BULLETIN

THE AMERICAN INTERPLANETARY SOCIETY

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Society Incorporates

Final papers for the incorporation of the American Interplanetary Society have finally been filed and the Society is now incorporated under the membership corporation laws of the State of New York.

Solid Fuel Rocket Models Rise 6000 Feet

Models of mail and passenger rockets were set loose on April 15, at Osnabrueck, Germany, by an aviation engineer, Reinhold Tiling. Six rockets in all were shot, the first four being simple rockets, one of which exploded at a height of 500 feet while the others reached altitudes up to 6000 feet, attaining a velocity of 700 miles an hour. The rockets burned for eleven seconds, maintaining an acceleration of 150 feet per second.

A fundamentally new feature of the rockets is the method of landing them safely. After the fuel is exhausted, small wings are automatically unfolded, allowing the rockets to spin around and descend gently after the fashion of the autogyro. One of the rockets was a passenger model, 54 inches long with a wing spread of 80 inches. It rose to a height of 5000 feet.

Herr Tiling declares that his invention is already beyond the experimental stage and that he has shot thousands of rockets secretly before giving the public demonstrations, and that he could easily shoot rockets to a height of 60,000 feet. He claims that it will require another year before a large rocket with a wing spread of 40 feet can be completed.

German Rocket Car Tested

A report has been received from Berlin that Dr. Paul Heylandt tested his rocket driven "Comet Car" at the Tempelhof Airport on the evening of May 2nd. The test proved successful. Because of the lack of banked curves on the Airport field, the driver had to hold the speed down to 90 miles an hour. It is stated that the roar of the rocket motor, which weighs 15 pounds and looks like a small cannon, startled pedestrians as far as two miles away.

Stratosphere Plane Under Construction

Built to fly at an altitude of 50,000 feet and at a speed of 500 miles an hour, the crude oil motor-driven stratosphere plane now under construction by Junkers at Deassau, Germany, may be the main competitor of the rocket-driven craft of the near future.

Little technical information has been given out, but it is reported that a special crude oil motor has been developed that will run at very high speed and drive a propeller designed to bite into the thin air in the upper regions. The blades of this propeller will be about twice as long as would ordinarily be used. Compressors will inject oil and air into the cylinders. A turbo-blower sucks in thin air for and delivers it to the compressors. The cabin will be enclosed and filled with air at sea level pressure. The walls will be double and heat insulated to protect the occupants from the extreme cold. Attempts to fly the plane may be made this Summer.

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PHYSIOLOGICAL IMPLICATIONS OF ROCKET FLIGHT

(Abstract of a Report by Thomas W. Norton to the American Interplanetary Society at Meeting of April 17, 1931 as a part of Research Program of the Society.

From a physiological point of view there are four major problems to be considered in a rocket flight into outer space. These are: 1.Acceleration. 2. An artificial atmosphere. 3. The effect of various temperatures. 4. The effect of radiations that might be met in outer space.

Acceleration

With respect to increase of acceleration, a few data are available as to how the human body reacts to this altered condition. Oberth mentions in his book that an aviator who rotated at a speed of 134 miles per hour along a spiral of a diameter of not more than 460 ft. and so was exposed to a pull of 51.5 meters/sec/sec., which is more than five times the earthly gravity, suffered no injury. Oberth thinks that this case verifies his assumption that human beings could stand this acceleration for 200 or 400 seconds.

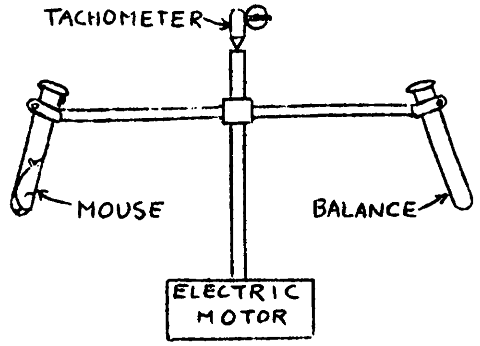
Furthermore, he mentions the case of a fireman who jumped from a building at a height of 82ft. into a net (which sank only 3½ft.) without any ill effects. acceleration which he had to withstand during this terrific compact certainly exceeded, says Oberth, 787ft./sec/sec., which equals almost 25 times the earthly gravity.

He also quotes the fact that the Hawaians are accustomed to leap from a rock 264ft. above the water level whereby they arrive at the surface with a speed of a good 114ft. per sec. (allowing for resistance) which means that as they enter the water they have to withstand a pull of more than 984ft./sec/sec.. Oberth strongly believes that this is a matter of training and that any person can train himself to withstand higher accelerations for even a longer time.

Certain experiments in acceleration can be performed on animals which to some extent may form a basis for comparison with humans. With the assistance of Mr. Konrad Schmidt I have actually performed such an experiment. The method was as follows:

For a period of more than one minute a white mouse was subjected to an acceleration which was composed of the earthly gravity and a centrifugal force created by a continuous rotation at the rate of at least 600 revolutions per minute. The mouse was placed in a smooth metal tube and no particular precautions were taken to protect it from mechanical injuries. The radius of the circle described by the near end of the tube was eight inches.

The centrifugal force caused by this fast rotation of 600 r.p.m. created a pull of 2,629 ft./sec/sec., which is more than 82 times the earthly gravity.



After being taken out of the tube the mouse showed signs of dizziness which lasted for about a minute, but at the end of that time regained its balance. No evidence of any physical injury was discernible on external examination.

And it may be said that the problem of increased acceleration is one that may partly be met with by systematic experiments and subsequent training of human beings to a higher gravational pull by employing specially devised apparatus based on the principle of a merry-go-round.

The problem of weightlessness in space does not offer possibilities for immediate investigation, but it may reasonably be assumed that exposing a human to a state of non-gravity will not cause any serious disorder during a short period.

Oberth thinks of detaching the observation chamber from the space ship proper after a definite course is established and having this chamber rotate around the rocket at such a speed as to create a pull similar to the gravitational force on earth. However, in my opinion, it does not seem necessary to have such an apparatus in operation on a trip to the moon and back, for instance.

An Artificial Atmosphere

The air in a hermetically sealed space ship will constantly be having oxygen removed and carbon dioxide added. One of the gravest problems in a flight into space will be how to restore this oxygen.

Mr. Noel Deisch a member of the Society in a paper on this subject has given a table, which he bases on a report of the Carnegie Institution, showing the amount of oxygen a man in a space ship would consume and the amount of carbon dioxide he would excrete. He presupposes that the man would sleep eight hours per day, work eight hours, and rest eight hours. The table is given below.

State of subject	Carbon dioxide liberated, gram per hour.	Oxygen absorbed gram per hour.
Asleep	23	21
At ease	48	40
at work	145	125
Average	72	62

In twenty-four hours, then, one man would absorb 1,488 grams of oxygen, and liberate 1, 728 grams of carbon dioxide. This amounts to about 45 kilos 99 pounds of oxygen per man per month.

Mr. Deisch is in favor of evolving the oxygen by the chemical process. He points out that a suitable catalytic agent, without any application of heat, will decompose hydrogen peroxide, and that the oxygen evolved will be of the highest purity. He suggests also, that if this method were used the greater part of the expeditions water supply could be stored as hydrogen peroxide; the water to become available only as the oxygen is subtracted.

He goes on to say that the matter of storing this reagent would call for a close study, since solutions of hydrogen peroxide show a decided tendency to slow spontaneous decomposition.

Liquid oxygen offers the greatest economy in weight. However, Mr. Deisch does not think this method practical. His reason is that liquid oxygen boils at -183° C., and that it will be impossible to prevent the supply of liquid oxygen from evaporating, as the best D'Arsonval-Dewar flasks allow their contents entirely to boil away in from a week to a fortnight. The D'Arsonval-Dewar flasks are comparatively small containers--less than a pint. When one studies the larger commercial containers for storing O_2 we find their contents lasting much longer. The rate of evaporation being only about 4.8% of their contents every 24 hours.

But based on results with commercial containers of fairly large size (about 50 kilograms) and using a figure of 4.8% loss per day from evaporation--which is an absolutely certain rate even now--it would be possible to make a fairly long trip in a space ship.

Not alone must oxygen be added to the atmosphere, inside a space ship, but the impurities, chiefly CO2 which is constantly being expired by the crew, must be removed. While the level of CO2 could safely rise to 5% in the ship it would be extremely uncomfortable for the crew and would become injurious after a short time.

Noel Deisch has outlined a plan for fixing this CO2 which he describes in his paper: CaO2, activated by hydration, is exposed to the current of impure air. When the Ca(CH) 2 has been converted to the carbonate it is transferred to a retort with an outlet into space. The carbonate is now calcined and ejected outside the ship, the calcium oxide (CaO2) produced by the calcining operation is used again and again.

Temperature

It is unknown just what temperatures will be met with in outer space, but we do know that these temperatures will be beyond the extremes which the human body can resist. These extremes are between freezing and 113 degrees F. Both these temperatures can be withstood for a few days, but a longer time means death.

While violent extremes of temperature can be withstood temporarily and while life is barely possible for a few days within still narrower limits, it is obviously necessary that there must be definite control of the temperature inside a space ship. Both refrigeration and heating provision must be installed, so far as present knowledge extends, although conceivably there will be encountered in space an excess of heat rather than not enough.

The determination of this fact, however, is in the realms of physics rather than physiology.

Radiation

The effect of radiation on a rocket in space, as said before, cannot very well be investigated here on earth; for the reason that the atmosphere absorbs short-wave radiation. Any prediction therefore, must necessarily be a matter of guess work. However, on the completion of a high altitude rocket that is successful in rising above the air-blanket, the problem can easily be studied.

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THE GERMAN ROCKETS

(Abstract of a Report by G. Edward Pendray to the American Interplanetary Society at Meeting of May 1, 1931 on the Results of the German Experiments with Rockets. This information was gathered by Mr. Pendray on a trip to Europe in April 1931.)

The German Interplanetary Society and the Raketenflugplatz

The Verein fur Raumschiffahrt, which may be translated "The Society for Space Flying", and which has now been also entitled "The German Interplanetary Society" by its leaders, was founded in July, 1927, in Breslau by Johannes Winkler, an airplane engineer, and the late Max Valier. In the following month Dr. Hohman, of Essen, became a member, followed by Professor Oberth, who is now the society's president, and Willy Ley, now its vice-president and secretary. Winkler was the first president, but he was connected with the Junkers Airplane works at the time. His employers objected to his connection with such visionary schemes as rocket flights and interplanetary speculation, and he was forced to resign. Valier then became president. Oberth had an assistant who outlined a plan for a simple rocket, without intricate pumps, and which could be built for comparatively little money. This man was Rudolf Nebel, a diploma engineer, and now director of the experiments at the Raketenflugplatz, which is the name of the rocket flying field near Berlin.

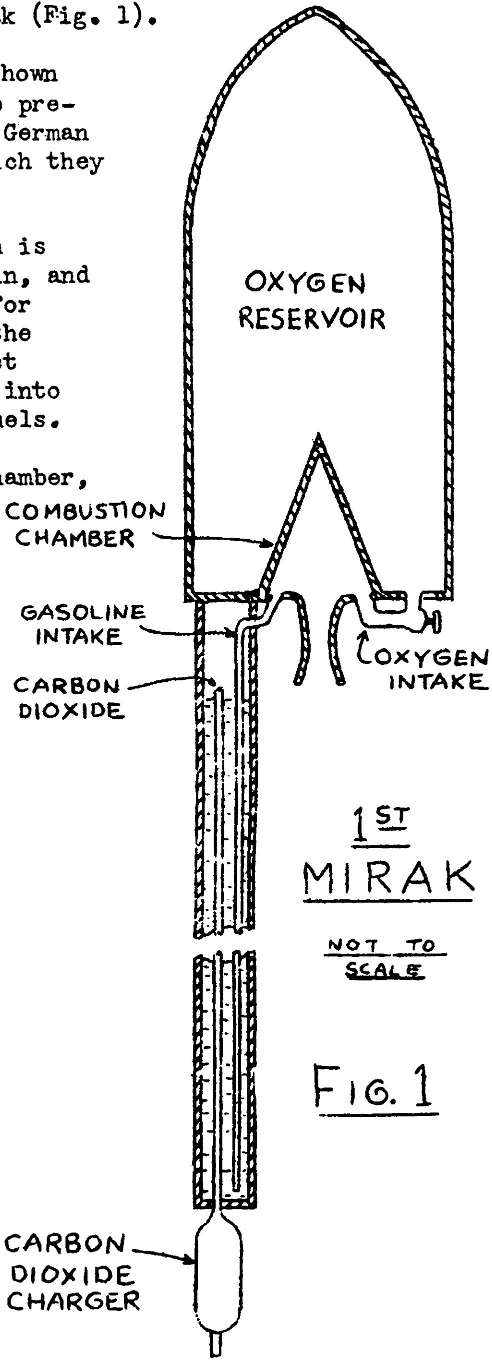
Also in the society was Klaus Reidel, a young engineer whose uncle owned a factory at Bernstadt. Encouraged by the society, these two men went off to Bernstadt, where, in June a year ago, they built and tested the first complete, continuously-burning liquid fuel rocket ever constructed, so far as is known. This rocket was constructed on the smallest scale considered feasible by Nebel, and was therefore called the Minimum Rocket. After the fashion of the Germans, this name was quickly shortened to Mirak. Later it became necessary to refer to it as the First Mirak.

Goddard, who has carefully prevented the results of his work from becoming public, is said to have sent up his 1929 rocket by a series of explosions, instead of continuous fire. It is difficult to see how this was managed, but in any case, it is clearly not the solution to the problem.

Others, including Oberth and Robert Esnault-Pelterie, have been convinced that the first step would necessarily be to build pumps capable of handling the liquids and jetting them into the chamber. Several types of such pumps have been designed or described, but it remained for Nebel and Reidel at the Raketenflugplatz to show that for the present, at least, pumps of a mechanical type are not necessary.

Their work rests upon experiments performed by Oberth, Valier and Dr. Heylandt prior to 1930, when all three of these men were at work on the liquid fuel problem. Valier and Heylandt announced the first continuously-burning liquid-fuel motor, but they did not attempt to adapt it to the rocket, but rather to the automobile. It was during experiments of this kind that Valier was killed.

To Oberth and Valier belong the credit for discovering the point and direction in which the fuels must be introduced into the combustion chamber. Armed with this information and his technical experience, Nebel set out in his first Mirak to adapt the recoil motor to an altitude rocket. How he did it may be seen by a study of the diagram of the First Mirak (Fig. 1).



1^{ST} MIRAK

NOT TO SCALE

FIG. 1

This diagram, and the others to be shown presently, are not drawn to scale, and were prepared only to make clear the nature of the German experiments and the succeeding steps by which they have advanced.

The First Mirak, the scheme of which is shown in the diagram, was built of duralumin, and consisted of three parts: the upper tank, for oxygen, the lower tank, for gasoline, and the combustion chamber. Observe how this rocket clearly indicates the complexities brought into rocket construction by the use of liquid fuels.

In the First Mirak the combustion chamber, following early ideas as to the proper construction of recoil motors for this use, was cone-shaped, made of heavy copper alloy, and was without special lining of any kind.

The two fuel tanks were built of dural. The upper one held about a litre of liquid oxygen, the lower about half a litre of gasoline.

The oxygen was forced into the combustion chamber by the pressure of its own gas, which forms quickly whenever the vessel is closed. The gasoline was forced in by carbon dioxide gas, furnished by the small siphon charger at the lower end of the chamber. By these simple expedients Nebel and Reidel overcame the pump dilemma which had stumped Oberth in the building of his Baltic rocket, and had caused so much discussion and thought among other rocket designers.

The Mirak weighed, loaded with fuel, about three kilograms (six and a half pounds), and firing tests against a spring balance apparatus showed that it had a lift of four and a half kilograms, or nearly ten pounds. In short, if the First Mirak had not been tied down during these tests it would have flown.

It was the expectation of the inventors that the oxygen would need some heating to produce the necessary pressure, and also that the combustion chamber would need some cooling. They hit upon the idea of placing the combustion chamber directly in the oxygen tank, as shown, to satisfy both requirements at once. This was found to be unsatisfactory, for the oxygen was heated too much--it needed no heat anyway---and the cooling effect was insufficient to offset the danger involved in this arrangement.

Another thing, learned was that the cone-shaped combustion chamber was unsatisfactory. The odd corners at the base appeared to obstruct the rapid flow of gases, and the forward pressure developed was disappointing. It was clear that more room was needed in the middle and top of the chamber for the mixing of the fuels and the explosion.

Finally the behavior of the oxygen, which at the end developed such tremendous pressure that the tank was burst, showed that the Mirak needed a safety valve through which the excess pressure could escape.

When they built the Second Mirak (Fig. 2) the engineers took these first lessons into account. The diagram shows how a simple safety valve was made at the top. This, after experimentation, was set to open at a pressure of six atmospheres, which was well within the safety limits of the tank's strength. The gasoline tank and its apparatus remained the same in the Second Mirak, but the combustion chamber underwent a radical change.

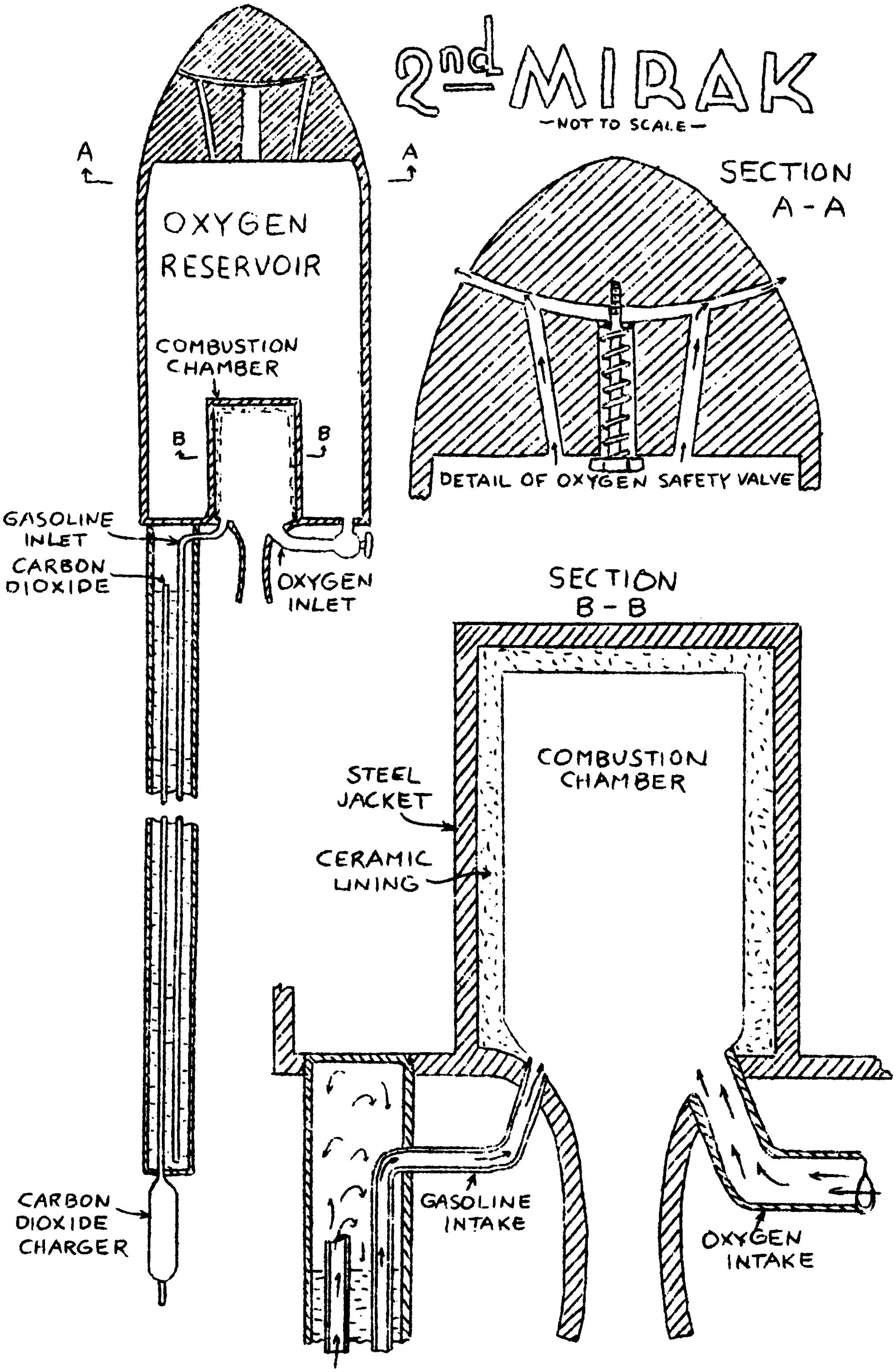
It still remained inside the oxygen chamber, but this time it consisted of a jacket of steel surrounding a lining of ceramic material made especially for the experiment by a company in Berlin. It was thought that the ceramic lining would resist the heat and prevent the too-rapid transmission of heat to the oxygen. The chamber itself was cylindrical in shape---a form suggested by the results with the First Mirak, which indicated the need for more room in the upper part of the chamber.

This Mirak weighed somewhat more than the first, because of the improvements and the heavier materials used. The new combustion chamber, however, made up for the difference in weight by developing a lift considerably greater than that of the First Mirak. The Second Mirak also would have flown had it been released, but it, too, had many weaknesses, and finally burst without ever being sent up for a flight.

In the First Mirak it was the oxygen tank that burst. In the second it was the combustion chamber. The ceramic material proved itself sufficiently heat-resistant, but lacking in strength. Consequently, as soon as the steel began to weaken under the heat the whole rocket exploded.

The Proving Stand

The lessons learned from tests with the Second Mirak indicated that much more needed to be learned about the shape, construction and handling of the combustion chamber---or, as the Germans refer to it, the motor. Even before the Second Mirak had burst, a series of tests had been begun on various shapes and designs to determine which was best for the Third Mirak. A number of shapes were tried, tested. In several cases they were deliberately exploded on the



2nd MIRAK

—NOT TO SCALE—

FIG. 2

proving stand, A technique was worked out for testing these motors which it may be useful for us to observe.

The proving stand was set up in a deep ravine on the Raketenflugplatz, where an explosion would hurt nothing. Because it suited the purpose, the engineers took the small steel tower and planted it firmly at the bottom of the hollow. On either side, partly covered by the banked-up earth, they placed tanks for fuel. At the right was the oxygen tank, at the left a gasoline tank communicating with a tank of nitrogen gas under pressure. The valves of both tanks were arranged so that they could be opened from a distance, by the turning of a wheel connected to them by wire cables.

Balanced in the proving stand like the arm of an old steelyard scales is a metal rod about six feet long, with a pivot at the center. At one end was a clamp for fastening the recoil motor under test, and an adjustable weight which the motor must lift if it has power enough to raise its end of the arm.

At the other end was fixed a clockwork device with a revolving drum of smoked paper and a needle fastened to the movable rod. When the test was ready the combustion chamber was fired, the fuels turned in, and the drum set to revolving by its clockwork. The amount of lift of the motor is accurately recorded on the drum, which can later be taken off, the curve calibrated, and the behavior of each motor studied and preserved for comparison.

In carrying on tests, the combustion chambers are placed in a small tin tank of water, the water being continually replenished by a hose. The usual procedure on the stand is to run a little liquid oxygen through the motor first, in order to begin the test with the metal as cool as possible. Then the gasoline flow is started. An electric spark ignites a wick, which blazes near the mouth of the nozzle. Then the oxygen is turned on. An explosion follows, blowing the wick away and starting the recoil.

During the first few instants the motor sputters a little. Then, as it begins to warm up, the fire grows steady. A jet of yellowish flame spurts downward from the mouth of the nozzle about three or four feet, accompanied by a furious hissing sound not unlike the roar of steam escaping under high pressure. An instant or two later the length of the flame shortens perceptibly, loses most of its color and becomes bluish, at times becoming almost invisible. With this change the sound becomes more intense. The power of the combustion is apparent even at a distance of several hundred feet. The earth seems to tremble with the vibration of the rocket motor.

A minute of such firing seems like a long time. It is usual in the tests not to fire for more than a minute to a minute and a half at each time. By this time the water in the little tin tank, which was frozen at the beginning of the test, is boiling, but the copper lining of the motor has not melted and is only slightly oxidized. When the fuel is shut off the oxygen reservoir is closed first, permitting pure gasoline to jet into the hot chamber. If it were otherwise the oxygen would immediately attack the hot metal, cutting it out.

In actual flight these small motors are not expected to burn more than thirty or forty seconds, and in this time the problem of overheating is not particularly serious. On the proving stand small motors have been fired for as long as five minutes, with water cooling, but all so tested have exploded with great violence before ten minutes of continuous firing have passed. These tests have shown that the greatest heat is developed near the head and at the sides of the

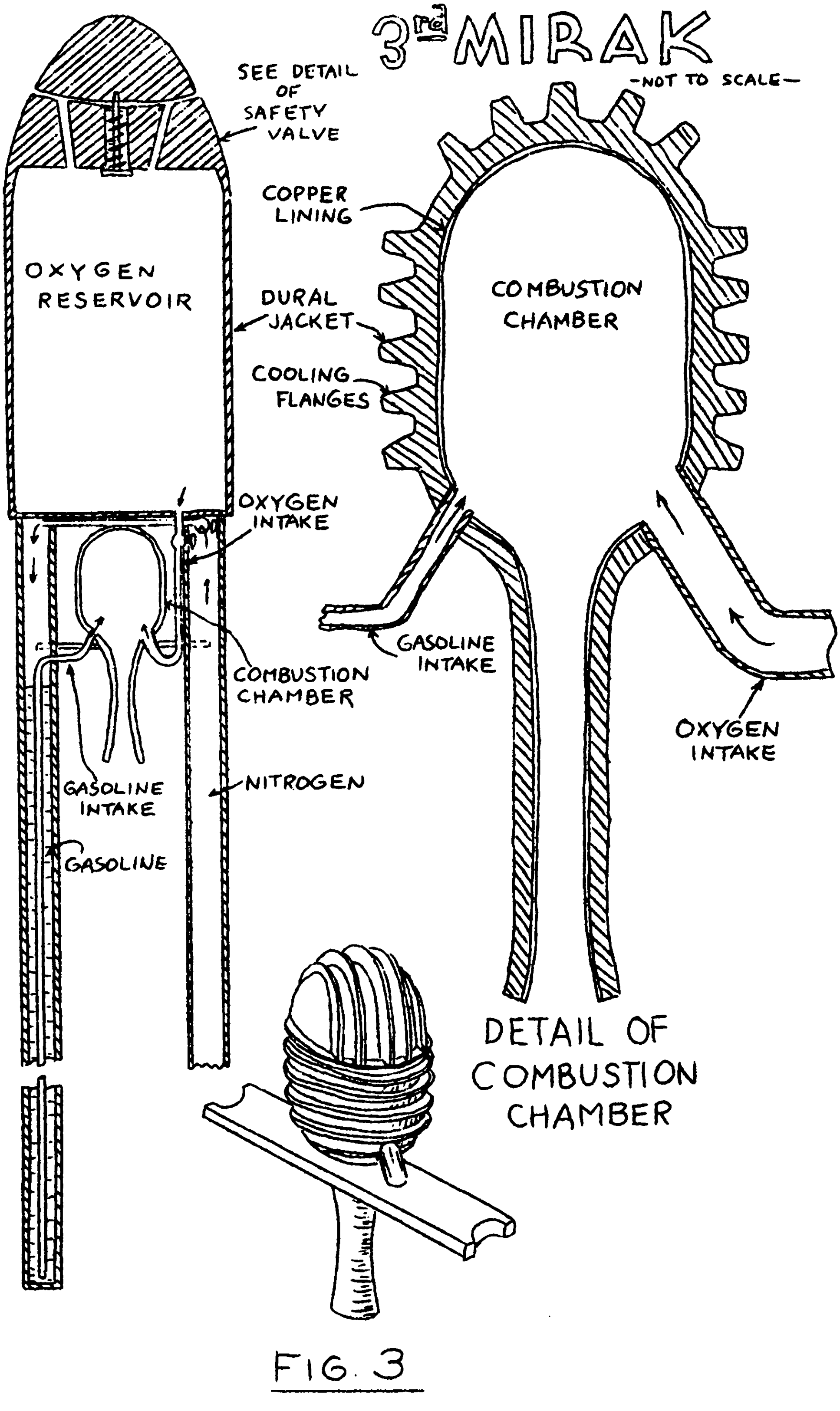

3rd MIRAK
-NOT TO SCALE-
SEE DETAIL OF SAFETY VALVE
COPPER LINING
OXYGEN RESERVOIR
DURAL JACKET
COOLING FLANGES
COMBUSTION CHAMBER
OXYGEN INTAKE
COMBUSTION CHAMBER
GASOLINE INTAKE
OXYGEN INTAKE
GASOLINE INTAKE
NITROGEN
GASOLINE
DETAIL OF COMBUSTION CHAMBER

FIG. 3

chamber, and not at the constricted throat, as many engineers had expected.

Taking the lesson learned by the unfortunate death of Valier, the German experiments are now being carried on with every possible precaution. The fuels are always controlled from a distance, and observation from the bank above the proving stand is made safe for the engineers by a double-mirror device which permits them to watch while completely behind cover. For necessary close observation and photography a covered dugout with a parapet of sandbags has been constructed a few feet away, in the side of the embankment.

The Third Mirak

Under these conditions the tests were made preliminary to the building of the Third Mirak, which was nearly complete three weeks ago, but had not yet been tested in the assembled form. The Third Mirak (Fig. 3) differs in certain important respects from its predecessors, the principal changes having been made in the construction of the gasoline fuel tank apparatus and the shape and position of the motor.

Instead of one lower tank we now have two, so weighted and constructed as to balance each other. One carries the gasoline fuel, the other a charge of nitrogen gas under pressure. A pipe connects the two so that the gas, pressing on the liquid, forces it into the combustion chamber when the valve is opened. The substitution of nitrogen gas for the carbon dioxide charger of the earlier experiments followed a number of tests which showed the new method to be more dependable and steady. Under the new method the full pressure is available at once, whereas by the charger method there was an appreciable lag.

The other important change in the Third Mirak has to do with the shape and position of the combustion chamber or motor. As the diagram shows, the motor chamber is now what the Germans call "egg-shaped". Actually it is cylindrical, with each end finished off in a hemisphere.

This shape was decided upon for the Third Mirak as a result of the tests upon the proving stand. It is built of duralumin, with an inner lining of copper. The choke is somewhat greater in the nozzle of this motor than in the others, and the ejection tube somewhat longer. The copper lining covers the whole inside, including the nozzle to its end. It is about a sixteenth of an inch, or a little more, in thickness.

With the adoption of this shape of combustion chamber, and particularly with this placing of the fuel inlets, a curious effect has been noticed. Whereas the pressure in the chamber is from twelve to twenty atmospheres, the pressure required to send the fuels in is much less than that. The phenomenon appears to be the result of currents set up in the chamber during combustion, which actually seem to create a kind of suction upon the intakes. It is the theory of the engineers that the gases move upward along the walls, meet at the top and explode, the outgoing gases rushing directly downward through the orfice.

The Third Mirak is obviously somewhat heavier than the earlier Miraks. It was expected to weigh, loaded with fuel, about four kilograms (about 9 pounds). The amounts of fuel are about the same as in the First Mirak---namely, a litre of oxygen and half a litre of gasoline. The nitrogen in the pressure chamber is under a pressure of ten to twelve atmospheres; the safety valve at the top of the oxygen tank is set to open at six atmospheres.

The pressure inside the combustion chamber, due to the greater choke at the neck, is higher than in the earlier Miraks, and will probably reach fifteen to twenty atmospheres. Experience has shown that the higher the pressure in the chamber, the longer the stem of the ejection nozzle should be. The flare of the nozzle is not great. In these small motors the engineers claim to have found little advantage in making the flare mathematically correct, though elaborate calculations have been made, notably by Guido Baron von Pirquet in Vienna, to determine what the exact flare should be. It varies for each fuel and fuel mixture, but even so, it is not as great as we had anticipated in this country.

The combustion chamber designed for the Third Mirak, which had not yet been tested when I was there, is expected to develop a lift of more than eight kilograms (about nineteen pounds) and possibly ten kilograms (about 22 pounds).

At 8 kilograms the acceleration of the Third Mirak should be one gravity at the start. The rate of acceleration of course increases as the fuel is burnt, in proportion to the increasingly smaller weight of the rocket. Since the starting load of fuel weighs about three pounds, the rocket itself weighs only six pounds, and the acceleration in the last moment of fire should theoretically be about two times gravity, or 64 feet a second.

The Third Mirak is expected to fire thirty-two seconds, using four times as much oxygen as gasoline by volume. Theoretically, it should rise well over three miles. Air resistance and other difficulties may be expected to cut this distance, so that the actual flight expected is about two miles,

If this performance seems small and unimportant, remember that a successful flight of any kind has never been made with continuously burning liquid fuel. If the Third Mirak flies at all it will be a matter of tremendous historical importance. Remember also that the Mirak, as its name implies, is the minimum size contemplated. If it is a success the way will be paved for the immediate building of much bigger ones, plans for which are all ready being drawn.

It is clear that an increase in size will be an advantage, even if it should happen that there were no increase in efficiency. Thus, a rocket with twice the capacity, both in the fuel tanks and the combustion chamber, need not weigh twice as much. Other things being equal, the proportion of construction weight to that of the fuel carried becomes smaller and smaller as the size increases. The fuel capacity of the Third Mirak could probably be doubled, for example, without adding much more weight than the weight of the extra fuel. Yet the rocket would fire and continue to accelerate twice as long, and would theoretically make an altitude of twelve or fifteen miles as compared with the Third Mirak's expected two or three.

Meetings of the New York members of the American Interplanetary Society are held on the first and third Fridays of each month at the American Museum of Natural History, 77th Street and Central Park West. Persons interested in the aims of the Society are invited to attend and to write to the secretary, Nathan Schachner, 113 West 42nd Street, New York City, for information about the various classes of membership, including active, associate and special, which are open to men and women who possess the necessary qualifications.