**CORRESPONDENCE . . .**

The prime fallacy in the whole argument is that the air over the sea is different from, and separated from, that over the land; and, therefore, by implication, that Coastal Command exercises sea power and not air power. Nothing could be farther from the fact. Coastal Command has played a dominant role in the last war, and, therefore, destroys his own later doubts as to whether in fact air power exists as a third force. In modern global warfare, sea, land and air forces are all necessary to the successful conclusion of hostilities. Overall strategic direction is, however, a supreme effort by, if necessary, the entire resources of the Royal Air Force. A situation is easily conceived in which the whole air power available may be directed against the destruction of a naval threat. During the last war Bomber Command was called upon more than once to supplement Coastal Command and Naval Air Forces. It is only by the integration and unification of all air forces that maximum air power can be obtained and can be directed according to the needs of the supreme strategy. That is the over-riding consideration and such purely administrative problems as training cannot be permitted to obstruct it. But even as a debating point the training aspect offers "Icarus" an unsteady platform, certainly not a weapon. All Naval officers must serve, and rightly, as ship's officers to qualify for promotion. Naval strategy and not air strategy is and must be their background.

Epsom, Surrey.

W. N. CUMMING.

**GAS TURBINE MATERIALS**

*THAT* the steel manufacturer "must always be one step ahead" is the burden of these notes on the use of special steels in gas turbine development and production. Prepared by a member of the technical staff of Firth-Vickers Stainless Steels Ltd., they review the materials used in the early Whittle units, and some observations on steels used in gas turbines today are included.

In the ten years that have passed since the first flight of the Gloster E.28/39, the revolution that has taken place in methods of aircraft propulsion is truly remarkable, especially when one bears in mind that the aircraft industry itself is little over a decade old. It is interesting to reflect, therefore, on the complex problems which have faced the designers, engineers and, in their turn, the steel and alloy makers, in whose hands rests much of the responsibility for the success or failure of so many enterprises. When work started in earnest on the Whittle unit in 1936, the best materials available had reliable physical properties, without excessive creep, only up to about 500 deg C. The steel used for the initial experimental work was Firth-Vickers "Stayblade," and this material itself represented a considerable advance on those previously available; it was a development of "Staibrite" corrosion-resistant steel, and was used for the discs in the W.1 engine which powered the flight. In fact, because of its higher creep strength, "Stayblade" continued in use for discs for practically all the development work until the end of 1943.

From 1937 to 1939 there was a steady improvement in the engine's performance, and the conditions imposed on the turbine blades became increasingly severe, largely owing to the higher operating temperatures employed. With the introduction of "Rex 78" steel by Firth-Vickers research laboratories in 1939, further increases became possible. "Rex 78" was used for the blades in the W.1 and W.T.X engines as it possessed considerably improved properties at elevated temperatures, being capable of working at a temperature 10 deg C higher than other materials under trial at that time. This was a very remarkable achievement, and when the E.28/39 first flew, powered by the W.T.X engine, both the turbine blades and the nozzle blades were made in "Rex 78." It may, incidentally, be placed on record that W. C. Whittle (now A. Cdr. Sir Frank Whittle) wrote to the late Dr. Hatfield on November 10th, 1941. "Indeed, without the special steels which you have developed, it would not have been a practicable proposition. You have therefore provided an essential link."

Another technique which progressed at the same time as the main development of gas turbines was the process of producing castor-rings and similar structural components by the centrifugal casting process. This development was born in the foundry and continuously developed by them, has made the production of these components a sound economic proposition. In the early days rings were made by forming Staibrite F.D.P. and H.R. Crown Max steel bars to ring shape, welding the joint, heat-treating to remove welding and bending stresses, and finally machining the ring to the desired section. This method was used for producing the Staibrite F.D.P. steel rings for the W.1 and proved a lengthy and costly business. Today numerous gas turbine components are made by the centrifugal-casting process, and, with modified techniques, complicated sections in the improved heat-resisting steels are in regular production.

Many other components for jet units are made from heat-resisting steels in sheet form and operate under conditions of high temperature and stress. Staibrite F.D.P., as used in the original engine, is still employed extensively. Although this steel is a standard corrosion-resistant material stabilized with titanium, it is of more useful strength and resistance to oxidation at temperatures up to 800 deg C.

As the designer's demands have increased, so the materials offered to him have improved; but the steel manufacturer must always be one step ahead. Many different alloys have been devised, with varying success, and amongst these Firth-Vickers have comparatively recently developed a series of new creep-resisting steels for turbine discs, rotors and blades—components which have to withstand high stresses at temperatures up to 800 deg C or even higher. Firth-Vickers 326 and 337 steels have been used in various forms, from blade stampings to large rotor forgings. "Rex 448" is a new ferritic steel for gas turbine components where service temperatures are not so high as to warrant the use of austenitic steel. "Rex 467," another recent development, is an austenitic steel which has creep-resisting properties of a very high order, but which does not contain in its composition the more scarce and expensive alloying elements upon which good creep resistance usually depends.

Research continues on both sides, the metallurgical and the fabrication aspects. The problems of today are attacked on the basis of experience gained with the problems of yesterday, but they are less acute than those which were overcome and culminated in that historic flight of the E.28/39 ten years ago.

**FORTHCOMING EVENTS**

- Aug. 25-29. International Air Circuit of the Dolomites, Italy.
- Sept. 1. R.N. Air Stations Gosport and Lee-on-Solent: Air Display.
- Sept. 2. A.B.A.C. Summer Convention.
- Sept. 10-16. Battle of Britain Week.
- Sept. 11-16. Society of Model Aeronautical Engineers (Northern Area): Model Flying Festival.
- Sept. 15-16. International Air Show, America, France.
- Sept. 22. Daily Express South Coast Air Race, Shoreham.