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NASA TECH BRIEF

Stress-Testing of the Throat of a Rocket's Nozzle

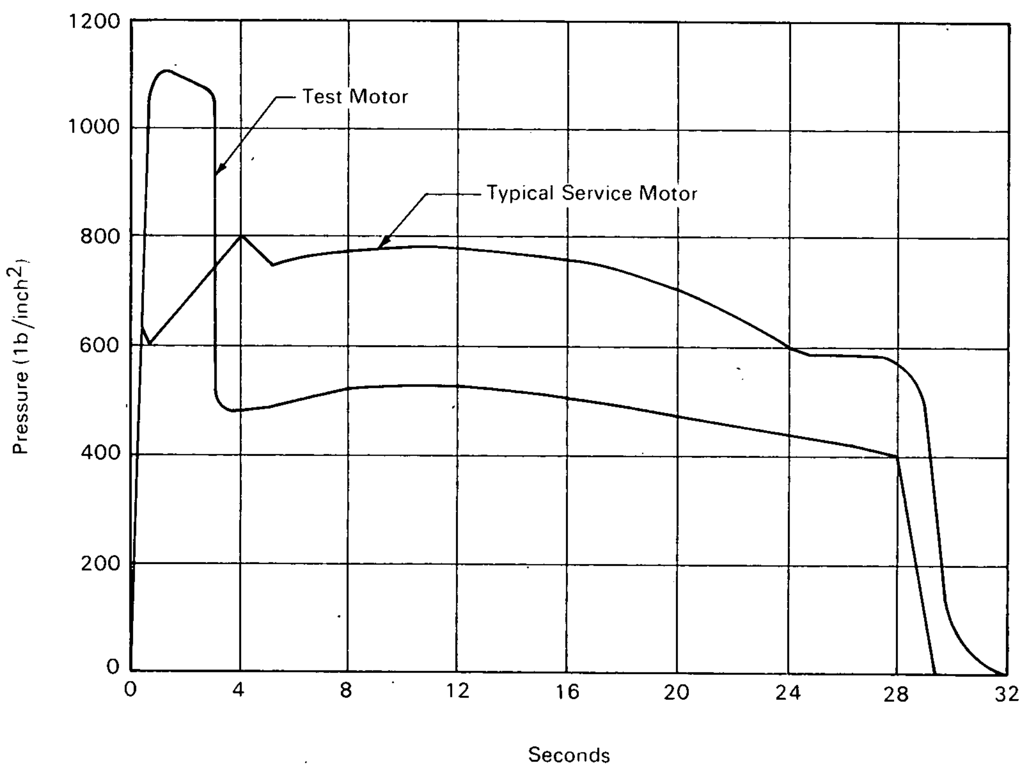

Fig. 1. Chamber Pressure Versus Time

The problem:

To develop a method of testing the effects of stresses in the throat of a rocket's nozzle. Tensile stresses are developed in the material of the throat by great temperature differentials; when the throat is submerged within the motor's chamber, the throat itself is compressed by the pressure in the chamber. A method was needed whereby the motor's operating pressure could be increased to aggravate the thermally induced tensile stresses in a submerged throat; at the same time, the opposing compression stresses had to be limited by control of the operating pressure.

The solution:

A test motor in which high initial pressure can be reduced suddenly.

How it's done:

Initially the motor is operated at a pressure higher than normal in order to create a higher-than-normal heat flux to the material of the throat. When the ther-

(continued overleaf)

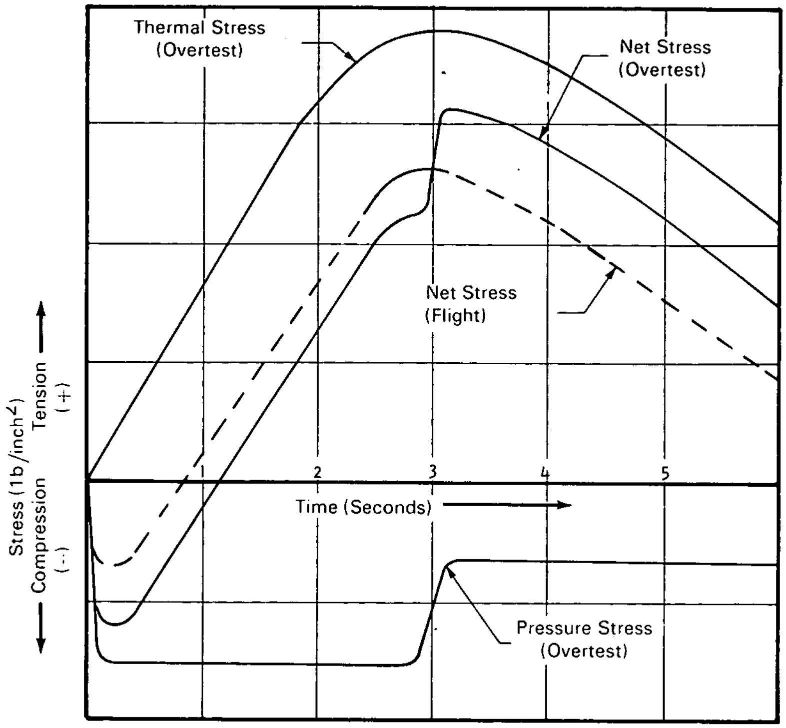

Fig. 2. Stresses at a critical point in the throat material versus time; net stress is thermal stress plus pressure stress.

mally induced tensile stress is at maximum, pressure in the chamber is dropped suddenly to a level well below normal so that the tensile stresses are dominant (figs. 1 and 2); the stress-inducing temperature differential falls much more slowly than the pressure. The time at which maximum tensile strength occurred was established by three-dimensional thermostructural analysis; the drop in chamber pressure was effected by designing a step in the propellant-grain burning-surface area. The analysis and propellant-grain designs were based on complete characterization of all involved materials, up to the maximum expected operating temperatures.

Earlier methods used either (1) test motors operating at pressures higher than normal in order to produce great heat flux, without consideration of the opposing pressure stresses; (2) propellants burning at extremely high temperatures to effect a great heat flux; or (3) heat-shock tests of samples of throat material in the laboratory. The new method has several advantages: it is selective, permitting testing of the throat for the critical stresses of concern; it is economical in that normal propellant and reusable hardware are used; by exaggeration (overtesting) of the critical stress, a high level of confidence in design of the throat is established by very few tests; and it is realistic, the throat being tested in its normal chemical environment.

Notes:

1. The method may interest manufacturers of rocket nozzles or pneumatic components or systems.
2. No further documentation is available. Inquiries may be directed to:

   Technology Utilization Officer
   NASA Pasadena Office
   4800 Oak Grove Drive
   Pasadena, California 91103
   Reference: B69-10358

Patent status:

This invention is owned by NASA, and a patent application has been filed. Royalty-free, nonexclusive licenses for its commercial use will be granted by NASA. Inquiries concerning license rights should be made to NASA, Code GP, Washington, D.C. 20546.

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