BULLETIN

THE AMERICAN INTERPLANETARY SOCIETY

113 West 42nd Street, New York, N.Y.

David Lasser, President — Clyde J. Fitch, Editor.

No. 16. — New York — February 1932.

CONTENTS — Page

* * * * *

THE PRINCIPLES OF INTERPLANETARY NAVIGATION

(Summary of an address delivered before the Society on Jan. 22, 1932 by C. P. Mason.)

For the success of the rocket as an interplanetary vehicle, we must assume that it is, to some degree, under the control of its crew. It cannot be fired, like Jules Verne's shot to the moon, to follow a predetermined orbit. The target is small; and the amount of deviation in the first stages of its flight, from the desired trajectory, will be too much, notwithstanding the use of gyroscopes or other automatic steering devices, for efficient flight. Nevertheless, the approximate path of a rocket, say from the earth to the moon, must be plotted in advance with considerable care. For this purpose, very thorough astronomical calculations must be made in advance. It must, thereafter, be possible to determine whether there is any material deviation from this course, and to correct such deviation by means within the rocket itself, under the direction of its crew.

The means of maneuvering a rocket have already been laid before you--- the discharge selectively, at will, of certain combinations of rocket tubes, disposed at such angles that the recoil will impart new compenents to the movement of the remaining mass. For further accuracy in aiming, we have a small, but swift - running rotary motor, near the center of mass of the rocket; which, by the reaction of its rotor, will slowly swing the whole vehicle about it as a pivot, and thus bring the tubes most accurately into the desired angle.

It now becomes necessary to consider something of the principles of navigation, as they are applied in a terrestrial voyage, and to realize a little more fully what a difference there is between our own snug, if occasionally depressed, planet and those regions beyond in which the sons of Adam are about to contend with the children of Eblis -- if I may personify the powers of Light and Darkness, Heat and Cold, Electricity and whatever its opposite may be.

The terrestrial navigator stands where Columbus did, upon a huge, temtest-beaten globe which rests immovable in the center of a heaven wheeling daily about it. (The navigator does, I say--not the astronomer.) The navigator may work his position as well whether the earth stands or moves; he is concerned with its surface alone; and perihelion or aphelion matters nothing to him, so long as he knows his position on that sphere. His guide book is the Nautical Almanac; with that, his chronometer and his sextant, he pushes ahead boldly.

The Nautical Almanac gives the positions of the heavenly bodies as they would be seen by an imaginary space traveler who has replaced our earth, and who sits in the center of its former toroidal path, regarding himself as stationary, and the heavens wheeling about him. From his observations, our navigator determines his position as it differs from that of the imaginary traveler--in other words, he brings himself to the surface of the earth.

Here is our observer, with a plumb line pointing to the center of the earth. The horizon he sees is a circle, slightly below a horizontal plane, parallel to his vertical. And here is his rational horizon, passing through the center of the earth, and also perpendicular to him.

Observations of the apparent horizon must be corrected for elevation and refraction; when this is done, the angles of the heavenly bodies from the horizon show his latitude and his local time; the latter, when checked against the chronometer, gives his longitude.
These two factors express his position.

Between the true horizon and the rational horizon--that taken from the earth's center--there is a difference of 3960 miles. This is nothing, in comparison with the distance of the stars. An observatory can detect it, with reference to the sun and nearer planets; but for the navigator, the moon is the only body which shifts in its apparent course materially with reference to his position on the earth. The moon will move nearly twice its apparent breadth; from north to south, or east to west, as the observer is at one edge of the earth's disc or another. However, the Nautical Almanac provides corrections for this parallactic effect.

The stars form a practically fixed background, which astronomers have mapped most painstakingly. Across this shift the sun, the moon and the planets, as they are seen from the earth. Two elements--the direction of the earth's axis, determining the poles of the heavens, and the time of its diurnal rotation, which causes the length of the day--govern the plotting of this apparently spherical surface. The earth's equator, projected on the celestial sphere, bisects it at the celestial Equator, or Equinoctial. North and south of this we measure celestial latitude, or Declination, just as it is measured on earth. Celestial longitude, however, is measured always from west to east. From an imaginary but well-defined point in the Heavens, called First Point in Aries (♈), we measure in hours, minutes and seconds the celestial longitude or Right Ascension, from 0 to 24 hours.

(These hours, because of the irregularity of the solar day, are measured in Sidereal or Star Time. The earth revolves on its axis once in 23 hours, 56 minutes, and some seconds, mean solar time. This period is divided into 24 hours in sidereal time; and the same fixed star always returns to the same position on the meridian at the same time of every sidereal day. The sun, however, because of the earth's motion in its orbit, "moves" steadily among the stars; and therefore 366 sidereal days are required to equal the solar year of

365 days, each four minutes longer.)

For astronomical purposes, calculations are made in sidereal time; for everyday purposes, these are then converted, by the aid of tables, into solar time.

The terrestrial navigator, therefore, has had his work reduced, so far as position-finding is concerned, to making observations and checking them against the very complete tables of the Nautical Almanac.

On the other hand, consider the navigator of space. When he has quitted the earth's atmosphere, he will find himself, it is believed confidently, in a vacuum in which there is no sense of direction. He has no horizon; the ball of the earth, which created it for him, has been taken away and is fast receding. He has no day or night, except as his vessel turns one side or the other to the sun and stars. He cannot, like the navigator, create an artificial horizon by pouring mercury into a dish, or drop a plumb line; for all the workings of gravity have apparently ceased in the interior of his ship.

On the dark side, the vault is studded with stars in greater number and brilliancy than he has seen on earth; on the other, the sun shines with a fierceness unknown at noonday in the tropics, with a radiance no man can bear and live. Is he moving in space? There is no indication. And, if he is moving, the position of his vessel means nothing. He may be moving up, down, forward, back or side ways, equally without sensation. Turn on the gyroscopes; but every atom of them partakes equally of the movement of the vessel in "free fall."

The stars mean nothing, except as he can observe the motion among them of the nearer heavenly bodies. The sun is there, as on earth, too bright to serve as an accurate basis of measurement. But we can measure the distance of a planet to a well-known star; and determine from the Almanac how its appearance contrasts with that it assumes on earth--if the difference be sufficient.

(The speaker indicated on a pair of star maps the apparent positions of the nearer planets at the time; and showed that Mars was unfavorably placed; that Jupiter was too distant to show much displacement; and that, at that hour, it would be almost impossible to measure accurately, especially with a sextant, the progress of a space ship from the earth to the moon, by the parallax of the planets).

The problem of observation also requires a new technique. In an observation on earth, it must not be taken through a window; because of the error introduced by glass in front of the instrument. Yet a window cannot be opened in a space ship.

We may conceive a space suit in which one window is replaced by an eyepiece. Stepping out through an airlock, the navigator screws the sextant over the eyepiece, and takes his observation in the normal fashion, undisturbed by any error of atmospheric refraction.

We may also have, say in the nose of the vessel, an airlock which can be exhausted. Here a telescope is mounted firmly to a central shaft, on which it may turn, marking angles on a graduated circle, with the accuracy at least of a small terrestrial observatory. When windows are flung open, measurements may be taken in any direction which their scope permits.

The sextant is an instrument devised for the special purpose of bringing together the images of two bodies--or usually, one heavenly body and the edge of the horizon--and reading off the angle. The contact depends upon the setting of the sextant, rather than the absolute steadiness of the hand of the holder.

In interplanetary navigation, we shall require especially an instrument designed for the accurate measurement of the diameter of an object--presumably by inverting opposite halves and opposing them. For a body such as the moon, with considerable irregularity of surface, it would be necessary to take the mean of several readings at various angles. This operation, with a body of known size, would give its distance instantly, on consulting a table.

With the distance of the moon known, by measurement of its diameter, and its direction known, by comparing its position among the stars with that which the preliminary plotting of the voyage indicated, the captain of the ship would be in a position to give the necessary orders for the correction of his course.

At present, the Nautical Almanac is calculated to give the geocentric positions of the planets and the sun--that is, as they are seen from the centre of the earth. There are also available, for the use of the astronomical profession, heliocentric tables, giving the position of the earth and planets, as they would be seen from the center of the sun, were that body removed. To these, before there can be successful navigation from our earth to its satellite and backs, there should be added selenocentric tables--that is, tables, carefully calculated in advance, giving the position of the heavenly bodies as they would appear from the moon, and by which the navigator, approaching or leaving the moon, could readily determine his position with regard to that body. To calculate such tables is within the power of our astronomers; and, though there is a slight irregularity in the moon's orbital motion, it means but a few miles and a few seconds at any time. Ready compensation could be made for it on the spot.

The problem of calculating the most efficient path of a rocket vehicle from the earth to the moon is one which will demand a great deal of labor from astronomers; since it involves a consideration of the attractive forces of three major bodies on the vehicle, as well as that of utilizing them to lessen the expenditure of initial energy. The best utilization of the rotary motion of the earth, to add its several hundred feet per second to the rocket's motion; of the pull of the moon, which will permit the journey to be made with an initial speed less than would otherwise be required to hurl a projectile 240,000 miles above the earth; the best time of the lunar month to make a journey, in both directions, with reference to the attraction of the sun--which over a considerable part of the trip is greater than that of earth and moon--must also be considered. We have also the problem of selecting a proper place of departure from the earth's surface. The rotation above mentioned, as well as the fact that the moon is always near the ecliptic (plane of the earth's orbit) suggest that a trip should be made from some point on the earth in or near the tropics; while other considerations dictate if possible an ascent from some elevated point where the air is quite rare, as well as clear.

The problem of travel to other planets, such as Mars or Venus, is too far in the future to deserve much consideration at this time. A trip to the Moon must be preceded by a great advance in technique, by the aid of high-altitude flights, stratosphere and hyper-stratosphere rocketry, etc. "When we get twenty miles up" said Bishop Wilkins, "We may consider flights to the moon"--or words to that effect. When travel from earth to moon and back has been put on a standardized basis, then the available knowledge will be sufficient to plan intelligently expeditions to the planets. The moon, with its lack of atmosphere and low "velocity of liberation", presents the essential bases for such further interplanetary work. In such interplanetary navigation, we may see, it will be necessary to proceed upon a heliocentric basis; for most of the trip must be made outside the jurisdiction of either planet concerned. Special methods must be devised and special conditions faced of which today we possess no knowledge. It may even be that some time a space ship will set out, equipped as a little world on which generations will come and go until the descendants of the first explorers will come to our nearest neighbor among the stars, and seek its planets--but this is departing beyond all that is at present calculable.

The question has been raised, of the manner of reckoning time in a space ship. In order to know whether a ship is proceeding on schedule, it is necessary to know, not merely her position but, even though she is in her appointed path, whether she is ahead of or behind her time. There are several possibilities. First, the standard chronometer, which is compensated and cushioned. Whether a chronometer of this type can be made to work in outer space is a question. We know that an electric clock, driven by a quartz crystal, can be made to work with an accuracy of one second in a million--sufficient for our purpose. However, in rising out of the atmosphere, a rocket must pass through a region of almost incalculable magnetic and electric activity, inducing within her, forces which may upset the functioning and calibration of any electric measuring instrument. We may also look to the radium clock, if it be proved that radioactivity is not affected by unknown cosmic radiation.

However, there seems little doubt that it will be possible to flash time signals, either by light or ultra-short wave radio, to a space ship, by methods laid down in his papers, some time ago, by Mr. Clyde J. Fitch. It is also possible, as proposed three hundred years ago, to note the eclipses, etc. of the moons of the major planets, which take place at frequent intervals, and may be predicted accurately. We have also what the first writer on interplanetary subjects in English (Bishop Godwin, in the Narrative of Domingo Gonzalez) pictured--the Earth rotating in 24 hours, presenting its countries in succession to the view. The Earth, however, with its highly refracting atmosphere, is not always a satisfactory object of observation; and the Moon, though always visible clearly, turns very slowly.

New instruments, new calculations, new navigators trained to the throttles of rockets, will be necessary to steer a space ship across a quarter of a million miles; but in all that is outlined, there is nothing which has so far presented a logical impossibility; and, on the other hand, there is no reason, why, barring the unforeseen, the problem of extra-terrestrial flight should not be worked out in a few years. It is possible that a method superior to the rocket may be found; but at present we have no intimation of a means which can be considered practical, except the rocket which, in the light of present science, can be developed to meet the necessities of the task.

* * * * *

NEW DISCOVERIES INDICATE METEOR DANGER IN SPACE

The following editorial, from the New York Times of January 15, 1932, indicates that more precise information regarding the danger in space to interplanetary travelers from meteors may soon be forthcoming. Although the editorial and the news story from which it was derived, did not state the density of meteors in space, Dr. Boothroyd has been approached by the Society for a copy of his complete report. The Times editorial follows:

DEBRIS OF THE UNIVERSE.

"The astronauts who would a-rocketing go to the moon and the nearer planets might ponder the implications of a preliminary report on meteors just issued by Dr. S. L. Boothroyd of Cornell. "We already "have observed nearly * * * 6,000 "naked eye meteors in three lunations and nearly * * * 500 telescopic meteors in one lunation." Professor Shapley's guess that a billion meteors large and small, may enter the earth's atmosphere in a day seems sober when we consider the limited field of the unaided eye and the telescope.

"Outer space can hardly be empty. Comets break up into fragments large and small, and the fragments continue to revolve around the sun, unless they are captured by the earth or some other planet. Fortunate are we in our atmosphere. It burns up most of the captured fragments by mere friction. The air is to a meteor what sandpaper is to a match. Were it not for that, the earth would be pitted by a terrific bombardment.

"Most of this debris of the universe consists of particles not larger than gravel or birdshot. But the velocities! They may be anything from 26 to 100 miles a second. A rifle bullet kills when it is traveling at only half a mile a second. With outer space as warm with high-speed bullets, not to mention rarer masses as large as office buildings, what chance has a rocketeer of seeing that face of the moon which is forever turned from us or of inspecting the canals of Mars?

"It is not to confound the astronauts that this study of meteors has been undertaken at the suggestion of Professor Shapley. Shooting stars are samples of the raw material out of which the universe was fashioned. It is as important to study them as to direct powerful telescopes at nebulae that were glowing before the solar system was formed. There is nothing spectacular about counting meteors or noting the regions whence they come. Yet such seeming drudgery adds more facts to the mass than astronomers have been steadily accumulating for centuries in their effort to solve the riddle of the universe."

* * * * *

RARE ATMOSPHERIC GASES VITAL TO LIFE, SAYS SCIENTIST.

To the necessities for an adequate amount of oxygen and water vapor in the air, other rare gases are also necessary for the sustaining of life, according to Dr. W. J. Humphreys of the U. S. Weather Bureau.

Without the one per cent of water vapor that our atmosphere contains no plant or animal life would be possible, said Dr. Humphreys, and the earth would be as dead as the moon. There would be winds across the earth, but no rain, and clouds of pulverized rock such as some believe fill the atmosphere of Venus, would be everywhere.

Even the small amount of carbon dioxide in the air is absolutely essential to plant life, and since animal life depends upon plant life the removal of carbon dioxide would cause the extinction of animal life on earth, The ozone in the upper atmosphere is necessary to protect us from the blinding intensity of ultra-violet radiations from the sun, altho the amount of this gas would hardly make a sheet about the earth 1/10 inch thick. On the other hand if this gas were removed we would lose what ultra-violet radiations we do get, no Vitamin D, so essential to life and health, would be formed. The study of the effect of the rarer gases of the atmosphere upon animal life should promote the knowledge of how man could exist upon other planetary bodies.

* * * * *

OTHER LIFE IN THE UNIVERSE POSSIBLE UNDER NEW PLANETARY THEORY

A new theory of how the solar system was formed, advanced by Dr. Ross Gunn of the U. S. Naval Research Laboratories, may indicate according to him that life in the universe is more prevalent than we had thought.

Dr. Gunn believes that instead of a collision between our sun and another star, the solar system was formed by the whirling of a great primeval star into two fragments. One became our present sun, the other rushed away into space and the fragments became the planetary bodies.

This hypothesis if accepted would make it possible for planetary systems to form much oftener than by the collision hypothesis, and so make the possibilities of life in other parts of the world more probable. Dr. Gunn believes that there are thousands of planetary systems in the universe some of which may have life not unlike that on earth.

Dr. Gunn's hypothesis is called appropriately the "skyrocket theory" and is intended to supersede the planitesimal hypothesis of Sir James Jeans, and Dr. Harold Jeffreys. Dr. Gunn believed that thousand-mile-an-hour electromagnetic winds blowing for millions of years caused the violent rotation of the mother sun, and when the speed of rotation caused a rovolution every six hours the star split." The other piece,"said Dr. Gunn, "went skyrocketing off into space."

* * * * *

NEW STRATOSPHERE BALLOON FLIGHT PLANNED

A rather novel ascent into the stratosphere by balloon, and descent to earth by a parachute is expected to be attempted by Count Theodor Zigly, Hungarian automobile champion and an Austrian engineer, Hans Braun, in February or March of this year.

The same Augsberg firm that manufactured the balloon of Professor Piccard is making the gondola for Zigly and Braun. This gondola, double-walled and supported by a balloon larger than that used by Piccard is expected by the men to ascend thirteen to fourteen miles. When they are ready to come down the men will cut themselves loose and descend to earth by a parachute.

Radio equipment will be carried, and through an Austrian radio station an attempt will be made to keep America informed of the flight by radio.

* * * * *

SECRET FARMAN STRATOSPHERE PLANE APPROACHING COMPLETION

A secret stratosphere plane expected to fly at 550 miles an hour at a height of 40,000 feet is approaching completion at the Farman airplane works near

Paris, France. Practical experiments on it by the French government are expected to take place within two months.

Gradual tests will be made of the 500 horsepower-motored, all enclosed plane. Its performance at 10,000 and 15,000 feet will be tested before the upper, rarefied region of the atmosphere are attempted.

Little is known to the public about this machine which has been under construction for a year. It is known that the Farman company was encouraged to go on with their work, by the successful flight of Professor Piccard to a height of nearly ten miles. It is becoming evident that there is nothing mysterious or dangerous about the upper reaches of the air, and that with proper equipment it should provide as safe a medium for passage as the lower levels.

* * * * *

SOCIETY'S ROCKET TO BE EXHIBITED

(At the Museum of Natural History in New York, the seven-foot rocket constructed by the Society will be exhibited on the evening of February 18. G. Edward Pendray, who has been in charge of the construction will deliver a talk on its features and possibilities, and parts of the German film, "By Rocket to the Moon" will be shown.)

* * * * *

ROCKET FUELS AND THEIR POSSIBILITIES

(A report delivered to the American Interplanetary Society, January 8, 1932 by William Lemkin, Ph. D.)

The problem of rocket fuels is as follows: Here we have a half dozen commonly known combustible substances or fuels. How best can we utilize each of these as a rocket propellent? By what combination of any two or more of these materials can we obtain highest thermal evolution, expulsion velocity, efficiency? What are the best means of transporting, handling, pumping, exploding this fuel to derive the maximum benefit out of it as a rocket propellent?

In the earlier rockets the fuel used was one of the common dry or powdered explosives, such as gunpowder, nitrocellulose, T.N.T., etc. In the case of all of these substances, the combustible chemical elements carbon, sulphur, hydrogen and others are provided with the necessary oxygen either in the form of an oxidizing agent, or as combined oxygen in the explosive.

Many of these explosive substances are remarkably powerful. In the early rocket experiments it was found that the gases left the nozzle of the combustion chamber, at a velocity of 8000 feet a second or more. Such ejection speeds, enormous though they might be, are insufficient to propel a vehicle into space.

With the turn to liquid combustibles, rocket investigators are beginning to see a solution to the problem of space flight. Professor Goddard was the first to give his attention to liquid hydrocarbons, and he is still engaged in perfecting a liquid fuel for rocket propulsion. In Germany, solid fuels had been employed on rocket propelled sleds and automobiles, as well as on airplanes and altitude rockets. These were all abandoned in favor of liquid fuels.

In each case the combustible liquid, is sprayed into the combustion chamber, where it meets a similar jet of liquid exygen. The use of the latter is one of the neatest devices contrived by rocket experimenters. Here is the necessary material to support the combustion of the fuel, and in a highly concentrated, easily obtainable and easily available form. True, liquid oxygen cannot be handled as any ordinary fluid. It is a highly volatile liquid, boiling furiously at any temperature above 181 degrees C. It must be transported and stored in double walled, spherical vessels made of spun copper, with the space between the walls highly exhausted. Care must be taken to permit any accumulated gaseous oxygen to escape from the vessel, otherwise a disastrous explosion might result. With the proper equipment, and necessary precautions, liquid oxygen becomes a powerful adjunct to the use of any liquid fuel in a rocket motor.

Professor Goddard, in 1929, was the first to send into the air a rocket propelled by a liquid fuel,- a secret combination of liquid hydrocarbon and liquid oxygen. In Europe, Valier, Heylandt and Oberth have employed a number of different fuels, with liquid oxygen. The German Interplanetary Society is engaged in developing liquid fuels according to the same general plan. The modest efforts of our own Society in the field of rocket experiment are directed along the lines of our foreign coworkers, with slight variations.

We are indebted to the Air Reduction Company of New York for assistance in our problems associated with liquid oxygen. Engaged in constant research is the field of liquefied gases, particularly oxygen, they are in a position to offer us much that is valuable in the way of advise and experimental data. They have extended an invitation to avail ourselves of their technical experience in the use of liquid oxygen.

Theoretically, liquid hydrogen, in conjunction with liquid oxygen is an ideal fuel. The chemical reaction results in a thermal evolution higher than that of most reactions. Hence the expulsion speed is extremely high. Oberth asserts that, with liquid hydrogen and oxygen he has obtained an expulsion speed of 14,000 feet per second. He employed double the amount of hydrogen called for by the laws of chemical combustion so as to decrease the strong tendency of the water vapor to dissociate back to hydrogen and oxygen. An added advantage in the use of liquid hydrogen as a fuel is that the expelled gases are relatively light, for the smaller the mass of the unit expelled at one time, the greater the general efficiency.

However, there are nevertheless certain practical limitations of liquid hydrogen. There is the difficulty of handling it. Liquid hydrogen must be maintained at a temperature lower than -252 degrees C. Its reaction with liquid oxygen is not easily controlled. We must turn to liquid fuels more amenable to handling and using, even if less powerful.

Oberth's second choice of a liquid fuel is ethyl alcohol and liquid oxygen. Alcohol does not present great difficulties of storing, handling and using. Further, alcohol has a much higher specific gravity than liquid hydrogen - the ratio is more than eleven to one-,and the size of fuel container necessary is materially decreased. Oberth states that, with a mixture of 9 parts of alcohol and 20 parts of oxygen he obtained a calculated expulsion speed of 9000 feet per second at a pressure in the combustion chamber of 20 atmospheres.

One of the drawbacks to the use of alcohol, is the difficulty of securing and maintaining it free from water. A highly purified fuel is essential and 100 per cent alcohol is more of a laboratory curiosity than an industrial commodity. One advantage, among others, in the use of substances like the hydrocarbons as rocket fuels is that these organic compounds are not missible with water in any proportion, hence can be obtained in an exceedingly pure state.

Most of the practical rocket research of the past two years has centred about hydrocarbons. Benzine, benzol, gasoline of various grades, as well as secret mixtures have been employed. Actual rocket flights have been achieved with the use of easily obtainable hydrocarbon fuels. Wherever rocket experimentation is being carried on, emphasis is being placed on the use of liquid oxygen in conjunction with either a pure hydrocarbon or a mixture of them.

The superiority of the hydrocarbon over alcohol liquid hydrogen becomes evident when both the energy content and the specific gravity are considered. Noordung states that, the number of calories per unit <u>volume</u> of fuel is more significant, than the number of calories per unit <u>weight.</u> In general, he says, compounds rich in carbon prove superior to those rich in hydrogen, though the heating value per unit weight is higher for the latter. Accordingly he suggests benzol, $C_6 H_6$, as a suitable fuel because of its high energy content per liter. Pure carbon would be the ideal substance, but, since this does not occur in liquid form, Noordung suggests a mechanical mixture of benzol with finely divided carbon in its purest form, such as lampblack.

Since gasoline has proved to be a practical fuel for rocket propulsion, a few pertinent facts about it are in order. Crude petroleum, the source of gasoline as well as a variety of allied products, is a mixture of hydrocarbons of the paraffine and olefine series. The chemical composition of these hydrocarbons ranges from C_3H_8 to $C_{60} H_{122}$. By fractional distillation this complex mixture is divided up into several parts containing the lower, intermediate and higher boiling liquids. Gasoline contains pentane, hexane, heptane and octane. It has an initial boiling point of from 70 F to 140 F, and a final boiling point of from 350F to 450F. Its heat of vaporization is 130 B.T.U. per pound and it has a calorific value of 120,000 to 135,000 B.T.U. per gallon.

Gasoline may be obtained with high purity and reliability; it is cheap in cost and requires no unusual precaution or devices for transporting, handling and exploding. In the forthcoming trials of the rocket built by the Society, it is planned to use several commercial varieties of gasoline with liquid air.

"High test" gasoline, also called "anti-knock" or "ethyl" gasoline contains a small amount of tetra-ethyl lead $Pb(C_2H_5)_4$. This ingredient is designed to eliminate motor knock, reduce the accumulation of carbon and furnish better acceleration and more power. It is problematic whether this will prove better than ordinary gasoline for rocket propulsion. The presence of the anti-knock dope does not help it varpoize more quickly or furnish more heat energy with oxygen. The presence of the organic lead may even, at the high temperatures in the combustion chamber, introduce complicating factors. Another possibly better fuel is aviation gasoline. Altho it does not evolve any more VTUs than other types it has higher volatibility.

* * * * *

Meetings of the New York members of the American Interplanetary Society are held twice each month at the American Museum of Natural History, 77th Street and Central Park West. Associate membership in the Society at $3.00 per year may be obtained by sending the first year's dues to the Secretary, Nathan Schachner, 113 W. 42nd Street, New York. Information on the other classes of membership, active and special may be obtained by writing the Secretary.