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THE AMERICAN INTERPLANETARY SOCIETY

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David Lasser, President   Clyde J. Fitch, Editor.

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RECENT WORLDWIDE ADVANCES IN ROCKETRY

(Abstract of a report by G. Edward Pendray to the American Interplanetary Society at meeting of November 13, 1931.)

Almost exactly six months ago tonight I addressed the society on the subject of worldwide advances in rocketry, particularly the work of the German inventors at the Raketenflugplatz, bringing up to date at that time the whole history of rocket experiments and ending with a description of the German Miraks.

It is a commentary on the rapidity with which this new field of engineering is being developed that since last May, the whole complexion of rocketry has changed. In this period the study of rockets has widened itself geographically--experimenters on at least two new continents have become interested in developing rockets. New experimenters have entered the field both at home and abroad. New designs have replaced the old.

It is in the latter phase that the most radical changes have taken place. Designs which were the latest thing last May are already obsclete. Liquid fuel problems are now definitely on the way to solution--may, in fact, be considered solved as far as small rockets are concerned. Liquid fuel rockets have for the first time been shot appreciable distances, and progress has been made toward controlled, stable flight.

The Miraks

To understand fully what the new developments mean and whence they have originated we must return briefly to the work of the German Interplanetary Society's engineers at the Raketenflugplatz, Berlin. (See Bulletin No. 9, May 1931, for a full discussion of the Miraks). Despite the fact that engineering interest in the possibilities of rookets first appeared in this country, through the researches of

Dr. Goddard, the Germans appear to have been the first to think constructively along these lines and to sacrifice any great amount of time and money. Whatever the reason, it appears true that the Rakentenflugplatz at Berlin is today the well of inspiration from which all rocket experimenters, with one or two possible exceptions, have drawn.

This is partly due, no doubt, to the fact that the German engineers have never undertaken concealment of their designs or discoveries. They do not give out veiled statements about secret fuels or secret designs. They have offered the results of all their discoveries freely to other experimenters, and the inevitable consequence of this is that rocketry has been greatly advanced by their efforts. Also, because of the interest they have stirred up in this new branch of engineering, many ideas are offered to them. They have a full-time staff of half a dozen or so mechanics and engineers constantly at work on the problems connected with rocketry. It is inevitable that the fastest advances should be made under such conditions.

Up until last May the Raketenflugplatz had produced three rockets, none of which had been flown, but all of which were capable of flight. These were the three Miraks---the first practicable liquid fuel rockets whose design is known to us. These rockets successfully demonstrated that liquid fuels could be used without special pumps, that oxygen and gasoline were adequate fuels for small rockets, and that the chief problem connected with rocket motors, aside from that of correct design, was cooling.

The general design which has superseded the Mirak type of rocket at the Raketenflugplatz has been named by the Germans the "Repulsor." The name Repulsor, it is evident, is derived from that of the rocket principle, repulsion. It signifies nothing, except perhaps the tendency of the Germans to fancy important-sounding names.

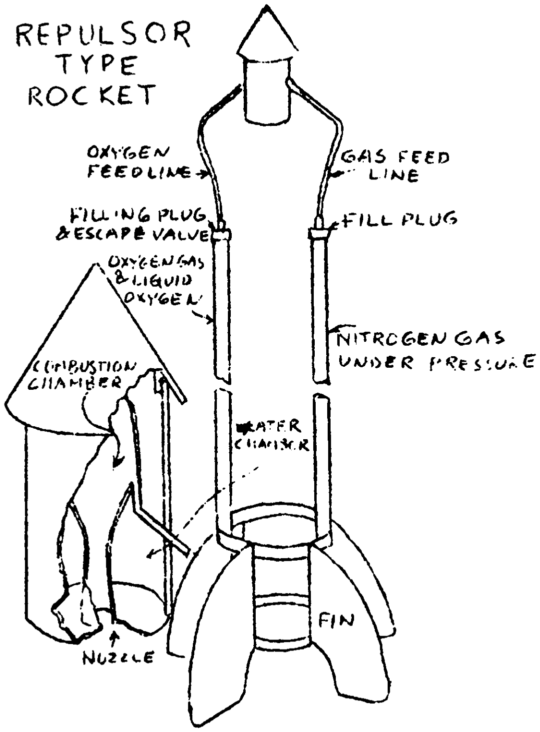
The first Mirak, like the others, was based upon the proposition that the minimum requirement was capacity for 1 litre of fuel. It consisted of two tanks, one for oxygen and the other for gasoline, a device for generating gas pressure over the gasoline to force it into the combustion chamber, and the combustion chamber itself, together with necessary feed lines and shut-off valves.

Fastened down to an apparatus which measured its lift, the First Mirak developed enough power to raise itself, fully loaded with fuel. But it was never released. After two or three tests the oxygen tank blew up. The trouble was that no safety valve had been provided, and as a result the gas generated by the heat of combustion of the motor was too much for the frail construction of the upper chamber.

In the Second Mirak two changes had been made. In the first place there was an escape valve for the oxygen pressure. In the second, the design and construction of the motor was changed. The Second Mirak, like the first, was never released. Experience with the design of the First and Second Miraks proved pretty conclusively that the shape of neither motor was correct, that ceramic linings were unsuited to small rocket motors, at least, and probably were no good at all, that a better balance was needed for the entire design, that the motor should not be placed in contact with the oxygen supply, and that carbon dioxide, generated by a charger, was not sufficiently reliable as a source of power for firing gasoline into the combustion chamber.

Attempts to rectify earlier mistakes and to take advantage of the lessons learned through the first two Miraks may be seen in the design of the third Mirak. The motor was no longer placed inside the oxygen tank, but perched beneath it, exposed to the air. Instead of one projecting leg we have two; one to hold the gasoline, the other to carry nitrogen under pressure for forcing the hydro-carbon into the motor. The purpose of two projecting legs was to give better balance, and the purpose of placing the motor outside was to keep it away from the oxygen and also to afford an opportunity for air-cooling. The efficacy of this latter plan was enhanced by putting on cooling flanges.

REPULSOR TYPE ROCKET



This Mirak would have been able to fly upward with an initial acceleration of more than 32 feet per second per second. It carried enough fuel for about thirty seconds of burning, and would have been capable of reaching a height of three miles or better. But unfortunately there seemed no simple way of equipping it with a parachute apparatus to bring it back safely, and without a parachute it would have been smashed on its first flight.

Furthermore, up to this stage the efforts of the Raketenflugplatz engineers had been directed principally toward getting a machine that would fly. Now that they had built one, they found themselves confronted by several unsolved problems. Not only was there the parachute problem to be solved, but there was also that of stability in flight. This had been settled in theory by placing a large part of the weight behind the motor. But there was no way of determining how the Mirak would actually fly without shooting it, and this might result in the first trial in a smashup which would destroy all the work without yielding any important information.

What was needed was a simple, cheap and easily constructed test rocket to settle these problems---a rocket which, if it fell or burst, would be no great financial loss, and one which could be quickly and cheaply replaced.

The result was the first Repulsor, which was put together by Klaus Reidel, one of the engineers. As you can see in the drawing, Reidel obtained the idea directly from the design of the Third Mirak. By putting the nitrogen and gasoline in one leg instead of two, and placing the oxygen in the other leg, the heavy and expensive aluminum tank at the top could be dispensed with.

The first Repulsor was built in a few hours. Unlike the rocket in the drawing, which was of a somewhat later development, the first Repulsor consisted only of tube-tanks, guiding fins, feed lines and motor. The motor was the same as that designed for the Third Mirak, with air-cooling flanges. After the first trials the air-cooled motor was replaced by one like that shown in the drawing with a pot of water for cooling. Later a little parachute was added at the top, worked with a time-fuse.

The gain represented by the Repulsor is somewhat greater than the advantage merely of lighter construction. It also places the motor ahead of all fuel weight, thus taking advantage of the maximum of the increased stability resulting from this arrangement.

The First Repulsors

It was a liquid fuel rocket of this design which first flew at the Raketenflugplatz. It has been preceded into the air by only two liquid fuel rockets---that of Dr. Goddard, shot in 1929, and one built by Dr. Winkler and shot off near Dessau, Germany, early last spring. So far as I can learn the Repulsors now hold both altitude and distance records for liquid-fuel rockets.

A number of shots have been made with these two-stick Repulsors, and their courses have been followed with cameras and other devices for determining their speed and height, though to date they have not themselves carried any instruments. When in flight they move so swiftly that the eye can hardly follow them, and often in an extremely erratic course, despite their theoretical balance.

In the first shot the rocket reached an altitude of only 45 meters, or about 150 feet. In the second it went nearly 440 meters, or nearly a quarter of a mile. Encouraged by these results, the engineers were astounded by the action of the device on the third trial. It went up a few feet, turned suddenly and knocked against the wall of a nearby building, then spent its energy in a series of loops a few hundred feet in the air.

During these loops the cooling water, which contained as shown in a hood over the motor, flowed out, and the motor burst. As a result the rocket had to be rebuilt, and a pipe was arranged to keep the water from running out so easily, but permitting the steam to escape.

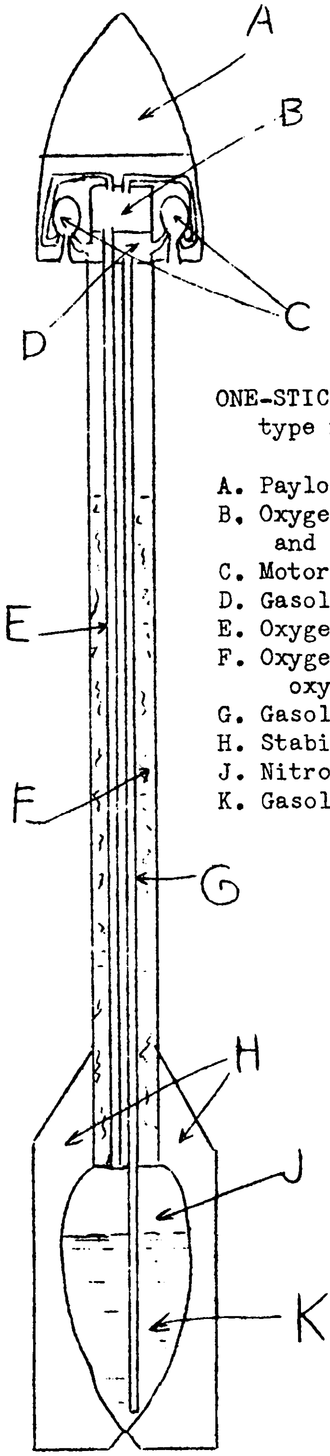
A similar experience, even more disastrous, brought an end to a subsequent experiment with this apparatus. Reidel, having repaired and rebuilt the rocket, filled the tanks and set it off, This time the Repulsor shot upward to an altitude of about 180 feet, then turned sharply northward and flew almost out of the Raketenflugplatz at a speed estimated at more than 150 miles an hour. As its greatest speed in this horizontal flight the rocket reached an estimated velocity of better than 250 miles an hour. It burned for about eight seconds after the overturn in midair, and the flight continued for more than four seconds after the fuels had ceased to burn. It is hard to tell how much farther this shot would have gone, for unfortunately a tree was standing directly in its path. The feed lines were smashed and the fuel-tanks torn loose from the fins, but the motor was found intact and the cooling water was still in the pot, though very hot.

It was in a subsequent experiment, after the steering fins had been somewhat modified and other slight changes made, that the most successful shot of all took place. In this effort the Repulsor nearly straight up, reaching an altitude estimated by the engineers to be about 1½ kilometers, or nearly a mile. It came down again by parachute.

The One-Stick Repulsors

In appearance and in action the Repulsors are little more than toys. Nevertheless, they represent an important development in rocket design, and they make possible certain indispensable experiments in balance, flight-stability, launching technique, fuel control, and landing apparatus.

It is obvious, of course, that their chief drawbacks consists of the weakness of the upper parts, their smallness, and the awkardness of the two-stick



ONE-STICK REPULSOR
type rocket

A. Payload compartment
B. Oxygen upper chamber and flight control
C. Motors
D. Gasoline upper chamber
E. Oxygen feed line
F. Oxygen liquid under oxygen gas pressure
G. Gasoline feed line
H. Stabilizing fins
J. Nitrogen gas under pressure
K. Gasoline

construction, together with the difficulty of incorporating any devices which make steering or stabilization in flight possible.

It was inevitable that after a few successful flights efforts would be made to overcome these difficulties. Obviously the main trouble lies in the spraddle construction made necessary by two sticks. If these two sticks could be combined into one, much of the trouble would be already avoided. Clearly this might be accomplished in three ways: (1) the two sticks or tanks could be fastened side by side, perhaps soldered together (2) one tank could be smaller in diameter than the other, and be placed inside it, or (3) the tanks might be joined end to end.

The first method will obviously not solve many of the difficulties because the amount of fuel in the two tanks differs considerably, causing unequal weight, and therefore throwing the rocket out of balance. The second might be accomplished, but it would lead to complicated design and probably extra weight. The third is certainly the simplest and most logical.

The joining of the tanks by the third method leads to the construction of a one-stick Repulsor which may look somewhat like the accompanying drawing. Now it is clear what all of this evolution has been leading to. This device, more than any other actual arrangement so far built, looks like a real rocket--one able to fly great distances, able to steer itself and to carry instruments and even men, if it were large enough.

The Germans have already succeeded in building two or three successful one-stick Repulsors. The drawing here indicates that this rocket has more than one motor, fastened to the side of the head in such a manner as to drive the rocket forward. In the first one-stick Repulsors only one motor was used, fastened, as in the case of the two-stick

Repulsors, upon a loop of tubing, well ahead of the fuel tanks to avoid overheating them.

Whether powered by one motor or several, Repulsors of this type are, from an aerodynamic point of view, arrows. The fuel tanks have the same axis, and the balance is not disturbed, whether the tanks are full, partly full or empty. The power is still applied well ahead of the load, thus aiding stability in flight.

The advantages of this arrangement over both the one-stick repulsor and the Third Mirak are obvious. Herr Ley reports that several successful shots have been made to date with one-stick Repulsors, using oxygen and gasoline as fuels. One shot, set in flight at an angle, went a distance of five kilometer (about 3 miles) and followed an almost straight course without serious deviation in the air. At the greatest height of this flight the Repulsor reached an altitude of nearly a mile.

As a result of these successful experiments the German engineers have announced that they are now building a rocket of the one-stick Repulsor type which they believe will be able to reach an altitude of about 25 miles. This rocket will have three motors, each about eighteen inches in total length, including the nozzle.

The first motor is already finished, and on the first trial in the proving stand it developed a lift of about 140 pounds. Slight changes in the fuel mixture and fuel inlets are now being made, and when they have been completed the engineers expect the motor to yield a lift of more than 180 pounds.

Should three of these motors be used on the new rocket they will have a combined lift of 540 pounds, or more than a quarter of a ton. They would be able to lift a rocket weighing 270 pounds (loaded with fuel) at an acceleration of 32 feet per second per second. The estimated altitude of 25 miles appears small for such a Repulsor.

The Rocket of the Future

Such tremendous changes in the design of rockets has come about since last May, when I last ventured to prognosticate the future of these developments, that I hesitate again to plunge into the icy waters of prophecy. But those of you who heard me then will probably remember that even at that time I asserted that I believed the inevitable development would be toward rockets powered at the nose. I then foresaw one rocket chamber with several nozzles placed around the periphery, but this development, it is now clear, will not come to pass, for there is an advantage, theoretically at least, in having separate motor chambers. This advantage lies in the possibility of using the power derived from the chambers in guiding the rocket during the powered part of its flight.

I will take up this question of steering the rocket a little later. At this point I wish to say that the arrow-shaped rocket, powered by several motors near the head, appears to be the logical development, and this general design will probably be seen in small rockets of the future intended to be used in air. It is likely that the body of the rocket will get thicker, gradually acquiring better streamlining and perhaps approaching once more the cigar-shape imagined by Oberth and others. It may even be that the exhaust will escape through flutings or special channels so that from a distance the rocket will appear like a smooth, torpedo-shaped projectile. Very likely the head, or a portion of it, will bear lateral scorings or flanges to promote cooling.

The pay-load, of course, will be placed ahead of the motors, together with the parachute for landing. Steering, while the motors are firing, will probably be accomplished by modulating the fuel fed to each one, according to the direction to be taken. After the rockets have been shut off steering will be accomplished either by movable fins or by spurts of rocket power applied only long enough to cause the projectile to take its new direction.

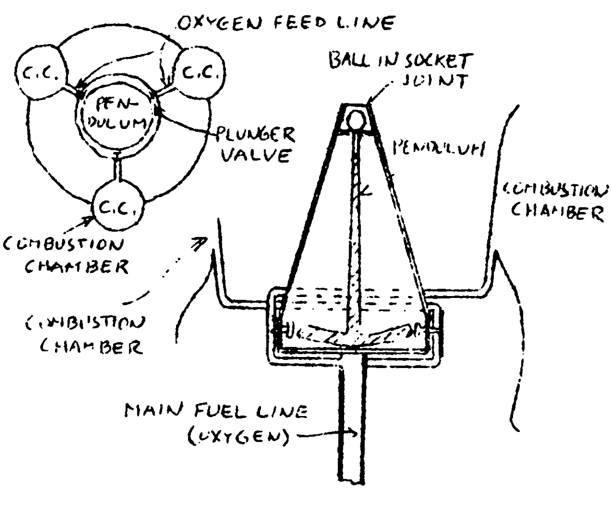
Whatever the future may bring in the way of additional changes in design, it is clear that for the first time, we have, in the one-stick Repulsor, a rocket that could be made in large size, able to carry scientific instruments into the stratosphere or into space, or able to transmit mail, freight and even passengers from one point to another on the earth.

But of course we must not let the success of this design and the solution of the problem of injecting fuel without pumps take our attention from the fact that tremendous problems are yet to be solved---problems which may prove far more baffling than those already mastered. Among these problems are (1) how to obtain absolute stability in flight, (2) how to steer and unmanned rocket so that it may be depended upon to carry mail or freight from one place to another without accident (3) how to land such a rocket safely and accurately (4) how to launch it properly and with the greatest possible speed to save fuel (5) how to get greater efficiency out of the fuel (6) how to keep the motors sufficiently cool so that they will not burn up or burst during a long period of firing, and (7) how to calculate the proper course for flights from point to point on the earth so as to take proper account of wind currents, atmospheric conditions, etc., and also so as to send the rocket by the most direct route consistent with efficiency.

Experiments in America

We turn with a great deal of interest to the experiments of American inventors in their home country, and though the results obtained to date are meagre and somewhat disappointing, there is reason to believe that important developments may be expected in the near future.

Dr. Goddard is still hidden away on Mescalero Ranch in New Mexico, where the exact nature of his work is being kept secret. All attempts to learn from Dr. Goddard what he is doing or plans to do have so far been without results, except that in a recent exchange of letters with him I learned that the fuel used in the famous shot of July, 1929, at Worcester was made with liquid oxygen and a hydro-carbon. What the hydrocarbon was, specifically, Dr. Goddard did not disclose.



Another sign of his activity, however, is to be seen in the patent he recently obtained for a rocket plane. This plane was pictured in the New York Times a few weeks ago, with an article signed by Dr. Goddard describing it. The plane is as yet only imaginary, for Dr. Goddard has not built one, nor is he at work on one. It was explained in the New York Times article that the Guggenheim fund of $100,000, which is financing his work in New Mexico, may be spent only on experiments for meteorlogical rockets.

More definite news comes from another of the society's active members---Harry W. Bull, of Syracuse. Mr.Bull, who gained international reputation last winter with a large, passenger-carrying rocket sled, is now working on liquid fuel problems at Syracuse University, where he is a senior in the Engineering College. A section of the laboratory has been set aside for his use, and he is now completing the erection of a unique test block there, upon which he will test a number of motor shapes and rocket fuels during the next month or so to satisfy himself as to the proper shape and specifications for these motors.

Mr. Bull has offered to let the Society have the full benefit of his discoveries on this test-block. Not only will the results be available for the Society's use, but he has been good enough to offer to test rocket motor designs suggested by members of the society---provided, of course, that these designs are founded upon reason or mathematical calculation. He will naturally not waste time and money trying out foolish ideas which do not appear intelligently reasoned.

Test block tests, of course, are lacking in spectacularity, but they are absolutely necessary to intelligent further experiment with liquid fuel motors. The results of tests will make available for the first time in America the engineering data upon which large and efficient rocket motors can be built.

Bull expects that his preliminary tests will be over by about the first of the year, and immediately thereafter, if he has satisfied himself as to the best motor shape, he will begin building a small liquid fuel rocket---probably one with three motors or more. The purpose of this rocket will be to test out in actual field conditions the efficiency of the motors, and also to test certain stabilizing and steering ideas Bull has worked out, theoretically, in detail.

One of these ideas is depicted schematically in the accompanying drawing. It is to be observed that no rocket, no matter how perfectly balanced will follow a true course without some internal means of guiding. Bull has here worked out a scheme for steering altitude rockets along a strictly vertical path by means of a pendulum. Of course, as shown here without necessary refinements which I have not troubled to indicate, but the idea is sufficiently suggestive to be worth trying. Several variants also suggest themselves. For instance, a leaden ball might be used instead of the pendulum, or even water in a small tank, the unequal pressure on the sides working shut-off valves in the fuel lines.

And now we come to our own experiments. I am able to announce, on behalf of the Society, that we are now actually building a small rocket---a preliminary experiment which we expect will lead soon to much more important ones. The first rocket will probably be completed in about a month, if all goes as planned. It will be a rocket of the two-stick Repulsor type, standing about six feet high, and will be equipped with an automatic parachute, though it will probably not develop sufficient lift to carry any instruments.

We cannot, of course, predict at this stage how high it will go. This will depend upon the total weight when it is finished, and also upon the efficiency of our motor, which is patterned after that used by the German experimenters, with certain slight variations. We will use as fuels liquid oxygen and high-test gasoline.

This rocket is being designed by myself, Mr. Lasser, and Mr. H. F. Pierce, who is also doing much of the machine work necessary on the rocket, as well as contributing valuable ideas. Mr. Pierce has, in fact, found a workshop for the society, and is lending his own tools for our use as well as contributing his time. Much of the success of this experiment, if it is a success, will be due to his efforts.

TILING MAKES 32,000 FEET ROCKET ALTITUDE RECORD

Reinhold Tiling, German engineer, who sent a rocket aloft 6000 feet in April of this year (see Bulletin No.9), has now sent a rocket 32,000 feet into the air above the Frisian Islands, in Germany, for a new altitude record. His rocket was sixty inches long.

Herr Tiling's new rocket, like the old, was powered by solid fuels, although Tiling is experimenting upon liquid fuels, and believes the ultimate solution of the rocket problem to rest upon liquid fuels.

According to the reports, the rocket, shaped in the design of a possible rocket plane, consumed 14.3 pounds of fuel and carried a cargo of 11 pounds. The rocket was started gradually from the ground and at the extreme altitude of its flight, wings that unfolded from the tail were outstretched and the Rocket Glided back to earth, landing some five miles from its starting point.

The wings are folded along the rocket, just as a bird's wings when at rest, and are outstretched, by a mechanism not mentioned, when the rocket is ready to descend. In a second model that Tiling has built and flown a parachute device is used to float it to the ground.

Herr Tiling believes that his present model is equally adaptable for liquid as well as solid fuels. He intends to test in under varying conditions gradually increasing its size and range until it can carry passengers and mail.

Tiling is thirty-five years old, a former war aviator. He is said to be financed and aided in his experiments by a Baron von Ledebur who has provided laboratory facilities for him at Arenshorst Castle.

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ADVANCE PROGRAM OF SOCIETY MEETINGS

On Friday evening, December 11, at the Museum of Natural History in New York, Dr. Alexander Klemin, head of the Guggenheim School of Aeronautics, New York University will discuss the "Goddard Rocket Plane."

On Friday evening, January 8, Dr. William Lemkin, will speak on "Rocket Fuels and their Possibilities."

On Friday evening, January 22, C. P. Mason will speak on "The Navigation of Rocket Vehicles in Interplanetary Space."

Mr. Nathan Schachner's illness prevented his delivering his address on "Can Man Live on Other Planets". A resume of his manuscript will appear in the January Bulletin.

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MARTIANS MAY DETECT EARTH MESSAGES

If messages were sent from the earth over a band of short-wave red light, stated Dr. R. B. Brode, of the University of California, Martians observing the earth with a large telescope could detect them.

Although radio waves are stopped by the Heaviside Layer, Dr. Brode believes that shorter waves such as infra-red could pass through just as light waves do, and be detected by our planetary neighbors 35,000,000 miles away.

MOON FLIGHT WILL COST $2,000,000,000, SAYS ASTRONOMER

A flight to the moon should be possible in 100 years, said Dr. John Q. Stewart of Princeton University in an essay in the book, "Science Today", recently published, but it will cost $2,000,000,000 to build the ship.

Stewart pictures a sphere 110 feet in diameter powered by 110 billion kilowatts of energy. This gigantic power would be provided by the discharge of 3 tons of load every second at a speed of 200 miles a second, from rocket tubes.

The trip to the moon, despite the enormous power developed, is believed by the Princeton astronomer to require six days, and should be the forerunner of more ambitious efforts into the heavens.

The explorer to the moon, however, will find it to be a mineral jungle with slag and tumbled masses of ore from ancient volcanoes and meteorites that found a last resting place on our satellite.

Dr. Stewart believes that a trip to the moon in the next few decades is out of the question, for no power now known can supply us with the necessary energy. We must, he states, await research in pure physics to obtain new fuels for powering the moon flight.

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PICCARD'S AIDE TO MAKE NEXT BALLOON FLIGHT

To further study the quality and quantity of cosmic rays in the stratesphere, Dr. Charles Kipfer, aide to Auguste Piccard in the historic balloon flight, will make the next flight in the Summer of 1932. Dr. Piccard will not accompany the expedition, but in a specially equipped balloon, Kipfer will be accompanied by a physician and a pilot.

The project will be financed by Belgians, and the expedition will be Belgian, said the report. Dr. Piccard asserted that not enough attention has been given to cosmic rays and their possible utilization by man. They possess great energy, and he believes they may be put to some use by man. In the meantime, Piccard will attempt to verify some of the findings of his first flight, in a secret laboratory "on the summit of a high mountain."

It is stated that Piccard may come to the United States to lecture on the possibility of stratosphere navigation.

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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 West 42nd Street, New York. Information on the other classes of membership, active and special may be obtained by writing the Secretary.