A Description of some Desirable Features of a Multitubular Boiler Plant and the Practical Working Thereof

By J. E. Bihl.

Mr. J. E. Bihl read the following paper on the above subject:—

It is not the intention in this short paper to try and lay down any hard and fast rules for the economical running of Boilers, but simply a few remarks and observations on the routine of a Boiler-house from a practical point of view.

Efficient results from all plants depend chiefly on:

(a) Knowledge of first principles.
(b) Attention to details.
(c) Competent supervision, i.e., the operator in charge should also have a working knowledge of the first principles of combustion, and every person in the plant, even in the humblest capacity, should be fully acquainted with his duties, and what carelessness or neglect might mean.
(d) Cleanliness, Sanitation, Ventilation and comfort for operators are very important factors.

One often finds that instead of getting results that are attainable from a plant, cases where there is a desire to get new or altered design incorporated before the best results have been obtained from that old plant.

More importance should be attached to economical maintenance than to continual alteration in design. Spasmodic alteration and additions are unfortunately often undertaken without any definite knowledge of the exact cause of the trouble to be overcome.

This refers particularly to the design of Boiler Settings, and is in most cases directly attributable to the fact that no drastic course of inspection appears to have been carried out, and no data accumulated. Therefore, an engineer is well advised, if the existing settings are at all efficient, to scrutinize very carefully any proposed alterations or additions, unless the suggestions are supported by facts.

Another important feature in the care and attention of a plant, is to keep an efficient record. Recording instruments and careful logging of details is essential not only for efficiency, but also for future reference and reliable data.

Steam flow indicators are necessary to enable the engineer to know what work his boilers are doing. Steam recording charts should be used, not only to check the daily steam pressure, but also to know what the average weekly steam pressures are and under what prevailing conditions.

CO_2 Recorders are essential to check the combustion of each boiler. It is only with the assistance of recording instruments that accurate data can be collected, as a guide not only to efficiency, but also, if necessary, as an indication where and what alterations should be made.

Elaborate instruments, however, are worthless unless those directly concerned understand and appreciate their value.

With these preliminary remarks I will now turn to the actual details of the working of Multitubular Boilers.

FIRING:

The method of firing multitubular boilers differs very considerably, the quantity of bagasse in the the furnace of each boiler in normal running must be determined by the engineer of each plant, as there are so many factors governing the efficiency of a boiler, especially since the introduction of large mill grooving, higher extraction and fine bagasse.

Owing to the rigid design of multitubular boilers, it is necessary to raise steam very slowly. To heat up a battery of boilers from dead cold should take from two to three weeks, depending on size, etc. Fires should be started very slowly, and so controlled that the required temperature is only reached on a given date, when crushing commences. A battery of boilers should take about 2½ hours to raise steam up to 100 lbs. per square inch during the crushing season, and for the first 1½ hours after firing up, if possible, only natural draught should be used with damper control, to ensure a slow but consistent rise in temperature.

About half-an-hour before crushing commences the main stop valve of each boiler is " eased " off its seat very slowly to heat up the main steam ranges, commencing, of course, with the boiler that has the highest temperature, having first ascertained that every steam drain is **open.** Every engine and pump is also heated up, and provision is likewise made to heat up the exhaust range.

The steam piping in so far as possible should slope gradually away from the boilers. Pockets that can hold condensate must be adequately drained. Traps of ample capacity should be interposed between the engine pipes. All piping should be well and properly hung, and provision, where necessary, made for expansion and contraction; small branches should be welded to the mains, and so obviate additional fittings and joints.

It is a serious waste of heat to commence turning on steam half-an-hour before crushing commences, but it is absolutely essential to **heat up slowly** to avoid sudden changes in temperature, leaky joints, water-hammer, and perhaps serious damage.

The steam drains must be left open and only shut off on each steam range, as the units on that particular range are started. The auxiliary engines and necessary pumps should all be working before the mill engines are started up. It is not then necessary to run the mills idle for more than a few minutes, and if the above method of raising steam, heating up, draining and starting up has been followed out, then the mills can be put under full load at once without any danger to the boilers, engines or steam ranges.

FEEDING BOILERS:

If possible never use cold feed water, especially when starting up, because, apart from the big changes in temperature in the boiler, with the resultant unnecessary stresses and strains, the evaporation of a multitubular boiler drops considerably whilst being fed in the ordinary way with feed water at 160—180° F. It is necessary, therefore, to pay careful attention to the feed water, especially when starting up and everything is more or less cold.

The boiler feed water should naturally be drawn from the purest source available, but, unfortunately, this is not always possible, and in some cases not even attempted, it being thought that what is conveniently to hand is sufficiently good. Assuming, however, that the boiler water is drawn from the river direct, there are times when it should most certainly receive treatment, if not at all times.

Far too little attention has unfortunately been paid in the past to the purification of our boiler feed water, and the maintenance of our boilers could be very considerably reduced if this very important matter received the attention it should.

It should be possible, and it is very desirable, that all boilers should be fed simultaneously, and that intermittent feeding be discouraged.

Regular water feeding is as important as regular firing, and in consequence a reliable feed water regulator would be a very desirable fitting.

Every advantage must be taken of pure condensate from all sources. Discharges into feed tanks should always be submerged in order that air is not churned and dissolved in the feed, and so permitting the water to carry air to the feeding range and boilers, air being the most prolific source of corrosion in feed piping and boiler fittings.

The pump should be placed sufficiently low to permit of the water flowing easily under a slight head to overcome friction and valve restriction, and so enable the pump to take water at a high temperature. A constant and fairly high water level should be maintained as it is in the water capacity that the reserved heat is stored.

If it should be necessary to use boiler fluids, then it should be mixed in a drum and fed into the feed tank drop by drop.

DRAUGHT:

I think I am correct in assuming that we have not yet discovered an ideal bagasse furnace. Opinions differ considerably as to ratio of grate area to heating surface and of the combustion volume to heating surface. The amount of draught necessary for good combustion with fine bagasse is a very difficult problem.

Each boiler should be regulated by means of its damper, which at all times must be in thorough order. Ordinarily the draught varies over each and every boiler, depending upon its position on the range in relation to the stack. The regulation in damper height should be determined from the CO_2 analysis of the flue gases.

Closely associated with draught is grate area, that is, " effective grate area," and usually though included, there are many square feet of grate area which do not function at all, being either covered with unburnt or completely burnt-out fuel. Therefore, the quantity of fuel lying on the grate, the rate of feed, the slope of the grate, among numerous other factors, might be safely said to determine the so-called " effective grate area."

Having arrived at an approximate ratio under those uncertain conditions, much can be done by the regulation of draught and feed. The draught must not be of that intensity so as to pull the bagasse off the grate, yet sufficient bagasse must be consumed to give the maximum of steam. Therefore, fuel permitting, the draught should be kept at almost its maximum, and the thickness of fuel maintained by close regulation of feed.

Most of this could be brought about by careful instruction and adherence to definite principles and by administering the "Big Boot" to those that have other ideas, or are above being taught.

To get a good combustion with 12 to 14% CO_2 at the boiler damper, requires constant care and supervision, and the quantity of bagasse to be fixed for each boiler is obviously dependent on the size of bagasse and prevailing conditions.

It is the custom of some factories to blame the boilers for all steam troubles, and such factors as shortage of cane, shortage of water, mechanical breakdowns, running slow (in badly balanced factories), or heat losses are, unfortunately, not considered.

FORCING OF BOILERS:

It is probably neither efficient nor economical to force a multitubular boiler, and the best results are always obtained with ample boiler power. I am only using the term boiler power to illustrate an example, and do not propose here to enter into the controversy as to the boiler power required in a sugar factory.

It is possible with pre-heated air and balanced draught to get an average evaporation of 9,000 lbs. per hour with a 2,200 square feet multitubular boiler. Low pressure boilers, however, should not be forced owing to the danger of foaming or priming and possible serious damage.

The above remarks do not apply to high pressure boilers, the forcing of which is becoming universal practice, especially in America.

If steam is low it is advisable to stop the mills, raise steam and re-start.

CLEANING OF FIRES AND TUBES:

Methodical and proper cleaning of fires is essential for good burning of bagasse, and since the human element cannot be eliminated in the cleaning of bagasse fires, provision must be made to make this uncomfortable task as easy as possible.

Dampers should be almost shut when cleaning fires or tubes to prevent undue cooling and stressing of tubes. If necessary tubes should be cleaned once per shift.

The most efficient portion of a multitubular boiler and the portion generating the most steam foot per foot, is the bottom. Only a few feet of the tubes at the hot end are really effective, but cleaning is very necessary.

BLOWING DOWN WHILST CRUSHING:

The problem of getting rid of daily accumulation of precipitates in boilers is very serious, and, obviously, a very important one. The frequency at which blowing down should be done depends on local conditions, purity of feed water, etc.

Boilers should be blown down very frequently when a change of water occurs, i.e., when the river turns muddy for the first time (if the water is drawn direct). In such cases the discharge from the blow down should be examined for "precipitated scale," which has been the cause in the past on the Coast for more than 80 per cent. of the bulging, etc.

Under normal conditions, with clean water, the boilers should be blown down at least every eight hours. The blow down valve should be very slowly opened and slowly closed, especially slowly closed to avoid the danger of water hammer and possible damage to life and property.

WASHING OUT OF BOILERS:

Boilers should never be emptied while brickwork is hot and severe strains and leaks about the tube ends and joints are often caused by the action of cold water on a warm boiler.

The sludging out of a boiler is not washing it, because the sediment laying on top of the tubes does not all come down with the water when the boiler is being emptied. A boiler should, therefore, be washed out with a powerful stream of water, when the boiler is hot, with a hose pipe from the top as well as the bottom manhole.

GENERAL ROUTINE AND REMARKS:

It is conducive to economy and efficiency to have the boiler-room practice as uniform as possible in all respects. Approved routine should be established for every detail in the room. When this is done the work will go on almost automatically.

It is essential that a competent person inspect the boilers regularly, especially at week-ends when boilers are being washed out.

Boilers should never be allowed to blow off (at the relief valves) when short of bagasse.

Heat is an invisible, intangible thing, but its generation costs money. Waste should, therefore, not be tolerated.

Radiation and condensation losses should be reduced to a minimum, and steam leaks should be regarded for what they are—carelessness or indifference to deliberate waste, if allowed to remain week after week.

STEAM LEAKS:

A hole 1in. in diameter will discharge 4,460 lbs. of steam into the atmosphere per hour at 100 lbs. per square inch=154 B.H.P.; ¼in. hole will discharge 10 H.P. per hour into the atmosphere at 100 lbs. pressure. Repairs should, however, never be made upon any boiler or pipes whilst under pressure.

HOT WATER DROPS;

Water drops from leaky flanges, steam traps, etc., are unfortunately a very common sight in most sugar factories, and, incidentally, a big heat loss which should be avoided whenever possible.

The heat loss due to unlagged steam piping, pumps, engine cylinders, etc., has likewise not received the attention that it should, and there is certainly room for considerable improvement in heat conservation in most sugar factories.

AUXILIARY FUEL:

It is not to the credit of the Sugar Industry generally that such a vast amount of auxiliary fuel should have to be burnt in the Natal sugar mills every crushing season.

With the high fibre content of Uba cane, every factory should be able to run satisfactorily with its own bagasse. One must not, however, lose sight of the fact that many factories are operating under extremely unfavourable conditions, and unfortunately it is sometimes necessary to burn auxiliary fuel. Wood should never be burnt with bagasse, and coal dross should only be sprinkled on the bagasse before it enters the furnace, and the fires must then be much more frequently cleaned.

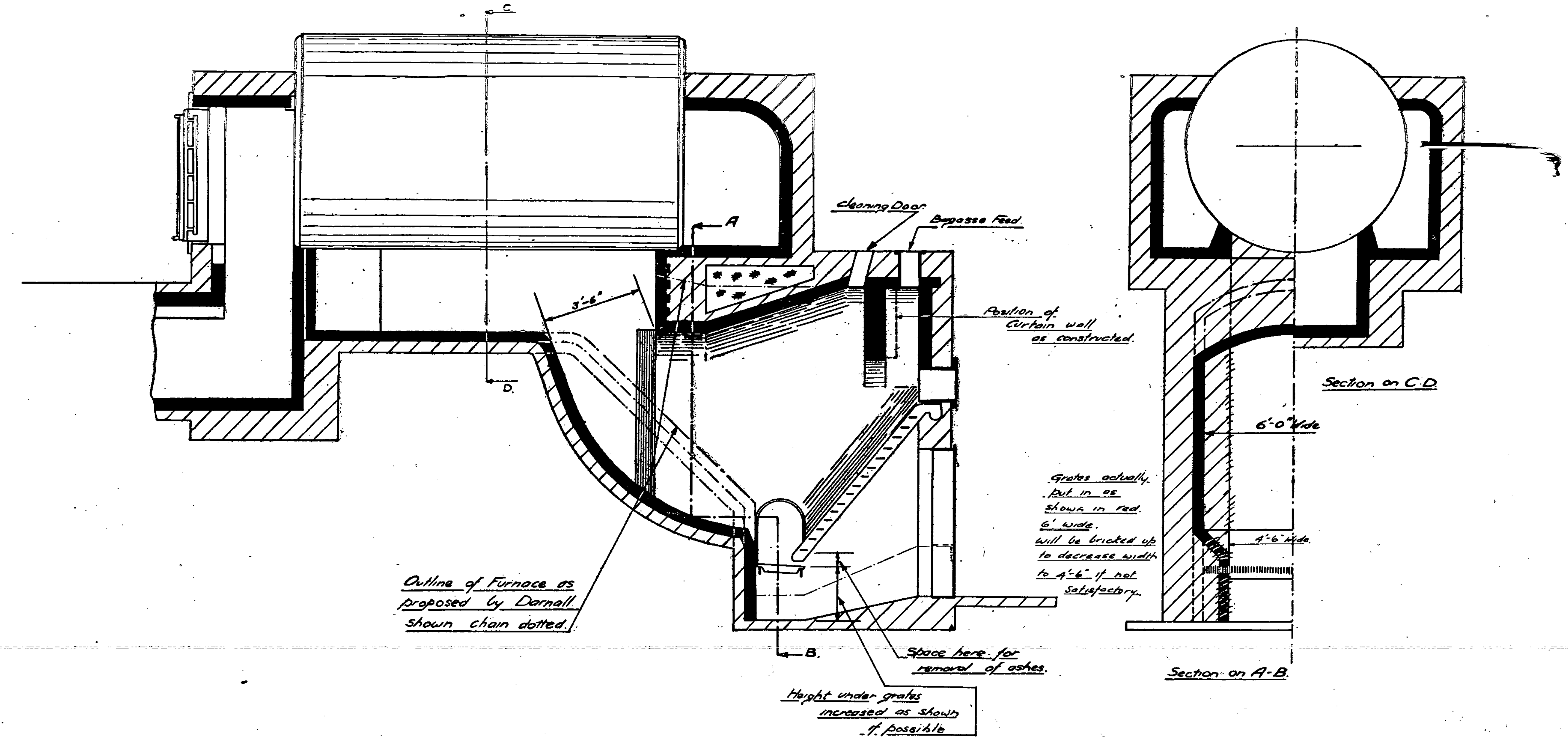
HIGH AND LOW WATER ALARMS:

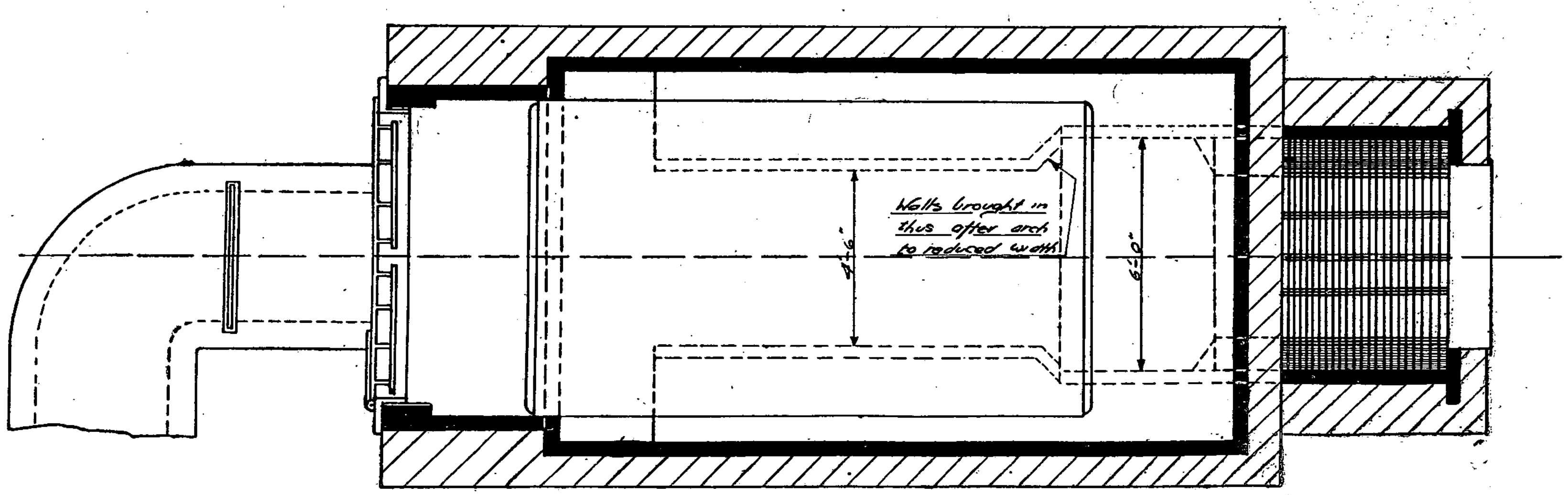
It is generally admitted that the Ashcroft Detector, which has been in use on multitubular boilers for many years, is not reliable.

There are several good high and low water floats alarms on the market. They are, however, very difficult to set in a battery of boilers, owing to the differences in specific gravity of the composition floats.

In conclusion I wish to emphasise the fact that since most of the plant in a sugar factory is operated by semi-skilled and unskilled labour, careful organization, consistent supervision and immediate attention to detail, is essential for the efficient and economical operation of any factory.

Chairman: We have to congratulate Mr. Bihl on the excellent paper he has put before us. Before passing on to any discussion of it I think we will have the next paper by Dr. Hedley and we can then discuss the two together.





Heating Surface of Boiler 2200 Sq.ft. Boiler H.P. 183	Darnall. As Existing Grate 4'-6"	Darnall. Proposed Grate 6'-6"	As shown on this Drawing Grate 4'-6"	As considered Ideal Conditions.
Combustion Chamber Vol Cu. ft.	260	388.	405.	457.
Ratio Combustion Chamber Volume to Boiler H.P.	1·42	2·12.	2·21.	2 to 2·5
Grate Area Sq. ft.	27.	40	27.	22.
Ratio Grate Area to Heating Surface	1 : 80	1 : 56.	1 : 80	1 : 100

Proposed Setting for 8' × 14'-0 Multitubular Boiler

Sir J. L. Hulett & Sons.
Darnall.

Scale 3/8" = 1 Foot.