The Enclosure of the Zuider Zee.

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THE remarkable series of operations now in progress at the Zuider Zee scarcely seem to have received in England the attention which so extensive and fundamental an interference with the natural littoral and fluvial regimen of northern Holland might reasonably be expected to arouse. They are, indeed, of an epoch-making character, and the effect on the map will be striking and drastic. The coastal contour will be completely altered, entirely new drainage systems will come into existence, and vast areas of submerged land will be brought under cultivation. Although the

and farther south, an extensive inland basin, the Zuider Zee, which probably acquired its present shape some time before the fourteenth century. There is a pronounced difference between the two basins. The floor of the Wadden Zee is full of irregularities. It consists largely of steeply rising sandbanks, many of which are exposed at low water, and are separated by more or less deep channels which become deeper as they approach the North Sea. The most important of these straits is that which finds an outlet between the island of Texel and the mainland, where it is from

FIG. 1.

works cannot be completed in their entirety for a number of years to come, some account of their inception and present position will be of interest. The moment, moreover, is appropriate, since the first section of submerged land, 50,000 acres in extent, scheduled to be reclaimed, has just been completely enclosed. The map reproduced as Fig. 1 shows the region of operations, with the reclamation areas indicated by broken lines.

The coast of Holland is fringed by ridges of sand dunes which towards the north have been intersected by incursions of the sea, forming a series of islands between which and the mainland lies a kind of roadstead, or outer basin, called the Wadden Zee,

100 ft. to 160 ft. in depth. Between the adjacent islands of Vlieland and Terschelling, a similar passage has depths varying between 60 ft. and 100 ft. The tidal range, though small compared with British standards, is appreciable, being as much as 5 ft. at Den Helder and $5\frac{1}{2}$ ft. in the Vlietstroom, and the currents are correspondingly swift.

The Zuider Zee, on the other hand, particularly that portion which lies south of a line drawn from Enkhuzen to Stavoren, has a remarkably even surface combined with relatively shallow depth. The depth varies from zero at the coastline to a maximum of about 16 feet below N.A.P. (Nieuw Amsterdamsch Peil, which is the average sea-level

datum for Holland) in the centre, and it is only to the west of the island of Urk that there is a slightly deeper channel of about 20 feet. The tidal range, moreover, is very moderate and does not amount to more than from 4 in. to 15 in.

Between the two basins lies an intermediate zone, the western section of which, called the Wieringen Lake, has a depth exceeding 14-15 ft. at low water, and probably represents a sheet of inland water which was in existence before the incursion of the sea.

The shallow depth and sheltered situation of the Zuider Zee have caused it to be the subject of speculative interest on the part of Dutch engineers for a long time past. Schemes of land reclamation, dear to the heart of the Hollander and indeed essential to the national development, have been propounded for several centuries. The earliest of which a plan is in existence dates from the seventeenth century. In the year 1667, Hendric Stevin published a treatise ("Wisconstich Philosophisch Bedryf") in which he proposed to link up the Frisian islands by means of dykes across the intervening channels. Nothing came of this proposal, the difficulties being too considerable. Various subsequent schemes were found either to be impracticable or were beyond the resources of the country at the time.

It is not until modern and comparatively recent times that we come to the definite promulgation of a feasible scheme which, after some vicissitudes of discussion and legislation, is now in process of being realised. In the early eighties of last century, Mr. Buma, a Frisian member of the Chamber of Deputies, was instrumental in establishing a Zuider Zee Association having for its object the institution of a technical and financial investigation into schemes for the enclosure of the Zuider, Wadden, and Lauwers Zees and their partial reclamation. Dr. C. Lely was appointed civil engineer in charge, and between 1887 and 1891 he published a series of eight reports, in which all the details of a properly conceived plan were thought out and determined. It was demonstrated that the best solution of the problem would be to construct, first of all, an enclosing dyke or embankment from the province of North Holland, by way of the island of Wieringen, to the Frisian coast near Piaam, and then to proceed with the reclamation of four *polders* or marshlands so defined as to leave a sufficient area of water to form an estuary for the effective discharge of the River Yssel. The length of the enclosing dyke was to be $18\frac{1}{2}$ miles and the enclosed area would amount to 360,000 hectares (889,560 acres), of which 232,000 hectares (573,272 acres) would be reclaimable. The total cost was estimated at 190 million guilders, say £16,000,000.

A State Commission was appointed in 1892 to examine the scheme, and in 1894 a favourable report was presented subject to some slight modification of the plan in detail. Here for a time the matter rested. On two occasions, in 1901 and 1907, bills were introduced into Parliament for the purpose of giving effect to the Commission's recommendations, in whole or in part, but without avail. Finally, in 1918, an Act was passed authorising the enclosure and partial reclamation of the Zuider Zee. By a Royal decree of July 16 of that year, the Zuider Zee Council referred to in the Act was instituted to render advice and assistance to the Government in the further preparation and execution of the work and a technical service was at once created.

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[Royal Dutch Air Co.]

FIG. 2.—Aerial view at Den Oever showing main dyke extending to left, and in centre, dyke, enclosing North-West Polder, stretching towards Medemblyk on horizon. In the foreground, foundations for sluices and lock, with working depot and harbour.

The Act, which is based on the plans approved by the 1892 Commission, prescribes the construction of an enclosing dyke and decrees that the work shall be carried out at the expense of the State. It does not specify the number and extent of the polders to be reclaimed, leaving these to be determined by later investigation.

Constructive work was actually begun in 1920 after some preliminary operations in the preceding year. The Amstel Diep lying between the island of Wieringen and the mainland was partially filled and the general level of the bed of the channel raised to a height of 15 feet below N.A.P. so as to provide a foundation on which the enclosing dyke could be constructed. In the following year, 1921, a works harbour with storage depot was constructed at the easternmost point of the island of Wieringen close to the little village of Den Oever. During the next four years, 1922-1925, the work proceeded but slowly, the Government feeling that the condition of the national exchequer would not permit of the expenditure of large sums of money. In 1925, however, restrictions were removed. Two Acts were passed to accelerate the progress of the work, and it was decided to proceed forthwith with

the construction of the great enclosing dyke from Weiringen to the Frisian coast and with the reclamation of the first polder, known as the North-western or Lake Wieringen Polder.

Since then progress has been steady and continuous. I visited the works in the early part of July and found that great strides had been made. By the courtesy of Heer J. A. Ringers, the managing director of the contracting company for the works, I had an opportunity of traversing the whole extent of operations along the western side of the Zuider Zee. The island of Wieringen is now integrally connected with the mainland, and where formerly was the Amstel Diep I motored over a properly made and substantial roadway protected on the seaward side by a stone pitched embankment. Southward from Den Oever towards the town of Medemblyk, the enclosing dyke (a view of which is given in Fig. 2) was well advanced and at the point of completion. Within a few weeks of my visit it presents an unbroken front and an area of 50,000 acres (the North-West Polder—see Fig. 1) has now been enclosed for reclamation—a process which will, of course, require some little time to effect, as the water has to be pumped out and the land prepared for cultivation. The seasoning and purification of the soil must necessarily be a slow process after its saturation for so long a period with salt water. An agricultural commission has estimated that a period of six or seven years must elapse before the polders can reach their full cultivable value. It is expected, however, from results obtained on a small experimental polder with the use of rape seed, that productivity will begin with the lapse of a couple of years.

The main dyke (the eastern extremity of which is to be seen in Fig. 3) connecting the island of Wieringen with the Frisian coast is proceeding apace and may be expected to be completed about the year 1934. It is being formed of earthwork (clay hearting and sand backing) and is being given a base width of about 120 metres (say 400 feet) and a height at the crest of 7.25 metres (24 feet) above N.A.P. As in the case of the dam across Amstel Diep, it will be provided with a roadway for vehicular traffic and space also for rail locomotion, as may be required. Locks are to be installed to permit the passage of shipping to and from the Yssel Lake (as the enclosed water area will be called), the level of which will be maintained at about 16 inches below N.A.P. The surplus water of the lake is to be discharged at low tide through sluices in the dyke. Sluice gates are being constructed at two points, at Kornwerderzand, an artificial location, about $2\frac{1}{2}$ miles from the Frisian coast and also just to the east of the

island of Wieringen. Each sluice gate will have a width of 40 feet, and the total breadth of sluice opening will be 1000 feet.

Reclamation work is comprised under the following four sections, one section lying to the east and the remainder to the west of the Yssel Lake:

N.W. Polder	20,000 hectares or	50,000 acres
S.W.	56,000 "	140,000 "
S.E.	95,000 "	235,000 "
N.E.	53,000 "	130,000 "
	224,000	555,000

As the total area of the Netherlands is about 3,262,000 hectares or 8,060,000 acres, it will be seen

Photo.]

[Royal Dutch Air Co.

FIG. 3.—Aerial view of main dyke, with foundations for sluices and lock at Kornwerderzand. Frisian coast in background.

that as a result of the reclamation work in the Zuider Zee the area of the country will be increased by about 7 per cent. As a matter of fact, the arable land will receive an increment of 10 per cent, a very substantial addition to its productive capacity. The cost of the enclosure works is estimated approximately at £7,500,000, and of the reclamations, including the drainage of the polders and their upkeep until full productivity is attained, at something more than £30,000,000. It is a great financial enterprise for a small country like Holland, and one cannot but be impressed by the courage of its promoters, as well as by the careful and systematic arrangements which have been made to carry it through to a successful conclusion.

Apart from personal observation and conversation and correspondence with Heer Ringers, to whom I tender my acknowledgments and thanks, I have derived much information on the subject, on which, of course, a great deal more could be written, from publications of the State Department of the Waterstaat. The photographs have been courteously furnished by Heer Ringers.