SOUTH AFRICAN SUGAR TECHNOLOGISTS' ASSOCIATION.

REPORT FROM THE COMMITTEE ON BOILERS AND BOILER PRACTICE.

Last year's work on the Boilers has made itself felt in many directions both directly and indirectly. The direct results are visible in the increase in efficiency reported by those factories where alterations were made in their boiler plant as a result of the 1932 work on the boilers. The indirect effect is seen in the large number of factories in which either new boilers and furnaces are being installed or structural alterations to the furnaces is being effected based on experience gained elsewhere.

Some definite examples may not be without interest. In one factory five of the furnaces were reconstructed and the efficiency resulting therefrom was such that two boilers could be laid off and still sufficient steam was provided for the requirements of manufacturing. The two boilers were cleaned during the week and another two would then be laid off and thoroughly cleaned. The advantages resulting from this convenience are very obvious.

In another place the installation of superheaters and a reconstruction of two furnaces led to the reduction of the coal by half its former figure. Moreover, since the high speed engines were then run on superheated steam no water was found in the oil and the bill for the latter was very materially reduced. Before using superheated steam it had been necessary to add oil regularly to replace that drawn off with the water in the oil sump.

A further factory reports that the alterations made to the draught system of the boilers overcame the steam shortage. They were in fact able to increase the crushing rate and the imbibition water used.

Let us now consider this year's work. This year we had at our disposal a Lea Recorder for measuring the boiler feed water, and much use was made of it in several directions. Beyond using this instrument in place of the meter used last year, the method of conducting the tests was not altered.

The list of figures given in the table shows much improvement, and they set forth results of tests on flat grates, semi-cook furnaces, cook furnaces, and steam furnaces. Semi-cook furnaces are grates surrounded on three sides with tuyeres through which auxiliary air is introduced by forced draught. The steam furnace is one in which extra air is introduced by means of jets of superheated steam.

Tests 1 and 2 are records taken in the same factory. The boilers are both Babcock & Wilcox boilers of the same heating surface but in one the steam is superheated and in the other it is not. In the former the grate is flat and of 31.5 sq. feet area, the latter has a semi-cook furnace of grate area 18 sq. feet. The combustion spaces are identical in the shape and volume. The first evaporated 89,254 lbs. of water during the test and the second 100,831 lbs. of water in the same time, i.e., 7½ hours.

The installation of the superheaters has meant that all the water evaporated appeared as steam, whereas in the second case the nett evaporation is less than the former, i.e., 83,993 lbs. as against 89,254 lbs. of water evaporated. The amount of bagasse used in each furnace was almost identical in weight.

The difference in the furnace construction shows itself in the greater average temperature maintained by No. 2, i.e., 1,867°F. compared with 1,584°F. The flue temperature in each case is too high.

The CO_2 is not particularly good 10.6% and 11.0%.

There is not sufficient combustion volume in either furnace. In both cases the bagasse burnt up the passes in the tubes, No. 2 being much worse than No. 1.

The two furnaces operated only on induced draught.

The evaporation from and at 212°F. of 5.12 and 4.7 is a great improvement on last year's evaporation of 3.74; 3.40; 3.42 (tests 7-9).

No. 3 was No. 11 in last year's tests and it will be seen how much the installation of the superheater has improved the work of the boiler. The water actually evaporated per square foot H.S. per hour being last year 2.95 lbs. and this year 3.81. Owing to the installation of a bagasse-feeder the excess air has been very considerably reduced and the CO_2 being brought up as a result. The combustion space in the furnace is too small as the bagasse burnt with flames up the first pass and sparks were carried through to the flue. This boiler is having a Cook furnace built on to it this off-crop.

Nos. 4 and 5 are Cook furnaces and in these we measured for the first time temperatures in the combustion space of over 2000°F. There were three boilers on the range during the test and the average of the temperatures in each was 2095°F.; 2190°F. and 2250°F. With a steady feed this type of furnace maintains a steady temperature and graphs of three tests are given for comparison with those shown last year. It will be noticed that the wide fluctuations recorded, Fig. 2, are absent from these records. The steam in the factory is not superheated and there is no air preheater used hence the flue temperatures are too high, like all the flue temperatures recorded this year.

Nos. 6 and 7 are both in the same factory and provide some interesting comparisons. The boilers are the same size and so is the combustion space but the grates are different. In No. 6 we have a flat grate 48 sq. feet in area, and in its bridge wall (but not round the sides as in No. 2) are tuyeres through which secondary air is admitted to the grate and also in the other side to serve the combustion space also. It is possible that this construction accounts for the steady burning of the bagasse noticed during the work, but it is not a satisfactory substitute for a Cook grate. The evaporation "from and at" is lowest of any of the results recorded this year. No. 7 is the record of the performance of a boiler to which is fitted a forced draught provided by a superheated steam furnace. When in use, usually, it is not the practice to burn only bagasse on the grate, a certain weight of dross coal is mixed with the bagasse. It was found to be impossible to maintain the steam pressure and output in a preliminary test if the same weight of bagasse was used per hour as that fed to No. 6. It is therefore interesting to note that when 144 lbs. per sq. ft. of grate area are burnt in No. 6, 224 lbs. had to be supplied to No. 7. The grate area and the combustion space was the same in each case. The water evaporated per pound of wet bagasse in the case of No. 6 being 2.12 lbs. and in the case of No. 7 is 2.04 lbs., so the additional fuel used in No. 7 is not justified by the results.

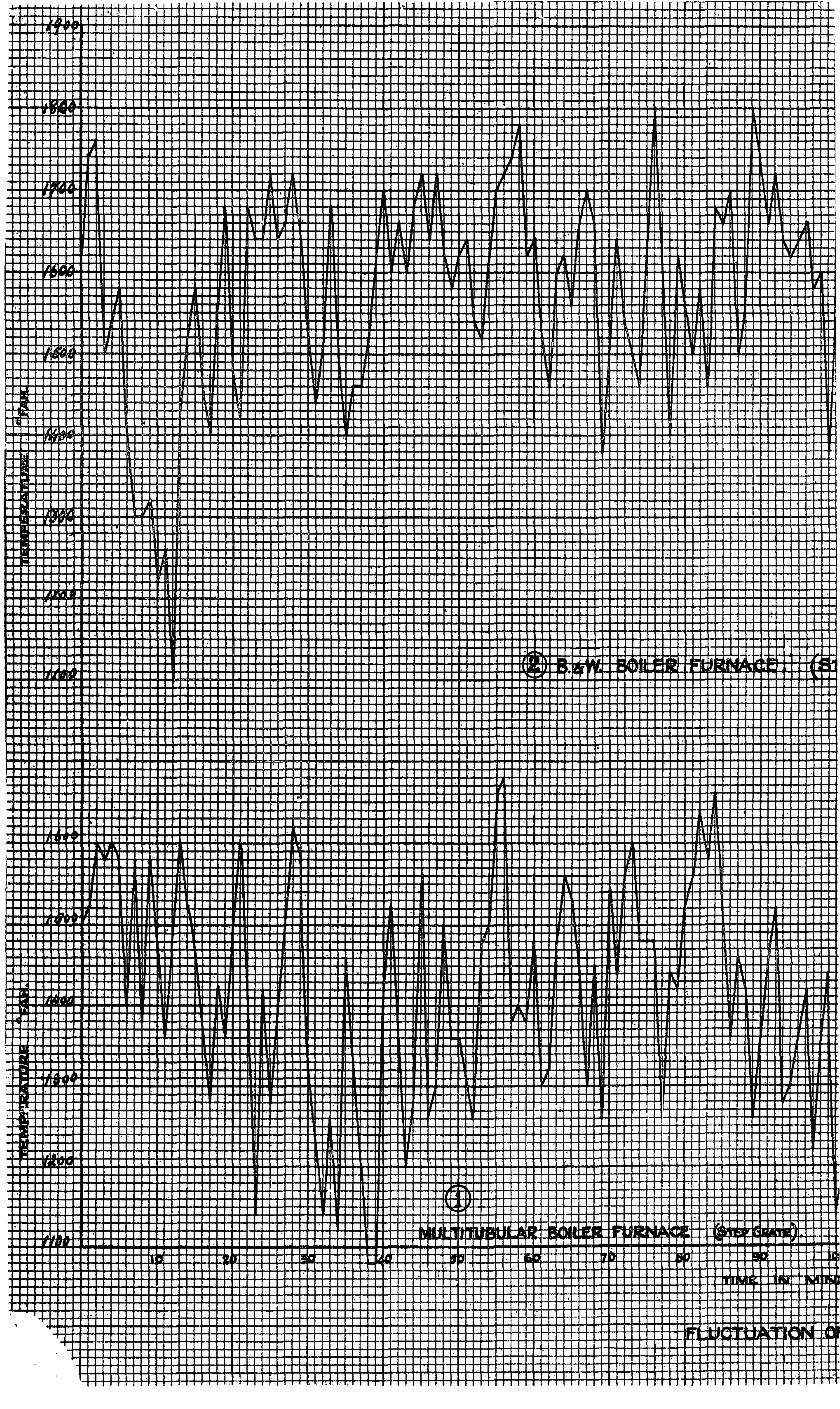
The flue gases are high in temperature but they pass through an economiser before going up the stack and their temperature is reduced to 380°F.

Tests No. 8 and No. 9 are in the same factory. No. 8 is a record of a small Babcock & Wilcox boiler with a Cook furnace. It looses too much heat up the flues. No. 9 shows for the first time the performance of a multitubular the grate of which is a semi-cook. This semi-cook differs from any of the others examined this year in that it is supplied with forced and induced draught. There were two boilers on the range tested together. As it was not possible to isolate one and get its individual performance they were treated as a unit as far as the water fed and evaporation were concerned. The bagasse fed however, was weighed into each furnace and brought out the fact that one was being given far more than its fellow. The temperatures of the furnaces were high and showed temperatures not reached under any other multitubular ever examined in South Africa. The flue gases, however, are far too high and some way of recovering this lost heat should be installed. The CO_2 in the common flue was the best recorded this year, the excess air percentage being very satisfactory.

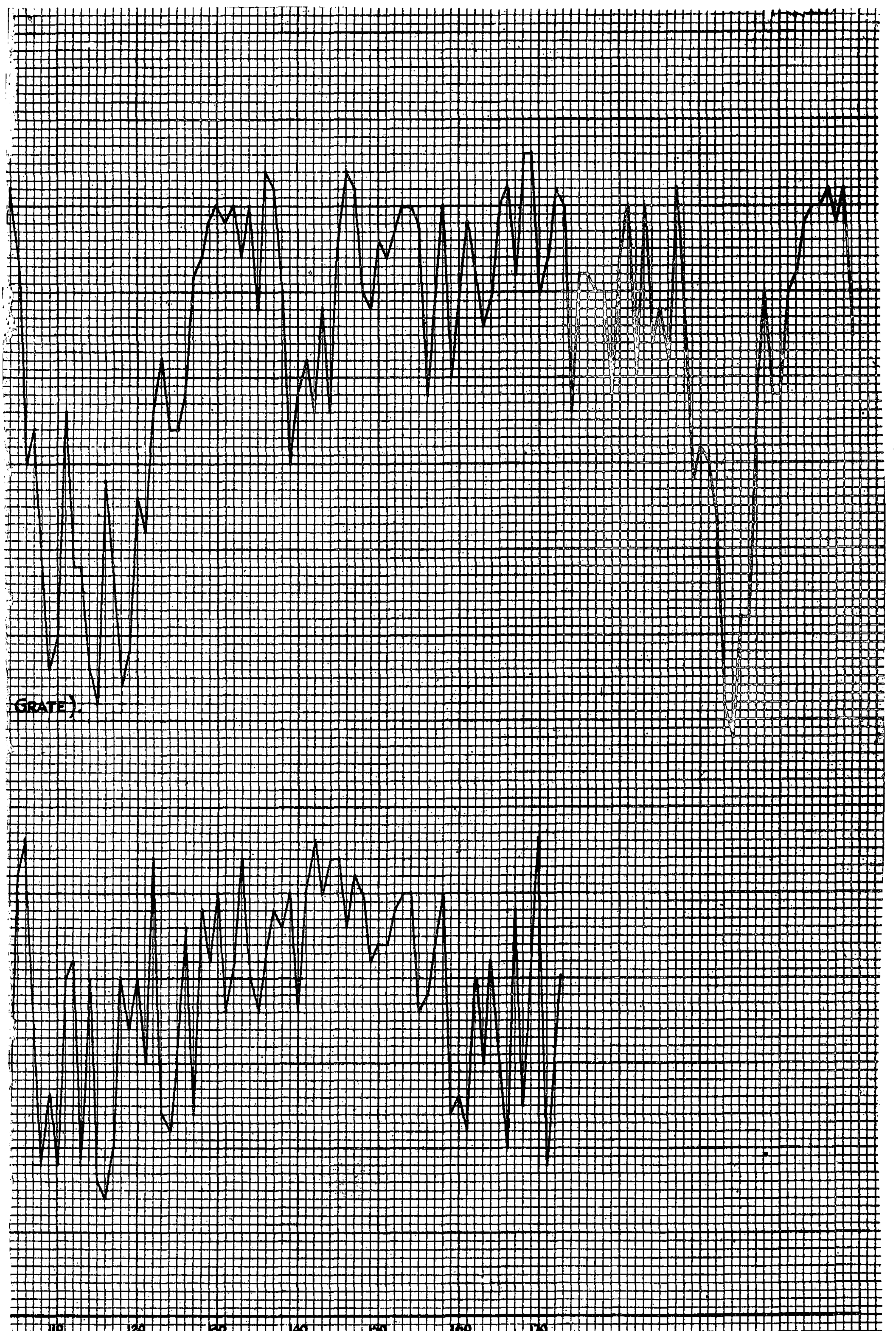
In conclusion these figures show a great advance on those reported last year, the thermal efficiencies —calculated in exactly the same way as last year— are far better than those reported then.

This examination of the figures in the report makes no pretence of being exhaustive, its only object is to call attention to some outstanding points.

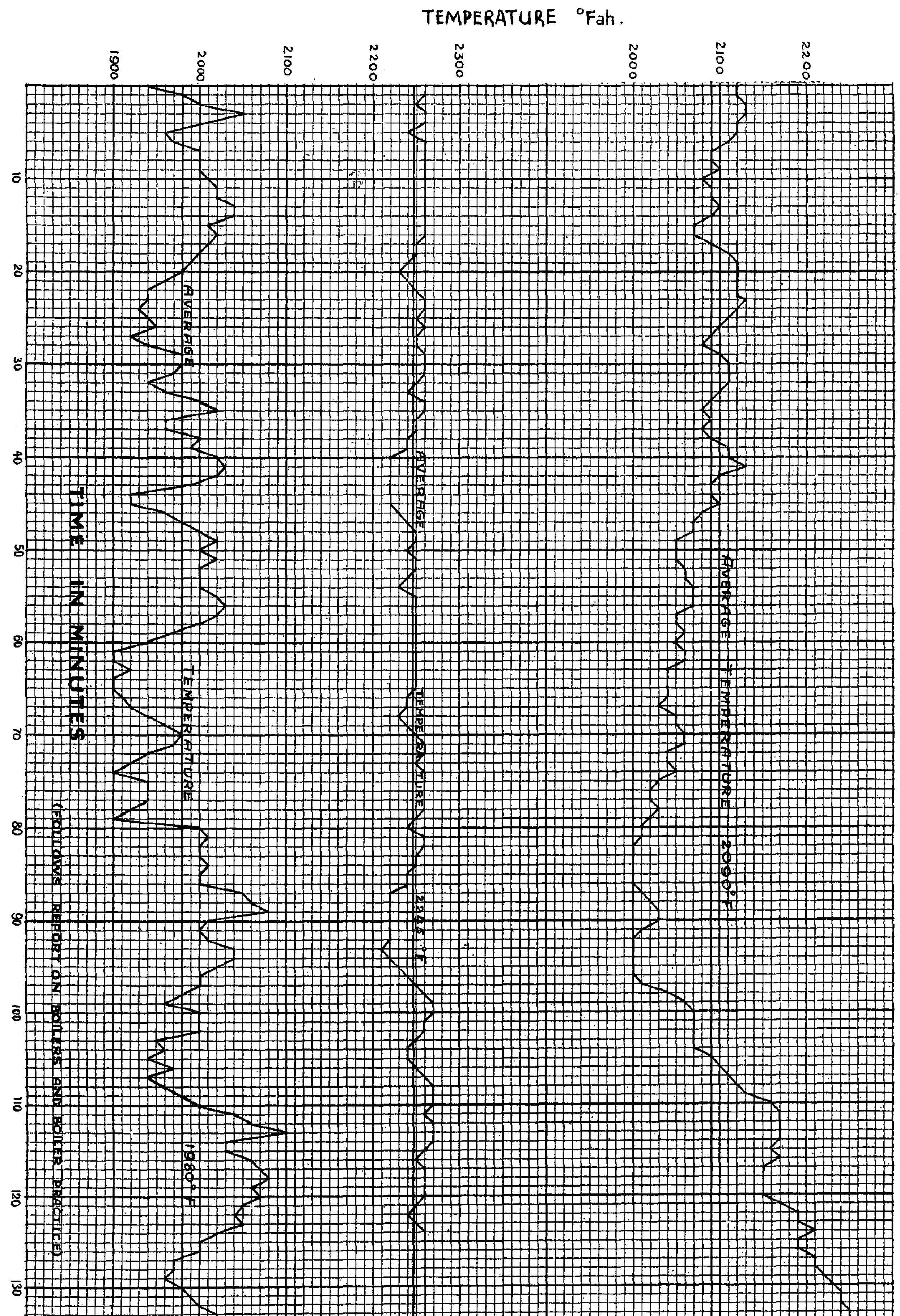
D. Heslop.
W. Mackesy.
P. Murray.
J. R. Simpson.
E. Camden Smith.
A. C. Watson.
G. Wilson.
E. P. Hedley (*Convener*).



1900
1800
1700
1600
1500
1400
1300
TEMPERATURE °FAH.
2 B.&W. BOILER FURNACE.
1600
1500
1400
1300
1200
1100
TEMPERATURE °FAH.
1 MULTITUBULAR BOILER FURNACE (STEP GRATE).
10
20
30
40
50
60
70
80
90
TIME IN
FLUCTUATION



EMPERATURE IN FURNACES. (STEP GRATE)



TEMPERATURE °Fah.
1900
2000
2100
2200
2300
2000
2100
2200
TIME IN MINUTES
10
20
30
40
50
60
70
80
90
100
110
120
130
140
AVERAGE TEMPERATURE 1960°F
AVERAGE TEMPERATURE 2245°F
AVERAGE TEMPERATURE 2090°F
(FOLLOWS REPORT ON BOILERS AND BOILER PRACTICE)

TEST NUMBER	1	2	3	4	5	6	7	8	9	
Duration of test (hours)	7½	7½	8	8	7	8	7½	8	8	8
Type of boiler	B. & W.	B. & W.	B. & W.	B. & W.	B. & W.	B. & W.	B. & W.	B. & W.	Multi.	Multi.
Number of boilers on range being tested	1	1	1	3	3	1	1	1	1	2
Heating surface, sq. ft. per boiler (or per test)	2,531	2,531	4,870	3×2,531	3×2,531	4,870	4,870	2,531	2,200	2,200
Heating surface, superheater	356	Nil.	735	Nil.	Nil.	Nil.	Nil.	Nil.	—	—
Type of furnace	Flat	Semi-cook	Step	Cook	Cook	Flat‡	Flat	Cook with a grate	Semi-cook	
Grate surface, sq. ft. per boiler	31.5	18	66	28	28	48	48	28	18	18
Ratio of heating surface/Grate area	80/1	140/1	73/1	—	—	100/1	100/1	—	—	—
Combustion space, cu. ft. per boiler	802	802	1,300	796	796	1,284	1,284	830	650	650
Ratio of combustion space/Heating surface	3.5/1	3.8/1	3.7/1	3.1/1	3.1/1	3.72/1	3.72/1	—	—	—
Water apparently evaporated—lbs.	89,254	100,831	145,898	244,807	209,961	117,980	164,725	72,221	182,950	
Moisture in steam %	Nil	16.7	Nil	15.6	12.2	17.2	18.1	18.1	18.1	
Water evaporated—lbs. (corrected for moisture)	89,254	83,993	145,898	206,618	184,346	97,688	134,910	70,914	149,840	
Feed water temperature—° F.	193	189	205	181	163	190	189	179	179	
Superheat temperature, ° F.	455	—	480	—	—	—	—	—	—	
Factor of evaporation from and at 212° F. into dry steam	1.125	1.071	1.131	1.07	1.09	1.066	1.064	1.070	1.070	
Water evaporated from and at 212° F.	10,041	89,956	165,010	221,081	200,937	104,154	143,571	75,878	160,328	
Steam pressure by gauge	133	125	97	86	100	128	114	83.5	89	
Weight of bagasse burnt—lbs.	43,781	43,650	81,600	101,520	99,600	55,536	80,655	38,025	52,895	34,710
Moisture in bagasse	53.3	52.8	49	48.7	49	53.2	52.5	52.3	52.3	52.3
Weight of dry bagasse	20,445	20,603	41,616	52,080	50,796	25,990	38,311	18,138	25,231	16,556
RATE RESULTS.										
Water evaporated from and at 212° F. per sq. ft. heating surface per hour—lbs.	5.28	4.7	4.31	3.64	3.74	2.72	4.00	3.74	4.55	
Wet bagasse burnt per sq. ft. grate surface per hour—lbs.	185	312	154	364	312	144	224	169	304	
Water apparently evaporated—lbs. per hour	11,900	13,444	18,237	30,601	29,994	14,747	21,963	9,028	22,858	
Water apparently evaporated—lbs. per sq. ft. heating surface per hour	4.70	5.31	3.81	4.00	3.95	3.08	4.59	3.56	5.19	
Water actually evaporated—lbs. per hour	11,900	11,198	18,237	25,827	26,335	12,211	17,988	8,864	18,730	
Water actually evaporated—lbs. per sq. ft. heating surface per hour	4.70	4.42	3.81	3.40	3.46	2.55	3.76	3.50	4.25	
EFFICIENCY RESULTS.										
Water evaporated, apparently, per lb. bagasse	2.03	2.30	1.78	2.40	2.10	2.12	2.04	1.89	2.08	
Water evaporated, from and at 212° F. per lb. **Wet** bagasse	2.29	2.06	2.02	2.17	2.01	1.87	1.78	1.99	1.83	
Water evaporated, from and at 212° F. per lb. **Dry** bagasse	4.91	4.36	3.96	4.20	3.95	4.00	3.74	4.18	3.83	
Thermal efficiency	64.6	57.6	51.2	54.6	50.9	52.9	49.3	54.2	49.8	
Temperature of flue gases, ° F.	610	550	630	630*	592†	514	566	630	666	666
Temperature of furnace, ° F.	1,584	1,867	1,610	2,178*	2,140†	1,660	1,764	1,840	1,987	2,027
Draught at back of boiler at flue damper—inches	1.2	1.1	1.1	1.1	1.0	0.71	0.82	0.9	0.65	0.7
CO_2 %	10.6	11.0	10.2	10.3*	8.2†	12.2	12.3	6.0	13.8	
O_2 %	8.6	9.0	7.2	8.2*	10.7†	7.4	7.1	13.6	6.0	
CO %	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	
N_2 %	80.7	79.9	82.6	81.5	81.1	80.4	80.6	80.4	80.2	
Excess air %	67.6	74.4	49.0	61.4	99.7	53.4	49.9	180	39.4	

* Averages of the three boilers. † Average of the three boilers.

‡ Tuyeres in the bridge wall blowing into the grate and into the combustion space.

CHAIRMAN: Discussion is now invited on this subject. I might remark that the work of this Committee this year has really been an amplification of what it did last year, and so far as we went, all the tests that were made bore out the results and the deductions we had made from the year before, pointing out that the main alterations were required in the design of furnaces in regard to the ratios of combustion space to grate area and so forth, and what actually was done simply went to show that our deductions of the previous year were on the correct lines, and we hope to continue and get further valuable information in the forthcoming year. Discussion is now invited.

Mr. J. MURRAY: I think the Sugar Industry is extremely fortunate in having Dr. Hedley to conduct these investigations, assisted, as he is, by this committee on the boilers. I might mention the good work done by Mr. Pat Murray and Mr. Heslop in this connection. They have done quite a lot of useful work in improving boilers in the Sugar Industry in Natal and Zululand.

This being a mining country, I think the sugar engineers are always liable to dig holes in the ground to put their boilers in. Generally the mill conditions circumscribe the conditions under which a boiler shall be erected. Dr. Hedley's remark about super heat is excellent. I think in our practice we ought to have a certain amount of steam superheated. In coal boilers there has been a very great advance in recent years. All engineers now should look for a key to the question of radiant heat. A boiler may have a very large heating surface, but may be very inefficient. The practice is now to get a draught through the boiler so as to get as much as possible of this radiant heat. There is no reason why all the air which comes into the furnace should not be heated with the exhaust gas. Then I think the question of a high boiler, the Natal Estates boiler has proved that placing the boiler well above the furnace is the right thing. I congratulate you, gentlemen, on the results you have obtained.

Mr. BOOTH: I have been deputed by Mr. Munro to read these few notes of his. He wishes to express his regret that this important paper should be left to the fag end of the session. (Mr. Booth reads Mr. Munro's notes.)

While the tabulated results of the Boiler Tests are of very considerable interest, I think it is agreed that from a practical point of view, it is possible that short isolated tests can be quite misleading. During the period that the apparatus is available at a factory there is seldom time to make any adjustments or improvements, and check and study the results of these changes. Therefore, my first point is that undoubtedly permanently installed control instruments are a very sound investment. For instance, in Test No. 4, the Thermal Efficiency is given as 54.6. At first glance at the figures that may seem to be a fairly satisfactory result. In Test No. 5, the Thermal Efficiency of the same Boiler Plant is only 50.9.

During Test No. 4, the gauge pressure is only 86, some 20 lbs. below normal, low enough to have a serious effect upon the efficient working of the Factory. The quality of the steam is also lower in the test indicating the apparent higher Thermal Efficiency. These tests are made on a small plant which is expected to obtain the maximum steam generation from the available fuel, and consequently is very sensitive to any variation in the fuel value of the Bagasse.

In the near future, considerable quantities of the new variety canes will be milled, and, in view of the drop in their fibre content, it becomes very necessary to obtain reliable information regarding the fuel value of the bagasse from these canes.

My second point, then, is a suggestion that the management of the various factories crushing new variety canes during the coming season be requested to indicate to the Experiment Station the date upon which these canes will be milled and to provide the necessary facilities for making a comprehensive series of tests of the fuel value of the bagasse.

If these tests can be made at several mills, the effect of different milling efficiencies upon the fuel value of the bagasse can be recorded.

In bringing out my third point, it is very evident that reliable fuel data will be of great value in the process of accommodating Boiler Plants to the new conditions.

It is reasonable to expect a very much lower moisture per cent bagasse and this factor must be considered in the design of future boiler settings. I hope that calorific values of bagasse will be obtained under actual operating conditions at a moisture value of say 45 to 46%.

Also, the maintainance of high efficiencies necessitates spare boiler units of suitable capacity in order to keep up a regular cleaning cycle throughout a long milling period, such apparatus as Soot Blowers is not enough and many other operating plans suggest themselves and will have to be prepared.

It now becomes necessary to adopt some standards for comparison.

What is combustion space?

In the case of a boiler setting with horseshoe shaped furnaces is it the whole volume from the floor of the horseshoe to the first bank of tubes?

What is the grate area of a furnace that has no actual grate bars?

Would it not be correct to state the tuyere area and the normal pressure and velocity of the air supplied through this tuyere area?

In the case of the so called Semi-Cook Furnaces is it not correct to describe the air entering upwards through the grate as primary air, and the air entering through the tuyeres as secondary air?

May I suggest that the series of boiler tests which may be planned for the coming season be arranged not so much as a test of present practice, but with a clear and definite view towards future design of the boiler settings and auxiliary apparatus necessary to meet the coming conditions.

In this respect, the Committee on Boilers carries a heavy responsibility and I would like to emphasise the necessity to request the Millers to provide every facility to the Committee and our efficient Technical Secretary to proceed with this important investigation.

Dr. HEDLEY: For "combustion space" this year for purposes of calculation, we took "the cubical contents of the furnace between the grate and the first place of entry into the tubes." This is the A.S.M.I. codes definition. The matter, however, is complicated in a Cook's furnace, because here there is no "grate." For the "grate" in such a case we took the area of the bottom of the horseshoe, and this, of course, is also wrong because the bagasse does not burn on the floor but on the cone formed by the bagasse falling on the floor. The bagasse also burns on the points of air delivery at the ends of the tuyeres when the draught is nicely balanced.

I think the air entering for combustion through a grate is usually described as Primary Air, and air supplied to the products of combustion as Secondary Air.

CHAIRMAN: In regard to Mr. Munro's remarks, as read by Mr. Booth, in connection with this question of the reliability of tests taken over a short period, to a certain extent it is quite right. We all know that in any experiment a short, isolated test has to be very carefully considered, because errors which might creep in to a short period test might be very serious ones as affecting the final results, and the suggestion that records should be kept by factory engineers throughout the coming season is certainly a good one. But after all the factory engineer has a great deal more, in most cases, to look after than merely keeping a record of boiler performance. If the average factory engineer gets sufficient steam, he is quite happy, and he goes on with other, and equally important work. However, it would certainly help this committee a good deal if we could get such results reliably recorded from each factory, and any factory engineers who would like to take records during the crushing season for as long a period as they can possibly manage it would be assisting us, and their records would be very welcome to this Boiler Practice Committee.

Mr. C. LINDEMANN: Mr. Chairman, I wish with your permission to submit some notes in connection with boiler plants situated in the northern districts of Natal, and which may be of interest to the Sugar Industry.

Engineers in these districts are faced with the problem of unequal deposits of scale in the nest of tubes and is not confined to any particular make of boiler. For example, when facing the grate, in the land type, the right hand side collects most of the scale, whilst the marine type accumulates it on the left side. Concurrently with the above, one is faced with the irregular water levels, as shown in the water gauges, whilst steaming.

Practically, engineers have tried out all sorts of schemes hoping to remedy the defects, such as feed control at both ends of the boiler, check in firing, alteration of feed ranges, dampers and flues, etc., but of no avail.

It is interesting to note that the irreguarities persist in spite of whether the fuel is coal, gas, waste heat or spent bark; or whether the steam unit is fired by hand or mechanically controlled.

In view of these perplexing characteristics, a survey of the majority of steam plants was carried out, totalling approximately 20 double drum land types and 16 marine class of boiler and several of the Sterling design, which, strange to say, were practically immune from the said characteristics.

As inferred previously, in my opinion, the question of the influence of the boiler furnace, may, with safety, be ruled out.

Having explored all the possible mechanical means, I carried out some electrical experiments with the aid of an ordinary compass. I found in majority of units, that an electrical field existed, externally to the boiler. A boiler fired by waste heat indicated an electrical field at the back-end. It was noticed that the intensity of the field varied, depending upon the layout of the boiler plant.

The question naturally arises, what causes this field, a difficult one to answer; but I wish to submit that an electro-physical effect is caused by the heating and circulation mediums, moving relatively to each other.

Boilers designed on the U tube principle, the heating medium or, in other words, the gases travel in an opposite direction to that of the circulating water. Additional, the flue gases move across the circulating tubes at right angles, and are deflected by means of baffles placed at right angles relative to the nest of tubes.

By placing oneself in looking in the direction of the circulating medium, it is apparent that the scale deposits lie to one's left hand side. Therefore a simple rule can be formulated, similar to Dr. Fleming's rule relative to directions of motion, magnetic lines and induced electro-motive force, e.g., by holding the thumb and the first finger and the rest of the fingers of the right hand as nearly as possible at right angles to each other so as to represent three rectangular axes in space; let the thumb indicate path of flue gas, index finger direction of the circulating water then the rest of the fingers will show the zone of scaly conditions in the different passes, and incidentally, indicate that the gases have been influenced to one side of the boiler unit. At this stage I am not sure which is the centre of positive potential electrically.

The rule has been checked up giving repeated results, even so far as to explain different thicknesses of scale in a water tube.

Before sitting down, I would like to submit some figures in connection with a water test, taken from the same drum, right and left hand sides of it.

WATER TEST

Position	Total Alkalinity	Caustic Alkalinity	Hardness	pH	Steaming Hours
Left	17.4	9.2	3.3	10	600 since sooting
Right	8.2	5.4	2.0	10	3,800 since overhaul

Colour of left-hand ends, water sample slightly darker than the other.

WATER TEST—Before and After Blow Down

Position	Total Alkalinity	Caustic Alkalinity	Hardness	pH	Steaming Hours
Left Before Blow Down	12.7	7.0	4.2	10	357 since
Right „ „	8.9	6.0	4.0	10	Overhaul
Left After Blow Down	11.1	7.0	4.3	10	
Right „ „	7.9	5.7	4.5	10	

Finally a draught test disclosed that the draught is a variable quantity, when traversing the passes.

I propose reading a paper giving fuller details on the subject before the Association of Certificated Engineers (Natal Branch), during October and no doubt anyone wishing to hear further above this interesting problem could arrange through the Hon. Secretary.

CHAIRMAN: Were these figures repeated after the boiler had shut down for the week-end?

Mr. LINDEMANN: I am sorry I made an omission there. The first test was 620 steaming hours since sooting, 3,877 hours since overhaul. They steamed all that time.

Mr. B. E. D. PEARCE: At Illovo, we have a range of five Babcox & Wilcox boilers, 4,870, and we find the same thing. We have very little scale on our boilers. We have some of the cleanest boilers in the country, because our water is so good. We had a turbine for feeding the tubes, and every season we had the same trouble—one side of the boiler was dirty, the other one clean. I have not been able to find a reason for it. I just "blew off" at the boys because they did not feed the boiler evenly. I thought they were feed'ng more on the one side and all the mud was deposited on the other side. We have certainly found that trouble at Illovo in our boilers every year.

Mr. LINDEMANN: If I might suggest it, I think if you take some magnetic tests, and explore the whole of the atmosphere surrounding the boiler, you will be assisting me.

Mr. J. MURRAY: I would like to ask Mr. Lindemann if the reverse occurs in the Northern Hemisphere. In the north of Scotland it is left-handed and in New Zealand it is right.

Mr. LINDEMANN: If I had to carry out the same tests in the Northern Hemisphere, I should expect opposite results. That was more or less indicated in that last paper on heat transmission.

Mr. MURRAY: Mr. Munro recommended, I understand, soot blowers in boilers. The practice, I understand, is to do away with these soot blowers. I understand the practice now is to increase the draught so as to sweep away any soot there may be. It may land in the flues, but that is better than having this continuous soot-blowing, and according to what I read, it would be better to use that excess flue temperature to heat the air rather than adopt these soot blowers.

Dr. HEDLEY: I am afraid I do not agree with Mr. Murray as regards doing away with soot-blowing. I went to one factory where they have a Babcox & Wilcox boiler, under balanced draught. On the tubes the soot was piled in a high ridge all along the tubes. I pointed out to the manager how much efficiency he was losing—probably 50% of his boiler tube surface, and persuaded him to buy a soot-blower, which he did and when I returned to do a test, those tubes were clean. He must have increased his efficiency by that. After all, the soot-blowing does not take very long when the soot-blowers are well distributed over the boiler heating surface, and the increase in efficiency must be very great.

Mr. J. ROBERTS: The Electricity Supply Commission have been very much interested in the results which the Boiler Committee have obtained from their boiler tests and I think you are to be highly congratulated on taking up such valuable work as this. The question of boiler efficiency is of the most primary importance, in order to obtain as much out of the bagasse as possible. We are intensely interested in any authentic results, such as these which have been obtained from your observations. I am told that one of the burning questions in regard to boilers on the fields is the type of furnace. Now we get here a list of nine carefully-taken tests, and I was sure before I saw them that I would see some excellent results from the boilers fitted with Cook furnaces. But to my surprise, No. 1, which has by far the best boiler efficiency of the whole lot is on a boiler with a flat grate. I suppose this is just an ordinary grate which we were accustomed to use for burning coal on in the old days. And it is rather significant that 1 and 2 are exactly similar boilers, except that the one has a super-heater, and the flat grate has not. The thermal efficiency of No. 1 is 64.6 and the semi-cook very much under that, only 57.6 and on all the tests one cannot say that the Cook grate is on the whole showing much if any better results than the flat grate. For instance, if we take the last two, which are multitubular boilers with semi-cook furnaces they have quite low efficiencies. Of course there are other factors which have to be taken into account. With the exception of No. 9, they are all Babcock & Wilcox boilers with more or less the same design. Another rather puzzling thing as between 1 and 2 is that with the same weight of bagasse burned—almost exactly—the installation of a super-heater has increased the actual amount of steam turned out. It has not only dried the steam, that is to say evaporated all the moisture, but it has super-heated it and increased the amount of steam too. That is a rather extraordinary result, it appears to me. I am not saying this in any critical way. I just put these two points. Probably there is some explanation of it.

Mr. DODDS: I consider that the Sugar Industry is greatly indebted to the Boiler Committee, and especially to the convener, Dr. Hedley, who has done most of the dirty work and also the equally arduous work of the mathematical calculations involved. To anybody who is seeking for a course of weight-reducing, I can recommend, from personal experience, the drastic and unpleasant, but very effective method of actively assisting in boiler tests. In our report on factory work, given at an earlier meeting of this session, where we made an attempt to trace the different factors associated with an increased efficiency in certain factories, in one factory in particular—No. 20—we mentioned that the improvement had been associated with ample supplies of steam. I am not given to the use of italics, but I think it would have been justified in that instance. The improvement in performance in that particular factory, No. 20, was spread over the past two years, as shown by reference to past reports. I have personal letters from the management of that factory in which they state that this improvement was largely brought about by the information that they have gained from this Committee.

Mr. MURRAY: Going back to Dr. Hedley's remark about soot in that boiler tube. I remember Mr. Damant wrote a paper when he came to the Power Station. I asked him about the relative merits of the vertical type boiler as against the Babcox. He said it has done equally well. Has Dr. Hedley anything to say about soot in a vertical type boiler? Would it be better to have a vertical type boiler so as to do away with this soot problem?

Dr. HEDLEY: I have nothing further to add. There is no doubt about it that you can get much more soot from a bagasse fire than from a coal fire. There is no question about it that, without any measurements at all, they cleaned these boiler tubes down, and the boiler was steaming better. That is all I can say. It was blowing off much more frequently. With regard to Mr. Roberts' remarks, there is much that might be said. Firstly it is difficult if not impossible to draw a comparison between one test and another because it is entirely out of the jurisdiction of the test and my committee to lay down what conditions the boilers have to be in before testing. In point of fact the tests are there to point out and help the engineer to locate where his boiler is defective. That is, he has to analyse the results and see, for instance, that there is too much excess air passing to the furnace, whether his baffles or brickwork is leaking or bye-passing the gases, wrong draught conditions, etc. Therefore, the figures set out are not to be accepted as test figures of boilers perfect in setting, absolutely clean and perfectly operated. The list of tests are brought together on a Table merely for compactness and not for the purpose of comparing one with another.

It is, therefore, unfair or impossible to compare the results obtained with boilers 1 and 2 in one factory with those working in another as No. 9, for instance. The settings are different, the furnaces are different and the whole operation different.

The Cook furnace too is not a panacea for all boiler setting troubles. The fact is that the earlier "Cooks" installed out here on American lines, were not a universal success. Noel Deer gives the dates of the original patents somewhere between 1886 and 1889, but it is only lately that this furnace, after modification, has been successful in South Africa. The success here has been due to the work of Mr. P. Murray and Messrs. Vincent and Pullar, and this year's report shows how successful have been the installations. Again, as all sugar engineers know, a "Cook" unsuitable for its load or draught conditions used may well be inferior to a "flat" or "step" grate which is suited to its conditions.

With reference to the super-heater increasing the amount of steam output, Mr. Roberts has evidently missed the fact that 16.7% of No. 2's apparent output has been deducted for moisture in the steam, whereas No. 1's output, being super-heated has suffered no deduction. One would naturally look for increased evaporation, or let us say, increase in B.T.U. output for the same amount of fuel, because the boiler square feet heating surface is increased by the amount of the super-heater tubes. This addition also gives the gases a longer pass, resulting in increased B.T.U. output and should lower the temperature of the flue gases. In this case it has not done so and something is wrong, and that is the function at present of the Boiler Committee's work. A comparison between the results recorded this year and that issued last year will show how useful has been our work.

CHAIRMAN: There is another paper to be read now. I think we are obliged to bring this discussion to a close. I have to thank the various contributors to the discussion, especially the visitors we have had here, and whose remarks have been very much appreciated. As I said before, the main work of this Committee up to the present has consisted in the study of combustion conditions and design of furnaces, and so forth, that being the first step towards improving our general boiler efficiency, which, up to about five years ago, as we all know, was deplorably low. The effect of the work we have done is now beginning to be apparent, and we trust these more or less refined points, as brought forward by Mr. Lindemann and Mr. Roberts, will in the near future come under our more careful study and consideration. It is rather invidious for me to thank our Committee for the paper, but in doing so, I think we ought to thank Dr. Hedley, for the bulk of the work falls to him. I think we can afford to accord Dr. Hedley a vote of thanks. (Loud applause.)

Dr. HEDLEY: Mr. Chairman, I get a lot of thanks for this work, and I really feel that it is not I who should be thanked but the whole Committee. I have experience of the working of many of our Committees and I know no Committee which does more work for the Sugar Industry than the Boilers and Boiler Practice Committee. Each member takes a keen and very active interest in the work.