

THE OBSERVATIONS MADE WITH THE COMPASS ON TASMAN'S
VOYAGE AND THE ISOGONIC LINES ACROSS THE
INDIAN AND PACIFIC OCEANS IN 1640

BY

W. VAN BEMMELEN.

ASSISTANT-DIRECTOR OF THE ROYAL DUTCH METEOROLOGICAL INSTITUTE AT UTRECHT.

(TRANSLATED FROM THE DUTCH MS. BY J. DE HOOP SCHEFFER.)

The magnetism of our globe itself possesses two chief properties, viz.: its distribution on the globe; and its changes in process of time. It now becoming more and more evident that terrestrial magnetism is most intimately connected with a good many and great problems, both of a terrestrial and of a cosmical nature, we should not allow any materials to remain unused or any opportunity slip by to increase our knowledge of both these properties. The more so, as candidly speaking our knowledge of this subject is in many points rather deficient.

Never until the present century, and even then not before its latter half we have been able to realize the distribution of the magnetic forces on the surface of the globe, so as to enable us to institute many successful researches. Also of the changes in the three elements (commonly called declination, horizontal intensity and dip) a mass of materials no less satisfactory for certain purposes has been collected in this century.

Yet in proportion to the slow progression of the changes of the magnetism of our planet the present century is but a rather short space of time, so that we see ourselves compelled to have recourse to former ages. Going back in point of time we soon find that any observations as regards horizontal intensity are wanting, while the determinations of dip are very scarce and not to be depended upon. But with respect to declination it is quite different. Since the sixteenth century a great many observations of this element have been made in different parts of the earth are at our disposal, and though owing to entire absence of the horizontal intensity and of the horizontal intensity a good deal of their value is lost, they, nevertheless, are of the highest importance for the inquiry into the secular changes of the terrestrial magnetism.

For the times for which the three elements are at our disposal we can find critical points in the history of declination, and by following these up to earlier times for which only declination is left to us we can obtain results of more general value than could be acquired by the study of mere declination.

In a paper read before the "Koninklijke Academie van Wetenschappen" ¹⁾ I adopted this method for tracing up to the seventeenth century some peculiar changes observed during the years 1780—1800. Hence for the study of the changes of the terrestrial magnetism it is necessary that we should collect observations made in former periods. Every newly found observation may become a valuable acquisition for the science of our day.

Fortunately observations of declination are indispensable for navigation; if not, our knowledge of the magnetic field of former times would not merely be next to nothing, but even that of the present time would still be very imperfect.

The necessity of knowing the variation; the observation thereof; the annotation in the log-books; these are the sources from which the materials for drawing the earlier isogonic systems are gathered. It might be said that every new voyage of discovery has likewise been a voyage of discovery into the field of these isomagnetic lines.

¹⁾ Ueber die Linien gleicher säcular-Variation der Declination. Verslagen en Mededeelingen der Koninklijke Academie van Wetenschappen. Amsterdam. Meeting of 30th Nov. 1895.

In this respect Tasman's voyage, which extended over no less than 132 degrees of longitude, and for the greater part into unfrequented waters, at once opened a wide field of information to us.

The first who collected old materials was Chr. Hansteen. He laid down the splendid results of his numerous investigations in his standard-work "Untersuchungen ueber den Magnetismus der Erde, Christiania 1819."

An atlas containing isogonic maps for 1600, 1700 and for later periods, drawn from those materials, accompanies this work.

It is a matter of course that during this century many new sources have been opened and fresh investigations made, and consequently materials for completing the Hansteen maps obtained. In this respect a good deal was achieved by Charles Schott, who collected everything relating to North-America, and by the late de Andrade Corvo, who reduced the observations made by João de Castro in 1538.

It might be reasonably expected that Holland with its navigation could still contribute much, and, indeed, I succeeded, chiefly by investigating the records of the East-India Company, in bringing to light some thousand new observations made in the sixteenth and seventeenth centuries, and in tracing by this means a new series of isogonic maps for these two centuries.

The results have been collected in an academic dissertation: "De Isogonen in de XVI^{de} en XVII^{de} Eeuw, Leiden 1893."

Subsequent researches have almost doubled the number of fresh observations, and having already reduced by the same method that vast body of materials, I intend to construct a new set of maps.

Already Hansteen utilized Tasman's observations, probably derived from an old description of that voyage; I myself made use in 1893 of Swart's edition, and now of Tasman's Journal itself, as it is now newly and more accurately edited.

Unlike in some other instructions of those days, in the one for Abel Tasman he is not specially enjoined to make a diligent and accurate observation of the variation. This was probably considered as a matter of course.

The collection of variation-observations in different parts of the globe was at that time considered as of great importance, especially for this reason that magnitude was then still taken to be a constant value.

Stephen Burrowes when navigating between the North Cape and Waigath was the first to discover this variation, while Gellibrand, professor at Gresham College, determined its amount and published in 1635 a paper on that subject. Accordingly, there are also continually found in other books on navigation tables of variations without any indication of the year in which these were observed. Likewise the Rev. Petrus Plancius, who so considerably stimulated 1) Dutch navigation, was at great pains to gather such a collection, which tables were inserted in Stevin's well known treatise the *Λιμενευρητικα* or "Havenvindingh."

Yet both Plancius' work and that of Stevin were based on the old idea, which from the time of Columbus down to the eighteenth century exercised so many minds, that by means of the declination (also dip) the longitude was to be found.

In their picturesque way our ancestors termed this the "Oost- en Westvindingh" (East and West findings).

There is no doubt that the observations of the declinations in some cases, when strong currents rendered the determination of longitudes entirely erroneous, were at that time very useful to the sailor, and I shall still have an opportunity to illustrate this with an example. (See van Diemen's voyage).

Of course, the Portuguese were the first to make and collect reliable observations of the variation. Accordingly, João de Castro on his voyage to Goa in the year 1538, was instructed to make as many observations as possible with new instruments. De Andrade Corvo 2) worked out in 1882 the journal and the observations, which are really very good. Indeed the importance of that material cannot be valued too high.

1) Compare: J. J. Dodt, Letterkundig Verslag van hetgene uit de landspapieren kan worden geput om daarna de verdiensten van P. Plancius omtrent de zeevaartkunde beter te doen waardeeren. Verhandelingen en Berigten betreffende het Zeewezen en de Zeevaartkunde door G. A. Tindal en J. Swart, 1845 V, p. 77; 1846 VI, p. 69.

2) João de Andrade Corvo, Roteiro de Lisboa a Goa por D. João de Castro. Lisboa 1882. This book I got possessed of very lately only, and has consequently not been utilized for my outlined map of the isogonic lines for the year 1540. This map will consequently be altered, though the map drawn by Corvo will not be followed.

The observations of the compass are communicated in Tasman's journal with less minuteness as is customary in journals of shipmasters of those days. In the latter the bearings are generally given as observed either in the evening or in the morning, or in both, to which is still often added the observed amplitudes, and in a single case the readings of two compasses. The importance of those observations is not very much decreased thereby. It is true, its reliability is most certainly increased by the comparison with another compass, and it is fortunate that in the other journal of the voyage, now extant, variations are also given, but the advantage of having added thereto either morning or evening observations is rather imaginary, owing to the inefficient determination of the longitude.

There can be no doubt that the observations communicated are absolute and not relative values of declination, in regard to a compass, which owed already a certain variation to its maker. This constant variation, distinguishing Dutch compasses from Oriental, Venetian and other ones, has already caused a good deal of confusion.

Indeed, if a variation was mentioned without any indication whether the observation had been made with a corrected or dipping compass, it was in those days very difficult to determine such without having further data.

In an amusingly arbitrary manner Nautonier in his work: "Mécométrie de l'eymant (1603)" makes use of these relative variations, in order to wrest them into his system.

In small vessels corrected compasses were always made use of. On board large East-Indiamen the card of the steering compass was from time to time corrected according to the readings of the azimuth-compass, but the indications of the variation are always absolute values. Only in a journal kept on board the yacht 't Duifke of the first voyage under the command of Houtman, I still found values given, which had been taken by corrected compasses. From additional communication I could conclude that at the end of the XVIth century a Dutch compass had $\frac{1}{8}$ point easterly variation and an Amsterdam one $\frac{2}{8}$ point. A dipping compass the author terms a sea-compass, as he writes: "Westerly variation on a compass south and north (i. e. a dipping) a maritime compass." ("Noordwesternen op compas van suden en noorden ofte Halyaensch compas"). Moreover, the correspondence of Tasman's observations in the Indian Ocean and Archipelago with those of his contemporaries removes every possible doubt.

Tasman nowhere gives a description, nor does he mention with a single word the construction of his compasses. In this respect he does not differ from the rest, as in none of the numerous journals I perused the compass was described.

There has never been made any study of the compasses of those days so complete as to enable us to state with certainty what kind of compasses was used by Tasman. Consequently I shall restrict myself to quoting what I found with regard to its construction in works on navigation of those days, and particularly in those published in the Netherlands.

At the end of the XVIth century there seems to have been in use a great many worthless instruments. Accordingly Barlowe writes in his treatise: *Magnetical Advertisements* 1616, p. 66: "the compasse needle, being the most admirable and usefull instrument of the whole world is both amongst ours and other nations for the most part so bunglerly and absurdly contrived, as nothing more."

Yet in our country very good compasses were made in the seventeenth century.

Schück 1) wrote a interesting paper on the magnets of the compasses, in which the most curiously shaped magnets are represented.

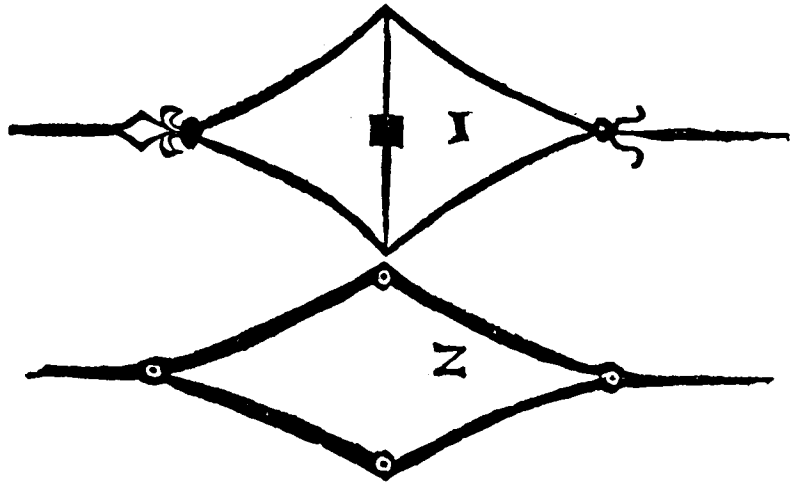
The quotation from the treatise of Keteltas, which I had formerly perused with a view to determinations of declination, I will copy here: Barent Evertsz. Keteltas, *Het Ghebruyck der Naeld-wysinge tot Dienste der Zeevaert beschreven door* —, Amsterdam 1609. Fol. 19. 9 Propositio: "wherein is represented the question of the compass-needles, and the shape and construction of needles which have been found to work with the most perfect precision."

"As much depends upon the construction of compass needles and upon the knowledge of the fittest material to be used for them this is the usual method of setting about it: two pieces of iron or steel wire, curved, and their ends filed into sharp points, so as to fit diamond-wise together, and thus pasted with a small bit of thin paper to the paper compass-card, having in its centre a small brass cup on which the card can

1) A. Schück, *Die Magnete des Kompasses*. *Central-Zeitung für Optik und Mechanik*, Leipzig XV, 3 & 4 Febr. 1894.

freely balance, which kind of compass needles do very well for ordinary compasses, as also for those having shifting cards, with which they hug the coast, which does not require so much accuracy as the determination of the needle's variation. But for observing the same the very best means should be employed, and we could not put up with the described ones, because these needles, being constructed in two parts and attached to a paper card, must, in order to be sufficiently solid, naturally be of too thick a paper as to point with sufficient accuracy, besides are easily liable to become rusty, owing to the dampness of the paste. To be able to observe the deflections of the needle with the utmost precision the needle ought to be made so that, with just a little care, it can be kept in perfect order for a long time; we will give a description of such a needle which we find to be accurate to a minute. It is made thus: Take the fittest steel, as described in the 2nd proposition, and have it stretched, split and bent diamond-shape, in accordance with the accompanying figures, and you are to make them entirely without any soldering.

The ends of the needles are to be filed into long sharp points, leaving at one end of the diamond a small lily, at the other a small fork or something else, by which the north end may be distinguished from the south. They ought to be fashioned in accordance with the size of the instrument. Midway the needle, taken lengthwise, you are to make on it a subtle brass axis, having in the middle a small cup filed out, which is of great consequence, and you are to take good care that



Facsimile from: *Keteltas, Ghebruyck der Naeldwysinghe*. 1609.

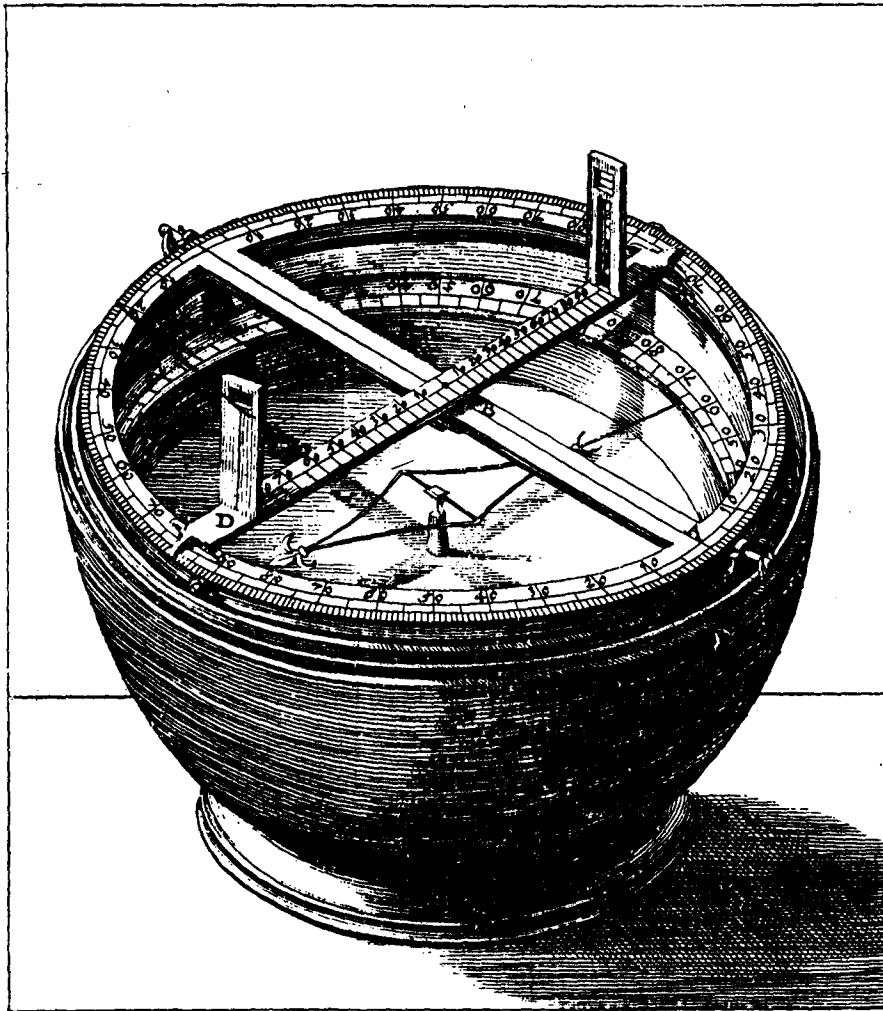
the cavity of the small cup be bored smooth and even, not too narrow so as to hinder its movements, nor too broad so as to cause the slightest eccentricity. This cannot be done better than with a perfectly square drill greased with a little oil, and you are further to construct the needles so that they can freely balance on a pivot, and they should be filed very subtle and thin, and they may be made as long as you desire, even if it were 8 or 10 feet. Let the diamonds of the needles be firmly constructed, and as they wear the more as they are heavier, the lighter they are the better, but they should stand their own weight without bending out. Now the needles which are used at sea are not required to be longer than at most 10 or 12 inches (25—30 c.m.), and therefore may be proportionately made somewhat thicker, and are to have at each end of the diamond a small hole for the purpose of attaching to it by means of two subtle brass nails a thin card of paper, as otherwise by the motion of the ship the needle is prevented from indicating, which is then kept steady by the card of paper, and you might also paste that card with a bit of thin paper on to the brass axis. But the"

"Now the needles, about six inches long, like those of the common azimuth-compasses, which are placed on a pivot, are to be constructed without any cross-axis. When placing it on a pivot, the point of the pivot will soon become blunt, and you are to make in that place the paper card somewhat thicker and to attach the needles to it by four subtle brass nails, securing the small cup to the paper in the same manner as is done with ordinary sea-compasses, but they do not indicate with the same precision as the aforesaid, unless your card be supported by a little screw-plate, as will be explained more fully when we come to speak of the instruments for needle-indication, in order so to avoid the wear caused by casting them on the pivot."

He further gives a description and representation (figure 42) of the azimuth-compass. ". . . and is the horizontal compass of which we gave already some account in our preface: which instrument is common in daily use with steermen."

page 43. "Now this instrument is composed of a wooden or brass box, wide about sixteen inches, though it is customary to make them smaller, in many cases not more than eight or nine inches; the reason why this instrument is made so small is that if they were made larger, owing to their weight, the cards would always indicate imperfectly, as also because suspending instruments must always be

unproportionately much heavier, so as to be kept steady on the agitated sea, and as otherwise it would be impossible to cast the card on the pivot. You shall therefore know, that the aforesaid have hesitated to take the larger size, not because they did not desire a larger one, but because they could not make use of one of a larger size. These difficulties we will now remove in this proposition, as neither the length of the needles nor the heavy weight of the instrument causes any pointing in a lazy or slow manner, and hinders us in no way to cast the needles gently on the pivot, for we therefore use a screw-plate, so that on account thereof the needles can easily be raised or lowered without any injurious effect. This method we have clearly expounded when speaking of the former instruments. We next take the circumference as wide as we wish, because in that manner every degree can be divided into four parts. Now this box is to be turned so as to form a half circular cavity measured in any direction, as we have mentioned in our account of the former instruments for needle indications. Further the compass shall be shaped into half a globe and be suspended by a ring on four axes, so as to be secure from the motion of the ship in its revolutions. Further the needles are to be made of good pure steel, as has



Horizontal-compass according to Keteltas (1609). (Facsimile).

been observed in the second proposition, shaping the needles as indicated in the ninth proposition." (See the former quotation from Keteltas), "diminishing the magnetic power of the needles so as to be able to keep the instrument in perfect order for a long time, of which a full account is given in the eighth proposition. Further the needles are to be supported by a screw-plate (as related before), and the pivot on which the needles are to float may also be made of steel, with a view to their steadiness but duly, very subtle; underneath with a screw, which with a brass nut is screwed fast in the bottom. One should also take good care that the hole in which the pivot is screwed be in the middle of the place where the needle-bearings are indicated on the ring, so that the pivot can be placed perfectly perpendicular. Further as regards the upper-part, take notice of the accompanying figures and letterings."

"It consists of a horizontal flat ring having a diameter marked A B, which ring should be turned perfectly even, and should also be a firm brass one, so as not to bent out when screwed up, as otherwise the hands could not everywhere travel horizontally. This horizontal ring shall be divided into 360 degrees,

and each degree again into 4 parts, and you shall fix it so as to have its numbers exactly correspond with the numbers on the ring inside the instrument, whereon the bearings of the needles are indicated; to the centre B on the diameter a hand shall be attached, having fixed on it 2 sights, 10 inches distant from each other, and at the same distance from the centre marked C D, which should be able to go round over the whole circumference. The sights fixed on this instrument are to be made about 4 inches high, the nearer being furnished with a brass string, and the other with a narrow slit to observe the rising and setting of the sun. The upper ends of the sights shall each have a broad slit with a string, in order to take the azimuth when the sun is at a height of 30 or 40 degrees. These dioptrics shall be divided inside into some divisions; likewise from the hand of the sight to the middle, altogether into 100 parts, everyone of which parts to be of the same size, and they only serve the purpose of ascertaining whether your instrument be suspended horizontally, as this is of great consequence. For which sake square holes shall be made at top of the sights, both at the same distance from the plane of the horizon, and you shall pass through them a cross-string, so as by means of the sun to indicate on the divisions. At the side of each end of the hand there shall be made two projecting small feet, in order to keep the hand always right when moving along the horizon."

Keteltas further writes on the use of the instrument:

"This instrument was used in two different manners; in the one case by turning away the instrument; in the other by letting the sunbeams fall on it (as can likewise be done with the 2 before described instruments), to wit: in the morning as soon as the disc of the sun rises, place the sight with the slit before your eye, and when viewing the string right in the middle of the sun, some one else shall observe the difference between the hand and the needle, and you shall accurately note it down and by means thereof calculate on your planisphere how much your needle deviates.

Now the second manner is this, when the sun has some degrees of height, you are to turn the instrument to the sun, letting the sun's shadow fall on the line of the hands, putting the hand at a certain number, then you can see to how many degrees the difference between the needle and the sun amounts, which to avoid errors should be done three or four times successively, noting down your results each time, and while you are observing the difference between the sun and the needle, some one else shall by means of the astrolabe or cross-staff or sea-quadrant take the exact height of the sun, which you shall each time notice next to these differences, and go therewith to the planisphere or astronomical mirror."

In the "Stuermans Schoole" by Simon Pietersz., Instructor for navigation at Medemblik, Amsterdam 1659, on page 73 we find:

"Sixth instruction in navigation and steering exercise, Treating of the compass, of the construction and use of the same, Ditto of taking and correcting the variation of the needles.

The construction is first of all composed of a round wooden box or case, rather heavy, so as to be less unsteady. In the centre of the bottom a brass point is perpendicularly fixed, pointed at top, fully an inch in height. On this perpendicular point a small plate is laid, made of pure, clean and polished iron or steel, cast flat and thin, in the shape of an oblong diamond or leaf of a lily. In the centre thereof is a small cup having a cavity, which should also be even and pure, with which it is carefully, freely and nicely laid on the perpendicular point, travelling horizontally on it. The terminals of this lying piece of iron, called needle-points, after a loadstone having been properly passed along them, range themselves north and south. But as a compass for the use of navigation is divided into 32 points, which the man at the helm must always have before his eyes, and steer the ship accordingly, so in like manner a small round (called a card) is made of dry, light, strong paper, which is properly pasted on to the aforesaid needle or to the needle under it, properly. I say properly as these are not always in the same manner; and again as concerns the direction which the needle points, of which we shall speak further on.

On this card the 32 points of the compass are printed, thus freely floating horizontally in every direction on the needle, which lies underneath and is fixed in the aforesaid little box.

The north point was marked with a lily and the east point with a little cross.

At the top of this box or case a clear glass is laid, all around inserted in it, and well stuffed with wax, so that no air, wind or water can make its way into it.

A compass thus far being constructed, this box is jointed at top by means of two opposite nails to a larger case, so that this box containing the card may freely and horizontally swing inside of it, without touching anywhere. This compass being a delicate instrument which requires great exactness a steersman should take good care of it, and pay attention that both the compass he has in the cabin and the one in the binnacle near the man at the helm have neither iron nor steel in their vicinity, nor that another compass be standing close to it, as the needles would be attracted by it, in consequence of which great mistakes might arise, by which loss and accidents might be caused.

This instrument is of such importance and use for the navigation that one could do nothing or little without it. But it would still be of more utility if it did always point right, which would be the case, if the impregnated needle did point directly north, but in various parts of the globe it has been found to have variations. In our country and in its neighbourhood 6, 7, 8, 9 degrees easterly have been observed, on account of which the compasses used here in common navigation should be corrected, so that the lily must be placed two thirds of a point west of the needle for the north point to indicate the true north ¹⁾. Except this one, another variation is found to be occasioned by the magnetizing of the needles by the compass-makers, which is such that even if a compass-maker draws one and the same stone along 3, 4 or 5 compasses which have the cards of the same angle with the needles, they will not indicate the same point in the horizon, which must be caused either by the iron of the needles being of a different temper or by the one needle being more and the other one less magnetized, to which the compass-makers are to pay attention. It is therefore of the highest importance that a steersman navigating in large waters should know to find and correct the variation of the compass.

For this purpose a compass is wanted having the lily placed right above the needle, and constructed at the same time so that when observing we can see how many degrees the sun rises to the eastward and sets to the westward, which compass must all round be divided into 4 times 90 degrees on a small brass circle having alongside its border an adjustable small point, which we can see traversing the middle of the compass in an exact line with the sun at the horizon.

To correct this variation it is of great use to have a compass with a shifting card, made of light wood or strong paper, which is laid flat on the top of the compass, to wit, on the pivot on which the card balances, but the upper end on which this card rests must have at the inside a rim along which this card moves.

This card must be fully one inch in breadth, on which the 32 points are indicated, so that by removing this card the numerical value of the variation is found; by this means one shall always have a corrected compass, for instance"

For curiosity's sake I still quote the questions put at the end of the sixth lesson:

"*Question.* What other precautions in regard with his compass has a steersman to take?"

"*Answer.* As regards this I have made a little poem in my own fashion."

"*Question.* How does it run?"

"*Answer.* "*Dat de Naalde wel is aangeleyt en gestreken,*"

(The needle should be well adjusted and magnetized)

"*Dat het Kasken en Roose vrij waterpas drijft*"

(The box and card should freely float horizontally)

"*Dat'er geen lucht, wint, noch water in komt geleden;*"

(Neither air, wind nor water should make their way into it)

"*Dat geen ijser noch staal daar omtrent verblijft;*"

(Neither iron nor steel should be in its vicinity)

"*Op dese vier dingen moet een stuurman t' allen tijden*"

(Of these four things a steersman should at all times)

"*Wel toesien, om ongeluck te mijden.*"

(Be careful, in order to avoid accidents.)

¹⁾ The variation of from 6° to 9° easterly was in the beginning of the 17th century observed in the neighbourhood of our own country. The keeper of the journal on board "t Duyfke," in 1595 states an Amsterdam compass to have $\frac{2}{3}$ point easterly variation. Accordingly it is evident that this Simon Pietersz. refers to compasses of an earlier date than the one at which his book was published (1657).