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DESCRIPTION OF A NEW STABILITY-APPARATUS.

By LUDWIG BENJAMIN, Member of the Institution of Naval Architects.¹

THE object of the apparatus is to find the height of the centre of gravity of a vessel under any load, and thus to indicate whether a vessel in any condition will have that amount of stability for which it has been designed. It consists of a beam-balance, shown in Figs. 1 and 2 (Plate XXVI), on one side of which a drawing r of the ship is fastened, which is especially prepared in the manner to be described later on. Over this drawing partitions are formed by means of little boards, as shown in Fig. 4. These partitions correspond with the various compartments of the ship; and in the same manner as the ship's holds are filled with dead weight, these partitions are filled with a corresponding amount of shot, and represent thus the loaded vessel.

On the other lever of the balance there is a scale s indicating heights above the top of the keel, and along it slides a hanger h , which is so loaded as to represent the total weight of the vessel. When this hanger is moved to that point on which it brings the balance into equilibrium, its position on the scale indicates the height of the centre of gravity above the top of keel.

Any naval architect can easily furnish for every vessel that height to which the centre of gravity can be raised, without endangering the safety of the vessel, for any given draught;² while another limit of the centre of gravity is experienced, below which it would make the vessel too stiff. It is easy, then, to see, by means of this apparatus, whether, for any intended load, the centre of gravity will be within these limits, or, if it be found to be not so, to study what changes will be necessary.

¹ Read at the meeting on Wednesday, June, 18th, Admiral Sir Frederick W. E. Nicolson, Bart., in the Chair.

² This information may be given either by a curve, or more handily by a displacement scale arranged in the following manner:—

Displacement.	Draught.	Dead weight.	Safe height of C. G.
tons.	feet.	tons.	ft. in.
6,000	22	3,500	17 2
5,500	21	3,000	16 10
5,000	20	2,500	16 8
4,500	19	2,000	16 9
4,000	18	1,500	17 0

Let us assume that the apparatus be applied to a three-decked merchant steamer as shown in Fig. 3. The drawing shown in Fig. 2 is prepared from Fig. 3 in contracted scale. As, for our purpose, the lengths of the different holds are of no moment, the bulkheads on this drawing are put down in given distances to suit the little boards forming the partitions, but the heights of the decks are drawn to scale. To explain this drawing better, the holds in Figs. 2 and 3 are marked by corresponding letters. The drawing is shown in Fig. 1 by the heavy line marked *r*, and is simply pinned to the board of the instrument, with the keel towards the point of suspension of the latter; a line for the keel is given on the board, and corresponds with the zero-point of the scale on the other lever. Over the bulkheads and decks of the drawing, the boards, Fig. 4, are then pinned, thus forming the partitions above mentioned.

Next the apparatus is to be adjusted for the light vessel. The weight of the light vessel and the position of its centre of gravity are data which need to be known, and which can be easily obtained from a naval architect or by a simple inclining experiment.

The sliding hanger of the instrument contains a box M, which is to be filled with shot, to make it correspond with the light weight of the vessel; then this hanger is placed on that point of the scale which is the given height of the centre of gravity of the light vessel; and now the box N on the other side of the apparatus is filled with as much shot as is required to bring the balance into equilibrium. The instrument is now in working order, and it will be noticed that the same instrument can be used for all vessels by adjusting it in the manner described.

Let us now suppose the vessel to be loaded up to the main deck with an homogeneous cargo. The capacities of the different holds are known, and the weight of the cargo for each hold is therefore known too. A corresponding amount of shot is now put into each partition, formed over the drawing of the apparatus, and likewise the partitions representing the bunkers are filled with shot corresponding to the weight of coal put into the ship. A weight equal to the total amount put into the various partitions is then placed on the hanger by means of solid blocks of lead P, properly arranged and marked, and which for simplicity are also used for the weighing of the shot.¹

The hanger is then removed to that place where it brings the instrument into equilibrium, and indicates on the scale the height of the centre of gravity. Suppose it be found that the latter is within the given limits. It is next to be investigated whether the ship will still remain safe when the bunkers are emptied. For this purpose, it is only necessary to take the shot out of the bunker partitions, to remove the same weight from the hanger, and to bring the balance again into equilibrium. Let the scale indicate now that the centre of gravity is too high, and therefore the ballast-tanks need to be filled. The amount of shot corresponding with the weight of the water-ballast is put into the ballast-tank partitions, the same weight is

¹ The weights are made so that one ounce represents 100 tons in the ship, which, without being unhandy, allows still a great amount of accuracy.

added to the hanger, and the new position of the centre of gravity is found by balancing the apparatus.

Let us now suppose that the vessel discharges in an outport the holds marked B, and fills them with a mixed cargo; say, the lower hold is filled up to 7 feet above the top of the keel by iron rails, and thence upwards to the main deck, light machinery is taken in. At a line 7 feet above the top of the keel one of the boards shown in Fig. 4 is placed, and the partitions are now filled with shot according to the weight of the loads mentioned; the additional weight is placed on the hanger, and the new centre of gravity is found. If the result should show that the ballast-tanks need to be emptied, this operation can be easily performed on the instrument in the same manner as explained.

Let us assume that, besides the load mentioned, some boilers are ready for shipment which can only be taken as deck-load. By placing a little box filled with shot (Fig. 5) on the proper place of the drawing, and adjusting the apparatus for it, it can be easily seen whether this deck-load would endanger the vessel or not.

From the foregoing, it will be evident that by means of this apparatus the loading of the vessel in all phases can be exactly studied. Imitating the real vessel, it shows in a very clear manner results which otherwise could only be obtained by laborious calculations, which do not come into the resources of those who navigate vessels. The apparatus will therefore be of great assistance to captains, superintendents, shipowners, &c. It will be of use, also, for ships of the Royal Navy, where it enables the Captains to study the effect of proposed alterations in armament, stores, &c. In merchant-vessels it will make the owners and captains more independent of the stevedore than they are at present, and they can at any time readily make sure whether their ships are safe, as far as stability is concerned.

The details of the model I have had the honour to lay before you are at present being reconstructed; and the new apparatus, which is manufactured by Messrs. Elliot Brothers, will in all details be as handy and suitable as possible.

If required, it can be made to be used at sea, or to indicate also the trim of the vessel, by extending the principle explained above.