clearance by turning to starboard, into the actual track of the other vessel. Is this not Q.E.D.? Figure 3 is another example, in which three ships on approximately the same bearing appear to yaw simultaneously in formation with a period of 90 sec. *Three* drunken helmsmen?

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Ship Speed Measurement

C. A. Robinson

If an analysis is made of the speed of a ship using data recorded in log-books the results are extremely disappointing, and do not reflect the accuracies of the instrumentation in use. Even data from a satellite navigator, where the speeds should have an accuracy of better than 1 per cent, give a 1-knot band in recorded speed; in a 20-knot ship this is 5 per cent. Such inaccuracies require explanation.

To begin with one must ask what is meant by ship's speed, and different interpretations come from different people. The navigator is concerned with speed over the ground, while the naval architect or marine engineer is mainly interested in the forward speed of the ship through the water. On the other hand a compiler of ocean current data will require both the speed over the ground and the speed made good through the water, but the latter must take leeway into account. Finally, a weather routing consultant is looking for the actual forward speed the ship can achieve through the water in the prevailing weather conditions. All users of speed data may require other related information, such as the ocean currents and the leeway characteristics of the ship, which can in fact only be compiled from ship speed data. At the present time all these different requirements have to be satisfied by the speeds measured at sea and recorded in the log-books and their abstracts. Ships' officers compile these records, but by the nature of their work they are biased towards the navigational concept of speed.

Figure 1 shows the relationship between the different speeds that can be measured at sea. The motive power provided by the engines and transmitted

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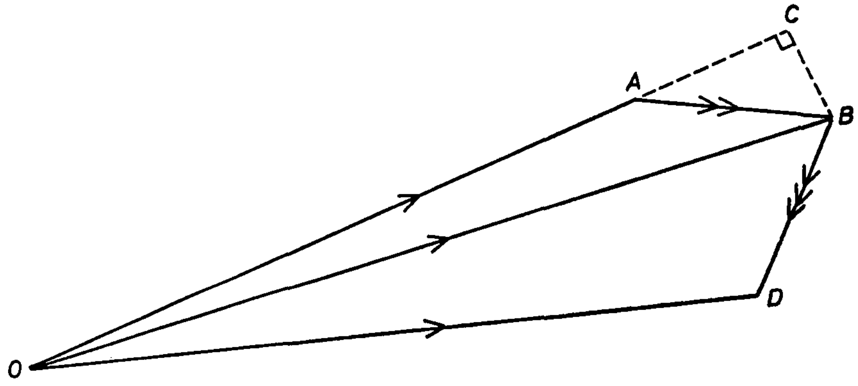

FIG. 1. Speed vectors

through the propeller will give a ship a forward speed in calm water of OA. This will be referred to as the 'engine speed', although the term is used at sea to describe the speed calculated from the theoretical distance a ship would travel if there was no propeller slip:

$$\text{Theoretical engine speed (no slip)} = n_t H/t = NH/101\cdot33$$

where n_t = total propeller revolutions in time t

H = propeller pitch (feet)

N = rev/min of propeller.

The apparent slip ratio percent is given by:

$$S_a/100 = \{1 - 101\cdot33\, V_s/NH\}$$

where S_a = apparent slip (per cent)

V_s = speed (knots)

The engine speed as defined here can therefore be found from:

$$\text{Engine speed} = NH/101\cdot33\ \{1 - S_a/100\}$$

If we consider a wind exerting a force on the ship's hull and superstructure, there will be a resulting motion AB, usually referred to as the leeway drift. Normal practice at sea is simply to consider the leeway angle between the direction in which the vessel is pointing, OA, and the track which the ship makes through the water, OB.

The ship's log is designed to give the speed through the water in the fore and aft direction; this will comprise the engine speed and the fore and aft component of leeway. Log speed will therefore be OC. In practice the change in forward speed through the water will change the propeller slip, and this in turn may affect the rev/min and power output from the engines. An equilibrium will be reached so that, for the purpose of this exercise, the feedback loop can be ignored. If the ship is fitted with a log that can measure the athwartship component of speed through the water, it will register CB. To find the leeway angle both the log components are necessary, but unfortunately few ships are fitted with a two component log and the leeway angle can only be guessed. As there is little published data about this characteristic of ships, and since OB cannot be reliably obtained by any other method, leeway angles recorded in log-books are of doubtful value. Ships' officers have no check on the validity of their estimated leeway.

At first glance it would appear that the speed made good through the water, OB, could be derived from the speed over the ground, OD, and an allowance for the current, BD. But in practice the only current data readily available are in chart form with too small a scale for each day's run to be considered accurately. Further, current charts are compiled from averages of hundreds of ship records, some going back to the nineteenth century; for many of these records the unaccounted leeway will distort the currents calculated. Small errors in estimating the leeway angle can result in considerable directional errors in the currents and it is therefore possible that current charts may simply reflect the wind patterns of the world. The similarity between the current charts and the prevailing wind charts is, after all, quite striking. Recent research suggests that currents are not a continuous flow of water but rather eddies varying in diameter, and thus giving changing velocities and directions with both time and position. This is not the whole story, the effects of the sea and swell on the ship are a far more complex problem, nor have the amount and frequency of rudder movements been considered. These all take their toll of power from the engines, as will the fouling and roughness of the hull. It is hoped that this article may bring to the attention of ships' officers some of the problems facing analysts who have to sift through log-book data.

Wheelhouse Design

Duncan M. Henderson

THE basis of wheelhouse design is comprehended in that wonderful Anglo-Saxon word—sea-man-ship. For the design of a wheelhouse should be such that the three elements in a mariner's work—the sea, the man and the ship are linked together in the most efficient manner. At all times and in all positions in a wheelhouse the mariner should have a clear view of the scene outside and also have as many clues as possible to the direction of the ship's head—so that he may relate the ship's head and the outside situation as easily as possible.

Figure 1 depicts the wheelhouse of M.V. *Conister* of the Isle of Man Steam Packet Co., Ltd. as seen from the after end centre, 12 ft. abaft the windows. The following points may be noted:

(i) The deck of the wheelhouse slopes forward about 2° from the horizontal due to the sheer of the hull. This permits the fo'c's'le to be clearly visible, even when standing at the after end, and the sea near the bows is always in view—small craft close to cannot get lost to view.

(ii) The for'a'd bulkhead is nearly flat and the deck is planked and payed with black marine glue—both these features indicate the direction of the ship's head.

Many modern ships have inferior bridges, compared to the *Conister*—the deck slopes aft and down from the windows, and only a few feet away from the for'a'd bulkhead all sight of the fo'c's'le has been lost, and indeed quite often