THE ACTIVITIES OF THE HYDROGRAPHIC INSTITUTE OF THE ITALIAN ROYAL NAVY

HYDROGRAPHIC AND SCIENTIFIC MISSIONS.

The following information is extracted from a publication presented by the Hydrographic Institute of the Italian Royal Navy to the 15th Congress on Navigation which took place at Venice in the latter part of September 1931, a copy of which was kindly forwarded to the International Hydrographic Bureau by the Director of the Hydrographic Institute of Genoa :

Previous to the foundation of the Kingdom of Italy, the only Italian charts for purposes of navigation which were available were the following :

A few charts of Venetia and coastal charts of the Adriatic, published in 1825, at Milan, by the Austrian General Staff ; also plans of the Ligurian and Sardinian ports, from surveys made by Admiral ALBINI. These charts (together with those of Sicily, compiled at about the same period by Captain Henry SMITH, of the British Royal Navy, and the surveys of the harbours and ports of the Kingdom of the Two Sicilies, carried out by the Topo-hydrographic Institute of Naples) not having been kept up to date with regard to the continual alterations of coasts and ports, no longer served the needs of navigation ; in fact, navigators in Italian waters were obliged to use French charts or those of the British Admiralty.

It was decided therefore to undertake hydrographic surveys of the coast and surrounding waters as soon as possible. Consequently, in 1867 a Hydrographic Committee was appointed, with the object of bringing up to date the charts of those parts of the Italian coast which had not greatly altered and to make fresh surveys of such areas the charts of which were no longer serviceable.

HYDROGRAPHIC SURVEYS IN HOME WATERS.

Hydrographic operations were begun on the Venetian coast, where a new general survey was necessitated by considerable alluvial changes. The survey was extended inland in order that detailed information regarding the rivers and canals in this vicinity might be included.

About the middle of the year 1868, as the result of an agreement made between Italy and Austria-Hungary, it was decided to make a joint survey of the Adriatic Sea, operations on the Italian coast being entrusted to the Italian Hydrographic Committee.

In 1875, surveys of the Adriatic and Ionian coasts as far as Cape Colonna were completed. Thus sufficient data were obtained for drawing up 26 coastal charts of the Adriatic and Ionian Seas, whilst the whole of the Adriatic Sea to the parallel of Cape Colonna was represented on 4 navigational charts, constructed from the data obtained by the Italo-Austrian surveys.

The distribution of charts to naval vessels at this time was made by the UFFICIO SCIENTIFICO DEL PRIMO DIPARTIMENTO MARRITTIMO (Scientific Bureau of the 1st Maritime Department) situated at Genoa. This Bureau was responsible also for the meteorological service and the compilation and distribution of *Notices to Mariners*, a short reference to which will be made later.

In 1872 this Bureau became the UFFICIO CENTRALE IDROGRAFICO DELLA R. MARINA (Royal Naval Central Hydrographic Office) and was placed under the direction of Commander G. B. MAGNAGHI, who, with his brilliant knowledge and organising capacity, gave great impetus to the new institution.

First, he installed an Astronomical Observatory in the Hydrographic Office, together with a workshop for the construction and repair of nautical and geodetic instruments. This was followed by the installation of a copper-engraving room for the new charts ; he then proceeded to improve and correct the signalling of astronomic time in the town and port. He established a magnetic service also for the compensation of compasses constructed in the workshop.

Meanwhile, in 1876, the surveys of the Italian coasts, which had reached Cape Colonna in 1875, were recommenced ; the surveying vessel *Washington* proceeded during this and the following year to carry out surveying operations of the Calabrian coast between

Melito and Paola, the Sicilian coast between Taormina and Cape Orlando and in the Eastern Eolian Islands, thus obtaining sufficient data for making 11 charts and plans which were issued in 1882.

During the following years surveying operations were continued along the western coasts of Italy and those of Sardinia. The surveys of the ports of Ancona, Pescara, Ortona, Barletta, Bari and Otranto were revised, and that of the Sicilian coast between Taormina and Augusta was made. For 18 years the *Washington*, with the occasional cooperation of the schooners *Chioggia* and *Ischia*, formed a brilliant and severe school for surveyors in home and coastal waters.

The Hydrographic Office, from the data collated during this period, issued 102 charts and plans between 1880 and 1894, thus continuing the brilliant tradition of Captain MAGNAGHI, the succeeding Directors carrying out numerous other hydrographic operations, more especially along the coasts of Sicily and the islands of Pantelleria and Linosa. Among these surveys, that of Graham Bank and the mouth of the Tiber between Fiumicino and the Torre di Paterno are of particular interest.

The *Eridano* replaced the *Washington* in 1895 and for two years carried out detailed surveying operations in the principal canals of the Venetian lagoons and the Ports of the Lido, Malamocco and Chioggia, making important corrections in the plans of several ports of the Adriatic, Ionian and Tyrrhenian Seas. From the data thus obtained, 27 new navigation charts were constructed, several of which replaced charts which were cancelled.

The gunboat *Scilla* was commissioned for hydrographic work in 1897, under the command of Captain LEONARDI-CATTOLICA, who having been appointed Director of the UFFICIO IDROGRAFICO, changed the name of this Office to ISTITUTO IDROGRAFICO as being more appropriate to its scientific work.

During the expeditions of 1898, 1899, 1901 and 1903, the whole western coast of the Adriatic Sea was resurveyed, from Cape Santa Maria di Leuca to the eastern frontier of Italy. Thus the number of Italian charts and plans reached a total of 229, including charts of Lago Maggiore and Lago di Garda.

The hydrographic survey of the seas which wash the coasts of Italy could thus be considered complete at this period, but there still remained to the Institute the important task of bringing all nautical charts up to date, as hydrographic surveys should represent the *actual* state of coasts and seas, which are continually subject to alteration by the action of man and by physical agencies.

From this time on colonial surveys were actively carried out. Apart from the hydrographic work which had been and was still being carried out in colonial waters, plans had been laid to survey certain areas in home waters as opportunity offered.

For this purpose, the *Magnaghi*, after her expedition in 1924 in the Red Sea, was commissioned in 1925 to ascertain the positions of the banks in the channel between Sicily and Tunis, more especially that of Graham Bank (formerly Julia or Ferdinandea Island) which, according to information supplied by a French hydrographic survey operating in 1923, was supposed to have disappeared.

The vessel was provided with an ultra-sonic sounding apparatus LANGEVIN-FLORISSON with a MARTI recorder, by means of which it was possible to investigate systematically the entire vicinity of the bank, the position of which had already been determined, as has already been stated, by the *Washington* in 1890. Having thus ascertained the existence of the bank, its geographical position was determined by means of intersections from stations on land (about 60 kilometres (= 32 miles) from the ship); during the night angles were taken to a special light on mast of the *Magnaghi*. Thereafter the bank was sounded out. A search for the Pantelleria and Avventura Banks was then carried out and they were sounded out.

In the year 1927, the *Magnaghi*, after investigations in the Gulf of Bomba, returned to home waters and carried out a survey of the Gulf of Trieste with the cooperation of the vessels *Mario Bianco* and *Cariddi*, and, finally, surveyed the Port and channel of Zara.

In 1928, before returning to the Red Sea, the *Magnaghi* undertook further soundings on the Avventura Bank, very close on its western part where the depths are very irregular. As a result of these investigations, it was determined that the Talbot Bank, which lies in this vicinity, has less water over it than is shown by the soundings marked on charts up to the present time.

The position of the bank was determined with great accuracy by direct intersection, by angles to the vessel taken simultaneously at night from three land stations, situated at 64, 74 and 84 kilometres (34.5, 40 and 45.3 miles) respectively from her. The obser-

vations gave very good results and this undertaking is, doubtless, one of the most remarkable determinations of position that has yet been accomplished at sea by methods of precision.

Thence, the *Magnaghi* proceeded to sound in the region to the northward of the Egades Islands, to survey the ports of Palermo, Trapani, Cagliari and Porto Torres and, finally, to a survey of the Cernia Bank.

HYDROGRAPHIC WORK IN THE COLONIES.

As soon as Italy had established a naval station at Assab it was recognised that the charts of this vicinity were insufficient. Operations were begun in 1880 by making a survey of the Bay of Assab.

In 1886, after the occupation of Massaua, the *Scilla* carried out a survey of this port and its vicinity, and in 1891-92 the same vessel surveyed the area comprising the Gulf of Zula and the Dahlach Islands. In consequence of considerable alterations due to harbour works at Massaua, a new survey was made of this port.

In 1892-93 the *Scilla* carried out a survey of the coast of the mainland to the north of Massaua to Melahat and from thence eastwards to the islands of the archipelago, to pick up a side of the earlier triangulation; in 1895 and in 1896 a topographical survey was carried out of a large part of the mainland coast working to the northward.

On the coast of Benadir, the first hydrographic work was carried out by the guardships stationed in this vicinity. More systematic work, carried out under better conditions, was accomplished by the *Staffetta* during the 1898-99 operations, in the course of which plans of Alula, Merca and Brava were made as well as those of the anchorages situated to the North of Itala and at Obbia Roads, these latter being surveyed by more rapid methods.

In December 1903, the *Staffetta* was sent to the coast of Benadir, where a running survey of the coast between Kisimayo and Italia was carried out; in the following year the same vessel made a survey in the Red Sea of the coast between Point Anfila and Ras Shakhs and this determined the position of Shab-Shakhs Bank.

During the years 1907-08-09, the *Staffetta* surveyed the coast of Benadir between the Giuba and Mogadiscio, including the topography of and sounding up the Giuba to a distance of 30 kilometres (= 16 miles) from its mouth.

In the years 1910 and 1911 the *Staffetta* went on a fresh hydrographic expedition to the Red Sea and the Indian Ocean. A survey was carried out in the North Channel of Massaua and new plans of Mogadiscio and the anchorage areas of Brava and Merca were constructed. The most important operations, however, were without doubt the topographical survey and sounding of the portion of the coast between Uasceik and Itala. The anchorages at Itala and Obbia were resurveyed during this cruise.

In 1912 (still with the *Staffetta*) operations were continued in the North Channel of Massaua, the survey of the coast being pushed on in a northerly direction to beyond Taclai. In the following years (1913-14) the triangulation for the survey of the North Channel was extended as far as the frontier of the Anglo-Egyptian Sudan. From the south coast of the Massaua Channel the eastern islands in that channel were linked up with the mainland by triangulation. These operations were characterised by the perfection of the methods and instruments employed.

As a result of the operations carried out in the Red Sea, the Gulf of Aden and the Indian Ocean between the years 1880 and 1914, about thirty charts were drawn up and published, the earliest of which need to and soon will be brought up to date.

The occupation of Tripolitania and Cyrenaica in 1911 necessitated immediate hydrographic operations in some of the more important areas of these regions, as, at this period, there were in existence but a small number of foreign charts of the vicinity, which were out-of-date and consequently inaccurate.

In 1911 and 1912 the *Ciclope* commenced operations by a survey of the roads and port of Tripoli and of the anchorage of Ras el-Machbez, after which, in September 1912, the vessel *Etna* made a survey of the anchorage of Misurata.

At the same time, all naval vessels frequenting Libyan waters made sketch surveys thus enabling several provisional charts to be published. Pending more regular and definite operations, partial surveys of the shoals situated between Ras-el-Machbez and Zuara were made, together with rapid surveys of the Ports of Bengasi and Derna and of the anchorage of Marsa el-Auegia.

In the Ægean Sea the cruiser *Amalfi*, taking advantage of a stay at the island of Lero, made a rapid survey of the Bay of Parteni and of the channel between the islands of Lero and Arkangelos.

After several years of interruption, hydrographic operations were recommenced in 1919 on the Libian coasts. During the winter of that year and the summers of 1920 and 1921, the surveying vessels *Garavoglia* and *Panaria* surveyed the coast and the anchorages between Bengasi and Derna in cooperation with the officers of the Military Geographical Institute, carrying out topographical work in this region.

It was thus possible to publish a track chart on a scale of 1:320.000 (from Bengasi to Derna); two coastal charts on a scale of 1:120.000 (from Bengasi to Tolmeta and from el-Hania to Derna); a chart on a scale of 1:50.000 (Bengasi Harbour) and plans of Bengasi, Tolmeta, el-Hania, Marsa el-Hilàl and Derna.

These represent remarkable progress in the charting of the Mediterranean colonies.

The surveying vessel *Ammiraglio Magnaghi* took up her work again towards the end of the year 1923, proceeding to the Red Sea to continue the work of the *Staffetta* which was interrupted in 1914.

In the course of this expedition, in which the Italian Thalassographic Committee participated, a completely new plan of Massaua was made and the soundings and coast survey of the South Channel of Massaua were completed by linking up the work interrupted in 1914 with that previously carried out in the Bay of Anfila, but interrupted in 1892.

A survey of Massaua and of the coast and islands of the South Channel was also undertaken and was partly made by means of aerial photographs taken by the local hydroplane section.

Biological and tidal investigations were made; current investigations, observations for relative gravity at Suez, Massaua, Asmara and Aden; complete magnetic determinations at several stations in the Red Sea, and, finally, astronomical determinations of the positions of the lighthouses newly erected at Guardafui and Ras Hafun, were carried out.

It was during this expedition that the lighthouses at Guardafui and Ras Hafun were erected, and this was hailed by all seamen as another and very necessary service for which they were indebted to the Italian Navy.

As a result of this cruise a new edition of the plan of Massaua was issued and the chart of Massaua South Channel was completed.

During a new hydrographic expedition in 1928-29, the *Magnaghi* made a complete survey of the Dahlach Islands with the object of determining the existence of a reported passage between these islands which would be of great advantage for purposes of trade with the coast of Arabia. The existence of such passage was established and it was permanently buoyed. A chart was published which gives detailed plans of the more important channels, thus ensuring safety of navigation between these islands.

In the course of this cruise, 4 magnetic stations, 3 bathymetric stations, 1 astronomical station, 3 tidal stations and 4 measurements of relative gravity were made.

Hydrographic investigations had been recommenced on the Libian coasts in 1922. In 1922-23 the vessels *Meteo* and *Abastro* had made a new survey of the Port of Tripoli and, almost at the same time, the *Scilla* had carried out a survey of the coast between Zuara and Ras Agedir and the anchorage of Bu-Chemmasc or Buchamez.

In 1924 the *Cariddi* made a survey of the coast between Sidi Ali and Zuara and that of the anchorage of Zuara, whilst the *Scilla* undertook a hydrographic survey of the coast between Gargaresc and el-Mattred.

In 1925 the *Scilla* surveyed the coast and the anchorages between Homs and Misurata; in the same year the *Cariddi* carried out surveys of the Bay of Tôbruch, the anchorage of Port Bardia and of the coast between Bardia and Marsa el-Aora. In the course of this cruise, accurate astronomical determinations of latitude and longitude were made at Tôbruch and Bardia which, with the determinations of Derna (1921) and Bengasi (1925), established the fundamental points by means of which the compensation of the geodetic net for this region of Cyrenaica will be made.

The geographical coordinates at Tripoli were determined with the same accuracy during the course of this year.

In 1926 the *Cariddi* carried out the survey of the anchorages of the Tre Scogli, Carcura and El-Agheila in the Gulf of Sidra where several shoals in the vicinity of El-Bueb were investigated, whilst the geographical positions of Ez-Zuetina and Carcura were determined at the same time by means of the prismatic astrolabe. During this year, the *Scilla* surveyed the coast between Misurata and Buerat el-Hsun.

In 1927 the surveying vessel *Ammiraglio Magnaghi* was commissioned to undertake an expedition in the Gulf of Bomba, for which there existed but a hastily made British survey dating from the previous century. The *Magnaghi*, with the cooperation of the

Cariddi, surveyed the whole of the Gulf of Bomba, as well as the waters of Ras et-Tin and the coast as far as Derna.

The investigations along the Libian coast, of which a brief outline has been given, provided sufficient data for the publication of 16 new charts, representing the coast and the principal ports and anchorages of our Mediterranean African colony, with the exception of a large part of the Gulf of Sidra which was completed in the course of an interesting expedition carried out in 1930.

The charting of the Dodecanese (Italian islands in the Ægean) was already ample and elaborate, thanks to hydrographic surveys carried out in the past, principally by the British Hydrographic Service; but these islands where our interests and maritime commerce have considerably increased since their occupation, were not ignored by the Hydrographic Institute.

In 1924, the vessel *De Lutti* carried out surveys of Alinda Bay, Parteni (Parthani) Bay and Porto Lago (Port Laki) in the island of Lero, and that of the anchorage of Rodi (Rhodes). The astronomical determinations of latitude and longitude of the islands of Rodi, Lero and Coo (Kos) date from this year.

In 1926 the *Mario Bianco* surveyed Port Vaty and Port Maltezana in the island of Stampalia; Simi Bay (Symi) in the island of that name; extended the survey of the Bay of Parteni and carried out certain hydrographic verifications in the anchorages of Rodi.

In 1927 the *Scilla* made surveys of the anchorages of Castelrosso (Castellorizzo), of Coo, Calino (Kalimno), Porto Scala (Patmo), the Bays of Lardo and Lindo and again extended the survey of the Rodi anchorages. During this cruise latitudes and longitudes were determined in the islands of Castelrosso and Stampalia.

As a result of this work, 12 plans of the principal ports and anchorages of the Italian islands in the Ægean Sea were published. These documents are incontestably of great utility to both naval and mercantile vessels sailing in these localities.

In 1930 a hydrographic and topographic survey of the Gulf of Sidra was carried out.

During the 19 years of Italian occupation, as has already been said, surveys had been carried out along the entire coast between the Tunisian frontier and Misurata and of the coast from Bengasi to the Egyptian frontier ; but the vast Gulf of Sidra which bathes nearly 800 kilometres (= 430 miles) of coast (*i.e.*, nearly half of the coastal extension of the whole colony) had not been investigated from the hydrographical and topographical point of view, with the exception of a few limited regions.

Navigators were obliged, therefore, to use foreign charts and documents, 60 or more years old, the accuracy of which was extremely doubtful.

Towards the end of the spring of 1930 three vessels (the *Magnaghi*, the *Dardanelli* and the *Azio*) sailed from Italy to undertake investigations on this coast; and in the space of six months, by following an itinerary drawn up by the Institute, they carried out 5,000 square kilometres (= 1,500 square nautical miles) of triangulation and topography, and 30,000 square miles of submarine survey, taking 250,000 soundings from the vessel herself and 125,000 soundings from boats.

The Hydrographic Institute had previously contributed, *i.e.*, before even the arrival of the vessels, to the preparation of the topographical work, by sending two officers ahead to make the intended triangulation and to commence a topographical survey of the eastern half of the Gulf, whilst the Military Geographical Institute worked, with its own officers, in the western half.

The extensive data collected during the expedition was collated on 8 charts, one track chart and 7 coastal charts, with 16 insets of anchorages; these charts, which were published in the month of May 1931, show, without any doubt and in spite of the short time allowed for their compilation, remarkable progress in the cartographic art.

OTHER SCIENTIFIC WORK.

Whilst the ROYAL NAVAL HYDROGRAPHIC INSTITUTE carried out surveys of the Italian coasts during the first years of its existence, its sister Institution, the MILITARY GEOGRAPHICAL INSTITUTE (which at that time was known as the MILITARY TOPOGRAPHICAL BUREAU) extended over Italy and her islands a close net of triangles of various geodetic orders which were later to supply data for the map of Italy on a scale of 1:100,000.

Therefore as far as possible the Naval surveyors based their work on the fundamental data previously determined by the officers of the Military General Staff. But in areas where these data were wanting, or where, on account of the extent of coast under survey, it was necessary to commence operations *de novo* (as in the Colonies), hydrogra-

phic surveyors were obliged to undertake not only the measurement of bases, but also all other geodetic and astronomical determinations for the determination of the geographical positions of fundamental points. At first base measurement was generally done by means of a properly checked steel metric tape, but this method was superceded by a Jäderin apparatus with invar wire.

In order to check these wires continuously for, as is well known, they are subject to slight variations owing to use or to natural alterations in their molecular structure, a standard base was made in 1910 in the Arsenal at Spezia by the Bessel method and apparatus, which at present represents the most accurate method of making practical measurements of a geodetic base.

Astronomical determinations of latitude, longitude and azimuth were always carried out by methods and with instruments of great precision. Data thus obtained were an important contribution to the total of astronomical determinations on the basis of which other Italian and foreign scientific institutes worked and are working to attain and improve our knowledge of the globe.

Without giving a complete and detailed list of the numerous geodetic-astronomical determinations made by our surveyors, of which an account will be found in the volumes of the "*Annali Idrografici*" of the Institute, it is sufficient to mention the determination of the longitude of Derna lighthouse, erected in 1921, for which radio-telegraphic methods were used for the first time in Italy.

An important contribution of scientific data for the solution of the problem of higher geodesy, more especially relating to the theoretical shape of the earth, was made by the Hydrographic Institute on the subject of gravity measurement, by numerous determinations of relative gravity. Thus, in 1904 the relative gravity was determined between Genoa and Padua and in 1907 Padua and Potsdam were connected gravimetrically, this being repeated in 1910. By these means Genoa was connected with Potsdam, which, as is well known, is considered as the basic station for gravimetric research.

In the domain of the application of astronomy the Institute has extended its field of activity. Besides determinations during hydrographic expeditions, the determination of the differences of longitude between Genoa, Milan, Padua and Naples, carried out in 1922 in collaboration with their respective astronomical observatories, deserves mention. On this occasion important experiments in the use of W/T were carried out as also were successful experiments with a new instrument for the automatic registration of radiotelegraphic time-signals, invented and constructed by an officer of the Italian Navy.

Mention must also be made of international operations carried out in 1926 for the determination of longitude at Genoa and Mogadiscio, which showed the Italian participation in the discussion and solution of a problem which, with the improvement in the technique of radiotelegraphy, has become of international importance.

During hydrographic investigations opportunity often occurs for carrying out important magnetic, tidal, meteorological or oceanographic observations. These data, although outside the sphere of activity with which the Institute is more generally concerned, are so closely connected with its researches, and therefore well worth investigation, that they cannot be neglected without detriment to its work.

Even before the foundation of the Institute, Italian hydrographic surveyors had undertaken these investigations. The name of General MARSIGLI and, more recently, that of Admiral MAGNAGHI, is linked up with the first important steps in the progress towards a knowledge of the physics of the sea; even to-day the instruments invented by the genius of Admiral MAGNAGHI are often employed in Italy and elsewhere. The cruises of the *Washington* can be considered not only as being perfect expeditions from a hydrographic point of view, but as masterly thalassographic cruises. The devices for sounding at great depths, the appliances for reversing the thermometer, the first instruments for measuring deep sea currents, water-sample bottles and all the other inventions bearing the name of MAGNAGHI were used for the first time on these occasions. They were also utilised during the exclusively oceanographic cruises organised by the Institute. Among the latter, mention must be made of those in the Dardanelles and the Bosporus, where the currents were investigated in 1888.

All geophysical questions allied to hydrographic research have always received efficacious attention from the Institute. Mention must be made of the investigation of currents by means of numerous drift bottles carried out in the Tyrrhenian Sea; investigation regarding the retreat of the water from the shore at Chiavari; the 14 cruises undertaken between 1909 and 1914 by the Thalassographic Committee, with the object of investigating the currents in the Adriatic Sea, and the 6 biological expeditions carried out by the same Committee between 1912 and 1914; the expedition of the *Città di*

Milano in 1914 in the Strait of Messina; that of the *Marsigli* in 1920-21 in the Sea of Marmara, the Black Sea and the Ægean; the cruise in 1922-23 of the *Marsigli* for the purpose of investigating the currents in the Strait of Messina; the maritime and terrestrial expeditions of H.R.H. the Duke OF ABRUZZI in 1897 to Alaska, in 1899-1900 to the Arctic Ocean, in 1906 to Ruwenzori and in 1909 to the Karakorum; Dr. DE FILIPPI'S expedition to Central Asia in 1913-14; and, finally, the expedition to Giarabub in 1926, and that of H.R.H. the Duke OF SPOLETO in 1928 to the Karakorum, without taking into account expeditions of a biological character of which the principal object was not geophysical investigation.

At the time of the expedition of the airship *Italia* in 1928 to the Arctic Ocean, the *Città di Milano*, which accompanied the expedition, carried out a series of hydrographic and scientific investigations in the Spitzbergen region between the months of April and September.

Several lines of ultra-sonic and acoustic soundings were run in the Arctic Ocean during the stay at Spitzbergen and in the course of the voyages there and back.

Hydrographic surveys in King's Bay supplied data for plans of Ny Alesund and London. At the latter place a complete astronomical determination of latitude, longitude and azimuth was made and the point thus determined was linked up by a series of triangles with the general triangulation of Spitzbergen and the local triangulation of Ny Alesund.

The relative gravity between Genoa and King's Bay was determined; this is of considerable scientific interest, for well-defined gravimetric stations are rare in such northerly latitudes.

A vertical section of the Gulf Stream on the parallel of King's Bay, which had been investigated by the Swedes at the lowest latitude of Ice Fiord, was reinvestigated. It was found therefrom that the warm salt water of this current was no longer on the surface, but at a certain depth below fresh (and consequently lighter) water emanating from glaciers on the coast.

Tidal investigations and investigations with regard to terrestrial and ship magnetism, carried out with the most modern appliances and by the most up-to-date methods completed the series of scientific observations which were carried out during the expedition. The former confirmed the opinion of F. NANSEN regarding the continuity and the depth of the Arctic Ocean, and the latter demonstrated the very close correlation of magnetic disturbances and the disturbances of W/T on short wave lengths.

The study of terrestrial magnetism, which has always been followed attentively by the Institute, has been continued during recent years, from the point of view of the new problems arising in connection with motor-driven vessels and aircraft, by the creation of types of compasses which have given very good results.

At the same time investigations concerning instruments of a geophysical nature connected with navigation, sonic and ultra-sonic sounding devices, hydrophones and direction finders are undertaken.

In the field of tidal records, existing data obtained from observation have been considerably augmented. Opportunity has been afforded for a closer investigation of the tidal systems of the Red Sea, the Adriatic, the Ægean and the Eastern Mediterranean. In spite of great difficulties encountered on these coasts, semi-permanent tide-gauges have been installed at Benadir, which have given interesting results.

With regard to meteorology, in 1926-27 a service for meteorological information by W/T was instituted; it is known as "*Meteo Marina*", and is now being extended to the coasts of the colonies with success.

During recent months an interesting gravimetric cruise has been carried out, on board a submarine, with the object of determining relative gravity in the Tyrrhenian Sea, more especially along the coasts of Sicily and Calabria, both regions with preeminently seismic and volcanic characteristics.

PRODUCTION OF NAUTICAL CHARTS.

Although the charts with which the Institute began its production 50 years ago are today objects of admiration, several charts published shortly before, during and shortly after the war did not entirely follow this tradition. On account of the necessity for rapid production in large quantities, the long and costly process of engraving on copper was often replaced by photozincography; but all the possibilities of this new process had not yet been fully exploited; the contrast with the earlier productions was accentuated by the type of paper employed which was not of such quality as to produce good nautical charts, as was also the case with that employed for certain foreign productions.

It became necessary to improve the process of zincography by taking advantage of the great progress made commercially in the graphic arts. If recently issued charts are examined the results of this improvement are apparent, especially in the case of the more recent charts of the Gulf of Sidra, already mentioned. Similar charts will shortly be issued for Tripolitania and Cyrenaica.

In order to comprehend the great efforts made in attaining this progress in the technique of the production of charts, it must be realised that photozincography demands the greatest care in the technical and artistic drafting of the original, in the photography, the preparation of the zinc plate and in the final printing of the chart.

It is indispensable therefore that the personnel be thoroughly competent, *i.e.*, that the technical draughtsmen should be very accurate in their work, that the artistic draughtsmen be worthy of the best traditions of copper-engraving, that the photographers be skilful and the "transposers" painstaking. The photographic and mechanical equipment must be modern and should possess all the latest improvements.

Bearing these facts in mind, new cartographic and artistic draughtsmen and new "transposers" were engaged. The fastidious service of revision was perfected; draughting materials were improved and renewed, both for photography and zincographic printing and a method of indirect printing by means of rubber was adopted, which allows accurate reproductions of the most intricate drawings to be made on strong paper with a slightly rough surface.

Among the new systems which allow a more regular and rapid production without impairing the perfection of the drawing, an interesting process for the inscription of soundings may be mentioned, by means of which it is possible to insert from 400 to 500 soundings of three figures each per day on the original chart with one operator, with absolute technical and graphic accuracy; formerly it was only possible to insert from 40 to 50. This is done by means of a very simple device consisting of the application on the proof drawing of the sounding figures prepared beforehand on small squares of "transposing" paper.

At the moment photozincography approximated as nearly as possible to the perfection of calcographic reproduction, with the added advantage of rapidity, care was taken not to abandon calcography as being out of date. On the contrary, efforts were made to bring it up to date, by engaging apprentice engravers who were to replace the older of the master-engravers as they were obliged to retire; by expediting the electrolytic reproduction of copper plates; and, finally, by quadrupling the capacity of the calcographic presses in a normal working day, with the ability of increasing this output in emergencies, by working the operators in two or three shifts.

But even this did not suffice. It is now hoped to overcome the obstacle of the slowness of the process of mechanical engraving on copper by introducing a process of chemical etching which considerably curtail the time necessary for making the drawing on the matrix, whilst retaining the sharpness of mechanical engraving.

No sooner had the cartographic production of the Institute been improved as mentioned above, both technically and in artistic presentation, than a considerable increase in the demand for Italian charts was observed with satisfaction; this went to prove how much the public and, above all, navigators appreciated the improvements introduced.

The considerable financial gain resulting therefrom enabled fresh improvements in instruments and production to be introduced by the Institute.

SAILING DIRECTIONS.

The *Portolani* used in former times were a kind of guide for the use of navigators and summarised, frequently in a picturesque manner, the information which is given nowadays, by strictly scientific and authoritative methods, on charts and in modern sailing directions.

Supremacy in this lay with Italy until the fifteenth century.

In spite of the great efforts made by the Hydrographic Institute in the publication of Italian charts, at the beginning of the twentieth century Italian seamen, when traversing the Mediterranean, still had to use the British "*Mediterranean Pilot*", the French "*Instructions Nautiques*" and a "*Portolano tascabile dei Mediterraneo*", compiled in an abridged form in 1898, by the Italian Commander PRESBITERO, from these foreign publications.

In 1904 the Hydrographic Institute began to publish the first pamphlets of its sailing directions, known as "*Portolani delle coste d'Italia*"; these contained numerous characteristic coastal views and were completed in the three succeeding years. They consisted of 6 parts, covering the entire Italian coast from Ventimiglia to Duino, including

Sardinia, Sicily and the other smaller islands. In 1914 a seventh part was added, covering the coasts and islands of the eastern Adriatic, from Porto Buso to Strade Bianche.

These volumes were revised, brought up to date and new editions issued, and, in addition, a more important and voluminous work was compiled (it is nearly completely printed) entitled "*Portolano del Mediterraneo*". It consists of 9 volumes and contains a description of the waters, coasts and islands of this Sea.

To sum up, the publications issued are as follows :—

In 1923 : the 2nd edition of the 3rd volume, relating to the coast and islands from Monte Circeo to Cape Santa Maria di Leuca ;
In 1924 : the 2nd edition of the 4th volume, relating to the coasts and islands between Cape Santa Maria di Leuca and Duino ;
In 1925 : the second edition of the second part of the 2nd volume, relative to Sicily and Malta ;
In 1926 : the second edition of the first part of the 2nd volume, relative to Sardinia and Corsica ;
In 1928 : the second edition of the 5th volume, comprising the coasts and the islands of the eastern Adriatic, between Duino and the Bay of Ftelia ;
In 1930 : the third edition of the first volume, relating to the coasts and the islands between Ventimiglia and Monte Circeo ;
In 1930 : the first edition of the 9th volume, comprising the Straits of Gibraltar, the Mediterranean coasts of Spain and France and the Balearic Islands ;
In 1931 : the first edition of the 8th volume, relative to the coasts of Libia, Egypt, Palestine, Syria and Caramania, including Cyprus.

The sixth volume is in the press and relates to the coasts of Greece and Turkey between the Bay of Ftelia and Cape Alupo (including the Ionian Islands, Crete, the Grecian Archipelago and the Italian islands of the Ægean Sea). The seventh volume is still being compiled and relates to Morocco, Algeria and Tunis. It is hoped to publish the sixth volume before the end of the present year and the seventh volume during the first six months of next year.

NOTICES TO MARINERS.

Since its foundation as the UFFICIO IDROGRAFICO, the Institute has published "*Avvisi ai Naviganti*" (*Notices to Mariners*) weekly ; these contain information relative to navigation and the keeping up to date of nautical documents. This information is extracted from notes forwarded directly by the national maritime Authorities or from *Notices to Mariners* published by foreign Hydrographic Offices. The Institute has always endeavoured to give these documents the wide circulation which their international importance demands.

During recent years the circulation of "*Avvisi ai Naviganti*" (*Notices to Mariners*) has been extended as far as possible on account of their great interest, not only to the national naval and mercantile services, but also to those of other countries. The number of these documents has therefore been increased and the printings doubled in order to meet all demands gratuitously. It should be mentioned that formerly distribution was not gratuitous except to the vessels of the Royal Navy, other navigators being obliged to make a small annual contribution. It has now been decided that the *Notices* shall be distributed free of charge by the Port Authorities of the Kingdom and the Colonies on request. Annual contributions are now only paid by private individuals, etc. (such as steamship companies, shipowners, etc.) who desire the *Notices* to be delivered to them. The amount payable is limited to the cost of postage paid by the Institute.

Still further to increase the circulation of *Notices*, copies are forwarded to Italian Consulates in the principal foreign ports where navigators can consult them on arrival.

In order that navigators may be able to obtain immediate information regarding the safety of navigation which has not reached them already in printed *Notices*, a service of *Informazioni idrografiche* has been organised, with which the Captains themselves collaborate efficaciously and spontaneously by filling up the special printed forms supplied by the Institute and which are then left at the Italian Consulates of the principal ports of the world. These forms contain all information relative to the safety of navigation, alterations in lighting and buoyage, meteorological conditions, currents, etc., which the Captain may have acquired during his recent voyage. One copy of each of these documents is forwarded to the Institute by the Consulate and the other remains in the archives of the Consulate itself, where navigators arriving in the port may consult it.

With regard to urgent information sent directly to the Institute and which, owing to its urgent character, cannot be circulated sufficiently expeditiously by means of a printed document, the information is transmitted as an *Urgent Notice* by ordinary telegraph to Port Authorities and coastal W/T stations, who, in their turn, transmit the information to ships at sea. Should the information be of interest to those navigating beyond the Straits, transmission is also made from the W/T station at Coltano.

LIGHT LISTS.

The Hydrographic Institute has published from the time of its foundation an *Elenco dei fari, fanali e segnalamenti marittimi* of the coasts of Italy, which has since been extended to include all the Mediterranean coasts, the coasts of the Black Sea, the Sea of Azov, the Red Sea, the Gulf of Aden, and East Africa from Guardafui to Zanzibar.

This publication is divided into two volumes, subject to revision every two years, in order that a new edition of one or other of the volumes may appear each year. For those years in which a volume is not reprinted, a supplement is issued, containing all corrections made in the volume since its last edition.

The *Elenco dei fari, segnalamenti marittimi, ecc.*, or *List of Lights, Maritime Signals, etc.*, was published and reprinted regularly after 1922; but both volumes have been considerably enlarged by the addition of supplementary information, views of the exterior appearance of lighthouses, buoys, and the principal signal stations, and also by an appendix giving a list of mooring and warping buoys situated in ports, and a table bearing translations in the seven principal languages of the expressions and abbreviations relating to the characteristics of lights, and another table giving the translation into the same languages of the heads of the various columns of the volumes, etc.

OTHER PUBLICATIONS.

The "*Annali Idrografici*" (*Hydrographic Records*) of the Institute constitute a documentation relating to all operations carried out by surveying vessels. They also contain reports on navigation and interesting papers on meteorology, magnetism, etc., by officers of the Navy and the mercantile service and other specialists in nautical matters.

The compilation of the *Annali* was begun in 1900. Up to 1915 nine volumes had been published.

Four volumes were published between 1919 and 1922.

After 1922 Volumes 10, 11, 11 *bis* and a supplement to Volume 10 were published. A twelfth volume is already in the press and will appear shortly.

As in the preceding volumes, the later ones contain reports of all hydrographic, oceanographic and scientific expeditions made under the direction or the auspices of the Institute and a number of papers bearing on different branches of investigation of the seas, including 9 interesting memoirs on marine biological research carried out in 1923-24 in the Red Sea by the Italian Thalassographic Committee with the *Magnaghi*.

In 1916 the Institute began to print annually an *Astronomical Ephemeris* for the use of navigators.

The Hydrographic Institute has also undertaken to draw up and print numerous series of volumes and pamphlets, among which may be mentioned the "*Tavole degli Azimut del Sole*" by Commander ALBINI, three editions of the "*Tavole Logaritmiche*" and the "*Tavole Nautiche*", with the object of facilitating calculations relating to plane and spherical navigation.

The "*Tavole per la previsione della marea nel Mediterraneo, Mar Rosso, ecc.*", the "*Manuale dell'Ufficiale di Rotta*", published in 1927 under the auspices of the Naval Academy, which is a valuable and much-sought-after guide, even abroad, for the use of Naval Officers, and particularly for navigating officers, a treatise on the *Principi generali delle girobussole*, all deserve mention, without taking into account other publications of which a list is given in the catalogue : *Publications of the Royal Naval Hydrographic Institute.*

The brief report which is given above of the activities of the Royal Naval Hydrographic Institute during the first 50 years of its existence shows that the Institute is not content to elaborate in its offices the scientific researches which have been carried out, and the numerous original investigations which have been undertaken on the home and colonial coasts; nor to construct, experiment with and repair in its workshops nautical, hydrographic and meteorological instruments; but it compiles and prints by means of adequate typographical, lithographical, calcographical and photomechanical devices all its own publications, whether charts or books.

As far as the most characteristic undertaking of the Institute is concerned, *i.e.*, the production of charts and nautical works, this does not end with the publication of each chart and each book. The difficult task of keeping them up to date by large and small corrections or by means of "*Notices to Mariners*", accompanies the publication of charts and books, in order that they reflect faithfully the actual state of things. It is an assiduous task of patience, which the outsider cannot realise, but which is of capital importance for safety of navigation.

An exact idea of the development achieved by the Royal Naval Hydrographic Service, of the importance of its undertakings and the part it plays, can be gleaned by glancing through the list of duties which have devolved upon it. Within its competence is included :—

1. To organise and direct hydrographic and topographic surveying operations, as well as astronomical, geodetic, magnetic and geophysical determinations in the waters and along the home coasts and those of the colonies, and, if necessary, in other regions ;
2. To undertake the compilation, publication and the keeping up to date of marine charts and sailing directions ;
3. To draw up and circulate to navigators notices useful for the purposes of navigation ;
4. To compile and publish Lists of lights, beacons and maritime signals and to give a considered opinion on new harbour works and the lighting and buoyage of coasts, from a nautical and hydrographic point of view ;
5. To distribute to ships and naval land services, charts, books and instruments necessary for the carrying on of navigation ; and the supervision of such material ;
6. To furnish the commissioned agents with charts and publications for sale to the public ;
7. To undertake investigation, rectification and, in certain cases, the construction and installation of nautical, hydrographic and meteorological instruments, such as compasses, chronometers, sextants, all kinds of goniometers, sounding devices, barometers, thermometers, etc. ;
8. To undertake investigations regarding publications relative to nautical systems, the formation of the seas, etc. ;
9. To organise periodically courses of theoretical and practical instruction for officers wishing to specialise in hydrography ;
10. To reply, within the limits of its province, to all questions of a technical nature addressed to it by naval or mercantile vessels.

For the carrying out of its important and intricate duties, the Institute, with its seat at Genoa, and placed directly under the authority of the Ministry of Marine, comprises several *Divisions*, besides a Directing Board and a Secretariat. These Divisions are divided in their turn into *Sections* (*Reparti*).

The *Cartographical Division* undertakes the compilation, construction, revision, printing and reproduction of nautical charts. A senior naval officer is in charge of this Division, which controls the drawing offices, revision office, archives, calculating office, the sections of engraving, zincography and lithography, the photographic section and the calcographic, lithographic and zincographic workshops.

The *Nautical Documents Division*, placed in charge of a senior officer, undertakes the circulation of charts and nautical publications to naval vessels ; the keeping up to date of documents ; the compilation and publication of *Sailing Directions* and *Light Lists* ; the compilation, publication and distribution of *Notices to Mariners*, and the supplying of charts and publications issued by the Institute to commissioned agents for the purposes of sale. This Division also includes the "Hydrographic" Section, Sections of *Sailing Directions*, of *Notices to Mariners* and of *Light Lists*, Sales Office, printing office and binding room.

The *Division of Astronomy and Geodesy* undertakes astronomical and geodetic investigations, determinations and research, as well as the compilation of the *Astronomical Ephemeris*, *Nautical Tables*, *Hydrographic Records* and other publications of a scientific nature. At its head is a professor, who is a Fellow of the University.

The *Division of Geophysics*, also under the direction of a professor, Fellow of the University, undertakes the meteorological, magnetic and tidal service ; deals with all enquiries relating to this service and collates all information received from vessels and the home and colonial semaphore stations.

The *Compass Division*, under the direction of a senior naval officer is responsible for investigations regarding the types and installation of magnetic compasses, their adjustment and the examination of the diverse problems arising in this connection. A magnetic laboratory is attached to this Division.

The *Instrument Division*, under the direction of a senior naval officer, constructs, experiments with and repairs all nautical, hydrographic and meteorological instruments and is responsible for their distribution to the Navy. Under this Division come also the workshop for the construction of high-grade instruments, the workshop for chronometers, that for barometers and for thermometers and the workshop for electro-plating.

The *Administrative Division*, responsible for the administration of the Institute, the personnel and material, is controlled by a senior officer of the pay branch.