CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.

NOTE.—Secretaries of Associations are requested to forward matter for publication in this Department not later than the 6th of each month.

THE STEAM BOILER AND ITS SAFETY.*

BY F. G. MITCHELL, M.E., London.

THE modern demand for high pressure engines is fostering sectional and water-tube boilers. The more rapid adoption of such boilers is retarded on account of so many of their parts being made of cast iron, together with so many joints and connections. These are objected to by the old type manufacturers and those unwilling to accept something new. Nevertheless, the external, horizontal, tubular boiler will soon be out of the modern class as a steam generator. It is limited in the thickness of sheet, and therefore in its diameter. Consequently, on account of its being externally fired, its pressure and power is limited. This alone has turned the attention of boiler manufacturers to a more perfect arrangement for stationary as well as marine purposes.

At the present day the demand is for high pressure in stationary boilers, embracing several designs of water tube and internally fixed boilers of different type. From an economical standpoint there is little difference, notwithstanding the claims and reports of efficient tests advanced by the makers of the different designs. On the other hand, as to the safe working pressure of the boiler, we are compelled to take the maker's figures, as there is no law in this province formulating the proper rules founded on mechanical principles to determine the safe working pressure of the steam boiler.

An instance of the above occurred to me quite recently when called upon to inspect a horizontal, tubular, externally fired boiler. The dimensions of the boiler were 72" diameter and 16' long. The plates were of steel $\frac{3}{8}$" thick, with a tensile strength of 60,000 lbs. per sq. inch. There were 114 - 3" tubes and the heads were of flange steel $\frac{1}{2}$" thick. The longitudinal joints were double riveted, the rivets being $\frac{3}{4}$" in diameter, and the pitch 3", and it is fair to suppose the holes at $\frac{13}{16}$". The efficiency of the joint so far as net sections of plate are concerned is 3" - 8125 ÷ 3" = 72.9%. The area of a $\frac{13}{16}$" hole being 0.5185 sq. in., the single shearing strength of one rivet is .5185 × 38,000 = 19,700 lbs. As there are two rivets in a unit section of the joint (the joint being double riveted), the total shearing strength of the rivets in a unit section is 39,400 lbs. The strength of a strip of the solid plate 3" wide being 3 × $\frac{3}{8}$ × 60,000 lbs, is equal to 67,500 lbs. Then, for the efficiency of the joint, so far as the rivet area is concerned, is 39,400 divided by 67,500 = 58.4%. This is much less than the efficiency of the net section, therefore it follows that the joint is badly proportioned. The rivet area is too small; notwithstanding this, the builders had no hesitation in recommending this boiler for a safe working pressure of 100 lbs. per sq. inch, whereas with a factor of safety of 5, the safe working pressure on it is 73 lbs. per sq. inch. The safety valve was set at 100 lbs. per sq. inch, and the owners of this boiler congratulated themselves on their new steel boiler. Really, the boiler was no stronger with the 60,000 lbs. steel than it would have been with 50,000 lbs. iron. Now, a proper double-riveted lap joint for this boiler would be, diameter of rivet $\frac{7}{8}$", pitch 3 - $\frac{1}{16}$"; efficiency of joint 69.4%. This would give a safe working pressure (with a factor of 5) of 87 lbs. per sq. inch.

Many years ago Sir William Fairbairn stated the efficiency of a single riveted joint to be 56%, and that of a double riveted joint to be 70%. No doubt he meant it to be understood that this was the limit practically obtainable with careful design and construction, and I am sorry to say that it is a common practice among engineers who should know better, to allow 56 and 70 per cent. for single and double riveted joints respectively, without the least regard to the actual proportions of the joint.

Another case which came under my observation not long ago was a horizontal, tubular boiler, externally fired, 48" diam. and 12' long. The plates were of steel, 60,000 lbs. tensile strength, $\frac{3}{16}$" thick and single riveted. The diameter of the rivets was $\frac{5}{8}$, and the pitch 1 $\frac{3}{4}$", and the heads $\frac{3}{8}$" thick. The workmanship of this boiler was excellent in every respect, and I believe the material was also. The only objectionable point about the boiler was the riveted joint. The diameter of the rivets being $\frac{5}{8}$", we will suppose the holes to be $\frac{11}{16}$", or 0.6875. The pitch being 1.75, the efficiency of the joint so far as the net section of the plate is concerned is $\frac{1.75" - 0.6875}{1.75} = 60.7\%$. The area of a $\frac{11}{16}$ hole being 0.3712 sq. in., the strength of one rivet (assuming the shearing strength of rivet iron were to be 38,000 lbs. per sq. inch) is 3712 × 38,000 = 14,100 lbs., and the strength of a strip of the solid plate 1.75" wide being 1.75 × $\frac{5}{16}$" × 60,000 = 32,800 lbs. We find that the efficiency of the joint so far as the rivet section is concerned is 14,000 divided by 32,800 = 43%, whereas if properly designed it should be 56%. Now, why is it that an otherwise good boiler manufacturer will allow construction such as this? He might as easily, and without any more expense, have turned out a very much better and safer boiler. It may be possible that the templets used had been arranged for 40,000 or 45,000 lbs. per sq. inch iron. But this does not explain the whole thing, for nowadays the manufacturer will go even a step closer by using only a factor of 4 with practically the same externally fired boiler.

There are many defects that are likely to be found about a steam boiler, and the ones most common are corrosion and grooving along the girth seams, generally on the bottom sheets, and cracks extending from the edge of the sheet to the rivet holes. On the outside landing, this is more often found where heavy plates are used. The most serious form of corrosion is that which attacks the plates along the water level, forming a continuous line of weakness. This is, of course, due to the acids in the feed water, and can only be remedied by improving the supply. External grooving is often due to leaky calking, and is very often caused by the use of what is known as a split calking tool having broken the skin of the metal. Buckled or boged sheets usually result from neglect in keeping the boiler clean. Soft deposits are permitted to accumulate over the fire and become hard, allowing the plates to become overheated and to be pushed down with the pressure. In iron boilers this has been attended by ruptures, while in steel boilers the buckled part grooves thinner at its lowest point until a small hole causes a leak.

I wish to mention, before closing, a very important consideration about the steam boiler, and that is, the so-called mountings. How many boilers do we meet with that have a perfect working safety valve, one that will permit the escape of steam as fast as the boiler will generate it, and not allow the pressure to exceed at most 10 lbs. above what it was set for? Anything else is only an excuse for a safety valve. It is also a common thing to see water columns connected to the boiler with $\frac{1}{2}$" and $\frac{3}{8}$" pipe and with 3 and 4 bends in it, and a small pet-cock at the bottom to blow it out? This is another excuse. Also, how often do we see a common plug-cock put on for a bottom blow-off? There are no mountings or fittings too good for a boiler, and none other should be used or allowed to be used.

* Paper read before the Hamilton Association, C.A.S.E., at December meeting.

WATER POWER ARBITRATION.

IN regard to an item in our last issue in reference to an arbitration between the Laurentide Pulp Co. at Grande Mere, on the St. Maurice river, and the province of Quebec, as to the purchase of some six islands in the river at that point, we desire to state that the great water power at Shawenegan Falls was not in any way connected with the matter in question. That part of the property at this point upon which any considerable water power development must be made is owned by Mr. John Forman, of Montreal, and he expects to be able to utilize it in the near future. Its importance may be surmised from the information given us that it is possible upon this property to create a development of 200,000 to 250,000 horse power, at a cost per horse power not approachable by any water power, so far as is known, upon this continent. For electrical developments, particularly, this property offers the most extraordinary advantages, and the recent completion and operation of the Great Northern Railway to within a mile and a quarter of the property brings these advantages within commercial reach.

As to the arbitration between the Laurentide Pulp Company and the province of Quebec, we learn that some of the islands were in the water fall of Chute de la Grande Mere, and the others in the river close by, and that the right was asked to partially fill up the bay below the falls, and so create a so-called beach lot. The arbitrators absolutely refused to commit themselves, and inasmuch as the Laurentide Co. now own the whole of the land on each side of the river, as well as all the islands in the river at that point, they can use the whole of the water in the river at that point, if this were possible, without the slightest interference from anyone, so long as they leave water enough in the channel to drive the logs of the lumbermen.

The horizontally set Crocker turbine for the electric light plant at Weedon, Que., has arrived from Sherbrooke, and is being connected to generators.