ENFIELD CABLES LIMITED

WIND-POWER

LONDON, NOVEMBER, 1952. PROGRESS REPORT No. 1

HOW IT BEGAN

On April 8th, 1949, the following notice appeared in *The Electrical Review* :

The British Electricity Authority invites tenders for the design, manufacture, testing and setting to work of ONE-Experimental Wind-Driven Electric Generator of 100 kilowatts capacity. Specification and form of tender may be obtained from The Chief Engineer.

At that time Enfield engineers were studying the economics of wind power as a source of heat for horticulture. Territories, such as the Channel Islands, where fuel is expensive and where wind availability is high, were found to offer a favourable market for ' packaged ' equipment, which would include soil-heating cables and other of the Company's standard products. The interest of the British Electricity Authority, as expressed above, led to a revision, or rather a postponement, of this policy. It was felt that by securing the order, and carrying the major project to a successful conclusion, the Company would establish a reputation in the new field of wind-power which would attach to any smaller machine which they might subsequently put on the market.

THE CHOICE OF SYSTEM

It was no easy task to determine the type of machine upon which to concentrate. ' Orthodox ' wind plants, machines in which a propeller drives a generator through a speed-up gearbox of high ratio, were in use in Denmark and one was to be tested in the North of Scotland. These machines were simple to construct but the risks of mechanical failure were known to be great. It seemed unlikely that the lessons to be learned from a 100 kilowatt plant of ' orthodox ' design could be applied to the larger sizes which would certainly follow. In several European countries ideas for improving upon the ' orthodox ' were being demonstrated by inventors.

By a process of elimination the ' depression ' principle (Figure 1), then being tested on a small scale by Andreau in France, was selected for further study. It was found that the Andreau System would produce electrical energy with a conversion efficiency slightly lower than could be obtained from ' orthodox ' plants of equal size and that the cost of its development would be higher On the other hand its physical and mechanical advantages were considerable, even in a plant of 100 kilowatts capacity. As machines grew larger these advantages would progressively increase in value.

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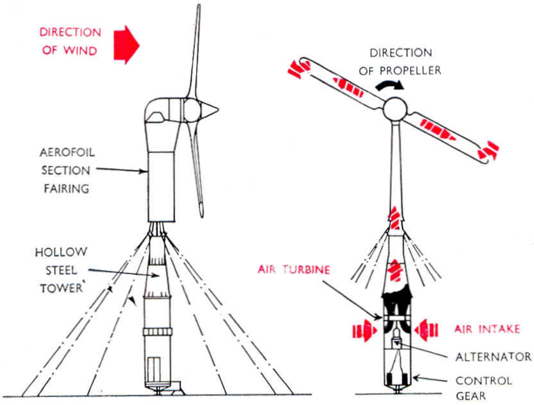

Figure 1

THE ENFIELD 100 KILOWATT ANEMO-ELECTRIC POWER PLANT

NOW UNDER CONSTRUCTION FOR THE BRITISH ELECTRICITY AUTHORITY

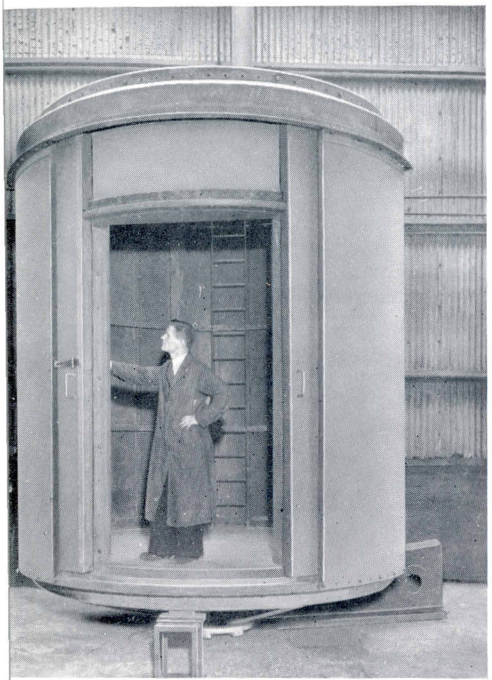

Figure 2

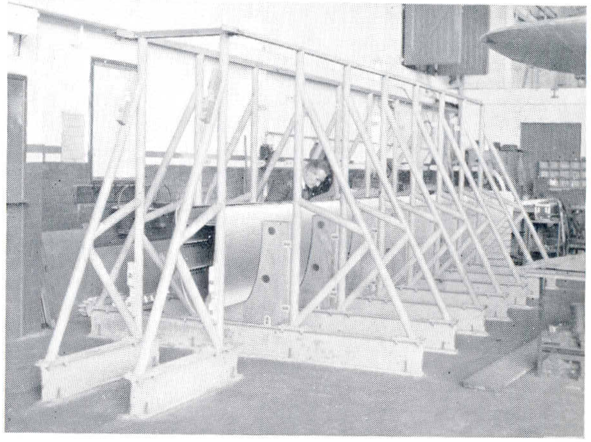

Figure 4

Figure 3

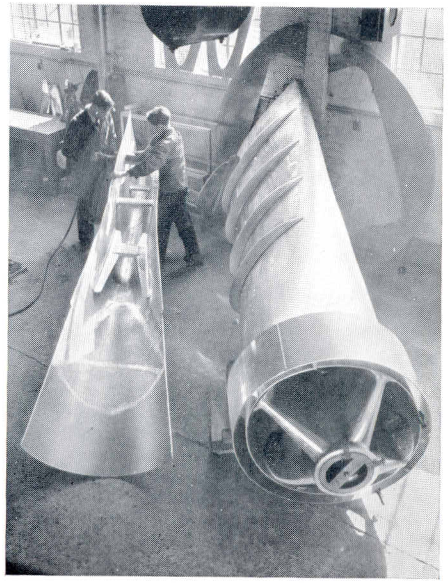

Figure 5

SOME FACTS AND FIGURES

ANEMO-ELECTRIC, (Gr. ἄνεμος: wind) a term analogous to hydro-electric and offered as a suggestion for international use.

CABLES, ELECTRIC, paper, cambric and rubber insulated.

CABLES, SUPPORTING, twelve of galvanised steel, equally spaced, inclined 50° and pre-loaded to 6 tons to reduce fatigue.

DEPRESSION, pressure below atmospheric.

DEPRESSION PRINCIPLE, (Fig. 1) an arrangement whereby the generator is directly coupled to an air-turbine, both being at or near ground level and neither being mechanically connected to the propeller, and where the propeller, by extracting air from the system, sets up a pressure difference across the turbine sufficient to cause rotation.

ELECTRICAL EQUIPMENT, one 100 kW. 415 volt, 3 phase, synchronous induction generator, with exciter, which is started from rest as an induction motor. When synchronous speed is approached direct current is fed into the field thus causing the generator to operate as a synchronous motor running under 'no load' conditions. Air is then admitted to the turbine which in turn drives the 'motor' in synchronism with the connected system. Fully automatic control gear is connected to the generator by flexible armoured cables.

ERECTION, by removable equipment comprising two 65 ft. derricks, two 6 ton hand winches, pulleys and steel ropes (Fig. 6).

FOUNDATIONS, central base, of reinforced concrete, and twelve anchors, on a pitch circle diameter of 96 ft., concreted into rock (at Mynydd Anelog).

HUB STRUCTURE, fabricated aluminium alloy structure faired with aluminium sheet and enclosing feathering mechanism and oil immersed main bearings (Fig. 3). The hub structure is mounted on roller bearings and rotates about the axis of the tower as the propeller orients into wind.

OUTPUT, increases from zero at wind speed of 17 m.p.h. (7.6 meters per second) up to 100 kW. at 30 m.p.h. (13.4 m.p.s.) and remains constant thereafter until the wind speed reaches 65 m.p.h. (29.1 m.p.s.) when the plant shuts down.

PROPELLER, two blades of aluminium alloy, hinged for coning and maintained by torsion bar springs at a mean coning angle of 5°. The pitch is adjusted automatically by a hydraulic system so that the rotational speed is maintained constant when the wind speed is in excess of 30 m.p.h. and not more than 65 m.p.h. Each blade is made in two sections—inboard (Fig. 5) of circular section at the root changing to aero-foil; outboard (Fig. 4) of constant chord, 5.75 ft. (1.75 m.), and thickness, terminating at the trailing edge with an exit port for extraction of air by centrifugal force. Diameter of swept circle 80 ft. (24.4 m.). The propeller operates down wind of the tower. Orientation is power assisted and controlled.

SPEED OF ROTATION, propeller 95 r.p.m. at rated output; generator and turbine 1,000 r.p.m.

TOWER, 100 ft. (30.5 m.) from top surface of foundation to axis of propeller. Of stressed steel plate and girder construction, circular in section and decreasing in diameter from 9 ft. (2.74 m.) at the base to 3 ft. 6 in. (1.07 m.) where it enters the hub structure. The control gear is housed in the base (Fig. 2). The upper section, within the zone of the propeller disc, is screened with a light alloy fairing of aerofoil section which is attached to, and rotates with, the hub.

TURBINE, axial flow, vertical axis, single stage, 48 in. (1.2 m.) diameter wheel, handling 50,000 cu. ft. or approximately 1.75 tons of air per minute (23 cubic meters per second).

WEIGHT, complete installation 36.25 tons (36,830 kg.). Propeller 4.25 tons (4,318 kg.)

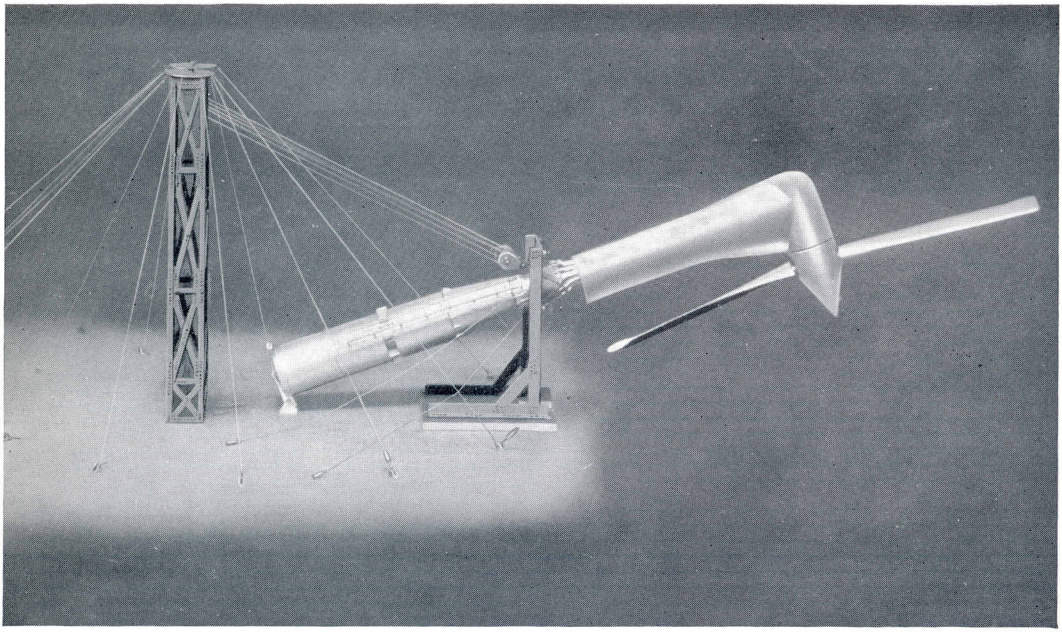

Figure 6

THE FIRST CONTRACT

Towards the end of 1949 it had become possible to offer such a machine to the B.E.A. and their acceptance was made public at the Plenary Meeting of The World Power Conference of 1950 (*Trans. of the World Power Conference* 1950, *pp*. 2553-4)

CO-OPERATION

Throughout the whole of this early period the co-operation of de Havilland Propellers Ltd., and of the English Electric Company Ltd., was an invaluable encouragement and a source of wise counsel. It is fitting therefore that these firms should have played a leading part as the principal sub-contractors. The machine described overleaf has been designed from first principles by de Havilland Propellers and has been largely constructed in their works. The electrical equipment is throughout ‘ English Electric,’ except for the cables which are of course ‘ Enfield ’ ; the Redheugh Iron and Steel Company built the tower on Tyneside to de Havilland design ; Butters Brothers made the lifting gear.

TODAY

The project has now reached the stage when trials can be regarded as imminent. Trial erection, to be followed by tests under light inland breezes, will commence during the present month. In May, 1953, the plant will be dismantled and taken by road to North Wales. Thence it will be hauled to the summit of Mynydd Anelog (628 ft.), on the Caernarvonshire coast, there to become the first wind-driven generating station to be connected to the B.E.A. system.