Diary of Trip to California - March 8 - 31, 1947

Harold Grad

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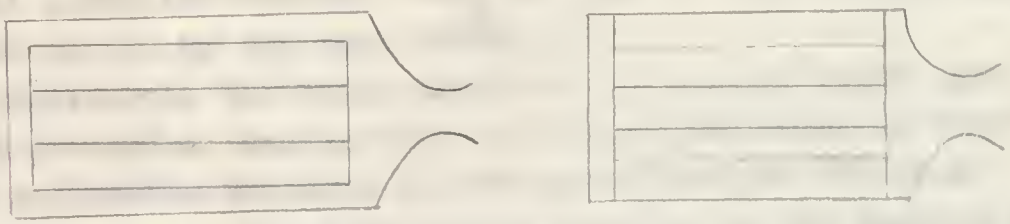
The problems of irregular burning and general hydrodynamic flow inside multiply connected hollow tube rockets were discussed with Dr. R. D. Geckler and A. L. Antonio.

Secondary peak and irregular burning phenomena similar to those observed at California Institute of Technology during the war have been observed in both the hollow grain and the rod and tube designs used by Aerojet.



The interrupted burning techniques used are still being developed, but from a discussion of results already available it appears probable that the resonance burning hypothesis set forth by the New York University group is correct. The physical basis of the phenomenon together with the qualitative effects of various rocket design features were discussed.

In order to verify certain aspects of the theory which has been developed, it was decided to perform experiments on rockets of varying geometry and type of powder. Experiments involving direct observation of powder reaction rates and flow patterns inside the rocket are not feasible at present. According to Dr. Geckler, it would be worthwhile to reduce the mathematical solution to a form whereby the incidence of pressure peaks and irregular burning could be predicted in terms of one or more parameters involving the rocket geometry and powder grain constants.

In addition to the resonance burning problem, work done at New York University on flow in multiple channel rockets and on the validity of one dimensional treatments was discussed.

Dr. Geckler was also interested in heat transfer with variable coefficients, and requested information on the work done by and under Dr. MacDonald on this subject.

Some problems in nozzle flow were discussed with R. Gordon, in particular the calculation of thrust for an inexact expansion nozzle. A memorandum on this subject will be sent to him by New York University.

Experiments are being performed on rockets which have purely diverging nozzles (i.e. no converging entry section). Shock reflection patterns in the exhaust can be observed directly by eye, since the various regions in the exhaust are distinctively colored.

Several problems involving straight pipe jet motors were discussed with Dr. F. Zwicky, who was interested in a memorandum being written on this subject, and who suggested some possible lines of further development. He also expressed interest in a report on the Pulse Jet by MacDonald and Schaaf and requested a copy.

Dr. Zwicky, as well as numerous other persons encountered in California, is eagerly awaiting the appearance of the revised Shock Wave Manual.

JPL-APL Symposium

JPL - Jet Propulsion Laboratory - California Institute of Technology

APL - Applied Physics Laboratory - Johns Hopkins University

The symposium consisted mainly of a discussion of free flight techniques and comparison with wind tunnel results. It appears that there are no results at present which allow of direct comparison between the two methods.

Certain anomalous drag effects are observed at transsonic speeds, but different experiments vary widely in results.

A novel method of measuring drag of a projectile in free flight using a so-called ballistic pendulum was described.

California Institute of Technology

Dr. Hans Liepmann was consulted on his work on interactions between shock and viscous boundary layers. It appears that the very large velocity gradients in the neighborhood of a viscous boundary layer at a wall produce shock reflection patterns which are entirely different from what is predicted by simple shock reflection theory, but it is expected that at sufficiently large distances from the wall the pattern may approximate that of the simple theory. Similar curved shock effects are found in Mach reflections because of the large velocity gradients in the slipstream. These effects, together with more complicated shock and boundary layer phenomena are found to be essential in describing transsonic flow around an airfoil (which may be somewhat connected with recent investigations in New York University).

Some properties of limit lines were discussed by Drs. Liepmann and Clauser at a lecture by the latter.

Several interesting problems concerning characteristics of hydrodynamic equations (with and without either heat conduction or viscosity); characteristics of lower order terms in parabolic equations; a comparison of the equations of transient nozzle flow and waves on sloping beaches; some features of the Karman-Moore perturbation method, and an equation of mixed elliptic-hyperbolic character were discussed with Dr. DePrima.

Two water tunnels (one for measurement of drag, lift, moment and one with a free surface at arbitrary air pressure), a centrifugal torpedo impact tank, and the transsonic wind tunnel were visited.

Other presons contacted on various matters are Professors Epstein and Bohrenblust.

Automatic Computing Machines

At California Institute of Technology Professor McCann of the Electrical Engineering Department was consulted about the status of various computation developments on the coast. He is at present constructing an analogue differential analyzer, aimed principally at elastic beam and electrical system stability problems, which treats on the order of 100 linear ordinary differential equations and some 10-20 nonlinear equations. There is a possibility of a digital computer being constructed at California Institute of Technology some time in the future. Various electromechanical simulators such as for torpedoes, guided missiles, etc. exist, and UCLA has a GE differential analyzer.

Howard Hughes Aircraft is constructing various small specialized machines, and one large digital machine (details secret) which is presumably to solve Maxwell's Equations. They have obtained some computing machine men from Bell Labs.

From a consensus it appears that the Bureau of Standards Institute of Numerical Analysis will probably be located at Stanford or Berkeley. According to the outspoken S. Raymo, Director of Research at Howard Hughes, the Bureau of Standards' methods do not offer much chance for any development in large scale computing machines other than a rehash of already existing machines.

Professors Spencer and Polya who were contacted at Stanford are anxious to have the Bureau of Standards' Computing Center either there or at Berkeley.

Dr. Spencer has some problems on schlicht functions which involve large scale computations and for which he is thinking of using the Eniac.

The problem of impact of a cone in water which is being put into final form by Drs. Spencer and Shiffman was discussed, and some necessary liaison between the two was arranged.