THE EVOLUTION OF THE ENGLISH NAUTICAL CHART

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1. — INTRODUCTION

In a previous contribution Professor E.G.R. Taylor has reviewed the development of the sea chart up to 1600, the year in which Edward Wright published his celebrated chart of the world on Mercator's projection. (1). Wright's chart represents one of many minor incursions on the part of English cartographers into the field of nautical cartography, which at that time and for the next hundred years was dominated by the flourishing Dutch school of hydrography. It was not until the latter began to decline towards the end of the seventeenth century that the English cartographer really came into his own and began to produce charts to assist the navigator. Thus the evolution of the English nautical chart to its present state of development covers a relatively short span when measured against the whole background of maritime enterprise and endeavour.

The development over the past two hundred and fifty years has been sporadic rather than continuous, being characterized by sudden advances followed by long intervals of consolidation. Factors such as the needs of national defence, the invention of navigational instruments and advances in hydrographic surveying technique, have at various times acted as stimulants to chart evolution. Throughout the period under review responsibility for supplying the navigator with accurate charts has gradually passed from the many private publishing firms to a specially created national department.

2. — SEA ATLASES.

In 1670 John Seller, from his shop at « The Signe of the Mariner's Compass » in Wapping, issued his *English Pilot*, thus initiating the series of nautical publications which were to be used by the Royal Navy and mercantile marine alike during the succeeding century. The *Pilot* consisted of a number of charts with accompanying sailing directions bound together in one volume to form an atlas. In this respect it followed the pattern set by the then well-established Dutch school, which for almost a century had issued similar collections, sometimes covering a specific geographical area but quite often made up to suit the requirements of an individual navigator. Lucas Janszoon Waghenaer with his *Speghel der Zeevaert* (1584) had given a lead which was subsequently taken up and developed by Willem Blaeu, who in 1608 issued his *Licht der Zeevaert*. Both these marine atlases, or « Waggoners » as English seamen named them (from a corruption of « Waghenaer »), had been translated into English and appeared as *The Mariner's Mirrour* (1588) and *The Light of Navigation* (1612).

The basic similarity of Seller's Pilot and the earlier and much used Waggoner meant that the navigator at home could quickly become proficient in the use of the new English sea atlas. He could still refer to details of lunar

phases, state of tide, magnetic variation and in most cases plot his course on the charts he had used in the past. Seller, with no new source of hydrographic information, had no option but to visit Holland and buy up any copper plates which he could lay his hands on. He himself states that he spent thirty years in this task before returning to Wapping, where he simply erased the original Dutch titles on the plates and substituted his own. By 1670 all was ready and in November of that year publication began. In the following March, Charles II gave Seller a thirty-year copyright for his work and prohibited the importation of « Maps, Charts or Plates or any part or copy thereof... from beyond the Seas, either under the name of Dutch Waggoners or Lightning Columes during the said term... ».

Examined against a background of contemporary continental sea atlases, Seller's Pilot represents a recession in chart evolution rather than an advance. Many of the copper plates which he purchased were out of date and destined for scrap. Moreover, Seller had not the great organization which the Blaeus had established in Amsterdam for collecting information and correcting their charts from ship's logs and journals, so that he was unable to effect much improvement to his second-hand plates. In fairness it must be added that one of his charts, that covering the Thames Estuary, represents an original compilation based on a survey of Captains Gilbert Crane and Thomas Browne, Elder Brethren of Trinity House.

The inherent imperfections in Seller's Pilot were soon apparent when it was used for navigation in the coastal waters around the British Isles. Many of the coastal landmarks which could be used for fixing were either not shown or were badly misplaced in position. In addition, the atlas contained no charts of the west coast of England or Scotland and those covering Ireland and the south coast of England were on too small a scale to be of much practical value. To remedy these defects Charles II, in 1681, commissioned Captain Greenvile Collins to undertake a survey of the home coast. Collins, a Younger Brother of Trinity House, had previously served under Narborough on his voyage of discovery to the South Seas in 1669 and later commanded a frigate in the Mediterranean. In fulfilling his new task he spent seven years surveying various parts of the coast of England and Wales, the east coast of Scotland with the Orkney and Shetland Isles and small areas in Ireland. When completed in 1688 his examination represented the first comprehensive survey in home waters. During the next five years the charts were engraved and in 1693 they were issued, again in atlas form, as *Great Britain's Coasting Pilot*. Many of the original compilation drawings prepared by Collins for the engraver are preserved in the Hydrographic Department of the Admiralty (Fig. 1).

No indication of the method of hydrographic survey used by Collins is given in the preface to his Pilot. From the appearance of the charts it would seem that the survey was done entirely from seaward, land detail being inserted by compass intersection from the ends of a coastwise « running traverse ». Depths were taken at intervals along the sailed traverse, the magnetic bearing of which was taken with a compass, and the distance along it estimated by dead reckoning.

Although in precise delineation of hydrographic detail Collins' charts for our own shores were superior to those of the Dutch cartographers, their basic style was similar. Collins followed the Dutch charts in inserting a system of intersecting bearing lines, originating from centres lying on the circumference of a circle, which the Dutch charts themselves had inherited from the much earlier compass-charts.

Longitude was never inserted and a latitude graduation only appears on a few charts. Although it was almost a century since Edward Wright had explained the principle behind the construction of the Mercator projection, its necesity in chart compilation was still ignored by English cartographers. In this respect the atlases of both Seller and Collins were inferior to the contemporary *Le Neptune François* issued by Hubert Jaillot in 1691, where the charts on both a large and small scale were drawn on a Mercator graticule. In spite of this deficiency Collins' atlas was well received by seamen, who adopted it as their standard work of reference for navigation at home. The Lords Commissioners of the Admiralty, however, whilst recognizing its great value, constantly strove to improve upon the accuracy of its charts as opportunity offered. In 1698 they themselves instituted a survey of the principal ports along the south coast of England, including Rye, Weymouth, Dartmouth, Fowey and Falmouth, all of which had been surveyed by Collins ten years previously. Security restrictions, however, prevented the newly acquired information from being incorporated in the subsequent editions of Seller's and Collins' atlases.

In addition to charts bound together in folio form, the private publishing firms issued individual chartlets based on surveys undertaken by Trinity House pilots and Custom House officers in the course of their duties. An early chart of this type was engraved from a survey by Captain John Mitchell in 1733, shortly after the placing of the Nore Light-vessel on station at the mouth of the Thames (Fig. 2). In appearance the chartlet, with its networks of radiating bearings, its engraving of ships and elaborate cartouche surrounding the title, and the absence of a graticule, closely followed the style set by the sea atlases. It was a period in which little progress in chart evolution took place, for as long as the average seaman was unaware of the value of an accurate chart as an additional instrument in the quest for precise, and hence safe, navigation, the private chart publishers were content enough to re-issue the old charts with but little subsequent amendment. When the navigator began to demand a more detailed and accurate chart, the necessary incentive was provided for further development.

3. — THE GROWTH OF HYDROGRAPHIC KNOWLEDGE.

From the mid-eighteenth century onwards chart evolution has been closely related to advances in hydrographic surveying. The necessity of a precise marine survey as a pre-requisite to an accurate chart was first realized by Murdoch Mackenzie (Senior). From 1746 to 1749 he was engaged in a private capacity on a nautical survey of the Orkney and Lewis Islands, his charting being based on a previously established rigid land triangulation. The soundings were taken with a hand lead and their position fixed relative to the land detail by compass intersection. The results of the survey were published in atlas form in May 1750 as *Orcades, or a Geographic and Hydrographic Description of the Orkney and Lewis Islands in* 8 *maps* (Fig. 3).

With the completion of this survey Mackenzie, with the backing of the Admiralty, turned his attention to a bigger project, that of examining the hydrography of the west coast of Scotland and the adjacent islands. This area had been neglected by earlier hydrographers, neither Seller nor Collins including charts of this part in their respective sea atlases. The Scottish cartographer John Adair was granted £600 in 1698 for a survey of the west coast, but like so much of his work it was never published and so the navigator did not benefit (2). Mackenzie, however, pursued his task with more vigour, and by 1771 when he retired not only

had he surveyed the west coast of Scotland on a scale of one inch to a mile but had extended his original commission so as to include Ireland and the west coast of England and Wales as far south as the Bristol Channel.

The attention which Mackenzie paid to ensuring that his hydrographic surveys were as precise as possible, with the limited resources at his disposal, was fully rewarwed in the charts which resulted. His insistence that an accurate land survey was an essential preliminary to any hydrographic survey meant that coastal detail and the coastline itself were more precisely delineated on his charts than on those of his predecessors or contemporaries (Fig. 4). The number of soundings inserted is not great, but this is not surprising when one considers the vast amount of ground covered by him in his twenty-five years as a surveyor.

Whilst Mackenzie was surveying in home waters, James Cook was developing new methods of marine survey abroad in order to improve the very poor standard of charting of foreign coasts. The imperfections of the existing charts in the sea atlases were only too apparent when subjected to constant usage during the North American compaigns. It was said that at the battle of Quiberon Bay none of the charts then available resembled one another, and still less the actual area they were supposed to represent. In a situation like this, in 1759, Cook was given an opportinuity to display his remarkable talents as a surveyor as well as a navigator. His first task was to survey a channel in the St. Lawrence River which could be used by H.M. ships for a projected attack on Quebec. Later, from 1764 to 1768, he was engaged on a survey of the coast and coastal waters off Newfoundland, his work being based on a land triangulation (3). On returning to England he was given the command of the *Endeavour* and in August 1768 he sailed from Plymouth on the first of his three voyages of discovery to the South Seas. Some idea of the contribution which Cook made to the extension of hydrographic knowledge can be gathered from the fact that during the first voyage alone no less than 5000 miles of coastline were surveyed.

The charts which Cook himself compiled from his surveys were superior to any which had appeared previously. During the course of his land survey he carried out a number of astronomical observations in order to determine the geographical position of prominent coastal objects. When the charts were later engraved, these positions were used to insert a latitude and longitude graduation. The old radiating network of bearing lines was still retained, their centres lying at the intersection of the parallels and meridians. This was not, of course, the first use of the graduated chart, for many had appeared in some of the old sea atlases, e. g. Sir Robert Dudley's *Arcano del Mare* published in 1646. The graduation on the latter, however, was of doubtful accuracy, being based on only one or two geographical positions.

The accurately graduated chart was made possible by the considerable progress made about this time in instrument invention and improvement. On land the theodolite had established itself as the standard instrument for taking both horizontal and vertical angles. At sea the octant or sextant for observing angles and the chronometer for measuring longitude differences had already proved themselves. As early as 1731, in a lecture to the Royal Society, Hadley had demonstrated his new octant and this was followed by a practical test at sea off the Nore in the next year. Almost simultaneously, but quite independently, in America, Godfrey had constructed a sextant, which although used at sea in 1730 was not brought to the notice of the Royal Society until 1732. The

Society when faced with the difficulty of deciding who was the real inventor awarded £200 to both Hadley and Godfrey. About the same time John Harrison began experimenting with a chronometer which could keep accurate time at sea and eventually after a series of rigorous tests he qualified for the award of the Board of Longitude, having provided a solution to a problem which had exercised the minds of both eminent scientists and leading navigators over the past centuries.

Instrument development also acted as an indirect stimulant to the production of more accurate charts. The navigator, fully proficient in the use of the chronometer for longitude determinations and the sextant for latitude observations was able to plot his course more precisely and so was more aware of any imperfections in the published charts. Any discrepancy between chart position and observation was no longer automatically put down by the navigators to errors in his own observations. In consequence he began to demand charts of a quality which, up to that time, Cook and Mackenzie alone were capable of preparing. Instruments like the sextant and chronometer, therefore, both created a demand for precise charts and at the same time furnished the surveyor with the means of satisfying the new requirements.

At a later date the sextant led to further advances in marine survey technique. When Hadley first demonstrated the use of his octant he had been primarily concerned with obtaining an accurate measure of the vertical angle between the horizon and a heavenly body, so that latitude could be calculated. The instrument, however, was equally suited to measuring horizontal angles, but it was not until 1774 that it was used for this purpose in British coastal waters. In that year during the course of a survey off the north coast of Kent, Lieutenant Murdoch Mackenzie, a nephew of Murdoch Mackenzie (Senior), took sextant angles from the seaward on three previously fixed positions on land and, using a station pointer invented by his assistant Graeme Spence, was able to solve the resection problem and so accurately fix the position of the ship during the sounding operations (4). In place of the few isolated soundings taken along a single coastwise traverse, the three-point fix enabled a detailed systematic examination of the off-shore area to be made. Not all the surveyed depths were inserted on the chart compiled from the surveys, for this would have led to a crowding out of other detail useful to the navigator. Instead, a selection of critical depths was made; for the first time the chart was not merely a direct copy of the hydrographic survey (Fig. 5).

Throughout this period of hydrographic expansion and progress the private publishing firms continued to act as the sole distributors of charts to the Royal Navy and mercantile marine alike. Measured in terms of output the latter half of the eighteenth century can claim to be the golden age of marine cartography. New chart publishers like William Heather (1765), Robert Sayer and John Bennett (1770), Steel (1782), Laurie and Whittle (1794) entered the field as successors to those firms which had published the early English sea atlases in the previous century. The Lords Commissioners of the Admiralty usually allowed serving officers in the Royal Navy to publish their surveys privately for their own gain; Cook's Newfoundland survey, for example, was published in *The North American Pilot* issued by Sayer and Bennett in 1775. The private publishing houses, however, would only publish charts of areas where the demand was sufficiently great to cover the initial cost of engraving, etc. For less frequented parts the surveys lay untouched in the archives of the Admiralty, along with information which, because of security restrictions, was not available to the private publishers.

The Royal Navy, entirely dependent on the privately printed chart, was in consequence often denied valuable information.

4. — THE ADMIRALTY CHART

It was to remedy such a situation that in 1795 the Board of Admiralty decided to establish a national office for the production of charts for the Navy for « on an examination of charts in office, we find a mass of information requiring digest, which might be utilized, but owing to the want of an establishment for this duty, His Majesty's officers are deprived of the advantages of these valuable communications... We therefore propose that a proper person be fixed upon to be appointed Hydrographer to the Board, to be entrusted with the care of such charts, etc., that are now in office, or may hereafter be deposited and charged with the duty of collecting and compiling all information requisite for improving Navigation, for the guidance of Commanders of H.M. ships. » The « proper person fixed upon » for appointment as the first Hydrographer was Alexander Dalrymple, a former clerk who had risen to the post of Hydrographer to the East India Company and who had attracted the attention of the Lords Commissioners with his many charts and tracts on hydrographic survey methods.

The creation of a national office to supervise the production and issue of reliable charts was not a new innovation. In France a « Dépôt des Cartes et Plans des Marines » was established as early as 1720, although no charts were produced until 1737. The formation of a Hydrographic Office in this country had been discussed in 1770 but the matter was shelved for another twenty-five years, the Admiralty at that time being too preoccupied with operations in North America.

The office in its early years was the scene of a domestic quarrel which not only affected its future but also the development of the Admiralty chart. Dissatisfied with the slow progress which Dalrymple had made towards providing the Navy with an adequate set of charts, the Board of Admiralty in 1807 set up a Chart Committee to report on the desirability of H.M. ships using privately printed charts for areas where as yet no official chart had been published. The terms of reference also included an assessment of the accuracy of these charts, taking into account the method of hydrographic survey on which they were based. From its inception Dalrymple completely ignored the committee and, contrary to instructions from the Board, denied two of its members, Captain Thomas Hurd and Lieutenant Columbine, access to relevant documents in the Hydrographic Office, a situation which culminated in his dismissal in May 1808. A letter from Pole, the Secretary of the Admiralty, informed him that their Lordships « Have commanded me to acquaint you that they deem it expedient to remove you from the office of Hydrographer to the Admiralty and that you are therefore not to consider yourself as any longer holding that situation. » His successor to the post of Hydrographer was Captain Hurd, R.N., who had sat on the committee which had brought about Dalrymple's dismissal.

With considerable practical experience behind him Hurd at once attempted to establish a more direct relationship between marine surveying and the production of charts. Two years after taking office he succeeded in bringing the surveying service under his direct control. Up to that time any surveying that was considered necessary either at home or abroad was carried out at the initiation of the Lords Commissioners themselves. The new arrangement meant that the necessity of a

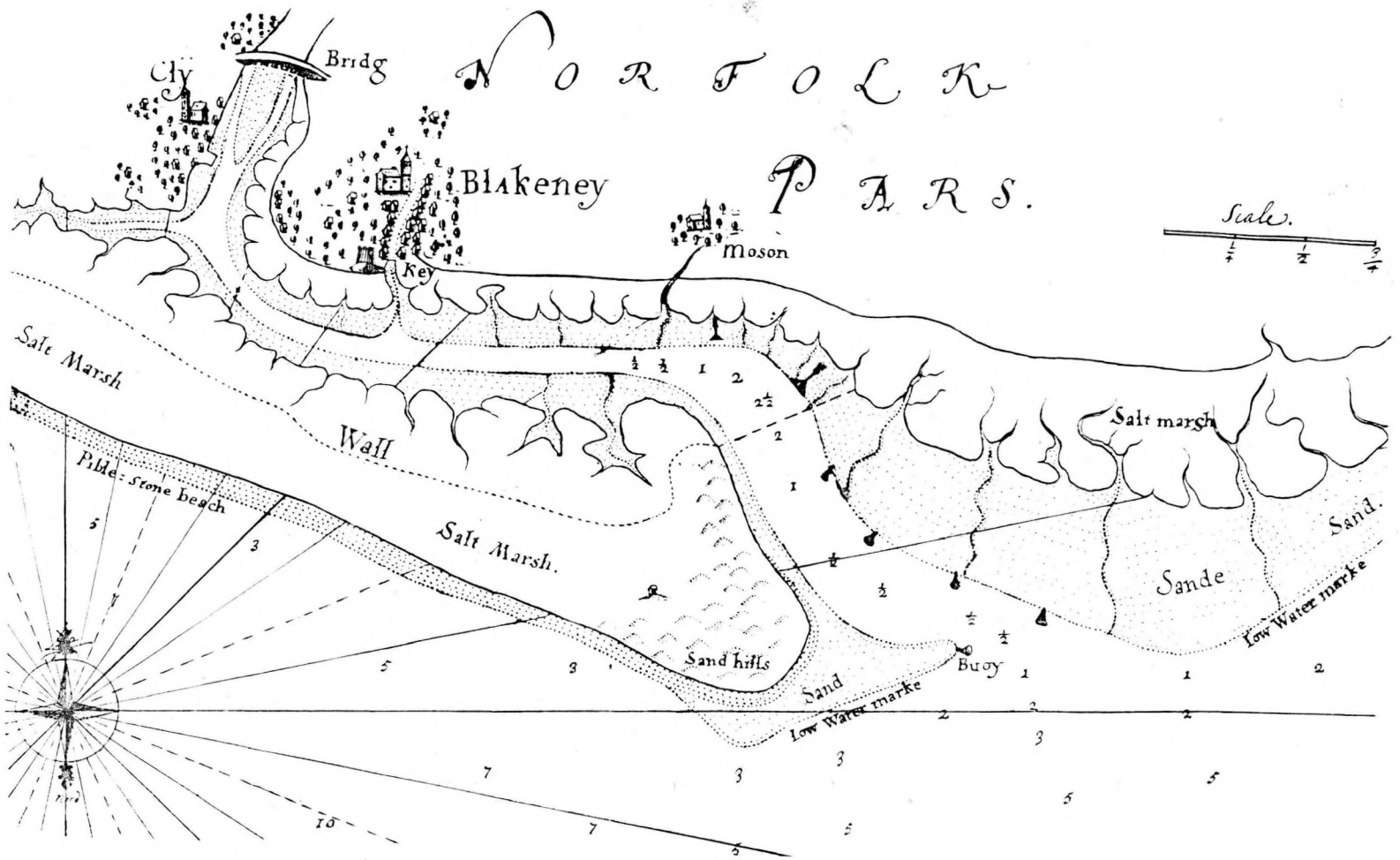
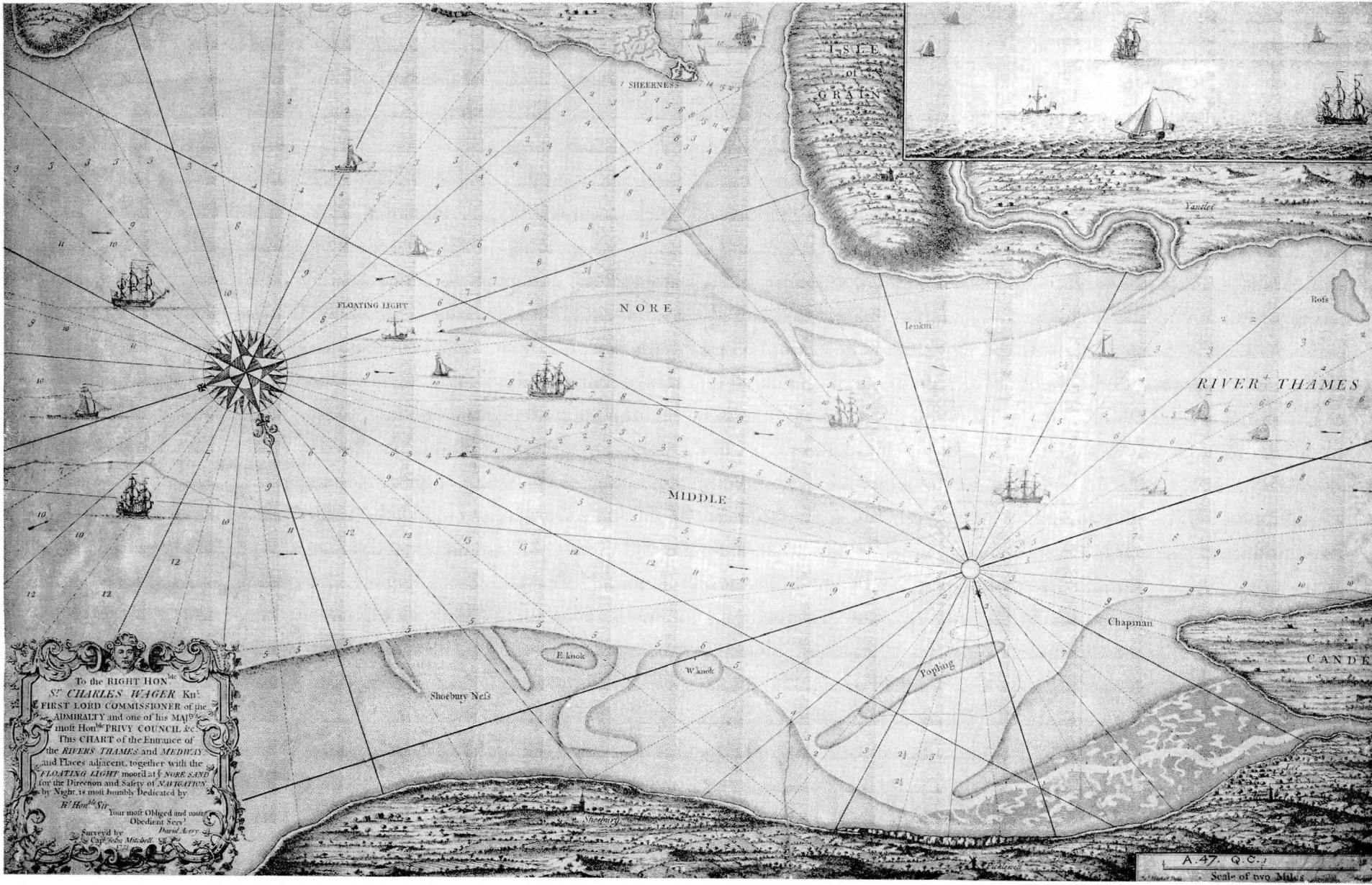


Fig. 1. — Blakeney Harbour and approaches as surveyed by Captain Grenvile Collins, 1688.


SHEERNESS
ISLE of GRAIN
Yantlet
FLOATING LIGHT
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MIDDLE
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Popling
Shoebury Ness
Shoebury
To the RIGHT HONble
Sr CHARLES WAGER Knt
FIRST LORD COMMISSIONER of the
ADMIRALTY and one of his MAJtys
most Honble PRIVY COUNCIL &c
This CHART of the Entrance of
the RIVERS THAMES and MEDWAY
and Places adjacent, together with the
FLOATING LIGHT moor'd at the NORE SAND
for the Direction and Safety of NAVIGATION
by Night, is most humbly Dedicated by
Rt Honble Sir
Your most Obliged and most
Obedient Servt
David Aerry
Surveyd by
Capt John Mitchell
A.47. Q.C.1
Scale of two Miles

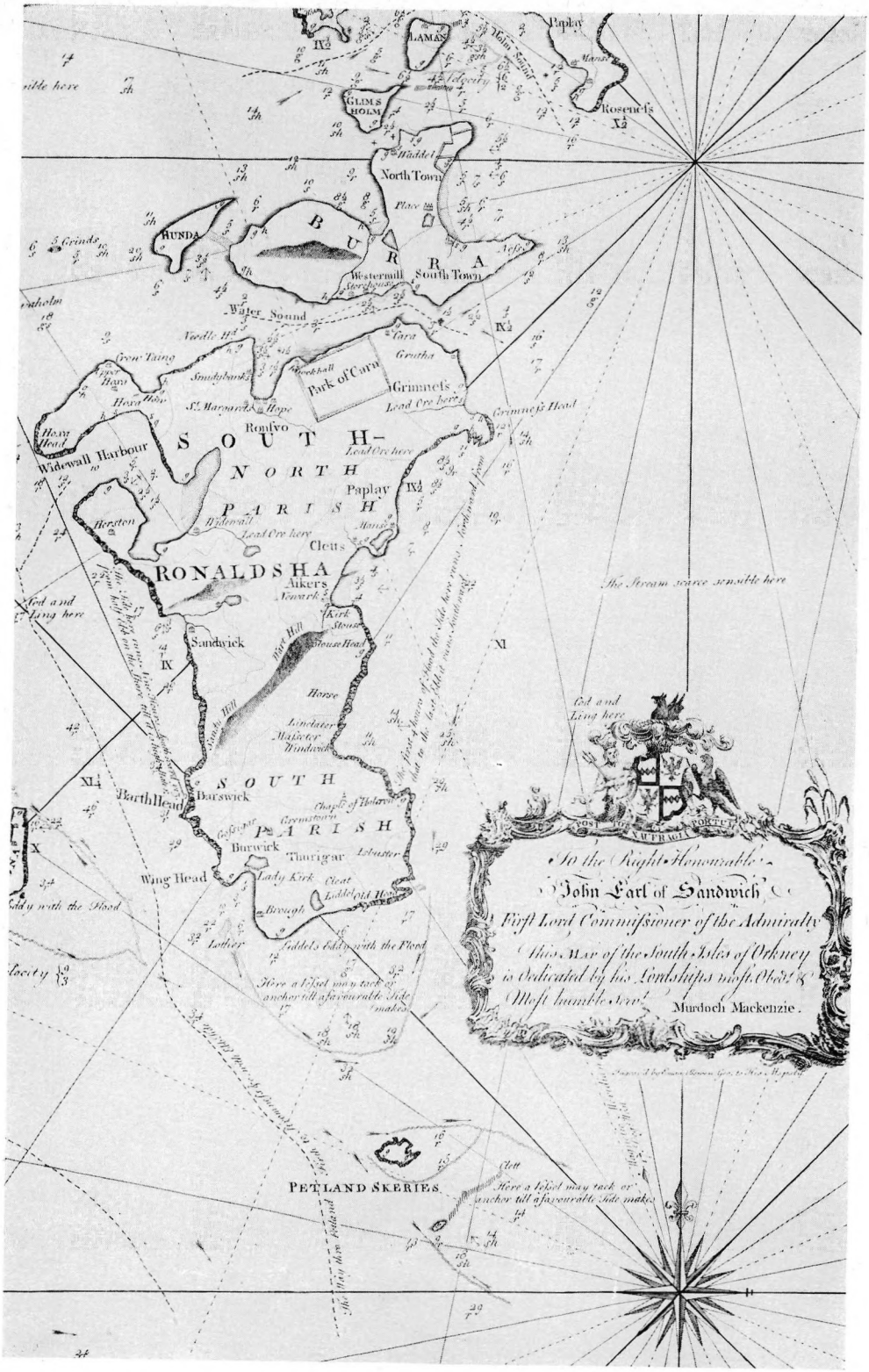

Fig. 3. — Part of Murdoch Mackenzie's survey of the Orkney Islands, 1750.

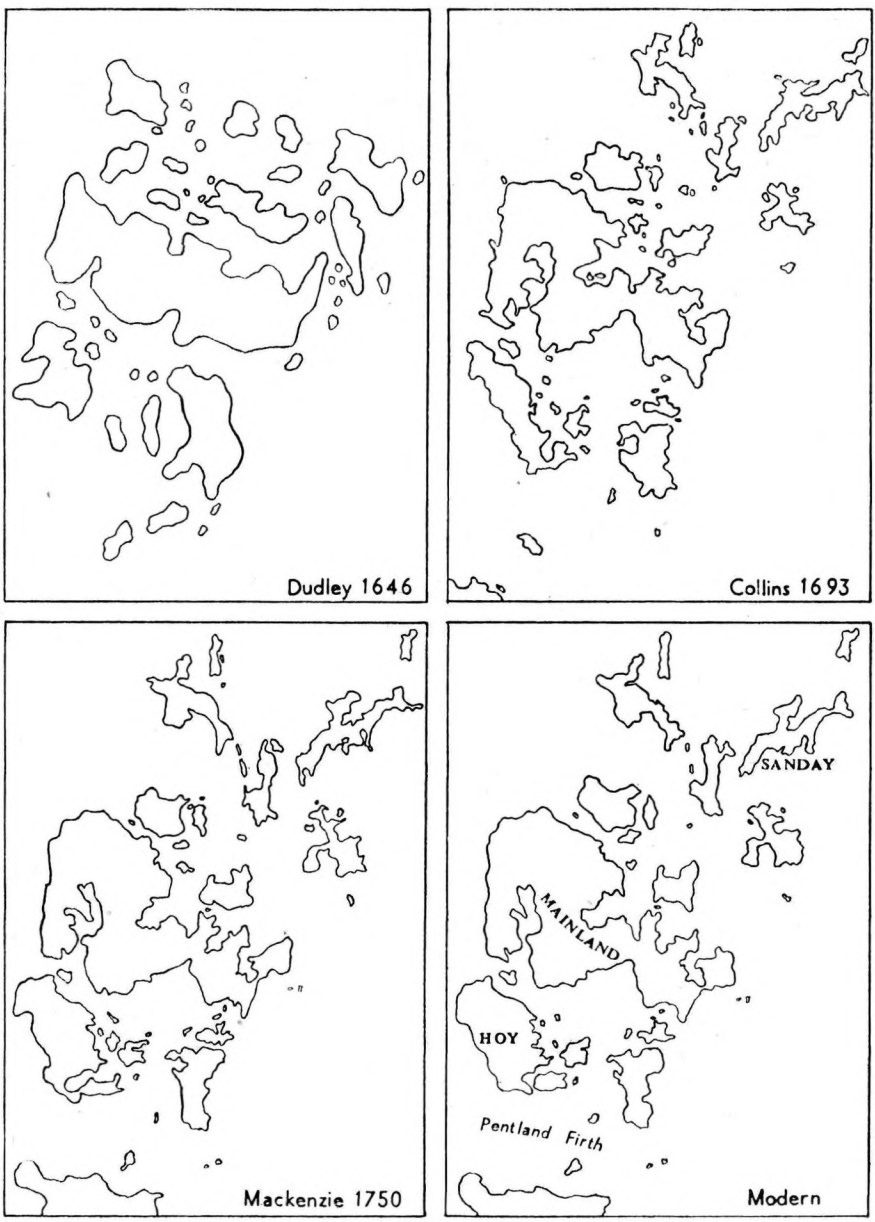

Fig. 4. — Comparison of the outline of the Orkney Islands as delineated by various marine cartographers.

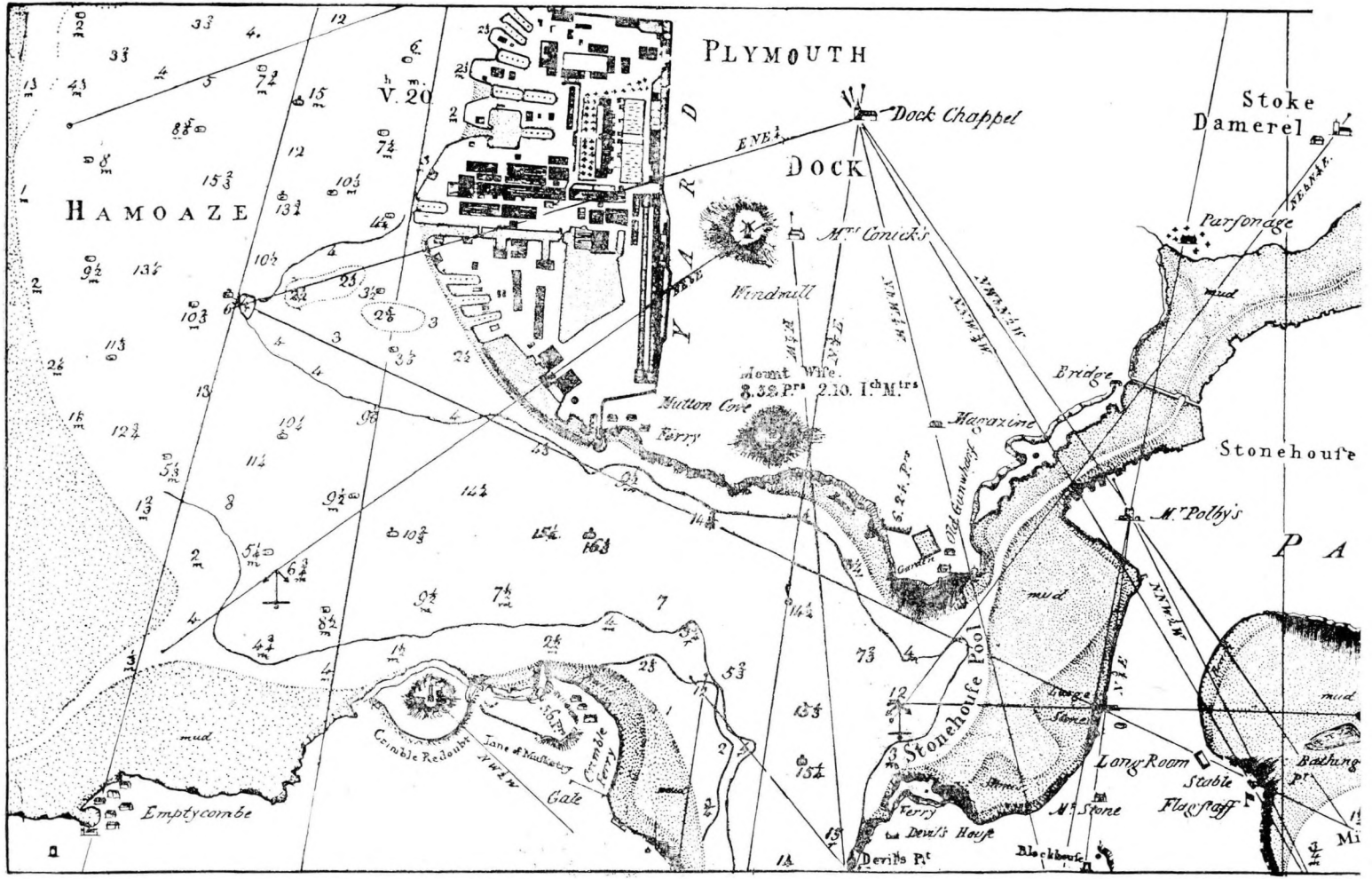

Fig 5. — Portion of a chart of Plymouth Sound compiled from à Survey by Lieutenant Murdoch Mackenzie, 1777-79. The original survey contains about three times as many soundings.

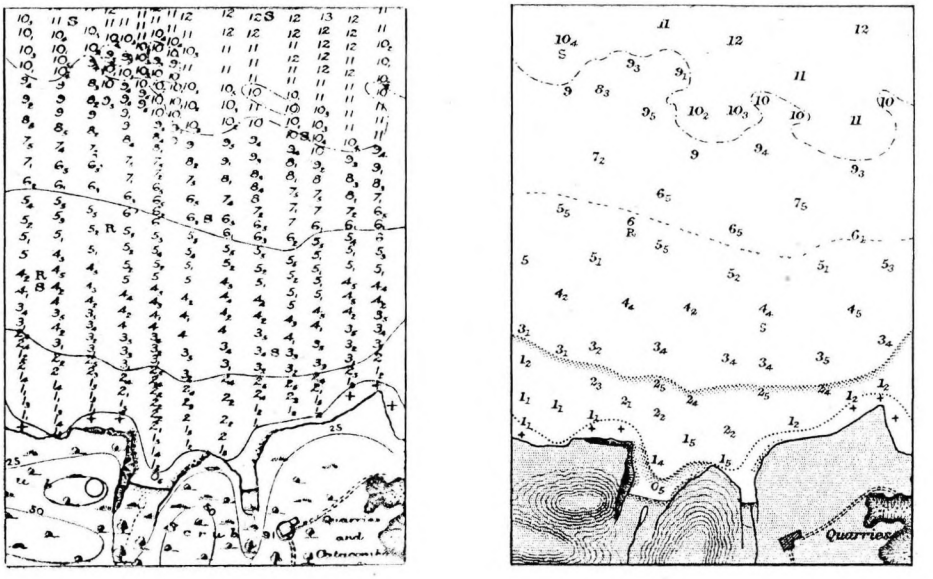

Fig. 6. — A portion of a chart compiled from a survey (left) using sonic sounding methods.

well-conducted survey for the production of an accurate chart was at last fully recognized.

It was during Hurd's term of office as Hydrographer, from 1808 to 1823, that the chart took on a style which in some respects it has retained to the present day. There was an insistence on accuracy, especially with regard to the graduated framework of the chart. For this country Hurd made use of Mudge's trigonometrical survey for the insertion of land detail. Only two months after his appointment he suggested to their Lordships « the necessity of an application being made to the Board of Ordnance that this office be allowed to have a copy of such part of Colonel Mudge's Military Survey of England as respects the sea coast thereof together with all remarkable objects in the vicinity, as may be judged useful to Navigation » (5). The topographic detail inserted on the charts was not merely copied from the land maps; a careful selection was made and only those features of value to the seaman were shown. The selection of soundings from the surveyor's fair sheet was brought to a fine art. In the interests of clarity the practice of inserting numerous systems of interlacing compass bearing patterns was discontinued. Only one pattern was shown and that was restricted to a part of the chart where it did not obscure other hydrographic information. One of Hurd's last acts before retiring from office in 1823 was to obtain permission for the navigation charts produced by his department to be made available to the mercantile marine.

The pattern of the Admiralty chart as established by Hurd was maintained by Francis Beaufort during his long period as Hydrographer from 1829 to 1855, and indeed remained throughout the nineteenth century. Minor improvements, such as the adoption of the small true-circle compass rose in place of the series of bearing lines, were made. In addition improvements in accuracy followed from advances in hydrographic survey technique. The old survey vessels, manœuvred under oars or sail, were replaced in 1869 by steamboats, and ten years later the Lucas automatic lead-sounding machine was introduced to supplement the old practice of « heaving the lead » in depth determination (6).

The continued expansion of the Hydrographic Office could only have an adverse effect on the fortunes of the private chart publishers. For a time in the early years of the century when the national department was still finding its feet, they continued to flourish and names like Blackford, Arrowsmith and Norie were added to those already established in London. Once the new department, with its own surveying service, got under way, and especially after Hurd obtained permission to issue charts to the mercantile marine, they were unable to compete and many were forced out of business. Although almost entirely dependent upon Admiralty surveys for information, one firm, that of Imray, Laurie, Norie and Wilson, who claim direct descent from John Seller, has continued to produce the more specialized Blueback Chart to the present day (7).

5. — RECENT DEVELOPMENT

In recent years, although the general appearance of the Admiralty chart has been retained, its reliability has been considerably increased as new techniques of marine survey have been developed. In particular, since the introduction of the echo sounder, a more accurate determination of the form of the sea-bed has been possible. As early as 1913 Behm in Germany demonstrated the principle of obtaining depths by measuring the time interval between the transmission of a sound pulse and the reception of its echo from the sea-bed. By 1930 the echo

sounder began to replace the lead-line in all branches of hydrographic survey. The continuous trace of the sea floor in place of the isolated depths of the old method meant that, provided that the sounding lines were run close together, a more thorough examination was possible (Fig. 6). In addition the survey operation was speeded up considerably, for whereas with the Lucas sounding machine twenty-five miles of sounding a day in depths of 0-10 fathoms was considered exceptional, this output could often be doubled using the echo sounder.

The introduction of new navigational aids such as Decca, Consol and radar has led to the production of special charts. For use with the Decca Navigator the ordinary chart has been overprinted with hyperbolae to allow the instrumental readings to indicate position directly on the chart. The special requirements of radar-assisted navigation have caused experiments to be made in emphasizing the appropriate topography. Accurate contours have been inserted and those on the seaward facing slope have been strengthened (8) or a system of layer colouring for various height ranges has been used (9).

Colour has also been introduced on the ordinary navigational chart to emphasize shallow-water areas and isolated shoals, a flat tint being used for depths of less than three fathoms and a ribbon tint around the six-fathom line. This improvement, coupled with the greater use of sans-serif lettering types in place of the flowing styles of the old copper engravings, has given the Admiralty chart of today an appearance in keeping with modern cartographic practice.

6. — ACKNOWLEDGEMENTS

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