MATERIALS FOR HOT STAGES OF GAS TURBINES.

1. INTRODUCTION.

During the last 20 years the gas turbine and, in a more general sense the aerospace industry, has actually been responsible for the rapid development of high temperature materials. Although some materials known in the 1940's are still being used to day the wide range of alloys available at present or potentially useful for the future were developed after 1950. The improvements achieved have been possible not only through progress in materials science but also through progress in technological areas regarding the fabrication (melting, casting, shaping etc) of the components.

The present paper will deal mainly with :

- the fundamental properties required for materials intended in hot stages of gas turbines
- a discussion on materials likely to meet the requirements
- the development of materials actually used
- current and future developments.

The paper provides thus an introduction background to those papers of this course dealing in depth with particular aspects of high temperature materials.

2. PROPERTY REQUIREMENTS.

A wide range of properties are required depending on the hot stage part considered : burners , discs, , stationary vanes , rotating blades, etc.. The basic requirements will be given here for convenience. More detailed descriptions are given in the literature (2, 15).

2.1. Burner cans.

Generally fabricated from sheet, these parts are subjected the high temperatures of the flame and to relatively moderate stresses. The cooling techniques permit to use burner can materials with flame temperatu exceeding vastly their own capabilities. These parts require materials with modest strength at high temperatures, a high oxidation resistance and a goo fabricability and weldability.

2.2. Discs.

Discs are primarily subjected to high stresses at relatively low temperatures. Materials for these parts should thus present a high yield strength at the temperatures considered, and, as recognized more recently, high resistance to low cycle fatigue. As the inlet turbine temperature increa the materials used at this stage become progressively more complex. At pre materials previously used for rotating blades are considered for discs. This development requires the handling of large pieces of complex alloys and pose difficult problems which will be mentioned in a later section .

2.3. Stationary vanes .

The important properties in this case are high oxidation and h corrosion resistance, moderate strength at high temperature and good therma shock resistance. The latter property depends in a complex way on a number of more simple material properties such as : modulus, yield strength, therma conductivity and coefficient of thermal expansion. As no satisfactory quantitat relationship has been established this property is evaluated by means of a vari of technological tests. In the case of vanes , cooling techniques permit the use of alloys at temperatures much lower than those of the hot gas.

2.4. Rotating blades.

Highly stressed at high temperature these parts require mate resisting to creep, oxidation and hot corrosion, mechanical fatigue, low cycle fatigue. Meeting these requirements has been and still is a challenge to metallurgists.