STEEL CASTINGS.

ON THE USE OF STEEL CASTINGS IN LIEU OF IRON FORGINGS AND BRASS CASTINGS IN BUILDING AND FITTING SHIPS, ETC.*

By Mr. E. C. WARREN.

THE short paper which I am about to read will, to a considerable extent, express the united opinion of the committee upon the use of steel castings for Her Majesty's service, with which I was lately connected; and I have permission to use such portions of that report as may, in my opinion, be necessary to place this subject fairly before you.

The proper value of steel castings is not sufficiently understood by shipbuilders, engineers, and other manufacturers who work in metals; it seems to me that a more intimate acquaintance with their value for many purposes, and especially as a substitute for iron forgings and brass castings, and even in lieu of iron castings where strength and lightness have to be considered, will before long bring about a very great change, and the more steel castings are used the more will they be appreciated and sought after, provided that a fair price be paid, and an honest material be supplied by the manufacturer.

Castings in steel are generally made from crucible or open hearth steel; but there are some makers who use steel of special manufacture.

The points which I propose to consider are:

1. What success has, up to the present time, been obtained in producing steel castings for use in lieu of iron forgings?

2. What description of articles usually made of forged iron, or brass castings, could with advantage be made of cast steel; having regard to weight, strength, and durability?

3. What tests should be applied to various descriptions of steel castings?

With regard to the first point, I can confidently state that very great success has already been obtained in producing steel castings in lieu of iron forgings: this opinion has been formed after visiting a large number of the principal steel foundry works in England and Scotland; and in carrying out a series of exhaustive tests especially with small castings. See Appendix I., and the diagrams annexed, which illustrate samples of one of the series of tests so carried out.

The small articles selected for testing purposes were:

1. Clips for water tight doors.
2. Eyeplate, 1 in., for use on iron beams, etc.
3. Pivot bar for 20 pounder gun.
4. Clips for securing chains for 6 in. breechloading and other guns.
5. Hooks for tackle blocks.
6. Internal binding for 10 in. snatch block, and swivel hook.
7. Internal binding for 10 in. treble block, swivel eye, and shackle.
8. Deck plate with double eye and links for securing guns.
9. Fighting pivot for 64 pounder and 7 in. guns.
10. Longitudinal intercostal angle 3 in. by 3 in. by $\frac{1}{8}$ in., long 3 ft.
11. Bedplate for Nordenfelt gun.
12. Intercostal beam angle 3 in. by 3 in. by $\frac{3}{8}$ in., long 2 ft.
13. Intercostal angle 3 in. by 3 in. by $\frac{1}{8}$ in., long 2 ft. 6 in.
14. Boat's crutch.

In addition to these, a great number of larger steel castings were examined and tested, viz.:

- a. Stems for ships of various sizes.
- b. Stern posts for "
- c. Stern frames for "
- d. Rudders for "
- e. Brackets for supporting after ends of propeller shafts.
- f. Dredger chains and buckets.
- g. Hawse pipes.

- h. Anchors.
- i. Frames for gun carriages.
- k. Saddles for gun carriages.
- l. Main bearing frames for engines.
- m. Crank shafts.
- n. Wheels of all sizes.
- o. Cylinders.
- p. Propeller blades.
- q. Rudder frames.
- r. Caps for masts and bowsprits.
- s. Riding bitts.
- t. Capstans.
- u. Cable holders.
- v. Deck pipes and plates.

Appendix II., with its illustrations, gives sketches to scale of some of the articles previously enumerated, and also the tests to which they were subjected.

These speak for themselves as to the difficulty of making perfectly sound and reliable castings for the

For large articles, good, sound, reliable castings can be made, with proper care, from either crucible or open hearth steel.

With regard to the second point, viz., What description of articles usually made of forged iron, or brass castings, could with advantage be made of cast steel, having regard to weight, strength, and durability? It is, I think, evident that the question of cost will largely determine the extent to which steel castings are brought into use; for small articles, where only a few of one description are wanted, it will be cheaper, and a saving of time, to continue to make them of forged iron; but even for very small fittings, where large numbers of similar patterns are required, the saving by using cast steel will be very considerable, both in time and money.

For larger articles, such as stems, stern posts, brackets for supporting propellershafts, rudder frames, racers for guns, frames for water tight doors, trolleys for machine guns, hawse pipes, etc., the saving would be very great indeed.

Appendix III. gives a list of such articles or parts of a ship, or her fittings, which could be advantageously made of cast steel.

The strength of good steel castings is beyond question, and their durability is very great, and the saving in weight is very considerable.

I have seen small steel castings which have been in every respect equal to the best iron forgings; but I am also bound to say, that I have seen others which could not be safely used on board ship, or in any position where they would be subject to shocks or vibrations, and the greatest care is required in selecting and testing steel castings before they are accepted.

There are steel castings and steel castings, good, bad, and indifferent, and the price paid will often, to a great extent, determine to which category the articles belong. I am certain that, even at the present time, a fair price paid to any of our well-known steel foundries will enable us to obtain sound and reliable castings, which will bear the most rigid examination and tests.

Too often prices are cut down to such an extent that the temptation to use inferior materials is irresistible, and when such is the case the usual results follow, and there is a failure. Thus it is we so often hear of steel castings having failed, and so an undeserved slur is thrown upon the manufacture.

There are some well-known firms who are too high minded to allow any but the very best materials to be used, and the result is that their castings are almost uniformly of the highest character, and none but the best are allowed to leave their works.

It is to makers of this type that we must look for improving and cheapening the cost of steel castings.

At the present time every effort is being made by most able and skillful men to investigate the nature and combination of metals, both scientifically and practically, and the trained chemist is standing by to watch, and work out carefully the results; and it is to be hoped that before long we shall be able to produce perfect steel castings at a most reasonable cost.

This brings us to a most important point of our subject, viz.:

What tests should be applied to various descriptions of steel castings?

It is extremely difficult to lay down any general law on this point; steel castings are used for so many purposes, involving entirely different conditions, according to the nature of the work required for them, that the tests which are absolutely necessary to be obtained in some cases may be dispensed with in others.

In Appendix III. is given the list of fittings proposed to be cast in steel, and also the tests which it is considered should be applied to each.

The appearance of the fractures of broken castings gives also certain indications of the nature of the materials. The percussive test is most valuable where it can be applied; and it is most desirable that when a number of articles, or fittings, of the same or similar patterns are supplied, a test to destruction should occasionally be made, to obtain information from time to time, as to the ultimate strength of the castings.

I consider it undesirable, and unnecessary, to specify

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articles shown; but the difficulty existed only to be overcome, and no one could see the splendid specimens of castings which were turned out, and which stood most satisfactory tests, without being convinced that in cast steel we have a material which, although only partially developed, is of the utmost value. We want the ability and determination of the makers and the intelligence and skill of the workers combined, to still further develop and perfect this branch of manufacture.

I think a similar process will have to be gone through with steel castings as that which took place with respect to the manufacture of mild steel for plates, etc., a few years since, and which has produced such great results that mild steel plates, angles, etc., are now produced at prices which were not then thought of, and of such excellent quality and homogeneity that we may almost say we possess a perfect article at a most moderate price.

When the same process has been passed through for steel castings, a great deal of inferior make will disappear, like the old steel plates which would break up like a sheet of glass if they were let fall upon an iron slab, and we shall get an article in every way reliable, at a greatly reduced price.

It is found that small castings made from good crucible steel are remarkably tough, ductile, and of uniform quality, while many of those made from other steels are very unsatisfactory, and unfit substitutes for small iron forgings.

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a minimum and maximum tensile strength per inch; if the minimum be given, and the elongation in a given length, and a bending test, together with a percussive test, where such may be applicable, it is sufficient to insure perfectly reliable articles.

It is a well-known fact that some steel which will

bear a greater tensile strain than the maximum specified will, notwithstanding, show excellent results of elongation and bending; and when this is the case, to insist upon its rejection because of its superior strength would be unreasonable; and as a matter of fact—having obtained the minimum tensile test to insure

sufficient strength—the elongation and bending tests should determine the question as to receipt or rejection.

I should like to make reference briefly to some steel castings which were cast at Stockholm by Nordenfelts' patent process; they were most interesting, and of superior finish, and they could be bent and twisted cold in an extraordinary manner without fracture. A

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specimen given by Mr. Nordenfelt, with permission to test it in any manner desirable, gave the following results, viz.:

Tensile test, 28 tons per square inch.
Elongation in 2 in., 12.8 per cent.

I am of opinion that if castings by the Nordenfelt process can be produced at a reasonable cost, they will be of very great value in lieu of small iron forgings and brass castings.

It will be observed that I have not dealt with chemical tests for steel castings. I attach very great importance to the labors of the chemist in relation to the manufacturer; but I do not attach any value to the chemical tests which are sometimes insisted upon before castings are accepted by the purchaser.

The large variations in the results of tests obtained by different chemical manipulators are most perplexing, and in my opinion they may be safely neglected, the mechanical tests previously named being amply sufficient to meet every possible requirement.

(To be continued.)

SIBLEY COLLEGE LECTURES.—IX.

BY THE CORNELL UNIVERSITY NON-RESIDENT LECTURERS IN MECHANICAL ENGINEERING.

By JAMES C. BAYLES.

THE RIDDLE OF THE SPHINX.

II.

DURING the comparatively brief interval* since I had the pleasure of addressing you upon certain historical phases of the labor question, so much has happened that probably the conclusions I shall present to-day will be very different from those I should have considered it my duty to present three months ago. Events move rapidly in times like these. Titanic forces take birth and exhaust themselves almost before one can study their phenomena.

The late A. L. Holley was once asked why he did not write a great work on steel, which should perpetuate his well-earned reputation; and replied, in effect, that before the last chapter went to press, the first chapter would need complete revision, and the man who bought it would have to hurry home with it, lest it should become obsolete on the way. It is so with the discussion of the labor question. Three months ago nothing would have seemed more improbable than a strike, without redressible grievance to excuse it, stopping the traffic on hundreds of miles of railroad, with rioting, bloodshed, and the wanton destruction of property, by a branch of an order pledged to seek by every peaceful means an amicable adjustment of all differences between employers and wage-earners. But just this has happened, from causes easily explained after the fact, but impossible of prediction. Fortunately, however, there are broad principles underlying all the relations of capital and labor, which are not touched by local and temporary conditions. I shall not attempt to consider the question in its news aspects; but a few words concerning the events which are now monopolizing public attention seem to me both appropriate and necessary.

The present is as good a time as we are likely to see in many years for those who have a fair amount of courage and nerve to refrain from becoming alarmed or excited. There is much that is disquieting in the present disturbed condition of the labor market. Men possessed of reasoning powers which they are able and willing to exercise independently of dictation, find it difficult to speak calmly of the folly of the working classes in making such enormous sacrifices to attain results which are, or at least seem to be, impossible of attainment. Those whose business is stopped, or threatened with stoppage, because of impracticable demands made on behalf of the labor unions, find it difficult to look beyond their immediate environment. They see that the men with whom they have had long and satisfactory relations yield a blind obedience to a power which is eager to lead them into trouble, but cannot stand between them and the consequences of their own mistakes. All this is very discouraging, but the teachings of human experience during centuries are not likely to be contradicted by the happenings of this year or next. Organized labor cannot accomplish impossibilities. The more it wastes its accumulated earnings in strikes and demonstrations, the more it dissipates the power it has for blocking the wheels of industry. The sharper the conflict it invites, the sooner will the issue be tested and the more decisive the result.

The eight-hour movement is just now the leading issue. The test strikes brought in different parts of the country to show the power of new organizations representing the workman have failed. The Knights of Labor permitted the Southwestern railroad strike to become what in law would be called "a test case." Their absolute and unconditional defeat was evident from the outset. A score of trade unions have since made a decisive issue of the eight-hour demand. No one need fear that this demand will be enforced where the conditions are not such as to permit the requirements of the market to be met by a production possible in eight

* For preceding—introductory—lecture, see SCIENTIFIC AMERICAN SUPPLEMENT, April 10, 1886, No. 536, p. 8557.