ASTRONAUTICS

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LEAVES FROM A ROCKETEER'S NOTEBOOK

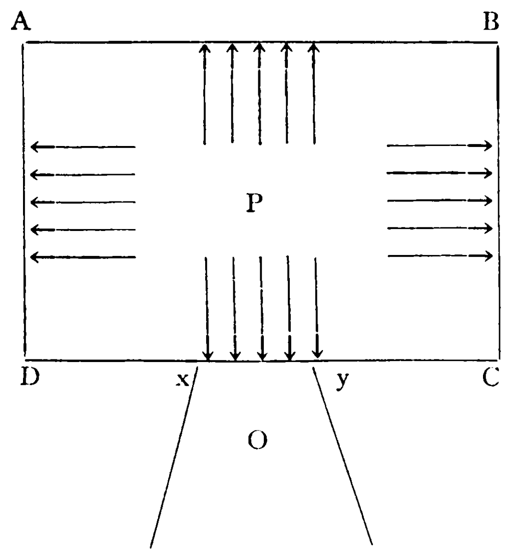
By G. EDWARD PENDRAY

Rocket enthusiasts now experimenting, or thinking about experimenting, are sufficiently numerous in this country to justify the collection of a few fundamental facts and calculations. In undertaking the task it is not my intention to develop a thesis on the theory of the rocket, or even to penetrate more than superficially into the mathematical analysis of a rocket's behavior. Rather, I hope these suggestions will form the beginning of a kind of field handbook for rocket experimenters, and a semi-technical primer for those who want to learn how a rocket works and why.

I

One of the questions most often asked—and one fundamental to our problem, is *"How does a rocket motor exert force?"* A companion question is: *"How can a rocket work in a vacuum, where there is nothing for it to push against?"*

Both of these questions can be answered graphically with the aid of this simple representation of a rocket motor, or combustion chamber:



Assume a chamber ABCD, walled solidly on all sides. An explosion takes place within it, building up pressure, P. According to our knowledge of the behavior of gases under pressure, the gas confined in the chamber will push equally on all sides, but the chamber will not move, for a push in any chosen direction will be exactly counterbalanced by a push in the opposite direction.

Now, assume that the partition xy is removed, allowing the compressed gas to escape through the orfice O. Under these circumstances there will be a push against the wall AB which is not fully counterbalanced by a push on CD. The chamber will tend to move in the direction of AB, with a force equal to the pressure on AB, less the pressure on what remains of the wall CD.

This makes apparent the mechanism by which reaction is transmuted into motion in the rocket motor. It also shows why such a motor would work as well in a vacuum as in air, if not better.

II

How May the Lift of a Rocket Motor Be Calculated?

We have seen that the lift of our theoretical motor is equal to the pressure on the wall AB, less the pressure on what remains of the wall CD. The push on the latter, obviously, will be equal to the original pressure on it, less the pressure on the area of the opening xy.

The lift of the rocket motor, therefore, will be equal to the pressure inside the chamber, multiplied by the area of the nozzle opening, plus or minus gains or losses due to expansion or friction in the nozzle flare. If the nozzle opening is circular, the formula for lift becomes:

$$L = P(\pi r^2) \pm x$$

Where L is the lift, P the pressure in the chamber, πr^2 the familiar formula for circular area, and x the gain or loss resulting from the passage of gas through the nozzle. In ordinary calculation the value of x may be ignored, though a combustion chamber might be so badly or so excellently designed that the values of minus or plus x would become an important part of the total.

It follows from the formula that very little change in the diameter of the nozzle will make a great difference in the lift of a given motor, provided the pressure in the chamber remains constant. Conversely, the lift may be considerably varied in the same motor, with constant nozzle diameter, by varying the pressure, as shown in the following table, in which the value of x is ignored:

Nozzle Diameter (in inches)	Combustion Chamber Pressures (in pounds per square inch)			
	150	225	300	1500
	Lift lbs.	Lift lbs.	Lift lbs.	Lift lbs
¼	7.4	11.0	14.7	73.5
½	29.5	44.2	58.9	294.5
¾	66.3	99.5	132.5	662.7
1	117.8	176.6	235.6	1178.1

III

What Should Be the Size and Shape of the Motor?

From our illustration it is clear that the chief factors, as far as the lift is concerned, are pressure, the cross-section area of the nozzle and the shape of the nozzle. The size and shape of the combustion chamber does not enter into the calculation.

Size and shape are of paramount importance, however, in determining the *efficiency* of a rocket motor. These propositions seem to be of fundamental importance:[1]

1. The chamber should be as small as possible commensurate with the quantities of fuels and gases handled.
2. The interior should be so designed as to facilitate the movement of gases and unburned fuels.
3. The routing of fuels and flame should be such as to assure complete combustion before the gases leave the nozzle.

Unlike the items earlier discussed, the problem of motor design does not lend itself readily to mathematical treatment, and there is still considerable experimental work to be done upon it. In general, experimenters have had most success with chambers which contain no pockets or corners. The favored shape is that of an elongated sphere, or that of an egg, with the small end opposite the nozzle.

The diameter of experimental motors is usually three to four times that of the nozzle. As to the size of combustion chambers, efficient motors have been constructed with lengths varying from 1½ to 3 times their diameter. Most experimenters favor introducing the fuels through in-

(1) Questions of motor design are too complicated to be discussed thoroughly in such brief space as can be given in this article. They have already been treated by Harry W. Bull in Astronautics (No. 21, 1932) to some extent. It is the intention of the author to amplify the above discussion in a later paper. Astronautics invites discussion from other experimenters also.

lets in the base of the motor, near the nozzle, the fuels being directed upward along the walls. This method appears to facilitate the movement of the gases, and to promote good combustion.

The inside dimensions of the successful motor of the American Interplanetary Society tested recently are as follows:

Chamber diameter	1½ inches
Chamber length	3 inches
Nozzle length	3 inches
Nozzle opening (small end)	½ inch
Nozzle opening (large end)	¾ inch
Oxygen fuel inlet	⅛ inch
Gasoline fuel inlet	1-16 inch

IV

What Should Be the Shape of the Nozzle?

It is evident that the rocket motor will be unable to extract all of the energy from the gases as they leave the chamber, except in the case where the speed of the motor is equal to or greater than that of the gas. In all other cases the products of combustion will leave the chamber bearing with them considerable amounts of unrecovered energy.

One of the most practical suggestions for recovering part of this power is the flared nozzle. The theory is that as the gases leave the chamber they will expand, exerting lateral pressure on the side walls of the nozzle. On the principle of the inclined plane, this lateral pressure can be turned into forward pressure if the nozzle is properly designed.

The flare is thus in the nature of a refinement on the rocket motor. For rockets moving at slow speeds the amount of energy theoretically recoverable by this device is an important fraction of the whole. Actually, there has been little or no experimentation; we have yet to demonstrate in practice how nozzles should be designed to gain the maximum value.

It is obvious, however, that an elongated nozzle, with or without flare, will tend to retard the lift of the motor, due to friction. The actual amount of energy recovered, then, will depend upon the excess of expansion "push" over the friction necessarily developed. It follows that the angle of flare will vary for every fuel used, and also for every different pressure developed in the chamber. Likewise it is clear that a slightly bell-shaped flare will be more efficient in all cases than a straight-angle enlargement.

The higher the pressure developed in the chamber, the faster the gas will be moving upon ejection, and the narrower the flare will have to be to gain energy by expansion. It appears likely, also, that the nozzle should be longer for high pressures than for low, though fine calculation is necessary to determine the point at which diminishing returns accompany further elongation, due to greater friction and greater weight.

V

What Will Be the Pressure in a Rocket Motor?

The pressure developed in any rocket motor will depend upon the speed with which the fuels are fed, the completeness of combustion, the ease with which the gas under pressure can escape through the nozzle, and the nature and specific behavior of the fuels.

Assuming that the combustion of the fuels is complete and practically instantaneous, we must consider two cases: (1) in which the fuels are fed by a positive pressure pump, and (2) in which the fuels are forced into the chamber by gas pressure in their tanks.

When the fuel is *pumped* into the chamber, the pressure will depend upon the volume of gas generated by the combustion of the fuel per unit of time, and the volume able to escape through the nozzle in the same unit of time. The pressure in a given system will vary with each fuel used. The experimenter will be able to change the pressure of his motor by three methods: (1) increasing the speed of his pump, (2) using a fuel of greater energy content, and (3) altering the area of the nozzle.

The comparative simplicity of rockets in which the fuels are sent into the combustion chamber by gas pressure in the tanks makes the problem of pressure in such motors especially interesting. Moreover, in such a case, the approximate calculation of the pressure is greatly simplified.

In such a system the fuels will flow at a rate dependent upon the difference between the pressure in the fuel tanks and that encountered in the combustion chamber. Since the pressure existing in the combustion chamber counteracts that in the fuel tank, when these two forces are exactly equal there will be no flow of fuel at all.

In a rocket motor the pressure in the chamber is created by combustion of the inflowing fuels, part of the pressure simultaneously escaping through the nozzle. Therefore, when combustion begins, the pressure will mount rapidly in the chamber to a point just short of the tank pressure, less line friction and other losses. For practical purposes, it may be assumed by the experimenter that the pressure in the chamber will then maintain an equilibrium with the forces behind the fuels at their entry ports, of such a nature that continuous flow will take place in just sufficient volume to offset the loss of pressure through the nozzle.

Thus, the pressure in a given chamber, provided the fuel entry ports are the proper size to permit inflow with sufficient rapidity, will approximately equal the pressure behind the fuels in the tanks. Obviously it cannot be greatly less, else extra fuel will spurt in to build up the pressure. It cannot be more, or the flow will stop.

The only exception to the latter observation is in the case of an "aspirating effect" developing in the motor. Some experimenters claim to have observed such an effect, which they ascribe to the rapid circulation of streams of gas past the entry ports, setting up areas of pressure lower than that generally obtaining in the chamber, and thus permitting fuels to enter at lower pressure than would otherwise be the case. The possibility of aspirating effect is not to be denied, and it is reasonable to believe that combustion chambers could be devised which will suck in their fuels with little or no outside assistance, just as steam boilers can be made to feed themselves with cold water without recourse to pumps. This is a field that requires considerable research and experimentation, however, before the practical builder of small rockets can take advantage of it.

If the pressure that actually develops in an experimental motor is conspicuously less than the pressure in the fuel tanks, faulty design is indicated. Faults may be looked for at five points: (1) the nozzle may be too large for the capacity of the chamber, (2) the fuel entry ports may be too small, (3) there may be clogging or excessive friction in the feed lines, (4) the proportion of combustible fuel to oxygen may be wrong, or the fuel poor in quality, and (5) the chamber may be so badly designed that combustion is intermittent, irregular or incomplete.

VI

How High Will a Given Rocket Go?

This calculation depends primarily upon the lift of the motor, the weight of the rocket and the fuel, and the resistance of the air.

The acceleration of a rocket may be obtained with this formula:

$$Ag=\frac{L-W}{W}$$

where A is acceleration, g the acceleration of gravity, L the lift of the motor in pounds, and W the weight of the loaded rocket in pounds. By this formula, if a rocket weighs ten pounds, and its motor lifts thirty pounds, the acceleration will be 2g, or twice the acceleration of gravity.

This figure may be refined by making a double calculation, applying the formula first to the weight of the rocket loaded with fuel, then to the rocket empty. Averaging the two acceleration figures gives the average acceleration of the rocket throughout its powered flight, air resistance being left out of account.

The height to which a rocket would shoot in a vacuum may be calculated thus:

$$\tfrac{1}{2}At^2$$

where A is the acceleration in feet per second and t the time in seconds. This figure must be doubled to find the full height to which the rocket would fly, since in a vacuum the upward distance covered on momentum would be exactly equal to that traveled during powered flight.

Let no experimenter assume, however, that his rocket will fly anything like as high in air as this calculation indicates. The resistance of the atmosphere is very great, at least within twenty to fifty miles of the surface of the earth. Moreover, it increases roughly as the cube of the speed; the faster the rocket is capable of traveling, the greater the resistance it will encounter.

Even with a rocket of the best possible streamlined design, the calculation based upon flight in a vacuum should be divided by three or four. If the figures show that your rocket should make an altitude of twenty miles, air resistance not taken into account, you may be fairly safe in expecting an actual altitude of four or five miles, providing the flight is perfectly straight and approximately perpendicular to the earth's surface, and the rocket well streamlined.

METEORS RECEDE AS ROCKET DANGER

Rocket flights of the future may very probably be free of at least one hazard in space—the Leonids. Every 33 years these meteoric wanderers in countless thousands have visited the earth and perished blazingly in the upper atmosphere. The last visit was in 1899 and even then a marked dropping off in number was noticeable from 1866. In 1933 about 200,000 Leonids were counted. During the 1932 visit, scarcely twenty could be counted around New York City, according to Clyde Fisher, curator of astronomy at the American Museum of Natural History. Twenty-four were reported from Philadelphia. The ascendancy of Jupiter has accounted for the phenomenon. It may be expected that none of the Leonids, or practically none, will be seen again near the earth.

Report on the Altitude Experiments with the Liquid Fuel Rccket HW 2 at the "Frischen Nehrung"

I. Purpose of the Experiments:

Since in March 1932 the motor-technique tests on the testing ground had drawn to a close, the apparatus now was to be tested as to its flying capacity. Special attention to be given to find out:

1. whether the estimated altitude of at least 5000 meters (slightly over 3 miles) as expected after taking into account the air resistance would be attained.
2. whether a greater flying stability was actually present in this larger sized apparatus, as compared with similar smaller ones that had been previously tested.

In the experiments, less emphasis was put on safety of operation than on determining upon what altitude of flight and what stability of flight one could depend in an actual test.

II Course of the Experiments:

On September 27, 1932 the test could not be undertaken, because of the feeding tube to the methane manometer not being tight while on the testing ground. Upon remedying the condition, the time for the test was fixed for October 6, 1932. In order to avoid an oxyhydrogen formation which might dangerously affect the cover between the explosion chamber and the outside coating, the apparatus was abundantly flushed with gaseous nitrogen shortly before igniting it. It was ignited in the usual way, by induction sparks. But before the controls for the liquid fuel could do their work, a tiny amount of oxyhydrogen (a few grams) ignited, exploding the thin outside coating and throwing the apparatus out of its starting position. During this experiment the outside coating was destroyed by the partial explosion, and furthermore the combustion chamber and the measuring instruments were damaged by the impact.

III. Results:

Flushing the hollow spaces between the fuel chambers and the outside coating, with gaseous nitrogen has proved insufficient. Flight-stability results could not be gained.

IV. Conclusions:

By way of construction, the formation of a methane oxyhydrogen mixture due to the unavoidable slight leakages, must be prevented, which might be accomplished by suitably arranged walls of separation.

V. Continuation of Experiments:

Since the damage done was not considerable, except for the outside coating, the apparatus is to be put in commission again. Next, the walls of separation requisite to preventing the formation of oxyhydrogen gas will be constructed. The experiments will be continued.

VI. Remarks:

Contrary to twisted descriptions of all sorts by the press, it must be said that these experiments were not to be regarded as a "demonstration" of a completely developed apparatus, but simply as one member in a sequence of experiments in the sense of pure research. It was neither expected nor was it essentially desirable that the series of experiments should be a success from the start. It is incorrect to say that these experiments were given publicity prematurely. The participants, in the first place, were representatives of official bodies which were connected with these experiments in one form or another. With respect to the attack directed against the existing rocket altitude record, only one paper, the Wolff'sche Telegraphenbüro, was invited, which did not send a representative to witness the experiment on October 6, 1932, so that the press was not officially represented during the actual test. Consequently, the test on October 6 was conducted with the public completely excluded.

Berlin, Oct. 10, 1932.

TIDAL EFFECTS NOTED OVER LAND SURFACES

Several indications point to the probability that the tidal effect of the Moon is not confined to the oceans. The actual continents move apart twice a day—the greatest recorded "stretching" being some 63 feet for the continents of America and Europe. This, of course, will help substantiate the theory of a plastic central earth core. The "stretching" effect was noticed first in a difference of astronomical time between observatories in England and in the United States amounting to one-tenth of a second. The only explanation was that the fixed points were farther apart at certain times of the day than at others. Evidence from other sources was later forthcoming.

REQUEST FOR BACK NUMBERS OF ASTRONAUTICS

Librarian Lee M. Gregory would appreciate receiving from members any back numbers of the old Bulletin, which they do not any longer need or may have in duplicate.

WINGS IN THE STRATOSPHERE

An excellent picture of life in the coming age of rockets and stratosphere planes is drawn by William H. Wenstrom writing in the New York Times December 18, 1932. Mr. Winstrom says, in part:

Before another year has passed some pioneering stratosphere ship may reach a height of ten or twelve miles; and if repeated test flights show practical high-altitude advantages, wings in the stratosphere may be common in five or ten years more.

When science and technology have produced planes which not only reach the stratosphere but carry fuel enough for several hours' flying as well, the real development of upper skyways will begin. Imagine the stratosphere ship SAS-1 taking off at dawn from Los Angeles into the golden east, bound for New York. Low-altitude transcontinental racers departing at the same time dart away like swallows while the wide-winged stratosphere ship, resembling rather a patient gull, slowly gains altitude.

At the end of the first hour, when the speed pilots can see ahead of them the red rocks of the Grand Canyon glinting under the climbing sun, the SAS-1 is still over California deserts, but now ten miles high, flattening out on a level eastward course through the blue silences of the stratosphere at 500 easy air miles an hour, and riding a sixty-mile tail wind besides.

As the second hour wears away it seems to the pilots of the SAS-1 that they are poised immovably in the blue depths of space. Only the gradual unfolding of the immense panorama beneath them, like a continuous and gigantic map unrolling ever out of the east, is the least suggestive of motion. But above the strangely insignificant mountains of Colorado are some minute specks which powerful field glasses might show to be the low-altitude racers. They are boring eastward at nearly 300 miles an hour, motors roaring wide open, every wire and stay joining in a strained whine, yet seen from the SAS-1 they appear to be moving inexorably backward toward the changing western horizon.

Further eastward the smudges of thickening cities merge into scattered clouds which gradually combine to obscure the variegated earth, hiding under a tumbled blanket of white wool what shrieking winds, what lightning, rain and hail the elevated stratosphere observers can only guess at. Then, far ahead at the eastern edge of the whole broad storm area, appears a thin band of darker blue that is the Atlantic, and, as it widens, a nearer and narrow strip of green shows that onshore winds are holding the clouds away from the coast.

As the ship nears the Atlantic seaboard her passengers can see through port cabin windows a spectacle of cosmic magnificence never duplicated on earth. The blazing sun sinks into the northwest, lighting a ring of yellow fire in the lower-level haze around the dark bulge of the world, and painting in the violet western sky an aureole of the most delicate rose. Overhead the deep atmosphere shades into varying tones of purple and blue, while to eastward the doomed earth-shadow climbs slowly into the evening sky. Low in the southwest hangs the new moon, a half-ring of burnished silver enclosing the old moon now distinct and clear in the soft, green radiance of reflected earthlight—no flat disk, but visibly the massive cold sphere that it is, swinging ponderous through unimaginable space under the gigantic pull of its parent earth.

As the western sky darkens, a great slanting pyramid of diaphanous white, based on the grave of the sun, marks the shy zodiacal light rarely seen through the dust and haze of lower levels. The unnumbered stars shine out everywhere with steady brilliance, and the luminous band of the Milky Way stretches, one continuous fabric of stars and nebulous star-dust, across the whole dark heaven. The stratosphere passengers sit quiet, awed—to stir only after the ST-7, sinking steadily on the long glide to Newark, has lost somewhat of cosmic glory in the unhurried approach of innumerable lights on the dark ground below.

As a later development of stratosphere transport, the oceans may be bridged by non-stop flights within the space of a few hours. Perhaps the AST-3 leaves Le Bourget, outside Paris, at 6 p. m., bound for New York. It is larger than the transcontinentals, its powerful radio can raise both shores from the middle of the ocean, and a navigator continuously plots its position by celestial observations and radio bearings. In case of trouble over the Atlantic, from a height of ten miles it can glide more than a hundred miles to a safe landing alongside some convenient steamer. Using rocket propulsion in the stratosphere, as well as the pull of its high-pitch propellers, it cruises comfortably at nearly 700 miles per hour, making the Europe-America run in a little less than five hours.

As the AST-3 gains altitude over the lower reaches of the English Channel, its passengers begin to notice a very curious phenomenon. The sun, which seemed on the point of setting, is now arrested by some invisible but all-powerful

Joshua; after an hour or two, in fact, it actually appears to be imperceptibly rising! The AST-3 is speeding westward faster than the great earth itself rolls around in its diurnal spin, and its passengers have temporarily escaped the inexorable march of time.

Out over the unending miles of blue water, the passengers amuse themselves by watching for the smoke trails of streamers on the ocean floor below. Even when directly beneath, the surface leviathans themselves look like slow water-crawling insects, wearily dragging diminutive trails of white foam across ripples such as the gentlest breath might stir on the surface of a pond.

Are the ST-7 and the AST-3 mere figments of the imagination, or some little prophetic of wonders to come? Experiment is the way to find out. Here in America we might well undertake some definite research with wings in the stratosphere. France and Germany are alive to high-altitude possibilities; why not the United States?

THE AGE OF ROCKETS

(An editorial from the New York Sun January 7th, 1933.)

Cross the Atlantic in thirty minutes? Professor Auguste Piccard believes it may be possible—not by ship or plane but in a rocket. He has invented a rocket that he figures should go 185 miles a minute. It could be designed to fly the ocean with passengers or mail. He knows seven other scientists in Europe who are experimenting with rockets. The next era may be an age of rockets, The present generation may live to see the sky full of whizzing projectiles. Such a possibility does not seem too fantastic when Professor Piccard thinks about it, for he is the man who started for the stratosphere and got there. It is his theory that the air at high altitudes is an ideal speedway for rocket flights and that any speed up to three miles a second should be simple—after the mechanical details have been worked out.

The first daredevil to pilot a rocket from Battery Park to the Rue de la Paix in half an hour will become another Bleriot; after him may come the deluge. New Yorkers will take a stratosphere express to a luncheon in London. They will go to theatres in Mexico City or Montreal after dinner. Business men and women will commute in rockets from the wilds of Long Island or New Jersey to Wall street in less time than they can now telephone across the distance. The rocket stations, local and express, will be in the tips of skyscraper towers.

The habit of spending winters in the South will become obsolete: instead, those who can afford it will swim, play and sleep in Miami or Los Angeles any day of the year and attend matinees and afternoon receptions in Manhattan. The summer tour of Europe will require only twenty-four hours of traveling, split into ten-minute hops from point to point on the Continent. The air will be screeching with projectiles carrying loads of merchandise, love letters and holiday greetings.

Ordinary aviation will be a hazardous business in an era of rockets. Show the world that a steel tube with a speed of three miles a second is a workable conveyance and some bright fellow will find a way to make them for the public at $250 or less. There will be no tire trouble, but the rocketeers will learn to beware of punctured parachutes. When the stratosphere is crowded with missiles that can outstrip the wind, when rockets leap aloft from the ground or swoop to the roofs of the city, anything as close to the earth as an ordinary airplane will find itself in a shower of vertical traffic. A dirigible will have no more chance than a soap bubble in a hailstorm. Traffic problems will be slightly different in the stratosphere from those on the ground; it will be easy enough to keep moving, but what driver of a rocket going a hundred miles a minute will stop on a red light?

MAN-CARRYING ROCKET PLANNED

Herr Heinrich Nebel has announced plans for the construction of a rocket to carry a pilot. The funds are assured by the City and Bank of Magdeburg, Germany, and permission granted by the authorities. The cost will be $4000 and the ascent is tentatively scheduled for next spring. The rocket is expected to rise 3,000 feet and will descend again by means of a large parachute. The pilot will leap out and float to the ground on a separate parachute.

An acceleration rate of 100 feet per sec./ per sec. (approximately 3 gravities) is planned and the exhaust is in the form of adjustable nozzles with which Herr Nebel hopes to regulate the velocity of ascent. Rocket is to be of aluminum and fuel to be alcohol and liquid oxygen.

SPEED-PLANE TO BE ROBOT-CONTROLLED

Lt. Com. Frank Hawks' new airplane, just completed, is to have an automatic pilot controlled by compressed air, for use as a relief to the regular pilot during long flights. The ship is expected to make its best speed at 20,000 feet above sea-level and to be the closest thing to a practicable stratosphere plane now in the air.

NEWS OF THE MONTH

ROCKET PATENTS RECENTLY ALLOWED

1,879,187, dated Sept. 27, 1932 by Robert H. Goddard and titled "Mechanism for Directing Flight". Essentially this mechanism consists of a series of vanes which may be projected into the atmosphere rushing past the rocket when in flight or, if in space, the vanes may be projected into the stream of exhaust gases. The control is automatically made by gyroscopes. A deviation of the ship from its course does not affect the position of the gyroscope, which continues to retain its original position. The result is that a valve opens, permitting gas to enter under pressure and so projecting a vane or fin which automatically causes the ship to resume its original set course.

1,879,579, dated Sept. 27, 1932 by Hermann Stolfa and Rudolf Zwerina of Vienna, Austria and titled "Rocket." This is a design for a rocket which includes a combustion chamber and an exhaust. The gases rushing from the combustion chamber make a turn of 180 degrees, which fact (the inventors claim) gives an added impetus to the force driving the rocket.

1,880,579, dated Oct. 4, 1932 by Reinhold Tiling of Osnabruck, Germany, and titled "Method of Producing Rockets, Especially for Aeronautic Purposes." This is a design for packing solid fuel rockets under high pressure, leaving a "core" which is loosely filled with powder. In burning such a rocket the early stages of combustion are relatively slow and the later stages relatively fast.

1,880,586, dated Oct. 4, 1932 by Reinhold Tiling and titled "Flying Rocket." This is a mechanism of two wings and their controls for the purpose of lowering rockets gently to earth after completing a flight. At the start the wings are closely pressed along the sides of the rocket. After the proper interval of time, or by means of any other device to operate the release, a charge is exploded forcing the wings outward. The rocket, now without power, sinks in a spiral to the earth. This method has apparently been the basis of several successful rocket flights during the past two years in Germany. In effect it is a substitute for a parachute.

DATA ON JUPITER'S ATMOSPHERE

Gaseous ammonia has been detected in the atmosphere of Jupiter by Dr. R. Wildt of Gottingen University, after a study of the infra-red spectrum of the planet's light. He has also found methane (marsh-gas) in the atmosphere of Jupiter, Uranus, Saturn and Neptune.

PICCARD PLANS LARGE ROCKET

Professor Piccard, who is scheduled for a lecture tour of United States at this time, is interested in other things than the stratosphere. Before he sailed for America January 4, he announced he invention of a rocket which he believes can eventually be made practical for trans-atlantic mail and passenger service. He has already carried on some experiments. He has calculated that his rocket could traverse the Atlantic in half an hour or less at a speed of three miles a second. No further details were announced, but Professor Piccard told reporters he knew of seven other scientists in Europe making secret rocket experiments at the present time and that he expects rapid progress in this realm of scientific study.

In regard to his stratosphere experiments, as previously announced, he expects to conduct investigations in the Hudson Bay region to test certain theories concerning the deviation of cosmic radiation toward the magnetic poles. He will bring with him to this country an exact reproduction of the metal sphere in which he made his latest ascent into the stratosphere. The real cabin has been damaged but will be later brought over and exhibited at the Chicago exposition.

PICCARD PROPHESIES ROCKETS TO PLANETS

The following Associated Press dispatch is worth quoting in full for the benefit of those who may not have seen it:

WASHINGTON, Jan. 13 (AP)—Professor Auguste Piccard said today that men may fly to other planets in rocket planes in the future, but they will not be able to come back.

It would take twenty tons of explosives to shoot a one-ton rocket plane away from the "pull" of the earth's gravitation and get it well started on its way to another planet, and ten more tons would be needed to act as a braking force when the rocket returned to earth. Carrying so much weight would be impracticable for rocket planes, he said.

Study of the cosmic rays, for which Professor Piccard made his two famous balloon flights into the stratosphere, may help unlock tremendous energy in atoms, however, he explained, and use of this energy might overcome the difficulties of sending rocket planes on "round trips" to other planets.