

STARTLING STORIES

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A Complete Novel



THE BLACK GALAXY

By MURRAY LEINSTER

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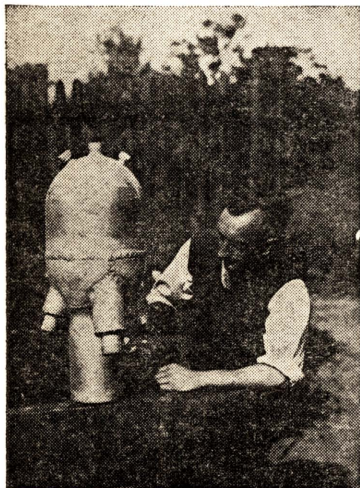
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The ROAD to

SINCE archeologists have yet to learn just where Man originated on this planet we don't know what his first major travel problem was. It may have been the crossing of a mountain range or a wide river.

Whatever the problem, it must have looked



A German scientist examines the 1933 Magdeburg rocket motor

impossible to primitive Man—but he finally solved it.

His next travel problem was the crossing of open water. For thousands of years men must have sat on the shore and studied the blue expanse to the horizon, dreaming of navigable rafts that would one day penetrate the unknown.

Sails, oars and rudders were finally discovered and those navigable rafts were finally built.

Today Man is confronted with what may be his final travel problem. It is not the land across the river or in the valleys on the far side of the mountains or the unknown shore across the sea. Today his goal is the cold silverscence of the full moon, the brilliance of Venus or the reddish glow of Mars.

The problem, as always, is how to get there.

The idea of space travel is far from new. It began about the time of Christ when thinking folk of the Mediterranean regions first realized that the "lights in the sky" were very probably material worlds like our own. Naturally this concept led to curiosity as to what those other worlds were like—and curiosity inevitably led to a desire to visit them.

The idea of space travel was to remain a mere philosophic wish for some nineteen centuries. Considering that neither scientific discoveries nor relevant technological advances furnished any nourishment to the idea, it is a major miracle that it did not die quietly.

And when astronomy, thanks to the telescope, did begin to provide scientific information, it seemed to put space travel into the realm of permanent impossibilities.

HOPE IN 1600

In 1600 Man could still hope for some sort of atmosphere between planets, so that space travel would be a mere extension of the problem of flight in air. By 1700 it was all too evident that space was a void. And by 1800, with the true interplanetary distances known, solution to the problem seemed crushed by its own sheer magnitude.

Actually, realization of the true requirements brought the solution closer. The true facts of astronomy did not prove the problem impossible—they merely revealed that the nature of the problem was very different from what had been previously supposed. It only needed some looking around to find new answers.

At first gravitation seemed to chain a

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SPACE TRAVEL

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In the first of a brilliant series of special articles, a world-famous authority on rockets chronicles the amazing progress which man has made toward interplanetary flight!

hypothetical space-ship to its planet. Then it was realized that the same law insured predictability in space. The fact that space was a void implied no obstacle to attaining the enormous velocities needed to traverse interplanetary distances in reasonable time. And the means of bridging space was already known and applied in practise, both as

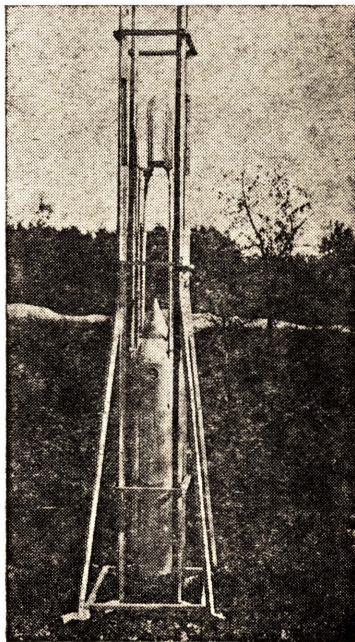
weapon and toy—the principle of the rocket.

Then came the first inklings of a technology applicable to space travel. In 1865 French author Achille Eyraud stated that a space-ship could be propelled by a *moteur à réaction*—or rocket. That same year Jules Verne

Johannes Winkler examines his second rocket, which he was not allowed to test



Primitive German rocket, 1932



published his famous novel in which a cannon fired a shot around the Moon. His theory boiled down to the correct one that space travel depends upon very high velocities.

GANSWINDT COULD DO IT

In 1891 eccentric German inventor Hermann Ganswindt claimed ability to build a reaction-propelled space-ship if someone would give him sufficient funds. And in 1897 obscure Russian schoolteacher Konstantin E. Ziolkovsky insisted in numerous articles that a space-ship was possible—that it would be a gigantic rocket—and that it would use liquid fuels.

These views, first printed in 1903, sound surprisingly modern. But thanks to Ziolkovsky's obscurity and his inability to get his articles translated, his influence upon contemporaries was negligible. Had not subsequent developments backed up the soundness of his theories, he and they would have been forgotten.

GODDARD'S REPORT

It was not until 1919 that the late Professor Robert H. Goddard published his now-famous Smithsonian paper, *A Method of Reaching Extreme Altitudes*. He knew nothing of Ziolkovsky. Nor did German Professor Hermann Oberth, whose similar volume, published in 1923, was the cornerstone upon which the Nazis later built their Peenemünde Research Institute, from which came the long-range V-2.

Professor Goddard saw the first liquid-fuel rocket lift itself off the ground in 1926—but this fact did not become generally known until ten years later. It is indicative of the scatter-gun history of early rocket development that a number of German scientists founded the German Rocket Society one year after that event, in July, 1927, and that the purpose of their society was to find out whether a liquid fuel rocket could be built!

They found out with some delay when, on March 14, 1931, the first president of the German Rocket Society, the late Johannes Winkler, sent his privately-built liquid-fuel rocket 2000 feet into the air. And the first liquid-fuel rocket of the society itself rose off the ground on the 10th of May of the same year.

All these rockets were ridiculously primitive contraptions which one man could carry

under one arm. They compared to the rockets of today in about the manner a rubber-string airplane model compares to a B-36. They employed the same basic natural laws, they embodied similar engineering principles and they did manage to get themselves into the air.

But they impressed only those who had been convinced in advance of the possibility of space flight through study of the theoretical works. By the time these first rockets staggered into the air, the theory of interplanetary travel was firmly nailed down in print and comparatively little has been added to it since.

ENGINEERING A DIFFERENT STORY

The progress of rocket engineering is a different story. The last twelve years have brought advances in this field which even the most optimistic prophet would not have dared to forecast. There is no better way of showing what has been done than by studying the record of accomplishments during this period.

This is how things stood in 1936.

By then a number of test-stand experiments with liquid fuel motors had been made by several experimenters and experimenting groups, usually successfully. Dr. Robert H. Goddard and the American Rocket Society had worked with gasoline and liquid oxygen.

The German Rocket Society had worked with gasoline and liquid oxygen and (at my insistence) with alcohol-water mixtures and liquid oxygen. Johannes Winkler had worked with liquid oxygen and liquid methane. Dr. Eugen Sänger of the University of Vienna had worked with oxygen (both gaseous and liquid) and fuel oil.

The German engineer Friedrich Wilhelm Sander had worked with nitric acid as an oxidizer and a fuel he did not name. And the rocket research group of the German Army, which later was to grow into the Peenemünde Institute, had worked with alcohol and liquid oxygen.

None of these experimental rocket motors had even approached a thrust of 1000 pounds.

A LOOK AT THE RECORD

By 1936 history could also have recorded a number of complete liquid-fuel rockets. Their builders were:

(1) American Rocket Society (gasoline and liquid oxygen)

(2) German Army, Ordnance Rocket Research Group under Count von Braun (alcohol and liquid oxygen)

(3) German Rocket Society (gasoline and liquid oxygen)

(4) Dr. R. H. Goddard (gasoline and liquid oxygen)

(5) Johannes Winkler (liquid methane and liquid oxygen)

With the exception of those rockets which will be mentioned in the next paragraph they were all small, weighing less than 50 pounds. The large ones were, in chronological order:

(A) The "Magdeburg Rocket" of the German Rocket Society's research group, finished in June 1933. It stood about 15 feet tall and was equipped with a rocket motor of 440 lbs. thrust. Its success remains problematical since one of its guiding rollers caught in the launching rack, ruining the take-off.

(B) Rocket A-2 (*Aggregate No. 2.*) of the German Army's research group. The rocket weighed about 330 lbs. at take-off, was equipped with a rocket motor capable of delivering a thrust of 660 lbs. and reached an altitude of 6500 feet in 1934.

(C) Dr. Goddard's rockets of 1935, tested near Mescalero Ranch, Roswell, New Mexico. These rockets also stood about 15 feet tall and were full of elaborate and advanced features but had comparatively small fuel tanks. Having an empty weight of about 60 lbs. they reached a maximum altitude of 7500 feet on May 31, 1935.

RECORD OF PROGRESS

And this is how things stood in 1948, a dozen years later:

The number of test-stand experiments made during these twelve years may number as high as twenty thousand. They led to the experimental and/or operational use of a number of new fuel combinations, notably nitric acid and aniline (American), high-concentration hydrogen peroxide and alcohol with admixtures (German) and nitric acid and vinyl ethyl ether (code name "Visol"; German).

As for complete rockets:

A large liquid fuel rocket, called A-4 by its German originators and V-2 by everybody else, with a take-off weight of about 12 metric tons, carrying a warhead weighing one ton, had been used operationally over a range of 200 miles during the last stages of World War II.

A total of 4300 of these rockets had been fired operationally, rising to an altitude of about 65 miles along their trajectory. A vertical firing by the Germans had resulted in a peak altitude of 100.5 miles.

Near-vertical firings of such rockets from the White Sands Proving Ground in New Mexico had resulted in a maximum altitude of 116 miles, the rocket being loaded with scientific instruments weighing one full ton, including the weight of the containers.

The U. S. Army Ordnance rocket *WAC Corporal* had reached an altitude of 34 miles in early Spring, 1946.

The U. S. Navy rocket *Aerobee*, carrying 150 pounds of instruments, had reached an altitude of 78 miles on March 5, 1948.

ROCKET PLANES

The German rocket-propelled airplane Messerschmitt Me-163B (code name *Komet*) had been flown operationally as an interceptor, using the "Walter" rocket motor, which burned high-strength hydrogen peroxide with alcohol to which some hydrazine hydrate was added. The Me-163B attained speeds up to 650 miles per hour. It was not designed for supersonic speeds.

The American rocket airplane XS-1 had reached supersonic speeds repeatedly during the summer of 1947.

The Navy rocket *Neptune* was nearing completion. About as tall as the 46-foot V-2, but with a slimmer waistline, the *Neptune* is designed to carry a 200-pound pay-load to an altitude of 235 miles. This corresponds roughly to the outer fringes of the earth's atmosphere. By the time this article appears in print the experiment may have been completed.

A ROUGH OUTLINE

But this tabulation of the technological progress of the last twelve years is only a rough outline of accomplishment. More important than the figures mentioned are the implications of these achievements. Most of the things which appeared doubtful in 1936 have been proved (and generally used) in 1948.

To realize how much doubt has been cleared away during these twelve years I only have to think back to many conversations which took place in 1936. One in particular sticks in my mind.

It occurred in New York, in a room in the Hotel St. Moritz and my audience consisted of several engineers who were supposed to report to their bosses.

In the course of the conversation I was asked to draw a sketch of a large rocket, about midway between the then existing experimental types and a manned spaceship. That was easy and the result was something looking very much like a cross section of V-2.

I did not even have to think while making this diagram. There was one very much like it in Prof. Oberth's book. Furthermore the first Oberth rocket and the second Winkler rocket showed the same general arrangement.

That the second Winkler rocket had exploded at take-off and that the Oberth rocket had not functioned at all for lack of a suitable motor I deemed wise to leave unsaid. The finished diagram showed a torpedo-shaped body, with stabilizing fins at the lower end.

The rocket motor was between the stabilizing fins and above it, in succession, were tanks for fuel and oxidizer and a payload compartment in the nose.

LIQUID FUEL PREFERRED

While making the drawing I explained the reasons for liquid fuel. One is the simple fact that the flow of a liquid through a tube (from tank to motor) is easy to control. Hence one can control thrust and even shut off the motor temporarily.

With solid fuels all these things are either completely impossible or very hard to accomplish. In a solid fuel rocket it is virtually inevitable that the "fuel tank" and the "combustion chamber" are one and the same thing. This means that most of the rocket has to withstand the pressure generated by the burning of the fuel *plus* the temperature which is generated in generous amounts along with the pressure.

This makes for a high dead weight and the prime criterion of a successful rocket is the ratio between dead weight and fuel load. And finally, liquid fuels happen to contain more energy per pound of weight.

"Ahem," said one of my listeners, "you say that such motors have actually burned?"

"Yes, Many times."

"They were all quite small?"

"Yes. A few had a few hundred pounds of thrust, most of them about sixty pounds. But

a rocket motor should be easy to enlarge."

"What, in your opinion, is the largest size that could be built?"

"I don't know, of course. Offhand I'd guess about three tons. If future rockets weigh more they would certainly need several motors."

The V-2 motor has a thrust of 27 tons and it now seems that there is no upper limit to the size and thrust of a single motor.

"That would mean that the tank for the oxygen might be large enough to hold several tons of liquid oxygen. How do you know that one could produce such quantities. The stuff evaporates while you make more."

"Judging by the performance of small amounts it should keep better the more you have."

"But you don't really know. You haven't really handled tons of it."

"No."

One V-2 charge is 11,000 pounds of liquid oxygen, the tank cars used by the Germans operationally held three rocket charges. The handling of many ton lots, as we now know, does not present any special difficulties.

"Such a motor," another one of my listeners said, "should burn out after a few seconds."

"Not if you cool it."

"Then you need extra cooling water. If the amounts of heat are large, as they are bound to be, you'll have trouble dissipating that heat."

THEY DIDN'T BELIEVE ME

"You don't cool in the manner of an internal combustion engine. You use the fuel itself for cooling and when it gets warm you burn it."

"Ridiculous."

"But it has been done—it works."

"I don't believe it."

By now almost everybody knows that rocket motors have what has come to be called "regenerative cooling."

"Well, supposing it does work, how long would the motor last?"

"The Austrian, Dr. Sänger, reported fifteen minutes burning time. The highest I have seen myself was ninety seconds."

"That won't get you very far."

Except, of course, that it is not the burning time that counts but the velocity reached by the rocket during its burning period. The V-2, with some 65 seconds burning time,

continues to coast upwards for another 90 seconds or so, attaining an altitude of 110 miles.

The Neptune with less than half a minute longer burning time, will go to more than twice that altitude. And eight minutes burning time will carry to the Moon. The figure of eight minutes is high because it is based on what the pilot will probably be able to stand.

"You said"—somebody else joined the battle of words—"that it might be useful to shut off the motor for a while and then reignite it. Has that ever been done?"

"No, but it should be possible to develop an ignition system that can do it."

IT HASN'T BEEN DONE?

"But it hasn't been actually done!"

Both the nitric acid plus aniline combination and the German hydrogen peroxide plus alcohol with hydrazine hydrate combination are self igniting, all you have to do is to bring them together. And the motor of the XS-1, developed by Reaction Motors, Inc. has demonstrated re-ignition in flight nicely, even though its fuels are not self-igniting.

"I saw a German movie recently"—the reference was to Fritz Lang's *Girl in the Moon*—"where things almost went wrong because the pilot nearly fainted before he could shut off the motor. What would happen if he really fainted?"

"He could just faint away. The job of cutting off the fuel when the proper velocity has been reached would be intrusted to a robot mechanism."

"Robots in the rocket! How could a mechanism sense the true velocity if there is no air outside against which it can work!"

The V-2 has a mechanism just like this. It is known to engineers as the "integrating accelerometer" and you can carry it in a suitcase.

"Well, let's suppose the pilot doesn't faint. He still could not steer in space."

DOUBT IN '36

"He could not steer against an airstream, true, because there is no air. But he will probably have separate smaller motors for steering. It might also be possible to steer by means of vanes in the exhaust blast."

"I'm sure, they wouldn't last long—if it can be done at all, which I doubt."

The idea of inserting a vane in the exhaust jet had been voiced several times then, but even most rocket people doubted it. Actually Dr. Goddard had made the experiment successfully by that time, using vanes touching the exhaust.

A few years later the Germans inserted vanes into the exhaust and the V-2 operates that way. Personally I prefer Dr. Goddard's method. Separate steering jets are still possible but so far nobody seems to have actually used them.

Then somebody fired the final round.

"All this is nonsense anyway. A rocket can't work in empty space. What has it got to kick against?"

Thus the meeting ended with a round of drinks and general head-shaking. The drinks, I seem to remember, were good.