UNCOMMON DEVIATIONS

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It is a well known fact that in correcting the errors of the compass, the magnets must not be allowed to come too near the compass. With regard to the position of the magnets, the text-books on the subject maintain that a magnet should not be placed nearer the compass than double its length. This rule, however, is only applicable in conditions where the length of the needle-system is short in relation to the distance to the magnet. In correcting errors of comparatively long-needled compasses, this rule is not quite adequate as in such circumstances we must also take into consideration the size of the needle-system. The rule should therefore be extended and made to read as follows : a compensating magnet must not be placed nearer the compass than double its length, nor nearer than 1.7 times the sum of the length of the magnet and the length of the longest magnet of the needle-system. If this rule is neglected, a heterogeneous field in the compass-region will result, producing deviations of a peculiar type. The term « compass-region » indicates the sphere occupied by the needle-system. This type or form of deviation, which is not mentioned in the text-books, is certainly unusual, but it does appear occasionally, and then often with considerably high values. A few examples, which will be dealt with below, show these forms of deviations.

In this connection it should also be mentioned that the statement of the text-books to the effect that the fore-and-aft and athwart-ship forces in the compass-region are fully compensated when the residual-deviations in East and West or North and South are of equal proportions and have the same signs, is not valid in general. This fact will be more clearly shown in the examples to be dealt with.

Ex. 1. — After correcting errors in the steering compass of the m/s *Arjäng* the following residual-deviations were observed :

North	+ 1°	North	+ 1°
NNW	— 2	NNE	+ 3
NW	— 4	NE	+ 4
WNW	— 3	ENE	+ 2
WEST	— 1	EAST	0
WSW	— 3	ESE	+ 2
SW	— 5	SE	+ 4
SSW	— 3	SSE	+ 2
South	0	South	0

The compass was an older model with needle lengths of ca. 13 cm. The compensation of the fore-and-aft forces was carried out with 2 magnets of 10 cm. at a distance of ca. 22 cm.; compensation of the athwart-ship forces with a similar magnet at about 40 cm. distance.

Although the deviation appears with its minimum value in the cardinal, and maximum value in the inter-cardinal points, it is not « quadrantal », as it has the same sign in two adjacent quadrants.

If we draw the curve of the deviation, its unusual form appears more clearly than can be seen from the cipher values of the table shown. The continuous curve in fig. 1 shows the course of the deviation. If we analyse the residual-deviations in the usual way by determining the coefficients of the deviation, we find that :

1) Coefficient A = 0.0°, which shows that no constant deviation appears after compensation;

2) — B = + 0.5°, when calculated from the deviations in East and West, but

— B = + 6.4°, when calculated from the deviations in the inter-cardinal points;

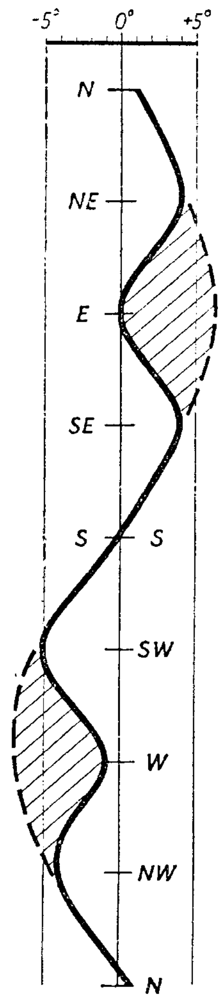
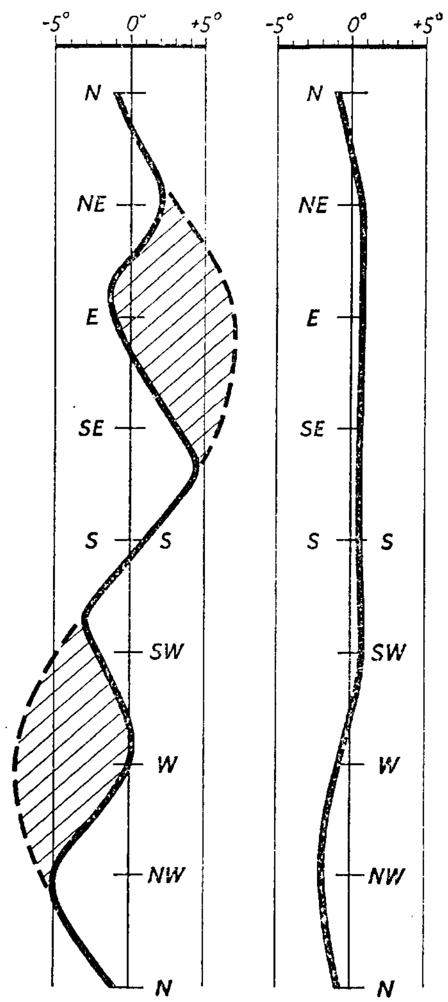


Fig. 1.



a. *b.*

Fig. 2.

3) — C = + 0.5°, or 0,4°, depending on whether its value is calculated from deviations in the cardinal or inter-cardinal points. Compensation of the athwart-ship forces can therefore for practical purposes be considered complete;

4) — D = — 0.3°, which shows that the position of the D-correctors is a trifle too near the compass and that the resulting deviation is at the most 0.3°;

5) — E = + 0.5°, which shows that weak forces caused by the unsymmetrical position of horizontal iron produce a deviation of at most 0.5°;

6) — F = — 2.1°, G = + 0,3° and H = 0°.

The coefficient values thus received show that we can practically ignore the constant and the quadrantal part-deviations and that the athwart-ships compensation has been correctly carried out. The rather high values of the residual-deviations must therefore be ascribed to the compensation of the fore-and-aft forces. The value B = +0.5° would lead us to assume that for all practical purposes these could be considered completely compensated, but the value B = +6.4° would seem to discredit this theory. The true B-value in this case can easily be arrived at by extending the curve beyond the indentation near East and West (the dotted parts of the curve). From the figure we can thus see that the residual-deviation observed can be considered as a semi-circular deviation — with a maximum value of 6° to 7° — which has been only partly compensated in the areas round the courses East and West (the diagonally shaded areas in fig. 1).

The B-value +6.4° must therefore be considered correct. The fore-and-aft forces are incompletely compensated, in spite of the fact that the deviations in the courses East and West are almost equal to 0°.

The fact that the fore-and-aft magnets are incorrectly positioned, although their distance from the compass is greater than double their length, can be noted from the comparatively large F-value.

After re-compensation, whereby the fore-and-aft magnets used were exchanged for four stronger magnets placed at a distance of ca. 40 to 45 cm., the deviation form mentioned disappeared. The new value of the residual-deviations was at most 1°.

Ex. 2. — After correcting the steering-compass of the s/s *Herbert* the following residual-deviations were observed.

0°	— 1°	180°	+ 1°
15	0	195	— 1
30	+ 1.5	210	— 3
45	+ 2	225	— 2
60	+ 1	240	— 1
75	— 1	255	0
90	— 1	270	0
105	0	285	— 1.5
120	+ 1.5	300	— 3.5
135	+ 3	315	— 5
150	+ 4.5	330	— 4.5
165	+ 3	345	— 3
180	+ 1	360	— 1

The compass was an older model with 3 pairs of needles, the longest being 13.5 cm.

The compensation of the fore-and-aft forces was carried out with 2 magnets of 12.5 cm., placed at a distance of 25 cm. and another similar pair at a distance of 38 cm.

If we draw the deviation curve we find that it has the same form as the one in Ex. 1 (fig. 2 a).

An analysis of the total deviations shows that from the practical point of view we can ignore the constant and the quadrantal part-deviations, as their coefficients are less than 0.5°. If we examine the semi-circular part-deviations by determining their coefficients, we find that C reaches a value of either — 1.0° or — 1.3° depending on which formula is used. As both values are practically similar, we can assume that the compensation of the athwart-ships forces has been correctly carried out, even if we have not succeeded in making C = 0°.

The values of B on the other hand, are dissimilar, as we use the different B-formulas. From the deviation value in East and West we get B = — 0.5°; from the deviations of the inter-cardinal points we get B = +4.5°.

That the latter value is correct may be discovered as in the foregoing example, by extending the curve beyond the indentations near East and West (the dotted parts of the curve). Even in this case we must consider the residual-deviation tables, as a partially compensated, semi-circular deviation (with a maximum value of + 4° to + 5°). The fore-and-aft forces are therefore even in this example incompletely compensated, in spite of the fact that the deviations in East and West are almost equal to 0°.

The comparatively-large F-value (+2.4°) shows among other things that the fore-and-aft magnets were placed too near the compass, although the distance of the nearest magnets is greater than double the length of the magnets.

At a later re-compensation the long-needled compasscard was exchanged for one with shorter needles (with a length of 7.4 cm.). No appreciable moving of magnets or D-correctors was undertaken. The fully extended curve in fig. 2 b shows the deviation value, obtained with the new, short-needled card.

If on compensating the athwart-ship forces the magnets are placed too near the compass, we obtain a residual-deviation of the same type as in the foregoing examples, but with the difference that the curve is advanced 90°. The deviation in both the northerly quadrants is positive (negative) and in both the southerly quadrants negative (positive), although the deviations in North and South are equal to 0° or are of equal value, and have the same signs.

If we calculate in such cases the coefficients of the semi-circular deviations from the different formulas, we obtain equal values for B but essentially different values for C. If we draw the deviation curve and extend it beyond the indentations at North and South, we find that the residual-deviation observed can be considered as a semi-circular deviation — with a maximum value corresponding to the C-value, calculated from the deviations on the inter-cardinal points — which has been only partially compensated in the areas round North and South.

An examination of the coefficients of the part-deviations shows that when the athwart-ships magnets are placed too near the compass, the coefficient G obtains a comparatively high value.

From the above investigations we see that, if after compensating the semi-circular deviation, we obtain considerably varying values of the coefficients B and C, when these are calculated from the alternative formulas, this depends on a heterogeneous field in the compass-region. The reason is usually that the fore-and-aft or athwart-ships magnets have been wrongly positioned. Before concluding the compensation the coefficients B and C should therefore always, as a check, be calculated from both the alternative formula systems — especially in the case of long-needled compasses.