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"NOTES ON MARINE BOILERS AND STEAM PIPES,"

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CHAIRMAN: PROFESSOR A. C. ELLIOTT, D.Sc. (LOCAL PRESIDENT).

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CHAIRMAN: MR. T. F. AUKLAND (COMPANION).

So many new cargo vessels are from time to time being ordered, either to replace those obsolete or lost, or to cope with the natural expansion of the carrying trade, that a discussion based on some practical details of their design and construction will surely not be out of place in a Society like this, and more especially if there can be elicited the experience of those whose chief interest, in the Bristol Channel ports at all events, lies in their efficient upkeep and maintenance.

The success or failure of the machinery of a vessel, which is in effect a little world in itself, is so entirely a matter of detail properly arranged, that the writer was in the first instance at a loss as to which items would be of the most general interest; they, however, gradually seemed to naturally reduce themselves into two very important and prominent ones, and these relate to the design and arrangement of boilers and steam pipes.

BOILERS.

(1) The question as to the future type of the marine boiler may surely be left in abeyance as far as the Mercantile Marine is concerned, the only competitor being that designated the "water-tube boiler," the success of which, however, except under special conditions, is fraught with difficulties that only time and experiment will entirely obviate.

(1a) The Scotch, cylindrical, or, as a gentleman once designated it, the "tank boiler," has now been on its trial for many years, and a definite conclusion seems to be arrived at that it has done its work well with a minimum of trouble and expense. It is also astonishing to find so few modifications or improvements in its design, which is now exactly as it was when the triple-expansion and higher pressures came into vogue about the years 1883-4. The material used, thanks to the excellence of its manufacture and care in testing, has proved thoroughly reliable, with a happy absence of mysterious cracks, etc., which were at one time causes of much trouble and anxiety. By the intelligent use of the evaporator, by careful packing of glands and care in saving fresh water, by the general use of zinc and soda in various forms, patented and otherwise, and also negatively by the absence of oil in the cylinders, the modern boiler appears to have arrived at a stage where its deterioration and upkeep has been reduced to almost a minimum, and its efficiency and longevity increased to a maximum.

With these facts in mind, it may be well worth while to bring to bear upon the design of the one in present use any modifications which experience, often dearly bought, has taught to be absolutely necessary for its long life and general well-being. After a fairly lengthy experience, the writer must place in the forefront of all boiler designs the imperative necessity of there being plenty of room for cleaning and access. Defective workmanship is now very rare, thanks to the introduction of powerful hydraulic machinery, and the question of proportionate heating surface is generally understood; but boilers are still being built which can never, in the common course, be financial successes except where run under circumstances which do not yet universally prevail in the common run of cargo boats.

The cost of upkeep may be considerably reduced by a little forethought in design, and the modifications suggested are as follows; premising, however, that many of them are in use in some instances, but in very few do they all seem combined:

(1) Thick end plates and large stays should be allowed for in the design, discretion being given to the draughtsman as to the thickness or doubling of the plates and the diameter of the stays.

(2) Thick combustion chamber plates and large stays follow as a natural sequence. It was shown in a paper read before the North East Coast Institute of Engineers and Shipbuilders in Cardiff in 1896, that by the adoption of this simple modification a saving of one hundred stays could be made in an ordinary pair of boilers working at 160 lbs. pressure where the plate was made $\frac{3}{4}$ in. instead of $\frac{9}{16}$ in. Furnaces $\frac{3}{4}$ in. thick are

frequently used, and there seems nothing against the use of the thicker plates in the other parts mentioned. One suggestion might here be made, viz., that the nuts fitted on the ends of stays could with great advantage be made considerably smaller and thinner, and would thus be less liable to perish from overheating. Other suggestions are, more space should be allowed between the furnace or combustion chamber side and the shell, between the flat sides of the chambers, between the crown of the furnace and the bottom row of tubes, and the mudhole doors should be fitted at the back end instead of the front. While boilers are found fitted with plenty of clearance over the tank top, and away from the surrounding bulkheads, etc., these small necessary details are frequently overlooked in the general design. The covering of boilers on the bottom as well as the top seems at last to be forcing itself on the attention of those interested; still it is far too common to see vessels of eight years old, or even less, having to undergo repairs costing many hundreds, sometimes thousands, of pounds, which seem to have been incurred merely for the beneficent purpose of keeping repairing yards busy, as the fact is incontrovertible that the extensive corrosion under the boilers is caused entirely by heat, and can be, and is, obviated by the simple and inexpensive method of an effective covering or protection.

It is not intended to deal in any way with corrosion and pitting except to remark that boilers with ample spaces are the best that can possibly be devised to prevent both of these evils. One note as to auxiliary boilers. The waste in these can to a great measure be counteracted by fitting a stronger stop valve; leaks into the boiler at sea combined with heat are the undoubted cause of the oxidation, the principal factor in the deterioration, and strong heavy valves so designed that under no consideration of stress or varying temperature can any steam pass through are the cheapest and safest deterrents that can be used.

STEAM PIPES.

Unfortunately main steam pipes have come into prominence lately, and this, it would appear, not from any decadence in the material used or owing to the increased pressure, but, as in the case of screw shafts, rather to the alteration in the type of vessel and the cargoes carried. Large vessels of light draught are now very general, and when run in ballast in heavy weather the vibration incidental to such conditions has enormously increased the danger likely to be incurred by a connection between two such distinct structures as the engines and boilers, a connection, too, made of copper or iron of such a thickness that its very strength is a part of its weakness through its rigidity. The means usually employed to give the proper compensation to counteract this evil may be arranged by bends in the pipes, or by expansion joints. With regard to the first, it is the opinion of the writer that too much confidence is frequently placed in the elasticity due to the bends, the fact of the enormous resistance offered by the pipe itself, from its very thickness, being almost lost sight of. This is generally recognised in iron steam pipes, but long sweeping pipes have frequently been fitted, and then there has followed the usual occurrence of a circumferential crack at the flange, the cause of much anxiety to those on board, and of frequent delay to the vessel in a foreign port while being repaired. To say that these cracks are altogether due to vibration and want of expansion would be perhaps too much, but where the pipe is solid drawn and bell-mouthed out, with a loose connecting flange, there can be no reasonable doubt as to the cause of the fracture. In brazed pipes, however, or when the flange is merely brazed on, latent defects occasionally occur through overheating in manufacture, which the most careful and thorough hydraulic tests will fail to discover. And now comes the question, when copper pipes are used, which is preferable, the solid drawn or brazed? Here it seems natural to decide at once in favour of the former, and for many reasons, the chief of which is, that the great risk from overheating is almost entirely eliminated. It is now pretty generally known the small range of temperature that obtains between the melting point of spelter and what may be designated the perishing point of copper. The experiment may be easily tried over any ordinary smith's hearth, and is always interesting: take a small piece of copper (sheet) say $\frac{1}{4}$ in. thick, with some spelter placed on it, and gradually increase the blast till the spelter fuses, then keep the material in the fire until it begins to fall to pieces. It will be noticed that the interval of time between the two is very short, and this is of course where the danger is incurred— a slight error in judgment, causing a small defect, which may develop, under the ordinary conditions due to expansion and vibration, into a serious and possibly dangerous fracture.

There is, besides, another drawback to the use of brazed pipe—viz., the liability of the spelter to lose the properties natural to its constituency, wherein it shows its likeness to some compositions of brass, which we all know are liable to rot when exposed to the air. This process, which is somewhat analogous to weathering, is seldom more than very local, and usually gives warning of its presence by setting up small leaks at different parts of the lap joint; still, the fact of its liability to this is an important point, and, where observed, prompt means should be taken to prevent further extension. The solid drawn pipe is not liable to the drawbacks that have been detailed, and this is the great point in its favour.

The use of bends has now been shortly alluded to, and the next case is the use and abuse of expansion joints.

Where iron pipes are used, expansion joints are almost universal; copper pipes have been used at the bends, but only in isolated cases, and indeed some firms make all their pipes straight, whether of iron or copper, and rely upon the expansion joint only for the necessary accommodation between the boilers and engines. This system has given universal satisfaction, but the abuse which has been referred to consists in the continual danger incurred by screwing up the nuts on the guard flange too tight. It has not been an unknown experience to find a nut ingeniously placed *on each side* of the guard flange and screwed up quite tight to the face, causing of course the absolute disuse of the necessary expansion fitting. From this cause, and also from screwing up the gland itself too tight with too hard packing, has been experienced the drawing off of the top part of the stop valve from its flange, and in fact causing the very disaster which the expansion joint was intended to prevent. One method of doing away with the risk now cited consists in fitting the stop flange, where convenient, at a considerable distance from the stuffing box, sometimes as much as 15 ft., the length of the connecting studs giving themselves, even if screwed hard up, the safe allowance for contraction and expansion.

The practical immunity from accident of steam pipes made of iron or steel cannot of necessity be omitted, and it must be further urged in their favour, that the internal parts, after many years' wear, have been always found free from any signs of wear or corrosion. In the writer's opinion, steel in the future will be as extensively used for pipes and connections as it is now for ships and boilers.

With a properly designed plan of steam pipe connections, and safeguarded in the way indicated, there appears to be no reason why the main steam pipe should give more cause for anxiety or trouble than any other part of the machinery, and it is certainly a large factor in favour of the general practice which now obtains that so few serious accidents have happened, especially when it is remembered what severe tests they are liable to undergo.

The question of the necessity of periodical hydraulic testing has been much discussed, but the racking strain in a light ship, the chance of rupture due to a slight collision even with the side of a dock, etc., and the stress due to expansion can never be imitated, and thus the weak parts are never discovered when tried by a force pump with cold water, and for these reasons careful examination and perhaps occasional annealing would, the writer believes, meet all the requirements of the case.

A final note as to engines and boiler fixing, in regard to the question of seating and collision chocks, may be added. Engine builders now usually make a good and substantial engine seating, which, combined with the large area necessary for a three-cylinder engine, gives in itself an efficient base; but in a new vessel running in ballast on deep floors the seating usually fitted is none too substantial, and the question of the life of a steam pipe may, and often does, depend upon the rigidity of the structure as a whole. The boiler fixing, especially in the chance of collision either with ships or other objects, is occasionally overlooked, and it is often found that the collision and other chocks which have been thoughtfully placed when the vessel was built, are completely corroded away and of no possible use if wanted in an emergency when the ship is a few years old.

No novelty has been attempted in these few lines, and it is hoped that the subject introduced may lead to an instructive discussion.