$20,000

REPORT OF THE HUTCHINSON WORKS.

Prof. M. Swenson, superintendent of the Kansas Sugar Refining Works at Hutchinson, reports as follows:

1. Acres of cane worked (100 for sirup only, 700 for sirup and sugar)	800
2. Tons of cane worked	6,100
3. Amount of seed, estimated ... bushels	10,000
4. Amount of sugar made ... pounds	250,000
5. Amount of sirup made ... gallons	50,000
6. Average yield of sugar per ton of cane worked for sugar ... pounds	47
7. Average yield of sirup per ton of cane ... gallons	7
8. Average yield of sugar per acre ... pounds	357
9. Average yield of sirup per acre ... gallons	53
10. Value of plant	$50,000
11. Number of hands employed in factory during working season, 10 hours per day	22
12. Wages paid ... per day	$1 50
13. Fuel used, coal ... per ton	$5 00
14. Commenced milling	Aug. 22
15. Closed milling	Oct. 30
16. Cost of raising and delivering cane at factory ... per ton	$1 50
17. Amount of juice expressed ... per cent	40
18. Working capital required	$20,000

* The company had orders for sirup which caused the operation of the works for sirup only during the first two weeks of the season. The last two weeks were also devoted to the production of sirup.

REPORT OF THE OTTAWA WORKS.

Mr. W. L. Parkinson, managing director of the Franklin Sugar Works at Ottawa, reports as follows:

1.	Acres of cane manufactured	600
2.	Tons of cane manufactured	6,100
3.	Price paid for cane ... per ton	$2 00
4.	Amount of seed, estimated ... bushels	1,600
5.	Yield of sugar per ton of cane ... pounds	30
6.	Yield of sirup per ton of cane ... gallons	5
7.	Value of plant	$60,000
8.	Number of hands employed, 12 hours per day	75
9.	Wages of hands per hour ... cents	14
10.	Fuel used, coal ... per ton	$3 35
11.	Commenced milling	Sept. 1
12.	Closed milling	Nov. 6
13.	Amount of juice expressed, about ... per cent	40
14.	Working capital required	$20,000

SUMMARY.

1.	Number of factories operating for sugar	3
2.	Capital invested in plant	$190,000 00
3.	Working capital	$60,000 00
4.	Number of hands employed	152
5.	Average daily wages of hands, nearly	$1 50
6.	Amount of sugar made, pounds	602,000
7.	Amount of sirup made, gallons	155,500
8.	Acres of cane worked	2,400
9.	Tons of cane worked	19,300
10.	Value of cane worked	$38,600 00

The sugars have been sold at 5 cents to 6¾ cents per pound wholesale.

The sirups have been sold at 15 cents to 30 cents per gallon wholesale.

PRESERVING CANE IN SILOS.

The experiments of this Bureau last year (Annual Report, 1884, p. 20) showed that sorghum cane could be kept very well in silos. Mr. E. B. Cowgill made some further experiments with siloed cane, with the following results:

Canes kept in silo.—Analyses of juices.

EARLY ORANGE.

Date.	Glucose.	Sucrose.	Other solids.	Name of analyst.	Remarks.
1884.	*Per cent.*	*Per cent.*	*Per cent.*		
Oct. 15	0.95	15.62	4.73	Cowgill	Cane cut yesterday covered with 2 inches of dry earth.
Nov. 15	4.88	10.72	3.90	do	
Nov. 29	4.03	9.45	5.82	do	
Dec. 26	1.19	11.69	4.62	do	
1885.					
Jan. 6	1.60	14.80	2.00	Hart	Part of sample taken from silo December 26, and kept in office of Hutchinson Sugar Works until this date.
Jan. 7	3.20	14.00	4.80	Hart	Expressed juice.
Jan. 9	5.83	8.84		Scovell	Sample taken from opening made, imperfectly closed December 26.
Jan. 12	3.45	12.34	3.81	Hart	Part of sample of January 9.
Jan. 14 or 15	6.84	9.82		Failyer	Part of sample of January 9; per cent. of juice. 44.9.
Jan. 24	4.80	10.85	4.55	Cowgill	186 pounds cane gave 100 pounds juice; 55¾ per cent. on hand crushed.

LINK'S HYBRID.

1884.					
Oct 15	1.16	11.21	5.33	Cowgill	Cane cut and covered with 2 inches of soil.
Nov. 15	1.11	13.02	4.37	....do	
Nov. 29	1.49	12.26	4.83	....do	
Dec. 26	2.72	12.93	2.65	....do	
1885.					
Jan. 4	1.10	15.25	3.94	Swenson	Part of sample taken from silo December 26 and kept in office of Hutchinson Sugar Company until this date.
Jan. 9	5.53	9.73	....	Scovill	Sample taken from opening made and imperfectly closed December 6.
Jan. 12	5.20	12.19	3.51	Hart	Part of sample of January 9.
Jan. 14 or 15	6.65	9.06	....	Failyer	Part of sample of January 9; per cent. juice, 45.5.
Jan. 29	5.49	11.40	2.91	Cowgill	Analysis of small sample with lime to neutral reaction and boiling.
Jan. 30	5.35	11.22	4.23	....do	600 pounds cane gave 312 pounds juice; analysis after defecation.
Feb. 2	11.49	24.10	10.21	....do	Semi-sirup reduced in open fire-pan

Samples of the products of the reduction of juices of the siloed canes were sent here and were found to have the following constitution:

Serial number.	Glucose.	Sucrose.	Water.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent*
3698	9.95	22.76	58.37	.70
3699	21.50	45.13	12 17	5.72
3700	19.16	45.41	22.86	4.63

No. 3698. Semi-sirup made at Sterling, Kans., January 29, 1885, from siloed Link's Hybrid cane.
No. 3699. Melada, from same source.
No. 3700. Melada from early Orange cane, as above.

OPERATIONS AT EDWARDSVILLE, ILL.

The Oak Hill refinery at Edwardsville is the model sorghum factory of Illinois. Mr. Belcher, the president, and Mr. Schwarz, the superintendent, have both had large experience in sugar making and refining, and the product of this factory always brings the best price in the market.

The following interesting extract concerning the value of sorghum as a forage crop is taken from a letter published by Mr. Schwarz in the Rural World, of Saint Louis:

"EDITOR RURAL WORLD: I was just thinking of how little the value of sorghum is understood and appreciated in this latitude as a forage plant. When I was in Garden City, Kans., last September, I found hundreds of acres raised for the purpose of feeding stock alone—in fact more acres than there were in corn. I saw pens full of Berkshire hogs, fat enough for the butcher, that they assured me had been fed on nothing else but sorghum, fresh from the field, and it is considered of more value per acre than corn for that purpose. A great deal was already cut, and there was a second growth covering the stubble about 18 inches high. It is there mostly sown broadcast or drilled, sometimes amber and orange mixed together. Cattle and sheep are fed on it all the time, the same as hogs, from the time it begins to head out.

"In this latitude, where we can only afford the seed for stock, it amounts to more than many have any idea of. I have this season made a careful estimate of the yield of seed per ton of different varieties, and it has surprised me. As we weigh all our cane it was little trouble to do so, and as we are just through thrashing it, I am able to send you correct figures. The estimate as you see is made on unstripped cane, which is considered to be 1,800 pounds of clean cane, and 200 pounds of blades per ton, or 10 per cent. difference; see statement.

Statement.

Varieties.	Yield of cane per acre unstripped in tons.	Seed per acre in bushels by measure.	Per ton of unstripped cane.	Weight of seed per bushel in pounds.
Early Amber	10	20	2	62
Stewart Hybrid	8½	25	3	50
Improved Early Orange	12	48	4	62
Link's Hybrid	11	33	3	60
Early Orange	10	30	3	60
Kansas or Texas Orange	9	27	3	57
Honduras	11	33	3	45

"This is by measure of clean seed from the machine. The tailings or screenings are not included, and would for feed add 5 per cent. more to the above. I have fed my milch cows on this for some time, ground up coarse, and they seem to like it as well as corn meal.

"My improved Early Orange, as you see, made 48 bushels to the acre, and weighing 62 pounds to the bushel. It is well for farmers to consider this at the present low price of wheat, when more stock becomes a necessity for profit and by requiring more feed and afford also a rotation from corn to something else."

Mr. George C. W. Belcher, president of the company, has kindly furnished the following information:

"In reply to your esteemed favor of November 12, 1884, we regret to say that we have not at hand anything like complete answers to the questions therein obtained, and we have hesitated much about replying because of the meagerness of the data which we are able to give.

"Most of our answers are estimated. Our books only show the pounds of cane that were received (all of which were rolled) and the gallons of juice and sirup obtained.

"As far as we know, the following returns are correct:

"Average in sorghum, between 90 and 100 acres (estimated).

"Pounds of cane worked, received, and rolled altogether, 106,490 pounds stripped cane and 1,484,070 pounds unstripped cane. Total, 1,590,560 pounds cane. This yielded us 75,400 gallons juice, whence we obtained 10,109 gallons sirup.

"On total tonnage this equals 12.71 gallons per ton. Deducting 10 per cent. from weight of unstripped cane, it would equal 14.02 gallons per ton of unstripped cane. * * * The sugar has not been estimated. We dry in centrifugal machine all the sugar settling in our tanks. We have sold one or two barrels this year, and have more on hand.

"Cost of planting and cultivating, $8 per acre. This includes $3 per acre for rent of land.

"Cost of harvesting and delivering at mill per ton, on a basis of 10 tons per acre, 50 cents per ton, or $5 per acre.

"Sugar sold at 5 cents per pound by the single barrel.

"Sirup sold at 45 cents per gallon by the single barrel. Large lots at wholesale sold at 36 to 39 cents per gallon. Some sold at less.

"Length of working season, fully two months.

"First severe frost during the week beginning October 19."

SORGHUM SUGAR FOR CONFECTIONS.

Mr. Charles Hamlin, of Lafayette, Ind., made sixty varieties of candies for the Department for exhibition at New Orleans, using sorghum sugar and the usual amounts of glucose, flavoring and coloring matters.

The samples were highly esteemed by all who tried them.

Of the goods Mr. Hamlin writes: "We were agreeably surprised with the result. We, of course, were compelled to experiment, since the nature of the sugar was quite different from that which we were in the habit of working. It made beautiful work. It worked better, I think, than any sugar we can get. We have sent an order on our own account for 13 barrels, since we prefer it in some respects to anything we can get. When properly made we think it would be the best sugar for confectioner's use."

This coming from a practical confectioner of long experience is a high indorsement of the sorghum sugar for this use.

HOME SUGAR MAKING.

In discussing the future of this industry the question is still asked, "Cannot the small farmer make his own sugar?" This question has already been answered in the negative by this Bureau,* but should there be any prospect of this result I shall be glad to welcome and proclaim it.

During the year two plans have been suggested and put into operation, proposing to evaporate the saccharine juices at a low temperature without using the expensive vacuum pan.

Mr. Decker has noted in his report the apparatus of Mr. John Stuart, of Traer, Iowa, and the results obtained therefrom. Quite a quantity of raw sugar has been made by this method, which, while not suitable in color and purity for general use, is yet useful for many of the purposes for which sugar is employed.

*See Bulletin No. 3, p. 27.

The apparatus of Mr. Stuart is the simplest form of applying air evaporation with which I am acquainted. It would be unwise, however, to assume that the difficulty of making sugar in a small way has been overcome because it has thus been made for one season. But the result of this work is sufficient to encourage further experiment, especially when it is remembered that the apparatus is inexpensive and easily constructed.

DESCRIPTION OF MACHINE BY MR. JOHN STUART.

"My improvement consists in the combination with an evaporating pan of the Jamaica or open-pan class of a reel provided with a plurality of concave blades for the purpose of forcing currents of air through the solution, distributing the air in small globules and agitating the same.

"In the annexed drawing, which shows one practical way of carrying out my invention, Fig. 17, represents a perspective view of an open pan and a revolving reel embodying my improvements.

"In the accompanying drawing, A represents an open pan, made of copper or other suitable material. (I prefer a flat bottom to a circular one.) In this example the furnace is placed under the pan, and is

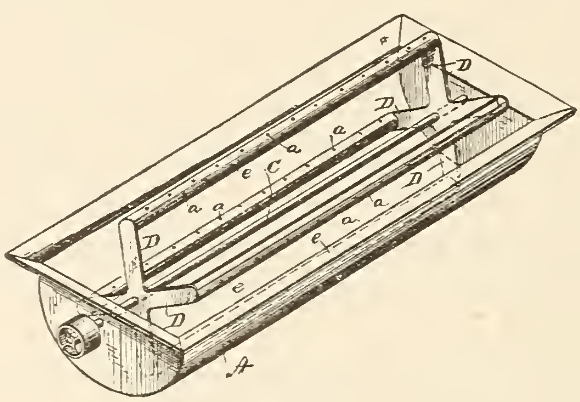


Fig. 17.

heated by direct heat; or it may be heated by means of steam or hot-air pipes suitably arranged within or around the pan. Preference, however, is given either to the steam or hot air as the heating agents to be employed. To the ends of the pan are suitably formed or secured journal bearings, to receive and support the ends of the shaft C, passed longitudinally through the pan. This shaft C is provided with two or more arms, D, at or near each end within the pan. To the outer ends of these arms are blades, E, preferably shaped concavo-convex so as to present the concave portion downward, substantially as shown. These blades are perforated, as indicated by *a*, for the purpose hereinafter stated. To the end of the shaft C is connected a crank pulley or gear to receive the necessary power to operate the reel.

"OPERATION.

"The cane juice after leaving the evaporator is conducted to the pan A, and the proper heat for evaporation turned on. By the application of power to the shaft the reel-blades are forced through the cane juice in the direction as indicated by the arrow. In the rotation of the reel air is collected within the formed chambers of the blades and forced into and through the cane juice, the latter forcing the air through the perforations in the blades. The air becoming heated expands and absorbs the moisture in the juice, converts it into true vapor, and as the blades continue to revolve an agitation of the juice is caused; also, as the blades come to the surface, a portion of the juice is carried upward by them, which is afterward poured out, thus subjecting it to the air and a purification. By this means I am enabled to get a circulation of air through the cane juice, and at the same time an agitation of the same, which causes a rapid evaporation at a low temperature, and, as a resultant product, I am enabled to produce an article in which the crystals of sugar are large and more numerous than if treated by the ordinary evaporator or vacuum pan. The heat having been cut off, the reel being kept in motion, the cooling of the cane juice takes place and the crystallization of the sugar is insured. The resultant product of this apparatus is now transferred to the granulating room, and after a proper treatment here it is ready for the centrifugal machine."

Mr. A. A. Denton, of Bavaria, Kans., has experimented for four years in the use of air in evaporation. I give below, in his own words, the results of his studies and experiments:

"I have in the last four years investigated the practicability of evaporating cane juice and other liquids by air. I have this season thus evaporated 2,000 gallons of sirup, having 45 degrees density Beaumé, from semi-sirups having 20, 25, and 35 degrees of density. I have tried many forms of apparatus for this purpose, but I do not suppose I have a perfect form or the only form of apparatus. Perfection is usually, if not always, the result of the efforts of many minds and of years of practical experience. My apparatus was defective in some respects, but I believe the results I obtained indicate the possibility of a cheaper method of evaporating saccharine liquids than vacuum-pan boiling, and a better method than open-pan boiling. My experiments lead to the conclusion that when the conditions necessary to success in evaporating liquids by air are fully understood and complied with, then sugar and sirup will be produced by air evaporation.

"The science of air evaporation is simple; it is contained in these well-known facts, viz: Air absorbs moisture as a sponge absorbs water. Dry air absorbs more moisture than damp air.

"Heated air absorbs moisture in proportion to its increase of temperature. A cubic foot of air at 32° absorbs two grains of water; at 160° it absorbs sixty grains of water.

"Evaporation in air is according to the extent of the surfaces exposed to air, and according to the quantity of air in contact with those surfaces, or the rapidity of the currents of air passing over those surfaces, and according to the temperature of the air and the dryness of the air.

Hence, to evaporate rapidly by air it is necessary to have dry air heated to the proper temperature, and made to move rapidly over large evaporating surfaces.

"All wet surfaces requiring to be dried, whether lumber, brick, fibrous material, fruit, grain, or liquids, should be treated in the same way; the process of drying or evaporating these is exactly the same, viz: large evaporating surfaces in contact with heated air in rapid motion. When these facts are appreciated saccharine liquids will be evaporated as easily, as cheaply, and as perfectly as solids and semi-solids are now evaporated or dried by air, and sugar and sirup and fruit sirups will be produced by air evaporation, just as salt is now produced by air evaporation. Usually more water is evaporated to produce salt than is evaporated to produce sugar; but although evaporating kettles and pans and furnaces have been greatly improved, yet the greater part of the salt of commerce is still produced by air evaporation, because it is the cheaper way. I believe sugar and sirup will also soon be produced by air evaporation instead of by boiling, not only because it is the cheaper way, but also because air evaporation can be performed at lower temperatures, thus causing less injury to the solids contained in the liquid, and consequently better product.

"High heat is necessary in evaporating saccharine liquids by boiling in open pan, because as the density increases the boiling point rises, and the greater the density is, the greater the heat necessary to distil or evaporate the water in the form of steam, and this high degree of heat injures the saccharine substances in the liquid. In air evaporation the process is independent of the degree of density, for water evaporates in air at all temperatures.

"In open-pan boiling it is well understood that quick and also shallow evaporation gives best results, and the shorter the exposure to heat the better the product. Shallow evaporation necessarily follows from this, for if it requires sixty minutes to reduce two inches in depth of cane juice to sirup of proper density, it will require thirty minutes to reduce one inch in depth, and one minute to reduce the one-thirtieth of an inch in depth of cane juice to sirup of proper density, with the same degree of heat. It is not possible to evaporate such thin films of liquid as one-thirtieth of an inch on any direct heat evaporator now constructed, but it is easy to evaporate such thin films by air evaporation.

"I believe the following comparison of the rate of evaporation by boiling, and the rate of evaporation in a current of dry air, which is due to the capacity dry air has for absorbing moisture, is mainly correct.

"If a given surface of liquid heated to its boiling point evaporates a certain quantity of water in a certain time, it requires twice as much surface to evaporate an equal quantity of water in the same time in a current of air heated only to 180 degrees.

"It requires four times as much surface in a current of air heated only to 150 degrees, and it requires eight times as much surface to evaporate an equal quantity of water in the same time in a current of air heated only to 120 degrees.

"If in air evaporation we combine these conditions, viz, shallow evaporation reduced to its ultimate limit, or to thin films of liquid, and large evaporating surfaces in contact with large quantities of air in rapid motion, we have as rapid evaporation in air heated only to 120°, or in fact at zero, without artificial heat, as we have in boiling deeper masses of liquid on smaller surfaces heated by flames at 1,000 degrees of heat. A gallon of water sprinkled over a large surface evaporates more rapidly than a gallon of water placed on a red-hot stove, and more water is evaporated from the comparatively large surface of the pond by the roadside then by an intensely heated steam-boiler.

"In attempting to evaporate saccharine liquids by air we can learn much from those engaged in evaporating fruit by hot air. The juices of fruits are not essentially different from cane juice; both contain saccharine substances, and vegetable acids, and albuminous substances, and evidently both can be evaporated in the same way and under the same conditions. The sliced fruits are simply sponges which hold the liquid upon the trays, in thin masses, so that air can everywhere come in contact with large and moist surfaces. If the air is heated too much the fruit will be cooked or burned, for air can be made hot enough to melt lead. If the air is not sufficiently heated chemical changes occur in the fruit and the product is inferior. It is said the finest and whitest fruit is evaporated at a temperature of 140 to 180 degrees, or about the same temperature in vacuum pan sugar boiling. In evaporating fruits it is necessary to have large evaporating surfaces, rapid currents of air uniformly heated and properly distributed.

"The fruit evaporators have met these conditions. They evaporate a bushel of apples weighing fifty pounds to five or six pounds of dry product. They evaporate this large proportion of water at comparatively low temperature, and with comparatively cheap and easily managed apparatus. They do this so perfectly that when their evaporated product is soaked until it regains its original water it is often not easy to distinguish it from freshly cut fruit; their dry product has as much or more saccharine substance as their raw material; their manufactured product has 400 to 500 per cent. greater value than their raw material, and their raw material costs from four to eight dollars a ton. Evidently their system of air evaporation is better, and gives better results, than our system of boiling saccharine liquids, and when they boil their fruit juices to sirup density their products are little superior, if any, to cane sirup.

"In endeavoring to meet the requirements of air evaporation of liquids I have tested many ways of bringing large quantities of air into contact with large surfaces of liquid. I forced heated air through liquid, but it requires very considerable power to inject the thousands of cubic feet of air required to evaporate a comparatively small quantity of water, and air passes so rapidly through liquid, impelled by its own buoyancy and the pressure, that it does not properly part with its heat. This probably accounts for the surprising fact that intensely heated air forced through a liquid evaporates but little more water than air at ordinary temperature. I sprayed the liquid in a chamber through which heated air passed, but saccharine liquids have varying degrees of density and viscidity, and do not properly spray. I used shelves sloping in opposite directions, the liquid flowing from first to second, and thence to third, and a current of air passing through, but only one surface of each shelf is an evaporating surface, and it is difficult to preserve an even and thin flow of liquid over the shelves.

"I have adopted vertical traveling carriers or liquid conveyors from twelve to sixteen feet high, and composed of chains and compound cross slats, so arranged as to present large surfaces. The lower ends of these carriers or liquid conveyers pass continuously through the liquid in a basin at the bottom of the carriers, and the entire surfaces of the carriers are thus kept uniformly wet by the adhesion of the liquid to the surface. Currents of heated air pass upward and around these wet surfaces and evaporate these films of liquid.

"I have built and tested five forms of this apparatus in the last four years. I had this season 600 square feet of evaporating surface, and with air heated to 140 to 180 degrees vaporated from 10 to 20 gallons of sirup having a density of 45 degrees Beaumé from semi-sirup having a density of from 20 to 30 B. I hope next season to build larger apparatus on the same plan with a steam air heater utilizing the exhaust from a 30 horse-power engine to heat the air and to manufacture sugar and sirup in this way only.

"I find the conditions essential to successful evaporation of saccharine liquids by air are large evaporating surfaces uniformly covered with thin films of liquid, rapid currents of air uniformly heated to the proper degree and properly distributed to all parts of the apparatus, and heat under control.

"In evaporating saccharine liquids by air the proper temperature is either above or below the fermenting point, in order to avoid chemical change, but I prefer 140 to 180 degrees of heat as being sufficiently rapid and also sufficiently low. The fermenting point varies as the density of the liquid varies; thus semi-sirup at 40 Beaumé may be evaporated at a lower temperature than semi-sirup at 20 B., and that may be evaporated at lower temperature than cane juice at 10 B. I have frequently evaporated semi-sirup at 20 B., with air at 100 degrees. To do this it is necessary to have the basin nearly full of nearly finished sirup. When the thin semi-sirup enters the basin it is quickly mixed with the denser sirup by the motion of the carriers or liquid conveyers, and is thus made more dense and less liable to ferment even at the temperature of 100°.

"I evaporated 50 gallons of heavy sirup from semi-sirup at 20 B., using air at 90° without the above precaution. In 24 hours it generated gas sufficient to test the strength of the barrel. Fermentation is the stumbling block which has prevented sugar and sirup from being made by air evaporation, as salt is made, and fermentation can be avoided by keeping the temperature above or below the fermenting point. It is possible to evaporate semi-sirup in winter with cold air, by using a fan to cause artificial currents of air over large evaporating surfaces and thus produce sugar and sirup by cold process.

"Usually air heated to 150 degrees in winter evaporates more sirup in a given time than air at the same temperature in summer. This is probably because the moisture of the air has been condensed at first, and the air is consequently drier and absorbs water more readily.

"When evaporating at ordinary temperatures I have sometimes admitted sulphur fumes with the air with a view to prevent fermentation. It is possible that sirup evaporated by cold air may contain bacteria or germs which may injure its keeping qualities, and it is probable that a temperature which destroys the germs is preferable. When this apparatus is used to cool sirup the large surfaces wet with the hot liquid induce currents of cold air which rapidly reduce the temperature, and as the steam escapes from the liquid instead of condensing in it, and the air also evaporates the liquid, the sirup gains from three to four degrees of density in a few minutes by being thus cooled.

"There is a remarkable difference in the temperature of the heated air entering this apparatus and the saturated air escaping from the apparatus. This difference is usually more than 50 degrees, and frequently more than 100 degrees, and I suppose is due to the fact that evaporation absorbs heat. Cane juice and other saccharine liquids should be boiled until the foam is clean and white, and the evaporation should then be completed by air. I have boiled cane juice to different degrees of density, using the thermometer and also the saccharometer as guides, but there are differences in cane juices, and also differences in defecation, and I prefer to boil till the foam is clean and white regardless of density, for otherwise sirup more or less green in color is produced. The less it is boiled the lighter the color of the sirup will be.

"I suppose evaporation is more rapid in this apparatus than in fruit evaporators, or in drying lumber, or other solids with the same evaporating surface, for the reason that when the surface of the solids has become dry evaporation can proceed no more rapidly than the liquid can work its way from the center to the surface, while in this apparatus the surface is always kept wet by mechanical means.

"I am aware attempts have been made to evaporate liquids by air and I suppose will be made until the requirements are successfully met, and then when the ordinarily intelligent man can manufacture sugar and sirup from cane of his own tillage, using cheap and easily managed apparatus, then sorghum sugar will supply the demand.

"My experiments lead me to the following careful conclusions. It is practicable to evaporate saccharine liquids and to produce sugar and sirup and fruit sirups by air evaporation. Air evaporation is sufficiently rapid. It does not discolor, but as it simply removes colorless water it concentrates any coloring material in the liquid. It does not invert or destroy sugar or produce chemical change. It is not expensive, and is peculiarly adapted to the dry air of the West."

Analyses of samples sent by Mr. A. A. Denton.

Serial number.	Total solids.	Ash.	Glucose.	Sucrose.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
2863	15.22	1.73	7.36	5.29
2864	50.69	3.20	24.59	20.96
2865	72.27	4.61	23.24	22.75
2866	....	....	22.99	42.89
2867	75.85	3.21	25.38	39.26
2868	80.81	3.39	26.47	33.97

2863. No. 1. Defecated juice.
2864. No. 2. Semi-sirup, 30 B.
2865. No. 3. Honduras semi-sirup, 40 B.
2866. No. 4. Sorghum juice dried in air-heater, 25 B.
2867. No. 5. Sorghum semi-sirup in air-heater, 30 B.
2868. No. 6. Sorghum semi-sirup in air-heater, 30 B.

From the analysis No. 2863 it is seen that if this juice is normal and the subsequent analyses show it to be so, it would be useless to try to make sugar from it by any process whatever.

The analyses in general show either the use of such poor juices as 2863 or else a large conversion of the sucrose into invert sugar during the process of evaporation.

Attention has often been called by this Bureau to the value of sorghum as a forage crop. The importance of this use of sorghum is emphasized in the address of Hon. Norman J. Colman, president of the "National Sugar Growers' Association," delivered at the annual convention in Saint Louis, December 16, 1884.

President Colman said:

"I think it my duty in this connection to urge the importance of paying more attention to saving the seed. In many places it is but little appreciated because its merits are little known. It is in value fully equal, bushel for bushel, to Indian corn for feeding all kinds of live stock. The best beef, pork, and mutton can be made from it. It is an excellent food for dairy cows, and the Philadelphia dairymen paid the Cape May manufactory ten cents per bushel more for the seed than they would give for corn, because it increased the flow of the milk proportionately more; but now the factory at Cape May feeds the seed to their own hogs, and obtain in this way more for it than by selling it by the bushel.

The yield of seed per acre is much greater than many suppose. Mr. C. M. Schwartz, of Edwardsville, Ill., who is very cautious in his statements, and an entirely reliable gentleman, has given me a tabulated statement of his crop of cane raised the past year, containing the yield of cane per acre, the amount of seed per acre, the weight of the different varieties of seed per bushel, etc.; and from the statement I find that the Early Amber yielded, per acre, 20 bushels; Stewart's Hybrid, 25 bushels; improved Early Orange, 48 bushels; Link's Hybrid, 33 bushels; Early Orange, 27 bushels; Honduras, 33 bushels per acre. This is more than our average yield of corn. The seed will pay the entire cost of cultivating and harvesting the crop. What other sugar plant can do the same? And the time is surely coming when sorghum need not fear any rival; its seed paying for raising the corn crop, and its culture being so cheap and easy—not more expensive than corn—a good man and team being able to raise at least 40 acres of it on land adapted to it. Surely there is a bright future for so promising a sugar plant.

"As a forage crop its value is not generally known. In traveling in Kansas, Kentucky, and other States the past summer and autumn, I found the localities where its merits as a forage crop had been tested, and it was grown on a large scale as a stock food. The hogs were fattened on the cane containing so much saccharine matter. The cane readily fattens all domestic animals. The dairyman finds no better forage for his cows during a season of drought. The shepherd is delighted with the cane and its seed for his flock. The farmer who raises mules, horses, cattle, sheep, or hogs has no crop that yields so much and goes so far in keeping his stock as the plant of which we are speaking."

GENERAL CONCLUSIONS.

A careful study of the foregoing data will not fail to convince every candid investigator that the manufacture of sugar from sorghum has not yet proved financially successful.

The men who have put their money in these enterprises seem likely to lose it, and intending investors will carefully consider the facts herein set forth before making final arrangements. The expectations of the earlier advocates of the industry have not been met, and the predictions of enthusiastic prophets have not been verified. It would be unwise and unjust to conceal the fact that the future of the sorghum-sugar industry is somewhat doubtful. This unsatisfactory condition is due to many causes. In the first place, the difficulties inherent in the plant itself have been constantly undervalued. The success of the industry has been based on the belief of the production of sorghum with high percentages of sucrose and small amounts of reducing sugar and other impurities.

But the universal experience of practical manufacturers shows that the average constitution of the sorghum cane is far inferior to that just indicated. Taking the mean of several seasons as a sure basis of computation, it can now be said that the juices of sorghum as they come from the mill do not contain over 10 per cent. of sucrose, while the percentage of other solids in solution is at least 4.

It is needless to say to a practical sugar maker that the working of such a juice is one of extreme difficulty and the output of sugar necessarily small.

Another difficulty with which the industry has had to contend has been found in the crudeness and inefficiency of the machinery which has been in use.

Successful sugar making depends more on the efficiency of the machinery used than almost any other kind of manufacturing. It is safe to say that should the sugar makers of Europe attempt to make beet sugar with machinery as imperfect as that used in the sorghum-sugar manufacture the attempt would end in disastrous failure.

The working of sorghum juices will be found as difficult as those of beets, and true success cannot be hoped for until the processes used for the one are as complete and scientific as for the other. It is not meant by this that the processes and machinery are to be identical.

The chemical as well as mechanical treatment of the two kinds of juice will doubtless differ in many respects. And this leads to the consideration of the third difficulty, viz, the chemical treatment of sorghum juice. It has taken nearly three-quarters of a century to develop the chemistry of the beet-sugar process, and even now the progress in this direction is great. The chemistry of the sorghum-sugar process is scarcely yet a science. It is only an imitation of what has been done in other fields of work. Sorghum will have to develop a chemistry of its own. This will not be the work of a day or a year, but it will be accomplished sooner or later.

Another serious obstacle that the sorghum industry has met is that of soil and climate. In Bulletin No. 3 this question has been pretty fully discussed.

Careful study of climate and soil, joined with experience, will gradually locate those areas most favorable to the growth of this plant and its manufacture.

This is an all-important point in the problem and is now occupying seriously the attention of the thoughtful advocates of the sorghum sugar industry. One thing is already clear, *i. e.*, that the area of successful sorghum culture is not nearly so extensive as it was thought to be a few years ago. I would urge a further investigation in this direction as a work peculiarly within the province of the Department, and one which would prove of immense benefit to the country. Five million acres of land, suitable to the purpose, will produce all the sugar required for this country for several years to come. It is therefore certain that the sugar industry will be confined to the most favorable localities. If a thorough scientific study of all the soil and climatic conditions does not point out this region, bitter experience and the loss of hundreds of millions of dollars will gradually fix its boundaries. Last of all, the sorghum industry has suffered from the general depression which has been felt by the sugar industry of the entire world. Low prices have caused loss where every other condition has been favorable. It is hardly probable that the price of sugar will rise again to its maximum of the years passed. Only war, pestilence, or disaster would produce this effect. It is best therefore for the sugar grower to accept the present price as final and make his arrangements accordingly. But low prices will produce increased consumption, and thus even with a smaller profit the sugar grower by increased production may find his business reasonably remunerative if not as enriching as before. The sorghum sugar grower will be injured or benefited with the growers of other kinds of sugar by these economic forces. Hence there should be no enmity between the grower of the sorghum, the sugar beet, and the sugar cane, but all should work in harmony for the general good.

It is true the present outlook is discouraging. But discouragement is not defeat. The time has now come for solid, energetic work. Science and practice must join improved agriculture, and all together can accomplish what neither alone would ever be able to achieve. It is not wise to promise too much, but this Bureau would fall short of its duty were it either to suppress the discouraging reports of this industry or fail to recognize the possibility of its success. The future depends on the persistence and wisdom of the advocates of sorghum. The problem they have to solve is a most difficult one, but its solution is not impossible.

The chemical researches of this Bureau have shown the composition of the sorghum sap during many years and in all parts of the country. They have discovered the difficulties which the practical worker must expect to encounter, and suggested the methods by which the difficulties may be overcome. This Bureau has sought neither to underrate nor to magnify these difficulties, but, on the other hand, to state clearly and without prejudice the results of the investigation.

It must be confessed, however, that the final conclusions are not as favorable to the success of the sugar industry as I had hoped they might have been.

For the future what aid may be given to this industry by the Department (not excluding chemical control of all manufacturing processes) should be mostly of a mechanical nature. Already a start has been made to apply the process of diffusion on a practical scale. That trial should be completed. Equally as important to the sugar cane industry as to sorghum, the result will be equally valuable to both industries, irrespective of the kind of cane on which it is tried. Because in Louisiana better systems of evaporation are found than among the sorghum factories is a good reason for making this experiment in that State.*

Fully as necessary to the future success of the industry is the proper depuration of the juice. With sorghum this is by far the most important problem. The large quantity of reducing sugar in its juice renders

* Since the above was written the Commissioner of Agriculture has decided to conduct two diffusion experiments, one in Louisiana and one in Kansas.

the use of an excess of lime very troublesome. Yet the large percentage of albuminous matter and other impurities are difficult to remove without large quantities of lime. This difficulty suggests the use in excess of lime, to be followed by treatment with carbonic acid, and this process should be tried by the Department.

The further improvements to be made to place this industry on a successful basis are outlined in the report of the Commissioner of Agriculture for 1883, pages 443, 444.

THE SUGAR INDUSTRY OF THE UNITED STATES.

Part IV.—MAPLE SUGAR.

MAPLE SUGAR.

The record of the chemical study of the maple saps, sugars, and sirups is very limited.

Julius Schroeder* has reported numerous analyses of the *Acer platanoides.*

His experiments were conducted as follows: Before the beginning of the flow of the sap the tree selected for experiment was bored in twelve different places. The lowest hole was bored 0.30 meter above ground. Each succeeding hole was made at a distance of 1 meter from the preceding. The height of the tree was 12 meters. The tree began to branch at the second tapping, and continued branching regularly to the top. The estimation of the sugar from the various borings gave the following results:

Date.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
April 19	2.51	....	....	....	....	....	....	....	....	....
20	2.67	(*)	....	....	....	....	....	....	....	....
21	2.70	3.10	2.58	....	....	....	....	....	....	....
22	2.44	(†)	(‡)	....	....	....	....	....	....	....
27	2.00	2.99	2.57	2.62	2.51	....	....	....	....	....
28	2.58	2.49	2.58	2.73	2.57	2.97	....	....	....	....
29	2.73	3.03	2.99	3.42	....	....	....	....	....	....
30	3.06	3.17	....	....	....	....	....	....	....	....
May 1	(†)	(†)	....	....	....	....	....	....	....	....
3	2.49	2.97	....	....	....	....	....	....	....	....
4	2.46	....	....	....	....	....	....	....	....	....
5	2.64	2.26	(†)	3.28	2.79	3.30	2.88	....	....	....
6	2.64	2.88	....	....	....	....	....	....	....	....
7	2.32	2.46	3.15	3.39	2.84	3.25	3.14	....	....	....
8	2.29	....	....	....	....	....	....	....	....	....
9	2.18	2.17	3.19	3.44	2.38	3.28	2.70	....	....	....
12	1.88	1.41	3.21	3.17	2.76	3.39	3.17	3.72	3.30	3.71
13	1.92	1.22	2.88	2.64	....	3.17	....	....	....	....
14	1.76	1.15	2.40	2.16	(†)	2.73	2.83	....	....	....
16	1.92	....	....	....	....	2.12	2.79	....	....	....

* Beginning of the flow, but too little for analysis.
† Too little for examination.
‡ Analysis failed and no further substance at hand.

From this it appears that from the higher borings a sap richer in sugar was obtained. In similar experiments made with the birch tree the opposite was found to be true, *i. e.*, the sap from near the ground was richer in sugar than that from higher up.

The author explains this difference by the different distribution of the starch in the two trees.

In the birch little starch is found in the smaller twigs, while in the

* Versuchstationen, Band XIV, 1871, p. 118 *et seq.*

maple there is as much found in these as in the larger portions of the tree. He also found that during the flow of the sap the evolution of the maple buds was almost stopped, and hence there was no drain on the starch in the small twigs to support the growth of the buds.

The influence of the season on the sugar content of the sap is shown in the following table, calculated from the mean of the flow from the lower half of the tree.

Date.	Sugar.	Date.	Sugar.
	Per cent.		*Per cent.*
April 28	2.74	May 7	2.90
29	2.97	8	2.85
30	3.06	9	2.77
May 3	2.97	12	2.64
4	2.91	13	2.37
5	2.90	14	2.05
6	3.02	16	2.12

Up to April 30 the percentage of sugar increased, on which day it reached its maximum.

The decrease thereafter was very slow, so that it was first on the 9th of May that the percentage of April 28 was reached.

From this time on the decrease in the content of sugar was regular. The sap from the roots showed a similar constitution to that of the branches, *i. e.*, it was richer in sugar than that from the trunk.

Albuminoids contained in one liter of sap.

Height of tap above ground.	Date.	Albumen.	Sugar.
		Grammes.	*Grammes.*
0.3 meter	Apr. 27–28	0.0205	22.9
Do	29–30	0.0186	28.9
Do	May 3	0.0238	24.9
Do	5	0.0117	26.4
Do	7	0.0152	23.2
Do	16	0.0079	19.2
3.3	7	0.0251	33.9
5.3	7	0.0344	32.9
0.25	Apr. 29	0.0081	14.9
Root, 1 meter from trunk	29	0.0093	19.3
0.25	May 6–12	0.0131	12.6
Root, 1 meter from trunk	6–12	0.0130	18.6

The sap from the upper part of the tree contained more albumen than that from the lower. Sap from the root in one case showed a higher, and in a second an equal, content of albumen as compared with trunk sap. Towards the end of the season the content of albumen grew less.

Ash contained in one liter of maple sap taken at different distances from the ground.

Date.	Height.	Ash.
		Grammes.
Apr. 27, 28	0.30	1.22
May 5	0.30	1.09
18	0.30	0.93
5	3.30	1.02
5	5.30	1.32

Ash contained in one liter of sap from trunk and root.

	Date.	Ash.
		P. ct.
Trunk, .25 meter from ground	May 5	.63
Root, 1 meter from trunk	May 5	.95

Composition of ash from maple sap.

Date.	Source of sap.	Parts in one liter.					
		K_2O	Na_2O	MgO	CaO	Fe_2O_3	P_2O_5
April 27, 28	3 meters	0.2708	0.0096	0.0584	0.2404	0.0050	0.0968
May 5	do	0.3529	0.0040	0.0660	0.2262	0.0012	0.0646
18	do	0.3009	0.0073	0.0524	0.1462	0.0091	0.0357
5	3.3	0.3321	0.0321	0.0673	0.2142	0.0112	0.0415
5	5.3	0.1345	0.0182	0.0921	0.2655	0.0067	0.0973
5	Trunk	0.1661	0.0056	0.0304	0.1798	0.0019	0.0354
5	Root	0.1857	0.0138	0.0281	0.0644	0.0025	0.0474

MALIC ACID.

Schroeder determined the malic acid as follows:

The sap was partially evaporated, treated with an equal volume of alcohol of 95 per cent., and left standing for some time, when the at first amorphous precipitate began to take on a crystalline form. The separated crystals were easily identified as malate of lime. The analysis of the silver salt of the acid gave the following numbers:

Constituents.	Found.	Calculated.
C	13.86	13.79
H	1.33	1.15
Ag	61.26	62.07
O	22.55	22.99

ANALYSES OF MAPLE SAP.

By Charles Wellington, B. S.*

Variety of tree.	Date, 1884.	Specific gravity at 15° C.	Sugar.	
			Glucose.	Sucrose.
Acer saccharinum	Mar. 26, 28	1.015	Trace.	2.777
Acer rubrum	Mar. 27, 28	1.010	0.012	1.458
Do	Apr. 8	1.010	Trace.	0.833
Do	Apr. 8	1.007	do	C.769
Acer Pennsylvanicum	Mar. 30, 31	1.010	do	1.428

GAS FROM SAP OF ACER SACCHARINUM.†

Composition by volume.

Constituents.	Gas from sap.	Air.
	Per cent.	*Per ct.*
N.	72.213	79.02
O.	22.435	20.94
Co 2	5.352	0.04

* Report Massachusetts Board of Agriculture, 1874–'75, p. 290.

† Report Massachusetts Board of Agriculture, 1874–'75, p. 291.

*ANALYSES OF MAPLE SAP IN INDIANA.**

The orchard from which the specimens were taken is an old one which has been in use more than fifty years. It is situated two miles west of La Fayette.

My first determinations were made on the 21st of March, after two days of a moderately hard freeze.

Specimens of sap were taken from twelve different trees, selected so as to represent in size, shape, age, &c., the average growth of the grove.

Following are the percentages of sugar obtained. I also give specimens taken from the same trees four days later, March 25, after two days and nights constant running.

Nos.	Per cent. March 21.	Per cent. March 25.	Nos.	Per cent. March 21.	Per cent. March 25.
1	3.95	3.44	7	2.51	2.00
2	2.95	2.63	8	1.95	1 87
3	3.26	2.80	9	3.08	2.00
4	2.70	2.34	10	2.67	2.34
5	2.70	2.60	11	2.70	2.11
6	3.20	2.42	12	3.51	2.74

The twelve trees above given had been "tapped" about a week before the examinations were made.

Wishing to try some perfectly fresh trees, specimens of sap were taken, on March 25, from three fresh trees, which gave in the polariscope the following numbers:

Nos.	Per cent. sugar.
1	3.93
2	3.75
3	2.42

The sap from a tree in Southern Indiana, taken near the end of the season and sent by express to La Fayette, Ind., gave, on examination three days after collection, *sucrose* 4.30 *per cent.*

This tree was noted for the richness of its sap, and was known as the "sweet tree."

The following analyses of maple sugars and sirups were made by this Bureau, previous to the beginning of the work in Vermont, during the season just passed: †

Inasmuch as the maple sap is always evaporated in open pans, it is not strange that the sugars and sirups contain invert sugar. On the other hand, in many cases the percentage of invert sugar is surprisingly low. These cases indicate that in pure aqueous solutions of sugar, heat does not invert the sucrose as rapidly as if mineral salts and organic impurities are present. A study of the proportion of inversion due to heat and to other causes would be of interest. Samples for analysis were

* Proceedings A. A. A. S., Saratoga meeting, vol. xxviii.

† Chemical News, vol. 51, No. 1317, p. 38, *et seq.*

purchased in open market and directly from retail manufacturers. Opportunity was thus afforded to compare the genuine with the commercial articles.

The results of the analyses, presented in the following tables, show to be true what has long been suspected, namely, that the commercial articles are largely adulterated. The commercial sirups are quite uniformly mixed with starch sugar, or glucose. No method of analysis, however, will detect a kind of adulteration which is probably common, that of the addition of cane or beet sugar to the maple. All of these sugars are identical chemically.

Of the sirups, Nos. 14 to 20, inclusive, are known to be genuine. Excluding from these No. 15, which had been made for more than a year and had undergone, undoubtedly, partial fermentation, it is seen that the sucrose varies from 39.22 per cent. to 64.45 per cent. The invert sugar (glucose), on the other hand, varies from 0.21 per cent. to 3.24 per cent. The percentage of water is, as an average, astonishingly large—over 30 per cent.

Of the sugars, Nos. 15 to 20, inclusive, are known to be genuine. In these the sucrose is quite constant, about 84 per cent., while the invert sugar varies between 0.80 and 5 per cent. The water is much higher, too, than one would expect.

Some curious results are shown by the analyses. Notice, for instance, the difference in sirups Nos. 2 and 3, 4, 5. In case of No. 2 the analysis clearly reveals a large addition of glucose. Nos. 3 and 5 had only a trace of reducing sugar. This is also suspicious. It shows that the samples were made, probably, by adding to a sirupy solution of cane sugar enough dark maple sirup to give it color and flavor. It is difficult to suppose that a maple sap evaporated to a thick sirup on an open pan would contain only a *trace* of reducing sugar. No. 4 is a genuine maple sirup.

In Nos. 9 and 10 are also found some interesting data. Both of these sirups are probably genuine, although differing so greatly in composition. If No. 10 is an adulterated sample the admixture is not glucose, but refining molasses. In glucose there are always dextrine and maltose, which were not determined above. In No. 10, therefore, there can be no glucose, else it would partly appear in the undetermined column. On the other hand, the percentage of reducing sugar is very high, indicating a possible addition of refining molasses; but the low percentage of ash in this sample is an evidence of its purity.

In No. 13 is found a sample from the butternut tree (*Juglans cinerea*).

Unhappily there is no method of detecting the adulteration of maple sugar with other sucroses. The temptation to this adulteration is great, because maple sugar commands nearly double the price of other sugars; but neither chemistry nor optics will help to a decision in a question of such an adulteration. If enough of the real maple sugar is present to give the characteristic odor and flavor, the sample must pass.

Lately in the United States a patent has been secured for manufacturing the maple flavor. It is done by extracting hickory bark with water, and the separation and purification of the product. This extract added to glucose or cane sirups gives them an odor and flavor very like the maple.

MAPLE SIRUPS.

No.	Sucrose by double polarization.	Invertose.	Water.	Ash.	Undetermined.	Description and remarks.
1	50.49	9.90	32.39	0.33	6.89	Thuber's Mountain sirup, quart bottles, bought in Washington, D. C.
2	22.94	27.77	25.06	0.58	23.65	Vermont maple sirup (McClary), quart bottles, bought in Washington, D. C.
3	63.57	Trace...	31.52	0.69	4.22	Vermont sirup kept in bulk, bought in Washington, D. C.
4	57.94	5.52	29.14	0.44	6.96	Do.
5	61.25	Trace...	29.68	0.74	8.33	Do.
6	32.07	32.79	19.01	1.00	15.13	Western Reserve (Black Bros.), ½-gallon cans, bought in Washington, D. C.
7	57.71	13.24	31.34	1.14	6.57	Western Reserve (Black Bros.), kept in bulk, bought in Washington, D. C.
8	61.41	1.58	28.72	0.82	7.47	Hazen's Vermont sirup, quart bottles, bought in Washington, D. C.
9	63.78	2.00	26.69	0.84	6.69	Ohio sirup, from Mr. La Dow, Washington, D. C.
10	49.46	17.24	33.98	0.38	....	Ohio sirup, kept in ½-gallon cans, bought in Washington, D. C.
11	29.41	17.57	33.66	0.86	18.50	Do.
12	64.26	0.66	31.28	0.74	3.06	Hazen's Vermont sirup, in quart bottles, bought in Washington, D. C.
13	44.54	16.00	40.26	0.79	....	Sirup made from butternut tree, from F. B. Hough, New York.
14	62.23	0.21	35.21	0.55	1.80	Maple sirup, from F. B. Hough, New York.
15	42.09	17.54	33.74	0.95	5.68	Maple sirup, made in 1883, from M. J. Smith, Middlefield, Mass.
16	54.80	3.24	38.58	1.03	2.35	Maple sirup, made from last run of sap in 1884, from M. J. Smith, Middlefield, Mass.
17	63.87	1.39	32.11	0.71	1.92	Maple sirup, made in middle of season 1884, from M. J. Smith, Middlefield, Mass.
18	64.45	1.39	31.67	0.76	1.73	Do.
19	62.90	1.78	32.84	0.68	1.80	Maple sirup, made early in season of 1884, from M. J. Smith, Middlefield, Mass.
20	39.22	1.79	36.72	0.94	21.33	Maple sirup, made in 1883, from M. J. Smith, Middlefield, Mass.

MAPLE SUGARS.

1	84.24	6.33	8.03	0.31	1.09	In bulk, bought at Washington, D. C.
2	81.67	9.26	8.84	0.97	....	Do.
3	79.08	6.02	11.57	0.91	2.42	Do.
4	71.80	12.19	9.73	0.70	5.58	In small cakes, bought at Washington, D. C.
5	86.27	5.91	6.77	0.76	0.29	Do.
6	86.52	Trace...	8.63	1.06	3.79	In bulk, bought at Washington, D. C.
7	80.22	6.89	8.68	1.30	2.91	Do.
8	86.24	4.54	7.82	0.41	0.99	Do.
9	84.58	1.11	9.74	0.96	3.61	Do.
10	84.51	3.22	8.24	1.26	2.77	Do.
11	85.42	0.87	8.78	0.67	4.26	Do.
12	84.14	6.57	7.47	0.49	1.33	Do.
13	85.68	0.43	10.81	1.21	1.87	Do.
14	85.13	2.23	6.83	1.50	4.31	Do.
15	84.72	0.80	9.53	1.21	4.54	Sugar made early in season 1884, about March 20, from M. J. Smith, Middlefield, Mass.
16	82.36	2.10	10.75	1.25	3.54	Do.
17	86.97	1.69	7.68	1.06	2.60	Do.
18	86.28	2.10	7.59	1.27	2.76	Do.
19	86.89	2.08	7.96	1.06	2.01	Sugar made from last run of sap in April, from M. J. Smith, Middlefield, Mass.
20	82.07	5.00	9.26	1.16	2.51	Do.

Analyses of sirups and sugars collected during 1885.

SIRUPS.

No.	Sucrose.	Invertose.	Moisture.	Ash.	Albuminoids.	Undetermined.	Descriptive remarks.
1	54.20	2.29	40.23	.354	.019	2.737	Made by H. Day, Lunenburg, Vt., April 9.
2	65.19	.78	25.13	.598	.044	8.258	Made by Hosea Thomas, Lunenburg, Vt., April 8.
3	44.88	8.27	39.17	.504	.063	7.113	Made by Harrison Stowell, Lunenburg, Vt., April 9.
4	62.19	.45	31.58	.573	.025	5.182	Made by V. E. Hartshorne, Lunenburg, Vt., April 9.
5	52.36	1.15	40.03	.527	.050	5.883	Made by Porter Smith, Lunenburg, Vt., April 16.
6	61.11	1.98	35.63	.516	.044	.720	Made by Fred. Luce, Lunenburg, Vt., April 20.
7	55.84	3.56	38.30	.647	.050	1.603	Made by Fred. Luce, Lunenburg, Vt., April 22: unfiltered.
8	57.51	6.06	29.92	.842	.075	5.593	Made by Wesley Stewart, Lunenburg, Vt., April 23.
9	62.10	.56	33.17	.617	.044	3.509	Made by Chester Thomas, 1884; preserved in corked bottles: very light-colored.
10	61.30	.61	31.52	.442	....	6.128	Made by Simon Perkins, Randolph, Portage County, Ohio, 1885.

SUGARS.

1	83.02	2.31	....	.693	....	13.977	Made by Wesley Stewart, April 8.
2	84.34	.78	8.54	.842	....	5.498	Boiled down in small pan without skimming.
3	84.00	.44	12.48	.602	....	2.478	Made by Ezra Pierce, Lunenburg, Vt.; milk used to raise scum.
4	85.25	....	8.62	....	....	6.13	Made by Hosea Thomas; from top of large can.
5	76.83	....	14.65	.755	....	7.768	Made by Hosea Thomas; from bottom of large can.
6	81.40	.56	6.16	.735	....	11.145	Made by Chester Thomas: small molds; very light-colored.

OBSERVATIONS MADE IN VERMONT.

Arrangements were made with Dr. H. A. Cutting, of Lunenburg, Vt., by which a representative of this Bureau was permitted to make some chemical studies of the maple sap during the present season.

The season was a very short one, and little more was done than to prepare the way for a more extended study hereafter.

Mr. William Frear was instructed to take charge of the Lunenburg station, and to collect as much information as possible concerning the maple-sugar industry. He went to Lunenburg on April 3, and remained until the close of the season, in the early part of May.

Following is his report:

SOURCES OF MAPLE SUGAR.

The Rock, Hard or Sugar Maple (*Acer saccharinum*, Linn.) is correctly regarded as the prime source of maple sugar; but while it is well known that in northern climates all species of maple yield sap containing more or less sugar, it is not generally supposed that any other species than the rock maple is extensively used as an available source in the actual manufacture. In Vermont favorable conditions exist for the growth of most species of maple found in the northeastern part of the United States; several species in particular are very flourishing, and have been much used as sources of sugar in addition to that afforded by the rock maple. To so great a degree has their use for this purpose grown that excellent authorities claim that at least 50 per cent. of the trees tapped in Vermont are of other species than the rock maple. Without attempting to make any accurate estimate in this matter, it may safely be claimed that these species, as well as the rock maple, deserve attention in the study of maple-sugar production.

The White, Silver, Soft, or River Maple (*A. dasycarpum*, Erhart) though considered as a lowland tree, is found in Northern Vermont growing high on the hillsides among the rock maples. This species ranks next in importance to the latter in relation to sugar production.

In Essex County there are few groves which are composed exclusively of rock maple. In a large proportion from one-third to one-half is of white, or soft maple, as it more commonly called, and at least one grove is known which is entirely made up of this species.

The trees are frequently very large, and the general conditions favorable to the best production in the rock maple have a like effect upon this species. The sap, though generally inferior to that of the rock maple in sweetness, is clear, and flows in good quantity.

A peculiar purplish coloration of the sap is noticed for two or three days after tapping, but it is not generally sufficient to materially affect the manufactured product. A similar coloration of the bit used in tapping is noticeable, and may be attributed to the action of the fresh juice of the bark upon the iron.* It is claimed by many that the sap yields a whiter sugar than even that of the rock maple.

The Black Maple, or Black Sugar Maple (*A. saccharinum*, var. *nigrum*, Torrey and Gray; *A. nigrum*, Michaux), occurs under conditions favorable to rock maple with considerable frequency, though greatly less abundant than the white maple. Having so much in its appearance in common with the rock maple, it often passes unnoticed, and, in consequence, may be of more importance as a factor in production than it is now supposed to be. It attains proportions and heights similar to those of the rock maple, and in the quantity of sap yielded is not inferior. It is claimed by some that the flow ceases sooner than in the case of the rock maple, but this season's observations fail to support the claim. The sap is clear, of good flavor, and in sugar content fully up to the average sap of the rock maple.

The Red, Swamp or Water Maple (*A. rubrum*, Linn.), though of com-

---

*Michaux notes the blue coloration yielded by the wood of the Red and White Maples when treated with a solution of sulphate of iron as a test to distinguish it from the Rock Maple, which strikes a greenish color. The bark is claimed to have considerable value as a dyeing material.—*Emerson, Trees and Shrubs of Massachusetts*, Vol. II, p. 562.

paratively infrequent occurrence among the mountains of Northern Vermont, is quite abundant in low swampy grounds in other sugar-producing localities. While it does not generally attain any great size, it may under very favorable conditions reach a height of 70 or 80 feet, and a diameter of 3 or 4 feet. It makes a pleasant-flavored sirup or sugar, as light in color as that from any other sap. Its yield of sap compares favorably with that from other species in trees of similar size; in clearness it surpasses all the other species, but it contains the least amount of sugar. It tastes slightly astringent at times, and, if boiled in iron vessels, is said to turn black.* Evaporation out of contact with iron, however, yields a light-colored sirup or sugar of very pleasant flavor.

The other species of maple which are found in Northern Vermont are comparatively rare, and attain too small proportions to be of any practical value as sugar producers. It is interesting, however, to note that Dr. Franklin B. Hough, in a recent paper on the maple-sugar industry† says that in Southwestern New Hampshire the red maple is tapped as often as the true sugar maple, and that the sap is really about of like value; that in the Western Reserve, Ohio, both red and white maples occur abundantly, and are used in manufacture, while in Logan County the black maple is the source from which large quantities of sugar are made; that the last-named species is used also in Arkansas, though the production there is slight.

He also notes the use on the Pacific coast of the sap of the cabinet maple (*Acer macrophyllum*) for making sugar and sirup. Mr. J. C. Brown, in the same report, p. 390, says that the sap of the vine maple (*Acer circinatum*) contains a large amount of sugar, and is frequently made into sirup.

Dr. Hough and other authorities also note the frequent use in Middle Western States of the sap of the ash-leaved maple, or box-elder (*Negundo aceroides*), a species closely related to the maples. It is said to contain a good amount of sap, which averages 2.8 per cent. of sugar, and to yield lighter-colored products than are produced from the sugar maple.

CONDITIONS AFFECTING THE FLOW OF SAP.

It has been observed that the quantity and quality of sap vary with the situation of the trees, their age and size, the nature of the season and of the preceding season, the meteorological conditions, and the methods of tapping. The general conclusions resulting from the experience of sugar-makers have been collated from as many sources as possible, and will be noted in their proper order. The frequency of direct

* The bark is well known as a dyeing agent, and as a source of ink among the earlier farmers of New England. *Bancroft, Philosophy of Permanent Colors*, II, 272; *Emerson, Trees and Shrubs of Massachusetts*, II, 555.

† Report on Forestry, Department of Agriculture, 1884, p. 394 *et seq.*

contradiction in the testimony, however, opens up many questions of great interest relating to plant physiology and chemistry.

THE SITUATION OF THE TREES.

Every sugar-maker is aware that the productiveness of a grove varies much with its position; and there are a great many theories to account for the differences. The facts observed may be most satisfactorily grouped under the following heads:

Elevation.—It is generally accepted that trees on a high elevation will yield sap which is sweetest, but not so great in quantity; whether or not the sugar product is greater than in the case of lowland trees is disputed. In several instances coming under my observation groves situated on high rocky ledges have yielded a larger weight of sugar to the tree than those in neighboring groves at a lower elevation. It has also been observed that, other conditions being similar, trees in elevated positions begin to flow sooner than those in the valleys. This would probably have a favorable influence upon the final yield.

Direction of exposure.—Owing to causes similar to those affecting trees at varied elevations, the direction of exposure has much to do with the yield of sap. The warmest and most protected groves flow earliest and with least interruption. The favorite sites are those with southern and eastern exposure. Those groves facing north and west are sometimes several weeks later than their neighbors on the opposite sides of the mountain.

Thickness of growth.—Exposure to sunlight and a full development of the tree being advantageous, the thickness and character of the growth has, of course, a very marked effect upon the yield. Where the trees are planted thickly, not only is the ability of the tree to store up the sugar-producing elements reduced, and its growth retarded, but also the shading of the trunk and roots from the rays of the sun lessens the flow of the sap, and delays the period at which it begins. On the other hand, the flow is often longer than in more exposed positions. Without exception, nevertheless, it is admitted that isolated trees yield not only the earliest and most sap, but also the sweetest.

Further, it is regarded as particularly important that other kinds of trees should be removed from a grove; especially such as spruce and hemlock, which shut out the rays of the sun, and whose falling needles are likely to injure the sap in the pails. A growth of these trees on the side most exposed to the wind will, however, frequently afford much protection, and cause an earlier flow.

The number of trees which can most profitably be grown on an acre will vary much with the position of the grove. According to C. S. Sargent* 160 may be considered as a fair number for medium-sized trees in flourishing condition.

Moisture.—It is generally admitted that trees in wet ground yield the

*Agriculture of Massachusetts, 1874–'75, p. 270.

most sap. There is much dispute, however, concerning the relative quantities of sugar produced, as it is noticeable in a great number of cases that sap when running most rapidly is not so sweet as when flowing at a much slower rate. The majority of makers adhere to the saying, "*The more sap the more sugar;*" and as far as exact observation has been made, this opinion seems in the main correct, but it certainly is subject to numerous exceptions.

Soil.—In addition to the warmth and moisture of the soil, other physical characters and its chemical constitution are regarded as influencing the sugar production. A loose rich loam is desirable. A. M. Foster of Cabot, Vt.,* prefers slate or limestone land to granite. Dr. Cutting, of Lunenburg, Vt., says that he has found by experiment that the application of wood-ashes and of plaster increases the sugar product of the following season. As an instance of the effect of soil constituents upon the quality of the sap, E. A. Fisk, Waitsfield, Vt.,† records a case in which some spent tanbark produced a decided coloration of the sap which disappeared only on the removal of the tan. There is room for much interesting experiment on the effect of fertilization upon the yield and qualities of maple sap.

SEASON.

Effect of preceding seasons.—The flow of sap varies not only with the season or period of flow, but also with the character of the preceding seasons. T. Wheeler, of Waterbury Centre, Vt., gives "an Indian rule" for determining the yield of sap in advance, which he had noticed several years without failure: "If the maple leaves ripen and turn yellow, and the buds perfect themselves so that the leaves fall off naturally without a frost, then there will be a good flow of sap the following spring; but if there is a hard frost that kills the leaves and they fall off prematurely before the bud is perfected, then we may look out for a poor yield of sap."‡

Emerson says: "A summer of plentiful rain and sunshine—that is, one which furnishes the trees with abundant nutriment, and is at the same time favorable to the elaboration of the saccharine matter and its deposition in the vessels of the wood of the tree—ought naturally to prepare a plentiful harvest of sugar for the subsequent spring."§

An open winter is also favorable to the best yield.‖ The sap flows earlier and the time of flow is generally longer. The quantity of sap also is greater and the percentage of sugar considerably higher. The

* Vermont Agricultural Report, p. 1874, 728.

† *Ib.*, 1874, p. 717.

‡ *Ib.*, 1874, pp. 723, 724.

§ Trees and Shrubs of Massachusetts, Vol. II, p. 562.

‖ In Southeastern Indiana and other localities of a similar climate the best sugar seasons follow the severest winters. But a "severe winter" there would be called an "open winter" in Vermont.

data at command seem to indicate an increase of all solid constituents as the result of the conditions accompanying such a season.

Time of flow.—It has been found that sap will flow with more or less abundance during any of the months between October and May, and even in the last-named month when the spring is especially late. The time is much more limited during which the flow is abundant and regular, and the sap yielded is in best condition. The date at which the trees are usually tapped varies considerably with the locality, as well as with the nature of the season. According to Dr. Hough, the season generally begins in Southeastern Indiana about the middle of February. In Northern Vermont the season rarely begins as early as the middle of March, and sometimes not till the second week of April. The duration of the period of flow is quite variable, but as a rule it is shorter when it begins late.

The total quantity and composition of the sap for a season vary with its earliness and duration, though there is a wide variation due to special conditions of weather, which affect the regularity of the flow. As a rule the earliest and longest seasons yield the greatest quantity both of sap and of sugar; notwithstanding, in a late season the maximum daily yield is frequently higher than in seasons of longer duration.

During every season there is a marked periodic variation in the quantity and composition of the sap. T. Wheeler, of Vermont, writes that the sap increases in quantity, density, and sweetness up to a certain time, and then again gradually decreases until the close of the season. The maxima of these different properties do not occur on the same date. Other writers confirm this observation more or less completely.*

Toward the close of the season the sap generally becomes thick, amber-colored, and opaque, and loses its pleasant flavor.

METEOROLOGICAL CONDITIONS.

While there seems to be an invariable periodic change occurring in every season, there are also numerous daily and hourly variations which are attributed to changes in the weather. General observation has led to the following conclusions concerning the effect of particular meteorological conditions:

A wide range of temperature for each day is most favorable. The sap seems to run only when there is an alternation of thawing and freezing. A thawing night is always unfavorable, while a freezing day, of course, tends to stop the flow.

A westerly wind is favorable, but southerly and easterly winds diminish or entirely stop the flow. Providing there is no great change in temperature, no variation has been noted on account of changes in the velocity of the wind.

Clear skies are most favorable. At the approach of a storm the flow lessens or ceases. Very frequently, however, after a fall of rain or a

* This is a point which should be studied by more numerous analyses.

light snow there is a great increase both of sap and of sugar produced, though the actual percentage of sugar in the sap may be slightly lower. A layer of snow and frozen ground over the roots of the trees is always favorable to the highest yield.

While the above rules are of general application, striking deviations are of frequent occurrence, for which no adequate cause has yet been discovered.

VARIATIONS IN TREE.

As would be expected, trees of different age and growth produce sap in varying quantities and of different composition. Many sugar-makers believe that the "first" or "old growth" trees yield a greater amount of sugar than the "second growth," and that the sap is better in flavor and color. Mr. Hosea Thomas, of Lunenburg, states that he has boiled sap from "first" and "second growth" trees alternately for several days, and in every instance obtained a lighter-colored sirup from the sap of the "first growth" than from the "second."

The size of the top is also known to be a potent factor in production. A tree with numerous spreading branches gives sap in greater quantity and of better quality than a tree with a small, slender top. Some observers claim that this factor is important only in the case of "second-growth" trees; but their statements are by no means received without question. Whatever the fact in the case may be, it is readily seen that a large spreading top is the means of bringing into play increased elaborative force, and an increase in the quantity and quality of the sap would naturally follow.

The age, and consequently the size, of the tree in general is also an important element. It is well known that the largest amounts of sap and the richest saps come only from large trees, and that when a small tree yields a large amount of sap and a very rich sap it may be regarded as exceptional. This applies, however, only to trees in flourishing condition. A young tree in active growth will, from readily understood causes, yield a greater quantity of sugar than a very large tree with little vitality. It has further been observed that quite small trees cease flowing more quickly than those of much greater size and are more sensitive to changes of weather. As a rule trees under twenty or twenty-five years of age and under 8 or 10 inches in diameter are rarely tapped. This is not always because of the injury which many suppose to follow tapping in the case of young trees, but because the yield is too small to pay for the attention required.

TAPPING.

The last of the general conditions which affect the quantity and quality of the sap obtained from different trees is the method of tapping.

The first difference may be noted by varying the depth of the bore. President Clark, in his studies on sap-flow, states that the sap taken from the heart alone is much smaller in quantity, but that the flow is of much greater duration, than is the case with sap from the alburnum.

T. Wheeler states, as the result of his experiments on this subject, that while a deep bore yields more sap and more sugar, it is of a quality greatly inferior to that obtained from a shallower bore. Moreover, the deeper the bore the greater the injury to the tree.

The size of the bit used in tapping is of importance, more in view of the injury produced by a larger wound than by reason of any variation produced in the quantity or quality of the sap. Practically as much sap flows when a $\frac{3}{8}$-inch bit is used for tapping as when a $\frac{5}{8}$-inch bit is used, while the wound is much more readily healed.

The height at which the boring is made also influences the product, both in quantity and quality, there being a very marked difference at intervals of only a few feet. The lower the tap is put in the greater will be the yield of sap and sugar, though sometimes there is really a larger percentage of sugar in the sap from higher portions of the tree.

The number of taps in a tree affects the yield in quantity, at least, though no changes in the quality have been recorded as a consequence of an increased number of taps. It is considered of very questionable utility to tap small or medium-sized trees in more than one place, because of the injury resulting from the greater number of wounds.

Trees tapped on the south and east sides yield sap earlier and in greater quantity than those tapped on the north and west sides. On the latter sides the flow continues later, and the sap is sometimes the sweetest, taking the average through the season; but the greater flow of sap on the south and east sides produces a greater quantity of sugar in spite of its slightly smaller percentage. President Clark says that the south side yields twice as much as the north side; this proportion is probably higher than can safely be claimed in all cases, but the difference is always notable.

The frequency of tapping is also regarded as a factor in production. It is commonly accepted that the sweetness of the sap increases in proportion to the frequency of tapping.

EFFECT OF TAPPING ON TREES.

There is much dispute as to the effect of tapping on trees. When the borings are deep of course the trunk is weakened, and a large cavity is left which is not refilled by new growth. Generally the fresh wood caps over the holes in the course of one or two years, but it often happens that the wound is never fully healed. For this reason some makers claim that the large shallow cut made by the ax, in the old-fashioned method of tapping, is less injurious than the small but deep hole made in boring.

When trees are tapped too early, and intense cold weather sets in afterwards, the bark around the boring is sometimes loosened by the expansion due to the freezing of the moist layer just inside. This is very injurious. It has also been noted that if the spouts are removed too early and the sap leaks down between the outer layers of bark, a large strip just below the boring will turn white and drop off, leaving a surface which is covered only with great slowness. Further, when nails are driven into the trees to hold the pails, a similar injury results, as well as a frequent rotting of the wood about the nail-hole.

Mr. Wheeler claims that tapping diminishes the elasticity of the wood, but no other observers note this as a fact.

Notwithstanding these disadvantages, the fact that large trees have been tapped for fifty and one hundred years without being killed in the process, and that, when compared with trees of the same age not often tapped, they are found to elaborate sap in larger quantity and containing more nutritive material, points to the conclusion that, with care, the injury to fair-sized trees is immaterial.

When used for lumber afterward, the few feet of the butt which show the marks of tapping are rejected, but mainly from fear of the nails which may be present.

DESCRIPTION OF EXPERIMENTS.

The trees from which the samples were taken for experiment were selected to represent, as far as possible, the varied conditions by which the quantity and composition of the sap are supposed to be influenced. They are as follows:

No. 1. Swamp maple, in low land, near a large brook, in thick woods but with a fair exposure on the south side. Height, 20 feet; circumference, 7 inches. Tapped on the south side.

No. 2. Swamp maple, near No. 1, but on a little higher and dry ground, with less exposure to the sun, and only about 2 feet from a large birch. Height, 40 feet; circumference, 40 inches; fair top. Tapped on the south side.

. 3. White maple, in an isolated position, in a dry and elevated pasture. Height 60 feet; circumference, 96 inches; with good branching top. Tapped on east and west sides.

No. 4. White maple, at the foot of a sharp incline, and on somewhat swampy ground, but in an isolated and moderately elevated position; roots shaded by a high stone fence. Height, 50 feet; circumference, 110 inches; large top. Tapped on north and south sides.

No. 5. Black maple, in the pasture near No. 4, but in closer proximity to other trees. Height, 60 feet; circumference, 66 inches; good top. Tapped on the south side, at height of 1½ feet.

No. 6. Black maple, about a rod distant from No. 5. Height, 55 feet; circumference, 53 inches; fair top. Tapped on the north side, at height of 2 feet.

No. 7. White maple, in the same pasture, but entirely isolated. Height, 20 feet; circumference, 34 inches; small top. Tapped on the south side.

No. 8. Rock maple, set out in 1860. Stands on high ground and on the north side of a house in a lawn closely planted with well-grown trees, among them some spruce; exposed to the sun at noon. Height, 55 feet; circumference, 35 inches; small top. Tapped in the south side.

No. 9. Striped maple, *Acer Pennsylvanicum*, in same lawn; much shaded. Height, 15 feet; circumference, 7½ inches; small top. Tapped on the north side 2 feet from ground.

No. 10. Rock maple, from a row of trees in a lane; ground high; good exposure to the sun. Height, 55 feet; circumference, 37 inches; good top. Tapped on the north side.

No. 11. Rock maple, in same lane; shaded in the afternoon. Height, 60 feet; circumference, 48 inches; very good top. Tapped on the south side.

No. 12. Rock maple, in lawn; much shaded in the morning and early afternoon by a thick spruce. Height, 55 feet; circumference, 38 inches; very good top, branching at about 14 feet height. Tapped on the west side in four places: (1) At 2 feet height, (2) at 5 feet, (3) at 8 feet, (4) at 11 feet.

No. 13. Rock maple, set out in 1869. Stands in lawn and is much shaded on the south and west sides. The top was cut off in 1875, but a large limb sprang up vertically in its place. Height, 25 feet; circumference, 16 inches; slender top. Tapped on the north side.

No. 14. Rock maple, from seed planted in 1860. In lawn at the northeastern corner of the house; much shaded. Height, 45 feet; circumference, 40 inches; medium top. Tapped on the south side.

No. 15. White maple, in the lane. Height, 40 feet; circumference, 31 inches; medium top. Tapped on the south side.

The above-mentioned trees were tapped on April 7, when the snow was 2 to 2½ feet deep. Later on in the season samples were taken from other trees previously tapped, which have the following characterstics:

No. 16. Rock maple, in the lawn. The top is shaded most of the day by a thick spruce tree, but the trunk has full exposure to the sun. Height, 50 feet; circumference, 37 inches; fair top. Tapped on the southeast side.

No. 17. Rock maple, in the lawn. Top quite full and not shaded; trunk shaded by a small spruce. Height, 50 feet; circumference, 39 inches; good top. Tapped on the southwest side.

No. 18. Rock maple, in the lane. Full exposure in the morning, but shaded the rest of the day. Height, 50 feet; circumference, 40 inches; very good top. Tapped on the east side.

No. 19. Rock maple, "old growth," in Alvin Thompson's camp; situated in wet ground at the foot of the hill near a large brook. Height, 80 feet; circumference, 143 inches; good, gnarly top. Tapped on the north side at height of 5 feet.

No. 20. Rock maple, "old growth," in same position. Height, 80 feet; circumference, 96 inches; spreading top. Tapped on the eastern and western sides at height of 5 feet.

No. 21. Rock maple, in F. Luce's camp, situated in low, wet ground, shaded all day by thick spruce tops. Height, 50 feet; circumference, 57 inches; good top. Tapped on the western side.

No. 22. Rock maple, near No. 21; with very large roots; much shaded. Height, 60 feet; circumference, 46 inches; small top. Tapped on the western side.

No. 23. White maple, in Luce's camp; situated on dry ground on a hill top, in an isolated position. Height, 60 feet; circumference, 119 inches; large spreading top, branching out at the height of 10 feet. Tapped on the eastern, northern, and western sides.

No. 24. Rock maple, in Luce's camp; near a rivulet; ground boggy; trunk very gnarly; near other large trees. Height, 50 feet; circumference, 60 inches; good top. Tapped on the south side at height of 5 feet.

No. 25. Black maple, on a dry knoll in Luce's camp; sunny exposure. Height, 35 feet; circumference, 55 inches; large spreading top. Tapped on the north side at height of 2 feet.

The trees, with two exceptions, are "second growth." The soil is such as would result from the decomposition of granite and talc-schist, and is quite loamy. The trees were tapped with a ½-inch bit to a depth of 1½ inches, and unless otherwise specified at a height of 3 feet.

The spouts used were galvanized, and supported the tin pails. The sap was gathered from Nos. 1 to 15, inclusive, as frequently as possible, weighed and sampled for analysis. Average samples were taken from the pails of Nos. 16–25, without determining the quantity of sap. There was a slight quantity of sap which was spoiled by the rain of the 8th instant, and is not included in the total flow; but it would not appreciably alter the results.

SEASON NOTES.

The summer of 1884 was fair, but the winter season was long and cold. In the middle of March the temperature was down to —30° F., while the snow was several feet deep.

Sap did not commence to flow until the beginning of the second week in April. In the warmer days which ensued the snow rapidly melted, but had not disappeared even in open fields as late as the 17th.

On the morning of the 8th there was a shower which added about 170 grams of rainwater to each sample; later in the day heavier showers occurred, which almost stopped the flow, and made any attempt at estimation useless. The following day was freezing, and consequently the flow was not resumed until the 10th; from which date it continued without cessation in most cases until the 23d. On the 21st there was a slight rain, and an inch or more of snow fell on the 26th, which caused a slight second flow, so slight that only in one case was enough sap gathered for analysis..

During the period of flow the alternations in temperature were marked. According to observations made by the use of self-registering maximum and minimum thermometers, the highest temperature was 81° F., occurring on the 23d; the lowest, 2° F., on the 9th. The greatest difference between the daily maximum and minimum was 38° F., and was found to occur on the 9th, 20th, and 24th; the difference between the maximum of the 24th and the minimum of the 26th was 58° F. The smallest difference was 12° F., occurring on the 28th. The mean daily difference from the 7th to the 28th, inclusive, was 26°.5 F.

The prevailing winds were northerly and easterly in the mornings and evenings, but frequently veered to the south at midday. There was not a really strong wind during the whole season.

More than half of the time the sky was perfectly clear, and when there were clouds they were generally light cumuli, rarely covering more than .5 to .8 of the sky.

ANALYSES OF MAPLE SAPS, ETC., AT LUNENBURG, VT.

In table No. 1 are found the percentages of sucrose in the saps of fifteen trees, together with the quantity of sap given by each tree from April 7 to 29.

TABLE I.—*Percentages of sucrose and weights of sap.*

Date.	Number 1.		Number 2.		Number 3.		Number 4.		Number 5.	
	Sucrose.	Weight of sap.	Sucrose.	Weight of sap.	Sucrose.	Weight of sap.	Sucrose.	Weight of sap.	Sucrose.	Weight of sap.
	P. ct.	*Grams.*	*P. ct.*	*Grams.*	*P. ct.*	*Grams.*	*P. ct.*	*Grams.*	*P. ct.*	*Grams.*
April 7	......	......	2.32	1,488	*5.95	4,593	......	......	......	......
8	......	......	......	......	......	......	3.81	3,813	2.67	3,798
10	......	......	......	......	......	......	......	......	......	......
11	......	......	2.71	3,629	5.39	3,232	4.48	2,140	4.03	1,176
13	......	......	......	......	*5.17	16,287	4.17	9,086	2.78	2,267
14	2.92	198	......	......	5.23	9,525	2.98	9,554	4.26	2,353
15	......	......	2.69	1,956	5.06	8,179	3.96	2,990	4.36	1,360
16	......	......	2.90	1,885	5.73	8,562	*2.94	6,903	4.18	2,494
17	......	......	......	......	4.78	7,895	3.12	10,460	4.63	2,721
18	......	......	3.32	1,417	......	......	......	......	......	......
20	1.98	340	2.84	3,685	4.72	17,647	4.43	12,302	2.97	10,432
21	......	......	3.03	666	5.30	213	4.84	2,380	3.24	3,387
23	......	......	2.74	936	5.59	1,602	5.20	2,267	3.38	1,984
24	......	......	......	......	9.88	128	......	......	......	......
25	......	......	......	......	......	......	5.33	1,374	3.66	2,055
28	......	......	......	......	......	......	......	......	4.18	141
Total weight of sap	......	538	......	15,662	......	77,863	......	63,269	......	34,168
Average sucrose	2.33	......	2.72	......	5.01	......	3.66	......	3.42	......

Date.	Number 6.		Number 7.		Number 8.		Number 9.		Number 10.	
	Sucrose.	Weight of sap.	Sucrose.	Weight of sap.	Sucrose.	Weight of sap.	Sucrose.	Weight of sap.	Sucrose.	Weight of sap.
	P. ct.	*Grams.*	*P. ct.*	*Grams.*	*P. ct.*	*Grams.*	*P. ct.*	*Grams.*	*P. ct.*	*Grams.*
April 7	......	......	......	......	......	......	......	......	......	......
8	3.23	1,729	3.93	439	3.27	2,963	......	......	4.30	382
10	......	......	......	......	3.55	2,637	......	......	......	......
11	......	......	6.41	1,091	4.39	524	......	......	4.50	694
13	3.19	9,241	3.45	2,253	2.69	11,709	3.99	85	4.10	3,331
14	3.29	1,871	3.44	963	3.09	3,657	......	......	3.63	1,586
15	2.90	9,979	3.55	935	3.02	2,991	......	......	......	......
16	4.78	1,601	3.39	1,133	2.85	3,956	......	......	......	......
17	3.89	3,019	......	......	2.87	2,467	......	......	3.17	2,210
18	......	......	4.10	1,133	2.93	2,904	......	......	......	......
20	3.03	9,979	3.15	3,231	2.91	4,138	3.62	212	3.05	4,818
21	2.91	6,647	3.76	240	......	......	......	......	3.66	453
23	3.04	3,288	3.98	212	2.71	368	......	......	3.58	1,077
24	......	......	......	......	......	......	......	......	......	......
25	3.20	2,749	......	......	......	......	......	......	......	......
28	......	......	......	......	......	......	......	......	......	......
Total weight of sap	......	50,103	......	11,630	......	38,314	......	297	......	14,551
Average sucrose	3.15	......	3.74	......	2.98	......	3.73	......	3.53	......

TABLE I.—*Percentage of sucrose and weights of sap*—Continued.

Date.	Number 11.		Number 12.		Number 13.		Number 14.		Number 15.	
	Sucrose.	Weight of sap.	Sucrose.	Weight of sap.	Sucrose.	Weight of sap.	Sucrose.	Weight of sap.	Sucrose.	Weight of sap.
	P. ct.	*Grams.*	*P. ct.*	*Grams.*	*P. ct.*	*Grams.*	*P. ct.*	*Grams.*	*P. ct.*	*Grams.*
April 7	......	....	......	....	......	....	......	....	......	....
8	5.14	866	2.03	2,538	2.84	326	2.67	539	3.11	679
10	5.47	510	......	....	......	....	......	....	......	....
11	2.98	213	4.26	965	2.51	269	6.04	539	3.69	1,488
13	4.75	2,906	4.03	3,430	4.85	510	6.17	1,885	3.58	2,807
14	4.59	1,361	†4.26	2,083	4.57	397	6.06	454	3.24	992
15	4.37	1,347	4.15	1,374	3.18	567	3.46	1,427	3.17	964
16	4.16	1,744	3.32	2,197	3.97	298	2.90	1,899	2.66	1,361
17	3.90	1,646	3.18	2,126	4.13	553	......	....	2.91	510
18	4.08	1,885	......	....	......	....	......	....	......	....
20	4.17	3,827	3.32	4,390	3.34	1,063	10.20	227	2.68	2,027
21	......	....	4.35	737	3.63	184	......	....	......	....
23	4.68	....	3.46	950	3.21	170	3.68	2,381	......	....
24	......	....	......	....	......	....	......	....	......	....
25	......	....	......	....	......	....	......	....	......	....
28	......	....	......	....	......	....	......	....	......	....
Total weight of sap	......	16,475	......	20,790	......	4,337	......	9,351	......	10,828
Average sucrose	3.75	....	3.55	....	3.69	....	4.36	....	3.18	....

*Analysis of sap from one tap only. †Analysis of sap from lower two taps.

The specific gravity of the saps taken by the hydrometer at 62° F. generally ranges between 1.010 and 1.020; where the percentage of sugar reached 5 or 6 per cent. the specific gravity would reach 1.025. The mean specific gravity is nearly 1.015.

The variations in the content of sugar in the saps of each tree are greater than would have been expected. In most cases, however, it will be seen that a notable increase in the content of sugar is accompanied by a decrease in the quantity of sap.

The highest percentages of sucrose are found in tree No. 3, April 24, viz, 9.88 per cent., and in tree No. 14, April 20, viz, 10.20 per cent. In both these cases it will be noticed that the flow of sap was small, being 128 and 227 grams, respectively.

The study of the sap from such a tree as No. 3 offers also the interesting suggestion that it may be quite possible to increase the percentage of sugar in the sap of future maples by planting the seed of such trees as show the largest percentage of sucrose. There are large areas in all the Northern States unsuitable for tillage but well adapted to the growth of maple forests. If such forests are not planted too thick the ground will afford good pasturage, while, after a quarter of a century, the trees will yield large quantities of sugar. In planting such forests it will be wise to take the seed from trees with the best pedigree. There is every reason to believe that a race of maples, yielding a large percentage of sugar, could be developed as easily as a race of cows, yielding large quantities of butter.

Among the maples there may yet be a race of Jerseys.

ALBUMINOIDS.

To determine albuminoids 10 cubic centimeters of the sap were evaporated to dryness, and burned with soda-lime. $\frac{N}{100}$ soda and acid were used for titration.

The following are the results obtained:

Per cent. of albuminoids.

Date.	No. 3.		No. 4.		No. 8.	No. 11.
	E.	W.	N.	S.		
April 8					.0119	
11		.0138			.0206	.0219
13		.0319	.0144		.0219	.0225
14	.0069	.0188	.0244	.0263	.0206	.0294
15, 12 m	.0094	.0269	.0112	.0300	.0275	
15, 3 p. m					.0044	.0200
15, 6 p. m					.0219	.0231
16						
23		.0300			.0469	
Mean	.0081	.0163	.0180	.0272	.0202	.0242

The albumen was also estimated in sap taken on the 17th, from the groves of Messrs. Stewart and Smith. In Mr. Stewart's grove of 700 trees the percentage was .0088; in Mr. Smith's grove of 1,500 trees it was .0103.

OTHER CONSTITUENTS.

All the early saps were tested for starch, but in every case with negative results.

All tests for reducing sugar in the early saps in the fresh state failed to reveal its presence. As the season advanced, however, it was present in increasing quantity. Eight determinations made in saps collected on the 23d give a mean of .256 per cent., but casting out three especially thick saps the average is cut down to .057 per cent.

Most of the samples were titrated with $\frac{N}{100}$ soda, to determine the amount of acid, which was calculated as malic acid.

The maximum amount in a fresh juice rarely reached .005 per cent., and more frequently fell to .0005 per cent. The clearest saps frequently contained the most acid.

The mean of 25 determinations of solids gives a purity coefficient of 95.0; and the mean of 22 ash determinations is .146 per cent.

The thick viscous sap which occurs late in the season, or when a sap is allowed to stand for any length of time exposed to a warm atmosphere, gives a slight precipitate of gum upon the addition of an equal volume of strong alcohol, which does not occur with the earlier saps.

Analyses of saps taken from different sides of the tree.

Date.	Tree No. 3.				Tree No. 4.			
	East.		West.		North.		South.	
	Sucrose.	Weight of sap.	Sucrose.	Weight. of sap	Sucrose.	Weight of sap.	Sucrose.	Weight. of sap.
	Per cent.	*Grams.*	*Per cent.*	*Grams.*	*Per cent.*	*Grams.*	*Per cent.*	*Grams.*
April 7	....	2, 977	5. 80	1, 616	....	....	....	....
8	....	....	....	....	3. 23	2, 155	4. 56	1, 658
11	6. 23	2, 169	3. 69	1, 063	5. 11	170	4. 43	1, 970
13	....	9, 299	5. 40	6, 988	3. 87	3, 544	4. 36	5, 542
14	5. 14	5, 585	5. 35	3, 940	3. 03	2, 665	2. 96	6, 889
15	4. 88	5, 542	5. 44	2, 637	3. 07	609	4. 19	2, 381
16	4. 53	5, 897	5. 17	2, 665	....	....	2. 94	6, 903
17	4. 69	4, 747	4. 92	2, 948	3. 27	3, 416	3. 06	7, 044
20	4. 78	9, 355	4. 66	8, 292	4. 65	6, 406	4. 20	5, 896
21	5. 30	2, 130	....	....	5. 16	1, 360	4. 41	1, 020
23	6. 15	1, 035	4. 56	5, 067	5. 46	1, 530	4. 67	737
24	....	Dry.	9. 88	128	5. 33	1, 374	....	Dry.
25	....	....	....	....	....	....	....	....
Total weight of sap.	....	47, 019	....	30, 884	....	23, 229	....	40, 040
Mean per cent. of sucrose	4. 93	....	5. 10	....	4. 10	....	3. 41	....

In tree No. 3 the west side seems to afford a slightly richer sap, but it will be seen that the flow was not so abundant as from the east side, In No. 4 the same is true of the north side.

Analysis of saps taken from taps at different heights.—Tree No. 12.

Date.	1.		2.		3.		4.	
	Sucrose.	Sap.	Sucrose.	Sap.	Sucrose.	Sap.	Sucrose.	Sap.
	Per cent.	*Grams.*	*Per cent.*	*Grams.*	*Per cent.*	*Grams.*	*Per cent.*	*Grams.*
April 8	2. 95	780	2. 22	496	1. 93	312	1. 22	950
11	3. 91	298	5. 17	142	5. 21	156	3. 78	369
13	3. 54	1, 120	3. 85	893	3. 88	652	5. 08	765
14	4. 03	680	4. 57	510	....	397	....	496
15	4. 16	312	4. 20	439	4. 31	340	3. 90	283
16	2. 74	751	3. 47	595	3. 82	454	3. 61	397
17	2. 77	822	3. 43	1, 304	....	....	....	....
20	2. 72	1, 488	3. 44	1, 215	3. 77	950	3. 81	737
21	4. 05	524	5. 08	213	....	....	....	....
23	3. 11	780	5. 06	170	....	....	....	....
Total weight of sap.	....	7, 555	....	5, 977	....	3, 261	....	3, 997
Mean per cent. of sucrose	3. 23	....	3. 70	....	3. 29	....	2. 96	....

From this it is seen that the sap from various parts of the trunk varies in composition, but not regularly in proportion to distance above the ground. Thus in the above experiment the best sap was found at a distance of 5 feet above the ground, while the poorest was taken at a height of 11 feet. Further experiments will be necessary to determine the influence of altitude of tap on the composition of the sap.

Analyses of saps taken from the same trees at different times of day.

Date.	9 a. m.				12 m.			
	No. 8.		No. 11.		No. 8.		No. 11.	
	Sucrose.	Weight of sap.	Sucrose.	Weight of sap.	Sucrose.	Weight of sap.	Sucrose.	Weight of sap.
	Per cent.	*Grams.*	*Per cent.*	*Grams.*	*Per cent.*	*Grams.*	*Per cent.*	*Grams.*
April 15	....	....	....	....	2.96	1,687	4.40	780
16	....	....	....	....	2.62	1,588	4.07	950
17	2.69	1,191	4.27	808	2.96	794	2.97	498
18	....	....	....	....	2.86	1,884	4.21	1,205
20	....	....	....	....	2.99	595	4.18	595
Total weight of sap	....	1,191	....	808	....	6,548	....	4,028
Mean per ct. of sugar	2.69	....	4.27	....	2.88	....	4.06	....

Date.	3 p. m.				6 p. m.			
	No. 8.		No. 11.		No. 8.		No. 11.	
	Sucrose.	Weight of sap.	Sucrose.	Weight of sap.	Sucrose.	Weight of sap.	Sucrose.	Weight of sap.
	Per cent.	*Grams.*	*Per cent.*	*Grams.*	*Per cent.*	*Grams.*	*Per cent.*	*Grams.*
April 15	3.10	964	4.31	411	3.12	340	4.38	156
16	3.05	1,503	4.18	496	2.93	865	4.43	298
17	3.18	482	4.40	340	....	....	....	....
18	3.06	1,020	3.86	680	....	....	....	....
20	3.27	340	4.27	369	....	....	....	....
Total weight of sap	....	4,309	....	2,296	....	1,205	....	454
Mean per ct. of sugar	3.07	....	4.16	....	2.98	....	4.42	....

The above results are also negative. In tree No. 8 it appears that the maximum richness of the sap was in the sample taken at 3 p. m., while in No. 11 it was found in the sample taken at 6 p. m. In all the above cases, except those of April 20, 12 m., it must be remembered that the sample taken at any given time included the whole product of the tree from the time the immediately preceding sample was taken; in the exceptional case, the sap taken was the product of the flow from 9 a. m. of that day.

Total quantities of sap and sugar from each tree.

Number.	Weight of sap.	Mean per cent. of sucrose.	Weight of sugar.
	Grams.		*Grams.*
1	538	2.33	12.51
2	15,662	2.72	436.66
3	77,863	5.01	3,939.75
4	63,269	3.66	2,317.93
5	34,168	3.42	1,169.22
6	50,103	3.15	1,579.28
7	11,630	3.74	434.33
8	38,314	2.98	1,141.40
9	297	3.73	11.06
10	14,551	3.53	513.94
11	16,475	3.75	617.05
12	20,790	3.55	738.36
13	4,337	3.69	160.22
14	9,351	4.36	408.06
15	10,825	3.18	344.48
Mean, omitting 1 and 9	28,257	3.75	1,061.59

The average yield of sugar to the tree varies much in different seasons. It is usually stated as two to three pounds. Large trees have yielded, however, as high as forty pounds, and quite a number are known to have yielded twenty pounds in a single season. The usual quantity of sap required for a pound of sugar is sixteen quarts, but Mr. Wheeler mentions a tree which yields a pound for every five quarts. This year Mr. Porter Smith made about 3,000 pounds from 1,500 trees; Mr. Hosea Thomas, 1,000 pounds from 500 trees, though in some seasons he makes twice that quantity. Mr. Chester Thomas made about three pounds to the tree, whereas he has made as much as five to six pounds, in very favorable seasons. The product this year would seem to be on the average two to two and a half pounds.

AVERAGE YIELD FROM GROVES.

In order to determine the average percentage of sugar from a large number of trees, samples were collected from the storage-tanks of different sugar-makers:

No. 1. From camp of H. Day, who has 250 trees, largely old-growth rock maple, on a low, moist piece of ground. Sample taken on the 9th.

No. 2. Taken on the same date, from the camp of V. E. Hartshorne, adjoining that of H. Day, and of similar character. Taps 300 trees.

No. 3. Taken on same date, from the camp of Harrison Stowell, which lies high on a hillside, with eastern aspect, and is composed largely of second-growth trees, with a good proportion of white maple. Taps 500 trees.

No. 4. From the camp of Wesley Stewart, which lies on a gentle slope with boggy ground, and contains mainly second-growth trees, and a good proportion of white maples. Taps 700 trees. Taken on the 17th.

No. 5. Sample taken on the same date, from camp of Porter Smith, which lies on the same side of the ridge with that of H. Stowell, and is similar in make-up. Taps 1,500 trees.

No. 6. Taken on the 22d, from camp of F. Luce, on a gentle slope with southern aspect. All good-sized second-growth, with many white maples.

Average yield of large number of trees.

Sample number.	Date.	Number of trees	Per cent. sucrose.
1	April 9	250	3.37
2	9	300	3.71
3	9	500	2.93
4	17	700	3.85
5	17	1,500	3.07
6	22	300	2.39
Total		3,350	3.25

MANUFACTURING NOTES.

The trees are tapped as soon as the sap will flow; ⅜-inch to ⅝-inch bits are used, and borings made to the depth of 1 to 1½ inches, preferably near the ground and on the southern or eastern sides. Trees under 7 or 8 inches diameter are not tapped. Spouts of tin, galvanized iron, or seasoned wood, are driven in so as to be supported by the bark. The metal spouts are best because they hold the pail on a depending hook, in the absence of which a nail must be used. Painted wooden pails are often used, but the tin pails are growing in favor, being lighter, more readily cleaned, and more durable. Covers for the sap-pails have been invented, but have not as yet come into general use.

The sap is collected as frequently as possible, by hand or in a draw-tub of tin or wood securely fastened to a sled. Before being placed in the storage-tank it must be freed from impurities by straining or settling. Draw-tubs and storage-tanks of tin are highly recommended. When the sap is dark colored, or thick, as at the end of the season, it should be kept separate, and can often be used for making vinegar. Sap must not be allowed to stand in storage-tanks longer than is absolutely necessary, and must not be kept in a warm place, since it spoils rapidly.

Kettles are used only by careless makers. The best makers use Russia iron pans, 5 x $2\frac{1}{2}$ x $\frac{8}{12}$ feet in dimensions; they are set on brick arches, which are 20 inches in depth, and made with an ash and air space below. A great many use the heater—a copper box with three or four large, or twenty or thirty small tubes passing through it, and with a funnel-shaped tin top provided with overflow tubes. The heaters are placed behind the pans, and the waste heat passing through the tubes is utilized. The sap always boils violently on each fresh addition, and overflows into the adjoining pan. The best makers are discarding the "heater," because the violent ebullition prevents skimming immediately after the addition of cold sap. There is little change in specific gravity effected in the heater. A few use evaporators, or pans so arranged that the sap flows in continuously at one end and comes out at the other as sirup. As they are more expensive and require more care than the pans, they are not very much used

The fuel used consists of soft-wood trimmings of the grove, spruce, and hemlock brush or saw-mill edgings. The usual quantity required is 1 to $1\frac{1}{4}$ cords for each one hundred pounds of sugar.

To produce a light-colored sirup, quick boiling and thorough skimming are necessary. A few use milk or white of egg for raising the scum, but it is apt to diminish the clearness of the sirup; the best makers add sap little by little, and skim immediately after each addition, most of the impurities coming at once to the surface.

The scum is generally of a very dark color, and sometimes contains as much as .37 per cent. of albuminoids.

When the sirup has reached the desired consistency it is run out of the pan and filtered, while hot, through flannel.

If the product desired is sugar it should be made directly from the sap, for the sirup darkens and loses flavor on standing. Chester Thomas, of Lunenburg, Vt., who has gained a wide reputation by his light-colored sirups and sugars, says that he always runs the boiling sirup down into sugar as soon as it reaches a slight straw color, no matter how small the quantity. When the boiling is completed the pan is removed and the sirup stirred while cooling to give a lighter color and a smoother grain to the sugar. Molded and stirred sugar requires more boiling, and consequently more care to avoid scorching.

The usual test for the completion of the boiling is the attainment of a given consistency, which varies with each maker, as the hydrometer is rarely if ever used. Mr. Whitcomb, of Enosburg, Vt., mentions the following temperatures as indicative of the degree of concentration for sugar and sirup: Sirup, 220° to 222° F.; tub-sugar, 228° to 232° F.; cake-sugar, 245° F.; stirred sugar, 252° F. The thermometer is, however, not often used.

A source of great annoyance to many sugar-makers is found in the so-called "sand" or "niter," which forms a non-conducting layer on the pans, deteriorates the appearance of the sirup by separating out, on standing, in dirty-looking flocks, and gives an unpleasant grittiness to the sugar. The deposition is said to occur only at a density of 28° to 32° of the saccharometer. If the coating is burned on the pan it is very difficult to remove, hence the pans should be scraped clean every day. While early analyses seem to conflict as to the composition of this substance, all recent investigations prove it to be invariably an impure acid malate of lime.

Its occurrence to a troublesome extent is very variable, and no satisfactory explanation of its variation has yet been found. Most observers agree that it occurs in greatest quantity after an open winter, or in seasons when the sap is sweetest, and that groves on low mucky soil are more affected than those on high dry land.

In Northern Vermont the sirups are sent to market in large tin cans. The greatest demand is for tub-sugar, which is poured, while warm, into tin or wooden vessels of about 28 pounds capacity. Occasionally a little sugar is made into 4-pound, 2-pound, and ¼-pound cakes, but there is little demand in the markets supplied by Essex County for sugar in this shape.

Mr. Wheeler estimates that the cost of manufacture is between 6 and 7 cents per pound. As good sugar in bulk brings 10 and 12 cents per pound, and good sirup $1 and $1.25 per gallon, it would seem that the business is quite profitable, especially since it occurs at a time when little work can be done on the farm.

INDEX.

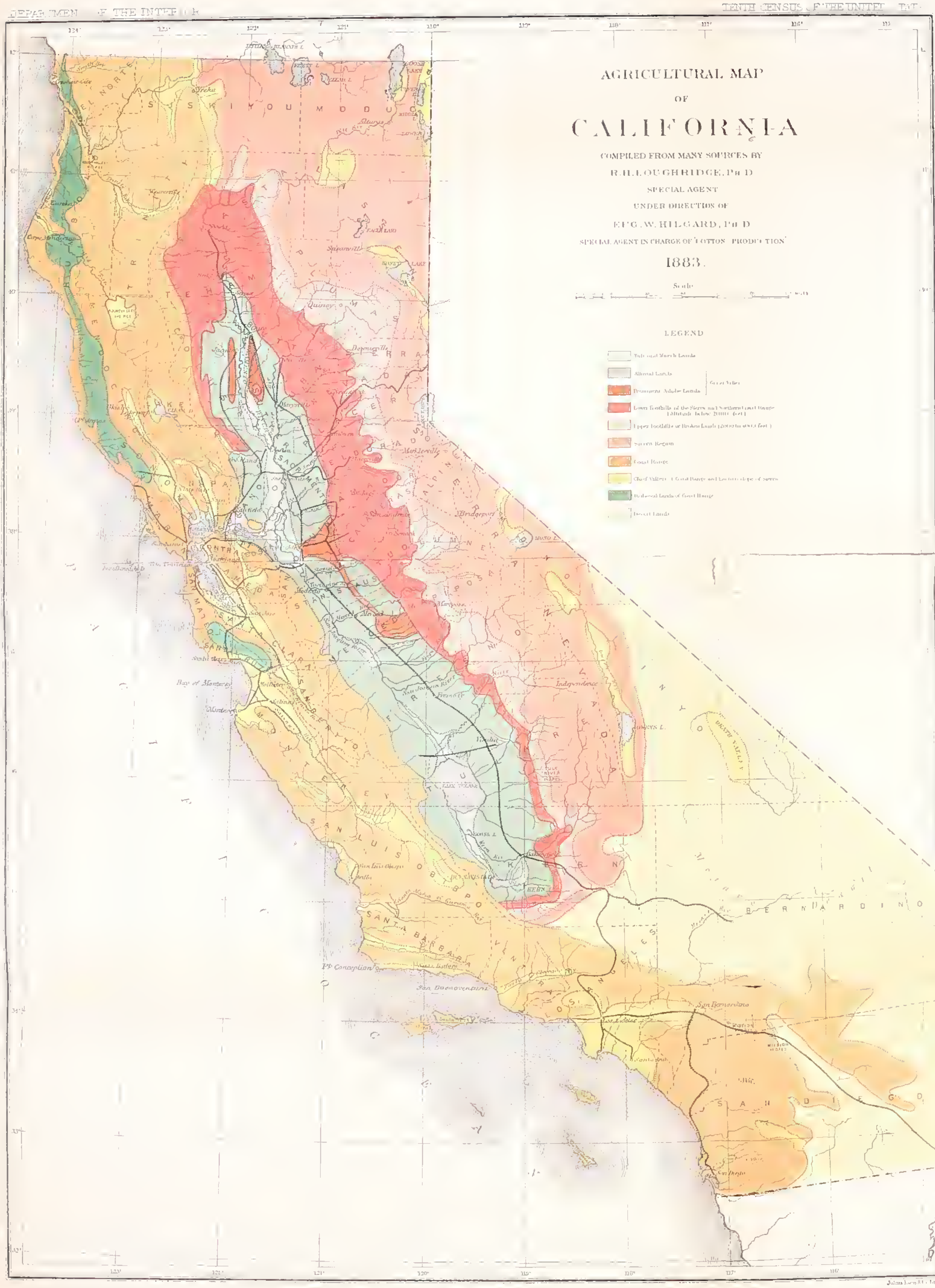
A.

B.

M.

N.


38°


AGRICULTURAL MAP
OF
CALIFORNIA
COMPILED FROM MANY SOURCES BY
R. H. LOUGHRIDGE, Ph D
SPECIAL AGENT
UNDER DIRECTION OF
E. W. HILGARD, Ph D
SPECIAL AGENT IN CHARGE OF "COTTON PRODUCTION"
1883.
Scale
LEGEND
Tule and Marsh Lands
Alluvial Lands
Great Valley
Prominent Adobe Lands
Lower Foothills of the Sierra and Northern Coast Range (Altitude below 2000 feet)
Upper Foothills or Broken Lands (2000 to 4000 feet)
Sierra Region
Coast Range
Chief Valleys of Coast Range and Eastern slope of Sierra
Redwood Lands of Coast Range
Desert Lands