MAGNETIC CHARTS (*Continuation*).

by

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Certain information received since the publication of an article on this subject in the *"Hydrographic Review"* of May, 1929, has made it possible for us to supplement the article with the following :—

a) FORMER MAGNETIC SURVEYS AT SEA. As soon as the navigators began to realize that the magnetic variation changed with the locality in which they happened to be, they undertook to make determinations of its value during their voyages. A chart showing the approximate curves of equal magnetic variation of the year 1500 was reproduced in U. S. Coast and Geodetic Survey Special Publication Nº 117 : *"The Earth's Magnetism"*, by Daniel L. HAZARD, Washington, 1925.

During the first half of the sixteenth century, the most important contribution to this subject was a study of the magnetic variation at sea by the Portuguese navigator, D. Joâo DE CASTRO, commanding one of the vessels dispatched to the East Indies in 1538. The observations made during his cruise around Africa appear to be the first scientific determinations made in the southern hemisphere. A chart showing the values of the magnetic variation which he observed in 1538 by means of the compass on board is reproduced below. The expedition which set out from Goa to Lisbon had as its mission the practical solution of numerous navigational problems and the study of magnetic variation. It was on this voyage that D. Joâo DE CASTRO was able to demonstrate conclusively that the lines of equal magnetic variation did not correspond with the meridians ; an error which has aroused the expectation of the possibility of longitude determinations by measurement of the variation. He also verified the influence of iron on board ship on the deviation of compass needles, (May 29, 1538), the action of magnetic rocks, etc., and compiled all of the information gathered on navigation, magnetism, meteorology and hydrography in his *Roteiro de Lisboa a Goa.*

(*See : Valores dos Elementos de Magnetismo terrestre na provincia di Moçambique* by J. Alves DE FONSECA and J. Simoes VAZ, Lourenço Marques, 1925).

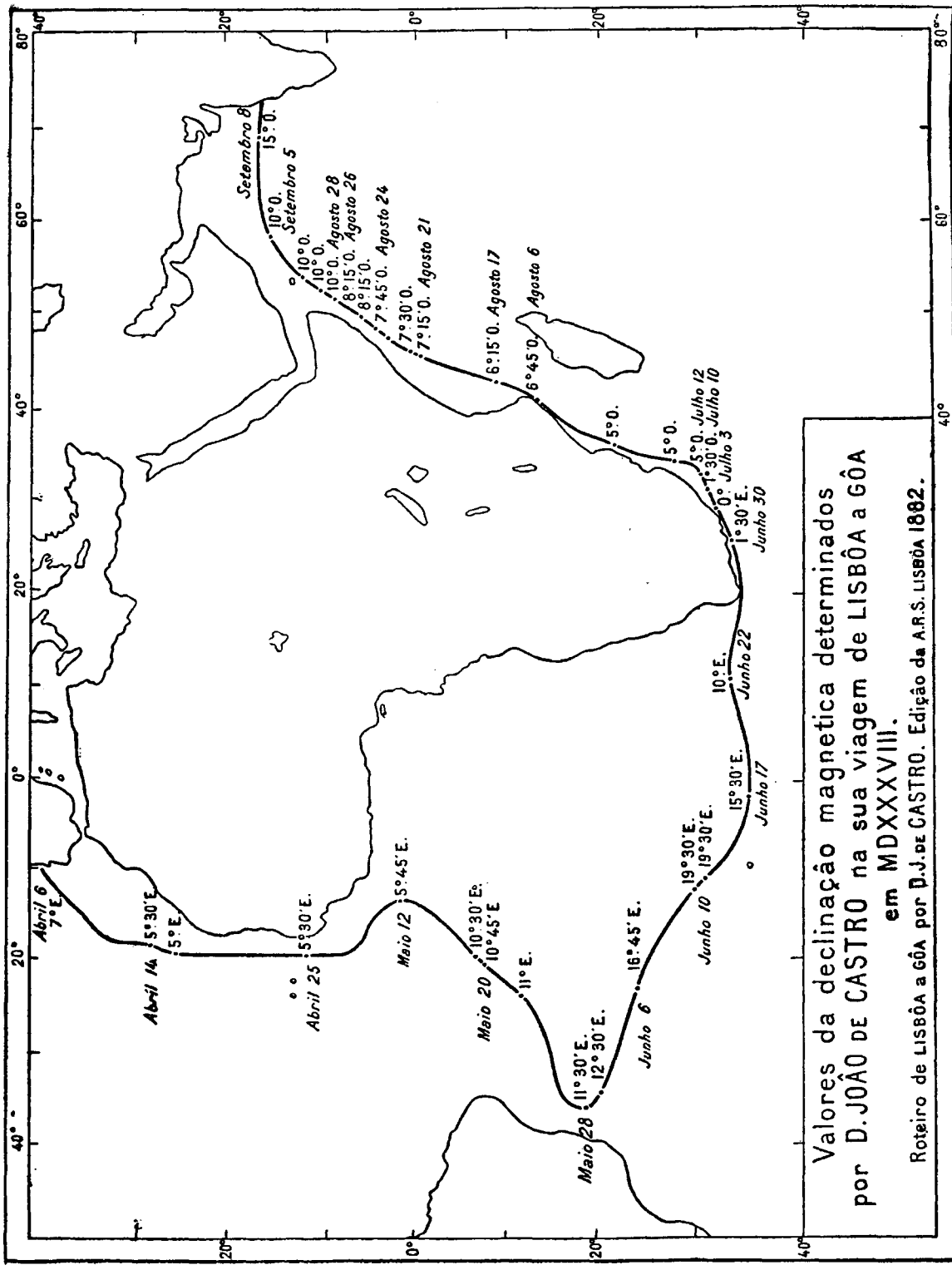

CHART BY JOAO DE CASTRO

b) WORK OF THE "CARNEGIE". Some provisional results of the magnetic observations of the *Carnegie* are given in the September and December numbers of *"Terrestrial Magnetism and Atmospheric Electricity"* for 1928. These were obtained on the voyage from Washington to Plymouth, Hamburg and Reykjavik, thence from Reykjavik to the Barbados and to Balboa between May and October 1928. Comparing these with the results referred to, the same period compiled from the most recent magnetic charts of Great Britain-Germany and the United States of America shows a mean error for the varia, tion (132 values) equal to 0.795°, 0.771° and 0.678° respectively; for the dip (49 values) mean errors equal to 0.53°, 0.81° and 0.69°; for the horizontal components (50 values) mean errors equal to 0.0057, 0.0040 and 0.0050.

It may be stated that these figures, which include also the mean observational errors, do not differ greatly from each other — a fact which seems to indicate that the same sources of information were used for all of the charts. For the same reason it is found that the discrepancies between the results of observations and the data given on the charts are almost invariably of the same sign in the same locality.

For variation these lie between :

—1.6° and +1.7° for the British Admiralty Charts.
—1.3° and +1.7° for the German Charts.
—2.0° and +0.8° for the U. S. Charts.

These results are not appreciably bettered by taking the mean of the data of all three charts. The mean error of the variation would become 0.712°.

It is a curious fact that the dip is just as well known at sea as the variation.

The March 1929 number of *"Terrestrial Magnetism and Atmospheric Electricity"* gives the provisional results obtained during the voyage of the *Carnegie* from Balboa to the Easter Island and to Callao from October, 1928 to January, 1929. A comparison of these results with the most recent magnetic charts of Great Britain, Germany and the United States of America shows the same mean errors : —

For the magnetic variation (96 values) respectively : 0.400°, 0.358°, 0.430°.
For the magnetic dip (34 values) respectively : 0.90°, 0.42°, 0.50°, 0.42°,
For the horizontal component (34 values) respectively : 0.0057, 0.0027, 0.0039.

These results, obtained in the Pacific, are of the same order of magnitude as those of the Atlantic, while the mean errors for the variation are clearly somewhat less in that part of the Pacific.

For the variation, the errors range between : —

—1.1° and +0.9° for the charts of Great Britain.
—1.0° and +0.9° for the charts of Germany.
—1.0° and +1.0° for the charts of the United States.

c) TERRESTRIAL MAGNETIC CHARTS. A magnetic survey was executed in 1924-1925 in the province of Mozambique by Lieutenants J. Alves DE FONSECA and J. Simões VAZ. The results were published by the Observatory of Campos Rodrigues in the work cited in para. (*a*).

A very pronounced magnetic anomaly was discovered in the Bay of Lourenço Marques.

In addition, the authors have compiled the results of all observations made in this province since 1878.

d) THE ARTIC REGIONS. Professor N. ROSE has published charts of equal values of the magnetic variation, dip and horizontal component for 1925 for the North of Siberia between the meridians of 25° and 195° East and the parallels of 65° and 85° North, which appeared in the *Report of the Proceedings of the IIth Conference of the International Aero-Artic Society* held at Leningrad, 18th to 23rd June, 1928 (Dr. A. PETERMANNS MITTEILUNGEN-ERGANZUNGSHEFT, N° 201, 1929).

The study of this question by Professor ROSE (page 46) includes a very complete historical summary of the observations which have been made since those of Stephan BOURROUGH in 1556 on the Coasts of Novaya Zemlya up to those of the *Maud* (1918-24) and of *Nowopaschenny* (1922-26).

The author concludes that, despite the 1850 observation points, which moreover are poorly distributed, it is not possible to consider the magnetic charts of this region as adequate for the needs of aerial navigation. The accidental variations, such as the diurnal and annual variations, are insufficiently determined owing to lack of permanent observations; there are numerous and pronounced local anomalies. He also expressed the hope that the gaps now existing in the magnetic surveys might be filled and the network of polar magnetic observations might be completed. The sole magnetic observatory which now exists in that region is that of "Matotschkin Schar" in Novaya Zemlya. The establishment of a second is projected on the island of O. Ljachowsky (opposite the mouth of the river Lena).

e) THE BALTIC. The Hydrographic Office of the Navy Department of Latvia has kindly furnished the following information :—

Magnetic Determinations in the Baltic along the Coasts of Latvia (1927-1928).

The Baltic Sea abounds in magnetic disturbances. The measurements made on the coast can naturally give only a general indication and can show but few of the local disturbances. Further research on the magnetic conditions in the Baltic Sea has been made, thanks to the extensive activities of the non-magnetic Estonian yacht *Cecilie* on the high seas (*). The yacht

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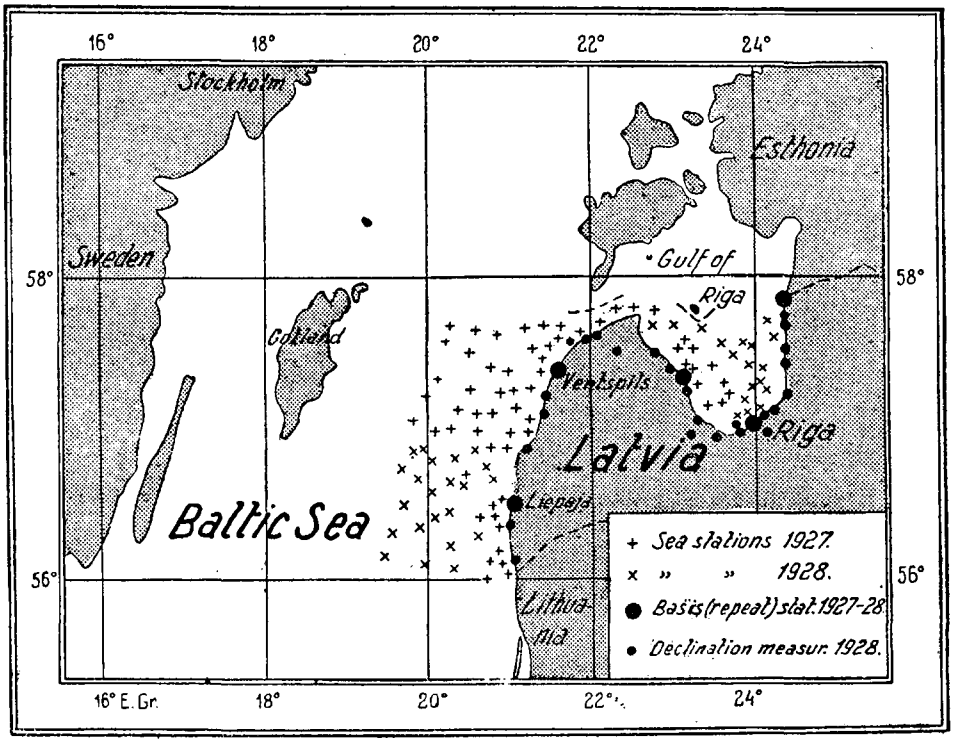
(*) A. W. GERNET. — *Überblick über den Gang der magnetischen Vermessung der Ostsee.* Zeitschrift für Geophysik 1928 H. I. - Braunschweig 1928.

Cecilie has made similar measurements along the Latvian Coasts during the years 1927-28. Besides, although some measurements had been made along the coasts, the last during the years 1911-12 by the Russian experts on magnetism: — N. TRUBAJATCHINSKY (*) in the Gulf of Riga and along the Baltic Coasts and by M. KAMENSKY (**) at Libau, other measurements of the variation were made in 1921 and 1923 by A. SCHAGGERS and L. SLAUCITAJS(***) to meet the needs of practical navigation. In the course of the year 1927 systematic work was understaken at sea and along the coasts, which was completed in 1928. Along the coasts the measurements of 5 stations were checked (*D. H. I.*) with the aid of the SARTORIUS-TESDORPF theodolite; at 300 points along the coast, *D* was measured by means of the NEUMAYER-SCHMIDT declination instrument. (In winter, measurements were also made on the surface of the sea covered with ice near the coast). The yacht *Cecilie* completed measurements at sea of *D. H. Z.* at 102 points (see Marine Chart appended). The determinations and measurements made with the theodolite were carried out aboard the yacht *Cecilie* under the direction of A. W. GERNET, representing

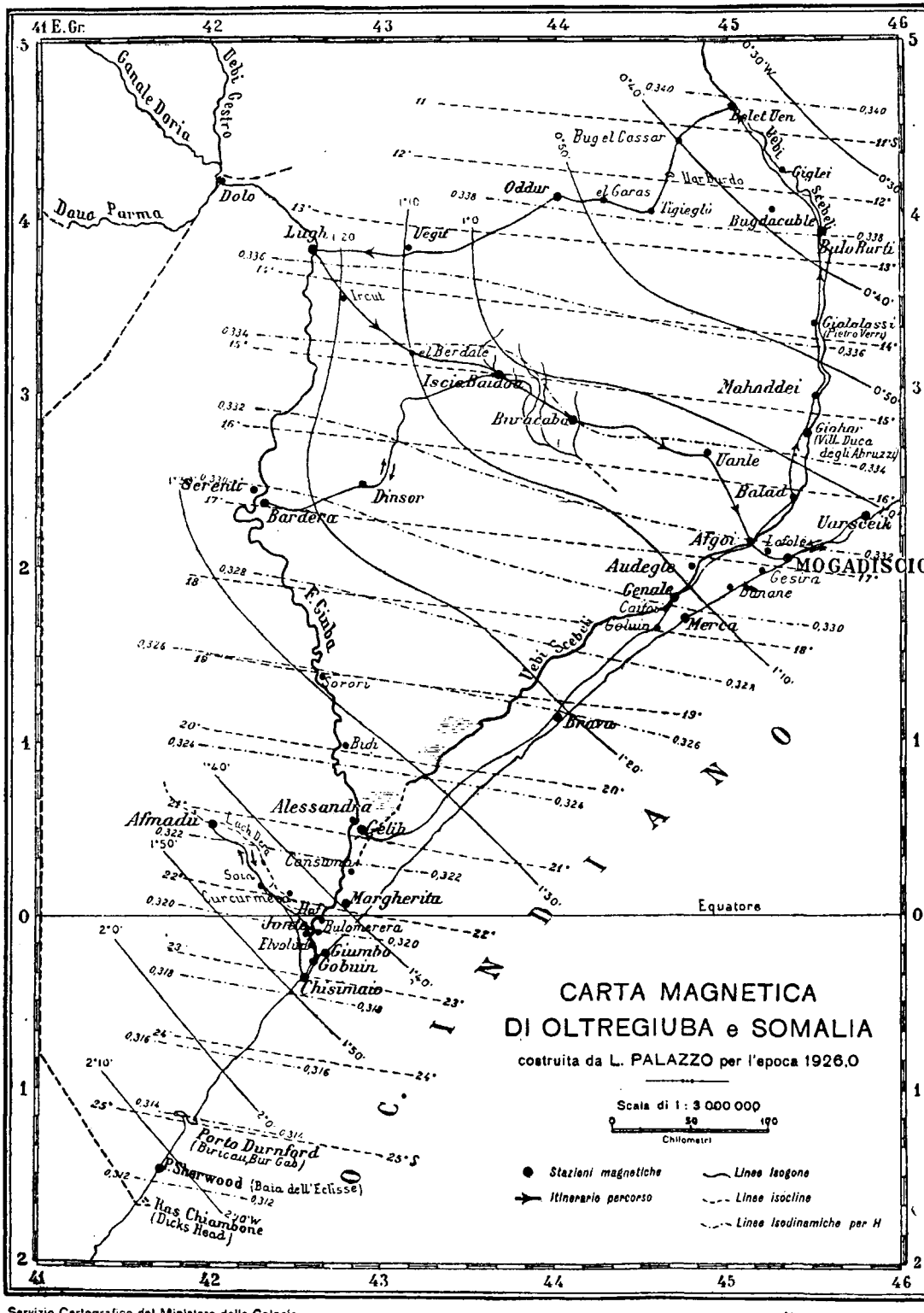


(*) N. TRUBAJATCHINSKY. — *Magnetic Measurements on the Coast of the Baltic Sea made in* 1911 *and* 1912 (Russian), Sapiski po Gidrografii, Vol. LI.

(**) M. KAMENSKY. — *The isogonic lines in the environs of Libava* (Russian). Ibidem. Vol. XXXIX and XL. - Petrograd, 1917.

(***) Not yet published.

Mem. Uff. Meteor. e Geofis. - *Vol. II.* *Palazzo - Misure Magnetiche - Tav. IV.*



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the Latvian Navy Department, while the author of this article carried out the measurements of *D* along the coasts. The results, after revision, will be published early in 1930. It is interesting to note that in this short stretch of territory, wide variations have been observed in the elements. Thus, the values of the variation in the region in question ranged from 4°W, to 3°E. Actually the isogonic curve cuts the coast of the Bay of Riga to the westward of Riga (near Kemeri) and continues in a N.N.E. direction across the Gulf. It might be stated that at the 20th meridian East of Greenwich the mean value of the magnetic variation is about 2°W, and at the 24th meridian about 1° East. Not far from the coast, near Riga, a number of anomalies in the magnetic variation have been noted, which in a small space, reach values as great as 3° and 4°.

(*Signed*) L. SLAUCITAJS.
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On the same subject the *Proceedings of the Fourth Session of the Geodetic Commission of the Baltic* which was held at Berlin on 24th to 28th September, 1928 — Report of Dozent SCHAGGER, pp. 71 to 73, may be consulted.

f) ITALIAN COLONIES. Professor PALAZZO has been kind enough to forward his memoirs, published in 1929 by the *Ufficio Centrale di Meteorologia e Geofisica* entitled: *Misure Magnetiche in Oltreguiba e Somalia en* 1926. This very interesting work includes a study of the instruments employed, a complete report of the observations, a study of the secular variation and a magnetic chart on which the data are brought up to date to 1st January, 1926. (*See* the attached chart which is a reproduction of the original).

g) The Chief of the Hydrographic Office of the Netherlands has kindly invited attention to the following work published by the Observatory of Batavia relating to magnetic observations in the *Dutch East Indies:*

"Magnetic Survey of the Dutch East Indies".

Dr. W. VAN BEMMELEN who executed this survey during the years 1903 - 1907, gives results of observations taken at 146 stations ; besides, the introduction contains the history of the preceeding observations.

Dr. W. VAN BEMMELEN has, among other things, made numerous interesting studies of the value of magnetic variation and its secular changes on the globe during the past centuries.

The Director of the Royal Magnetic and Meteorological Observatory of Batavia has kindly caused to be forwarded to the Bureau a book by Dr. S. W. VISSER entitled: *Isomagnetics for the Netherlands East Indian Archipelago, Epoch 1925, 0,* published by the Observatory, and which gives in tabular and chart form the results of a new magnetic survey carried out from 1917 to 1924 in the Dutch East Indies. The Isogonic chart is reproduced herewith.

h) Attention is directed to a very interesting study by Professor S. CHAPMAN, F. R. S. entitled *"Cosmical Magnetic Phenomena"* published in the

July 6, 1929, number of the British journal *"Nature"*. The various theories which have been advanced relative to the cause of terrestrial magnetism are briefly and very clearly treated in this article.

i) MAGNETIC WORK IN FRANCE. A new magnetic survey net has been carried out in France between 1921 and 1927 under the direction of the of the Section of Terrestrial Magnetism and Electricity of the Comité Français de Géodésie et de Géophysique. This net comprises 1328 stations; the observations are reduced to 1st January, 1924.

The results thereof are contained in the following memorandum: *Nouveau réseau magnétique de la France au 1er Janvier 1924*, by E. MATHIAS and Ch. MAURAIN, extracted from Vol. VII of the *"Annales de l'Institut de Physique du Globe"* of the University of Paris - *Presses universitaires de France.*

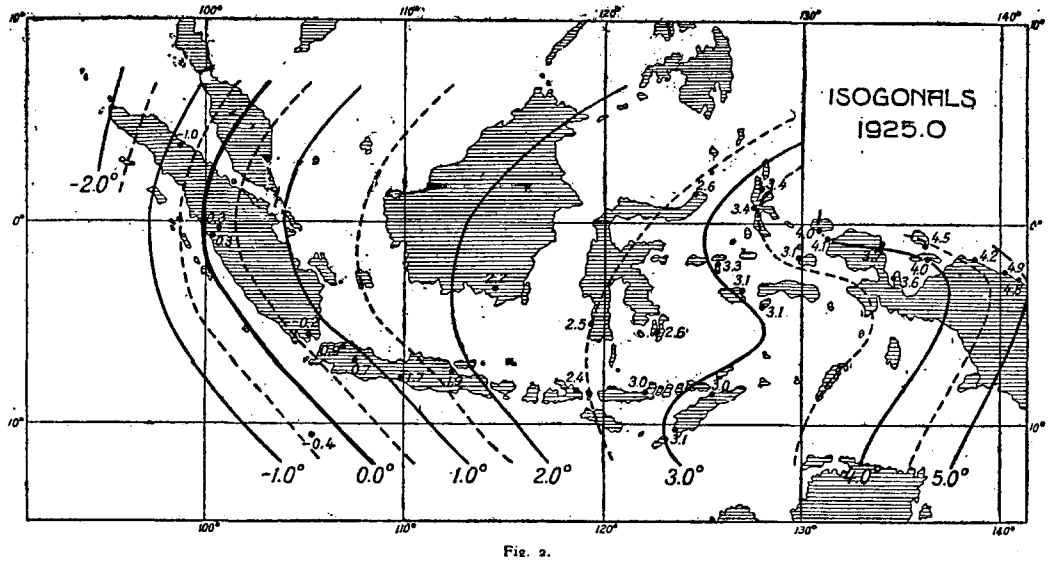

FIG. 2.

This new, very closely spaced net, has enabled a distortion of the whole of the magnetic field in France, between 1896 and 1924, to be ascertained. In course of time memorandums will be published on the algebraic representation of the results as functions of the geographical coordinates of the stations, the detailed study of the anomalies and the study of the secular change.

Charts on scales of 1:2,000,000 and 1:1,000,000 give the Isogons. Others on a scale, of 1:2,000,000 give the lines of equal horizontal, vertical, North and West components as well as the lines of equal total force and the Isoclinic lines.