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500 YEARS OF GRAPHICAL AND SYMBOLICAL REPRESENTATION ON MARINE CHARTS

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A marine chart has always been, first and foremost, a navigational instrument. Such beauty as the chart may have attained at times during its long history has been a by-product of dedicated draughtsmen or cartographers in a similar way that the work of the agricultural craftsman has often enhanced the beauty of the countryside.

For a chart to be of use for navigation a means of plotting direction and distance must be provided on the sheet. For safe passage from one haven to another, channels, shoals, safe anchorages, dangerous submerged rocks and the depth of water must all be graphically represented, together with positions and descriptions of landmarks, hilltops and beacons which may be recognised from seaward and used to fix the vessel and set her on a safe course.

It is the development of the various forms of graphic representation of these components of the marine chart over the 500 years prior to 1900, together with the ever-growing acceptance of recognised chart symbols, that forms the subject matter of this paper.

The earliest sea charts which will be considered here are those compiled and hand-drawn on vellum during the 13th, 14th and 15th Centuries by craftsmen in Genoa, Venice and Majorca, which conform to a style now known as the "portulan chart". The oldest existing portulan chart is said to be the *Carta Pisana* which was probably drawn about 1275, now housed in the Bibliothèque Nationale, Paris.

The first thing that strikes one on looking at this chart are the two circles, one covering the eastern and the other the western half of the Mediterranean, each circle having lines of bearing extending from the centre and from 16 equidistant points around the circumference. Where

the circles do not cover the charted area a grid of lines of bearing has been extended.

NORDENSKIÖLD [1] does not consider that these networks were used in the construction of the charts, as they are invariably drawn over the top of the landwork. However, I am inclined to think that this was not so, for clearly the network was of great value in the laying down or copying of a chart, "squaring down" as a surveyor would put it, and it seems likely that the network was first laid down in lead crayon, finally being redrawn in colour as an important aid to navigation.

It is also difficult to agree with NORDENSKIÖLD [1] that the N/S line of bearing lay in the direction of true North. The magnetic compass was in use at sea in the Mediterranean by the end of the 13th Century, but there was no understanding of magnetic variation for another 200 years.

When navigators were first introduced to the lodestone and floating needle they must have thought it magical that the needle pointed, as near as they could judge, to the Stella Maris. Seamen recognised this star as the fixed point about which the heavens revolved. They used it as an index of reference for the eight courses they were accustomed to steer before the prevailing Mediterranean winds such as Ostro (S), Levante (E), Sirocco (SE), etc., later broken down into sixteen half-winds, such as are represented by the lines of bearing on the *Carta Pisana*.

When constructing charts, distances (by numbers of days' sailing) and direction (by the steering magnetic compass) must have provided a major source of data — the relative position of a new landfall from an accepted departure.

However, the northerly magnetic pointing of the needle varied considerably from one end of the Mediterranean to the other due to the then unknown, and changing, value of magnetic variation. It is because Mediterranean portulan charts were based on magnetic north that they show an inclination towards the north of about 11° at their eastern end when the coastline is superimposed on a modern chart.

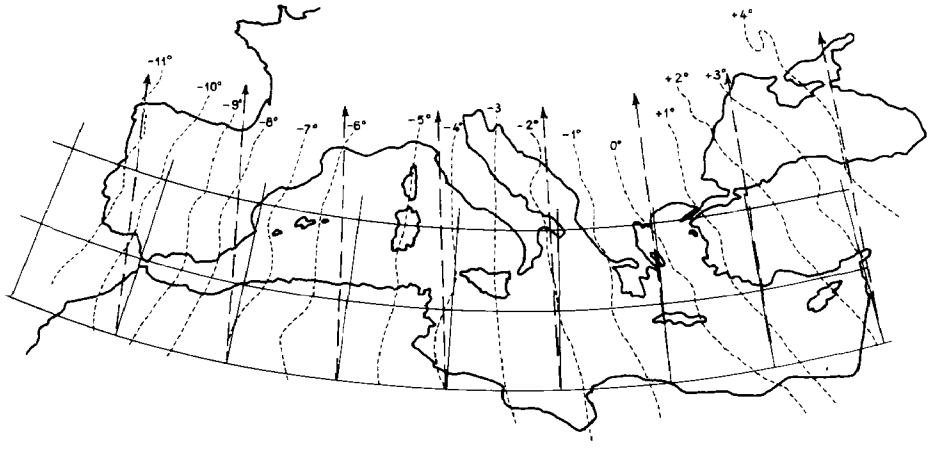


FIG. 1. — Chart showing the convergence of the lines of equal magnetic variation in the Mediterranean, and the comparison between magnetic meridians (pecked lines) and geographic meridians. Epoch 1944. (*After* CLOS-ARCEDUC, 1956).

In 1956 CLOS-ARCEDUC [2] presented an interesting paper in Rouen in which he takes this idea further. Assuming that portulan chartmakers used magnetic north, whilst at the same time plotting each N/S line of bearing parallel to the next, and taking into account that they did not employ parallels of latitude, then, in the comparatively limited area of the Mediterranean, they were using an early form of Mercator's projection (figure 1). Ignoring the 11° northerly slew referred to, then generally the Mediterranean coastlines on portulan charts fit astonishingly well to those of modern charts on the Mercator projection.

This may be taken as one of the reasons for the success of the Mediterranean portulan, which led to its unchanging appearance up to the end of the 15th Century. It became frozen in style and content, each new chart being little more than a redrawing, sometimes with embellishments, of its predecessor.

To assess the state of symbolism employed on the portulan chart, that of Angellino de DALORTO (figure 2) may be accepted as typical. Drawn about 1325, this chart was reproduced full-size in colour by the Royal Geographical Society of London in 1929 [3].

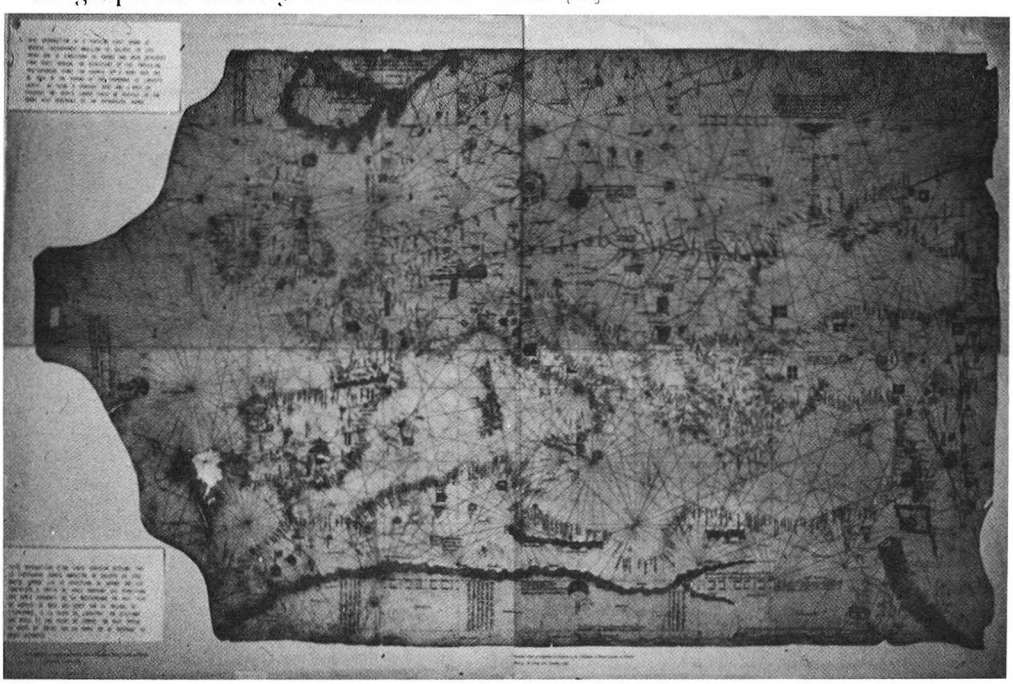


FIG. 2. — Portulan Chart by Angellino de DALORTO, *circa* 1325.

The Red Sea is normally shown in red, as are off-lying islands and important river mouths giving access to shipping. Names of ports where safe anchorage, water and provisions were available are also shown in red, black being used for other names. Coastal names are on the land at right-angles to the coastline, which permits the navigator a 'clear view' of inshore waters and associated dangers. Dotting in reddish brown is used to show sandbanks or shallow sandy bays. Green is invariably used for mountain ranges.

Flags and banners of states and cities are a prominent feature and doubtless served a useful purpose by indicating, indirectly, what sort of a reception the mariner might expect when he landed. There are also a few vignettes, but these indicate the importance of a major city rather than providing recognition views from seaward.

The rhumb lines are a major feature, finely drawn alternately in black, green and red to facilitate their use for setting the vessel's course. In contrast with the draughtsmanship employed on the rhumb lines are the carelessly drawn scales, usually two in number. Each division of the scale is subdivided into five parts by crudely penned dots, each division representing two "portulan miles".

NORDENSKIÖLD [1] has derived the value of the *portulan mile* by averaging a considerable number of distances measured between defined points of land within the Mediterranean, and gives his answer as 3.15 minutes or 5.83 kilometres, a measure of distance, later known as the *league*, which continued to appear on charts until the 17th Century.

The original of an anonymous Catalan portulan-atlas of 1375 was housed in the Bibliothèque Nationale in Paris where it was reproduced photographically in 1883. The map sheets of this atlas were in turn reproduced from the photographs by NORDENSKIÖLD in his *Periplus* of 1897 [1]. It forms an important stepping stone from the Mediterranean portulan chart to those covering the known world beyond.

Far out in the Atlantic, to which the Mediterranean sheet of this atlas extends, is shown a crude compass rose at the intersection of the rhumb lines. This rose appears to have been developed from the magnetic compass card which MAY [4] believes was in use at sea "well before" 1380.

The "cross" symbol for an inshore (and presumably dangerous) submerged rock may be seen for the first time on the sheets of this atlas.

The great Majorcan cartographer Abraham CRESQUES appears likely to have been the chief architect of the Catalan atlas of 1375. Forty years later his son Jafuda went to Portugal to work for Henry the Navigator, who was gathering cosmographers and cartographers around him at Sagres. From now on the story of the portulan chart is dominated by the Portuguese. Henry set his learned staff to work to devise a method of finding latitude at sea from altitude observations of celestial bodies, and to making charts on which discoveries far south along the African coast and in the Atlantic could be precisely laid down.

Henry died in 1460, Bartolomeu DIAS rounded the Cape of Good Hope in 1497, CABRAL discovered Brazil in 1500. Portuguese chartmakers must have been busy during the 15th Century, yet only one or two anonymous fragments remain today. One of these is housed in the Biblioteca Estense in Modena and is reproduced in *Portugaliae Documenta Cartographica* Vol. I [5]. Marcel DESTOMBES considers the chart to be Portuguese [6] and it is thought to have been drawn in the last quarter of the 15th Century. It therefore shows what progress had been made in the hundred years since 1375.

Drawn on parchment backed with cloth, this chart of the Atlantic and the West Coast of Africa is notable for its clearcut outline such as

navigators appreciate. The use of crosses and sand-dotting has continued, as has the scale in leagues. Eight-point compass roses in beautiful colours are placed at the rhumb intersections around the major peripheral circle, with a 16-point rose at the centre.

On a portulan chart of 1500, reproduced in *Portugaliae Documenta Cartographica* Vol. I [5] possibly drawn by Pedro REINEL, a great Portuguese cartographer, a latitude scale makes its first appearance in the Atlantic far to the west, reflecting the successful accomplishment of finding latitude at sea which Prince Henry had envisaged. The compass roses have a sort of embryo fleur-de-lys on the north point, but within a few years Pedro REINEL had developed this embryo into a beautiful flower which, with many variations, endured for two or three centuries.

The compilation and drawing of portulan charts reached a high standard of utility and beauty, the Portuguese chart-makers being encouraged by the many details of new discoveries their seamen sent home to be included. Pedro REINEL's son Jorge was one of the leading cartographers, and his two charts of the Atlantic *circa* 1535 and 1540, both reproduced in *Portugaliae Monumenta Cartographica* Vol. I [5], are as good as any portulan could be. (That of 1535 is housed in the National Maritime Museum, Greenwich and that of 1540 in the Biblioteca Barone Ricasoli-Firidolfi, Firenze.) A clear latitude scale, the Equator, Tropics of Cancer and Capricorn properly aligned to the latitude scale, a superb centre 32-point compass rose and conformation with all the usual portulan chart symbols make these two charts excellent examples of the cartographer's art towards the middle of the 16th Century.

It was now that the wide-ranging Portuguese navigators attempting rhumb line sailing far out in the Atlantic were in difficulty, for they were still using a plane chart. They put their problem to Pedro NUÑEZ, the Chief Hydrographer.

Meanwhile in north-west European waters mariners were still without charts, navigating by lead-and-line and compass according to sailing directions handed down to them by their fathers or exchanged with fellow captains.

The first book of printed Sailing Directions "*Le grant routtier*" was published by Pierre GARCIE of France in 1520. "Routiers", "rutters" and "leeskaarten" were then increasingly published in France, England and the Low Countries respectively. At first these printed directions were illustrated solely with coastal recognition views from woodcuts, but, in particular, the "leeskaarten" began to include rough sketch plans of river and harbour entrances which carried neither scale nor orientation, but on which new symbols began to appear. These symbols developed further when similar plans began to appear as loose sheets known as "sketskaarten". One of these: The Entrance to the Ems — probably prepared by D. SAEL in 1565 [7] — shows symbols for a navigational buoy, a recommended anchorage, and a navigational beacon. Soundings appear in the vicinity of the bar. An interesting feature is the way that views and vignettes appear along the coastline in panoramic style.

Cornelius ANTHONISZ was among the first Dutchmen to compile a

printed marine chart, that of the North Sea and the Baltic, but it was on too small a scale to contribute greatly to the development of symbols. For this one must look to the work of Lucas Jansz WAGHENAER, a seaman and pilot of many years' standing, who turned to the publication of marine charts. In 1584 and 1585 he published the first and second parts of his *Spieghel der Zeevaert,* the first printed marine atlas to have charts and associated sailing directions assembled together [8] & [9]. These plane charts were printed from copper engravings; one of them — a chart of a part of the Prussian Coast, 1585 — is reproduced as fig. 3.

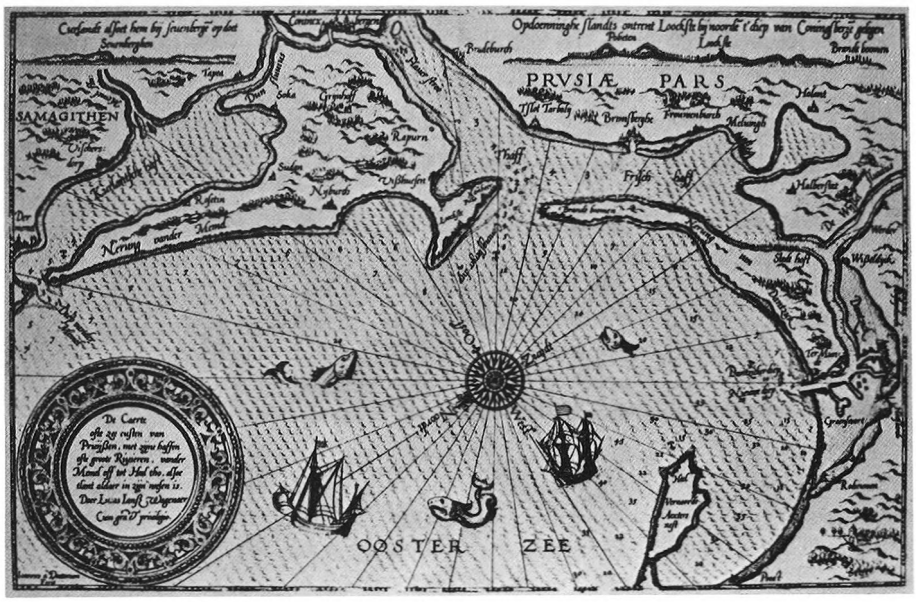


FIG. 3. — Chart by WAGHENAER published in *Spieghel der Zeevaert,* Leyden, 1585.

WAGHENAER adopted the portulan style of compass rose and rhumbs but, on large scale charts, only one set of rhumbs was required. Each chart was orientated in a way considered convenient to the navigator approaching the coast, whilst the rhumbs were not continued on the land where their unnecessary presence would tend to obliterate landmarks used by the seaman. Magnetic variation was now understood, and the needle was affixed below the compass card in such a way that the fleur-de-lys now pointed to true north. The coastline was drawn in the panoramic or "half-view" style, but separate, well executed, coastal views now made their appearance on the chart.

Buoy and anchorage symbols appear, whilst soundings in *fathoms,* reduced to mean tidal level, are comparatively prolific. Scales of Spanish and Dutch *miles* make their appearance (17½ Spanish and 15 Dutch *miles* to a degree).

LANG [7] has published a table of symbols in use by Dutch chart-makers in the 16th Century, some developed from the portulan chart,

others new (see figure 4). The sandbank symbol appears to be used for drying or submerged banks. There are two types of beacon, those placed to mark the limits of shallow water and those, with more complex topmarks, executed on land as steering marks, the latter referred to apparently as "kapen".

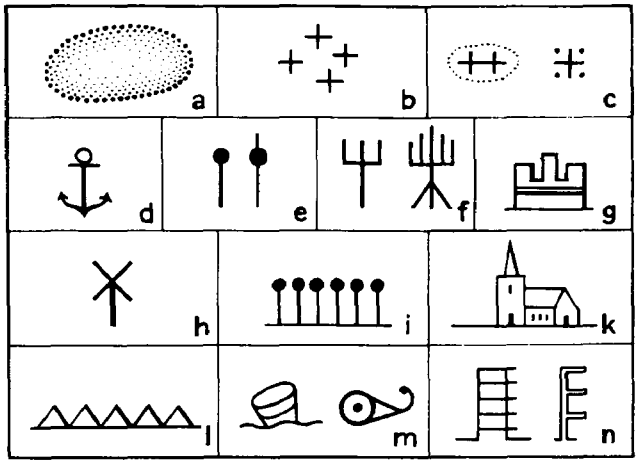


FIG. 4 . — 16th Century Dutch chart symbols as tabulated by Dr. A.W. LANG.
a. sandbank — b. submerged rocks — c. large submerged rocks
d. anchorage — e. beacons — f. steering beacons — g. castle
h. windmill — j. trees — k. church
l. houses — m. buoys — n. quay or wharf

The 17th Century saw the establishment of the big Amsterdam houses concerned with the publication of marine atlases, culminating with the Van KEULENS, who in the early 18th Century were charting the world. Charts in Vol. I of *Nieuwe Groote Lichtende Zee-fakkel*, 1728 [10] show how this major chart-making industry in Holland had standardised style and symbolisation. The rhumbs are alternatively firm, thin or pecked to facilitate use for course setting on a monochrome chart. The 16th Century Dutch symbols remain, to be joined by clearly defined bearing and leading lines based on natural or man-made shore marks, including two *kapen* in transit.

Meanwhile in the 17th Century, Britain, under the spur of Charles II and the Secretary of the Navy PEPYS, and France, similarly stimulated by Louis XIV and his sea minded Minister of State COLBERT, both began to survey their own home waters, and both nations published significant marine atlases in the same year 1693.

Great Britain's Coasting Pilot resulted from the surveys of Captain Greenvile COLLINS. As WAGHENAER'S "*The Mariner's Mirror*" had been in regular use by British seamen since its English publication in 1588 it is not surprising that WAGHENAER'S symbols were largely adopted by COLLINS. A greater use of leading and clearing lines, with views to illustrate, is a feature of COLLINS' charts; whilst soundings were reduced to a low-water level. The scales were of English *miles* (20 miles to a degree).

Le Neptune François benefited from the scientific advances made under Louis XIV, in particular the work of CASSINI as Director of the

Observatoire de Paris, for he had developed a method of finding longitude onshore by the observation of Jupiter's satellites. Not only did he fix the Observatoire but a number of points along the coast were also fixed. Furthermore, although the Englishman Edward WRIGHT had explained to seamen in 1599 the value to them of Mercator's projection, it was the compilers of *Le Neptune François* who first adopted the Mercator system generally for a series of charts.

Thus these charts carried both latitude and longitude borders, the latter being referred to the meridian of Paris. WAGHENAER's symbols were again generally adopted for there had been a popular French translation of *The Mariner's Mirror*.

The 18th Century saw great progress in chartmaking in France, where a "Dépôt des Cartes et Plans" was established in 1720 which later came under the direction of Jacques Nicolas BELLIN who published a series of atlases of beautiful yet entirely practical charts. His large scale plan of Gibraltar Bay from *Le Petit Atlas Maritime* [11] is typical (see figure 5). Soundings are in *brasses* (fathoms), with a horizontal scale in *toises*. The coastline is clearcut and points on which to fix, towers, etc., are well

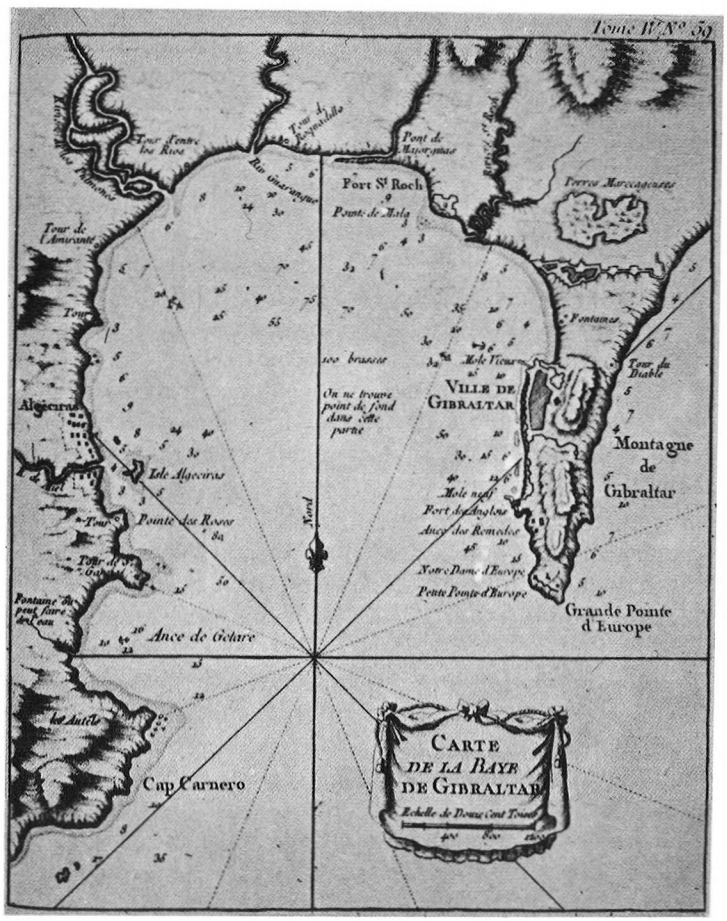


FIG. 5. — Chart of Gibraltar Bay by J.N. BELLIN, published 1764.

marked. One could take a ship to anchor on this chart to-day, provided one knew that there are roughly two metres to a *toise*.

Captain James COOK's chart of New Zealand of 1772 [12] is of interest in showing how the compass rose and rhumbs developed once it was possible to find longitude at sea. Both latitude and longitude scales are to be found in the chart borders, the latter referenced to the Greenwich meridian, whilst the N/S rhumbs have become meridians and the E/W rhumbs parallels of latitude on Mercator's projection. Magnetic variation is shown along the ship's track wherever it was observed. As surveys became more complete in the early 18th Century a separate pointer, emanating from the centre of the compass rose, indicated the direction of magnetic north on the date on which the chart was published.

Two British Admiralty-employed hydrographic surveyors who compiled atlases, Murdoch MACKENZIE (Senior) (*A Maritime Survey of Ireland and the West of Great Britain* (1776)) and DES BARRES (*The Atlantic Neptune* (1784)) both included tables of reference showing the symbols they employed. These largely conformed to current developments with some notable new additions such as a feathered arrow to show the direction of the flooding tidal stream, symbols for overfalls, whirlpools and eddies, and abbreviations for the nature of the seabed, which had until now been written in full. An earlier use of roman figures to denote the time of high water at various places on the chart at full and change of the moon was standardised.

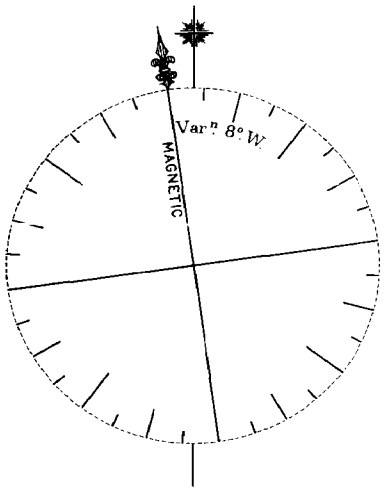
At the opening of the 19th Century only France, Denmark, Great Britain and Portugal had established national hydrographic offices, but before the century was out twelve more nations had done so, including the United States of America which had both a Naval Hydrographic Office and a Coast Survey.

Early in the century the marine atlas disappears; charts and sailing directions bound up together were unsuited to the seaman who needs to plot his course on a chart laid on a table or other flat surface. Since then marine charts and volumes of sailing directions have been complementary.

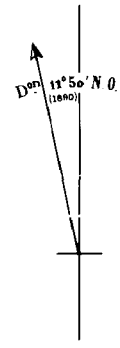
With the growth of international and world-wide seaborne trade in the 19th Century, modestly priced charts as tools of the navigator were increasingly required. Colour, which was time consuming, was no longer employed; but the skills of the copper engraver were exploited to give the black on white charts a three dimensional appearance. Hill shading and, where the density of the surveyor's soundings permitted, varying styles of engraved lines to represent the low-water line and the depth contours (fathom lines) beautifully achieved this end.

Much of this may be seen, from the British angle, in the "Plate to illustrate Hydrographic delineation", which appears in the first edition of the *Admiralty Manual of Scientific Enquiry* of 1849, a plate which was repeated, in up-dated form, in each of the five editions of the manual up to 1886. A notable advance shown on the plate in the 2nd Edition of 1851 [13], is the "tidal stream rose" which shows by feathered and plain arrows the direction of the flood and ebb tidal stream at various hours before or after the time of high slack water at full and change of the moon. The number of black balls on the arrows indicates the hours, while speeds in knots are written.

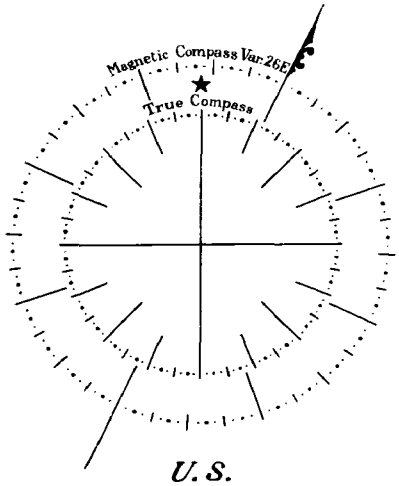
With so many nations in the chartmaking field, advancing on a broad front as it were, the diversity of styles was bound to increase, and this may be briefly illustrated by looking at four different national compass roses — those of the French, Italian, British and United States Hydrographic Offices — in the 1880s (figure 6).



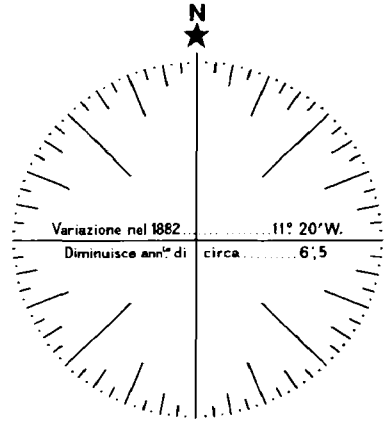
United Kingdom



France



U.S. Hydrographic Office



Italy

Fig. 6. — Different national styles of Compass Roses, 1880-1890.

A major diversity arose in 1840 when France finally adopted the metric system which had been worked out by her scientists forty-five years earlier. Continental charts changed increasingly from *fathoms* to *metres* for indicating heights and depths.

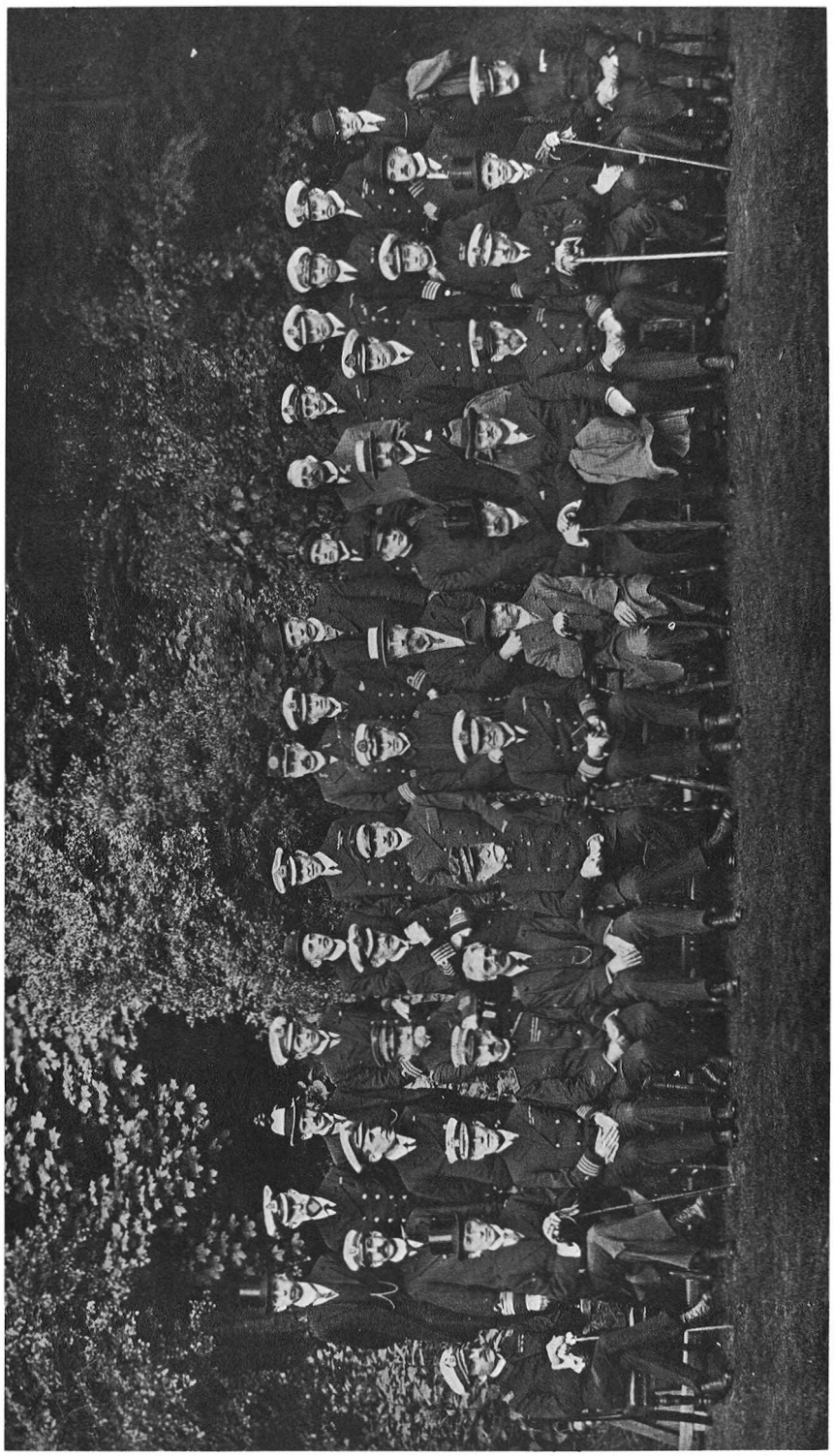


Fig. 7. — Delegates to the International Hydrographic Conference in London, 1919 (from the Report of the Proceedings, *published by* His Majesty's Stationery Office, London, 1920).

Perhaps because it had two national hydrographic offices, which were naturally in competition, it was the United States which first realised the diversity that was developing in the graphic representation and symbolism among the world's chart producers.

An early standard reference sheet of symbols in use by the U.S. Coast Survey was published under Superintendent HASSLER's orders in 1840 [14], which shows that many of the established European nautical symbols had been adopted. This is not surprising because HASSLER had been sent to Europe in the years 1811-1815 to visit nautical offices and obtain instruments. HASSLER became Superintendent in 1832 and remained in office for twelve years.

A symbol for a *sunken wreck*, a horizontal line crossed by a number of graded vertical lines, appears on HASSLER's sheet. Before the end of the century a further symbol for a *stranded wreck* had been developed, that lifelike symbol on the chart at the sight of which every navigator still shudders momentarily.

In 1878 Ernest R. KNORR, Chief of the Drafting Department of the U.S. Hydrographic Office, proposed a permanent international hydrographic bureau where periodic conferences of the heads of national hydrographic offices and their assistants could be held in order to look towards a standardisation of marine charts and symbols [15] (*).

In 1903 the U.S. Hydrographic Office published the *Manual of conventional symbols and abbreviations used on the official charts of the principal maritime nations* (**). An International Maritime Conference in St. Petersburg in 1912 decided to use this publication, up-dated, for a study of how complete international agreement might be reached. World War I intervened. No positive step was taken until the first International Hydrographic Conference was held in London in 1919 (see figure 7), which led to the establishment in Monaco in 1921 of a Bureau such as KNORR had envisaged over forty years earlier.

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(*) Since this paper was written, a photocopy of KNORR's holograph proposals has been presented to the IHB Library by the U.K. Hydrographic Department. The 27 page report was submitted to Captain EVANS, the British Hydrographer, by U.S. Hydrographer S.R. FRANKLIN in 1879.

(**) A copy of this early Manual was recently presented to the IHB Library by the Director, Defense Mapping Agency Hydrographic Center.

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