

Mr. RADFORD observed, that if the platforms had been placed deeper, there would have been less risk of decay.

Mr. R. STEPHENSON, M.P., V.P., believed, that the piles had been driven below the line of saturation of the ground.

Mr. CARR, in answer to questions, said, that the ground was of alluvial formation, and permitted the filtration of the water. The whole of the piles were of larch, or oak, and they were never exposed to the action of the air; it was from considerations of economy, that they were not driven deeper. The water would not rise to the top of the piles under the land arches.

No. 830.—“On the Nominal Horse Power of Steam Engines.”¹
By Commander LEOPOLD G. HEATH, R.N.

THE term ‘nominal horse power’ is daily becoming more and more inadequate to give any notion, either of the dimensions of an engine, or of the work to be expected from it. This arises from the changes which have taken place in the methods of applying the motive power, since the original introduction of the term.

Engines are now worked under such various loads on the safety valves, and at such different degrees of expansion in the cylinder, that the constant 7 lbs., which was used by Watt as the mean effective pressure per square inch on the piston, is not only itself inapplicable, but no constant quantity whatever can effectually replace it. It appears, for instance, that in H. M. S. ‘Garland,’ when the safety valves are loaded with 16 lbs. per square inch, the indicator diagrams show a mean effective pressure of 22·96 lbs.; whilst in H. M. S. ‘Basilisk,’ with a load of 8 lbs. on the safety valves, the indicator diagrams show a mean effective pressure of 15·3 lbs.; yet in calculating the nominal horse power, the constant quantity 7 lbs. is used as a multiplier in both cases. The evil caused by this is two-fold; in the first place, the nominal horse power will not, in either case, give any approach to the absolute horse power; and, in the second place, it will not give a true account, even of the relative power of the two engines.

Again, in Watt’s formula, the actual speed of the piston was used as a factor; but as there was no authorized rule, by which to obtain the value of this speed, previous to trial, and as the value obtained even by actual experiment, depended upon the load required to be moved, the supply of steam, &c., it was thought advisable to sub-

¹ The discussion on this Paper extended over portions of two evenings, but an abstract of the whole is given consecutively.

stitute for the actual speed recommended by Watt, a conventional speed, depending upon the length of stroke of the engine. The formula thus revised was called the Admiralty formula, and may be thus stated:—

N. H. P. =

$$\frac{2 \text{ length of stroke} \times \text{area of cyl} \times 7 \times \text{No. of revs. per min.}}{33,000}$$

the revolutions being obtained from the following Table, well known to Engineers:—

| Length of Stroke. | | Number of Revolutions. | Length of Stroke. | | Number of Revolutions. |
|-------------------|-----|------------------------|-------------------|-----|------------------------|
| Ft. | In. | Per Minute. | Ft. | In. | Per Minute. |
| 3 | 0 | 30 | 6 | 6 | 17·4 |
| 3 | 6 | 27 | 7 | 0 | 16·5 |
| 4 | 0 | 24·5 | 7 | 6 | 15·7 |
| 4 | 6 | 22·7 | 8 | 0 | 15· |
| 5 | 0 | 21 | 8 | 6 | 14·4 |
| 5 | 6 | 19·8 | 9 | 0 | 13·7 |
| 6 | 0 | 18·5 | | | |

The unfitness of the constant factor 7, to represent the mean effective pressure, has been already shown: a further investigation of the same examples will display the fallacies which are introduced, by taking the revolutions from the Admiralty Table. In H. M. S. 'Garland,' with a length of stroke of 4 feet, the nominal horse power would be calculated, as if the number of revolutions was 24·5 per minute, instead of which the real number of revolutions is 33 per minute. In H. M. S. 'Basilisk,' with a length of stroke of 6 feet, the nominal horse power would be calculated as if the number of revolutions was 18·5 per minute, whereas it was, in reality, 18·1 per minute. In the latter case, the horse power, calculated from the Admiralty formula, would not, in respect of the number of revolutions, be far from the truth; but, in the former case, the result would be affected in the proportion of 24·5 to 33, and thus, for purposes of comparison between the two engines, the factor representing the number of revolutions, is as likely to mislead as that representing the pressure.

It is, however, frequently said, that although the nominal horse power does not represent either the absolute, or the relative, power of engines, it does, nevertheless, represent their relative size. It is proposed, then, to examine and compare the engines of the 'Garland,' which are of 60 nominal H. P., with those of the 'Basilisk,' of 200 nominal H. P. In both cases the engines have oscillating cylinders, and are applied to drive paddle-wheels. The 'Garland'

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has cylinders, $43\frac{1}{4}$ inches in diameter, and a length of stroke of 4 feet. The cylinders of the 'Basilisk' are 74 inches in diameter, with a length of stroke of 6 feet. This gives 41·6 cubic feet for the contents of one cylinder in the 'Garland,' and 179·4 cubic feet for the contents of one cylinder in the 'Basilisk.' Here, then, the cylinders, which may be taken as representing the size of the engines, are in the proportion of 41·6 to 179·4, whilst the horse power is in the proportion of 60 to 200; or, in round numbers, the cylinders are as 4·2 to 18, whilst the horse power is as 5·4 to 18. It is, therefore, clear, that the nominal horse power of engines does not give an idea either of their power, or of their size.

If a similar comparison be instituted between the engines of the 'Basilisk' and the 'Niger,' the former of which are used for driving paddle-wheels, and the latter for propelling a screw, it will be found that, although both are nominally 400 H. P., the cubic contents of one cylinder of each are, respectively, as 179 to 45; the equality of nominal horse power being brought about by the use of the Admiralty formula in the one case, and of Watt's formula in the other.

An investigation of vessels in the merchant service would exhibit a still greater discrepancy, as some makers use Watt's formula, and some the Admiralty rule, whilst others have invented formulæ for themselves. Thus the term 'nominal horse power,' indefinite and useless as it would be, if calculated from any one formula, is rendered still more so by the indiscriminate use of many formulæ.

In proposing a remedy for these defects, it is conceived, that a general definition should be adopted, which would determine the size and first cost, as well as the expenditure, daily cost, and comparative power of engines; and it is more necessary, that these points should be relatively, than that they should be absolutely, true.

At first sight, it would certainly appear easy to amend the old rule, by substituting a tabulated varying effective pressure, for the 7 lbs. constant of Watt, and substituting for the conventional speed of the Admiralty formula, a tabulated speed, depending upon the effective pressure, jointly with the dimensions of the boilers and of the steam cylinders. But the dimensions and shapes of the paddle-wheels and floats, and the propellers are so various, that the formation of these Tables would be almost impracticable; and even if this difficulty was overcome, the actual and relative sizes of the engines would not be included in the definition.

It is, therefore, considered, that the term 'nominal horse power' should be abolished, and that engines should, in future, be designated by the cubic contents of their steam cylinders, jointly with their

nominal consumption of a standard description of fuel. This nominal consumption might, in the first instance, be determined by an examination of the recorded expenditure of a number of boilers, such expenditure being reduced to the standard fuel recommended in Sir Henry De La Bèche's Report on coals for steaming purposes; and then drawn up in a tabulated form, giving the consumption in terms of the grate and heating surfaces, and accompanied by rules and directions, to insure the uniform true measurement of these surfaces. Under this system, the engines of the 'Garland' and the 'Basilisk,' would respectively be described as 42 feet,—12·5 cwt. engines, and 179 feet,—19·5 cwt. engines, from which their relative size and power might be at once inferred, within limits quite near enough for practical purposes.

Although marine engines only have been discussed, the same arguments will equally apply to all other kinds, distinguishing, of course, high pressure from condensing engines.

The term 'nominal horse power,' being almost coeval with the invention of the modern steam engine, has gained a hold upon the public mind, which can only be removed by the influence of some recognized public body, such as the Institution of Civil Engineers; it is on these grounds, and from a knowledge of the evil and uncertainty arising from the present definition, that the Author has been induced to venture upon submitting the subject for discussion.

Mr. R. STEPHENSON, M.P., V.P., said, the opinions of Engineers varied so much on this question, that it was most desirable to agree upon some uniform standard. Watt had tested the power of a horse by ascertaining the quantity of water it would draw, and with him, horse power really meant what the words imported. Now, however engines might be improved, the power of the horse still remained stationary; he thought, therefore, that in estimating the power of steam engines, the standard fixed by Watt ought to be adhered to. He considered, that the Paper was defective in this point, that it did not take into account one of the main elements of a steam engine; it supposed the cylinder to be the criterion of the power, but such was not the case. Watt laid down his rule at a period when a certain proportion existed between the boiler and the cylinder, and between the cylinder and the other parts; thus, a cylinder 30 inches in diameter, had a piston rod 3 inches in diameter, and the engine was 30 H. P., and this relation remained uniformly the same for many years. But the Engineers of the present day had introduced different proportions, and the power of