8th August, 1912.

ADJOURNED DISCUSSION.

Mr. A. Stobo, in continuing the discussion, said that the author had made it clear that condensers and air pumps were used in the manufacture of sugar, mainly for the purpose of obtaining low temperatures during evaporation. He thought this point would probably be more clearly demonstrated by referring to a table showing the varying temperatures corresponding to degrees of vacuum. The table, which was no doubt very well known, was shown in the following figure, No. 1, from which it would be seen that, while at low

Table of Temperatures of Boiling Points of various Pressures & correspdg inches of Mercury & Ft of Water

Inches of Mercury	Tempt of Boiling Pt F	Press're per □" in lbs	Head of Water in Ft	Inches of Mercury	Tempt of Boiling Pt F	Press're per □" in lbs	Head of Water in Ft
29·92	0°F	0	33·9	14½	181	7·62	16·33
29½	59	·25	33·34	14	182	7·86	15·78
29	80	·49	32·78	13½	183	8·11	15·20
28½	92	·74	32·21	13	185	8·35	14·65
28	102	98	31·65	12½	186	8·60	14·07
27½	109	1·23	31·07	12	187	8·84	13·52
27	116	1·47	30·52	11½	189	9·09	12·94
26½	121	1·72	29·94	11	190	9·34	12·36
26	126	1·97	29·37	10½	191	9·58	11·81
25½	130	2·21	28·81	10	192	9·83	11·23
25	134	2·46	28·24	9½	194	10·07	10·68
24½	138	2·70	27·68	9	195	10·32	10·10
24	141	2·95	27·11	8½	196	10·56	9·55
23½	144	3·19	26·55	8	197	10·81	8·99
23	147	3·44	25·98	7½	198	11·06	8·40
22½	150	3·68	25·42	7	199	11·30	7·84
22	152	3·93	24·85	6½	200	11·55	7·27
21½	155	4·18	24·27	6	201	11·79	6·71
21	157	4·42	23·72	5½	202	12·04	6·14
20½	159	4·67	23·14	5	203	12·28	5·58
20	162	4·91	22·59	4½	204	12·53	5·01
19½	164	5·16	22·01	4	205	12·77	4·45
19	166	5·40	21·46	3½	206	13·02	3·88
18½	168	5·65	20·88	3	207	13·27	3·3
18	170	5·90	20·30	2½	208	13·51	2·74
17½	171	6·14	19·75	2	209	13·76	2·17
77	173	6·39	19·17	1½	210	14	7·61
16½	175	6·63	18·62	1	210	14·25	1·04
16	176	6·88	18·04	½	211	14·5	·46
15½	178	7·12	17·49	0	212	14·7	0
15	179	7·37	16·91				

Fig. 1.

vacua the difference in temperature only showed a small rise of 2° to 3° Fahr, per inch; for higher vacua, say between 28″ and 29″, there was a difference of 13° Fahr.

The author showed us quite a variety of condensers, and gave some very interesting and instructive particulars. The speaker had spent quite a considerable time in sugar mills, and, consequently, had actual experience of many condensers. It was pointed out in the paper that surface condensers were not largely used in sugar factories, but he had one under his care that gave very satisfactory results.

In the next Figure No. 2 was shown the condenser in question, which was connected to a triple effet apparatus. It may interest members to know that when the air pump was first started with this plant, it was only possible to obtain about 16″ of vacuum, with a corresponding temperature of

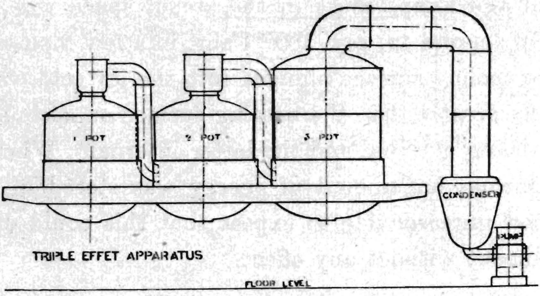
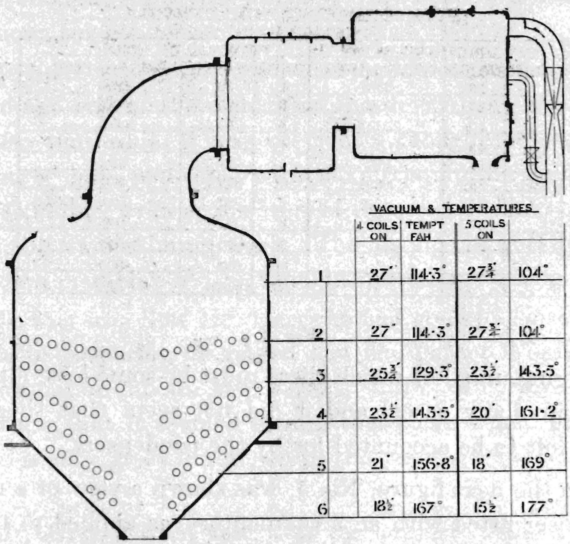


Fig. 2.

176° Fahr., and until the temperature of the juice in the 3rd pot rose to boiling point, and vapour was given off so that the surface condenser came into operation, the vacuum remained the same. However, after the surface condenser came into operation, in about half-a-minute's time the vacuum quickly rose to 26″, with a corresponding temperature of 125° Fahr. This sudden rise of vacuum was responsible for such a commotion in the 3rd pot that, unless the juice had been kept at a low level, a large quantity of the liquid was liable to boil over and be lost out of the pot. He had seen this happen on several occasions when the apparatus was in the charge of an inexperienced man who could not believe that such a thing was possible. Although the matter was rather irrelevant, he considered that it was sufficiently interesting to justify his referring to what he considered was a similar case. He referred to the explosion of the boiler of a ship when it sank. It was stated that those of the "Titanic" exploded when she went down, and since then the boiler of a small steamer on one of the American lakes. The matter was one often referred to, and he would like to hear what Members' views were on the subject. He knew that some would ridicule the idea of such a thing happening, but, for his part, after the experience he mentioned with the effet apparatus (which he might add had a safety valve in the outlet pipe, the latter being 4 ft. in diameter), he quite believed that such a thing was possible; especially, seeing that the temperature in the steam space was reduced from 176 degrees to, say, 100° Fahr. in a few moments, and that the cooling surface plunged into the icy cold water was relatively greater than the heating surface on account of the former being external and the latter internal. When it was realized what an amount of energy was stored in a boiler it seemed unreasonable to expect that this could disappear in a moment without any effect.

Here is a further table shown in Figure 3, which gave some particulars of tests made to show the difference in temperature in deep vacuum pans. On referring to the figures it will be seen that, whilst in the upper part of the pan there was a vacuum of $27\frac{3}{4}''$, with a corresponding temperature of 104°, the temperature of the massecuite in the lowest part of the pan was 167°, so that it will be understood that it was quite possible for the temperature of the discharged massecuite to be very much higher than the temperature due to the vacuum in the top of the pan. He remembered that at one period of his experience a very great difficulty was met with owing to a disease in the cane called "Gumming," and this made tne massecuite so stiff that it was practically impossible to circulate it in the pans. The suggestion was made that some jets of steam be blown into the bottom of the pans, and this immediately made a great improvement. He believed that the diameter of these jets was about ¾" and that all of the pans were now fitted with such.



VACUUM & TEMPERATURES

	4 COILS ON	TEMPT FAH	5 COILS ON	
1	27"	114·3°	27¾"	104°
2	27"	114·3°	27¾"	104°
3	25¾"	129·3°	23½"	143·5°
4	23½"	143·5°	20"	161·2°
5	21"	156·8°	18"	169°
6	18½"	167°	15½"	177°

BOILING TEMPERATURES & PRESSURES

IN A VACUUM PAN

Fig. 3.

It may be interesting to quote some tests which he had made to show how rapidly the rate of evaporation drops as the boiling proceeds and the massecuite gets heavier. These figures were given on the following Figure 4, and were obtained by measuring the condensed water from the steam coils. This reminded him of the question of entrainment mentioned by the author, and he thought it was obvious from this test that, if there was any entrainment at all, it could only occur during the first half hour or so, and while the pan was boiling down If a loss from this cause did occur it would of course be serious, but he thought the loss actually was small, as the total undetermined loss in a sugar mill was not great. This included losses at the juice wells, pumps, clarifiers, filterpresses, effets, pans, coolers, centrifugals, and

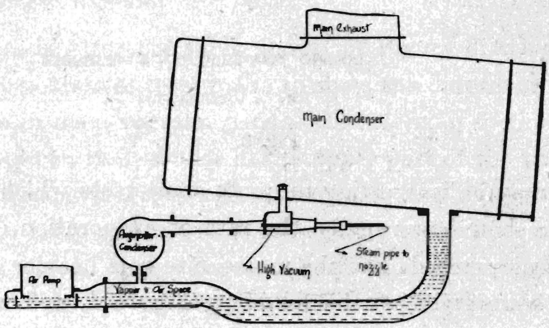
TESTS OF CONDENSED WATER FROM COILS IN A VACUUM PAN

FROM LOWEST COIL IN PAN			FROM ALL THE COILS		
TEST Nº	MINUTES	CALLS PER HOUR	TEST Nº	MINUTES	CALLS PER HOUR
1	20	500	1	20	2250
2	25	395	2	20	1500
3	40	267	3	30	1000
4	45	175	4	30	1000
5	55	166	5	50	550
6	75	115	6	60	500
7	75	100	7	60	750 5COILS
	85	28	8	60	500
			9	60	500
			10	60	500
			AT	FINISH	325

Fig. 4.

in bagging, in all of which there must be some loss, although small in many cases, and it did not seem that there was much left to be accounted for by the condensers.

In the next figure, No. 5, was shown a view of a marine condenser fitted with an "Augmentor" as applied to the Gt. Western Railway Co's. steamers for use with their turbine



VACUUM AUCMENTOR FOR MARINE ENCINE

Fig. 5.

engines, and the speaker had endeavoured to make use of a similar device in connection with a vacuum pan condenser, with a view to obtaining an extra $\frac{1}{2}''$ or so. The result was not satisfactory, and although quite a number of trials were made, he could not claim to have gained $\frac{1}{8}''$, probably because the vacuum was already high, viz, $28\frac{1}{2}''$, and, unlike pressure, there was a limit in the case of a vacuum, and he thought they were probably very near to it under the conditions the condenser in question was working.

He had learned, however, that it did not matter at what part of the end of the condenser the device was connected, and also that while it was previously thought necessary to have an 8″ pipe connected with the air pump, he found that $1\frac{1}{2}''$ was ample, even at the start of the process when the pan was doing its maximum work. The air pipe in question was now 4″ in diameter and he thought quite large enough.

He was sure that Mr. Harricks had gone to considerable trouble in preparing his paper, and had gathered quite a lot of information about the various forms of condensers in actual use, but it seemed to him that there would probably not be a very great difference in the results obtained therefrom.

Mr. Hector Kidd said that the subject of the author's paper covered a wide field and one that was now receiving the attention of engineers throughout the world, more particularly in connection with the steam turbine, in view of the importance of high vacua for obtaining the best results.

In raw sugar factories, refineries, and other industries which dealt with organic materials, such as sugar, syrup, milk, blood, gelatine, etc., the use of the condenser was essential, as the boiling and evaporating should be done at a low temperature to prevent injury to, and deterioration of the solutions.

The economy to be gained by the use of the condenser in steam engines and turbines varied from 20 to 25%. In the case of vacuum pans and single effet evaporating vessels, there was practically no economy over the system of open evaporation, but with multiple evaporators the use of the condenser permitted the solutions to be evaporated at low temperatures and with very considerable economy of steam.

He was able from experience to endorse the statement of the author that the highest efficiency and economy could only be obtained when working with the highest practicable vacuum in multiple effets; and also that in a well balanced raw sugar factory the exhaust steam from the power plant was about sufficient to do all the heating, boiling and evaporation required in the production of sugar from the sugar cane. This result was mainly due to the system of multiple evaporation in use in all modern factories.

The diagramatic sketch shown in Figure 1 of the paper illustrated a quadruple effet apparatus and condenser of the ordinary kind. With the author's permission he should like (although it was rather outside the scope of the paper) to supplement his description with a few figures to explain its working and economy in evaporation.

Assuming the apparatus to contain 16,000 sq. ft. of heating surface, divided equally in each of the four vessels, i.e., 4000 sq. feet in each vessel, the rate of evaporation per square foot of total heating surface may be taken at .6 gallons per sq. ft. per hour $= 16{,}000 \times .6 = 9600$ gals. of water evaporated per hour. Without computing an accurate heat balance, but taking round figures, it may be stated that the 9,600 gallons, or 96,000 lbs. of water, could be evaporated in the apparatus by the condensation of 2,400 lbs. of steam supplied to the first vessel $= \frac{96{,}000}{2{,}400} = 4$ lbs. of water evaporated per 1 lb. of steam condensed. Under these working conditions the weight of vapor or steam passing from the 4th vessel of the apparatus to the condenser was approximately about 27,000 lbs. per hour.

Broadly speaking, condensers may be divided into two classes, viz.: the jet and surface types; the surface condenser was only used in raw sugar factories when it was deemed necessary to save the water of condensation for use in the factory. An example of this kind, the speaker remembered, occurred in the year 1888 when enlarging and re-