RRS NEWS

FOR THE ADVANCEMENT OF
ROCKETRY AND ASTRONAUTICS

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97

Reaction Research Society

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REACTION RESEARCH SOCIETY NEWS

— FOR THE ADVANCEMENT OF ROCKETRY AND ASTRONAUTICS —
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REACTION RESEARCH SOCIETY, INCORPORATED
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REACTION RESEARCH SOCIETY MEETING NOTICE

Headquarters Section Discussion Meetings will be held on the second Mondays of February 10, March 9, April 13, and May 11, at the Casa Verdugo Branch of the Glendale Public Library, 1151 North Brand Boulevard in Glendale, at 7:30 p.m.

These next two meetings will present plans and discussion for a Field Tripsto the M.T.A. one trip will be a Work Party in which to rebuild some structures and the other will be an actual test set-up to simulate conditions for practice toward real tests to be run in the immediate future.

The RRS NEWS is published quarterly by the Executive Council of the Reaction Research Society Incorporated.

Subscriptior . rates are: Single copy 50¢, Yearly $2.00

A LETTER FROM THE PRESIDENT TO ACTIVE MEMBERS

The last issue of the R.R.S. NEWS included an article on making a research report. Before making a report, however, you must first decide on a field of study. Although there are numerous fields of research in rocketry, the rocket vehicle itself, generally, is the center of study. However, there may be a preference for such specific fields as propulsion, vehicle design and construction, guidance, tracking, telemetry, recovery, or a host of other subjects. The decision as to what to study is up to you. Once you decide what to study, I'm sure you will enjoy searching for answeres to your problems. It is a valuable asset to cultivate the habit of going to the nearest library to read current magazines and books on the jubject of your choice. Enough time should be taken to make organized notes for future reference. You may have tried this before but gave up because of lack of encouragement. The R.R.S. intends to provide the physical and moral encouragement necessary to see a project through.

Complete answers to the questions on the questionnaire recently sent ot active members by the Executive Council will be of definite assistance to the Council in its attempt to disseminate pertinent information.

A program of textbook procurement is being studied at this time to aid in Society project research.

The research contract is being revised to include space for requests for materials, information, and equipment.

The task of providing test equipment for Society research has been initiated. Our Nine channel oscillograph is nearly ready for use. A load-cell is complete and other accessory equipment is on the way. There are many uses in which this instrument can be a most valuable tool for our research. Consideration is being given to the construction of a solid propellant strand-burner to measure burning rates. Static test facilities for motors of moderate thrust are now in the preliminary design stage.

The facilities and efforts of the R.R.S. are for the use of all active member's projects. If you don't have what you need, ask for it. If we don't have it, we'll try to get it.

The following listed books are suggested for general study:

Fuels and Reaction Principles;
Rocket Propellants, by Francis A. Warren, Reinhold Publ.,Corp. New York, 1958.
Rocket Propulsion Elements, 3rd edition, George P. Sutton, John Wiley and Sons, N.Y.
Combustion Processes, Vol II of High Speed Aerodynamics and Jet Propulsion, Lewis B. Pease and R.N. Taylor, 1956 Princeton University Press, Princeton, N.J.

Internal Ballistics of Solid-Fuel Rockets, R.N. Wimpress, Mc Graw-Hill Book Co., New York, 1950.

(Continued)

Guidance Coverage Study Technical Books:

Fundamentals of Advanced Missiles, Richard B. Dow, John Wiley and Sons, Inc, N.Y. 1958

Exterior Ballistics of Rockets, Leverett Davis Jr., James W. Follin Jr., Leon Blitzer, D. Van Nostrand Co., Inc. Princeton, New Jersey, 1958

Guided Missile Engineering, Allen E. Puckett, Simon Ramo, McGraw-Hill Book Co. 1959.

Inertial Guidance, George R. Pitman Jr., John Wiley &Sons, 1962.

Telemetering Systems:

Radio Telemetering, Myron H. Nichols, John Wiley & Sons, 1957.

Event Recording Sensors:

The Strain Gage Primer, C.C. Perry, H.R. Lissner, 2nd edition, McGraw-Hill Book Co., 1957.

Electronic Instrumentation. Sol D. Prensky, Prentice Hall Book Co.,
Experiments in Electronics, W.H. Evans, Prentice Hall Book Co.

E.B.P.

DEVELOPMENT AND TESTING OF A HYDROGEN PEROXIDE ROCKET

The Reaction Research Society has recently re-printed a research paper on the Development and Testing of a Hydrogen Peroxide Rocket by David Elliot and Lee Rosenthal. This is the First report on the Reaction Research Society's project for developing a liquid propellant sounding rocket.

The report was honored with an award by the American Rocket Society. It describes the design, construction, and testing of the first liquid propellant rocket to be fired by the R.R.S. The report which is twenty three pages in length, contains four drawings and charts, and seven photographs.

Since there has become wide use of this highly concentrated hydrogen peroxide in space vehicles, the R.R.S. believes that this report will be of exceptional interest to rocket researchers.

The price is $2.00 post paid ($1.50 ppd to members), ordered from the R.R.S., P.O. Box 1101, Glendale, California (91209).

THE INERTIA SWITCH: WHY AND WHEN

by Maryann Butterfield

Contrary to the belief of many amateur rocketeers, the inertia switch alone cannot be used to trigger the ejection of a nosecone at maximum altitude. The simple inertia switch can, however, be used for triggering almost any mechanism desired to fire very shortly after burnout.

Inertia switches may include such devices as the mercury switch, a ball bearing in a tube, certain types of spring mechanisms, pendulums, and certain types of strain gauges and piezo-electric transducers.

Newton's first law of motion, which in effect states that a body has zero acceleration when left to itself and that an acceleration other than zero is a mark of external influences, explains how an inertia switch works.

To determine when an inertia switch will function, some of the "external influences" must be examined, and one assumption made. The assumption is that the switch is set to function by closing a circuit when the seismic mass (the mercury, ball bearing, etc.) reaches the contact at the forward end of the switch.

There are three major external influences acting on the rocket during its flight: gravity, the thrust of the rocket motor, and drag.

If gravity is the only force acting upon an object, then that object is experiencing free fall. The term "free fall" has caused much confusion because of its inference that the body being acted upon must be moving toward the earth. THIS IS NOT TRUE. Any object being accelerated by gravity alone is in a condition of free fall, no matter which way its momentum is carrying it with respect to the earth. If the rocket were in a vacuum, it would begin free fall immediately after burn-out (while rising) because from this time until impact there is only one force acting upon the rocket, and this force is acting with fairly constant magnitude and direction. (Gravity does vary, for example, with altitude.)

The thrust of the rocket motor moves the rocket forward (or upward). The inertia of any object which is not firmly supported within the rocket will tend to hold it still while the rocket moves forward around it. The object would seem to be moving backward (or downward) with respect to the rocket. In the case of the inertia switch, the seismic mass would settle in the back end of the switch. As soon as the seismic mass comes in contact with a solid part of the rocket, the acceleration of the rocket acts upon this mass and moves it forward at the same rate as the rocket. If no other force is acting upon the rocket (i.e., drag), when the acceleration produced by the rocket motor ceases, the inertia of this seismic mass will not allow it to move from its relative position within the rocket. (It has been noted already that since gravity is, for all practical purposes, acting equally upon the rocket and everything within it, it will not affect the relative positions of these bodies.)

When the rocket ceases accelerating (at burn-out) it immediately begins to decelerate. This deceleration is due to gravity and to drag forces created by the friction of air on the skin surfaces of the rocket. Since we are disregarding gravity, as explained earlier, we shall consider drag forces only. These forces act to overcome the inertia of the rocket and to slow it down. There are, however, no appreciable drag forces acting upon surfaces or objects within the rocket, since the skin protects them from the airstream. Therefore, in the case of the inertia switch, the inertia of the seismic mass will allow it to proceed at the same rate while the rocket is being slowed down around it. Relative to the rocket, the seismic mass would seem to be moving forward. When this mass contacts a solid part of the rocket, it will decelerate at the same rate as the rocket. It is at this time of contact of the seismic mass with the forward end of the switch that the electrical circuit is normally closed and the inertia switch performs its function. The time of contact will vary with the drag forces acting upon the rocket, but for amateur rockets will probably be immediately after burn-out. Since the rocket will normally coast a considerable distance after burn-out, the use of a simple inertia switch would free the payload section from the rocket long before the maximum altitude was reached.

Ideas on methods of using inertia switches in conjunction with other devices for the purpose of maximum altitude separation have been expressed, but no testing has been carried out. An obvious application of the inertia switch to rocketry would be as a staging device for separating the stages of a two-stage rocket. (Every inertia switch must be equipped with a safety switch to prevent its functioning and the accidental ignition of the second stage while the rocket is being handled prior to launching.) Please note that some sort of interlocking system must be used when inertia switches are used in rockets of three or more stages in order to prevent all the stages from firing at one time.

It is hoped that the information presented in this article will induce more effort in the development of a reliable device for the separation of a payload at maximum altitude; and will prevent the further loss of amateur rocket payloads because of misconceived ideas on the functioning of the inertia switch.

A REVITALIZED SOCIETY

As many an old member is aware, the R.R.S. has had a period of relative inactivity. This inactivity was due to the unexpected and unexplained cancellation of the groups insurance. But now-! now things are humming again. We're on a very stimulating upsurge. With all the new activities and planning going on, its time to re-join the ranks. We want former members to rejoin and to renew old aquaintenceships and there are openings for new members with the possibilities of organizing local sections.

"The RRS Wants You"

We have new leaders who are planning some exciting and new activities. It promises to be the beginning of a very active season. Plans are developing very rapidly and if you don't want to miss the activities, get out that 4 cent post card enquiry, or drop in at the next meeting.

As you can see, the RRS NEWS is back on the air and will keep you abreast of the latest activities. We'll probably have to increase the number of pages of the NEWS in order to keep up with all that is happening.

For example, the Executive Council is planning an excellent field excercise to test equipment and to allow every member to participate in a pre-firing activity. The experience should be unique.

Several members propose to do some static testing with instrumentation. The Society now has a good 10 channel recording oscillograph which promises to be most useful in obtaining some valuable data. Others are working on related amplifiers, power supplies, and various transducers.

Radar Tracking Project is almost complete and should be a fascinating addition to our group. You've probably noticed the emphasis on a shift toward research, for which the Society is becoming noted.

Another activity that is being eagerly anticipated is the Annual R.R.S. Mail Firing which is already in the construction and testing stage. This is one of our major yearly projects and will require the participation of all members. The Council plans to follow this up with a public firing. So now is the time to join the activities.

Other activities, still in the planning stage, including participation in the Los Angeles Hobby Show in 1964. And sometime in the Spring there will be an affair for recognition of prominent work in the R.R.S., with the presentation of the Dean Haddon Award for outstanding contribution to the field of Amateur Rocketry.

ELECTION RESULTS

The results of the annual election, held December 10, 1963 are as follows:

President: Edward B. Parker
Vice-President: Lawrence G. Teebken
Secretary-Treasurer: Richard R. Butterfield

An amendment to the Constitution of the Reaction Research Society was passed, giving all active members the right to vote at the annual elections.

LETTERS TO THE EDITOR?

Would you, the reader enjoy seeing a letters column in the RRS News? We are limited in space, so only those letters of general interest to the readers will be printed. If you would like to write a letter concerning your activities, ideas you may have on some phase of rocketry, or perhaps a question or disagreement concerning an article in the RRS News, why don't you?

Address correspondence to: Editor, RRS News
Box 1101
Glendale, Calif. 91209

RRS GETS A RECORDING INSTRUMENT

The Reaction Research Society has acquired a very fine, professional, multi-channel recording oscillograph. This is a 10 channel instrument and at present there are five galvanometers available. The instruments film drive operates at 24 volts D.C. and the internal light requires 4 to 6 volts D.C. A preliminary report and technical data are available in the Society's file.

With this instrument, it will be possible to record pressure, temperature, thrust, and burning time simultaneously. It is a small instrument and with a small power supply, the entire system could be portable.

Since the RRS is a leader in the field of micrograin development, this instrument can help us maintain and expand that lead. Through rigid and continual testing, we can become authorities on the characteristics of micrograin and other fuels.

When the necessary power supplies and timing devices are complete, testing will begin. Testing can be accomplished at the Mojave Test Area and possibly at the Pacific Rocket Society's test cell.

Some of the problem areas are the power supplies, amplifiers, and transducers. It may take some volunteer work to adapt existing power supplies and to build the necessary amplifiers. A 1000 pound pressure transducer is available and is being adapted to work with the oscillograph. Any other member wishing to volunteer his ideas, services, or equipment for adapting the Society oscillograph, please contact the Executive Council.

FLAME PROPAGATION IN A LIQUID FUEL CHAMBER

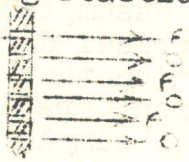
by R. E. Nelson

(Second of two parts)

One of the major factors concerning flame propagation and combustion in a liquid fuel rocket motor is the method of injection of the fuel and oxidizer. Many injector configurations have been tried, but the main purpose of each is to get the propellants into the vapor phase so the reaction can proceed.

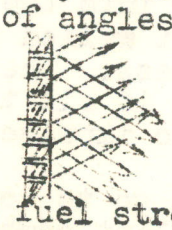
By experimental determination, a particular propellant combination will operate more satisfactorily with a specific injection pattern. Of the many injection patterns, there are four that appear to be the most widely used. These are (1) shower head, (2) atomizing, (3) fuel on oxidizer, and (4) splash plate.

The showerhead injector has the orficies parallel to the axis of combustion. This configuration usually will require a larger chamber volume for combustion, and diffusion is the rate-controlling reaction in the process of combustion.



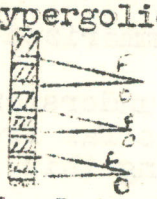
Showerhead injector

Atomizing injectors will vaporize the propellant very quickly and are usually used with monopropellants. Commercial spray nozzles are commonly used and will provide injection in a fine spray at a variety of angles and patterns.



Atomizing injector

When the fuel stream is directed to contact the oxidizer stream, intimate mixing of liquid droplets occurs. The liquid-phase reactions are enhanced. This type of injection pattern can be used on hypergolic propellants.



Fuel on oxidizer injection

The splash plate injector has become a very widely used method of injection. The incoming propellant streams are directed to impinge upon a wall, or splash plate, which results in jet disintegration, evaporation, and liquid phase mixing. This method is useful when liquid phase chemical reactions are the rate controlling reaction in the combustion process.

Splash plate injector

In all cases, intimate mixing of the propellants must take place before the reaction can occur. After mixing, the propellants are heated principally by convective heat transfer from the reacting or reacted gases previously injected into the chamber, and by radiation from the hot walls and gases. This heating of the propellants is known as the preheating zone and the zone's thickness is essentially dependent upon pressure and burning velocity.

All the processes up to this point can be combined into a single term known as ignition delay. In non-hypergolic systems, undesirable motor performance is the result of excessively long ignition delays resulting in the accumulation of abnormally large concentration of combustible gases and/or liquids in the combustion chamber. For this reason it is important that the propellants ignite rapidly after injection into the combustion chamber.

Ignition of the propellants is accomplished by contact with the flame front. The actual propagation of the flame front through unburnt gaseous propellant is carried out by high speed diffusion of certain active groups, molecules, or atoms (OH, N , H, or CH_2). These can be classified as chain carriers. The assumption is made that each liquid droplet is surrounded by a spherical diffusion flame whose position is determined by the condition that the ration of delivery of fuel and oxidizer to the flame front are in a stoichiometric proportion. This flame front is not a simple plane surface across the combustion chamber. Ignition and combustion introduce an intense amount of turbulence in the gases of the combustion chamber and the flame front progresses throughout the mass.

After ignition occurs, the propellants enter into the reaction zone which can usually be observed, in transparent walled test motors, as the luminous zone in a combustion process. The critical nature of the reaction zone lies in the fact that if all the propellant is not completely reacted, the specific impulse of the rocket motor will be adversely affected.

The correct volume to enable the reaction to go to completion must be experimentally determined for each propellant combination. The measure of this volume is given by a term designated L*, which is the chamber volume divided by the throat area.

The foregoing combustion processes can be summarized in the following diagram: (see page).

In conclusion, it should be stated that the understanding of the combustion process in a liquid fuel chamber is far from complete and much work has yet to be done regarding this important branch of rocket engineering.

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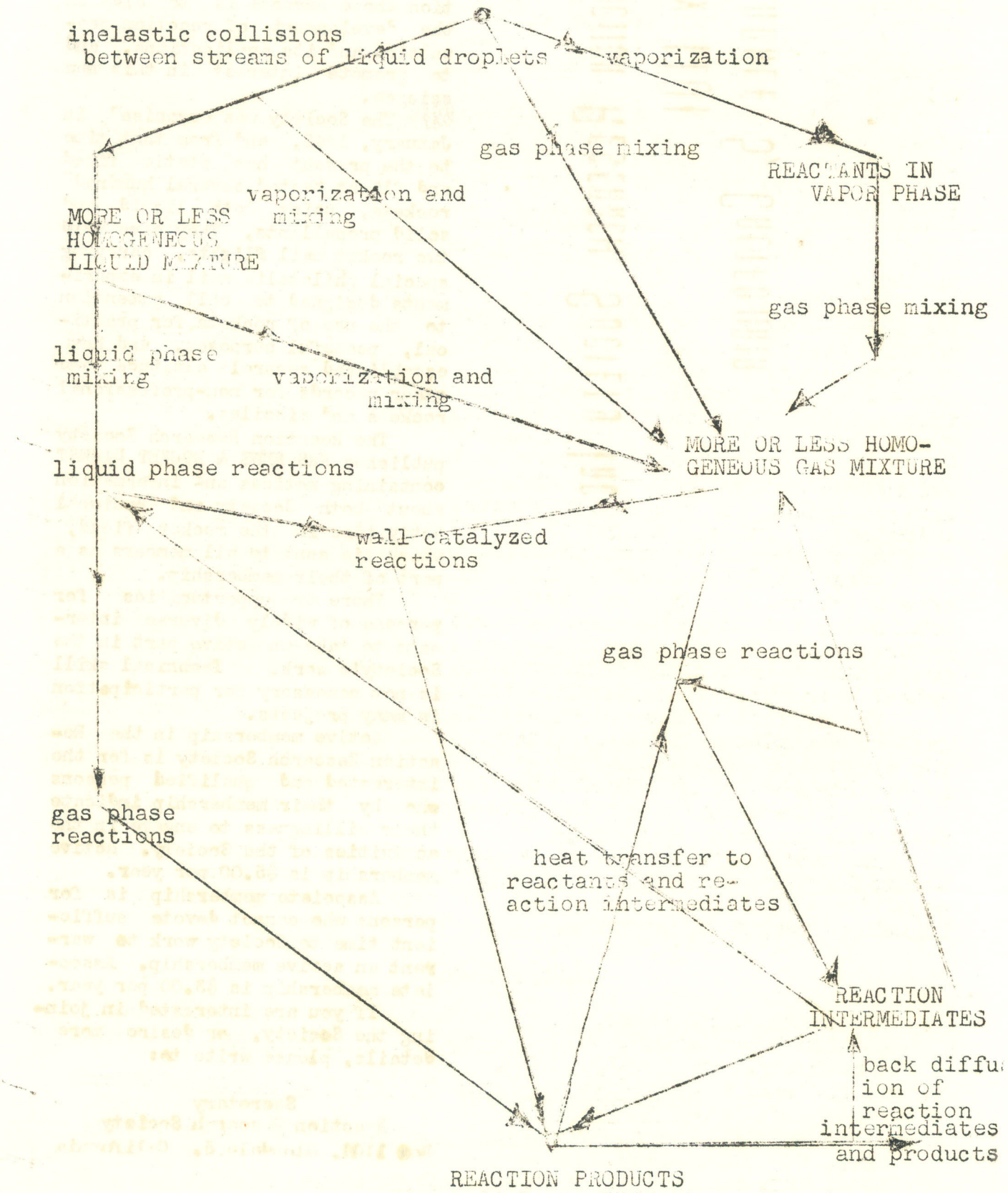

SCHEMATIC REPRESENTATION OF ROCKET ENGINE COMBUSTION

THE REACTION RESEARCH SOCIETY

The Reaction Research Society is a non-profit civilian organization whose purpose is to aid in the development of reaction propulsion and its applications, and to promote interest in this new science.

The Society was organized in January, 1943, and from that time to the present has static fired and flight tested several hundred rockets, using both liquid and solid propellants, They have held two rocket mail flights, carrying special philatelic mail in experiments designed to call attention to the use of rockets for practical, peaceful purposes, and have established several altitude and other records for non-professional rockets and missiles.

The Reaction Research Society publishes RRS NEWS & ROCKET DIGEST containing notices and information about both Society and national activities in the rocket field, which is sent to all members as a part of their membership.

There are opportunities for persons of widely diverse interests to take an active part in the Society's work. Technical skill is not necessary for participation in many projects.

Active membership in the Reaction Research Society is for the interested and qualified persons who by their membership indicate their willingness to engage in the activities of the Society. Active membership is $5.00 per year.

Associate membership is for persons who cannot devote sufficient time to Society work to warrent an active membership. Associate membership is $3.00 per year.

If you are interested in joining the Society, or desire more details, please write to:

Secretary
Reaction Research Society
Box 1101, Glendale 5, California

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