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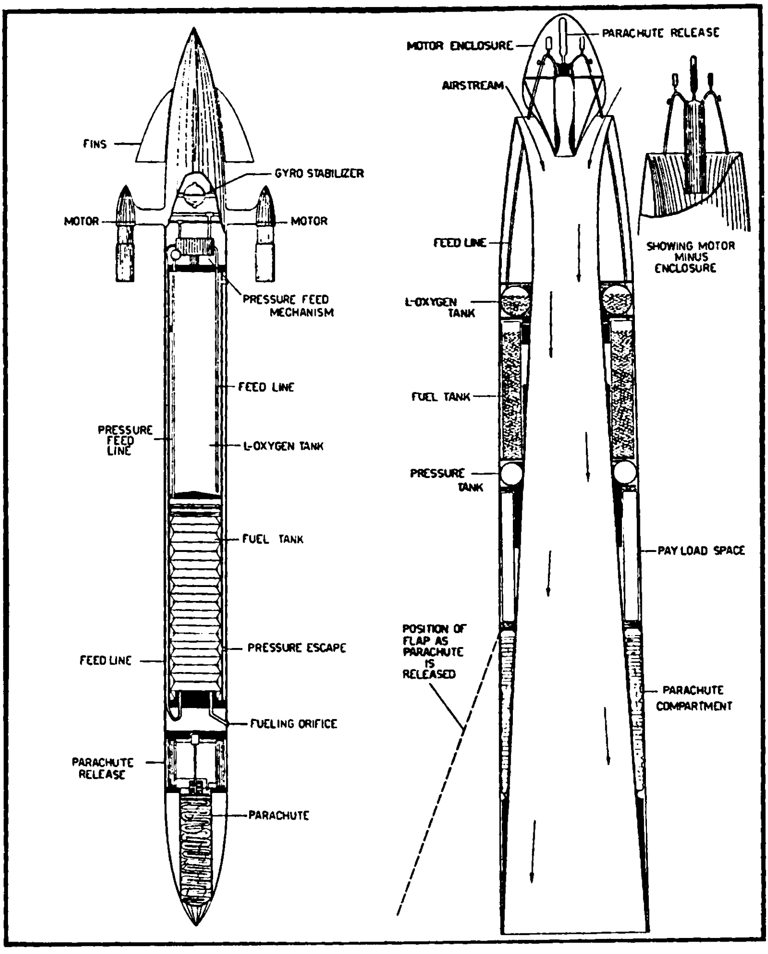

NEW ROCKET DESIGNS—Louis Goodman renews the controversy of nose-drive versus tail-drive for aerological rockets. —See Page 12

THE AMERICAN ROCKET SOCIETY was founded to aid in the scientific and engineering development of jet propulsion and its application to communication and transportation. Three types of membership are offered: **Active,** for experimenters and others with suitable training; **Associate,** for those wishing to aid in research and publication of results, and **Junior,** for High School Students and others under 18. For information regarding membership, write to the Secretary, American Rocket Society, 50 Church Street, New York City.

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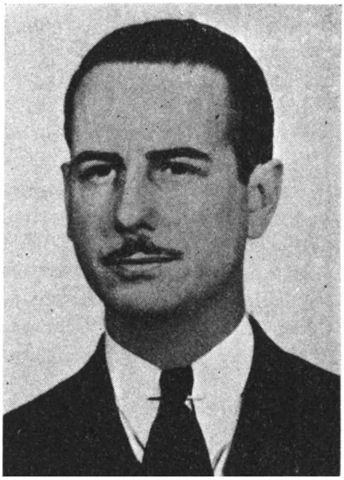
NOTES AND NEWS

NEW OFFICERS: As befits a democratic society in a democratic land, the members of the **American Rocket Society** each year select a new roster of Directors who are intrusted with the destinies of the organization for the coming twelve-months. These Directors, in turn, elect the Society's officers.

At its Annual Meeting in April, the following men were elected to the Board of Directors of the Society: Alfred Africano, H. Franklin Pierce, John Shesta, Alfred Best, Dr. Samuel Lichtenstein, James R. Glazebrook and Roy Healy. On May 1, at its first meeting the Board chose the officers listed in the box at left. At a later meeting the Directors conferred an honorary position as Vice-President to Burton H. Johnson, who has left his

(Continued on Page 16)



President H. Franklin Pierce

Preliminary Design Of A

3" Rocket-Projectile For Aircraft

By ALFRED AFRICANO, M. E.,

THE times being what they are, the natural thought occurs that an important application of an efficiently designed rocket, powered by smokeless powder or a liquid fuel, is in the field of armament for military airplanes. It is well-known that most existing warplanes are deficient in this respect. The lag in development is due, of course, to the heavy cannon required for the larger caliber projectiles and the correspondingly excessive recoil forces. The rocket principle requires no cannon for its operation. Hence, in spite of a probable lower efficiency in the use of the propellant energy the fact that practically any size of projectile can be launched from existing airplanes without imposing severe recoil stresses is sufficient basis for this preliminary study of the factors involved. It is not intended so much to give any immediate practical result—there is not enough data—but more to present a tentative method of design based on our current knowledge of jet propulsion.

Characteristics of the Ordinary 3" Projectile

The standard shell fired from the 3-inch Field Gun, Model 1905, weighs 14.98 lbs. and during 6.21 ft. of travel through the bore is accelerated at an average of 7200 "G" to the muzzle velocity of 1700 ft. per sec. The acceleration is produced by the pressure of the gases formed in the powder chamber by the combustion of 1.355 lbs. of smokeless powder. These gases expand more or less adibatically from a high pressure of approximately 32,000 lbs. per sq. in. down to an exhaust pressure of about 5000 lbs. per sq. in.

Smokeless powder propellant is principally pure nitrocellulose of 12.6% nitrogen and contains about 1,400,000 ft. lbs. of energy per lb. Therefore, the ratio of the kinetic energy imparted to the projectile to the heat energy of the powder is:

$$E_t = \frac{\text{Kinetic energy output}}{\text{Heat energy input}} = \frac{MV^2/2}{wH} \qquad \text{Eq. (1)}$$

For $M = w/g = 14.98/32.2$, $V = 1700$ ft. per sec., $w = 1.3555$ lbs., and $H = 1,400,000$, the thermal efficiency of E_t of the 3" Field Gun for this shell is 0.35 or 35%.

This is a very efficient utilization of the heat energy and while the rocket cannot approach it at present it should be remembered that we are eliminating the 3000 lbs. of weight of the ordinary 3 inch Field Gun, and what is more important, the recoil. Part of the loss can be made up by the reduction in weight of the steel shell walls and base since we do not have to design for the 32,000 lbs. per sq. in. maximum chamber pressure, and the corresponding high acceleration or "setback" which for this case would amount to 15000 "G". This gives an idea of the enormous forces to be provided for in one way or another by the cannon's recoil mechanism, and the difficulty of doing it on an airplane.

The Rocket-Projectile. Basic Factors of Design.

A. "Payload". The weight of explosive, TNT, carried by the above projectile is about 8% or say 1.2 lbs. This is to be the "payload" of our 3" rocket-projectile if we are to duplicate the target performance of the 3" shell. In addition, assume 2.5 lbs. for the nose fuse and the ignition cap and since we cannot know in advance what volume of container is required for the unknown amount of propellant, use the weight of a 24 inch tube of 1/16" stainless steel, 4.5 lbs., together with the weight of a 1/4" refractory lining, 7.1 lbs. The total dead weight is then 14.1 lbs. Assume 15 lbs. for this.

B. Propellant. For a smokeless powder propellant, which is desirable for initial experiments, although certain liquid fuel plus oxidizer combinations contain over three times as much energy per pound of explosive mixture, the construction of the combustion chamber would be very simple. No feed problems are involved since the powder would burn progressively from some initial chamber shape radially outward.

C. Jet Velocity. For an expansion ratio of 20 to 1., the jet efficiency, E_r*, would be about 50%, and equating this amount of converted heat energy to the kinetic energy of the jet gases which escape with a constant velocity, C, ft. per sec., the formula:

$$C = \sqrt{2E_rHg} \qquad \text{Eq. (2)}$$

gives a value of 6700 ft. per sec.

D. Air Resistance. The drag due to air resistance will vary according to a power of the velocity, the square, cube, or even the fifth power, as the shock waves produced at the speed of sound are encountered. Any exact calculation is outside the scope of this study, so an approximation of the added propellant required to overcome this will have to be made by using the fact that the air resistance at 1700 ft. per sec. for a 3" shell is about 75.7 lbs. This is imposing a more severe condition on our rocket-projectile design than actually occurs since it is covering ground toward its target while attaining this speed, whereas the shell is losing velocity rapidly from the start, and will reach the target with a lower "remaining velocity".

E. Amount of Propellant Required. Allowing 5 seconds for the time of acceleration to the maximum speed of 1700 ft. per sec., we have an average rate of velocity increase of 340 ft. per sec. per sec. This amounts to 10.5 "G" and therefore requires a reactive force 10.5 x the weight. The final weight is 15.0 and total reaction the sum of 10½ times 15.0 and the air resistance 75.7 lbs., or 233 lbs. The initial weight is guessed at about 20 lbs., including 5.0 lbs. of propellant. Thus the initial reaction must be 10.5 times 20 or 210 lbs. Initial velocity and air resistance are zero. The average required reaction turns out to be 222 lbs.

Since the reaction of a jet is the product of the mass of the gases flowing out per second times their velocity, or:

$$F = mC = \frac{w}{g} C \qquad \text{Eq. (3)}$$

the amount of propellant required per second is about 1.07 lbs., and the total for 5 seconds is 5.4 lbs. A second approximation using this figure as the initial weight to be carried along would give a closer agreement.

Dividing the kinetic energy given to

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*See Equation (5) of "Rocket Motor Efficiency," by the author in Astronautics No. 37, July, 1937.

the final weight by the total heat energy of 5.4 lbs. of smokeless powder gives a nominal comparative value of about 9% for the overall efficiency of the rocket as a prime mover as against 35% for the 3" Field Gun.

F. Other Considerations. Matters of stability and whether or not the rocket trajectory is inherently capable of as exact computation as that of the projectile are problems that only test firings can solve. Rotation of the rocket-projectile for stability may be effected by offset fins designed to force a screw-like motion through the air much as the projectile is forced to rotate by the rifling in the gun bore. The variation of the center of gravity certainly has an effect on the stability and causes a corresponding variation in the ballistic coefficient.

An ordinary projectile follows its trajectory more or less independently of whether it tumbles or not, i. e., except for extra air resistance, because the attraction of gravity acts vertically on its center of gravity no matter what position it may be in at the moment. A rocket, however, is acted upon by the jet reaction, which, being fixed in line with the rocket's axis, must change its line of action along with the trajectory motion, whatever it may be. Tumbling in a rocket, therefore, must be absolutely avoided.

Conclusion. It is interesting to note that the rocket trajectory in a vacuum is. a straight line at an angle from the horizontal equal to that formed by the vector sum of the rocket jet reaction and the vertical action of gravity. The projectile trajectory in vacuo of course is a parabola. When enough data is available to compare the various trajectories possible by the rocket-projectile combination with the trajectories of existing projectiles many startling new features will be disclosed.

The strategic advantages of the rocket-projectile in modern warfare, so dependent on the airplane, may well make its development a most promising field of research.

* * *

Ed. Note: Mr. Africano recently completed special studies in Ordnance Engineering made possible by his share of the REP-Hirsch Prize awarded jointly to him and to the Society in 1936, and is a member of the Army Ordnance Association.

Item from the New York Times of Wed. June 26:

"Pasadena, California

A discussion of the use of rocket motors for propelling airplanes, set for today's session of the Institute of Aeronautical Sciences, was cancelled on recommendation of the Army. The cancellation was made without explanation."

Recently published articles on rockets include the following:

Fantastic Hoaxes Fantastic Adventures, Jan.
Rocket Planes Yet? Popular Aviation, March
What's Wrong with Rockets? Amazing Stories, March
Secret Weapon No. 2 Quest, Yearbook Issue
Tomorrow's Rocketship Mechanics Illustrated, April
The Rocket's No Racket Flying Aces, April
War Rockets Amazing Stories, May
Seeking Power for Space Rockets Popular Mechanics, August
Rockets of Destruction Newark Sunday Ledger June 30

As always in presenting the subject to the layman, these articles are in the sensational vein, exaggerating what has already been accomplished and painting glowing pictures of what will be achieved in the near future.

Following The Rocket In Flight

Performance Report on Range Finders

A PAIR of rocket range finding instruments have been used on two occasions in the field, by the Experimental Committee, to determine the altitudes reached by powder rockets. The instruments were originally planned to be built for recording the vertical angles during the entire trajectory of the rocket, but it was decided to use them visually for the initial tests. In this capacity only the maximum point of altitude could be observed, but it was felt the experiences gained in this way might lead to improvements in the final design.

This field experience showed that we were well advised to use the instruments visually, since it was found to be practically impossible to follow powder rockets on the way up with any degree of accuracy, because of the rapidity of their motion. On the whole it was found that the plain sight bar, used in lieu of a telescope, was quite satisfactory, and that determinations of sufficient accuracy could be obtained if the instruments were properly used.

Locating the Instruments

The best location for each instrument was found to be about 500 feet away from the rocket launching station. Sloping and hilly ground does not interfere with accuracy, as the differences in elevation can be easily determined by trignometric leveling and the proper corrections applied.

One important fact brought out by the tests was that the instruments should not be set up too near the rocket station. When a rocket crosses an observer's zenith the reading is lost, because he cannot tell when the maximum altitude is reached. In fact he has no means of knowing whether the rocket is going up or down. This has happened on one or two occasions when the instrument was set up in too close proximity to the rocket station.

Another and a more serious difficulty was brought out, which should be rectified before the next series of tests. It is not necessary for our purpose to calculate the rocket's altitude to the last foot, a 5% accuracy is quite sufficient, but it is essential that we be absolutely sure of the results we do get.

More Observers Needed

It must be realized that observations are often made under adverse conditions, that a rocket in flight is a difficult object to sight upon, and finally

Zolton S. Farkas
Range finder in action

that the observers themselves, being human, are quite fallible. The way to increase reliability is to use numerous observers.

The present design of the instruments requires that the vertical circle of each be oriented in the plane of the base line, so we cannot station these observers at random. Each pair must be lined up at their respective base line.

Eliminating Errors

The most effective way to use these instruments appears to be to station them at several points along the same base line. If that is done, we can use different pairs of readings in various combinations. Using two instruments we have one triangle, with three instruments—three triangles, with four—six triangles, and so forth. As a general rule it may be stated that whatever the number of observers, a positive result is assured if any three of them manage to get a true line on the rocket, whatever faulty bearings the others may happen to get. The more observers the better, but there is a practical limit to this. On one base line four stations should suffice, if the first man is 500 feet from the rocket site, and the next one about 200 feet beyond the first. If we go further than this the visibility becomes poor, and the terrain may impose limitations, so that additional observers, if any, must be established along independent base lines.

Four Station Technique

It may be thought that the labor of reducing the observations of four stations will prove too great, but such is not the case. With four stations the trignometric method of calculation would no longer be used. The transit stations would be plotted upon a large sheet of drawing paper, at their proper elevations, etc. A card protractor, pivoted in the center, would be affixed to each station and a string would be stretched along the reported bearing. In this way the convergence of sights may be judged by inspection, and any faulty readings can be at once spotted and eliminated. With a scale of 1" to 100' an accuracy of better than 5% can be easily maintained. The plotting can be done in the field if desired, and a larger scale can be used. The altitude corrections for differences of elevation of stations is automatically taken care of in this method without any more ado.

John Shesta
Chairman, Experimental Committee

By diligent searching our Library Department has managed to round up a few more copies of **"Rockets Through Space"** by P. E. Cleaton. Although officially out of Cleator in this country we are offering this excellent book on rockets at our previous price. It is $2 to members, $2.50 to non-members.

What are your ideas about rocket design, the most efficient way to cool a rocket motor, potential fuels, methods of feed and control, and the nunumerable problems which beset experimenters in this field of science? **Astronautics** is eager to receive contributions from members, sketches, plans, photos or written ideas.

The newly organized Photographic Committee, headed by Miss Ruth H. Greene, has been formed to make permanent, complete pictorial records of all experiments. Previously important moments in field tests were missed in hurried, unplanned filming.

Professor Yellott On Nozzle Design

Expert Honors A. R. S. With Lecture

FEATURE of the April meeting was an engrossing resume, by Professor John I. Yellott, of his exhaustive research into the behavior of steam flowing through variable nozzles. Particularly fascinating to embryo rocket motor designers were slides and natural color films, illustrating the lecture, which clearly depicted the lines of flow through nozzles possessing different angles of flare.

In studying the complete range of discharge pressures such extremely low values were obtained in some tests that temperatures dropped below the freezing point of water and ice actually formed on the mouth of the nozzle and on the search tube.

Nozzle Function

Professor Yellott opened his talk by defining the function of a nozzle as a means of providing a passageway for a fluid expanding from a high pressure area to a low pressure area. The efficiency of the nozzle for a given ratio of initial to final pressure is dependent principally on the ratio of the throat area to the discharge area.

$$\frac{W}{3600} \quad \frac{A}{144} = \frac{Vel}{V}$$

where **W** is the weight of fuel flowing in lbs. per hour, **A** is the nozzle throat area in sq. in., **V** is the specific volume in cu. ft. per lb.

Professor Yellott, acknowledged expert in the field of nozzle design, leaves Stevens Technical Institute at the end of this term, to head the Mechanical Engineering department of the Armour and Lewis Institute of Technology at Chicago.

The mathematical equation of continuity expressing flow is:

The pressure-volume relationship for adiabetic flow is:

$$p_1 v_1 K = p_x v_x K$$

where **p** and **v** are pressure in lbs. per sq. in. and specific volume in cu. ft. per lb., respectively. Subscripts $_1$ and $_x$ indicate initial and exhaust or discharge conditions, respectively, while exponent **K** is the ratio of specific heats for the fluid in question.

Pressure and Volume

This adiabetic relationship of pressure to volume for a given initial pressure shows that beyond a certain point very little additional volume can be passed by further reduction of discharge pressure.

Discharge velocity is determined by the equation:

$$Vel_x = \sqrt{2g\frac{K}{K-1}RT_1\left[1-\left(\frac{p_x}{p_1}\right)^{\frac{K-1}{K}}\right]}$$

where **T** is initial chamber temperature, **g** is the acceleration of gravity, and **R** is the universal gas constant.

Expansion Angle Important

Throat area for a particular flow is the minimum value of the nozzle area against the pressure. An interesting fact in this connection, pointed out by Professor Yellott, is that the velocity of flow under certain conditions is the velocity of sound in the fluid under the same conditions.

Beyond the throat the nozzle angle must be correct for all conditions of flow. If too small the discharge will

(Continued on Page 15)

The Rocketor's Workshop

A Department Devoted to Shop-Talk, Ideas, Devices

INGENIOUS RADIO CONTROL SYSTEM — Outlined by Lovell Lawrence, Jr.

With more efficient rocket motors being developed and the potential range of rockets increasing it is time to consider some practical remote control devices for the projectiles. This article will deal mainly with methods of radio control, synchronization and apparatus to be used in the rocket itself.

First of all, a method of steering must be decided on. A gyroscopic stabilizing device, controlled remotely, would be one method of steering the rocket, but as this requires a means of spinning the gyro it appears somewhat in the future. Vanes or rudders on the rocket similar to aircraft controls might work, but are of questionable value at the anticipated speeds. On smaller rocket models, however, vane control might be practical due to

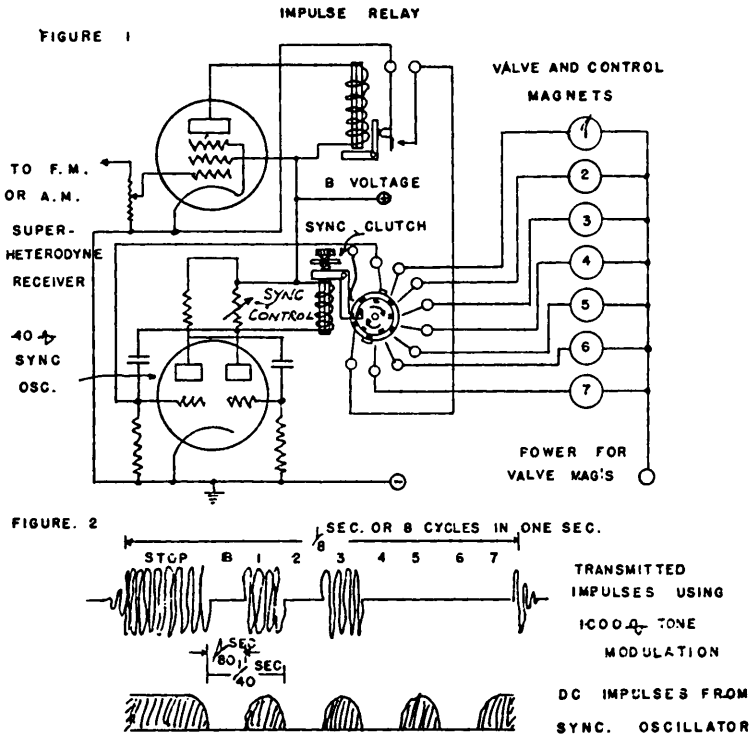

Diagram 1. Receiver and Occillogram

its simplicity and probable lower velocities.

A third method of directing the rocket's course can be obtained by positioning the motor nozzle, the motor being connected to the hull by means of a ball and socket joint. The motor could be swiveled by means of small electrically operated air valves. This is shown in Dia. 2 Fig. 3.

Multi-motor Control

A more promising method of steering would be to control the firing of a multi-unit motor. It is known that a motor of one inch nozzle throat will produce a certain force for propelling our projectile. By splitting up this motor into four units, actually four separate motors, the same force would be achieved. With four motors available, we can control the firing of each one individually, thus turning the projectile in any desired direction.

Ultra High Frequency waves seem best suited for this system of remote control. The carrier or wave can be directed into a beam by means of a properly designed antenna. We know that waves of this frequency can reach beyond the stratosphere. The simple receiver, whose circuit is shown in Diagram 1, is very efficient for short range work. It is a superregenerative type using one stage of amplification and a relay control tube which turns on a magnetically operated switch when a signal is received. Naturally, a more sensitive and accurate receiver would be necessary for very remote operation.

Synchronizing The Motors

Synchronization of the operation of each motor or other piece of equipment in the rocket is most important. One method of accomplishing this is to send a series of timed impulses to the receiver, which are in turn selected by a small commutator. The commutator is synchronized by an oscillator which is controlled from the transmitter. Each time the impulses desired are sent out an oscillator in the receiver, and one in the transmitter, are allowed to oscillate at the same frequency for the period of one control impulse cycle. This may be used to control any motor, or combination of motors for steering purposes. An oscillogram of the signal pattern and frequency is shown in Fig. 2 Dia. 1.

Selecting The Impulses

Seven impulses seem to be enough control channels for present purposes, alloting an impulse for each of the four units of the motor and leaving three for other operations, such as parachute opening, etc. The most practical system of selecting these impulses and placing them in their proper relation is through the use of the commutator mentioned before. This could be driven by a spring-wound motor and clutched in synchronism by a small electro-magnet, which is controlled by the oscillator in the receiver.

Another type of synchronizing mechanism, simpler but not as accurate, is one in which relays are used, with the same system of impulsing. The relays are started by a break impulse, which controls the first relay. This, in turn, controls each following relay of which there are seven, one for each control circuit. The complete circuit, with necessary control contacts and other accessories, is shown in Fig. 2 Dia. 1. By using this type of selection, an oscillator is not needed, as the pick-up time from one relay to another determines the frequency or synchronization of the circuit.

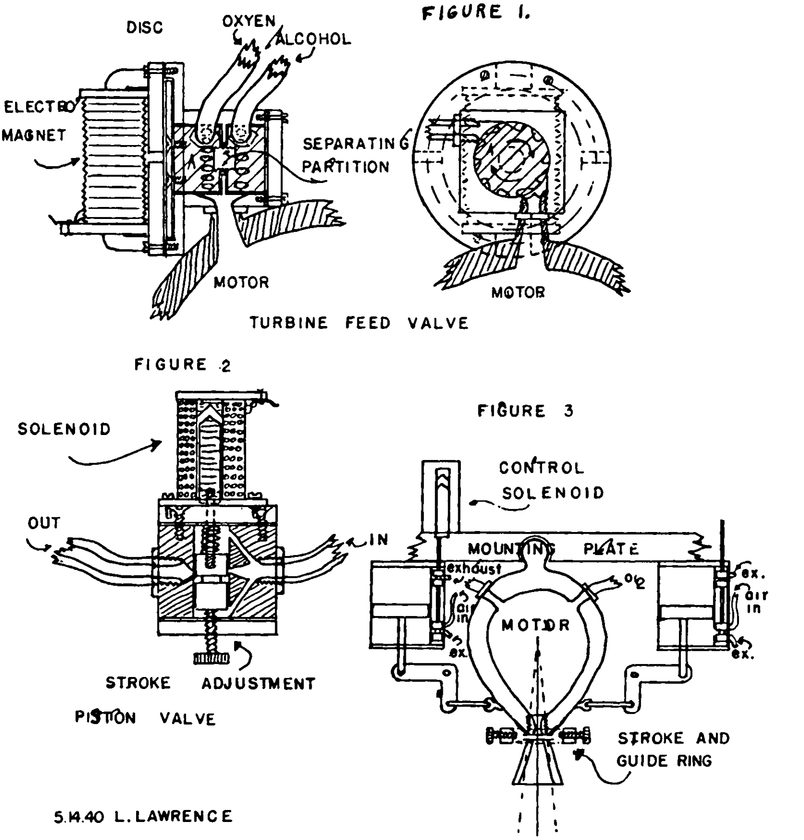

Diagram 2. Steering details

Turbine Valve Control

Now that we have devised means of getting selected control, some means of controlling the motor position or fuel feed must be used in order to steer the rocket while it is being shot upward. The magnetic valve or the vibrating piston valve, shown in Fig. 3, would have their place in this operation.

The turbine wheel (A) should have two sets of feeding cups, oxygen feeding in one side to one set of cups and alcohol to the other. The cups should be placed on the wheel in such a manner as to give the proper mixture. The wheel should be fitted into a well machined casing, with an iron disc of about three times its diameter connected to the wheel. An electro-magnet properly constructed to give maximum magnetic field over the surface of this disc, should be mounted as closely as is practical. The fuel which is fed to this wheel under pressure will cause it to revolve at high speed. A current is now applied to the magnet, generating a field about the iron disc, this causing a braking action of the amount desired, according to the current supplied to the coil. This should give us a very positive control of the fuel supply.

Mixing should be greatly improved by this method for both fuels instead of being fed separately, are squirted immediately into the firing chamber, with greater rapidity of combining achieved. The cups on the turbine can be placed in alternating positions giving a proper fuel proportion.

Vibrating Piston Valve

The other type of valve, (Fig. 2 Dia. 2) is the piston type and is possibly more familiar. If this valve were electrically vibrated and the speed of its vibration controlled very good results could be obtained. This mechanism would also be practical in controlling the air pistons suggested in the third method of steering. Valves of this type are well suited to test stand work and remote firing of the rocket, as well as the above mentioned use.

Transmission of these control signals by a small radio transmitter of approximately fifty watts of antenna power using a good beam antenna. would be most practical for short range operation. The synchronizing mechanism would, of course, be identical to that in the receiver to insure proper impulsing.

These methods of synchronization have been thoroughly tested and found quite practical. Although no workable models of these motors have as yet been devised, this system of synchronization can be adapted to similar plans without much difficulty.

Lovell Lawrence, Jr.

New Rocket Designs

Embodying several unique features the two rockets depicted on the cover, designed by Mr. Louis Goodman of the Experimental Committee, should give rocket enthusiasts food for thought.

Mr. Goodman has a preference for nose drive. These two designs are attempts to surmount the difficulties usually associated with this type.

In the twin motored projectile the jets are parallel to the axis. Potential range is increased by elimination of the nitrogen pressure tank. The self-generated pressure in the loxygen container is used to feed both oxygen and fuel into the motor. This is accomplished by leading the pressure to a chamber formed between the bottom of the oxygen compartment and the top of a piston. As the piston is pushed downward in the cylinder it squeezes the fuel from its flexible tank and forces it upward into the motor.

Also incorporated in this design is a simple parachute release method. When the rocket turns over at the top of its flight gravity pulls a steel ball downward to close an electrical circuit. This fires a small powder charge which ejects the parachute.

In the other rocket the motor is centered above a Venturi tube whose hollow walls contain propellants, payload and parachute. Feeding is orthodox. Nitrogen pressure from a doughnut shaped tank forces the loxygen, from a similar tank, and fuel, from twin cylindrical tanks, upward through feed lines which also serve to support the motor. It is generally agreed that a Venturi arrangement of this type would contribute appreciably to the thrust obtained from the motor.

State Of The Society

Secretary Krauss Reports Membership Gains; Interesting Meetings

We can look back upon the past year as one of definite progress. Proving stand tests and dry fuel shots have been directed to cover a wider field than has previously been the case, and much useful data have been accumulated.

Meetings

The program committee is to be congratulated in having brought to us such prominent personages as Dr. Sanford A. Moss, a pioneer in the field of Jet Propulsion; Dr. Otto Steinitz, a moving figure in German rocket experimentation; and Professor John I. Yellott of Stevens Institute of Technology.

Membership

Membership has shown an increase of over 20% in the past year, a most encouraging sign. The new membership shows a larger proportion of technical men than was evident in previous years.

Geographically, the membership is distributed over 23 states and the District of Columbia; Canada, England, Cuba, British Guiana, and France.

Effect of War

The war has caused a loss of some foreign members, but on the other hand, has resulted in additional subscriptions to **Astronautics.** There are at present 18 foreign subscribers to **Astronautics**, chiefly research groups, engineering firms, foreign official libraries, and foreign military attaches. As might have been expected, the war has given impetus to the interest of foreign governments in the rocket; this interest is manifest in increasing inquires from foreign official and quasi-official sources. This increased interest is not limited to foreign governments, as there is definite activity in our own military establishments. It is hoped that this activity in our own government will eventually lead to some financial assistance to experimenters.

After 10 Years

It was just ten years ago, to be exact, was just ten years ago, to be exact, Friday, March 21, 1930, that the first meeting of the Society, then known as the **American Interplanetary Society,** was held at the home of G. Edward Pendray. To quote from the minutes of that meeting "Those present were C. P. Mason, C. W. Van Devander, Fletcher Pratt, Nathan Schachner, Laurence E. Manning, William Lemkin, Warren Fitzgerald, Everett Long, G. Edward Pendray, and David Lesser". Who knows but what these ten have carved for themselves a niche in history, as ten daring individuals who had the courage to launch an undertaking which was undoubtedly looked upon by the general public with amusement, skepticism, perhaps derision.

Perhaps, as was the case with the airplane, the war will give the great impetus that will lead to the realization of the dreams of those early pioneers—the rocket as a practical medium of transportation.

—Max Krauss, Sec'y.

April 19, 1940

NEWS OF MEMBERS

TO PROMOTE ACQUAINTANCE among members **Astronautics** will list from time to time names of new and renewal members. Letters addressed to members listed, in care of the Secretary, will be forwarded. Thereafter, if the recipient wishes, the correspondence can be carried on directly.

Recent new and renewal members include:

Active Members:

James E. M. Garvey, North Royalton, Ohio
J. J. Pesqueira, N. Y. C.
Ludwig Stazer, Jr., Avalon, Pa.
George C. Putnam, Pacific Palisades, Calif.
Melville Ross, Sussex, England
Dr. Samuel Lichtenstein, N. Y. C.
Burton H. Johnson, N. Y. C.
Constantin P. Lent, N. Y. C.
James R. Glazebrook, N. Y. C.

Associate Members:

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Lt. Com'd. Justin M. Miller, Washington, D. C.
John H. Howe, Providence, R. I.
Lovell Lawrence, Jr., Jackson Heights, N. Y.
Lyman P. Hill, Hawthorne, N. J.
Michael Dublin, San Diego, Calif.
Douglas C. Davis, Webster Groves, Mo.
Miss Grace Huntington, Los Angeles, Calif.
Robert Gordon, Los Angeles, Calif.
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Morojo, Los Angeles, Calif.
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Igor I. Sikorsky, Stratford, Conn.
C. Chapin Cutler, Deal, N. J.
Adam Margeskes, Bronx, N. Y.
John A. Carlson, Pasadena, Calif.
Warren E. Stokes, Butler, Pa.
John G. Lee, East Hartford, Conn.
Walton A. Wickett, Palo Alto, Calif.

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Paul Tuntland, Baldwin Park, Calif.
Allen N. Saltzman, Bronx, N. Y. C.
Henry Kordella, Buffalo, N. Y.
Lee Tutching, Rockwood, Mich.
R. H. Muellerleile, St. Paul, Minn.

Affiliate:

Yale Rocket Club, New Haven, Conn.

LT. COMD'R. J. M. MILLER, who urged anti-aircraft rockets for national defense in the last issue of **Astronautics**, has been called back to duty in the Bureau of Ordnance, U. S. Navy.

LONG A WORLD FAMOUS DESIGNER of large flying boats, new member Igor Sikorsky recently added more laurels to his crown by earning the first U. S. license as "Helicopter Pilot". His outstanding Sikorsky S42s were used by Pan American Airways to pioneer both their Transpacific and Transatlantic routes.

BERNARD SMITH, a pioneer member of the Society and builder of its rockets Nos. 2 and 3, is currently engaged in forming a rocket experimental group at Los Angeles, where he now resides. Formation of the group is not yet complete, but present plans are to affiliate the Los Angeles experimenters with the American Rocket Society. Members of the Society living in or near Los Angeles are advised to get in touch with Mr. Smith. Hiss address is 1484 West 29th Street, Los Angeles, California.

AT A RECENT SESSION of the Junior Science Congress, held in New York City, junior member Allen Saltzman presented a prize-winning talk on "Rocketry". The growing interest in the subject by the youth of America is one of the most encouraging signs to veteran experimenters.

MEMBERS WHO RECALL the interesting paper on "A New Method of Determining the Rocket Trajectory", presented by J. J. Pesqueira at our March meeting, will be interested in knowing that some features of his design are being incorporated in a new pair of Range-Finders, now being built by the Experimental Committee.

NOZZLE DESIGN

EXPERT HONORS A. R. S. WITH LECTURE

(Continued from Page 8)

be under-expanded and will display the phenomenon of standing waves, but if greatly oversize the jet will be diverted from its axial path and cling to one side or the other of the divergent nozzle. To study these peculiarities of flow Professor Yellott used a most ingenious nozzle whose angle of opening could be adjusted by a simple manual control. This apparatus could be photographed in action, through a transparent plate, to show the flowing steam.

Most pertinent fact to rocket enthusiasts was that for the pressures now in use nozzles should be designed with flares of about 8° to 12° and should be cut about 10% shorter than the theoretically correct length.

Jet reaction is expressed by the equation:

$$R = \frac{W}{3600} \times Vel$$

As velocity of jet at exit is difficult to measure it is usually calculated from this equation, the other factors of which can be readily determined by test. This method has been used by the Society in all its test stand work.

In answer to a question regarding Mach's angle and its relationship to the frozen shock waves found in some of his tests Professor Yellott stated that this was determined by the ratio of velocities of sound in the jet and in the surrounding medium, the sine of the angle formed with the axis being equal to the ratio of these velocities.

James R. Glazebrook

NOTES AND NEWS

(Continued from Page 2)

home at Asheville, N. C. to devote his entire time and energy to the welfare of the Society. Mr. Johnson will be on hand to answer questions and discuss rocket research with callers at the Society's office: Room 382, 50 Church St. N. Y. C.

It was with regret that the Board accepted the resignation of Mr. Max Krauss, who has long served the Society as Secretary. Mr. Krauss asked not to be reappointed, because of the press of other work, and his feeling that the Society's offices should be rotated among the members to promote efficiency and greater understanding of the organizations' problems. Members of the Board, in accepting this request, expressed the opinion that the Society perhaps owes more to Mr. Krauss than to any other member for its continuance and success, and the business-like way in which its affairs have been managed. It is a pleasure to report that Mr. Krauss will serve the Society in other capacities, and will take an active part in its work.

In its new President, the Society is fortunate in having chosen a pioneer experimenter to head up its activities. Mr. Pierce joined the Society soon after it was founded in 1930. He was one of the principal builders and designers of its first rocket. At that time and since he has made innumerable contributions to rocket technology, and is one of the Society's most active and valuable members.

President Pierce has announced the following committee chairmen:

Committee on Public Relations and Membership, James R. Glazebrook
Experimental Committee, John Shesta
Technical Committee, Alfred Africano
Photographic Committee, Ruth H. Greene
Advisory Committee, G. Edward Pendray

CONTENTS

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