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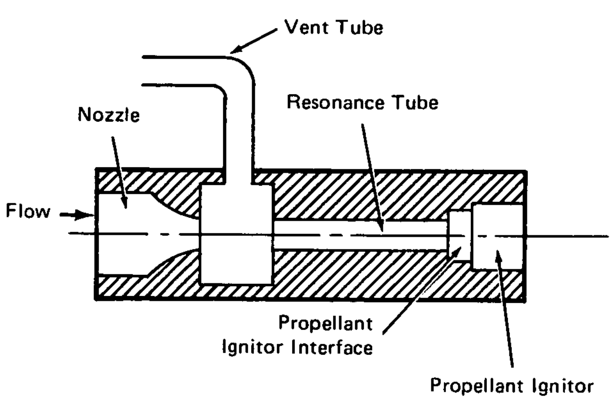
NASA TECH BRIEF

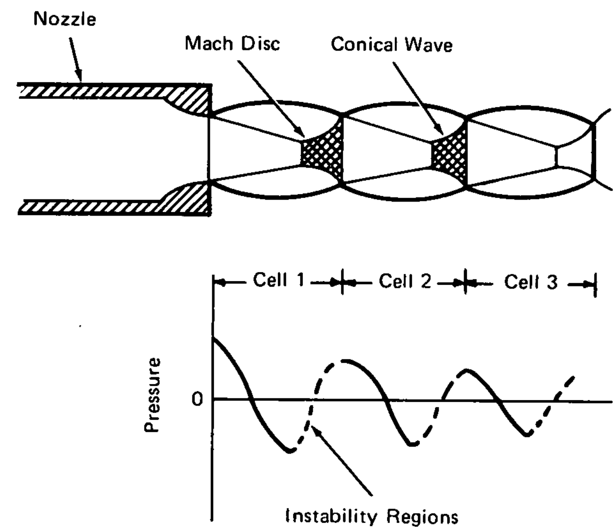
Langley Research Center

Ignition of Sounding Rocket Motors With Hand-Pumped Air

The development of this pneumatic/flueric ignition method has demonstrated an inexpensive, safe, and foolproof ignition system concept for solid propellant rocket motors, using a simple handpump to deliver air. Although devised for use with a sounding rocket, this system has broad potential applications in all solid propellant motor vehicles in first stage ground launch, or in upper stages utilizing fluidic programmers. The feasibility of the flueric ignitor concept has been demonstrated analytically and experimental verification of margins of operation have been obtained by igniting boron potassium nitrate ($BKNO_3$) and nitrocellulose over a range of operating parameters.

Flueric ignition was accomplished using a system without stored energy and with the complete absence of electrical energy and wiring. Instead, the flueric ignitor (see illustration for schematic view) is based on a two-component, aerodynamic resonance heating device called the pneumatic match. Temperatures in excess of 800° C were generated in closed resonance tubes which were excited by a free jet from a simple convergent nozzle. Using a nitrocellulose resonance tube, ignition of $BKNO_3$, a commonly used rocket motor ignition material, was accomplished with air supply pressures as low as 0.4 MN/m^2 (55 psig). These tests revealed that an operator using a simple hand pump for 30 seconds could ignite $BKNO_3$ at a standoff distance of 100 m (330 ft) with the only connection to the ignitor being a piece of plastic pneumatic tubing.





The pneumatic match consists of a resonance tube (hollow cavity closed at one end) and a convergent excitation nozzle. The device functions when a free air jet emanating from the nozzle induces a resonant condition in the cavity. When the flow emerges from the nozzle, it accelerates to supersonic speed and then readjusts to subsonic speed by compression through a shock wave. This process creates a series of diamond-shaped cells of alternate supersonic and subsonic flow which intersect the jet axis throughout the length of the jet. A plot of a typical static pressure distribution along the axis of the jet is illustrated. It can be seen that the pressure rises in the conical fronts of the diamonds and drops in the divergent portions to a minimum at the intersections. By placing a cavity in certain portions of

(continued overleaf)

the jet, a self-sustaining system of oscillations is created by driving the gas in the cavity into resonance. Although there is a continuous flow into and out of the resonant cavity, a portion of the gas remains trapped at the closed end where it is subjected to a succession of waves producing periodic compression and rarefaction of the trapped gas. This periodic compression and expansion of the gas within the rigid cavity of the resonance tube, produces irreversible temperature increases at the endwall of the cavity sufficient to ignite pyrotechnic materials.

Notes:

1. The following documentation may be obtained from:
   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.25
   (or microfiche $2.25)

   Reference: NASA CR-2418 (N74-28223), Development and Demonstration of Flueric Sounding Rocket Motor Ignition
2. Technical questions may be directed to:
   Technology Utilization Officer
   Langley Research Center
   Mail Stop 139-A
   Hampton, Virginia 23665
   Reference: B74-10202

Patent status:

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C. 2457(f)], to The Singer Company, Kearfott Division, Little Falls, N. J. 07424.

Source: Edward L. Rakowsky and
Vincent P. Marchese of
The Singer Co.
under contract to
Langley Research Center
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