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MAX VALIER - A PIONEER OF SPACE TRAVEL

I. Essers

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16. Abstract

This is a biography of Max Valier, who is credited with popularizing interest in space travel and rocket research in Germany in the 1920's and 1930's. He died in an accident involving the testing of liquid rocket fuel propellants.

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Max Valier, A Pioneer of Space Travel, 1895-1930

by I. Essers, Aachen

PREFACE*

Max Valier studied astronomy. During the war, in the aviation corps, he reached the boundaries of high-altitude flights aboard propeller-driven aircraft.

In 1924 he was the first to consider seriously Hermann Oberth's rocket theory. In many publications and lectures he stated that Oberth made possible the penetration into space.

Valier planned the technical development of the rocket by stages: first, measurements without motion, then ground vehicles and aircraft propelled by powder rockets, then the development of the reaction engine operation by liquid fuel for rapid transportation through the stratosphere (jet engine), then further steps towards space travel.

In 1930 Valier constructed the first small combustion chamber for liquid fuel and reached 28 kg thrust for any length of time (exhibited for the press on April 17, 1930).

On May 17, 1930 an explosion occurred while he was experimenting with various fuels. Hit by a component of the exploded chamber, Max Valier died, becoming the first casualty of space travel.

*Editor's note: This preface was especially prepared by I. Essers for the English translation edition.

Max Valier

Valier differs basically from the other people concerned with rockets in that he was an astronomer. He has never worked on the rocket for a Ministry of War nor for war purposes. He believed that he was serving peace on earth whilst directing people's gaze into the vastness of the universe. In this way he hoped that they would forget quarrels and wars.

In his very active idealism, like Otto Lilienthal, he died for the great idea to which he had dedicated his life.

Walter Boeltz

VDI - Verlag GmbH, Düsseldorf

1968

Printed in Germany.

Figure 1.: Max Valier
1895 - 1930

(Photograph from the year 1927)

"In order to fully appreciate the importance of Valier one must remember that, up to the publication of the trailblazing document of Hermann Oberth "The Rocket Into Interplanetary Space" (Die Rakete zu den Planetenräumen) in the year 1923 there already existed first-class researchers in space travel and rockets in Ganswindt, Ziolkowski, Esnault-Pelterie and Goddard, but that they all could not initially strike any response in the scientific world nor with the public with their work. Only in Germany was there an astonishing development in the field of rockets and astronautics subsequent to Oberth's document. The lasting merit of having started it off is attributed to Max Valier."

Alfred Fritz 1960.

The completion of the study on Max Valier was sponsored by the Georg - Agricola - Society for the promotion of the history of the Sciences and Technology.

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Early Years in Bozen

Max Valier was born on February 9. 1895, in Bozen in the Southern Tirol. His grandfather Gotthardt Valier[+)] was a native of Röfleuten near Füssen in the Algau. There he learnt the baker's trade, then, in accordance with the old custom of the guild he went abroad, worked for a long time in Paris and in many foreign towns and learnt a great deal. He then returned to his home town Bozen. He remained there and married Maria Rotter. Then both moved to Vienna for a couple of years. Their son Edmund, Max Valier's father, was born there. Later they returned to Bozen. The Valier bakery "Under the Arcades" (Unter den Lauben) was soon the first in the town. The three sons learned the baker's trade. The oldest, Gotthardt, had inherited his father's passion for travelling, he too worked in Paris for a long time before he founded his bakery in Innsbruck. The second son, Edmund, ceded his father's bakery to the youngest brother, became a confectioner, married Olga Wachtler and ran his confectioner's shop in Bozen, Poststrasse 4. There his son, Max, was born. The boy was not yet one year old when his father died. Therefore his mother had to take care of their livelihood, for that reason the child was raised in the home of her parents by her sister Sophie. Later the young widow married a certain Mr. Renneberg who came from Lüneburg. In this second marriage she gave birth to a daughter Martha. This stepsister, who was five years younger than Max Valier has told us a great deal about their early life together and has put pictures, letters and the journals of her brother at our disposal for the chronicle.

At the Franciscan High School

In 1910 the 15 year old high school scholar began to enter his astronomical observations into a small book, which he called his Astronomical Journal. In the introduction he says enthusiastically that astronomy is the queen of the natural sciences. Then follows the flashback to 1906 to 1910 which he writes with great earnest in the tone of a good essay:

"Hardly out of primary school there stirred in me the desire for an independent activity . . . . Guided in certain paths by the natural philosophy taught in the third stream at the high school I applied myself more to chemistry. When physics was studied in the fourth stream and I was conversant with optics, I had recourse to the telescopes left to me by my grandfather. One has approximately a one inch aperture and a focal distance of 1 1/2 feet, the other (by Fraunhofer) had an aperture of 41 mm and a focal distance of 450 mm, for an enlargement of approximately 18 linearly . . . . From then on I often observed Jupiter and was lucky if I could see one of its moons. Now and again I also succeeded in seeing two at the same time. I could even see the oval shape of Saturn and once I even saw the ring. - The moon was often the object of my observations and, in spite of the slight enlarging effect of the telescope, I tried to see the crescent shape of Venus, but I only succeeded in doing this with uncertainty."

+) The name Valier (previously written as Falier) is distinctive in his native town in the Algau and also in the Tirol, as is Falkenier or Papier. Only from 1922 onwards, when Max Valier lived in Munich and was known as a writer, did people of Munich, and later the whole world, pronounce his name in the French way.

His sister Martha gives an account of these telescopes:

> "Our grandfather Wachtler had once lent a sum of money to an acquaintance who was in pecuniary straits and this acquaintance had brought him both his telescopes as a security. The money was never repaid and both the telescopes lay gathering dust in the loft. At first the Wachtlers had tried to see something through the telescopes but without success; one saw a murky grey glimmer of light, but otherwise nothing, in spite of all their efforts. - Initially Max did not do any better. But now it plagued him continually. He unscrewed the telescopes, examined them, cleaned them, tested them, studied in his physics book and tested them again until he finally succeeded in repairing the telescopes."

In his Astronomical Journal it says in addition:

"My knowledge was very small since I still did not possess any work nor had I read any. One main advantage was that my telescope did not need any erection at all.

In 1909, on June 3, I observed the eclipse of the moon with all eagerness. In August I bought myself Littrow's "Wonder of the Sky" (Wunder des Himmels), through which my theoretical knowledge was broadened a great deal . . . .

At Christmas in 1909 I received a telescopic tripod of the kind used for photographic equipment, and I now made myself a quadrant and an azimuthal instrument of the most primitive kind, the circle of which was divided into $1/4^{o}$ . . . .

For the measurements I proceeded in the following way: After I had set up the quadrant fairly horizontally and vertically with the help of a level, I observed the star (in Meinhardstrasse in the bitter cold of winter) in accordance with its height, struck a match in order to read, then measured again after 10 minutes and then compared the results obtained, at home. The first observations of this kind date from December 30, 1909, and are concerned with Venus."

Now he relates the whole process in his journal in order to show, with this example, what one can work out from the measurements. There it says:

"First observation 5:40, second observation 6:00" etc.

How great must his pleasure in astronomical observations have been that he was not afraid of getting up early nor of standing with numb fingers on the instrument in the cold winter. He was not well supplied with warm clothing. Actually he was never well dressed. His father had already been dead for a long time, the grandfather too had now been dead for a few years. Who was to buy him good clothing? At Christmas he wished for skates and each year a season-ticket for the municipal skating rink or even things such as the tripod for his telescope and when he earned pocket money it was to buy himself an astronomy book. That he went around badly dressed was quite irrelevant to him.

I asked his sister whether his gradmother and aunt Sophie were not anxious when the thirteen year old boy first left the house at night with his telescope and stood alone in the street. She replied:

"No, everyone had such a great confidence in Max that we willingly gave him permission."

In addition to the Astronomical Journals his sister has preserved another small note-book, which bears the title: "Poems III. Max Valier." In it there are legends of his homeland in the form of ballads and other poems. Here he expresses his thoughts in verse, thoughts which occurred to him during his travels. One of these small modest rhymed monologues, from which we can see his great love of the stellar system, is called:

"Longing for Winter" (Wintersehnsucht)

"The winter night first shows the
stars so well in all their splendor.
They twinkle with a gleaming appearance
and seem to be really happy.
They glitter in white and blue
and the grey of the heavens becomes darker.

That does not happen in summer's orbit,
in the summer night the stars are pale.
Not even in fall does it grow dark enough
for the drift of constellations to illuminate brightly.
In spring, even then, it is completely absent,
little does it show of the starry host.

For that reason I long for the winter's coming
and when it arrives greatly do I rejoice.
I love it far above the others,
it is for me the most pleasant season,
for only in the glimmering winter night
does the sky appear in all its glory."

Let us follow his Astronomical Journal further:

"I succeeded in finding a better set-up for my telescope and the result was that I could recognize 3 satellites of Jupiter . . . ."

"I saw the January comet on January 27 and 29 (1910) whereas it must have been at its finest on January 24."

"Incited by the subscription to the periodical "Sirius" I mapped a celestial chart I on January 5, and celestial chart II on January 7, according to the ephemerides . . . ."

Therefore he now begins to make a graphic record of what he saw.

"In May, Halley's comet promised to be very interesting. I saw it again on May 22, mapped it on May 26, and on the following days. I admit that its appearance did not conform to expectation. The people had imagined it to be far more spectacular. I had to permit being scoffed at by my school-friends as a notorious astronomer.

But the fact that my student friends[+)] Oswald Gschliesser and Gottfried Hohenauer teamed up with me, who was the only one with a telescope, as a result of the comet was of much greater advantage to me. I am indebted to the first, especially, for an extended knowledge of the constellations, the latter called my attention to the binary stars, which I keenly sought out from this time onwards.

It was June 1st which magically produced for me ζ Lyra in the telescope erroneously instead of ε Lyra, the duplicity of which being immediately recognizable left me highly astonished. The discoveries increase daily. Halley's comet disappeared from my view completely on June 12. On June 14, I was able to isolate Mizar itself, a record of closeness which I was not able to surpass again in this period.

Perfectly systematically I now continued the hunt for binary stars which, aside from Jupiter, which I often observed, are also my only objects."

His "Astronomical Journal I" has 24 pages. He reports about successes and even errors, about shooting stars, clusters of stars, satellites of planets, moonscapes and about mapping celestial charts. But nothing in the booklet is dry, everything is animated, from the short lines one can sense his joy in discovery, when, for example, he writes:

"I map the Andromeda Nebula. Finally I find one of the clusters of stars of Perseus - a magnificent sight . . . ."

Max was particulary friendly with his class-mate Oswald Gschliesser, whose father, a captain in the 2nd Tirolean Imperial Rifle Regiment had been posted to Bozen in 1908.

Prof. Dr. von Gschliesser (University Professor of Modern History in Innsbruck) told us of those years in high school together:

> "Valier was a good climber and ice-skater. (At that time skiing was still fairly unknown in Bozen.) Moreover he knew a few acrobatic tricks such as crossing a bridge, balancing on its railings like a rope-dancer. Another was to fall to the ground stiffly head first like a balten and only at the last moment did he break his fall with his hands. When a new teacher arrived at high school and the other scholars made a bow on meeting him on the way to school sometimes, to the joy of his friends, Valier made this stiff bow right down to the ground.

[+)] Usage in Bozen (actually in the whole of Austria, as in northern and eastern Germany): The high school scholars were called students from the upper grade onwards, and when they did their homework, they would say: I must study.

For this reason in his youth Valier did not attach a great importance to social manners and clothes."

Max had been invited by his school friend Johann Psaier to spend the long vacation with him on his father's farm in St. Peter in the Villnösstal. Hans Psaier was the head-boy of the class. The friend who was so active intellectually but who achieved success even in field work and mountain tours was his dear companion. For this reason, even in the years to come, Max was invited again and again by the Psaiers for the long vacation. As was his nature, in 1911 Max wrote a few verses in his poetry booklet, from which we now come to know his holiday home, indeed we see it with his eyes:

"Departure from Villnöss (Abschief von Villnöss)"

"The time is drawing near and once again I must part
from this valley which is so familiar and dear to me,
where the leaves, already autumnal, clothe with red
and yellow wherever man's gaze turns. And where the
farmer cultivates fields and pastures with winter rye
for the new year. So must I leave this beautiful valley
and return again to the streets of Bozen.

The valley which is incomparably surrounded by
precipitous rocky peaks of limestone, where even life
in the rocks themselves wakes with the bright light of
the setting sun. Around which a thousand legendary spells
are woven which do not cease to enchant me. -
And I must return again to Bozen but it is not meant for
me alone but for many another."

He had obviously always taken his telescope with him to Villnöss. In the mountains the nights are clearer but even colder than in the valley. Many pages in the journal were filled.

"July 1910 . . . . I observed the moon, mapped a few of its mountains, especially the Pyrenees. Various shooting stars could be seen, one which was particularly beautiful fell at 9:45. I counted twelve in a good half hour . ."

In those weeks he wrote even more often ". . . . I mapped moonscapes, . ." and in his booklet of poems there was another poem before the poem entitled "Departure from Villnöss," which consisted of 8 verses of which we will see at least 4 here because they especially show his way of thinking.

"Prelude to the Lunar Diagrams"

"1. What I can offer bears but a faint resemblance
to that miracle of creation which,
revolving serenely in the celestial spheres,
gladdens the eye of the weary traveller,
and makes the scholar's knowledge, painfully acquired,
pale into nothing in infinity.

2. For millions of years the moon has circled in the sky,
accompanying our earth along its orbit.
Always it turns to us the same face,
a shining model of perseverance.
Its other face remains forever hidden from us,
An image of our imperfection;

3. A token of the fact that it is not given to us
to know all things completely.
To labor, doubt and seek: such is the nature of man.
Even our achievements are a prize which,
making us aware of still more enigmas,
proves Socrates' saying that we know nothing.

. . . . . .

6. But even what I see is so prodigious
that my pencil trembles at every stroke,
and so very beautiful that I must heave a sigh
on contemplating what my hand produces.
My only solace is that it may improve,
with practice, if I only persevere.

. . . . . ."

However, in the Astronomical Journal, entries are made as objectively as possible.

"On September 1, I returned to Bozen.
Recapitulation of the second period. Observers: Oswald Gschliesser, Gottfried Hohenauer, Johann Psaier, Alois Kerer and myself. Results:

Binary stars: ζ Lyra, β Cygnus, δ Serpens, α Sirius, ζ Great Bear, γ Delphinius (12")? where separated, in addition to ε Lyra, ? Scorpii (v)?, ?Aquarius?, α Canis minor; 11 altogether.

Clusters of stars: η Hercules, β Ophiuchus, χ Perseus.

Nebula: Andromeda nebula."

On the next page of the journal is the title:

"Third period September 1, 1910.

There are two factors which brought an end to this period, namely the refinement of my instruments and the acquaintance with Heinrich Pichler.

Before my departure from Bozen I had written to several firms for a catalogue for astronomical equipment. In addition I had ordered the astronomical dictionary. From the catalogues I had now learnt that the magnification of my telescope could be increased by other astronomical eyepieces.

September 17. Today I observed with Heinrich Pichler for the first time and I used the new lens which produces a 60 x magnification. A moon diagram terminated the observation."

He then ordered another eyepiece so that his telescope had a 100 x magnification. In addition to that a helioscope.

"September 25. I have ordered a parallactical telescope from H. Gugler, a precision-tool manufacturer."

The telescope therefore had led him into the workshop of Mr. Gugler. Perhaps this gentleman had advised him perhaps Max hit on the idea himself that he must learn precision-tool manufacture in order to be able to make improvements on his equipment himself later. In any case the high school scholar decided to do this and carried out his plans! His mother informs us:

> "Max went into apprenticeship with Gugler which we did not know at the time, since we regarded his interest in precision-tool manufacture as a pastime and he took his journeyman's test according to the rules, for which he was given a testimonial."

Even his friend Gschliesser relates about this apprenticeship and added: "Max had very skilled hands, which was often useful to him later."

In the journal is also written:

"September 27. Today I used the parallactic telescope for the first time which satisfies my expectations remarkable . . . . the new eyepiece has arrived. 100 x magnification! Only the small field of vision (1/4° diameter) makes itself unpleasantly perceptible.

September 28. Saturn shows its ring quite perfectly, ..."

After a series of further observation reports there is a summary in the journal:

"The costs for the telescope amount to:

The first eyepiece and helioscope	15.85 K.
The second eyepiece	12.--
The parallactic telescope	30.--
Eyepiece mount and eyepiece ring	7.--
Polishing of everything	5.--
Total	69.85 K."

On November 8, he makes an entry:

"Today my article appeared in the "Tiroler Volksblatt" (36 lines). For this reason I received the copy free of charge. The article is called: "On the lunar eclipse on November 16 - 17." It is my first work."

He carried on his association with the press.

"December 12. I have taken the completed astronomical calendar for January, 1911 to the editor's office of the Volksblatt, it will be printed at Christmas."

The fifteen year old boy had therefore carried away with his great enthusiasm for the stellar world not only many of his young friends but has also interested the chief editor in it.

Another typical trait of Max Valier is apparent from what his friend, Professor von Gschliesser recalls, looking back on his early years:

> "Not only astronomy but also many other intellectual interests united us during our high school years. Valier informed me, on our way to school together, of all his plans and results in the diverse fields which occupied him and incited me to my first literary attempts and found a place for a story written by me in the Sunday supplement of the Tiroler Volksblatt in Bozen. This shows that Max Valier, unlike many other intellectual creative spirits, was completely free of literary egoism and envy of competition."

On New Year's Eve he enters in his astronomical booklet:

"Recapitulation.

Resources and Instruments:

Parallactic disposition of my telescope at magnification
(M) = 60; then eyepiece for M = 100;
later projection apparatus;
finally Zeltner's 3 inch;
5 astronomical books.

The results arising from this are:

1) 40 moon diagrams and planet diagrams

2) September to December, 38 observation days" etc.

Typical of the young boy, for whom it was hardly a question of "I," is this sentence: "The results arising from this are" - another would have cherished it proudly as his accomplishment.

At the end of the year he writes:

"With this I close the 3rd period. What will the future bring? Now if astronomy is really my career then God will help me with it."

In Gries, a residential suburb of Bozen, Mr. Zeltner had built himself a fine house. We do not know how he had got to know the young Valier. The entry in the booklet only says:

"Today I could observe for the first time with the 3 inch telescope of the Councillor of Commerce, Mr. Zeltner. The magnification must only reach 70 to 80 but on account of the tremendous focus number much more can be seen than with my instrument at 100. The pleiades are a beautiful sight in the view-finder; the three peripheral stars just come into the finder. The ring of Saturn is very visible. Only the set-up of the instrument is unseemly for a 3 inch."

The journal further shows with many examples how large the visual field of the view-finder is and how, as a result of the great focus number of Zeltner's telescope, quarters of the heavens which are otherwise dark, shine full of stars, like the region of the Pleiades.

"But the main thing is that I can order a new eyepiece for approximately 200-fold magnification; I can see a new era downing once I put it into operation."

The old gentleman was pleased with the enthusiasm of the high school pupil for his telescope. He allowed him to come to his house at his own convenience and to look at the stars through the 3 inch telescope.

In the journal "Sirius" a couple of lines written by Max Valier were published, "Report on the Meteor which fell on January 8, 1911, 10:44, from α Ursa minor to α Ursa major, approximately 10°, almost as bright as the moon," With it was a small diagram.

Now the telescope was directed on the sun, "January 24. Morning. Observation of the sun. No spots to be seen." Often he had already sought for sun-spots in vain, finally he finds some and writes:

"February 14. Today from 2 p.m. to 3 p.m. I was at Zeltner's house. I saw a beautiful group of sun-spots of 4 or 6 spots. At a magnification of 80 only the largest was visible, only a magnification of 200 could reveal them all . . . ." He mapped the group and measured their diameter with the telescope; the largest 8", the smallest 3".

February 15. Noon, observation of the sun at home. The sun-spots are just visible as 3 dots at a magnification of 100. I am glad that my instrument shows them" . . . . Later:

"April 1 (1911) . . . . How surprised I am, as instead of the 3 sun-spots observed yesterday I can see 17 spots which, of course, I mapped. Such changes in 24 hours!"

If we give a lot of details about his astronomical observations here and have quoted word for word many entries in his journal it is to show that he set his hand to the task, not with childish amateurism but with perseverance and earnest to observe the celestial bodies - with joyful earnest.

If clouds covered the sky and made observations impossible one would be of the opinion that he settled down with his school books to catch up on the gaps which his astronomical craving for knowledge had brought him in his philosophy. But no, he then took up his astronomical calculations or a book of pure literature. As he was rapid in learning he kept up well enough in his class with a minimum of home work. In physics he was the best so that gaps in other subjects could be compensated for. His teachers, the Franciscan fathers, must obviously have been very liberal that they left him his so pronounced personal manner. As a result of their wise leniency he did not take a dislike to the high school but it was what it should be, the source out of which flows many things which the mentally alert youth assimilated.

On January 1, 1912, Valier began another journal with the introductory words:

"This booklet is to include everything that suggests itself preferentially to my mind and which invites intellectual activities, except for my astronomical activity."

Here the titles of his poetical works are quoted but for a long time his booklet was not written as regularly as his astronomical journals. Often there was even a Latin poem.

"In the first days of February I worked eagerly on a modern dramatic idea and communicated it to Gschliesser and Röggla with whom I take a stroll every Sunday during which a few pieces of work are read aloud and during which the most edifying philosophy is professed."

Then we find in the journal two short entries which show how he already loathed the mere thought of bloodshed. - Moreover in his journals there is never a derogatory remark about his teachers and school, only on March 7, he rails:

"In the morning I must listen to the wretched circumstances of the French Revolution. My God it's a dreadful matter!"

Two days later he wrote 2 lines only:

"March 9. Dramatic thought: Guillotine, at the critical moment an earthquake, etc."

Another time he says that when he wanted to play the piano two young girls came and engaged him in a conversation. Since the two did not have anything intelligent to say he directed the conversation to the Gesellenhaustheater and then to philosophy.

"I have brought about a fine thing and it would be understandable but I noticed that there could not be a more monotonous subject for these two girls than my philosophy. But cruelly I kept to the subject."

On March 11, the title of a drama appeared in the journal for the first time, a drama which continued to occupy him for quite a long time:

"The "Marienritter" will not be suitable in five acts, it requires even harder work . . . ."

Then hidden between entries on work on the "Marienritter" are quite short lines on a new subject.

"March 13. My work was read out in the seventh year invitation to write poetry, which partly seems to be successful."

"March 14. Design of the title page of the class newspaper which is to be founded."

Professor von Gschliesser said about this class newspaper:

> "At the age of 17 Valier started, edited and reproduced a school newspaper. It was called "Mentor" and was initially published in 30 copies, later in 80. Valier participated with contributions under the pseudonym "Charon." This "Mentor" represented a notable organizational accomplishment."

One can imagine how many hours of work this newspaper cost him, which he produced with a duplicating machine. With this he was faithfully assisted by his sister. Today Mrs. Martha still possesses the original "Mentor." The first number appeared on March 22, 1912. It begins with the following prefatory remark:

"With these pages the realization of a long-cherished plan appears in public, which is shut in by the same boundaries which separate the seventh year from the outside world . . . ."

The public is his class, the seventh year. What inspires and stirs the seventeen year old boys they can entrust to the newspaper. Thus the "Mentor" is a mirror of the personal intellectual life of the schoolboys and it trains its contributors to aspire to a good, clear style.

In the May number it says: "The "Mentor" has introduced itself and has stood its ground." A proper duplicating machine was now purchased, and even the other streams (classes) of the upper school were called upon to contribute. Up to this time 9 seventh-year pupils had made contributions. Ekkehard (Gschliesser) participated with poems and with very clearly written essays. From Charon (Valier) there appeared sketches, poems, epigrams, essays and once a long astronomical essay "The Sun," which is reproduced entirely in appendix 1. Here we quote only the introduction:

"The sun diffuses light and warmth, strength and life over the earth. The Egyptian fell to his knees in worship and entreated it as his divinity.

And our sun has something divine about it; when we contemplate it in all its might and splendor, we are struck with wonder at the omnipotence of the creator who produced such a thing.

In primitive times man had a presentiment of the importance of the daystar for his existence, for thousands of years the scholar aligned armillary spheres, measured in terms of gnomons and tried to determine the orbit of the sun.

But only in modern times, since the invention of the telescope, could information be acquired about the solar bodies as such, and in spite of all the spectroscopes and photograms in calcium light even today the enigmas are not all solved and the opinions of the most notable scholars often differ greatly from one another on many points especially in solar theories.

Those extremely interesting solar phenomena which may be explained in what follows are, on the other hand, facts which are confirmed and only the causa primaria of their origin is often obscure." . . . .

Thus he points out that the theories with which the astronomers explain the original causes of present incidents in the orb of the sun often differ greatly from one another. The still unsolved enigma, which attracts the author himself to this subject, holds also the interest of the reader.

And as he himself is not an abstractly thinking mathematician but one for whom all figures represent something concrete, he continues:

"For the understanding of the meaning and the scope of those phenomena on the sun, we must first of all get an idea of their dimensions, for which the known distance of the earth from the sun and the known apparent size of the face of the sun provide the necessary fundamentals.

. . . . the distance of the moon from the earth = 385,000 km, which is only 1/4 of the diameter of the sun or in other words: If we were to displace the earth into the center of the sun which is thought of as hollow, the moon rotating around it would be almost as far away from the surface of the sun as from the earth."

Then with simple phrases he describes vividly and keenly what can be observed on the sun. At the end the reader has understood the astronomical concepts which are very alien to daily life on earth, concepts such as "photosphere," "chromosphere," "prominences," and "sunspots." And he now knows that the sun does not shine statically like a large bulb in the sky but he has now obtained a slight notion of solar activity, of the eruptions and of the prominences erupting with a speed hardly imaginable.

Here there are more entries from Valier's journal which show that the realization of his many plans has often made it difficult for him to work. Already in his early years he had to accustom himself to rapid, concentrated work.

"March 17. I received "Sirius," in which my maps are well reproduced. I compared them with those of Jakob Müller and found that mine are nevertheless still considerably inferior to those of Müller. That will not do, I must still learn the art. If I am to be suitable to be a selenologist I must also learn these graphic arts."

"March 28. Unfortunately I still experience a confounded dissipation. In addition to my studies I must go in for astronomy. I must hurry along the essay on the moon on account of the fee and then there is still the work for the "Mentor"."

In the long vacation Valier again goes to the Villnösstal with Hans Psaier. A varied action report can now be seen in the journal:

"Fieldwork; mathematics with Hans. (Presumably the two friends went in for mathematics in the vacation from the delight in voyages of discovery in the new territory of mathematics.) Composed "On the Mountains" (Auf die Berge); looked for plants, determined and classified them; played the organ, at the same time posted a letter to the editor's office of the "Leuchtturm" and cards to mother, grandmother, aunt and Martha; a card written in Greek to Father Joachim." (Father Joachim Schroffenegger was the old kind-hearted Greek teacher.)

Interspersed amongst these activities there are days with mountain trips, once to the small Fermedaturm, later to the Campiller Türme. Another time plants were painted in aquarelle. Another day 3 poems come into being, 1) To Dante (An Dante), 2) To the Devil (An den Teufel), 3) To Maria (An Maria). - After the field work he read, Kleist, later Rosegger. Then in the journal we find:

"July 13. Idea for a new rotating celestial chart."

"July 30. The idea of the rotating celestial chart offered to O. Maier, Ravensburg."+)

+) When I read this passage in Valier's journal I remembered that I had received a present of rotating celestial chart at Christmas in the year 1912, with which I liked to go out of doors on clear winter evenings to look at stars and constellations.

I looked for the chart and found it, for I had preserved it well together with a few books which are particularly important to me and had carried it with me throughout the whole eventful decade. What I had never noticed before I now discovered on the back: "Publishing House of Otto Maier in Ravensburg" and "Maier's Rotating Celestial Chart, Registered" are there. - By turning the upper disk one can adjust it to the day and hour so that the aperture shows the section of the starry sky which was situated above Central Europe as a celestial sphere on that date (see appendix 2).

That was Max Valier's idea which he offered to the publishing house of Otto Maier.

On August 6, it reads:

"In the evening by the lamplight I made up the cock-and-bull story "From Mars to the Earth" (Vom Mars zur Erde) and wrote a large part of it."

Then in Bozen again:

"August 22. Played the piano in the morning. In the afternoon read reviews, then typed an article for the Volksblatt. Then at Gugler's (precision-tool manufacture)."

"September 26. Dear journal, I do not have the time to write a great deal in you. My routine is school, precision-tool manufacture until 6 pm, then literary activity at home. With horror I realize that I study too little. For that reason I must have myself wakened earlier."

"27. I now study sufficiently, carry on my astronomical work until 10:30 p.m. and get up at 5:30 a.m."

"February 1 (1913). For the first time of my life I masqueraded on ice as a Bedouin. In the evening I looked through the microscope."

"March 1. I work hard and study little."

"March 17. Mentor no. 5 is ready after a great deal of bad luck. We had to write the whole issue again."

Then comes a particularly interesting passage in the journal for chroniclers:

"As I considered it desirable not to allow the Valier family tree, as far as my grandmother had knowledge of it, to fall into oblivion, I made the following notes on the occasion of a search:

Grandfather Valier born and bred in Pfronten-Röfleuten, district of Füssen in the Algau.

I. Grandfather's Generation

1. Gotthardt Valier 1826 - 1902
(married my grandmother in Bozen in 1862)

2. Clement Valier 1827 (28?) - 1878 (80?)
(Merchant in Regensburg)

3. Josepha Valier
(married Mr. Markwart Niedermayer)

II. Father's Generation (only the descendants of Gotthardt Valier)

1. Gotthardt born February 11, 1863
Sebastain " April, 1864 1/2 year +
Engelbert " September, 1865 2 1/2 years +

2. Edmund born January 30, 1867 1895 +

3. Willi " March 10, 1868

III. Our Generation

from (1)	Gotthardt	born	March 10, 1910
	Fritz	"	?
from (2)	Max	"	February 9, 1895
from (3)	Willi	"	May 18, 1895
	Alfred	"	April, 1896
	Karl	"	June 30, 1897
	Anna	"	September 8, 1898"

(A family with a great number of sons!)

The information of the place of birth and year of grandfather Gotthardt Valier made it possible to discover earlier ancestors in parish registers of the district of Füssen in the Algau:

Great - grandparents of Max Valier:

Engelbert Falier and Viktoria, née Reichler
born June 29, 1797
in Bidingen near Kaufbeuren in the Algau

Great - great - grandparents:

Jacobus Falier and Margarethe, née Eningerin
from Rieden in
the Algau.

(The name Valier therefore was written with an F three generations earlier.)

"Easter Sunday, today I began to study with great determination."

Now he seems to really concentrate on his school books. The next entry, which he obviously made in passing immediately after the termination of the oral examination, reads:

"July 3. Successful in the final examination with a majority, 3 p.m. - 7 p.m."

"July 12. Departure for Villnöss. I have my photo-micro-, telescopic and touristic equipment with me."

It is strange that he has never noted anything about his departure from high school. A sentence which Professor von Gschliesser wrote about his

childhood-friend Valier, may give the explanation for this: "The loner was adverse to drinking beer, smoking, drinking songs, etc., to every corporation and club system"

Of the many things that the journal relates of the weeks in Villnöss, only two mountain trips made by the two friends will be mentioned here.

"July 28. Attempt to make the Campillergrat. Return down into the valley . . . . Wasserkofel,+) east peak, main peak, 12 p.m. midday rest, west peak until 1 p.m. Down amongst a great deal of snow (often hip-deep in the deep virgin snow). On the notch between Wasserkofel and little Furchetta . . . . Ascent of the Torkofel and back again. (Was not easy in many places) . . . ."

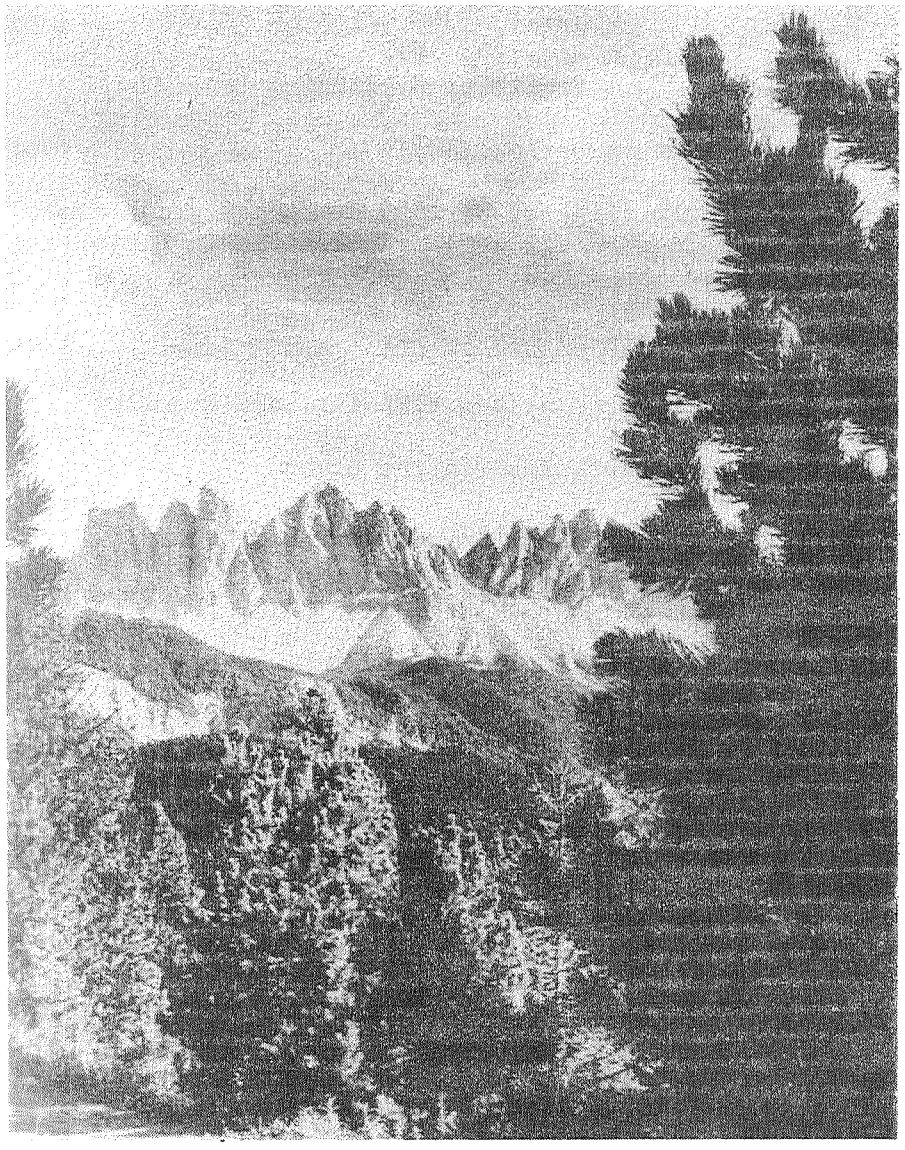

Figure 2: The Geisler group in the Dolomites

+) Figure 2 shows us from the left: Wasserkofel 2915 m, Furchetta 2936 m, Sass Rigais 3025 m, Fermeda Spitze 2832 m and Fermeda Turm 2678 m.

"August 18. Trip to the small Fermedaturm, through the breach between the foremost peak and the rote Wand. Climbing shoes and rope necessary in the breach. Playing at the summit without a rope."

The departure from the Psaiers' house, from the Villnösstal and from the calm, proud Dolomites was particulary difficult for him this time. "The days of youth are past," he wrote sadly.

For mountain climbers and hikers, who know the Dolomites, who have once seen this splendid mountain region in the evening sunshine, their heart beats faster when they think about it. From the whitish grey bouldered slopes, which surround the foot of the mountains, shining rose-colored, the huge rock peaks tower up into the sky. - The rose-garden, the fairy-realm of the gnome-king Laurin, they are so called in the old German legends and epic songs.

But where does the new name "Dolomites" come from, which the mountain ranges east of Etsch and Eisack have borne for approximately one hundred and fifty years? The French naturalist Dolomieu, a famous mineralogist and geologist investigated this part of the Alps thoroughly and in 1791 wrote a scientific work about the special rock which the mountains are composed of. Then in his honor the rock was called dolomite and later even the mountain range was called the Dolomites.

Studies in Innsbruck

He studied astronomy, mathematics and physics as major subject and meteorology as a minor subject.

"October 15. I am at the university in Innsbruck as a regular student."

"October 17. Today for the first time at the observatory. The 4 inch telescope is put at my disposal."

"October 19. Today I went on a trip with uncle Gotthardt. In doing so I got to know a man, who is the first to take my problem of the free flight of birds without a motor seriously. He wants to build me my flying-machine. The terrain here would be very favorable."

"On his mountain trips Valier noticed that often a wind blowing in an upward direction passed over the mountain slopes. But to glide in this upslope wind like the birds only remained his plan and was not realized by him. (Only from 1920 onwards did former German war aviators develop gliding in the Rhön.)

"November 12. I am extremely inspired by the ancient works of astronomy, by Poggendorf's affair and I am moved to study with every determination."

"On December 13, I was matriculated."

Christmas vacation in Bozen. -

"On January 1, 1914 I became "membre de la société astr. de France"." -

In the summer term of 1914 in Innsbruck between lectures and classes an aerodynamical idea came suddenly to Valier. He rapidly built himself a model airplane, however not with the usual propeller with a twisted rubber band as a motor but with another propulsive power, namely a firework rocket. Rockets were to drive his airplane through the atmosphere with their reaction!

An eyewitness, who told about that very successful model flight many decades later will get a hearing here:

Tiroler Nachrichten

"The Inventor of the Jet Plane - a Tyrolean.

> As reported, the Congress of Lunar Rocket Researchers met recently in Paris. Many fine speeches were made, partly serious, partly hyperutopian plans were developed, one heard in amazement of the most recent researches and confidently believed, at least up to now, in the beautiful myth of lunar travel. Mention was not made of one man only - that man namely, to whom we owe our present day knowledge (aircraft technique), in fact the rocket motor, that man is Max Valier, ...
>
> As soon as Valier was scarcely 18 years old he made himself notorious in Innsbruck. Perhaps the older generation remembers even now a wonderful night in June in the year 1912 or 1913, when a comet whizzed away over the small Tyrolean country town which at that time was still homely. Or at least the fiery thing looked like an incalculable planet which alarmed and frightened the population. And what, in reality had taken place? The high school pupil Max Valier has constructed a kite out of impregnated paper, a kind of glider, to which he had attached a system of three fireworks instead of a tail, in such a form that one rocket lit the second and then the third before it burned to the end.
>
> Start: Hotel Mariabrunn on the Hungerburg. The kite landed in Pradl . . . .
>
> No one could argue quite seriously that Max Valier is, in actual fact, the inventor of the jet aeroplane."

The reporter is indeed slightly in error as regards several particulars - no wonder, four decades had passed since that event - it was Spring 1914 and the 19 year old Max Valier was a student in the second term. But how well the writer of this article had found the truth with his last sentence, which will surprise even him when he follows up the years 1924 to 1930 in this book.

But then, in Spring 1914, no one hit on the idea of appreciating this first, very successful flight of a reaction driven model aeroplane as a very promising invention, on the contrary. Sister Martha says that she remembers

well "that Max got into difficulties with the police, the police even wanted to commit him to prison on account of the prank and that uncle Gotthardt who had an influence in the municipal council settled everything." Presumably, however, the uncle had made his nephew give his promise never to speak of this affair - for not even his friend Gschliesser knew about it.

His fellow-students from that period tell us that he was a good conversationalist and a bad listener. He always spoke about his own thoughts and plans. A girl student in Innsbruck gave him a good name - she called him the troubadour of the stars. His love belonged to the stars in the vault of heaven.

In the vacation he worked on his literary plans. The first is a fanciful operetta, "The Moon Fairy" (Die Mondfee). The action takes place on the moon. A couple of human beings visited the inhabitants of the moon. There is love and threats of war and finally a good ending. This strange dramatic work was written almost completely in the weeks of the vacation in Bozen. Poetry and music. The latter helps to make the unsubstantial attractive. -

Valier's second literary work which came into being in 1914 appeared on the book market as a booklet of 100 pages and was called "Astronomical Mapping" (Das astronomische Zeichnen).

The Natur and Kultur publishing house in Munich thus accepted the manuscript of a student how, at that time, was in the third term. In this part of his life the young student generally assumes an academic arrogance especially if he is the first university man in his family. Max Valier was not like that. The subtitle of his booklet was "A lucid understandable initiation into the observation and graphic representation of celestial objects after looking in the telescope, destined for laymen and amateur astronomers."

Here Max Valier's manner of social perception became apparent. The starry sky is for him the incarnation of beauty; indeed it is not there for the world of scholars only. Each person who finds pleasure in looking at the stars will find that the booklet is a friend and aid. In a vivid, fluent way it talks about celestial charts and planets and makes the reader conversant with them. It even talks about the phenomena of the sun and moonscapes and broadens our knowledge without lecturing.

After many articles for newspapers, periodicals and encyclopediae this booklet of Valier was his first publication.

> "Dedicated by the author
> to the Councillor of Commerce, Mr. Zeltner,
> in admiration and gratitude."

In this way the twenty year old young man thanked the rich man, who at that time in Bozen did not see in him the badly dressed high school scholar but had taken him and his great love for the stellar world seriously.

In addition to these two amiable small literary works he began a third which he tackled with absolute earnest and which, for him, was much more than a mere literary work.

In the journal we read:

"May 5, 1914. I am beginning to write about the miracle of the sky, I round off "The Forsaken God" (Der verlassene Herrgott)."

By accident it seems to be that these two titles are found together in such a way. But between the two there is a deep, inner connection.

In those decades Haeckel's "Natural History of Creation" (Natürliche Schöpfungsgeschichte) had such an effect in intellectual life that the educated did not wish to know anything more about a creator of the heaven and earth, about a Lord and God. The Lord God was good for the upbringing of children, for the oaths of soldiers and for simple folk. But even in the masses the simple belief of their fathers was undermined by the single-minded work of the social democracy of that time: "For the dull folk the dear God and the church exists; the scholars have not believed in it for a long time." - He now met with such an attitude again and again and he would say to his sister: "The scholars are robbing man of his finest thing, his act of lifting his eyes up to God. Consequently they are making themselves guilty of a great wrong. They do not notice it in the cynical arrogance of their erudition but he, from whom they have taken his inner happiness, does not ask whether they have done this bad turn to their fellow-beings blindly or consciously."

- In the Second World War the same thought had plagued the courageous French author and aviator, Antoine de Saint Exupéry. In his last text, the "Letter to a General" (Brief an einen General) (written in 1944) he complains about soulessness:

". . . . The robot man, which one feeds with readymade culture, with standard goods like one feeds the ox in the stall with hay, is the human being of our epoch.

He who has only known the bar, the racing-car and the magazine as intellectual life patterns, he today finds himself in a gregarious situation, which no longer has any charm . . . ."

Of his companions he says: "They are upright, respectable, fine and loyal. Certainly, but also miserable. They are so badly in need of a new bond with God." -

The young son of the Alps, Max Valier, the student of natural science, realized the same thing three decades earlier. Human beings who no longer wish to know anything about the Almighty God, are miserable and empty. -

Up in the mountains, when one stands on a ridge where the keen mountain wind sings its song, where the towns of human

beings are so far-off and so small and the sky so great, when one asks oneself there quite honestly: Do you yourself believe in God? - the question then seems so useless and stupid. Up there the insignificant human being can have a slight presentiment of God's greatness. But what good is that to the many human beings who live in the plain country, amongst the mere feats of the human hand? - Indeed even they can perceive a grain of God's greatness when they avert their eyes from the work of man and look up to the stellar world.

The plan developed in Max Valier's mind: I will write a book about the miracle of the heavens. The finest knowledge of our astronomers must figure in this book but it must be written so simply that every human being who so desires can understand it. In this case it is necessary to find the right tone, worthy of the subject but intelligible to the reader. If a book of a scholar has destroyed so much why should another scientific book not build it up again?

These were the thoughts which filled the enterprising youth in Spring 1914. In 1924 the book planned appeared. It bore the title "Orbit and Nature of the Stars" (Der Sterne Bahn und Wesen).

In the War

Summer 1914. - The war had broken out. - Valier's mother talks about that period:

"Max had never had any enthusiasm for military service and had regarded it as good luck that at that time he had no citizenship. His father who was deceased was registered in Bavaria but we had omitted to register the child. For this reason he remained exempt even longer than other fellow-pupils. But, in 1915, when the regulation was published that even people without citizenship had to join the services where their birth place was, he too received the order to present himself. Thus he was mourning for the continuation of his studies but he accepted the inevitable without alarm. Then he went from Bozen to Brixen, to Enns . . ."

Military drill, rifle exercises, and practising quick marches went against Max Valier's nature but he never complained about it. Soon even his company leader discovered that one could readily appoint him for the most varied special duties. Cheerfully Valier wrote to his friend Gschliesser:

"For the time being I am all right, am here in the orderly room of Baon but not permanently, only for as long as we stay. Even have my typewriter here. Have recently voluntarily taken part in a large scale drill so that I will not get rusty. As a mountaineer in a region which is well known to me, above 2000 meters, where even we were once together. I commanded the detachment on skis. Hope to be able to still accomplish fine things in this mission in the field, where we shall soon be."

In 1916 he sent a photo home from the Italian front, there he is shown as a corporal of the riflemen of the Imperial and Royal Rifle Regiment Bozen No. 11 at an aiming circle theodolite for anti-aircraft defense. He is still a youth who looks calmly and thoughtfully at the apparatus.

In the year 1916 the small "Booklet of Stars for Everyone" (Sternbüchlein für Jedermann) appeared, which Max Valier had written for the man in the trench. - The fronts ran from the North Sea to the Alps, through Upper Italy, through the Balkans and through Russia to the Baltic Sea. Many thousand posts stood watch at night. When the sky was clear and calm prevailed in the sector of the front, many a soldier looked up to the stars. The small booklet was quickly out of print, the booklet in which amongst scientific explanations there vibrates faintly the exhortation: Look outside, how wide the world is! Look how small the earthly being and human sorrow are! -

The next photo came from Russia in January 1917. The serious lean face of a combatant looks out from under the steel helmet. His mother says of that period:

> "He was assigned to a German army weather station in Russia, the detachment for gas-attacks. In one of these, with danger to his life, he saved a whole regiment from the deadly gas, which streamed backwards due to the change in direction of the wind, by running in, heedless of the danger to his life, and stopping the machines. For this he was recommended for the Iron Cross, however it was never allocated."

Soon after this gas-attack Valier was transferred to the army weather station No. 17 of the Imperial and Royal Airforce on the Austrian-Rumanian front, there he received the Austrian war decoration, the silver medal awarded for bravery, for his "conduct in the face of the enemy in the gas-attack at Smorgon on February 25, 1917."

The senior librarian of the University of Innsbruck, the Privy Councillor Dr. Hans Hochenegg has described life at the Rumanian front:

> "Meeting with Max Valier.
>
> . . . . As adjutant of a newly drawn-up rifle battalion I was transferred from the Russian front to the Rumanian front. We encamped in a South Hungarian village to equip ourselves and be trained for coming operations. On official matters I sometimes had to ride to Györgey Szent Miklos to the Imperial and Royal Corps Headquarters. The presence of an army bookstore in that town especially pleased me; in spite of the neighborhood which spoke a foreign language I could supply myself with German books.
>
> One day I was again amongst the new books. Suddenly a well-known voice resounded beside me. My former professor of physics in Innsbruck had just entered, the kind-hearted

Figure 3: Valier at the aiming circle theodolite for air defense, Austrian-Italian front

Figure 4: January, 1917, Valier at the German-Russian front

Figure 5: Cadet Valier on home leave and his sister Martha. (She preserved his letters, photos and books, and therefore has been instrumental in the completion of the biography

Figure 6: Valier's first flight for meteorological measurements, August 15, 1917

Dr. Josef Dinkhauser, a distinguished scholar. As I now learnt he was in charge of a meteorological station of the Air Force in Szent Miklos, with the post of sub-lieutenant of the air corps. Our meeting again far away from home was extremely cordial. Dr. Dinkhauser immediately invited me to accompany him and he told me: 'You will be surprised. An officer cadet from the Tyrol has been assigned to my station, whom you will certainly know by name, cadet Max Valier!'

In this way we met and soon became good friends. I see him so vividly before me, this sharply profiled Tyrolean characteristic head with its active mind. Max Valier found enormous pleasure in having found a compatriot of the same age. Full of enthusiasm he told me of his favorite science. As an art historian without a specialized knowledge of natural history I could hardly follow him; but in any case I was an attentive listener, who understood the courageous theories in admiration but immediately forgot them again. Valier also spoke repeatedly about his official position. This pleased him less. He would have preferred to become an aviator. But as a naturalist he was condemned to an activity which was indeed necessary but disregarded. Every morning he had to go up to great altitudes with the kite-balloon to measure air temperature and wind flow. He wore the aviation badge but he was not allowed to steer an airplane himself. As an unpretentious 'barometer-Fritz' he had to point out the way through the air for the others. Even this task was not harmless. Kite-balloons were always the objective of enemy attacks. The unwelcome observers were hated and one sought to make them crash with every possible means. Even Max Valier once hurtled to the ground from a height of a few thousand meters with a damaged balloon. In spite of this he escaped with his life. His hour had not yet arrived . . . ."

Was Valier a good soldier? He was always ready to risk his life, in the high mountains as in the listening-post trench in Russia, in the kite-balloon as later in the airplane. But it was never reported that he had fired one single shot at the enemy. Bloodshed was his aversion. For this reason he always procured for himself a post at a technical apparatus and his senior officers were happy to have a capable and reliable man for this and they did not oblige him to real soldiering with a weapon.

In August, 1917, Valier succeeded in convincing the commander that meteorological measurements can be made even from the airplane. A photo which he sent to his mother with the words "My first flight" shows him in the observer's seat of a biplane.

On September 14, he wrote to his friend Gschliesser that he would not like to swap with him, "for, since I have also been allowed to fly I have almost nothing left to wish for. On August 15, I flew for the first time, since then frequently . . . ." - From these lines in his letter the joy of

the generation, which still saw in flying the long desired realization of an old dream of mankind, resounds towards us. For later generations the airplane has become an obvious means of transport and flying has therefore lost a great deal of its prestige.

On June 23, 1918, Valier sent in an application asking for admission to the technical course for the training of technical officers for the front formations of the Imperial and Royal Air Force troops. The application was recommended and approved of by his senior officers, and Valier became a pupil of the technical course.

After this training as an airplane-observer he was used for trial flights and test flights of new types of aircraft, in conformity with his physical and technical accomplishments. - Of this period he wrote later:

"Commanded as an officer of the Austrian Air Force troops to frequent altitude test flights, the realization took shape in my mind that the present propeller airplane must always remain unsuitable for reaching the highest altitudes and only the rocket as a means of propulsion is suitable for the altitudes of the stratosphere."

"He developed this finding as an exposé whilst he lay in the infirmary in September/October 1918. He wanted to send it in but the end of the war made the rocket plans redundant. The reason why he was in the infirmary is given on September 28, on a postcard to Hörbiger:

"I am in the infirmary. Yesterday at 8:30 a.m. I crashed at the airfield at Aspern from a height of 3200 meters with a burning airplane. Fortunately the fire went out at a height of approximately 1500 meters and by the combined presence of mind of the pilot and of myself we managed to pull the bird halfway out of the vertical dive. If we had had another 200 - 300 meters he would perhaps have managed a smooth landing at the airfield. So there was a crash. The pilot has a few fractures. Except a hard blow on the shoulder blade, which hurts very much I have nothing, not even a fracture. What luck! I have had your Glacial Cosmogony material sent to me in the infirmary, as the most important of books."

We wish to complete this short account with the description which his mother wrote:

> "During the testing of a new aircraft at the airfield at Aspern he crashed with a burning motor from an altitude of 3000 meters, without injuring himself seriously. His presence of mind had saved him. Later he related that, hardly noticing the darting flames of the motor, he was immediately intent on gliding. His pilot weakly hung on to his seat in fright. Max leapt forward into the pilot's seat and at an altitude of 200 meters he managed to begin to glide. They were then already in a cabbage field, the aircraft was completely wrecked but he himself felt his body and crept out in amazement that he was still uninjured. Then he helped his companion out who was indeed in a

worse situation but who, too, was soon cured. Max lay in a garrison infirmary in Vienna for four weeks with a contusion of the shoulder blade and a buckling of two ribs."

After the War - Hörbiger's Glacial Cosmogony.

Hanns Hörbiger to whom Valier had written the postcard from the infirmary was a man full of ideas, a very skilled mechanical engineer. The factory, which manufactured the Hörbiger plate valves invented by him is today still in the family possessions and supplies the whole world.

But Hörbiger was not only a designer and inventor of useful technical things, he was strangely even an inventor of an astronomical theory, glacial cosmogony.

From his youth the beauty and mysteries of the starry sky had fascinated him. As soon as his income made it possible he bought himself astronomical books and a telescope with which he often observed the moon and the stars in the peaceful evenings. In the course of time the engineer formed his own ideas on the origin and disappearance of the solar system, strictly speaking, the first idea about this had come upon him suddenly. The more he now followed up this new idea in order to verify it, the more observation facts he found in the distant stellar world than in our own solar system, which confirmed his new theory. The cause of all changes, of all birth and growth and, above all, the cause of cosmic catastrophes he found was explained by his new theory, which he called glacial cosmogony.

After long years of study he wanted to inform the authorities on astronomy of his new finding. In 1895 he sent notes on glacial cosmogony to the president of the Berliner Urania, Dr. Wilhelm Meyer and to the director of the Observatory of Vienna, Hofrat Weiss. But he did not receive any answer. That could not damp Hörbiger's courage, he was too strongly convinced of the accuracy of his theory.

My glacial cosmogony is too new for the astronomers, he would say to himself and he continued to study minutely all astronomical publications, especially the reports on new observations. Finally he found a friend and assistant, Philipp Fauth. This private astronomer, whose lunar chart met with great international recognition from the professional world in 1932 (just at that time Fauth's Lunar Atlas saw a re-edition), at that time he took up Hörbiger's findings, agreed with them and together with Hörbiger, wrote the first large complete works on Hörbiger's theory "Glacial Cosmogony" (Glazial-Kosmogonie). It appeared in 1912 in Voigtländer's Publishing House, Leipzig. But the situation was barely changed even with this book. A few new friends and followers of the theory of glacial cosmogony came forward but the specialists did not wish to be bothered with it. - "Dilettantes" are always unpopular with the experts. They busied themselves, in their spare time, with technical literature and then figured out a personal opinion and then wished to inform the experts. Of course that is completely nonsensical - thus thinks the expert who has behind him long years of serious study and to whom comes the person who does not have these years of study and who does not want to know

any better, a thing which is very pretentious, in spite of all the polite words of the accompanying letter.

But engineer Hörbiger knew the laws of physics, not only from school, they were the world of thoughts in which he lived, which he had to use continuously in his profession, for he was a responsible constructor of huge blast-furnace gas-driven blowing engines as well as cold compressors for artificial ice plants. The designing of pumps with maximum and minimum pressures was as familiar to him as the domain of thermodynamics: heat of fusion and heat of vaporization, coefficients of thermal conductivity and coefficients of radiation. The success of his constructions prove that he had accurately understood these natural laws and applied them correctly.

When Max Valier's first small book "Astronomical Mapping" (Das astronomische Zeichnen) had appeared in 1915, Hörbiger read the small volume. It pleased him greatly and, via the publishing house he wrote to the author who at that time was receiving his military training in Enns. Soon there began a correspondence+) between Hörbiger and Valier. Valier sent to Hörbiger copies of short essays, which he published in "Natur- und Geisteswelt." The latter sent him his own essays in reply, which treated the same subject in terms of his glacial cosmogony theory. Here one opinion contradicts the other. Ingenuousness in the interchange of ideas was agreed upon as early as the first letters. In October 1915 Valier wrote to Hörbiger: "I do not want to argue with you any more about the degree of truth of your glacial cosmogony until I have read your principal work three times in due time."

Of course, at that time Valier had told himself that the specialists were killing the theory of glacial cosmogony by silence, i.e. they thought nothing of the ideas which the engineer had about the happenings in the realm of the stars. But they are often not even in agreement with the theories of their colleagues.

The high-school pupil Valier had already realized this, at that time (1912) he had written in his astronomical article for the school magazine "Mentor:"

". . . . Even today the mysteries are not all solved, and the opinions of the most distinguished scholars often differ from one another a great deal on many points, especially in solar theories . . . . The solar phenomena, which will be described in what follows are facts recognized for certain, only the causa primaria of their origin is often obscure . . . ."

+)Mrs. Martina Hörbiger has kindly left to our attention the copy-books, preserved in the archives of the Hörbiger Valve Works, of her father-in-law. Dr. Hochenegg, the Hofrat has sought and deciphered the stencil printings, which have already faded in parts, of Hörbiger's handwritten letters to Valier. Unfortunately the letters which Valier had written to Hörbiger, were no longer in the archives in 1961. However in Wolfgang Behm's book "Hanns Hörbiger, a destiny" (Hanna Hörbiger, ein Schicksal) the most important passages of these letters can be found.

Thus an engineer now believed that he was drawing nearer to the solution to such mysteries of the universe than the astronomers had succeeded in doing up till then. In any case one must get an insight into it and analyze it critically!

Now Valier had read through the thick book in peace in the weeks in the infirmary and had become a confirmed disciple of Hörbiger's glacial cosmogony theory.

Soon after his discharge from the infirmary there came the downfall and end of the war. With 300 crowns' severance pay in his pocket the second lieutenant of the reserve, Max Valier, now found himself in Vienna, cut off from his home town; the boundaries again ran to the Brenner. - The conquering powers had handed South Tyrol over to Italy - it was indeed the prime cost for the sake of which Italy had left the Triple Alliance (Germany, Austria, Italy) in the war, and had waged war upon its allies on the side of the entente.

Now it was a matter of continuing his studies. He had to earn his livelihood by means of literary works and evening lectures.

We quote from Behm's Hörbiger Biography:

". . . . In the increasing scarcity of provisions of the winter Valier was dependent on the proceeds from aerodynamical and astronomical lectures, colored more and more with glacial cosmogony. On the occasion of three glacial cosmogony lectures to the Viennesse "Urania" even the Councillor of the Government, Dr. Eduard von Josch (Secretary of the Academy of Decorative Arts), among others, had heard him and immediately invited him to repeat these lectures before a specially invited circle of Friends of Natural Science in the Anatomy Hall of the Academy; these lectures actually took place before a capacity audience. -

From this audience, within a few weeks, the "Cosmotechnical Society in Austria" with Count Rudolph Schaffgotsch as the President and Dr. von Josch as the Vice-president developed to its peak with the connivance of Hörbiger's oldest son Johann Robert . . . ."

Only an enthusiastic disciple of the new theory can speak in such a striking manner that his audience not only showers him with applause which dies away quickly but they are so carried away and convinced by the lecturer that they themselves show their conviction and want to help the cause and adhere to the Cosmotechnical Society.

In Behm's book there is also an application to the Viennese Under-Secretary of State for information concerning lantern-slide lectures, especially on Hörbiger's glacial cosmogony, in which Valier asks for a suitable hall to be made available for evening courses which will last a long time. To justify his project he adds a rather long personal report in which we read:

". . . . In the long run I would not like to contest the theory of glacial cosmogony. All the objections, which technical science, according to which I was nevertheless educated, can make, give way against the conquering logic and closed chain of arguments, which means nothing other than the solution to all cosmic and terrestrial problems, before which technical science still stands helpless. Then the dies were cast for me. Having become a Paul after being a Saul, I now decided to add the new theory to my banner and to carry this banner everywhere, even in defiance of the whole of specialist learning. I decided, in all expectation, to obtain a state post, to resign straight away and if it should be necessary, to even make the sacrifice of my doctorship. Hörbiger has languished long enough in ostracism, his theory made ridiculous and transmogrified, in the September of this year it will be twenty-five years since our master made the great discovery, ... It is truly time that what was hidden comes to light.

Of course a battle will now begin. How I wish that it had already begun. Now the beginning has been made in Innsbruck and I am already branded as a heretic. When I went to Prof. Oppenheim on July 17 (1919) to ask him a question as regards the affair of my dissertation, he explained to me (since, in the meantime he must have learnt that I was a disciple of Hörbiger) that he did not accept any dissertation which was connected, in any way at all, with Hörbiger's theory. I will deliberately put the historical words on record here: To a further question from me Prof. Oppenheim literally explained Hörbiger's theory as a downright swindle. To my question whether he had actually read the great work, the scholar replied likewise literally: Not a single page, thank God! (Mr. Under-Secretary, I am prepared to affirm these words by oath at any time.) Therefore specialized erudition judged the new theory in this way. Blind with rage it wants to make the troublesome rival harmless by means of an ostrich policy! . . . .

. . . . Prof. Oppenheim refused my invitation to the lecture with the words: I can hardly, as it were, sanction such a lecture with my presence! As long as gentlemen speak in this way, there is certainly no basis for discussion.

And nevertheless the recognition of cosmotechnology could be of the greatest use. On a cosmotechnological basis alone man will be able to predict the general meteorological situation for the year if the necessary observations are placed before us; but it will also be possible to find the coal and petroleum beds in accordance with cosmotechnological - geological deduction. In 1906 Hörbiger predicted rich sources of petroleum for North American districts where no traces of petroleum had yet been found and today we receive reports that these sources have in actual fact been discovered. What practical perspectives result from the new theory! . . . ."

The word "Glacial Cosmogony" (Glazial-Kosmogonie) was now replaced by "Cosmotechnology" (Kosmotechnik). Later the name "Glacial Cosmogony" (Welteislehre) was chosen for it and in 1922 was even recognized by Hörbiger as the official name for his theory.

There follows an extract from an appeal which Valier had distributed at the entrance to the hall in 1919:

The Cosmotechnological Theory

Epigraph: If a new verity is not considered as a whim of an irreverent and half-crazy crank for at least a quarter of a century, it was not worth bringing it to light. ("Welt and Haus," year 1907)

It is twenty-five years to the day, for which we invite you, gentlemen, to attend our first lecture, that Engineer Hans Hörbiger, the finder and master of our new theory, got wind of the theory of glacial cosmogony by looking at the moon in the telescope, in pursuit of which, for him a logical ring of a new cosmic system above the firmament which was obviously heretical from the point of view of all the sciences, was formed which comprised the heavens and the earth. This idea came to him after years of untiring work.

The enigma of the firmament as well as that of meteorology were separated in a new way, so to speak, even the mysteries of the depths of the earth broke up and attached themselves to a whole, without the boundaries, which have existed up till now between the fields of astronomy, meteorology and geology. New perspectives are opening up and it became possible to predict the general meteorological situation of the earth from the position of the planets years in advance as well as designate the spot where riches of the earth, coal, salt and oil must be found. One has already read about confirmations. In America rich deposits of petroleum were drilled during the war exactly in the areas predicted in 1906 by Mr. Hörbiger.

The following program of the lecture series, which Valier conducted in Vienna in September and October of the year 1919 shows the abundance of problems dealt with by glacial cosmogony:

Cosmotechnology

Beginning	Program of Evening Courses	End before
at 7:45 p.m.		9 p.m.

In the Anatomy Hall of the Academy of Decorative Art, Vienna I, Schillerplatz 3.

I. Preparation and Introduction (Preliminary course).

Tuesday September 16: The firmament and its movements.

Wednesday September 17: At the observatory. Astronomical Observation methods.

Thursday " 18: The miracle of the sky observed through the telescope.

Friday " 19: Development of Weltanschauung up to cosmotechnology.

Saturday " 20: Methods of graphical representation.

II. Fundamentals (actual beginning of the course).

Monday September 22: The fundamentals of cosmotechnology.

Tuesday September 23: Cosmic ballistics I.

Wednesday " 24: The birth of our solar system.

Thursday " 25: Cosmic ballistics II.

Friday " 26: Elementary studies of the solar system.

Saturday " 27: Chosen topic. Synopsis. Question time.

III. The Planets.

Monday September 29: The planetary system. Dimensions and numerical references.

Tuesday " 30: Contraction of the orbit.

Wednesday October 1: Mercury and Venus. Their problems.

Thursday " 2: Lunar captures. Satellites with a normal course and retrograde satellites.

Friday " 3: Mars! - The mystery of the canals. Its inhabitableness!

Saturday " 4: Chosen topic. Synopsis. Question time.

Perhaps from October 5, lecture in another lecture hall.

Monday October 6: Jupiter and Saturn.

Tuesday " 7: Planetoids and comets.

Wednesday October 8: The moon as a celestial body.

Thursday " 9: The exceptional position of the earth as an inhabited planet.

Friday " 10: The clusters of stars. The construction of the world of fixed stars.

Saturday " 11: Chosen topic. Synopsis. Question time.

IV. Cosmic Meteorological Forces.

Monday October 13: The sun and its phenomena.

Tuesday " 14: The ice-haze horn of the Milky Way.

Wednesday " 15: Zodiacal phenomenon (zodiacal light).

Thursday " 16: Cyclones, rapid falls of temperature interpreted in a cosmotechnological way.

Friday " 17: The problem of shooting stars.

Saturday " 18: Chosen topic. Synopsis. Question time.

V. Geological Factors.

Monday October 20: The problem of floods.

Tuesday " 21: The deluge.

Wednesday " 22: Geology in cosmotechnological illustration.

Thursday " 23: The coal seam. Its problems.

Friday " 24: Rock salt and petroleum deposits.

Saturday " 25: Final evening. The economic importance of cosmotechnology, especially for German Austria.

Advance sale of course cards from Kehlendorfer, Vienna I., Krugerstrasse 3 and at the cinema.

Prices: Single cards K 6 -, 4 -, scholars K 2 -, course card (6 lectures) K 18 -, 10 -, scholars K 6 -.

Destitute scholars obtain free entry with an attestation from their head.

Lecturer: Max Valier, astronomer.

Each lecture is complete in itself and open to individuals!

called glacial cosmogony, then cosmotechnology.

(Here we try to give the reader an insight into the basic ideas of Hörbiger's theory by means of an extract from Valier's writings which will be as short as possible.)

Glacial cosmogony will not be the history of the universe from the "creation of the world" to its end. These limits or frontiers into the infinite will be left to philosophical and theological trains of thought.

Building on the observations of astronomers Hörbiger inquired into the forces which cause the formation and disappearance of solar realms with their planets and satellites in the cosmos, i.e. into the forces which bring about the cycle of nature, the death and genesis in the stellar world.

Because our sun is the nearest bright star to us and is best accessible to our observations, the phenomena on its surface, sunspots, prominences (fall-outs), faculae, coronae, etc., have been recorded since the invention of the telescope, i.e. for approximately three hundred years. (Our readers can find the principles of the so-called solar activity described briefly in appendix 1 in Max Valier's Mentor article "The sun.")

From what is small one will then point to what is large, to gigantic occurrences, similar to explosions on a Nova, a new star, which has glowed up in the sky and is many millions of times greater than our sun.

Hörbiger says: If we see that prominences, similar to explosions, leap out from our sun and if we observe that these prominences are composed of glowing hydrogen gases, which leave the sun with tremendous velocity and diffuse into space, whereas the glowing metal gases which are obviously carried along in the explosions usually fall back again onto the sun, then we must inquire into the cause of such explosions.

Hörbiger's answer runs: If a huge lump of ice or a small planet which is completely frozen lands on the fiery ball, the sun, an explosion must take place, sunspots and prominences must occur as we observed.

The basic idea of glacial cosmogony is the assumption that everywhere in the universe as far as is accessible to our eyes and astronomical apparatus, the cosmic polarity of a hot substance and ice is the driving force of all changes. The total cosmic effect of forces can be explained from the common force of gravity (also called gravitation) which is striving towards union and from the expansive force of water vapor which tends towards separation, even if electric, magnetic and other forces, especially the radiation pressure of light, contribute in part.

Let the following explanation be interpolated beforehand: Chemistry distinguishes approximately 100 elements which we know to be the constituents of our earth and which are found with the help of spectroscopic analysis even

in the glowing gases of the sun. Glacial cosmogony distinguishes only between H_2O (water and ice) on the one hand and the entirety of the other elements on the other hand. What is not ice is a heliotic substance, i.e. a glowing substance.

The cause of all solar activity can therefore be found according to Hörbiger's interpretation that cosmic ice collides into the orb of the sun.

". . . . A main objection, which is raised again and again against glacial cosmogony culminates in the assertion that ice could not subsist, especially in open space because it ought to evaporate immediately in the pressureless atmosphere . . . ."

(Taken from Max Valier's book "Orbit and Nature of the Stars" (Der Sterne Bahn und Wesen), p. 343. - The following passages, designated with the page number only are also taken from this book.)

Valier demonstrates the counter-proof by means of a simple experiment. A small bowl with 100 g of water at 0° C, into which a thermometer has been plunged, stands on a spring-balance. A bell jar with an air pump attachment is put in an inverted position over it. The whole thing is well protected against heat input from outside by lagging and ice.+) Now a vacuum is made. As soon as the air pressure beneath the bell jar reaches 4.6 mm barometric pressure the water in the bowl begins to boil. The spring-balance shows that 13 g of water volatilize as steam, however the remaining 87 g freeze into a block of ice. The thermometer reads -40° C. All further pumping does not make any difference, the ice continuously remains at its original weight. How is that explained?

"The decrease in pressure facilitates the evaporation of a matter but it does not cause it. Heat is always and first of all, part of evaporation. Only insofar as this is present and available can the volatilization of ice (sublimation) take place in the, as it were, pressureless area. . . . . To begin with each gram of water in the bowl contains the 80 latent heat of fusion units. Now the heat for a pressure of 4.6 mm barometric pressure, at which the water beneath the bell jar begins to boil, reaches approximately 606 units. Hence it can be seen that even if all the heat of fusion contained in the water supply is used in the evaporation, i.e. if, as it were, the water draws upon the latent heat of fusion in order to be able to evaporate, only 80/606 of the original quantity can dissipate in vapor form; 87% of the weight must remain in the bowl as ice of 0° C to begin with." (pp. 345/6)

Accordingly a quite small vaporization of ice takes place, this extracts the necessary heat for vaporization from the rest of the ice and causes the

+) For this experiment, which is even demonstrated in physics lessons in many secondary schools one needs a vacuum pump with a very large hourly volume throughput and a good final vacuum. . . . . The lagging for protection against heat input must cover the bell jar and its base completely, even the observation windows must be shielded by insulation covers, which are only opened for a short time when taking readings.

temperature of the ice to drop to -40^{o} C. From then on any further ice evaporation was not possible. - But the temperature of space reaches approximately -270^{o} C. Ice evaporation is certainly impossible there.

Therefore the possibility of the existence of ice in pressureless space is proven.

Since the bright stars diffuse hydrogen and oxygen into space as prominences and since there must be a zone the temperature of which is suitable for the combination of H and O to H_2O somewhere between the heat of bright stars and the coldness of outer space, very minute drops of water are reformed again and again, drops of water which, at the instant of formation freeze into powdered ice and are thrust into outer space by the radiation pressure of the sun. There the powdered ice may somehow form a ball and partly fall back, partly wander through space and finally come into the gravitation area of other things travelling in space.

Question: What happens when blocks of ice approach a bright star?

". . . . If the approaching blocks are small they explode on impact with the blazing sun mass. The result of this is the eruption of a gush of glowing gas, generally of pure hydrogen gas, when the depth of impact is greater it is also combined with the glowing gas of heavy metals (metallic and eruptive prominences!). Many ice masses which are quite smaller, however, do not generally reach the photosphere of the surface of the sun but frizzle away thousands of kilometers away from it (cf. our pyrometric deductions p. 353). Their vapor is caught up by radiation pressure and carried back into space (high prominences), where they again assume the form of powdered ice at a sufficient distance from the sun. As a comparison one may imagine a pan full of molten iron in a heavy snow storm outdoors in winter. The flakes which are drifting down do not reach the surface of the glowing melt but vaporize in the hot column of rising air. Carried upwards by the current of air they must freeze again at a sufficient altitude.

The sun faculae arise when masses of ice, which are still not large enough to produce sunspots make an impact on the sun and bring out glowing masses of lower sun strata to the surface by their vaporization which is nevertheless sufficiently turbulent . . . ." (pp. 413-415)

To clarify the question of how large a block of ice must be so that, on approaching the sun, it does not vaporize completely, but that there remains an ice core which reaches the surface of the sun, Valier examined examples. He assumes that three blocks of ice, of different sizes (e.g. with a diameter of 20 m, of 2000 m and of 200 km) come from outer space into the area of gravitation of our sun and make impact on it with increasing velocity. He calculates their falling time:

". . . . In order to rush through the whole solar realm of 36 astronomical units, i.e. the farthest range of Halley's comet via the orbits of Neptune, Uranus, Saturn, Jupiter, a free-falling block takes 144,000 hours, which is equal to 16.4 years." (p. 349)

In this falling time, in which the gravitational pull of the sun has an increasingly greater effect on it as it approaches, its velocity has increased from 0 to 630 km/s.

Then the amount of heat was calculated which strikes the block of ice during its falling time through solar radiation. It depends on the condition of the surface of the ice what percentage of radiation it absorbs, how much penetrates and also how much it emits back into space by means of radiation.

The calculations now show that the small block of a diameter of 20 m vaporizes before it reaches the sun.

The average-sized block, it may have a diameter of 200 to 2000 m, (a size which the smallest asteroids have), will also experience an intense vapor generation when it approaches the sun. The vapor rising on its south side is bent back by the repulsive force of solar radiation and will represent a comet's tail behind the comet's head. But a vestige of the unvaporized ice will reach the glowing orb. There detonation takes place amongst phenomena resembling explosions. - From the earth we can discern faculae on the sun.

Even in the very large block of a diameter of 200 km a tremendous vapor generation will set in near the sun, however the block will retain the vapor due to its own very remarkable gravitational pull. The vapor rising on the side turned to the sun, which had permeated backwards due to radiation pressure will again freeze fast on the night side, for the cold of outer space still more or less prevails in the deep shadow of the mass.

Let us assume that the block has accurately reached its objective and makes an impact on the sun (i.e. that it has not shot past the sun and then, orbiting it, has vaporized gradually).

". . . . Because the block of ice is very large, therefore its circumferential surfaces are quite small in comparison to its ice mass capacity, the heat necessary for the vaporization of the block cannot be absorbed in a few seconds even when it dives into the glowing mass and, in addition to that, because the surface, through which the heat transmission must take place, is not adequate on the one hand, because the glowing masses immediately adjacent to the block of ice do not contain so much heat as is necessary for the instantaneous vaporization of the ice. Therefore a kind of solidifying skin is formed from the formerly molten mass by the rapid extraction of heat around the block of ice. But this skin which thickens continuously is puffed out into a kind of sponge substance by the vapor penetrating outwards, which makes its way into millions of pores, during the nevertheless intense vaporization at the contact surface of heat and ice. This sponge substance can be compared to pumice. This slag pumice shell around the ice core is therefore formed from the substance of the incandescent orb.

. . . . Inside this shell the general liquefaction of the ice and the heating of the melted snow and ice to the level of retardation of boiling now takes place. This continues until finally a state is reached where the slightest shock from outside, a small pressure relief, a rise of the bomb,

which is ready to explode in the glowing body of the celestial giant, is enough to trigger off the dreadful explosion which is beyond all human conception.

. . . . The force of the explosion can be great enough to take at least a part of the mass rising from the crater in the incandescent explosion cone past the limit of the area of gravitation. We know that, for our sun, eruption speeds of 630 km/s would suffice whereas for our earth approximately 11.2 km/s is sufficient, whereby, in each case, the figure holds good for the case which corresponds to the firing of a cannonball from the surface of the star. In this way we would certainly arrive at very high 'parabolic' velocities for giant stars with a millionfold solar mass, velocities which would have to be reached if the expulsion of the masses from the crater should be understood in this way only. But in reality the ejected masses are not shot out of a short-barrelled mortar but still precipitated on a tremendously long path by the propulsive explosive gases, probably out on several giant radii so that we must imagine a ship's gun directed vertically whose bore is 20,000 km long to rectify the comparison with the cannon-shot. In order to fire a projectile from the earth out of such a barrel in such a way that it does not fall back again to our native star it is sufficient to give it a velocity which is ten times lower (i.e. approximately 1 km/s) up to the muzzle of the gun, for up in the air the 'parabolic' critical velocity is approximately ten times smaller than on the earth's surface on account of the decrease in the force of gravity. Now velocities of ejection up to 5000 km/s have already repeatedly been measured by measuring the shifts of the spectral lines (as a result of the Doppler effect) during the outburst of the Novae, which, in the light of what has just been said, must be considered to be sufficient to shoot masses, even of enormous giant stars, into space in such a way that they do not fall back again. . . . This part of the ejection, which is free from fall-back, the course of which cascades down like a fountain, and which sweeps through space victoriously and by this time alone, is regarded by the theory of glacial cosmogony to be the primary element of star realms in the making. - Whether a solar state is formed like our own or whether a cluster of stars evolves from the ball of the incandescent projectile, depends on the particular circumstances in the individual case. Perhaps there are other possibilities of development.

In any case the phenomenon of the impact of a fundamentally icy celestial body into a glowing star is the only one which, contrary to all others in the universe, transforms thermal energy back into kinetic energy on a large scale by the retardation of ebullition explosion occurring after impact and thus counteracts the tendency of gravitation, which is inclined to drive all bodies together and finally to unite them into one mass."

This is the fundamental idea of glacial cosmogony.

Hörbiger amplifies: If the ejection from the Nova comprises an exceedingly large incandescent sphere a solar realm like ours is formed from the projection cone which sweeps through space. The smaller spheres orbit the big brother as planets. But even from the beginning there were many free hydrogen and oxygen gases in the projection. As was described above, ice

results from this, which accompanies the newly formed solar realm as an ice-haze horn, as Hörbiger called it. - The force of gravity causes the small asteroids to be absorbed by the large bodies in the course of time. The major part crashes into the sun. The loss of energy which the sun suffers through radiation is counteracted by the kinetic energy of the falling bodies. Often a planet also takes in a smaller planetoid which then rotates around the bigger brother as a moon. Hörbiger says that a displacement of the water masses on earth was caused by the capture of our present moon and the enormous climatic variations, which were the cause of the birth of our Ice Age, could be explained by this. In addition he follows the idea that the earth has already known a small attendant moon, the tertiary moon, to approach the earth in spiral orbits which contracted more and more until it finally fell down onto the earth. This resulted in tremendous flood disasters and, in many places on the surface of the earth, the folding of mountains, in others displacements and volcanic eruptions.

(The ancient stories of the Bible of the deluge and of the Last Judgement on Doomsday [described in the Apocalypse] and also the old Germanic myths of the universal conflagration to come, everything points to the fact that humans have already inhabited our earth when the calmness of the surface of the earth was disturbed by the approach of a moon. These images of surrender from prehistoric times of terror can also become images of the future.)

In celestial bodies, which, like our earth, have for an outer shell a solid crust which has cooled down the falling of a foreign body naturally produces other effects than in a bright star.

Whilst meditation on the phenomenon of the fall of the tertiary moon Hörbiger found an explanation for many geological facts. In pursuit of such trains of thought he came, for example, to considering where deposits of petroleum might be situated on our earth. In doing so he named regions which were previously not known to contain petroleum. In one such area in North America a rich petroleum deposit was found later.

Even meteorological questions appear in a new light through the conceptions of glacial cosmogony. Contrary to the opinion of astronomers up till that time, which saw in the Milky Way an accumulation of the remotest suns, glacial cosmogony believes in recognizing an accumulation of ice satellites at the furthest limits of our solar system. - Hörbiger says that blocks of ice which rush towards the sun are partially captured by the large planets, especially Jupiter and Saturn. Whether these planets act as a screen separating the blocks of ice which are hurtling in and the sun or whether they are situated in a less influential position in their orbit influences the occurrence of sunspots and the weather situation on our earth.

Hörbiger drew such conclusions and many others from the new theory. As has already been mentioned at the beginning, what is described above is only a short and very incomplete extract from Valier's book. He who wishes to become more acquainted with Hörbiger's glacial cosmogony theory must study it in the original, that is, read through the thick book entitled "Glacial Cosmogony" (Glazial-Kosmogonie) by Phil. Fauth or at least read Max Valier's book entitled "Orbit and Nature of the Stars" (Der Sterne Bahn und Wesen).

If we compare the conception of the cosmic events of glacial cosmogony (which Hörbiger had submitted to authorities on astronomy as a memoir as early as 1895 and had published as "Glacial Cosmogony" in 1913) with present-day notions, as are described, for example, by Rolf Müller in 1958 in "Solar Research in the International Geophysical Year" (Sonnenforschung im Internationalen Geophysikalischen Jahr), VDI publishing house, the physical notion of the world has of course changed in the meantime because of the new knowledge of atomic power.

Hörbiger's question about the cause of the cosmic explosion phenomena, which he had asked himself as an engineer eighty years previously and which he sought to answer with his glacial cosmogony, is solved differently in the atomic age as is his question which asks what compensates for the loss of energy which the sun suffers continuously due to radiation.

R. Müller answers the latter question: "Now one short word about the source of solar energy . . . . The roll of the stoker, who keeps the furnace of the sun operating over billions of years, consists in the transformation of hydrogen atoms into helium."

Hörbiger could know nothing at the turn of the century about nuclear processes with their huge development of energy.

But many a thing which figures prominently in Hörbiger's theory and which he concluded from his conception of the origin of our solar system, can now be found in publications on observational findings, for example in chapters on solar-terrestrial connections or on radiation belts and zones which surround the earth outside of its atmosphere, etc.

At that post-war period, between studies and lecturing activities Valier wrote a short Utopian tale "Spiridion Illuxt" which appeared as a pamphlet at Easter 1919 printed by the 'Deutsche Buchdruckerei, Innsbruck.' It is not known to us that somewhere in a previous publication the thought of an atomic bomb or of a nuclear power-plant is to be found. Thus, we must assume that these ideas appear for the first time in Valier's novel of the future.

In Spiridion Illuxt he portrays the life of a misanthrope endowed with every ability but villainous. He plots destruction out of despised love, destruction of the earth with every living thing. - The demonic Spiridion goes through all the explosives and their effect in thought and then comes to the conclusion:

"If one could succeed in exploding not only molecular compounds but in thrusting the cleaving wedge into the body of the atoms themselves, thus, if this method is once successful in causing a single atom to explode, every other atom of the same chemical element must explode in sympathy . . . ."

Then on a South Sea island he builds a solar plant with thousands of concave mirror reflectors,

"in order to expose the giant collective molecule of all terrestrial elements, which he constructed synthetically by means of chemicals with immense assiduity, to the explosive radiation. If this molecule exploded each of the elements appearing in it must explode with it and hence the whole world must disintegrate, must dwindle into nothing.

And Spiridion Illuxt himself?

He wanted to view this spectacle of the end of the world from a safe cosmic distance.

He had carefully made his whole globe from aurhodium, an element produced artificially by him in the laboratory and he had also been careful that no trace of aurhodium had got into that aliphatic parent molecule of the explosion . . . ."

The technical novel of fantasy describes in an immensely exciting way how Spiridion prepared everything for this act of destruction. He himself left the earth in his globe of aurhodium, for everything was adapted to automatic delayed ignition.

"The hand jumped from dash to dash inavoidably. - The last second.

Then Spiridion saw a cloud thundering upwards where the island was situated in the sea. - He shouted for joy. With a steady gaze he clung to his telescope, ..."

But now before the giant collective molecule which contained all chemical elements, except aurhodium, exploded, it had dwindled away and had been transmuted into pure aurhodium under the influence of the overwhelmingly concentrated sun-spot radiation. In that case only the explosion of the aurhodium molecule had taken place. For this reason this explosion, which was to destroy the terrestrial globe, had not affected the natural elements, the components of the earth, but had annihilated his space ship-aurhodium globe. Thus the monster - Spiridion Illuxt, met his death in the void of space as the last victim of his own atrocious deeds.

Valier may have written this gruesome tale not only on account of the necessity of earning money, there may also have been depressing thoughts of the war which brought death and destruction, which he had to write out of heart in this way.

But if he had to toil around with this gloomy tale and with debts, he himself was not gloomy. His member's ticket for the German and Austrian Alpine Mountaineering Club shows that from Innsbruck he again found the way into the mountains.

In August, 1919, Valier wrote to his mother:

". . . . Dear mother, do not bear me a grudge if I entreat you, as I have already done on the card and also in the telegram, to send me my dear little sister, Martha . . . ."

He describes how urgently he needs a secretary, and assistance with the lectures and also someone who takes pains for him and his needs.

His sister Martha had attended the girls' college and in 1919 had taken the final examination at the "Real-gymnasium." The talented girl had wanted to study medicine and be a doctor. But after the collapse of 1918 such a plan was no longer financially possible for her parents. Then she had attended evening classes for stenography, typewriting and book-keeping. She would have been able to be a true help for him. But her parents did not permit it.

In the meantime another book by Max Valier appeared printed by the "Deutsche Buchdruckerei Innsbruck:" "The Fundamentals of Cosmotechnology" (Die Grundlagen der Kosmotechnik). -

In the correspondence of 1919 and 1920 we find many passages where Hörbiger warns his young partisan "against spending too much" and against unauthorized actions. On September 6, 1921, Hörbiger wrote to Valier in dismay:

> ". . . . I could say a great deal about your Jules Verne projects. They will again give a free rein to youthful fancy. . . . ."

From this letter and from an account given by Dr. Lanner of a conversation in Innsbruck we learn that Valier was, at that time, concerned with the project of a rocket research flight to other celestial bodies. The realization of this pipe-dream could prove the accuracy of the theory of glacial cosmogony truly and irrefutable. All the arguments in newspapers and evenings of debate would then founder and dwindle into silence. But Hörbiger, the bold creator of a new notion of the world, did not believe in Valier's rash ideas of the space flight of a rocket. - Max Valier stands in the bitter struggle for existence; to chase after the pipe-dream is impossible for him.

Hedwig Valier

In 1919 Valier became acquainted with the woman who became his partner for life.

Dr. Gottfried Hohenauer, a school fellow from Bozen was kind enough to communicate to us the following recollection:

> ". . . . Soon after the collapse I met my school friend Valier in Vienna and sat with him repeatedly until late at night in an inn of the old Freihaus in the Naschmarkt. I have the recollection that this was a very dark time of scarcity of

Figure 7: The Valier married couple

provisions and coal; but when we sat together for hours we forgot the whole world around us because we debated enthusiastically about cosmic issues. We had already gone in for astronomy at the high school of Bozen together with Valier's school fellow Oswald von Gschliesser, also a childhood friend of mine and we had regularly made astronomical observations with a parallactic telescope rigged up by Valier, observations mainly of binary stars which would seem, according to a memo in Valier's journal which was preserved from the period in Bozen, to have been drawn to his attention by me. In those meetings and debates at night in Vienna the conversation revolved mainly around Hörbiger's "Glacial Cosmogony" to which, at that time, Valier was passionately devoted, whereas I appeared, as it were, as an advocatus diaboli. At that time I was a quite young official in the Ministry of Food and Agriculture. I had never heard about trial flying but I indeed heard about his keen literary activity. At that time Valier had a secretary for this work, I think that she was called Mrs. Bucek or something like that; he once introduced me to her and her still very young and beautiful daughter at their domicile. The ladies were extremely pleasant and helpful, I think that we were entertained. I also had the impression that Valier toyed with the plan of marrying the mother; in any case, I know that this lady was already very bound up with his work at that time. I no longer know whether Valier married the woman whilst I was still in Vienna, but I never doubted that this serious and intelligent woman, whom I got to know at that time, was his future wife."

For outsiders the great difference in age - she was twenty years older than he - has often given rise to conjectures which were too unjust, but spread abroad unscrupulously. In the year 1951 Mr. N. . . . told us, for example, that Valier had married a rich woman just to be able to devote himself completely to his

work on rockets and not to be obliged to practice a profession. This affirmation is entirely wrong.

Mrs. Hedwig Valier, born Alden, was born in 1875 in Breslau. Her father was a chief conductor and at that time a wealthy man. He had bought himself a beautiful villa in Austrian Silesia and retired there. His daughter, married to a Viennese wine merchant returned to her parental home soon after the birth of her small daughter, the unhappy marriage was dissolved. In the war she attended a nursing course in Vienna and then worked in infirmaries. At the collapse in 1918 - 1919 her father lost all his property. Then there began hunger and starvation in Vienna. - Even later, as far as Max Valier is concerned, life brought enough material distress.

When we came into contact with her in 1958 she was 83 years old, a sick woman who was bedridden and very lonely. Writing gave her pains and in spite of this there began a brisk correspondence between us. She wrote full of spirit, fluently and clearly. She always spoke of Max with admiring enthusiasm.

Works on Metaphysical Problems

In Autumn 1920 Valier applied himself to another field, trains of thought which had appeared before him in the nights during the war and which could not be pushed aside forever. "What good is the ostrich policy. One day one must jump to it," he would say and on the occasion of his journey to Munich he took up a liaison with the publisher Wilhelm Barth to acquire the available literature on metaphysics which was to be taken seriously.

Mrs. Valier, who had learnt typewriting and stenography in order to be able to help him in his work, said to her husband anxiously after a long dictation:

"If you issue such a publication you will compromise yourself with it in the eyes of your university professors more than with your campaign for Hörbiger." -

"In external things, clothing and manners one should take the pains to be as required, I have fallen in with you as far as that is concerned and acted upon your exhortations. But, Hedi, look what is concerned here, it is not external things. How many people who have come home from the war say: A strange thing happened to me there, which I cannot explain. Many would like to forget what they experienced in the field. But many must grapple with the encounters with other worlds and with thoughts which touch on these worlds. And your Max belongs to these latter."+)

In this way "The Transcendental Vision" (Das transzendentale Gesicht) (Christmas 1920); "Things of the Beyond" (Dinge des Jenseits) (Easter 1921); "Trinity of the Original Being" (Des Urseins Dreifaltigkeit) (Autumn 1921) came into being.

+)Adapted from Mrs. Valier's account.

- Even Hörbiger was very unhappy about Valier's metaphysical works, he feared that they would do damage to the reputation of the theory of glacial cosmogony, since Max Valier was known as its pioneer. -

The three books appeared in Munich printed by Wilhelm Barth's Faustverlag; they were collected together in the book "Metaphysical Problems" (Metaphysische Probleme) for the new edition. In the preface to his first small volume it reads:

". . . . The pages which we have collected together for the first time about a hypothesis and its experimental confirmation will not and ought not to contain anything else than what we have deducted up till now, that is up to the conclusions of the first experimental group, according to our intellectual and insignificant methods with reference to the problem of the psychophysical wave and what we have obtained by hard work. We are fully aware that little is positive but we also know that the slightest thing can develop to something of enormous importance if only it is really positive. . . ."

In the second part which he called "Things of the Beyond" (Dinge des Jenseits), in the preface he speaks directly of the fact that he and many brothers in arms were suddenly confronted with such questions without having gone in search of them.

". . . . At that time, in the fighting trench, when the realm of the beyond seemed near to him (the author) who was under the flying flag of death which threatened a hundred times each hour and when the present world seemed small, ..."

A student friend into whose hands such a book had found its way, once said to Valier: "Yes, Max, your maxim reads: My own judgement is for me the only criterion of all things." - Valier replied: "All very well but why do you use such fine bombastic words for a truism?" Laughing, the friend turned to Mrs. Valier: "Your husband is a hopeless case. He has not noticed that I was talking tongue in cheek to remind him that one must, nevertheless, pay attention to what the authorities, professors think and say."

Many approving letters came in. But the old ones in the field, the "real occultists," disliked the fact that a young scientist came and wanted to verify by means of experiments and endeavored to say everything which they were in the habit of expressing so finely, obscurely, ambiguously and awkwardly, in a clear way. The author, Dr. Reinhold Eichacker, who was good friends with Valier, talks about him in his obituary:

> As early as 1921 he surprised us with a brilliant three-volumned work "Metaphysical Problems" (Metaphysische Probleme) in which he attempted to find a solution to eternal questions from numerous practical experiments in his own train of thought and often in critical approaches to the theories of the authorities. This deep thoughtful work of the young revolutionary made many readers sit up and take notice. But it met the usual fate

of all books which venture to tackle and overthrow traditional opinions. This work was silenced early. For in the eyes of his contemporaries Valier was not an expert."

In order to complete our close-up, two more of Valier's acquaintances from that time should get a hearing.

Dr. Lanner wrote:

"In 1921 his philosophic period begins - with the publication of the three famous Faust books. The first is called "The Transcendental Vision" (Das transzendentale Gesicht) with the descriptive subtitle: "Of the connection between physis and psyche in the world" (Vom Zusammenhang zwischen Physis and Psyche in der Welt). Here the most important metaphysical problems were discussed much in the sense that Driesch treated them recently in his writings. The subject of the second volume is the "Things of the Beyond" (Dinge des Jenseits), i.e. time and eternity, space and infinity and the elements of pure spirituality. The third volume examines the "Trinity of the Original Being" (Des Urseins Dreifaltigkeit) - with the aid of schematic graphics, starting from the first movement the ideas traditionally connected with it are discussed in such a way in his own opinion that everything obscure about it disappears and only what is clearly intelligible remains.

In the same year there appeared one book entitled "Man and the Theory of the Universe" (Der Mensch und die Weltallslehre) and the book "Occult Theory of the Universe" (Okkulte Weltallslehre). But actual occultism is of very little importance here. The cosmic questions are elucidated from the standpoint of Indian philosophy and at the same time - which is precisely the valuable thing in this work - from the modern scientific standpoint."

Engineer A. von Weiss-Trostprugg tells us about the years 1920/21:

"At discussion evenings in the Urania Society of Bozen we got to know one another, since we both had a great interest in the progress which at that time was beginning in the scientific field. It is now quite strange to take up his books again after such a long time in which our judgements have changed a great deal. But from these books one sees the active mind in perpetual search of new knowledge in order to find explanations for facts. Only in this way can it be realized that he sometimes became a victim to false theories because he hoped to find in what was new an explanation for things which, up till then, could not be explained. A joyful abandon to everything new, without a too critical attitude, connected with a deep, somewhat naïve credibility, which is rooted in the Tyrolean heritage, in an omnipotence which controls everything according to the same principles, inspired him.

He finally fell a victim to his true pioneering spirit. - "

Munich becomes his adopted hometown.

After a fairly long stay in Bozen Valier moved to Munich at the end of 1921 with his wife and her daughter from her first marriage. Here he had himself matriculated at the university and signed up for the course of lectures of Professor von Seeliger, a famous astronomer. At the beginning everything went well, they were able to live on the remuneration of his books and of his lecturing activities. But when inflation increased more and more it was very difficult for an author to support a family of three people. He was obliged to work and to work constantly in order to earn his living.

Necessity is the mother of invention. Valier would say to himself: One should appear in illustrated weekly papers. They pay their authors well and quickly. But in that case the articles must be written gaily and lightly. One must not notice that the author generally is reflecting on the most difficult problems of the human intellect. Therefore it was a matter of adopting a new style, a manner of writing which does not smack of the wisdom of books. Then Valier went to carnival balls. The love of life and common sense of the women of Munich should help him to find the right tone. And soon, after dancing the night through, he succeeded in writing on a theme from science and technology in such a popular way as the picture magazines desired. - That was, so to speak, Valier, the student who works his way.

But we find the true Valier in the lecture-room of Professor von Seeliger in lectures and oral examinations. In Behm's biography of Hörbiger we find the following letters which Valier wrote to Hörbiger:

> "May 21, 1922. Councillor R. von Seeliger comes extraordinarily close to your theory (without his knowing it). When I recently lectured in the oral examination on spiral nebulae (before all the gentlemen of the observatory and even before Professor Emden, who was present as guest) and in doing so literally developed nothing but your theory (without mentioning your name of course, rather in such a form that I harked back to the work on spiral nebulae in Astronomische Nachrichten of its time). I even met with Seeliger's approval versus the other gentlemen. Seeliger agrees with you on the following points: He considers the range of gravitation to be comparatively narrow, he considers space to be full in principle (he declares the assumption of an empty space to be nonsense); in his lectures he always argues for the theory that we can hardly calculate the orbits themselves of the large planets to 50,000 years with sufficient accuracy and mentions this very frequently, only on the understanding that certain assumptions, which one is given to making, are correct whereas in other respects the uncertainty of our calculations would be much greater. Moreover, he considers spiral nebulae to be structures which are not so large and not so far away from us (consequently to a certain extent he rejects distances of over 10,000 light years and will have nothing to do with the calculations which give hundreds of thousands of light years). Seeliger adheres to the repulsive nature of the solar coronae and has calculated that particles

moved by the pressure of light can reach a maximum of 15,000 km/sec. and he believes that the irregularities in Encke's comet can be traced back to the filling of space and its particular local movement (corona ray), etc., etc. Often in his lecture one would think that he was a secret follower of your theory. But in spite of that he once said to me in his library when I cautiously mentioned your name and your book (whilst he took Glacial Cosmogony from the shelf and opened it before me on the table) "what shall we do with the man (Hörbiger), there are no mathematics in the whole of the book, everything is merely figures and speculations"."

"July 30, 1922. In any case he (Seeliger) is the astronomer, for whom I still have the most respect. Last Friday he closed his lecture, which had given me a great deal of interesting information about your theory, positively favorably for you; Seeliger considers that gravitation does not strictly follow Newton's theory, that the whole perturbation calculation up to now stood on fairly shaky ground and that all results were very uncertain. One could only speak of a stability of the solar system in terms of tens of thousands of years."

"February 21, 1923. Today in conclusion two more historical things to make note of. On January 20, after the lecture of Councillor Seeliger I asked whether one could not bring something to a head with the polarization of light in space, whether it was a question of reflected light or not, I also asked him whether one can recognize asteroids in any other way than by their movement. In reply Seeliger said: Out of the question, neither spectroscopically nor in any other way. Only by their movement. The polarization effect fails completely. Polarization cannot once be established in the case of such a bright moon. Therefore if one was assigned to the task, today one could not yet determine whether the moon itself emits light or whether it is illuminated by the sun. There is nothing to be said about the planets, nor about the asteroids. Quite out of the question for spiral nebulae, for example the bright Andromeda nebula! As much as 25 years ago Seeliger maintained that these nebulae do not consist of millions of fixed stars which are so far away from earth, but that they are only illuminated dust clouds which are comparatively near to earth and have a fixed star spectrum because one fixed star amongst them illuminates them. On February 10, I gave Seeliger my book about the end of the world. Yesterday after the lecture I asked him whether he had read it yet. He replied that he had read a part of it and that the book was not bad only it was a pity that I sympathized so much with Hörbiger. In reply I asked: Why should it be such a shame, I would have thought that on careful appraisal, Hörbiger's theories must be acknowledged as having brought new

life into many arid fields of astronomy. Seeliger replied: Yes, but what about the Milky Way, the Milky Way!! That is impossible, simple impossible!"+)

In addition, the following report from Helmut Lang, graduate engineer, who studied at that time at the Polytechnic tells us of the true Max Valier in Munich.

"Munich after the World War.

Eisner and the Soviet Government were held off. The voluntary militia stood ready to keep order. It was the tunics of the former soldiers refashioned into plain clothes, which filled the lecture halls in this year and also the small lecture rooms in which evening discussions were held on Spengler's "The Downfall of the West" (Untergang des Abendlands) and on problems of natural science. He who loves controversy found a worthy adversary there for a reasonable entrance fee; an esprit de corps reigned there, as could only generally be found in a close circle of friends. These evening lectures were announced on the bulletin boards of University and Polytechnic. There I got to know Max Valier as a speaker, who set forth Hörbiger's theory in examples. -

Inflation increased more and more. I was then in the same situation as many fellow-students, we had to find a job. In the newspaper I found "Barth Publishing House Schellingstrasse seeks assistant." I went there, looked at the books in the window for a while, all of them were unfamiliar to me. Sheer occultism! I worked at the publishing house for a few months. Wilhelm Barth was an astronomer of conviction, but at the same time a level-headed businessman, personally unassuming and immensely hard-working.

The others, authors, artists and regular customers believed in their occult science as firmly as Barth believed in his astrological knowledge. Each had another field in which he was master and researcher. All acted very mysteriously in consequence and all felt infinitely superior to normal people, these ignoramuses. - If the publishing house brought out a new book I had to wrap up and address books, for this I got a long list of addresses. However I only had to wrap up a number of books. In the evenings Barth himself wrote the addresses, which were on his list of secret customers, on the packets of books. Barth explained to me "Gentlemen who occupy

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+)The Milky Way, which consists of millions of fixed stars, thousands of light years away from the earth, according to the conception of technical science, is considered by Hörbiger as a structure which is comparatively near to earth. He says that a few light years away there are, above all, blocks of ice which shine in the light of our sun and which accompany our solar system to the farthest limit since they come from the same ejection cone. (Relative Parallax see Max Valier "Orbit and Nature of the Stars" [Der Sterne Bahn und Wesen] p. 484)

high positions in public life, even professors from the university and college are on it, but who do not want it to be known that they are customers of mine."

In this strange world it was always pleasant for me when Max Valier turned up. He too belonged to the authors whose books were bought by many people. In spite of this he was quite unlike the illusionists here. Everything that he said was straightforward and clear, without mysterious dissimulation and without emotion. When we once went a part of the way together in the evening, the gist of what he said was: "Of course, here there are often many pods which must be shelled, lapses into bad taste, and a great deal of imagination, often even shallowness. - But in many a one there is a small core of truth. Do you think that there is even more than our visible world. I find it facile and stupid to laugh at metaphysics." Later he said to me: "You must read Faust once, but beforehand you must forget completely that you have before you a work of art, which is recognized to be so great, you must forget that the actors play Mephisto so readily, when you obliterate everything from your mind and read the book quite impartially the idea will then come to you: 'How must the man, who wrote this book, have known the urge to questing!'"

Yet another recollection of Helmut Lang:

"After a very interesting lecture with discussion had roused the spirits one evening, I saw a small group of students in eager conversation in the college grounds. Amongst them was Max Valier. The bright grey of his suit, which had been tailored from an Austrian uniform, stood out boldly from the fieldgrey of the others. I suspected that the discussion was again about Spengler's theories and I went up to the group. I was correct, it was a question of: Has Germany no longer any great man? Then one said: 'Valier, your Hörbiger is an Austrian, like yourself, that can be seen from the smart grey of your jacket, which was an Austrian tunic.' Valier then replied:

'The political frontiers, which divide the German people into separate countries, are not laws of nature. It is an intellectual bond which unites all Germans.'"

In the inflation, which brought capital goods and housing property to the speculators, the great mass of the German people grew poorer and poorer. On account of the increasing depreciation of the currency, salary had to be paid out twice a week to the employees, salary which was adapted to the decreasing purchasing power of the mark. If 30,000 M. = 1 dollar today, three days later 75,000 M. = 1 dollar. For the old people, who wanted to live on the interest of their economies, it was catastrophic. In order to be able to buy bread, silver-ware and what was left of articles of value, had to be sold piece by piece. The currency depreciation was quite bad for freelance artists, who had not yet seen a good year and who did not yet possess any articles of value.

Max Valier was indefatigable in discovering new possibilities. It was a course with newspaper articles, astronomical calendars and lectures. His books still sold well but one could not collect the money as quickly as it depreciated in value. In 1922 a book by Valier was published by the Natur und Kultur Publishing House, Munich, entitled "End of the World" (Untergang der Erde). A couple of passages from the preface must be quoted here, from which it is apparent how he became spiritually accomplished with the oppressingly hard times.

"Preface: The small work in question owes its creation to the large number of requests made by numerous auditors of the author's lectures . . . . Indeed, it would be too much of a pity to let the interest in astronomical research awakened by the lectures themselves which is usually treated without kindness in school instruction, to die away again like a straw-fire.

No, especially at a time when humanity has come under the spell of an egotistical daily life, due to the outer appearance of recent years, to a much greater extent than behooves the intelligent inhabitants of a planet, and at a time when humanity has forgotten its mission to strive after knowledge of the universe, all those who have kept a better hope for the future, aspire, subject to their knowledge and capacities, to intervene in the chaotic turmoil of a dismal present. - How should it not then tempt the astronomer to play his part by his insight into the depths of the universe, in comparison with which we, together with our home planet earth and our sun, are nothing more than a speck of dust."

Then Valier speaks of stellar bodies, which burst into flame in the universe as "novae" and he says that the catastrophes, which have led to the flowing of a star which had already cooled down a long time previously, could also strike our earth one day.

Almost entirely without using strange words, he treats the various possibilities, the geological, then the meteorological, then the cosmic possibilities of catastrophes, which can obliterate all traces of life from our earth or even annihilate the self-existence of our whole planet. The sun as a source of danger; the comets and meteors; large and small planets and moons. He deals with everything and discusses how great or small the probability of such catastrophes is. The last section of the discourse, or the book is called: "The end of the world by the falling of the moon." - When the earth captured its present moon a comparatively short time ago (it may perhaps be 10,000 years ago), the latter caused violent upheavals with its first visit to the earth's surface, in doing so it drew the water to the equator so that the sea-level there rose 150 to 200 m, on the other hand at the poles it fell by approximately 400 m. - After life on the surface of the earth had gradually gotten accustomed to the new sea-shores, an equilibrium set in and our moon barely produces the formation of the tides.

If the observations now prove to be correct that the revolution of the moon has become smaller by 6 seconds within 100 years, that means that the moon is approaching the earth at an almost imperceptible rate. If, after all,

an approach is taking place, this increases in the course of time, not linearly but quadratically. The orbit of the moon will therefore change more and more into a spiral orbit.

". . . . As the moon approaches more and more, the gravitational pull of the moon will have an increasingly stronger effect on the water of our earth. When the radius of its orbit is still only 7 times the radius of the earth, all the waters of the ocean are divided into two domes which roll away as huge mountains of flood water over the continents. At this catastrophic time a suction of air will take place by the lunar forces, the air pressure will fall and a glaciation of the earth's surface must take place. - And there will barely be a few regions on earth which can offer a sparse population wretched conditions of existence. But these awful times are not yet the end." etc.

He who leaves the lecture room takes a different view of the present. He says to himself: The danger which looms over us is not at all natural, it is only a result of the incompetence of humans, a result of inept government, of unintentional blundering into war. But as long as we have sowing and harvest on our planet, we can still hope.

Valier did not make efforts to keep his family going in the tumult of the epoch after the manner of an Indian philospher who plunges into meditation, but as a strenuous European. He worked together with the author Dr. Reinhold Eichacker, who had to labor, like him, under inflation. Saleable books had to be written, interesting books, which could be easily read, therefore light reading. Thus, two technical Utopian small volumes, "Panic" (Panik) and "The Journey into Nothingness" (Die Fahrt ins Nichts) came into being.

Reinhold Eichacker died in 1931. His son, Rolf Eichacker Eng. D., sent us the books in 1959 and in addition, wrote:

> "The technical ideas contained in these books come from Valier and were in part so well worked through by him that about 7 years ago I received an inquiry from a firm how the author had conceived further details of an atomic-power submarine described in "Journey into Nothingness" (Fahrt ins Nichts) for diving depths up to 10,000 meters."

"Orbit and Nature of the Stars" (Der Sterne Bahn und Wesen)

The inflation came to an end. In the winter half-year 1923/24 Valier sat at his desk over a great work. Pleasure gave wings to his work. Since 1914 he had nursed the desire to write an all-embracing book about the stellar world. Voigtländer's Publishing House in Leipzig had now given him a commission and payment in advance of his remuneration and had consented to his proposal: the book "Orbit and Nature of the Stars" (Der Sterne Bahn und Wesen) with the sub-title "Popular Introduction to Astronomy" (Gemeinverständliche Einführung in die Himmelskunde) was to sketch the whole of our present knowledge about the cosmos, as well as to convey the physical information necessary for comprehension. So that the man, who has received no

humanistic education can also read it without stumbling continuously over the many foreign words of technical language, Valier sought the correct German word for each of these foreign words. Often his German terms are very graphic, for example computation theory of the propagation of light for theoretical optics, or erection on an equal with the earth's axis for parallactic erection, or shadow rod for gnomon. This self-imposed task of the author requires not only a good knowledge of Latin and Greek but also a genuine command of the German language in its rich vocabulary.

In the preface writers are in the habit of saying what the book should offer the reader and why it was written. Since we know Max Valier since his youth, we can well understand his introductory sentences and we can delight in the lofty nature of his ideas.

"The universe sends us the message of the ray. It is our one and all! All our knowledge of other worlds around us is contained in it. If a perpetually impenetrable cloud prevented the open view into the expanse of the heavens, if the message of the ray of stars did not reach us, we would know nothing of its existence . . . .

. . . . But the messenger of the universe, the ray, is dumb. His mouth does not automatically announce to us a greater mystery. Firstly, human intelligence must untie the bonds of his tongue so that he can speak to us and reveal to us the miracle of the celestial worlds and the exalted order of the expanse of the stellar world.

We may joyfully appreciate the fact that we are dependent on ourselves. The solutions to the enigmas of the world are not cast down to us. We must seek them ourselves. A task which is worthy of our existence and surely worthy of the sweat of the noble!"

How was the author to arrange and convey all of the vast subject matter without the book's becoming a tiring textbook, which no one will read to the end of his own accord? For a long time Valier had been figuring out his plan. He leads the reader step by step through the historical formation and development of our knowledge of the universe.

". . . . We are recommencing at a quicker speed, as it were, on the path which human intellect has travelled at the slow pace of a pilgrim in circles, thousands of years long, around the comprehension of world affairs and on it we also get to know the means which it has created for the conquest of the inadequacy of its natural mental organs."

In his large astronomical book - as in his later books on rockets - Valier imparts to the reader specialized knowledge whilst describing how this knowledge was slowly built up; how, in earlier centuries, one person established the basis by his new knowledge, how, later on, another person added a further idea to it and how, often, what was new was dismissed by the contemporaries and was only recognized in later decades and became common knowledge. Thus the edifice of our present-day knowledge comes into being before the reader. At the same time he gets to know the men (not only their names) who have

contributed large stones to the construction. - This kind of story, the story of human intellect appeals to Valier very much. And in addition he gives the deserved scientific appreciation to many a one, who was otherwise almost completely forgotten.

The first chapter of the book is called "Theory of Radiation." He describes the wave theory of Huygens and the emission theory of Newton; then how in the nineteenth century the latter was replaced by Maxwell's theory of electromagnetic luminiferous ether. Many experiments proved the undulating nature of light, i.e. they confirmed the notion of Huygens' basic idea. But when contradictions to the wave theory of light emerged in experiments for the examination of radiation at the moment of its formation (in statu nascendi) Newton's idea was again taken up. Planck formulated his new findings which were a continuation of Newton's idea, in the light quantum theory, which even Einstein subscribed to.

"But even in this way there were still strange discrepancies, since certain groups of phenomena could only be explained by the emission of particles, other groups only by the wave theory. As recently as 1924 Einstein acknowledged the existence of open objections. And yet, as early as 1921 an idea was expressed by Anton von Mörl, which perhaps contains the solution to this great enigma. Von Mörl maintains namely that what we simply call radiation, is two different things, according as the phenomenon takes place in an empty space (vacuum) or in gaseous, liquid or solid bodies (media). In the first case Newton's basic ideas should hold good, in the second case Huygens'. Therefore what we call sunlight, for example, and what we can take in with our eyes is in proportion to what overcomes the abyss of space from the sun to the earth like the waves which travel in the water, to the stone which falls into the water and causes them."

Now to the substance of the book, certainly reduced a great deal, but nevertheless with Valier's own sentences:

"I.) 140 A.D. The notion of the world of Ptolemy, the celebrated great astronomer: at the center of the universe lies the earth alone around which all the celestial bodies rotate in perfect orbits. - The theory is in keeping with Aristotle's philosophy of life. And even since several scriptural passages seem to confirm it, according to the conception at that time, it was able to remain unchallenged up to the beginning of modern times (265 B.C. Aristarchus of Samos, one of the most perceptive astronomers of the past, had supported the theory of the movement of the earth around the sun, but he could not carry his point with his theory.) . . . . Nikolaus of Oreome, Bishop of Lisieux, had, in the fourteenth century, restated the theory of the movement of the earth around the sun with great clarity. But even his writings fell to oblivion.

II.) Copernicus' conception of the world. Described in his life-work "On the Revolutions of the Celestial Spheres" - (six books) Nürnberg 1543 (Uber die Umlaufsbewegungen der Himmelskörper) the new theory of the canon of Frauenburg goes back in substance to the two basic ideas: 1. The daily revolution of the celestial globe is only apparent. In reality our earth

rotates on an axis going through its center. - 2. The sun is the true center of the revolutions of all planets. The earth, itself only a planet, revolves, like them, in an immense orbit around the blazing day star. - The elaboration of these basic ideas yielded, above all, a considerably simplified description of all the movements in the stellar awning which had been established up till then, it permitted the previously incomprehensible inclination of the orbit of the sun to be simply put down to the inclination of the earth's axis to the plane of revolution, it permitted the reciprocal distances of the planets from one another and their distance from the sun to be expressed at least in ratios and the deviations of the orbits from the shape of perfect circles to be discovered. Of course the true form and the cause of the movements were not yet deduced. Only Kepler was to discover the mode of revolution and Newton the uniform basis of the law for planetary motions."

Then the merits of Tycho Brahe and Johannes Kepler were valued:

". . . . closer observations of the positions of planets . . . . To have initially produced these indispensable fundamentals of all further progress is the merit of the Dane, Tycho Brahe (December 14, 1546 to October 13, 1601). When he died his assistant, Johannes Kepler, took charge of his notes. Kepler's three laws have become the foundation-stone of the present-day system for the calculation theory of the orbits around the sun. Like most of the great laws of nature they are also very simple. The first runs: 'The planets move in ellipses, in which the sun is the focal point.' - Today this does not appear to us to be something singular. But for that epoch it was the most outrageous affirmation which one could make. With it the theory of Aristotle was ruined at one blow, the theory according to which only perfect circles should be worthy orbital forms for celestial stars. But there was even more to come. With his second law Johannes Kepler, the son of a poor family in the town Weil in Württemberg, solved the problem for which the best intellects had lost their labor for three thousand years.

On 8 pages Valier now describes how Kepler discovered his new information.

He describes the great moments in the life of the researcher. He did the same thing for Newton's life. And the reader must share the experience. -

"III.) The theory of the world of astronomy of our present time. - What is set forth in our best and most recent works on astronomy goes back, on the one hand, to Newton, on the other hand, to the invention of the telescope and its accompanying apparatus. Above all the principle, discovered by Robert Mayer, of the conservation of kinetic energy, and everything which was obtained by direct study and measurement with the telescope up to the present day as well as by the various processes of reception of the message of light, of analysis and of interpretation are added to this."

Then he describes the further findings obtained by the dispersion of light. Further on it reads:

"If one asks what has been achieved up to now by these processes, one can say that the present-day view of the world depicts almost all of the movements

of the celestial bodies adequately and for each individual phenomenon of the heavens, for example, sun-spots, canals of Mars, comets, the ring of Saturn, etc., respectively, it submits a great variety of explanations . . . . A few years ago another view of the world of specialized knowledge, or strictly speaking a new, fourth view of the world was added to its predecessors.

IV.) The view of the world of glacial cosmogony. - Initially formulated in Fauth's voluminous work "Hörbiger's Glacial Cosmogony" (Hörbigers Glazialkosmogonie) a new ideological concept comes to the fore here. The engineer is faced with the task of understanding happenings in the universe in the spirit of technology. The whole of the observational facts of all earlier research results is easily adopted, as it is self-evident. But the interpretation of phenomena in the heavens is completely revised, ..." etc.

On page 486, in the conclusion, he writes that hundreds of individual apparitions and phenomena in the universe find their natural explanation by Hörbiger's theory. And because all of these phenomena in the heavens fit into the view of the world of Hörbiger's theory,

". . . . the whole of the celestial phenomena support the fundamental idea of glacial cosmogony with conclusiveness. Whilst writing this with a cheerful heart we do not forget that all human work is imperfect work. But say no more! All the imperfection of our representation cannot obscure the excellence of the new view of the world, which the German engineer Hans Hörbiger has given to the world."

Six years later Dr. Lanner wrote about this book:

". . . . Here Valier proves himself to be a prudent specialist as well as the master of description. He not only knows how to couch the difficult questions for novices vividly with a fluent style but also to satisfy even the experts with an infinitely rich specialized subject-matter. And here Valier has found the opportunity to develop a cosmogony in accordance with the theory of glacial cosmogony and to have recourse to this for the explanation of all those questions, where it alone is able to give ideal elucidations, where, in comparison with other theories of evolution, for example the Kant - Laplace nebular hypothesis, it achieves incomparably more and provides the most comprehensible fundamentals even for much discussed geological problems."

Mrs. Valier told us:

"My husband was, in actual fact, of a prodigious productivity. The books which he wrote had already been prepared in his thoughts. Thus one would think that he was only improvising. He was at his typewriter day and night almost without interruption. I would put his meal ready to eat on the desk otherwise he would even have forgotten that. It went on in this way day after day. And suddenly the end. Then there followed a couple of dreadful days, when lassitude came after heavy concentration."

It was a hazardous enterprise for the publishing house to publish a thick astronomical book with many figures which ventured to depict a view of the world which was sharply dismissed by the doctrine of officially confirmed astronomers. - Whether these new ideas would meet with universal approval, like the findings of the canon from Frauenburg, Copernicus, or whether they would soon sink into oblivion was the question?

At Easter in 1924 Valier sent his manuscript to the publisher.

His wife informs us:

> "He walked through the streets worn out and exhausted. The book's future was unknown. Even his own future was not clear to him. Now the great task which he had set himself ten years before, had been brought into effect. -
>
> But there was no long rest for him.
>
> Rucksack packed and into the mountains! A walking tour of the ridges. The first flowers sparkled in the melting snow. One's eyes can roam over the countryside for a great distance. Birds of prey circle around. - Then he remembers how in the first term in Innsbruck he wanted to build an airplane without a motor. - Now gliders fly in the Rhön mountains. Therefore his idea of that epoch was not unfeasible. But how much hard work remains for such a plan to be carried out! - Clouds cover the mountain ranges in the south, weave their soft thread around the sullen mountain summits. "How magnificent and beautiful the earth is!" Youthful vigor is reawakened in the lonely hiker. He must pause for a moment and sing a hymn to the glory of God.
>
> When he returned into the valley I immediately noticed that he again had his intellectual vigor and his former character, impetuous and enthusiastic."

Collaboration with Professor Oberth

In January 1924, Valier found, by chance, the book by Hermann Oberth entitled "The Rocket into Interplanetary Space" (Die Rakete zu den Planetenräumen) in a bookshop. On seeing this title he felt as if he had suddenly met a friend from former times. He bought the book and read.

He read and was not able to put aside Oberth's book even though he himself was completely possessed by his important book, which was to show the vast stellar world and in addition to that the human intellect, which will take it in and understand it. To understand the cosmos - the many points of controversy, which trouble men, the so many different explanations and theoretical systems, which have been knocked into shape over the centuries! - Suddenly, as though it was already a reality at that time Valier saw men in the small chamber of the rocket in space on a long voyage to other celestial bodies. - What they see there solves many mysteries, settles many controversies - - .

Although, or rather because he was so possessed by the important questions which his book contained, he was immediately compelled to write a letter to Oberth and to the Oldenbourg Publishing House. -

Professor Oberth has preserved the correspondence which now began and has kindly placed it at our disposal for the chronicle. Probably in doing so the thought never occurred to him that is is impressive to read this epistolary dialogue today. Amongst many physical and technical reflections we find hope and venture and great disillusions, and in spite of all these he never loses heart.

- The reader of the letters, who therefore draws from the fountain of historical reality must, of course, ponder over them even more than if he was to receive everything from the author presented in an easily intelligible way. -

Of course we can only give an extract from the 207 pages, which were often closely written on both sides, a great deal must be abridged but the passages from which the development of physical and technical ideas is apparent, are quoted literally, as well as sentences, which are characteristic of the letter-writers' way of thinking.

"The Rocket into Interplanetary Space" was the work of a physicist, a treatise with many formulae taken from advanced mathematics. Oberth had actually written it as his thesis for the degree of doctor and had also submitted it but the professors under whom he had studied and to whom he had finally submitted the thesis did not want to accept it. Then Oberth began to pursue his profession as a physics teacher at the High School in his home town, Siebenbürgen. But he did not want to abandon his work on rockets. He offered the manuscript to various scientific publishing firms for publication. After several refusals R. Oldenbourg, Munich, showed willingness to publish it. The publishing house was ready to publish the book, of course the author had to defray the printing expenses as is frequently agreed upon for scientific works, when the sale seems to be questionable for the publisher. Thus in 1923 this strange book came on the book-market.

Valier reflected upon it: How will this book, written by Oberth, fare? It appeals to the scientists who understand these derivations, the calculations taken from the field of dynamics and thermodynamics. - What does the technical world do with such a book, which presents something completely new and which was written by a man, whose name no one knows? - Indeed, if the author was Professor Sommerfeldt or Privy Councillor Föppl or even Professor Einstein, a respectful murmur could go through the forest of leaves. But Oberth, who knows him? Who reads his book with the audacious title? At best a critic who has a mind to methodically run down once again a cause.

Correspondence Valier - Oberth

On January 8, 1924, whilst Valier was still in the middle of the work on his book on astronomy he wrote to Oberth and to Oldenbourg and proposed the following plan:

1) To make propaganda for Oberth's work in all the journals available to him by means of illustrated articles,

2) To pursue this end by means of lantern-slide lectures,

3) If possible, to write a book in collaboration with Oberth - Valier was to write the part which will be intelligible to all.

To do everything with the purpose of providing, in this way, the means for Oberth to build first of all an experimental rocket.

Oberth's written reply of January 19, informs Oldenbourg that he himself had already had the intention of writing something popular, he gives many of his ideas for it, but is of the opinion that Valier, whom he knows and esteems as an author, has a much better style; for this reason he is in agreement with Valier's proposition.

The publisher Oldenbourg is of the opinion that "it would be better if both wrote a separate book but collaborate to the extent that both books do not compete with one another but complement one another." - Both books appeal to quite different circles of readers.

On February 10, 1924, Valier, the pioneer of the theory of glacial cosmogony, writes to Oberth:

". . . . it sounds to me almost tragic (not only on reading your book but also your two letters) that you set your hopes on those very points which seem to me to be unpromising, whereas you hold in low esteem what appears to me to be very important. I will be even more explicit. For example your hopes on the economic utility of the giant sodium screen (its fabrication presumed) and with regard to the exploitation of metal in the meteoric blocks on the moon, the cooling and rendering inhabitable of Venus etc. I cannot believe in all that but I do believe in something else which seems to me to be more important than all these hoped-for successes, something which you, in turn, do not take into consideration. Your hopes are founded on the fact that you take certain (in my opinion out-dated) astronomical ideas as a basis whereas I am one of the pioneers of Hörbiger's glacial cosmogony.

Just at this time, after the stage where this theory was ignored completely is fortunately traversed, begins the real fight for the new theory which, at all events, will rage chiefly in 1925 - 30. And now you think: Hörbiger maintains that the moon is completely ice-bound, that everything that we see on the moon, craters, mountains, etc. is ice and merely ice; Hörbiger further maintains that, with the exception of the earth, all other planets are completely covered in the same way with a shell of ice, even Venus and Mercury, in spite of the heat of the sun (as can easily be shown mathematically the sun cannot melt the ice even on Mercury, if it does not have an atmosphere). Now for Hörbiger's theory the moon is the king's evidence and touchstone. You understand, professor, what for us, the followers of the theory of glacial cosmogony, the possibility of going in person to the moon, means. This means simply everything! If it is found that the moon is not composed of ice, we are completely

beaten, then there is no salvation but if the whole surface of the moon is a crust of ice everything is won and all astronomy, astrophysics, meteorology and geology up till now is beaten and we are triumphant!! This is what bids me personally to support your invention of the rocket first and foremost for all I am worth. Not in order to make a sodium screen and to pick up lunar meteors but solely to provide us with the information: Is the moon covered with a crust of ice or not? That alone will suffice for us so that we can make the most expensive experiment seem lucrative. Of course we, the followers of the new theory, (which, at the same time, means a new vision of the world and a new philosophy of life) do not today have the resources to bear the costs. But we would make every attempt to support you in your venture. Moreover the matter is urgent. Today the master of the new theory is 65 years old. It is our most fervent desire that the voyage to the moon will be successful whilst he is still alive. . . ."

This extract from Valier's letter of February 10, 1924, is indeed one of the most informative of the whole of the correspondence.

Max Valier, the author and lecturer, made propaganda for the rocket and the advance into space in numerous articles and lectures from 1924 to 1930; but however much he spoke and wrote about space travel, he only mentions the aim, which was to establish the truth for Hörbiger's new vision of the world, once in his letter to Oberth. - He says to contemporaries: Rocket propulsion for world speed records or for economic air transport at an altitude of 10,000 m are objectives which the public understands.

But another idea gave him wings. He, who got to know Valier in "Orbit and Nature of the Stars," where, now and again the high-flying ideas of the seeker after God can still be distinctly heard interspersed among astronomical matters, knows that even the proof of the truth of Hörbiger's vision of the world is not yet for him his last highest objective.

He struggles, bears every hardship resolutely and stakes his life.

Contemporaries have said all sorts of things about this strange man, Max Valier:

> Felix Linke in his book "Rocket flight into the Universe" (Raketenflug ins Weltall) called him a sensationalist.
>
> Gartmann defends him and writes: "As if it has ever been a question of sensations for the purposeful Austrian engineer with the bald thick skull!"+)
>
> The chief editor of the Münchner Neueste Nachrichten, who knew well Valier from collaboration over the years, wrote about him after his death: ". . . . He did not attach any importance to Max Valier, to himself, to self-conceit, to a personal desire to assert himself. Not once did he attach any importance to the

+)Heinz Gartmann: "Visionaries, researchers, engineers" (Träumer, Forscher, Konstrukteure), page 137

construction of a special vehicle. He attached importance solely to flight into space, in flight to other stars. - And at a time, which is so well contented with the paltry day's profit so long as it is assured." -

After Valier had finished the manuscript of his large book and had sent it to Voigtländer's Publishing House he set to work on his new great task, the rocket, with the vigor peculiar to him.

For the confirmation of a verbal discussion he wrote to R. Oldenbourg on April 24, 1924, and once again, developed his plans in a clearly defined way, plans which, in the main, he had already proposed as a program for collaboration with Oberth in his letter of January 8: to propagandize Oberth's ideas and his book 1) by illustrated, up-to-date articles, 2) by lantern-slide lectures, 3) by a popular comprehension of Oberth's book.

He names the papers in which the acceptance of his articles is as good as certain: Leipziger Illust., Frankfurter Illust., Münchner Illust., Gartenlaube, Nach Feierabend, Der Michel (Czechoslovak.), Natur und Kultur; in addition to these 6 others, whose acceptance is very proable. For the first ones mentioned he was consequently a permanent contributor.

About point 2, the lantern-slide lectures, he wrote that the initial costs would be very high. Oberth's book will be sold during the lectures since, according to experience in this domain, the greatest market must be reached.

"It would be my personal ambition to cause the first experiments to be brought about with German money in Germany and if possible in Bavaria (Zugspitze) by my propaganda for Oberth."

About the third point he writes:

"For a few years now I have wanted to write a book on the different fantastic ideas which have been expounded in novels up till now, which are concerned with voyages in space . . . . I want to proceed chronologically and to describe how thoughts over the centuries, in conformity with the level of science and technology, have dealt with the problem . . . . Jules Verne, Kurd Lasswitz, ... to lay bare what is technical and scientific and to throw light on it critically so that the reader sees . . . . why these Utopias have not been able to be turned into reality.

Such a book would, of course, have been possible even if I had not heard anything about Oberth's rocket. But since Oberth's work is now available, it would be a crowning and conclusion for my book . . . . let us say with the title: "Voyage into space - from dream to reality." . . . . I imagine the book itself somewhat in the nature of a small volume about the cosmos with an attractive title page . . . ."

Then Valier went to Zürich, where he studied for the summer term. We do not know which lectures he attended there but we know all the more about his activity as an author which he carried on zealously even there.

Oberth, who did not yet know Valier's address in Switzerland, wrote to him at the University of Zürich on June 9, 1924:

". . . . The famous private astronomer of Linz and head of the famous wholesale coal merchant's business, Mr. Heinisch, Jr., likewise takes an interest in my rocket and when the occasion arises would like to finance a small model. A certain Mr. Gustav Heisler Dresden Eng. put a question to me in the name of several interested parties . . . . To whom have you spoken up till now as regards the financing of the experiments? Perhaps you can manage to get the affair financed jointly . . . .

. . . . In this summer or autumn I would like to come to Germany but I can only afford it if I can pay the travelling expenses by giving popular lectures . . . .

. . . . I have already given a little thought to my book, ... I imagine the disposition as something like this:

1) The Copernican - Newtonian vision of the world. Our main evidences for it.

1 a) How it must appear in a spaceship in the middle of the sea of ether. What one must expect there.

2) What kind of means are theoretically possible to travel through space.

3) Extract from the novels which have become famous up to now and from serious propositions. (It is evident that these points will not be of the same length. 1) can be very short. 2) must fill up at least half the book. 3) could be divided into more sections: a) balloon ascents, b) suppression of gravitation, c) machines, which are catapulted from the earth. Among others the proposed canon-shots must be discussed here. d) electric repulsion, e) the pressure of light. Here one could also think of Mathew's rays etc. f) the principle of reaction.

4) Are foreign heavenly bodies inhabitable, are they inhabited, could they at least be made habitable? Are there anywhere in the universe beings which are similar to humans? Reasons for the improbability of this assumption. Telegraphy to Mars.

5) The kingdom of heaven. Galilei, Giordano Bruno, pantheism, how the belief in gaseous gods must have come into being. - Is there a 'soul.' The 'enigma of the universe.' Consciousness, mechanical effects of the phenomena of consciousness. Telepathy, reasons for the failure of most of the telepathic experiments. Why do all religions locate the seat of the good angels up above? The fiasco of the religions of revelation. Parapsychologic experients beyond the atmosphere of the earth. (Moreover, I must remark that

this is terribly hot ground, one must think a great deal here over what one will publish, if one does not want to be immediately torn into 1000 shreds by uncomplimentary criticism.)

6) The economic, scientific, etc. prospects of the space-ship voyage to the sea of ether.

7) Conclusion. The broad lines of the evolution of nature. From the inorganic to the organic, from chaos to organization, from the meaningless to the meaningful. From barbarism to civilization, from conflict amongst everyone to co-operation and to the mastery of nature by co-operation. ---

What is annoying in this classification is only that the whole thing must be written in a more or less lecturing tone. It would be better if one could publish the book in the form of a novel or adventure but it is not, at the moment, clear to me how this would be done.

These days Dr. Franz Hoefft from Vienna as well as a certain Mr. Eilert Pastor, Berlin - Wilmersdorf, Gasteinerstr. 4-5 wrote to me to say that they would be prepared to write a popular book together with me. What shall I say to them in reply? Shall we engage them? Dr. Hoefft has a considerable knowledge . . . ."

In his reply, which he sent to Oberth in Schässburg and to Oldenbourg in Munich at the same time, Valier gave an account of his propaganda in the rocket affair on June 19, 1924. At the beginning of May the article "Rocket flight into Outer Space" (Raketenfahrt ins All) with large illustrations appeared in the Münchner Neueste Nachrichten, even on the front page, and in the Gartenlaube, in mid-June in Ost und Süd and in the Schweizer Illustr., varied somewhat each time. Other papers, such as the London Illustrated News and the Kopenhagener Illustr. Famil. Journal followed. As a result of the articles perhaps even more financial backers will come forward. He proposes appointing Oldenbourg's Publishing House as the center for interested parties, for Munich seems to him to be a suitable headquarters for many reasons. "To name only one: Linde's ice plant, which can provide the necessary quantities of liquid air etc. Liquid air is very cheap at the place of production, but the slightest transport raises the price of the stuff a great deal. Then secondly Linde's plant itself might also be an interested party in so far as, later, huge quantities of liquid oxygen etc. might be needed. Thus I propose that you, Professor Oberth entrust the affair initially to Oldenbourg's Publishing House or else to a man of confidence in that all offers from financial backers are collected in Munich and an attempt made to reconcile the gentlemen. These gentlemen ought to be called upon to put the money together even if an agreement has not yet been reached so that you can come to Munich for, let's say 14 days. (In addition I must ask you to reimburse my travelling expenses for I would also like to be present.) He who poses as a financial backer and does not want to do that is not to be taken seriously. The cause must be worth so much to the people. If the affair is so far advanced the day must be decided when we all will meet in Munich. Since my propaganda will only just be having its effect, as I have already said, it would be advisable to wait a little longer and to

choose a day some time at the beginning of August (when you are sure to have a vacation from teaching). Then one would indeed see how the cause is getting on, how much capital is represented, and what the gentlemen think. Probably an association in some kind of legal form can be entered into, which undertakes to give you the resources to carry out your experiments and, of course, the necessary maintenance. And then work with Linde begins. For without a large plant of liquid air situated near-by you cannot do anything in the long run. . .

I would above all not advise you to count on lectures in Germany as a source of income. I have enough of experiences of that. I now only give lectures with a fixed engagement, I no longer do anything even at my own risk. I can now permit myself that because I have slaved and worked at my own risk for 3 years. But he who, today, wants to begin with something, be it the best of affairs and to begin with has not already got the reputation, will find no one to relieve him of the risk.

Now finally to the question of the books. Unfortunately here I must agree with the opinion of Oldenbourg's Publishing House, since your new proposals seem to me to be unfavorable. You must dismiss your point 5 and all other delicate points without fail. The same applies to me. Often I would willingly like to be active in such a field but I have still a bee in my bonnet for it and must finally say to myself: the cobbler must stick to his last! One only attains a thing when one concentrates on it alone and pursues it with true fanaticism. Therefore please stick to rockets and let Giordano Bruno and Galilei, gaseous gods and enigmas of the universe à la Häckel rest in peace. If you are rather keen on it you will soon be taken really seriously throughout the world as the rocket man, something which, at the present time, no one yet does but if you fritter away your talents you furnish your antagonists with the desired matter for criticism.

Therefore I urge you not to meddle with it if your rocket is dear to you. . . . .

. . . . I am quite in agreement that we should proceed spearately and each of us should write his book alone, only I would willingly submit the manuscript to you so that it is, as it were, authorized and so that I do not describe something as your assertion and theory which you do not maintain and profess at all. I must admit that even to me many of your calculations are not clear, that is, less the pure mathematics as such than the physical meaning of it. Your book on rockets is really not written very clearly in the sense that one could immediately see through the problem of energy around which everything finally revolves. I hope that I have made that more clear to the reader with my articles for the various papers. Therefore in a word, I would tackle my book quite differently and I even believe that I would finish it ten times quicker if I would write it alone (at least the first edition) than if we first had to work out the terms of collaboration. If it was only a small book, you know, I would write it off, as it were, in one sitting and then it is perfect and that is always best for the reader. It is now merely a question of how far you want to be financially concerned with the book. Since I do not make use of your ideas only but will also give many others and my own, moreover since I would in no way wish to take the opportunity from you of writing another book yourself after it, I think that it would be sufficient if I offer you 1/4 of

the remuneration obtained. In doing so you would only be under the obligation to answer my possible questions and to authorize the book, as it were, but other than that you would not have any work to do. I hope that you find this just and fair. But tell me frankly, I too am a plain honest German who likes to talk frankly . . . ."

Then he considers the others, pastor Eilert/Berlin and Dr. von Hoefft/ Vienna, who have offered their services to Oberth for literary co-operation.

"Probably, initially on the strength of my articles, others have now noticed that something might possibly be found and thus you ought to get even more letters. But I initially supported you, I have even done numerous scribblings and made numerous contacts for it, much more than you think!! I do not want to boast of these services and I have taken them upon myself, above all for the sake of your cause, out of enthusiasm for it, as also on account of the importance of reaching the moon for Hörbiger's theory, not for the sake of the financial gain which will perhaps result from it one of these days. I would also like to do even more. I have already worked out the program for the experiments in Munich and have expounded a whole system, which, as Mr. Oldenbourg knows, holds great promise of success. I should also like to be present with you and see the matter come off. I am also an expert instrument worker (I learnt for 3 years as an improver) and was an aerodynamic officer in the war, I have also made numerous flights and among them three crashes, the last crash was in flames and from an altitude of 3200 m so that I myself know the whole business with counter pressure. I can only corroborate your chapter about it; what you have learnt from flying I have experienced a hundred times. For this reason, on the whole, I do not want you to make up to so many other gentlemen. . . .

. . .Best wishes to Munich and Schässburg

Yours very truly

Max Valier."

Oberth replied to Valier on July 7. He thanks him for his energetic support.

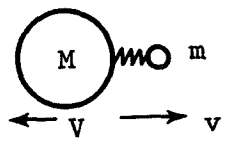
"In actual fact I would not have been able to make any such propaganda for my cause . . . .

I am very much in agreement with a share of 1/4 . . . .

Of course, I am very ready and willing to answer all questions to the best of my knowledge and to rectify possible errors . . . .

I have lately read your article in the "Münchner Neueste Nachrichten"; many thanks for it. The article which was kindly sent to me from the "Schweizer Illustrierte Zeitung" unfortunately contains a few errors, as, moreover, I have also found in other places. In fact I must have expressed myself rather abstrusely in my book.

If I separate two spheres in an area free of air and gravity by means of a spring placed between them, the kinetic energy on each side is not equal, but the momentum of body on each side is equal. If M is the mass of the larger sphere, m the mass of the smaller sphere, V the velocity of the larger sphere, v the velocity of the smaller sphere and if we imagine the spheres to be at rest to begin with, then



$$|M \cdot V| = |m \cdot v| \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(I)}$$

or if we wish to express the opposed direction of V and v by opposed signs:

$$M \cdot V = - m \cdot v \ldots\ldots \text{or: } M \cdot V + m \cdot v = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(I)}$$

This equation does not usually correspond with the energy equation:

$$1/2 \cdot M \cdot V^2 = 1/2 \cdot m \cdot v^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(II)}$$

For the rocket theory quite strange conclusions can be drawn from these equations. I shall perhaps publish details later in an article "The Problem of Synergy" (Das Synergieproblem) . . . ."

Then there follows three pages of physical considerations and mathematical derivations, which we omit, with the exception of a few short characteristic passages, in order not to be too long-winded:

Footnote: "Moreover, from the article in "Ost und Süd" I observe that it was only a question of a printing error."

Two days later he wrote in addition to the long letter:

"Schässburg, July 9.

The 'Tagespost' of Hermannstadt has just printed a copy of your article in "Ost und Süd" of June 14. I must congratulate you on your literary success. A number of people, among them even those, who had heard my lecture, explained to me that the cause had only just become so really clear to them . . . ."

One must read this passage of the letter. From it one realizes that Valier knows how to handle a physical question more clearly and simply than the physics teacher. And Oberth acknowledges this and declares it openly. - How rarely does one find such a strength of character! - Then there follows again comments on the necessary prerequisites for reaching space and on the transfer station which rotates around the earth and on a distance from the earth which would be suitable.

If one reads the letters, one would almost think that one sees the two men before one: Oberth, who has already nursed the great adventurous idea of the realization of space flight for 15 years, and who attempts to find the solution to the problem earnestly and conscientiously on paper, - and Valier who, as

early as a few months after his imagination for this problem has been aroused, comes with propositions for a practical realization. One must make propaganda for the great idea, one must obtain financial backers by articles in the press! In his next letter of July 16, he thanks Oberth for the correction of errors and treats each point, which Oberth had to expose in his articles, in detail. Even the passages in Oberth's book which are abstruse to him or with which he does not agree are treated by him, he candidly gives his opinion about them. A longer letter is the result, 11 closely written pages in all. Several pages from it follow:

"I am very grateful for your development of the formulae in your letter, in addition I have understood everything, today I have gone through your whole book once again and have understood it much better than on first reading but much still fails me. Moreover, I am opposed to formulae and partial to curves. In many passages your book drives me entirely to despair. I can follow and understand the calculations as such, which are purely formal, but what the expressions mean (physically) is not always immediately clear to me. It seems to me that you often tackle the whole thing in a much too detailed way, which also requires multiple calculations. I take the liberty of developing on a separate sheet the whole mathematical framework, which I use in my book as a reference for myself and for the curves, which I will introduce (I will avoid calculations in my book with the exception of a few simple ones) in order to ask you if it is not sufficient."

We omit the other 7 pages here in order to solicit the attention of our readers for the following 2 1/2 pages of the letter, because in these pages Valier develops his plan. Already in the last letter he had written to Oberth that he had discussed this plan with Mr. R. Oldenbourg before his departure from Munich and that Oldenbourg agreed with him. Valier pursued this plan from the Spring of 1924 for 6 years.

". . . . the plan. - You initially intend to build and launch a small test rocket. Costs approximately 50,000 M, the rocket is lost, even if the test as such succeeds. And then you want to fire rockets, at first unmanned later manned, onto the moon.

But I say we must do things the other way round. Above all we must master the mechanics of the motor of the rocket completely. Therefore we will not fire anything straight away, not even a small test rocket. But we will build such a rocket motor on the ground on the platform at our leisure and clamp it down and just let it run to see how the combustion gas hisses out of the jet. If it is so that we master what is purely mechanical with these tests without having flown in the air twenty times, if the supply of alcohol and water and of liquid oxygen functions, we will firstly assemble the machine, which originally did not have the appearance of a rocket but any shape at all so that the fuel tanks were situated where it was convenient, into the rough form of a rocket and we shall put the whole thing onto a truck (railway truck) which stands on a straight stretch of track and we shall take up a position close to it on the truck and start the rocket, which has been screwed down and is in a horizontal position. Then the whole truck must be set in motion by the reaction; we can measure its speed. Since its total weight is known, and the friction has also been investigated for railway trucks, etc. we can thus obtain an

empirical opinion of the capacity of the rocket motor and we can calculate accurately the percentage we can really utilize of the chemical energy contained in the fuel. You are indeed right when you say that it does not matter how many calories there are in 1 kg fuel as long as I can make M_1/M_0 very small and I can travel with only 40% efficiency instead of with 80%, if only M_1/M_0 becomes small enough. Yes, you can indeed say if! That is just it. I believe, now as ever, that it is the most important thing to take that fuel which contains the most calories in the kilogram and to see that it maintains the greatest percentage possible. Moreover, I believe that the rocket motor will operate in the air with 60-70% but in space with 80-90%, for there are hardly any energy losses through internal friction (as in piston engines). The direct expulsion of gas from the rocket must, according to my technical instincts, set in motion even the most perfect, on the whole, possible transfer of the energy present in the fuel. The rocket is, as it were, the long-sought after 'explosion turbine' only in a special form. If we once have firm technical control of the rocket motor along these lines and if we are well informed about the performance of the motor, I then propose that one of these days we put such a rocket motor in a quite ordinary all-metal airplane.

Initially we take off with the normal motor. According to the altitude reached we switch off this motor and let the rocket function. I bet that the airplane then reaches a speed per hour of 1000 km and more. The next step is to make an airplane which no longer has a normal motor but a rocket motor only and we take off with this directly. If this is achieved and we have the knack of flying without a propeller merely on the rocket principle, then be begin (with hermetically closed rocket-planes) to fly higher and higher, firstly 10 km, then 50 km, then 500 km and finally 5000 km, i.e. we will pass over progressively from airplane to spaceship. Therefore we do not make a leap into the dark but we proceed systematically on the basis of knowledge gleaned, according to the technical progress made each time.

But my plan has also its advantages from another angle. From the beginning it does not need a considerable sum of money (50,000 M and more) for a test to be "detonated," a test which can never really be of any use but with this money experiments can be made for quite a long time and a great deal of progress made. Furthermore, it will become apparent comparatively soon and in due course whether insurmountable technical difficulties on the whole will make the affair impossible. But if the tests are advanced, the course proposed by me has the advantage that as early as after the first tenth of the tests a practically utilizable thing comes of it so incidentally, namely, the rocket motor, which in itself represents a very useful discovery. If only it turns out as I imagine. If the flight tests are successful the rocket-plane will be completed in the middle of the course of our project and will again be a lucrative discovery in itself. And only when we have great resources will we rise slowly into space. But the resources are, as it were, automatically at our disposal for, in order to go up into space, the airplane must function beforehand and if it functions it has also brought in money. So!

Furthermore: One could begin quite small, only it is best to be near a large plant for the liquefaction of air . . . . Now in Munich there is Linde's well-known plant and Mr. Oldenbourg knows Mr. Linde and his sons well in person. For this reason I have told him that he must try his luck here.

Should Linde agree and if more money were to come in for the experiments and for your maintenance you could then begin in quite a small way with Linde outside in the workshops which are already at hand, together with a skilled mechanic. Therefore, as far as concerns the question of expenses, only your maintenance and that of the mechanic and the cost of some material must initially be covered. That is very important. I think that you could work for a year with 20,000 M, if we could raise such a sum.

In my book I shall of course make an appeal for a fund-raising drive at the end. I was not able to do that in the newspapers. Once again, say in September, I shall attempt to obtain the acceptance in all the papers, which up to now have published my articles on rockets, of a short announcement which reads: "Our readers surely remember the article in number ... about rocket flight into the stellar world. In the meantime the cause has made progress and fortunately there were some people in Germany, - as in America for Goddard, - who wished to provide funds to help the cause to its completion. It is notable that the tests promise that, on the way to the conquest of the moon, important secondary discoveries are made whose utility on earth today is unquestioned and thus the whole affair is not only revealed as an audacious fantastic idea but also as a universally useful one. Of course the funds collected up to now are not yet sufficient to actually embark upon the tests. Therefore all those people who are interested and would possibly contribute their share, are requested to get in touch with R. Oldenbourg's Publishing House which has kindly taken in hand the gathering together of all persons interested." ---

That's roughly the gist of it. I do not know whether it is of great use but one must, by all means, make the attempt. I think that if we show the people that we are not simply "crazy lunarnauts," as many people think, but that we think quite practically and proceed from rather simple and obvious facts, we will obtain money more easily.

Concerning all the critical onslaughts I advise you only one thing, do not take any notice of them. Even if it was in an obviously influential journal. I can see that you are on the point of making the same mistake as Hörbiger always makes. He too always thinks that when someone attacks him he must write a whole book in refutation. One should do nothing at all. The humiliation of scholars is all the greater if the attempt succeeds. Even before the invention of the railway they maintained that it would not go and even our good Zeppelin was declared to be crazy. What a pity for each line which, let's say, Zeppelin wrote against his assailants. One converts no one with writing, only with actions!!

With very best wishes

Yours

Max Valier."

There appeared in the "Journal for Physical Instruction" (Zeitschrift für den physikalischen Unterricht) a very derogatory review of Oberth's book, written by Privy Councillor Prof. Dr. Spies. Oberth's reply was not accepted.

Oberth had told Valier: ". . . . they do not want a discussion, they do not want to publish their journal for the purpose of Privy Councillor Prof. Dr. Spies' being refuted with vengeance by an unknown schoolmaster from Siebenbürgen." Not once did the editorial staff want to return his manuscripts to him (he had sent in one long and one synoptical manuscript for selection) with the explanation that the Lei notes sent in as return postage could not be exchanged in Berlin. - The same thing often happened to Oberth. That must be exasperating.

On August 1, 1924, Oberth wrote to Valier:

> "Mr. Barthel, the banker from Würzburg wrote to me that when the occasion arises he is ready to finance my invention. I replied that I was already in the midst of talks on this account with you, with Mr. Heinisch and Dr. Hoefft, but that I would of course very readily accept his offer of assistance . . . ."

Oberth made use of his vacation to reply to Valier's long letter of July 16. In it Valier had named all the passages which had not become clear to him and which justified why he was of another opinion. Valier wanted to explain the movements of the rocket in our atmosphere and outside of it with the law of the conservation of energy. - At that time many serious scholars contested the possibility of the acceleration of a rocket in the vacuum of space because they would say to themselves: Where the burnt gases can no longer support themselves on the resistance of the air they can no longer produce any propulsion. - As counter-evidence Valier wanted to quote his imaginative vision in his book which is intelligible to all and he hoped to convince everyone with it: the potential energy which the rocket carries with it is converted into kinetic energy. The expulsion of the combustion gases results in a reaction force, which serves for the propulsion of the rocket. That is evident. Moreover, it is still a question of maintaining a good efficiency. What is favourable for this must be found by way of technical tests. -

Oberth then replied:

Schässburg August 4, 1924

"Dear Mr. Valier,

Please excuse me for the delay. It was not easy to reply to your valued letter of July, 16 which, moreover, I only received on July 27, in the framework of a letter. I would first of all like to inform you that you are much too modest. By this we mean: I am superior to you in the purely theoretical field, in every other field: constructive talent, mechanical knowledge, aeronautical experience, vigor etc. you have made more of a name for yourself, have a better style and more literary experience than I have.

But now to the theory of the rocket: in my opinion you work somewhat too much with the law of the conservation of energy. With this law the propulsion of burning rockets cannot easily be calculated. Firstly the exhaust gas velocity cannot be given by it. I

can only say that 1 kg of fuel produces umpteen calories of which a part is used for the movement of the exhaust gases, the rest serves for its heating. (My rocket transfers hardly any heat to the surroundings, rather it absorbs heat.) The law of the conservation of energy, however, is fulfilled no matter how great each of the two constituents is. With equal pressure, equal temperature and with an equal number of atoms in the molecule, e.g. if specifically heavy gases escape more slowly, the result is (c = exhaust-gas velocity; V = specific volume, i.e. the volume of 1 kg of gas in m^3) $c_1 : c_2 = \sqrt{V_1} : \sqrt{V_2}$. With the same energy content, of course, gases with heavy atoms would now warm up much more, since their specific heat is correspondingly smaller; but since c increases as the temperature increases and is likewise proportional to the root of the absolute temperature it seems as though this difference would again be adjusted and c would however be mainly determined by means of the inner heat content. But it only appears to be so: That the combustion unit would not stand temperatures of more than 4000° C would be the least of our problems. Nothing is too difficult for the engineer and the combustion unit could be made of tungsten or vanadium. And the outer cooling by means of the fuel could be made more efficient than I have made it. But it must be borne in mind that the exhaust gases are dissociated at a high temperature, in other words that the conversion ceases to be complete, meaning of course that correspondingly less energy is released . . . ."

This is only a sample. Unfortunately we must again omit a great deal of the 21 typewritten pages. Only a couple of passages follow, which show how difficult it was to work scientifically in the remote Siebenbürgen.

"(As a proof of how the post operates here: In Spring I ordered the book on Glacial Cosmogony for myself, I have still not received it to this day. - A book which I ordered 2 years ago because, in the previous year I needed it for an examination, arrived safely a few months ago.) If you wish to publish that sort of thing in your book without fail or if you at least want to have an early reply to your questions, I ask you to divide any synopsis in booklet form into parts of 10-20 sheets and to send them to me by book-post as registered printed-matter. Then I receive them in 4-5 days."

After these short digressions the discussions continued calmly and clearly: ". . . . In order to reply to this question one needs to know: the boiling point, the specific heat of the liquid, the specific heat of the steam and of the gas, the ratio of the specific heat of the gas at a constant pressure to that at constant volume, the degree of dissociation and the chemical energy of the substances used. . . . ." etc.

Page after page there were explanations and arguments which were written fluidly and were easy to understand. He was well up in the knowledge of his

epoch in all the fields which are necessary for the construction of a rocket and it was clear to him and he also knew how to express it clearly in communication by letter.

If, in many books, which talk about Hermann Oberth, one reads again and again that his first and pathmaking book "The Rocket into Interplanetary Space" (Die Rakete zu den Planetenräumen) is not suitable reading, the result is that one has the impression that Oberth is of those who have a great deal of knowledge and good ideas but who do not know how to express themselves. The letter dated August 4, 1924, shows the contrary. Indeed in this letter he says of his book:

> "As far as my book is concerned I originally wanted to submit this work as a dissertation for my doctor's degree and to show everything that I had learnt. Initially, when it was ready I decided that I would simply rather have it published. Therefore I have already simplified the calculations considerably. In my chest there lies approximately 9.5 kilos of calculations, curves and jottings.
>
> That I have not simplified them even more is because I feared the scepticism of certain scholars and because I wanted to reduce these gentlemen to silence right from the beginning by the fullness of the calculations. At the same time I wanted to write the book in such a way that in it each of the more serious objections to the cause, which I could conceive, is refuted or is at least dealt with."

Then on page 5 of this letter:

"If I have understood you correctly, you propose simply to mount on a truck a rocket model, which will propel the truck when it burns. This is indeed an interesting experiment, but it still is not an economical means of propulsion. At a low velocity of the truck, that is to say that almost all the kinetic energy released is manifested in the retrograde movement of the gases, not in the forward movement of the truck. If the speed of the truck relative to the gases is 20 m/sec, but the speed of the gases relative to the truck is 2000 m/sec, the reaction on the truck, in one second does the work $P \cdot s = P \cdot v \cdot t = P \cdot 20$. On the other hand, on the gases, which have the velocity of $c - v = 1800$ m/sec to the earth, it does the work $P \cdot 1800$, thus 90 times more.

Thus you recover only 1/90 of the total kinetic energy as the energy of propulsion. It would be quite different if the truck had a velocity of 2000 m/sec. Therefore the gases expelled behind the truck would stop immediately and the whole of the kinetic energy would benefit the propulsion. In the meantime should the truck run more slowly it is better, one makes the stream of gas pass through a turbine so that it comes to a halt immediately as a result of its working capacity and consequently passes all of its kinetic energy on to the turbine. -"

(As early as the summer of 1924 Valier's attention was drawn to this characteristic of rocket propulsion. Later when, contrary to this advice, he demonstrated

the propulsive power of the rocket on terrestrial vehicules it was to prove to the whole world that combustion gases produce thrust. With a low efficiency at low speeds he insisted upon this in his lectures.)

One of the many ideas which Oberth proposed in his book in 1923 and which were carried out approximately 25 years later can be found expressed on page 17 of this letter in a few short lines: "We have little influence on G • dt. On account of the low resistance to counter pressure of man the propulsion must last for a long time. At most that we make man somewhat more resistant to counter pressure by habituating him to it on the centrifuge."

Oberth takes up one point after another from Valier's letter. On page 22 he is through and writes:

> "I am of your opinion as regards the points which I have not discussed.
>
> Please excuse the length of this letter. Firstly in writing it I felt like the late Pliny. Because I have no time to write you a short letter I wrote you a long one. But secondly it seemed to me a good idea to explain these things to you although I know that you can at most use one or two sentences from this letter in your book. But I hope that this insight into the rocket theory will be useful for your book, for now you are perhaps in a better position to judge what is essential and what is inessential. Perhaps the book will be easier to understand because of it.
>
> Excuse my writing sometimes in a pedantic fashion, it is only a result of my profession, moreover it means no harm.
>
> The fact that even this time I again introduced a great many formulae is mainly due to the fact that I cannot do much more than calculate. But do not pore for too long over the calculations.
>
> With best wishes
>
> Yours sincerely
>
> H. Oberth."

At the end of August Oberth went to Würzburg to see the banker Barthel.

On August 11, 1924, Valier was in the Palatinate before his departure for Landstuhl. There he again wanted to pass nights in Philipp Fauth's observatory at the large telescope - a pleasant thought for the "Troubadour of the Stars." On a card he thanked Oberth for the long letter: "I will set to work on the preparation of the manuscript as quickly as possible and then send it to you with sketches of the illustrations for your opinion . . . .
Moreover, I did not intend to use rockets on railway trucks for the propulsion of the truck but I intended using the truck solely to measure the reaction empirically, but, from what you have said, I realize that perhaps this would not be a good method. Now I am once again, however, inclined to begin with test

rockets. Then the public will surely flock to demand entrance whereupon I would hope to bring in 25 - 30,000 Marks in entrance money, on the occasion of the launching of one of the first rockets, which costs approximately 10,000 Marks. The more come the better."

The unbelievable optimist Valier speaks from this card. Of the intellectually interested people, which can be found in all towns and who come to his lectures he points to the great mass of people. Perhaps he thinks of what immense amounts of money in entrance fees will be taken at the October Festival in Munich and is convinced that the crowds will pay an entrance fee just as readily to see the launching of a test rocket at close quarters as for the primitive but popular pleasures of the October Festival.

Observation of Mars.

Valier talks about the weeks in Landstuhl in the preface to the 5th edition.

"In 1924, when the first edition of this present book appeared as a small pamphlet with the title "Advance into Space, a Technical Possibility" (Der Vorstoss in den Weltenraum, eine technische Möglichkeit), the author wrote the whole text within 4 weeks on those late summer days when the planet Mars came closest in its great opposition to our earth, as near as it will never again come up to the year 2000.

Night after night we, that is the author and Philipp Fauth, who had been an untiringly active explorer of the planet world for 40 years, went from the peaceful place of Landstuhl in the Palatinate and climbed the 130 meter high mountain to the observatory which houses the famous largest medial telescope in the world; we firmly intended to penetrate as far as possible the mysteries of the Martian world. And we saw more than the author ever dared to hope, we saw how, on the star of the god of war the summer of the southern hemisphere, which at that time was turned towards us, approached and how the face of the previously pale planetary disk changed from night to night until it stood before us in our field of vision in color like an artist's palette, with a snow white patch at the pole which was dazzling bright and surrounded by a greenish-grey border, with pale yellow and tawny, olive green and sky-blue areas in the southern half, with predominantly brick-red, wide-ranging regions in the northern hemisphere, shining bright border of clouds at approximately Martian noon-time around the border areas of the so-called continents and oceans and finally set off with a network of mysterious, very thin lines which linked together the roundish points dotted like dark oases in the brick-red regions. We saw Mars so clearly that after only 10-15 minutes the fact that our neighboring world rotates on its own axis could be recognized by the perspective displacement of the very impressive dark formations, it was sufficiently clear to get to know by careful observation the dissipation of the morning mist which often takes place in 5-10 minutes and it is sharp enough to see so many very fine points sparkle for fractions of a second at the very best moments, in the tropical areas which are either tinged with carmine or lutescent that the pencil proved to be powerless to graphically depict this fullness of the faces.

The optical wonder of the medial telescope which, like no other, permits one to eliminate the otherwise so annoying secondary air spectrum by simply

turning a screw, that is to say allows us, at propitious moments, to bring the planet Mars, which passed by in opposition to the sun in those weeks at a distance of 57-62 million kilometers from our earth, as near as 100,000 km by using a 550-620 fold magnification. We therefore saw the ball of the Martian globe floating before us four times nearer than the naked eye sees the full moon.

That is what distinguishes the observation of Mars so much from that of all other planets: It is the fact that here one can actually look down upon the solid surface, upon the very soil of our neighbouring planet and one discerns on it again and again certain contours, which have been known for centuries, that one can observe seasonal changes and such things which are connected with the hours of daylight, which have many connections with the occurrences on our earth.

On the other hand what is the use that the beautiful star of the goddess of love appears in the telescope more than twice the size of the crescent and shines much brighter than Mars, what use is it that Venus comes a good third nearer to us on its orbit, since the perpetual halo of its silver clouds only rarely clears a little in decades in order to allow the observer an uncertain view of several brighter and darker regions on its actual surface.

Observation of Jupiter proved to be completely dreary. At first sight this planet shows the most and the clearest details even in the smallest telescope but only to indicate that even after taking pains for decades one still only looks down upon changeable cloud formations, for solid contours have never been observed on the orb of Jupiter and have never been recognized again later. The marvellous planet Saturn hovers even more fixedly like the Sphinx in the field of vision of the telescope, encircled by its remarkable system of rings, which seems to be drawn around it as if with a trammel.

Finally Uranus and Neptune are too far away to reveal clear details on their tiny pale greenish disks. On the other hand, Mercury, the nearest planet to the sun, in spite of its proximity to the earth and in spite of fierce insolation, offered us such unfavorable observation conditions that the power of the telescope ran short at less than a tenth of what the same glass could show under good conditions.

Therefore, of the whole circle of the round dance of the planets, time after time only Mars remains as a neighboring world, which we can recognize as such and which has already been made so familiar to us by the research carried out till now that we are, of necessity, filled with a burning desire to learn even more about it and finally to know what the surface of the fiery-red star is really like. The more the spell of the lenses which magnify a thousandfold reveals to us, the more furiously one must curse the abyss of space which separates us unmercifully from Mars and from the moon, which is more than a hundred times nearer, so that we cannot once reach the latter, which, after all, still belongs to our earth.

Therefore the nightly observation of Mars was not uninvolved in the copy of the book. It was this which roused the will to the unfulfilled desire to overcome the difficulties standing in the way and to bridge space.

In this way the "will to advance" at that time sets its stamp upon the book. It was their aim alone to portray in a popular form what Professor Oberth had tried to demonstrate one year before in a highly scientific way in his work "The Rocket into Interplanetary Space" which was published by the same publishing house, that is to say that our present day technical resources and fuels are sufficient to construct a machine which is capable of breaking through the shell of the globe and to rise into outer space."

Intensive work at a desk in the hours of daylight followed the nightly observations. Then the manuscript came into being:

"Advance into Space,

a Technical Possibility

A scientific study, intelligible to all, written by Max Valier."

Again Valier visualized his audience from the lectures on cosmotechnology. People from all walks of life, in addition to many scholars and students, had so often sat opposite him when he stood at the speaker's desk. They had come not to have a pleasant evening, not even to acquire professional encouragement, they had come because a desire for a wider, deeper knowledge compelled them.

Was this thirst for knowledge, which people had, not the basis and actual root of all philosophy? Because he felt an inner affinity with these people he had, time after time, spoken in each town with fresh joy and his lectures had never become boring.

He now turned to these people who were thirsty for knowledge.

His booklet was already almost prepared in his mind when he sat down at his desk and wrote down the arrangement:

" I. The Boundary of Gravitational Pull

II. Our Fighting Resources

III. From the Signal Rocket to the Space Ship

IV. Advance into the Celestial Space

V. The Conquest of the Stellar World."

Because Valier always expresses in the introduction what has caused him to write the book, here too a passage from his introduction must be quoted:

"A dream of mankind seems to be near to its realization! What thousands of years have anticipated, what millions, who in the meantime have returned to dust have hoped, what countless poets have celebrated and authors have described in boldly devised novels will now be really possible: the advance into the expanse of the heavens, the trip to the moon, the ascent into the stellar world, the conquest of the celestial bodies, at least of the planets, which,

like our native earth, revolve around the blazing orb of the sun, in obedience to the laws of the cosmos.

For thousands of years the thought of travel into outer space hung over humanity. 2000 years ago Lucian wrote his "Menippus" and this work was certainly not the first to talk about a daring voyage to the moon. Man can never be satisfied with what has been attained or what is easy to attain, an innermost compulsion urges him at all times to attempt precisely what is apparently impossible. And there is absolutely nothing unnatural in this. This aspiration is only the living expression of our being, which longs for a higher and higher and more and more perfect development of its way of life and which seeks to achieve this by continuously extending its control over nature.

Primitive man may have needed many thousands of years to stand up against the overwhelming animal world only, initially without any other weapon but the superiority of his intellectual capacity, which only gradually allowed him to discover the effective fighting resources, by means of which he rose to be the master of all living things on earth in the course of time. And once more thousands of years passed up to the time when man achieved so much in technology and art that he could leave us evidence such as the Egyptian pyramids and constructions of temples, before which we stand in wondering awe even today.

The vane-wheel of progress revolved faster and faster.

We ought to look back on the achievements of the past century with pride. The earth, our native star, seems to be conquered. The breadths of the continents, the depths of the seas, the heights of the atmosphere no longer frighten us. Our roads pass through countries, ships plough through the ocean, our flying-machines sweep through the air and we come to agreements by wireless round the world.

One single thing still remains unconquered, the tremendous gravitation of the terrestrial globe! The gravitational field surrounds the earth like an impenetrable shell. Up to now man stood powerless in the face of this, the most powerful force of nature, a bound Prometheus, chained with unbreakable bonds to the ground, free only in his ideas; nothing can damper their flight advancing boldly and invincibly to the limits of everything which may be. Now thoughts will become acts!

The spell seems to be broken, which up to now held us in doubt about whether we would ever succeed in making our way into space. Two scientists of quality, Professor Rob. H. Goddard from Clark College in Worcester and the physicist Professor Hermann Oberth, a German, have satisfied themselves by calculations and tests extended over years that the possibility of leaving our earth consists, for our present-day technical resources, in using these resources, if only it is successful, in the correct way in order to overcome the only true obstacle, the terrible gravitational field of the earth . . . .

. . . . Professor Goddard initially published his work temporarily in the reports of the Smithsonian Institution in Washington in 1919 under the title

"A Method of Reaching Extreme Altitudes," a publication which caused a great sensation in America and soon made the funds flow in, which were necessary for the completion of his tests on a large scale.

On the other hand, Professor Oberth initially handed over his investigations to the public, before the space of year had passed, in the Oldenbourg Publishing House under the title "The Rocket into Interplanetary Space." In the endeavor to justify his plans before scientific examination he did not hesitate to fill the whole of the first part of the publication with the formulae of the advanced calculation theory. The second and third part of his book may be termed intelligible to all."

Then Valier begins the instructive section "The Boundary of Gravitational Pull," psychologically very well with the words:

"Most of the authors of recent novels about space ship voyages make it easy for their heroes to break through the gravitational field of the earth. That is to say, they generally have these heroes simply discover a new substance which of itself is weightless, ..."

Therefore the reader is seized with pride: he does not want to concern himself with simple novels of fantasy but with genuine reality. He is now ready to follow the clear explanations of gravitation and its effect and to consider, with accuracy, the lines which represent the gravitational fields of two stars with different masses. Everything is described graphically. The last drawing of this chapter bears the inscription: "Route from the earth to another planet." And in the text it is explained why one must not travel on a straight path but on a previously accurately calculated Kepler's ellipse on a trip to another planet in the solar realm.

The second chapter "Our Fighting Resources" (against the gravitational shell of the earth) is at least written as graphically and as vividly. It reads:

". . . . It is well worthwhile to go into Jules Verne's journey to the moon, at least into its technically ballistic part a little here." Of course, in a very shortened form consisting of 14 pages he tells the fine story of Jules Verne's "Gun-Club," this society of enthusiastic artillery men and he quotes Jules Verne literally: "whose members enjoyed an esteem which, on a direct scale, is proportional to the square of the distance which the shots fired by the cannons invented by them reached." Because precisely no war on earth had given them the opportunity to indulge their ballistic ambition, the proposal of the President to consider a projectile to reach the moon, was accepted by the Gun-Club.

In the first chapter Valier had already made his reader familiar with the velocity 11182 m/s, which a projectile must at least have, to leave the gravitational field of the earth. Our esteem for Jules Verne increases even more when we see that his Gun-Club President had also already worked out this figure.

But, with all esteem for the skilled artillery-men, it must finally be established that the rocket as a rival to the cannon-shot is far superior and "that simply and solely the rocket can come into question as the space ship of the future."

Now one simple example after another was quoted for 9 pages so that the notion of propulsion by means of reaction, the fundamental thing in the rocket, becomes quite clear to the reader. Finally this fundamental idea is illustrated even for different velocity ratios by means of the example of the advancing train, which travels faster and faster, on the last platform of which there stands a man, who continuously throws stones out backwards with the same projectile force.

If these fundamental ideas of mechanics have become second nature to the reader, it goes further: "Professor Oberth has calculated that from the economic standpoint . . . . etc."

On the next page:

"According to Professor Oberth it ought to be possible . . . . etc." "Professor Oberth proposes to use two rockets, fitting one into the other and placed one above the other, of which the lower one is operated with alcohol and oxygen and the other one with hydrogen and oxygen . . . ." etc.

In this way Valier combines his ability, namely to explain the laws of nature simply and graphically on examples and to write vividly and captivatingly, with the great, bold and so well worked through ideas, calculations and working drawings of Professor Oberth.

If Valier's booklet only has 95 pages, it nevertheless handles the most remote problems. Thus in the last chapter a figure shows the power-station on the moon which, with the help of a large concave mirror, utilizes solar energy to produce electric current and to decompose the melted ice electrolytically so that oxygen and hydrogen, i.e. the fuels to continue the flight to other planets, can be obtained.

The last 2 pages contain even more dreams of the future:

"The idea of making the phenomena in the cathode tubes of our laboratories useful for space ship travel has been considered by Professor Oberth for many years. If he has not gone into more details about it in his book, this was because he did not want to work with resources the possibility of employment of which is still doubtful today, but he rather wanted to show that the moon and the nearer planets could be reached by using mere fuel rockets."

Thus Valier wrote the book which was to raise Oberth's ideas and principles of construction from the rampart of formulae and equations and which was to state this in an easily intelligible way and in a way so as to kindle enthusiasm in the contemporary who is only equipped with common sense.

He did not now speak of the fact that the thought of flight with rocket power did not only go through his mind once (1918) like a comet but that he

himself had brooded over it for years. It was a matter of serving the great plan. The ego was unimportant. But it was revealed to us by an article by Dr. Lanner in "Keys to World Affairs" (Schlüssel zum Weltgeschehen) 1935. Lanner wrote:

> ". . . . Much earlier (before 1924), on the occasion of a lecture held to this effect in Innsbruck he had personally discussed the problem with me whether it was theoretically possible to obtain progressive acceleration even in the vacuum of space by means of the reaction of the rocket. He believed that he could maintain this, he was of the conviction that the resistance of the air was at least as inconvenient as the counter-pressure of the air against the explosion gases was beneficial and in areas of considerably reduced air pressure the propulsion must prevail all the more. He believed that the experiment must have the last word."

(This conversation took place in Innsbruck before 1922, therefore before Oberth's book had appeared in public.)

On September 16, 1924, Oberth wrote from Würzburg:

"Dear Mr. Valier,

I have just studied your manuscript minutely. May I firstly congratulate you wholeheartedly!

I have noted the passages where I was not completely satisfied with your rendering, in accordance with your wishes and those of Mr. Oldenbourg; whether it is because the calculations seem to me to be wrong, or because I have not understood the passage very well or because they seem to me at least to be too difficult for amateurs or finally because the opinion expressed in learned circles is not universally acknowledged so that I consider a vague rendering better. In any case I should like to read the work once again before its printing. As far as regards the lay-out and the style I am very pleased with them, as I have said.

I can only repeat what I wrote in my previous card; it would be better if we were to speak about these matters. One fools away too much time in literary elucidations . . . . Verbally one can immediately come to a compromise on a conflict for form's sake, whereas otherwise one writes back and forth for months and finally one becomes impatient and ungentlemanly . . . . But in order to do at least what I can in the event of our not meeting I will begin from the beginning.

Page 1) third and second lines from the bottom:

. . . ." etc.

There follows 7 long pages until Oberth writes:

". . . . Now I must stop. Next time we shall continue.

With kindest regards

Yours sincerely

H. Oberth."

At the end of September Oberth went to Innsbruck to the Conference of Natural Scientists. He had been invited to give a short lecture on the fundamental ideas of his book.

On October 20, Valier, who was still in Landstuhl, wrote to Oberth:

". . . . I could deduce from a card from Mr. Barthel, the banker, of October 7, that you achieved welcome success in Innsbruck and are now already at work. I presume that you are so overburdened that you do not find the time to put me in the picture with a few commonplaces about it. Well then, I am to give a lecture in Frankfurt on October 30. In any case in doing so I shall travel via Würzburg on the return journey on October 31. If it is somehow possible for me, in doing so I shall take the opportunity to visit you and Messrs. Barthel and Freher. I hope that you can then tell me a little about your success personally. Finally, I must really keep in touch on that account because I have to organize my literary tactics, circumstances permitting, in accordance with it . . . ."

On December 29, 1924, Valier wrote from Munich:

"To Professor Hermann Oberth, Würzburg, Frühlingstrasse 15, Director Barthel of the Union Bank Würzburg,

I must observe that I have not heard anything for a very long time about you nor about the position as regards the rocket cause. If only I had not expected to be kept informed about the progress of the tests let's say in detail, it would be alright, if only I was informed of the general state of affairs from time to time so that I can also arrange my propagandistic activity for the rocket cause suitably for the success of the whole affair and so that I myself know which standpoint I shall eventually take as regards people who question me . . . ."

Then Valier tells of a certain Mr. Wolfgang Blech, business manager of the Pontos Publishing House Freiburg, who, after reading Valier's book which had just been published, wrote to the author that he was, if necessary, ready to undertake the financing.

"Soon, when the new articles on the rocket cause, containing a great many figures, will appear in several illustrated magazines, perhaps even more such financial backers will come forward, for the gentlemen can get to know my address very easily through the editor's office.

With this in mind I request you to give me short reports once again on the state of affairs and on your wishes so that I know how I must comport myself vis à vis these people. Indeed, today, for example, I do not know whether you need money or whether you desire it, above all, in the form of the accession of even more gentlemen or not. Therefore I must see daylight.

Another suggestion: Before Mr. Blech wrote to me, in reply to your last card from Würzburg, from which I learnt that industry is still not so keenly interested in Professor Oberth's rocket turbine as one would have wished, I recently made the conjecture whether, under the circumstances, it would not be a good idea to make tests even here in Munich with simple powder rockets and airplanes independently from the more laboratory-like tests of Professor Oberth in Würzburg and for the purpose of tackling the problem from two sides. Whilst Professor Oberth develops his rocket motor one could gather practical experience, in this easy way, of the combination of rocket and airplane and of the development of the space ship from the closed all-metal airplane. If everything goes well - until Professor Oberth has perfected the motor of his liquid fuel driven rocket machine, one would have even a considerable experience so that Oberth's engine simply needs to be built and the affair can begin.

As you know, contrary to Professor Oberth's first book, my plan has always been, not to attain the passenger-conveying space ship via smaller and larger models of rockets but rather to develop this from all-metal airplanes.

If you do not want new gentlemen to be brought into what you are doing in Würzburg as financial backers it would be conceivable that one could have recourse to the willingness of these financial backers for Munich and the tests taking place here in the direction indicated. - If, at the present time, the work otherwise gets too much for me I must confess that later, perhaps in the summer of 1925, I would quite readily concern myself with the running of these tests in Munich. Finally two heads are better than one to obtain the objective more quickly. We march separately but we battle together. Of course I could never come into competition with Professor Oberth. I technically understand too little of his rocket machines whereas the combination of the rocket with the airplane is in my line. Moreover, the tests contemplated by me would never lead to a space ship suitable for use, for Professor Oberth's machines with liquid fuel are required for this means.

As far as my booklet is concerned I can make the pleasing communication that the first edition (4000 copies) is practically sold out so that the new figures for the new edition have already been recently prepared and the new edition will appear in the middle of January. It will be 16 pages thicker. The former text remains, only in the last major part will I work out many a thing

in more detail by the addition of 12 pages of text. The new, considerably improved figures occupy 5 whole pages. After publication I shall make a copy of the book in the new form available to you.

In conveying my best wishes for Christmas belatedly and for the New Year I am

Yours faithfully,
Max Valier.

N.B. My first lantern-slide lecture on the advance brought a great moral success. It was an offering financially. If I count the cost of the new slides I have lost over 100 marks. If I leave out the slides I have made a profit of 3,50 marks net."

Oberth replied from Schässburg on January 16, 1925:

"I have not written to you for so long because I still wanted to wait until I had something positive to say. On January 2, I was in Munich but I did not find you at home. My discussions with Barthel chiefly came to nothing because a Professor Dr. Franke from the College of Science and Technology in Charlottenburg, who had been asked for his opinion, did not want to give it and in the middle of December must have commented that my calculations are intrinsically correct but that I proceeded from incorrect basic assumptions. In the middle of December I asked him by letter which basic assumptions were incorrect but I have not received a reply up to this day of course since, presumably, no answer can actually be given. I shall write to him once more pressingly, if he does not reply to my next letter, I know what I must think of him.

The sad thing in the affair is simply that I stayed in Germany all the time, relying on Barthel's promises and in order to avoid not being allowed back into Germany by the Rumanians, I spent the whole period in Germany and in doing so I spent all my own fortune and a part of that of my relations so that now I can no longer continue my studies and tests, even at home. Therefore, I am temporarily no longer in the position to do anything in the rocket affair. Moreover, it is about time for mechanical engineers with the necessary practical experience to take up the experiments.

In Würzburg I had little opportunity for practical work and thus the preliminary tests are still approximately at the point where they were in the August of last year. My other studies, however, have given me many new results so that at the present time I am quite sure that the affair will be realizable and that it can be considerably simplified. Unfortunately it still requires a few preliminary tests before one can set about building a model.

At the present moment a certain Mr. von Schreiner from the college of Science and Technology of Vienna is interested in it and is endeavoring to bring about the participation of a renowned engineer as well as the financing of the affair. Mr. von Schreiner is a former Austrian naval officer. He espouses the cause out of pure interest in research. He lives in easy circumstances and disposes of good connections. He has succeeded in interesting a film company in the invention. I shall inform him of the proposal of Mr. Blech. We can always make use of money. I shall write to Mr. Blech this very day.

I shall perhaps come to Germany this Spring and give a few lectures, amongst others before the Bavarian Society of Engineers in Munich, that is if someone gives me the money for it, otherwise I simply cannot do it.

It is not quite clear to me what you intend by the tests with powder rockets. For my invention such tests are out of the question. - It would perhaps be even better to interest the Junker works or else an aircraft-factory in it so that engineers with the necessary practical experience take part in the affair . . . ."

On January 24, 1925, Valier wrote from Munich:

"Dear Professor Oberth,

I acknowledge your letter of mid January. On January 2, of all days I was at the Wendelstein, otherwise every day I am always in Munich, ... Of course I am extremely sorry that we did not meet for you could have then informed me about the immediate situation of the affair and up to the present day I could already have done a great deal to set the affair going and to take the fine Mr. expert down . . . .

Today I enclose for you a letter which I have just received and which perhaps brings you another financial backer. Today Scherl's Magazine appeared with my long article on rocket travel. Perhaps new people will come forward again. Let's hope so.

But I will do even more. In the position in which you now find yourself nothing avails except to resort to publicity. Therefore I shall now do the following immediately: to ridicule the Professor as well as his expert opinion in as many papers as possible and to tell the people throughout Germany that your epoch-making invention is in danger of being lost from our native country, if people are not soon found who will help you out. Therefore, don't be afraid, I shall make things warm for people. The campaign is only just beginning. I am convinced that in several months, when I have lanced the propaganda in this form, you will be able to come to Germany once again and then you will be able to work with better equipment.

. . . . What you say about Junkers etc. is very good. I shall see what I can do about it. Report very soon . . . ."

On January 30, 1925, Oberth replied to this letter:

". . . . I am against taking on Professor Franke, the "expert," now. I would like to deal with the affair for a while privately, since I hope for something more from this procedure. I do not even know to what extent this expertise was made at Barthel's instigation and the whole thing is a concocted affair. Dr. von Hoefft, who is working in Vienna at the present time, would like to found a "Society for the Promotion of Space Ship Flight."

My financial situation at the present moment is fairly dismal. My deputy went away from Schässburg 3 months ago and the direction has not received any replacement in his place so that it was at a loss what to do other than to invite applications for the post again. Unfortunately my own application arrived 4 days too late. When and where I shall obtain another post, God only knows. You may think how handy your 200 M. (share of the remuneration) are to me now. - I would be very grateful to you if you would make inquiries one of these days in your large circle of acquaintances whether and under what kind of conditions I could obtain a post in Germany as a meteorological assistant, as a teacher or as a senior master . ."

Oberth is a pater familias, without an income and in addition to this, with other obligations; that is tough.

From Valier's letter in reply dated February 11, 1925, we quote only a few sentences from which we see Valier's way of thinking:

". . . . Do not let it worry you if you have lost your post there. It is certainly a sign of fate that you will be soon here again. It is always good as things turn out . . . ."

Then there follow reports on lecture acquaintances and on the good sales of the second edition. At the end of the letter Valier writes:

". . . . Your affair is so important that it can no longer founder. For that reason you must always have courage and hold your head high . . . ."

In his next letter on February 21, Valier says:

". . . . A few weeks ago I received the work of Engineer Hohmann for examination from Mr. Oldenbourg. The work is entitled "On reaching the planets" (Uber die Erreichung der Planeten). It is considered to be as highly scientific as your book, in general it comes to the same results, but prudently treats in detail just those things which you have skirted and leaves out what you have

dealt with in detail. Since the book best complements your work in such a way, I have recommended it to Mr. Oldenbourg for publication. The style of Engineer Hohmann is very clear and illuminating even in the most difficult mathematical matters. I understood it completely including the calculations on first reading . . . .

He actually deals mainly with the navigation of the space ship without entering into the technical construction of the machine, he calculates accurately the travelling times, the necessary directional shots etc., etc., the adjustment of orbital disorders, the orbit of celestial bodies and the landing on celestial bodies with and without an air-jacket.

Yesterday I also received the novel of Mr. O. W. Gail "Shot into Outer Space" (Der Schuss ins All) for perusal. It is a striking book, which can be very useful to our cause. The first impression will appear from March 20, in the Münchner Illustrierte Presse, four further impressions are also already promised. The author has never written anything before in his life and sets down here a novel which is one of the best that I have ever read. If the purely technical suspense is handled marvellously, the novel has ethical and dramatic merits, which I would never have considered possible. When I arrived at the end of the book yesterday at 2 o'clock in the morning I was not only "complete" with reading but with my own forces. Gail has depicted the tremendous experience of space in such a striking manner, he has dealt with and created the tragedy of human fate on such a large scale that the work disturbed me very profoundly. The book will have a rousing effect on thousands but it also has passages which concern us directly, dear Professor. Now I shall ensure that you too receive a copy of the Münchner Illustrierte Presse regularly.

Now I shall write an article with illustrations for the number, in which it is published that in the next number the new novel "Shot into Outer Space" appears. In this article I shall point out to the people that this novel at the present time is not merely a Utopia at all but that we are nearer to reality than most people think. At the same time even the portraits of you, of myself and of Gail will then be printed in this paper. Therefore, with this in mind, I urgently request you to send me a good photograph of yourself. I shall then see to it that your portrait also appears in other newspapers after being printed in the Münchner Illustrierte Presse. That must be done at the present time, otherwise we shall not make a stir and we shall not obtain any money."

On February 28, Oberth wrote from Mediasch (Siebenbürgen):

". . . . I have now obtained a post as a lecturer at the High School of Mediasch. The post is not exactly magnificently paid, approximately 90 M per month, in addition, I do not have many advantages which I had in Schässburg (free lodging, garden,

amongst other things). Under the circumstances a further interest in your book would also suit me very well all the more as I still have debts from my trip to Germany . . . .

. . . . What you write about the books mentioned on space ship flight interested me a great deal. Moreover do you feel completely up to the subject? Of course I do not wish to offend you in any way with my question and I know that you have learnt a great deal in this period. I should only like to remark that two critics see better than one and that I consider it necessary that the books with which we and Oldenbourg identify ourselves, can bear up against a scientific critique in every way . . . ."

On March 10, 1925, Valier wrote a fairly long letter to Oberth, amongst other things he said:

". . . . For the time being I congratulate you on your new post but I hope that it will not be permanent. Goodness knows, for a better remuneration I would also have employed you as a scientific assistant, for I am at the present time overwhelmed with literary commissions to such an extent that if I had an assistant, who understood something about astronomy and can work tolerably well as an author, I could certainly earn 300-400 Marks per month more, than I have at the moment; because I am, at present, unfortunately incapable of handling all the commissions and I must forego so many things . . . . It is true that in Germany you need more money . . . . The only snag lies in the fact that I naturally cannot, in any way, offer guarantees. If the situation remains the same in Germany I am of course not afraid. The number of papers which desire my collaboration increases daily.

. . . . Therefore please write to me to say what you think about the affair. You know I always think that you should be in Germany. If only you were here again in some way or another (and I should like to help you with that even at my own risk) we shall soon find the way again and find capitalists who make even the acceptance of your experiments possible . . . ."

Oberth proffered his thanks for Valier's offer, but he did not want to accept it because "as you yourself say it is anything but sure," whereas in Rumania the post as a teacher is superannuable. The monthly earnings can be considerably increased by means of private lessons. "Furthermore I have my own home here and I live with my family, a thing which seems to be imperative particulary on account of my children."

Then the letter talks about questions of counter pressure, ". . . . to add the three components vectorially . . . ." etc. Oberth's information is very concise and clear, information which Valier had requested for a problem over which he and Gail had sat for hours pondering without having come to a satisfactory solution.

On March 25, 1925, Hermann Ganswindt, Berlin-Schöneberg, wrote a long letter to Valier. The latter related many things from the days of the previous century which are already almost forgotten, times when people laughed at and pronounced as insane everyone who spoke about the construction of a flying-machine or of a dirigible balloon or even of a rocket vehicle, if he regarded it not only as a theme for Utopian novels but also as a technical problem to be taken seriously. - Ganswindt had risked that. His creative spirit was not satisfied with his practical technical improvements for everyday life, - he had really constructed a helicopter, which at that time, of course, still lacked the necessary light engine. However the flying machine took off from the ground and by a short caper showed that its wings lift it, when they turned on a perpendicular axis attached to the flying machine like large windmill sails. For a short time a falling weight whose cable line was wound around this axis of the windmill sails ensured rotation.

Ganswindt had also done some drawings for his idea, the "Weltenfahrzeug" (interplanetary vehicle) and had endeavoured to convince his contemporaries in lectures of the fact that the reaction of cartridges of dynamite can serve as propulsive power for the "Weltenfahrzeug" in outer space. - In 1891, in his lectures in Berlin he was ridiculed and forgotten soon afterwards.+)

Ganswindt's letter from 1925 and also Valier's reply can be found word for word in Appendix 5. Here we quote only the most important passages, i.e. extracts from Ganswindt's letter.

> ". . . . Whilst searching for Professor Oberth's book in the bookshops I also found your book and I learn from it that you espouse the opinion of Oberth and also mention Professor Goddard, but you pass over me in silence. Now I may well expect you to mention me as the first and only inventor of rocket vehicles in the copies of your book which are still available to you, at all events in the next edition of your book, in accordance with the customs in scientific circles.
>
> . . . . In 1891 when I began a series of several hundred public lectures on the three problems: dirigible balloons, airplanes and rocket vehicles which I call "Weltenfahrzeug" (interplanetary vehicle) (it will never be able to become a ship, at most a long train coupled together outside of the atmosphere) (I had already given lectures on it now and then ever since 1883), all three problems are still considered to be insoluble, however, individuals were still willing to learn about the dirigible balloon and the airplane but an airplane for journeys to other stars was inconceivable for all of them. Till then no one had ever yet thought seriously about the possibility of such a flight. Not even Jules Verne, who moreover came forward with his purely fantastic view of a human cannon later than I did in the seventies in my circle of friends with my serious project of a rocket vehicle.

+) See also H. Gartmann: "Visionaries, Researchers, Engineers" (Träumer, Forscher, Konstrukteure) (Düsseldorf 1955) pp. 25 to 27, and pp. 33 to 37.

All the newspapers of the world reported on my lecture on these three problems, given on May 27, 1893 in the Berlin Philharmonic Hall before an audience of approximately 1000 for an entrance fee of 1-5 marks, but most of them were sceptical. The Berliner Lokalanzeiger of Sunday May 28, 1893 reported in the most objective way under the title "Flying Humans. A Glimpse into the Future" (Fliegende Menschen. Ein Blick in die Zukunft). In the article it reads: . . . . "The ancient myth tells about the bold inventor Icarus . . . . Icarus is not dead . . . . and yesterday (Saturday) we saw him in person and alive, the bold spirit striving forward, who rises above time and space, and seeks to storm the heavens. The ordinary intellect calls that eccentric and that is the mildest expression! . . . ."

Furthermore the letter quotes the few who marvelled at his high-flying ideas and who said to him approvingly: ". . . . Fantasy mates with sober knowledge in unusual boldness . . . . He hopes, he thinks of visiting Mars one day, which is millions of miles away, or of visiting luminous Venus. According to his calculations . . . . etc. . . . . It would be very rash to pronounce a judgement on Mr. Ganswindt's invention in accordance with the models submitted. The models do their duty! (i.e. they fly!)"

Then Ganswindt's letter relates what sad consequences his statement (October 17, 1901, "when my helicopters have been flying in the air with humans for a long time") had for him at the Ministry of War.

The sad lot of the man, who stormed too far ahead of his time, is expressed in the letter.

Valier replied immediately and at length. He explains to him that he himself, who was born in 1895 in Bozen and who was brought up there had never heard anything about Ganswindt.

". . . . I think I have adequately substantiated to you the fact that I knew nothing of your name nor of your inventions, so that you will now appreciate that in my book "Advance into Space" I did not ignore you intentionally by any means. After all I am not the man to ignore anyone but - if you had followed my literary activity, you would have noticed that a long time ago - I am the very person who again and again espouses the cause of researchers who are not yet acknowledged. Thus since 1916 I have championed the theory of Glacial Cosmogony of the Viennese engineer Hans Hörbiger, I have given more than 800 lantern-slide lectures for the cause, published more than 150 articles in over 60 different newspapers for the subject and up till now I have written 6 books, amongst them the great work "Orbit and Nature of the Stars" in the form of propaganda for the new ideas of Hörbiger. And I dare say that it is chiefly due to these activities of mine if today Hörbiger's theory of Glacial Cosmogony, which was set up thirty years ago, is being gradually taken seriously in learned circles and is coming into evidence with the common people. But I have also always endeavored to advance unappreciated and ignored inventors and discoverers in other fields. To name only a few e.g. . . . ."

He names three more inventors whom he had encouraged.

". . . . In general the propaganda for new inventions and discoveries in all scientific and technical fields take up more than 3/4 of my literary work, for nothing pleases me more than when I can tell the world about the accomplishments of the German intellect both so that finally our people realizes who are its most precious assets, (I mean the inventors and discoverers) and so that even in the most distant countries of the world the German intellect will be appreciated and acknowledged. With this in mind, I am extremely glad to have also made your acquaintance now and it will be a pleasure for me, indeed an inner necessity, to deal with your name and your inventions properly in an objective way (after I have, of course, acquainted myself more closely with what, in fact, your inventions and ideas concerning space ship travel are all about) in the third edition of my book "Advance into Space." I shall do this - as I should like to point out in detail - absolutely of my own free will out of enthusiasm for the cause and because I am filled with joy at the fact that you too are German and, what is more, I declare myself willing, if you send me your portrait and other material, to write articles about you and your inventions to the best of my ability and to publish them in the most important illustrated newspapers however often I can, since for most of them I am considered amongst those collaborators who are welcome. But in this matter I must protest against your demands in your letter, as if you could force me to do all this that I offer to do for you of my own free will. You have no right to demand me to so much as mention you in the third edition or even to have any kind of slip of paper, describing you as the first and only inventor of the thing, pasted in the copies of the second edition which are still available to me. For I do not know whether you are really the first and only inventor of the thing. I can merely say to you that since I published my book, "Advance into Space," for the first time, several gentlemen have reported to me, who have been concerned with the problems of space ship flight for 10-15 years . . . .

. . . . Therefore, dear Mr. Ganswindt, do not blame me, I can only stick to the facts and depict them but I cannot maintain and prove before the public as well as to myself that you, of all people, are really the first and only inventor of the idea of travelling to the moon with rocket machines. And finally what does "inventor" mean? After all, is one really the "discoverer" of an idea and only the "inventor" of a complete machine. The discovery of the idea is at the moment when the intuitive realization flashes upon the lucky person, an invention is only when the idea has found the form which is technically possible and when it has been brought into effect or when it is complete with all the dimensional and material data in the workshop drawings. . . . You go too far when you describe yourself as the inventor of the airplane which is to carry the rocket vehicle to the limit of the

atmosphere i.e. to an altitude of 400 km. In my opinion you cannot write: 'which I had, at that time, already invented when it took off practically only one year later (1901)' . . . . In my opinion you likewise go too far when you make out everyone, who claims to have invented the rocket machine after 1900 to be a plagiarist of your ideas. . . . Oberth would certainly have mentioned your name and your invention in his book "The Rocket into Interplanetary Space" if he had been aware of them, as he did with Professor Goddard by giving a detailed account of him in the appendix, although he only learnt of his work during the printing of his book . . . ."

Then Valier talks about the novel by O. W. Gail appearing in the near future entitled "Shot into Outer Space" to which he had written a preview for the Münchner Illustrierte Presse.

"In this article as well as in my book (I still knew nothing of you) I have designated Professor Oberth as the inventor of the rocket space ship with liquid fuel. In any case it is he. Of course, I do not say "as the first who had this idea." In addition I do not know whether you have thought of liquid fuels, for Professor Oberth's invention lies in using liquid fuels, not in the idea of firing a rocket to the moon, therefore it is his invention because he gives technically feasible workshop drawings.

Even now that I know about you I see no necessity to change the article, for what I say in it complies in each case with the facts. And nowhere in the article have I maintained that Professor Oberth was actually the first inventor or discoverer of the idea. I am convinced that historically qualified personnel could soon prove that even your ideas had umpteen forerunners soon after the invention of gunpowder i.e. from 1600 right up to the nineteenth century. But that is hardly the point, however it is the decisive factor whether each individual person from amongst these discoverers and inventors has brought the idea an actual step nearer to realization."

The letter ends with:

"I am saying this today in order to point out to you my views. In readily declaring myself once again disposed, of my own free will to do all that is in my power to help you to due recognition. . ."

On March 29, Valier wrote a circular letter to Professor Dr. Wolf, College of Science and Technology, Vienna; - Professor Oberth, Mediasch; - Engineer Hohmann, Essen; - Dr. von Hoefft, Vienna.

He sent to these gentlemen a copy of Ganswindt's letter and a copy of his reply and he wrote:

"I have the feeling that his account in the letter is indeed very exaggerated but there must be some truth in it. If the man

has really genuine merits I would willingly make an effort to help him to the recognition still due to him in so far as is in my power to do so. He must indeed already be an old man. All the more since I would then consider it to be my duty to rescue him from oblivion and I would willingly make him out as a forerunner of Oberth and of the other gentlemen, who now deal with the problem. But I cannot do that on the basis of the biased data in Mr. Ganswindt's letter, for otherwise I run the risk of taking a man under our banner who perhaps has accomplished nothing in reality and was actually only a visionary, at best a visionary of genius."

Further on in the circular it reads:

"Finally I still bring the proposition of Dr. Hoefft to the attention of the other gentlemen too, that all the researchers concerned with the space ship problem would like to get closer together. Of course I agree freely with them. I assume that the other gentlemen are of the same opinion, right down to Professor Wolf, from whose post at the College of Science and Technology there result certain considerations which are likely to prevent Professor Wolf's being able to join such an association, whatever form it may take. - But finally one must not always found a society or an association in any kind of legal form immediately. In that case I would be quite against it. It is obviously sufficient if the gentlemen get to know one another by letter, or even better, in person, if they consider one another not as rivals but as united champions for a common cause. The less the outside world notices of such an intellectual ring, the more effective it is." . . . .

There then follows another half page intended solely for Professor Oberth on the question of the landing of a rocket which approaches the earth at a speed of 12 km/sec. and which must not exceed a tolerable negative acceleration of 40 m/sec^2.

Finally:

"Otherwise I must simply call your attention to the supplement to the letter and to ask for your reply to the questions which are asked in it. Especially my sheet on the questions concerning the development of the spaceship from the airplane.

Excuse the typing errors. Today I have already turned out almost 20 pages of this kind on my faithful typewriter.

As I heard from Oldenbourg, you are compiling the second edition of your book. Just see to it that the publication does not drag along for too long. Such a book must not come to a standstill, i.e. be out of print. My new edition will appear in the middle of May."

The supplement contains Valier's idea, to which he reverts again and again. Now he tries to point out to Oberth again the advantages of this approach:

"Concerning: The Development of the Space Ship from an Airplane. (Copy to Professor Oberth and to Engineer Hohmann)

I have the intention of developing the approahces to the manned space ship more clearly to the reader in the third edition of my book. And in fact, I shall distinguish three approaches. One leads from the usual gunpowder rocket via rockets of increased power with liquid fuels in accordance with Oberth, via model B of these, following trains of thought of Dr. von Hoefft, to machines which lift recording apparatus initially to an altitude of only several hundred kilometers, then thousands, then hundreds of thousands of kilometers. In continuation of this approach there are machines, which could carry a large Hoefft-Scheinpflug sequence camera, stereoscopic cameras, for example around the moon and finally, as von Hoefft wrote to me in his letter, could even forge ahead unmanned as far as Venus and Mars and could bring back to us from there photographs of these celestial bodies from close quarters.

The second approach is the one given by Oberth where large manned space ship rockets, soon branching off from model B, and gradually flying higher and higher, will reach the moon with a crew.

For the first approach Mr. von Hoefft will give me a whole series of information, up to now the second approach has already been mainly dealt with by me (in the second edition of my book).

The third approach has always encouraged me personally, even though Oberth had once written to me that he considered the affair to be fairly unpromising. I mean the development of the space ship from the present-day airplane. I was near to giving up this idea when it received a new impetus, on the one hand by Engineer F. X. von Blicharski's airplane with the flapping propeller and by Hohmann's work on the deceleration of the space ship landing on the earth, for which the necessity of using airfoils and not only a parachute is emphasized. If it is correct that the space ship must have airfoils for the landing (in open spaces they are no longer inconvenient, if they are hollow, as in the case of the Junkers airplanes, even their interior can be made useful for tank storage etc.), then I say to myself why should we not also take advantage of their structural conditions in the ascent.

Therefore I ask you, gentlemen, to submit the idea to mathematical treatment, that the rocket space ship (up to now conceived by Oberth without airfoils, equipped with fins only, after the manner of the torpedo, but not fitted with warping balancing planes) should (or could) now receive airfoils after the manner of the Junkers airplanes. Will you please inquire to what extent these airfoils may be cumbersome or beneficial to the ascent (Oberth in particular will not let his manned rockets take off vertically but in a synergy curve on account of the more advantageous utilization of the maximum acceleration). My opinion on the airfoils is this: they are indeed cumbersome in as far as they increase the total drag in the ascent but they are of use through the fact that they help to turn to good account the buoyancy of the air . . . ."

He explains and justifies the idea in very much detail and calculates examples.

". . . . I beg you to investigate this problem in the light of figures given for drag and lift of the best airfoils in order to ascertain how one best proceeds in this affair. I have the feeling that the airfoils are therefore of considerable use even in the ascent of manned machines and they could save up to approximately 600 m/sec. of ideal propulsion . . . ." (which otherwise is lost as a result of the attraction of the earth. - Ideal propulsion (v_x m/sec), see Oberth, "The Rocket into Interplanetary Space," 1st edition, pages 18 and 78).

"Now to my real question. Please look into my idea of developing the space-ship from Junkers airplane. I initially imagine such an airplane to be provided with Blicharski's flapping propeller and to be closed hermetically, with normal air pressure inside, as in a submarine so that the travelers are not affected by the external air pressure . . . . etc. . . . . then there would be a trend toward an intermediate type between airplane and space ship. These ships would therefore take off like airplanes but at the altitude where the airplane propeller-engine fails they would then be driven uniquely by rocket propulsion, after that they would move in very flat orbits over the main section of the distance to be covered like the projectile of a long-range gun in a free ballistic trajectory (however they are assisted by the effects of the airfoils), in the rising branch of the curve at an altitude of approximately 12,000 - 10,000 m they would pass over into the normal gliding flight of airplanes again, thereby taking advantage of the already semicosmic velocity as much as possible to prolong the gliding distance, in which case the airfoils now help quite well and finally they land like airplanes. . . . ."

The following calculation is, of course, not of the kind used by aircraft engineers. Valier lacked exact knowledge of aerodynamics. For this reason he worked with comparisons proceeding from well-known facts to new ones. He told himself if the intermediate type flies in the lower atmospheric strata with only a reciprocating engine and a propeller, i.e. it flies at a normal speed, on take-off, in flight and on landing everything will go well. The tremendous velocity, approximately twenty times greater than that of the civil airplanes of that time, was only to be reached gradually by the substitution of rocket propulsion at great altitudes where the atmospheric density is so thin that the high speed does not damage the airplane, but then rocket flight becomes economical.

Therefore by his ideas on the various velocity stages he hoped to avoid many difficulties.

". . . . Therefore I think that I have shown that it would by no means be futile to try this approach. These desired velocities are perhaps not too difficult to attain and there would be quite good long-distance airliners, which fly from country to country, which could even reach America from Europe and which would take little over an hour for this journey, since they would reach 7200-9000 km per hour in the thin air of the stratosphere."

Valier agreed to the suggestion of Dr. von Hoefft that all researchers working on space ship problems should get together in an intellectual circle. To this effect he now sent to Oberth and to Hohmann copies of a letter from Dr. von Hoefft.

". . . . Vienna, April 2, 1925.

. . . . The problem of flight, even in space, has interested me since 1891 and up to 1910 I have done a number of sketches, amongst them even a solenoid cannon which is not, however, an entirely mature project. I do not consider myself to be its inventor, according to Ganswindt, for I always had ideas in abundance, the difficulty begins in accomplishing them . . . . I had also persuaded Oberth to speak at the Natural Science Congress in Innsbruck in 1924 and I myself talked about my own projects, especially about sounding rockets . . . . no one has spoken of Ganswindt since I at least had never heard of him . . . ."

Then Dr. von Hoefft describes his various projects (one of them follows as an example):

". . . . In 1895-1910 in accordance with the basic idea of the tremendous zero-point energy of ether postulated by Nernst and Wiechert I designed a space ship which was to fly by means of the reaction of the ether blast . . . . in 18 hours it would reach Venus, in 22 hours Mars, in 70 hours Jupiter, in 100 hours Saturn etc. . . . . But unfortunately the zero-point energy of ether has eluded understanding up till now. . . . . Since I am anxious about the matter -, for if the confounded glacial cosmogony theory (I have a book about it from Fischer, which does not impress me strongly at all, at the very utmost by the self-importance of it) lets our culture perish without a trace within a few thousand years, we are indeed all working to no purpose!, in accordance with Bölsche (whose life success, Cosmos 1905 I once again recommend to you as an apotheosis of astronautics) and N. W. Meyer I must see in the space ship more than the only salvation but also the only justification of humanity and its culture, which unfortunately has many first officers and staff officers but no field marshals. Thus I should very much like to do something, for I can clearly see that the space ship and nerves and genetic patterns are those problems which must and can be solved whilst the champions of culture, who are without a leader now storm positions which are neither ready to be assaulted nor indispensable at present . . . ."

Whilst the letters went backwards and forwards from which we can see how, in 1925, Valier and Oberth, at times strove for the solution to technical difficulties, at times for financing and therefore for the possibility of a realization of the rocket problem, Valier carried on his literary activity zealously.

The success of the book, the first edition of which was out of print in a few weeks, proved that the concern of wider circles for this problem was much

greater than the author and the publishing house had expected at that time. As early as in January, 1925, the Oldenbourg publishing house published the second edition - 5 to 7 thousand copies. Therefore the little book which stated one of Newton's basic laws of mechanics and Professor Oberth's trail-blazing calculations and principles of construction had many readers. (Even the third and fourth editions followed at short intervals. A prospectus of 1927 says: Advance into Space - 3rd edition, completely rearranged, considerably enlarged and improved edition, 128 pages with 60 illustrations. - R. Oldenbourg Publishing House, Munich 1927.) But what are a few thousand readers! Who amongst the leading men ever takes up such a book? Of course the youth does and therefore it becomes a body of thought for the future. But such a man as Valier will not wait until what is now taking root bears fruit after 10 or 20 years.

In order to make it familiar to the leading figures of the present time, newspaper articles must repeatedly be written. As an example of many of his newspaper articles which ran through most of the larger papers and journals, here in the Appendix to the chronicle an article is printed which appeared on July 4, 1925, in the "Münchner Neuste Nachrichten:" "Advance into Space" by Max Valier. (See Appendix 6.)

It is written clearly and fluently. He made the reader familiar with the situation of the great problem. In his lively, captivating way Valier endeavored to interest wider circles in the cause.

On April 2, 1925, Valier wrote:

"To Messrs.

Professor Hermann Oberth, Mediasch, Rumania.
Engineer W. Hohmann, Essen.
O. W. Gail, Author, Starnberg.

Dear Sirs,

Enclosed you shall find something as a supplement to the last letter and something for Mr. Gail to complement yesterday's conversation. I cannot get away from the idea of the space ship with airfoils. In particular from the "intermediate type," the rocket plane which daily seems more likely to be realized.

I know that Professor Oberth does not have a liking for this "intermediate type" but I think that everyone should defend his own ideas and seek his way: We march together but we battle on alone.

If only we had more accurate mathematical foundations, for which I ask Engineer Hohmann in particular, I hope that industry, especially the aircraft industry, could be won over to the side of the "intermediate type."

Therefore a rocket plane with gasoline for fuel could, on precompression of air, still work with the oxygen of the air and

could, according to my intuition, reach an altitude of 15-20 km and a final velocity of 1400-1500 m/s. Then the troublesome liquid oxygen may initially be suppressed and one would be dealing, on the whole, with fairly well-known technical matters.

Therefore I ask for an unbiased examination of my ideas, a thing which concerns Professor Oberth and Engineer Hohmann in particular.

With best wishes to you All

Yours Max Valier."

5 closely written pages full of reflections and calculations bear the title: "Concerning the use of airfoils in rocket ships." They begin with notions of astronomy and then seize upon numerical values of the aircraft industry at that time.

"By referring to my table as per my last letter I calculated for Kepler's ellipses, the apogee of which is 30 km above the surface of the earth . . . ."

In his illustration of the problem he considers which kinetic and potential energy will be available to his space ship weighing 200 kilograms mass (i.e., relative to the surface of the earth $200 \times 9.81 = 1962$ kg) up in space "in order to spend its fury in the atmosphere against the aerodynamic drag in the case of a ship with wings. How far will this amount of energy be able to carry the ship?" . . . .

He then enters data from aeronautical technical literature into comparison as an illustration of the problem: ". . . . a good aircraft weighing 1900 kg . . . needs a level-flying speed of 150 km/hr to keep it hovering at an altitude of 1000 m, which is only an engine power of 50 hp . . . ."

For the calculation of his intermediate type he comes to the result: "We therefore see that the rocket-plane requires 1700 kg of gasoline, of course the normal aircraft needs only 1100 kg to travel 3000 km but it takes about 20 hours to cover this distance whereas the rocket ship travels approximately 3000 km in one hour."

(At that time when this intermediate type, which, today, we call a jet-propelled aircraft, took shape in Valier's technical phantasy, he spoke of the rocket-plane because, in comparison to the airplane with a propeller, it is propelled by reaction to the combustion gases.)

Then another long letter accompanies it on the utility of airfoils for the lift-off and landing of the space ship:

"A) In a vertical take-off the force of gravity is completely added to the acceleration. On account of a counter pressure from the force of gravity of approximately 10 m/sec^2 the flight acceleration should therefore reach approximately 30 m/sec. only . . . .

B) If we take off at an angle of 45^{o} . . . .

C) Take off at 17^{o} 28' inclination . . . ."

Numerical examples are calculated. Finally it reads:

". . . . The landing with a space ship with airfoils takes place in the way that I had already explained to Engineer Hohmann in a letter and to Mr. Gail orally: tangential shot at the earth at an altitude of approximately 150 km; by pulling out, penetration of the atmosphere up to that depth which yields suitable deceleration (layer at an altitude between 75 and 110 km). Allowing the cosmic parabolic velocity of the vehicle to peter out in several undulatory movements of the ship, which can, at times, be lifted to 110 km again by reversal of the balancing planes, at times can descend to 75 km above the surface of the earth. If the parabolic velocity of approximately 11000 m/sec. is first moderated to the orbital velocity of something below 8000 m/sec., there is then petering out of the momentum whilst the pilot drops slowly into the lower, thicker atmospheric layers, always in such a way that the deceleration does not become intolerably high. Finally after slowing down to approximately 100 m/sec. at an altitude of some 1000 m a normal glide landing, like a gigantic airplane."

On April 13, 1925, Valier again wrote a circular letter to Oberth, Hohmann and von Hoefft. He reported how, during a lecture tour, he had the opportunity of getting to know Mr. Hohmann personally and how he later visited Engineer Lasswitz (the son of Kurd Lasswitz), who is editor of technical material with the Frankfurter Illustrierte and with the Frankfurter Zeitung.

"We spoke for more than an hour about the problems. . . . . All sorts of doubts also came up for discussion in the conversation. Even Engineer Lasswitz was of the opinion that any rocket machine, however imperfect it was initially, so long as it achieves a little more than our present-day aircraft in as far as concerns flight altitude and velocity, would be more valuable, if only it was really brought about, than great calculations on giant space ships which cannot even be built at the present time. But Engineer Lasswitz did not believe in the fact that one would succeed in solving the technical question of the rocket engine so soon. Above all he could not imagine how the fuel was to be vaporized and ignited in the combustion chamber . . . . Then a new idea suddenly occurred to me, but which I was careful not to communicate to Engineer Lasswitz and which perhaps seemed to me to be likely to give us a rocket machine, even it is still a primitive one to begin with, in a short time.

In what follows I shall communicate to you this idea, even for the protection of my priority (for I think that it is really a question here of such a thing) and I shall ask for your opinion.

Gentlemen, you all know the operating characteristics of our ordinary four-cylinder automobile engine. Therefore we have here the four strokes, induction stroke, compression stroke, explosion stroke, exhaust stroke . . . .

If I were to open the exhaust valve completely at the moment of explosion, i.e. at the beginning of the third stroke, the explosive gas mixture would come out of the exhaust pipe with its full tensional force. In other words, the cylinder then turns into the combustion chamber of the rocket and the exhaust pipe widening into a funnel shape) turns into the rocket-jet nozzle."

Furthermore he points out that the explosion pressure on the piston-head, when the exhaust valve is open, will still suffice to do the pumping, which the engine needs for the induction, etc.

"The piston-engine rocket machine, which I imagine as the first step towards the real rocket, differs from the aircraft engine mentioned above merely by the fact that the exhaust valve and exhaust pipe are constructed according to the principles of the rocket combustion chamber and of the most suitable jet-nozzle form in order to reach the highest possible exhaust-gas velocities and that the exhaust valve opens automatically at the moment of explosion so that the main part of the force produced in the explosion immediately becomes effective in the exhaust from the jet-nozzle according to the rocket principle, on the other hand only a secondary portion acts upon the pistons in the cylinder which fall back in the third stroke, that is to say just so much that the necessary power for the induction stroke and the compression stroke and the exhaust stroke plus the inner tractive stresses of the whole machine is surmounted. Therefore even for me there is a crankshaft, but not to transfer the main force to the propeller but only to achieve the induction, compression and exhaust power in the individual cylinders. Since the exhaust valve in my engine remains open in the whole of the fourth stroke I can say that up to now my machine differs from the aircraft engines in nothing else but that the exhaust valve is opened at the moment of explosion at the beginning of the third stroke instead of at the end of the explosion stroke, as it has been up till now.

If the airplane is to be propelled by the machine conceived by me the crankshaft must, of course, now be situated diagonally to the direction of travel and the exhaust pipes of the 6 cylinders must all point backwards . . . ."

After further constructional descriptions it reads:

"Therefore the machine represents a transition from the present day piston engine to the free rocket, it is certainly not perfect yet nor so simple as the ordinary rocket, probably even

its efficiency is lower but possibly better than in the engines up till now, because here the transmission of power as such via the main crankshaft and aircraft propeller ceases, therefore the main amount of work is done by the rocket principle and only the dead travel work of the machine must be supplied as up till now. My proposition has the advantage that such a machine can, without doubt, be built since the main parts are the same as in the engines up till now. Yes, one could perhaps transform any old worthless aircraft engine into my type of machine for research purposes with no difficulty at all by converting the cylinder heads. The main thing would be to actually carry out such an experiment. . . . ."

On April 19, 1925, Oberth wrote to Valier:

"Permit me first of all to express my admiration for your activity. My goodness, if only I could find half of your energy. I would not be here where I am today.

I do not think 150 M is too much for Professor Dr. Wolf.

As recently as 6 days ago I wrote to Oldenbourg to the effect desired.

Wolf's elaborate study puts me very ill at ease. In it there are errors which I should not like to see propagated, on the other hand I fear that we would again lose his friendship which was gained with difficulty if I were to tell him bluntly what kind of errors he has made. I think that it would be the most sensible thing if I put together briefly and concisely what I have to say in reply to his work and I then send you the whole lot and you turn it into a diplomatic form. At the moment I am not capable of doing that for I am still quite dopey as a result of the influenza . . . .

First of all I should like to reply to you solely about your engine proposition so as to deter you from unprofitable work. . . . . 1) the whole affair would be too difficult on this occasion. 2) the jet-nozzle would function spasmodically and that would have the disadvantage which I pointed out to you in the discussion on Goddard's rocket. The whole matter, therefore, would certainly not come into question for the conveyance of passengers. 3) the whole affair would be too complicated."

Valier again establishes the usual interchange of ideas of the people interested in the space ships by sending a copy of letters, which he wrote to von Hoefft and to Hohmann, to Oberth. In this way these letters have remained preserved for us. In a letter to von Hoefft of April 13, there is information about earlier years. Valier writes:

". . . . I myself studied for 3 terms under Professor Exner before the war and I have even been examined orally by him and I also had him as my immediate superior in the war when

I was head of Field Weather Station 17. I last saw him in the Spring of 1917 when I was in Vienna on training at a high level and at that time he assumed command at that very place, if I am not mistaken. Remember me to him if you should see him . . . .

Now one more thing: You speak of a film novel, which you wrote at the time; you now want to readapt it for Oberth and it will soon appear as a book or as a film. I received this piece of news with mixed feelings, because just before my departure I was able, at the beginning of April, to arrange for the novel written by O. W. Gail, Munich: "Shot into Outer Space" (Professor Oberth already knows more about it) to be filmed by a good company in Munich. I have already made a rough draft of the film scenario for the first act, we are also already in agreement about the rest, and I am already negotiating (successfully) with the observatories where several shots will be taken; after all, I have been engaged by the company as scientific-technical director for the film. Like Gail, I shall probably also play some part, perhaps the part of the first mate Engineer Korf. 'Korf is the main hero of the novel. The preliminary studies for the film will be finished by July, the shooting will be done in summer so that the whole film can run by about Christmas. The matter is legally such that Mr. Gail (who needs to ask no-one about it) has himself given up the film rights to the film production company. I have only been called in, on the part of the company, as technical and scientific specialist, as an assistant to the director who is not acquainted with cosmic matters, and for this I receive my fee as well as for being a supporting player, circumstances permitting. The affair has only been concluded recently . . . .

. . . . The whole film will be a magnificently presented propaganda in each and everything for Professor Oberth's ideas. The main hero can be, as it were, identified with Oberth. The whole story of the novel is apt to arouse the public to patronize such men as Oberth.

Since the risk of undertaking a film is, properly speaking, great, it would have been impractical to burden the film company with another author's fee i.e. for Oberth, but if the film is subsequently successful everyone, and above all our affair, will have the greatest financial gain from it. For, as you too say in your letters, it does not depend on who does it but it merely depends on the fact that it is actually done.

I will, of course, not prevent you from writing your novel and from making an attempt to film it. But you have arrived somewhat late for we are already at work on writing the fair copy of the film manuscript ready for shooting. Even all the main technical difficulties which come into question have already been surmounted in meetings which lasted for many hours. From

the economic point of view therefore it would very likely be a waste of time for Professor Oberth to sit down with you now over a "competitive film," if I may use this expression for a moment. Professor Oberth should rather promote the second edition of his work and forge ahead in a scientific and technical way, he should rather accomplish what I cannot do and not do what I am capable of doing. Therefore the matter of the film is already in good hands and is fairly progressing and most decidedly it will not be trash but a film, the like of what there has not yet been.+) . . ."

Oldenbourg had handed over to Valier a copy of Hohmann's manuscript for perusal. Valier wrote to Hohmann on this subject on April 15, 1925:

". . . . I have gone through your new version and have only one thing to remark about it, in matters of the stream-lined ellipses. I will not, let us say, refute your objections but, - with your permission - you seem, on the whole, to have made some omissions, you seem to have shown a mathematicl neglect, which is not admissible.

In a word: Your calculations on the energies to be spent in stream-lined ellipses for the elliptic nature of the orbit would be correct if the planet had the mass zero. But since it has a mass which produces a strong gravitational field at a close proximity, I tell myself by intuition, without numerical verification, that the planet will effect the elliptic nature of the orbit itself by means of its attraction (see my sketch I). I think that one would travel more accurately if, a few units of time before the theoretical point of intersection of the orbits, one were to reduce the motion of the space ship which is moving toward the planet, which is thought to be in repose, relatively to the latter and if one were then to investigate which orbit around the planet (hyperbola, parabola, or ellipse) will emerge. However the planet has already perturbed the space ship for a long time before both come to the theoretical point of intersection of the orbits, i.e. the theoretical angle of intersection of the bilateral tangents to the orbit has no practical effectiveness there etc.

When I realized this, it occurred to me that from the same basis your calculations on the expenditure of energy in tangent ellipses are not quite accurate. They are only valid again when we equate the mass of the planet to zero. You calculate, for example, for an ellipse, which is tangent to the orbit of Venus and to the orbit of the earth, the difference in velocity of the

+)"Gail has already sold his film rights to Dr. Nier, the owner of the film company" - it reads thus in Valier's letter of June 17, to Professor Oberth - . . . . - "At the present time negotiations are pending with an English firm to persuade the latter into participation in the filming, for the success of the film on the world market can be achieved practically only in this way. But it is still a long and difficult path."

ship tangential to the earth's orbit in aphelion, in comparison with the orbiting earth as - 2.4 km/sec, i.e. one must add so much to the space ship for it to accelerate to the full speed of the earth. Then I tell myself: the earth will take care of that by means of its gravitational force, so long as the orbital contact takes place at a point so close to the earth's surface that this difference in speed, referred relatively to the stationary earth, is smaller for that distance of the space ship from the center of the earth than the difference in speed, relative to the earth, in the case of a parabolic orbit. Seen from the earth which overtakes the space ship from behind, the latter moves towards it with a relative velocity of 2.4 km/sec etc. I think that in the proximity of the planets one must always regard the planets as the main points and the solar field as a mere object of perturbation . . . ."

From this letter we learn that Valier took the problem of space travel very seriously and conscientiously labored so that everything which he himself wrote or which other people concerned with rockets wrote, actually tallied.

(Later in his books Valier always wrote about W. Hohmann Dr. Eng. We do not know whether Hohmann whose refined, unassuming character Valier stressed in his letters to Oberth had at first kept silent about his doctor's degree vis-à-vis Valier or whether he had graduated between 1926 and 1928.)

In Valier's letter of April 20, 1925, to Oberth he once again deals with airfoils on the space ship:

"It would surprise me if they were to burn. The pilot can be sure to guide the ship in such a way that they do not get hotter than a certain maximum temperature, he just must not descend into lower atmospheric layers. . . ."

He gives reasons for this point of view. -

On May 6, Oberth wrote to Valier:

"Enclosed you will find the rough draft of my letter to Professor Dr. Karl Wolf. In no way can I really deviate from what is said here. Professor Wolf has, in my opinion, made the matter too easy for himself, and I must show him that I do know somewhat more about this special field than any specialist in mechanics could say."

"Should my style, on the other hand, be too ponderous I would rather listen to any suggestions for modifications on your part. I ask you not to construe it as presumption that I ask you for suggestions for modifications . . . . For the sake of our cause only I consider it better if I give you this letter to read <u>before</u> it departs . . . ."

On May 14, Oberth wrote to Valier:

". . . . Hoefft's idea, on the whole, amounts to a random creation or modification of the force of gravity of which not even the slightest indications have been discovered up to the present day, as I have repeatedly written. - It could of course be splendid if there were such a thing . . . .

. . . . I have already written to you that I myself have already thought of the rocket-plane. - Where has Mr. Valier read that a good aircraft of a total weight of 1900 kg only needs an engine power of 50 hp at an altitude of 1000 m at a horizontal speed of 150 km/hr? If that is correct, the question of the rocket-plane actually takes a quite different aspect . . . . By drawing in air no more force, of course, is lost than if it were a question of compressing the amount of air in question to 30 atmospheres in a pump. And 2/3 of this work serve the purpose of preheating the air and benefits exhaust-gas velocity. Therefore it is now only a question of whether the information mentioned as regards 50 hp is correct. Perhaps you too can inquire in Munich, there you can make inquiries much more easily than here in Siebenbürgen.

Unfortunately I have not yet had the time to check my calculations on the heating of the airfoils and to put them into an intelligible form. But why do you not believe me that of the 15,200 kg of calories of energy equivalent, which is in every kilogram of a body, when it has a velocity of 11 km/sec, enough still remain to burn it up like a shooting star if special precautionary measures are not taken on deceleration? Moreover I have not got all the formulae and tables on the viscosity of the air and the friction on the air here. I calculated this in Göttingen with the help of the library there and in doing so I also had the imprudence of not noting down all the sources for myself.

Many thanks for your article in the Münchner Illustrierte. However things are not exactly so bad. The High School of Mediasch is the largest in the whole of Siebenbürgen . . . . This very day I have refused an invitation to the University of Klausenburg."+)

On June 28, in a letter to Oberth and Hohmann, Valier gives an account about ". . . . things specified below which are important for us . . . ." which he had found at the Transport Exhibition of Munich.

+)Why did Oberth decline the invitation to the University of Klausenburg? On account of the postal censorship he could not tell Valier the reason from Mediasch. When Oberth gave a lecture in Aachen in the winter term of 1959/60 he answered this question for us in the following way: I refused the invitation because I did not want my rocket research to belong to Rumania but to Germany. More than once I have submitted an exposé on rockets with liquid fuel to Berlin - unfortunately it was always to no purpose.

"1) Success was achieved with one of the small aircraft exhibited there weighing 300 kg with pilot, when it is ready for take-off, in keeping it hovering continuously at the same altitude with an engine power of only 4 hp. and in doing so success was achieved in developing a horizontal speed of 30 m/sec = 108 km/hr. The airfoil loading was approximately 12 kg/m^2.

2) With such machines one succeeded in reaching a ratio of lift to drag of 1:20 in the glide at a gliding speed of only approximately 20 m/sec = 70 km/hr.

What is said under number 1) means that with modern airfoil constructions it is possible to keep 75 kg hovering continuously with 1 hp. at a horizontal speed of 30 seconds per meter, which is exactly 5 times less than the same power needed in outer space. Therefore the airfoils counteract 4/5 of the effect of gravity, in which case even the surmounting of the aerodynamic drag in the fifth fifth which is lost or must be effected by the engine, is included. The lift-drag ratio given under section 2) is in good agreement with 1) for a ratio 1:20 at a velocity of 20 m/sec means that the gliding aircraft drops exactly 1 m per second instead of falling 5 m as in outer space.

The tractive power of the propeller is easily found to be the following: 4 hp are 300 mkg/sec. The distance per second was 30 m, therefore the tractive power of the propeller is equal to 300:30 = 10 kg! That is relatively small and I think that a rocket which gives the same reaction and propulsion should not indeed be too difficult to build. Perhaps Professor Oberth is calculating the necessary dimensions for a gasoline rocket. Should the construction of such a relatively unpretentious rocket machine succeed, one could at least let such a small aircraft take off with it, an event which would immediately make a stir. Of course, the rocket would have to be incorporated in the aircraft in such a way that the point of application of its tractive power (it must only be pulled, pushing does not work!!) is situated somewhere before the center of gravity of the aircraft, i.e. approximately where the propeller operates at the present time . . . ."

The idea that an aircraft or vehicle must be drawn by its rocket is constructively very difficult to realize. -

At that time, in the twenties, the tractor propeller was generally common in aircraft construction. The fact that in the early years aircraft were often built with pusher propellers and outrigger tails was unknown to Valier. Unfortunately he had also not come across any G-aircraft from the "Flugzeugbau Friedrichshafen" whilst he was in the Austrian Airforce. These biplanes (Fig. 8), in which the two engines were situated on the outside in the airframe between the wings, had pusher propellers. The flight characteristics of this type of which 800 aircraft were flown in the years 1916 to 1918 in difficult combat sorties were satisfactory in every way; the fully laden machine was just

as stable at the rudder as the one returning home empty. The steering force of the side rudder situated in the slipstream was so great that, if an engine became inoperative, the aircraft could fly straight on and even bank to both sides.

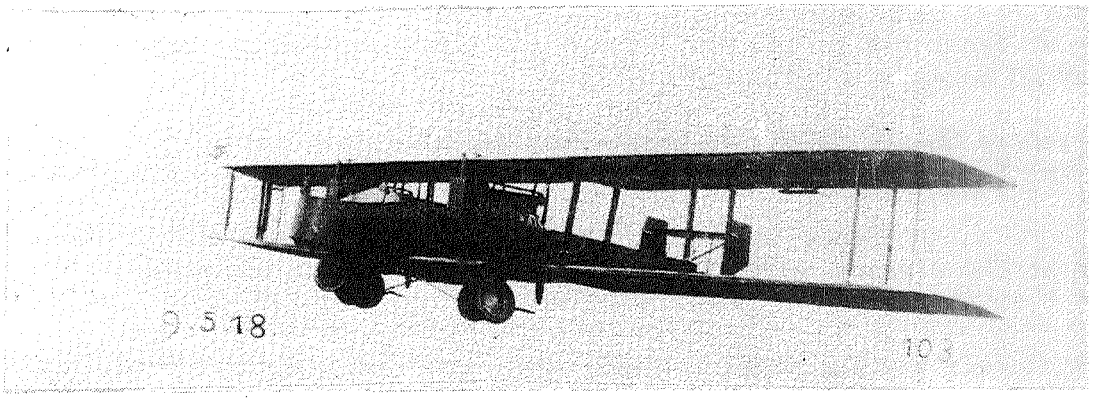


Figure 8: Aircraft with pusher propellers, Fsh-GIIIa
The pusher propellers are situated one meter behind the center of gravity.

On July 2, Valier received Oberth's letter of June 29. He thanked him and replied; at the end he wrote:

> "Ever since I saw the most recent small aircraft I just cannot help thinking that it might be a good idea to try them out in tests. Starting from this simple reflection that each new type of engine (consequently even the rocket engine) had a low performance when first introduced which could only later be developed to reach hundreds of horsepower. I consider a rocket which attains a performance of 20-50 hp. to be, at all events, more easy to realize than a rocket which attains performances of 500 h.p."

On July 9, Oberth begins his letter in a pedantic derisive tone:

> ". . . . In spite of my many warnings you have once again taken the energy concept as the basis for impulsive calculations. I can only repeat what I advised you in Würzburg: For rocket calculations proceed as if the energy concept has not yet been invented. If ever someone were to ask about the energy to be expended it is preferable to leave the calculations to me. Nothing personal is meant . . . ."

(Indeed unlearning is not Valier's strong point. - But he does not take Oberth's pedantry amiss. Throughout the last part of the letter the former feeling of friendship is quickly re-established completely.)

Oberth continues,

". . . . The only difficulty in the reaction airplane, which fortunately does not arise in the case of the rocket, lies in the question of a pump which is light enough and which supplies the nozzle with the necessary quantities of air which is very thin in spite of the ramming. I should not like to predict anything about this pump before I have made preliminary tests on it, costing at least 200 Marks. Unfortunately, for the present I have only 50 Marks at my disposal . . . ."

Therefore Oberth is now no longer so completely antipathetic to the idea of the reaction airplane. This pleases Valier and on July 29, he writes to him:

". . . . Since Saturday, Engineer Hohmann is here at my house and at the present moment we are working together on our books, which we soon hope to submit to Oldenbourg . . . ."

Six closely written pages follow. The points of controversy of Oberth-Wolf are discussed. Valier and Hohmann discussed the technical efficiency of the rocket, drawing comparisons between single-stage rockets and Oberth's multiple-stage rockets of 54 tons take-off weight. The letter talks about this but then passes on again to winged rockets:

". . . . Finally to the problem of landing, air friction, burning of the airfoils etc. Here I think (unanimously with Engineer Hohmann) that the ship returning to earth from a voyage in space must initially have the form of a Zeppelin, at least in the front part and must enter into the atmosphere with the blunt end foremost, for the more its form is adapted to the body of least resistance the less the heating in the air. I think that we must, therefore, proceed from the principle that the less the ship decelerates by means of its own head resistance, the cooler it will remain. For the same reason, however, even well-built airfoils set at a suitable angle of attack will remain comparatively cool since they too are structures of a very low aerodynamic drag, for I believe that not so much the air friction on the sides of the ship and on the surfaces gives rise to a dangerous rise in temperature but that mainly the compression of air before the frontal area is dangerous . . . .

. . . . The 15,200 kg cal which are present in each kilogram of the ship returning at 11 km/sec do not alarm me at all if, in this way, one succeeds in contriving that the aerodynamic drag of the ship becomes a <u>minimum</u> and that, if possible, this energy of braking is used for the creation of turbulence or, on the whole, for air flow. For if I consider the air in itself to be mainly quiescent and if I now launch the ship into this quiescent air mass, all the energy which afterwards appears in any movement of the air molecules is taken from the ship and the rise in temperature . . . .

. . . . Of course for this another parachute must be used but I do not think that it is possible in the form which you

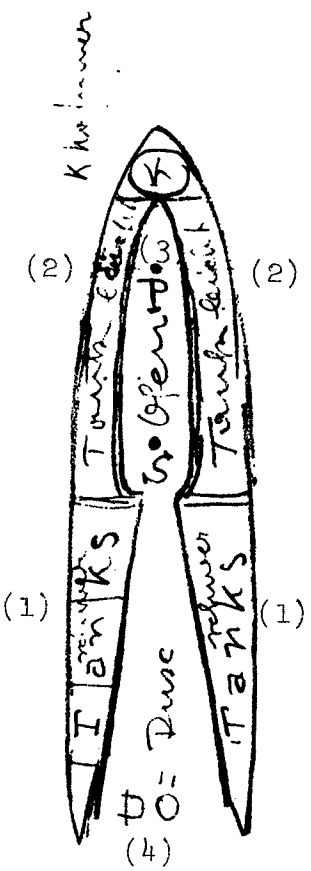
described. It will perhaps not burn but the ropes to which it is attached will be all the more sure to burn, for, as is known from experience, such cables have an enormous aerodynamic drag. But I also think that any parachute which is large in comparison to the ship must tear. If it is small it is of no use, if it is large it is reduced to shreds. On the whole I do not think that transverse surfaces are possible. I am rather of the opinion that one can decelerate with conical surfaces, i.e. cones the tips of which lie in the direction of travel. In my opinion one will be able to allow a rope to run out behind the ship in the longitudinal axis, with a concial tassel attached to it, if I may express myself so. This tassel, like the tails of children's kites, will create as much turbulence as possible. In addition several tassels can be placed behind one another on the rope; these tassels are designed in such a way that the last one has the highest resistance and burns first (if it actually comes to that) and then the next. If the rope burns too the ship can pay out a new rope with new tassels. I cannot imagine transverse circular disks as a means of braking, for if such a disk were so small in relation to the Zeppelin-shaped ship that its aerodynamic drag were just as high as that of the fuselage of the ship it would have to absorb as much braking heat as the whole surface of the ship and since it is much smaller it would burn immediately. Your parachute seems to me to be only possible if its surfaces are very sheer and are not slanting, if it were, so to speak, the shell of a truncated cone, the tip of which is situated to the rear. But the many ropes are an impossibility. It is a fallacy to think that all you need to do is make the parachute just so big that its surface loading, that is the mass of the ship/the area of the parachute, is very small. This notion is correct when it is a case of a person bailing out of an air-ship where it is required that the velocity at which he floats downwards does not surpass a certain rate. The smaller the surface loading of the parachute, the slower the person drops to the ground. But here we must proceed with entrance velocities higher than the floating velocity. If a parachute were to be designed with which the ship will make the last landing, i.e. float downwards in order to land on the ground gently that would be another matter and without doubt your parachute design could be used. On the other hand I contest this for the entry into the uppermost atmospheric layers. Even if you say that the parachute only has the task of pulling the tip of the ship to the rear, that is all very well but, if the parachute is large it will have a very high aerodynamic drag and therefore, in the main, will brake, a thing which it should not do. I shall ask you for a prompt reply to these views of mine, which I have expressed here, for it is understandable that I should like to have the illustrations for my book in the correct space ship form right from the beginning.

And now one more thing:

The question of the point of application of the force in rocket travel. You say that it is where the chamber pressure

encounters a solid bulkhead of the ship for the first time, which then passes the pressure of the reaction on to the whole ship. That is indeed correct if the chamber is simply shut off transversally to the ship's longitudinal axis at the front by means of a partition. But!!! In this system it would be impossible for you to transfer the point of application of the reaction before the center of gravity of the whole ship but that must be how the experts of the rocket firm Sauer told me because otherwise, in spite of the tail fins, the rocket loops the loop in the air, not to mention travel in space. (Indeed Ganswindt also has always emphasized that and even Engineer Hohmann has confirmed it.) Already a ship in water without a rudder, with the screw at the stern travels in a very unstable manner and hardly travels straight ahead . . . . Projectiles must be fired from a twist barrel . . . ."

He amplifies his ideas even more with many arguments. The diagram at the edge of the letter shows which solution he considers to be physically correct and technically feasible.



Key: (1) Tanks (heavy)
(2) Tanks (light)
(3) Chamber
(4) DO = jet

K = cabin

P = point of application of the rocket force

S = center of gravity

The tanks are designed and emptied in flight in such a way that S is always situated as far behind P as possible.

Thus Oberth and Valier describe and justify their thoughts to one another. The manuscript for the new edition of the book "Advance into Outer Space" must be submitted to Oldenbourg. Questions which conern Oberth's model B must be clarified in advance for the diagrams and description.

> ". . . . Therefore the external shape of the space ship is very much affected by this idea.
>
> Now I think that I have asked all the necessary questions and I am now asking you for a prompt reply. Excuse me if my attitude has perhaps sounded somewhat self-assured at times. I know that you understand everything better than I do, but, I cannot, after all, withhold my hesitations.
>
> With best wishes . . . ."

On August 31, Valier writes to Oberth:

> ". . . . On the basis of my propaganda for the space ship cause in the press, a very important firm now seems interested in beginning practical tests. On September 7, I shall travel to Berlin for a discussion with them (also for other reasons) . . . .
>
> . . . . Indeed one day the moment must come when you will be brought back to Germany once and for all (completely covered financially of course) and you will perhaps be able to bring the first experients which were previously begun, to a successful conclusion.
>
> I am pleased that you like the design for the title-page of your book. I merely request that you return the drawing to me. One can, of course, easily replace a few stars. When will you be ready with your manuscript? . . . ."

For the three books, Oberth's, Hohmann's and his own, the new editions of which Oldenbourg wanted to publish at the same time Valier had designed the title-pages. Oldenbourg and Hohmann liked them and now Oberth was also in agreement with them.

On September 11, Valier wrote to Oberth and Hohmann. Firstly he talks about the propaganda, devised by him for the three books on space travel, which were to be republished shortly. At that time he had just received the information "that the filming of Gail's novel was to begin in mid-October, that means that I should stand by to go to Nice about this time, where the outdoor shots are to be filmed, the remaining shots are to be taken in the studio in Munich. In Berlin I heard a rumor that even Laffert's novel "Oriflammes from the Sky" (Fanale von Himmel) is being filmed by the Ufa,* to be precise a concurrence, but since the two novels are considerably different even the films will turn out to be very different and it makes no difference before the public, the main thing is that throughout the world people will talk about the rocket ship since two films are perhaps

*Universum-Film Ltd.

better than one. Therefore from the narrow-minded point of view it is competition and of apparent detriment, from the higher point of view perhaps it will be advantageous to our cause."

Then he comes to the main point:

"3) Realization of our plans. In order to attain this, on September 7, in Berlin I had a discussion with aircraft industrialists and other people who are interested. Unfortunately in view of possible censorship it is not possible for me to give the names of the people. The result of the talk which lasted over 2 hours was, essentially, that the aircraft industrialists explained that they now had a principal interest in the affair, that they would promote it and remain in contact with it but as long as the rocket has not yet been developed in a technical way they themselves could not take it in hand. They could merely make some calculations, in their engineering department, of the stresses occurring, taking as a basis the still hypothetical performance of a rocket motor, and this they did intend to do. But as good luck would have it there were also representatives of another group of interested people there, of a group which takes the view that it now has an interest in taking up and developing the rocket principle to the point of the technical design of the engine. This group,+) which has at its disposal large resources and laboratories, therefore wishes, in fact, to take up the rocket affair completely, i.e. to investigate each particular point scientifically from the very base. Therefore they would take it upon themselves to bring the rocket cause to the point where even the aircraft industrialists declare that they will participate. Of course only representatives of this group were there, who, therefore, had to report back to their superiors about my statements in this memorable preparatory discussion. In a few weeks I shall receive a more accurate reply.

If everything turns out in accordance with the impression I had at the end of the conference, which was that things will be successful, in as little as a few weeks' time experiments on the combustion in rockets of all possible fuels will presumably be resumed on a large scale from the fundamentals in the best equipped laboratories. The leading chemists, physicists etc., specialists in the individual fields will be summoned so that they may initially carry out these individual investigations. If it becomes apparent that the results obtained are, to a certain extent satisfactory and that they agree with your calculations, Professor Oberth, one will not hesitate to bring you to Berlin in order to engage you for all further details of the affair."

+)Valier thought that they were engineers from Junkers-Motorenbau and from the branch which had built the large Junkers engines in Russia. - It was forbidden by the Dictatorial Treaty of Versailles to build these in Germany. In the meantime we have learnt other things through Wallisfurth's book "Russia's Path to the Moon" (Russlands Weg zum Mond). (See Appendix 7.)

A memorandum of the conference on September 7, 1925, which an engineer of the J.F.A.G.[+)] wrote is enclosed in the letter. It reads:

". . . . The question was whether a rocket engine could be installed in one of the aircraft which are now in use and whether it could offer economic advantages. The practical example on which this question is investigated is the current Junkers' large aircraft of a total weight of 6 tons, which has to fly the distance Berlin-Moscow, approximately 1,200 km. The empty weight of a 6 ton aircraft, including its engines, is approximately 3.5 tons, of which the engines weigh approximately 900 kg, the fuel approximately 900 kg for 1200 km. It would be your job to calculate how much one must strengthen the aircraft so that it can absorb the tremendously increased head resistances . . . . - At the present time the pay load amounts to approximately 1/6 of the total weight. If this were to become more advantageous on utilization of rocket engines . . . . my firm, however, would only consider deliberation of this question once practical tests have been carried out by you somewhere. I think that I may presume that Mr. Valier will find assistance for this test from the party with whom we are on friendly terms."

On September 15, Oberth replied:

"Many thanks for the active help which you give to the work we have in common.

But here I cannot refrain from making an observation: it is only made in the interest of space travel which you, too, would like to see as much as I would. Therefore I ask you not to take this observation amiss. Be as careful as possible at interviews, negotiations with factories, etc. One can destroy a great deal with a single remark. You are reputed to be an authority in the field of future astronautics. If, in the heat of the moment, you say something nonsensical, which can, after all, happen to you in the rush, then 99 people out of 100 will think that the whole rocket affair is nonsense. Therefore it is preferable to confess openly: "I am an author and an astronomer, not an engineer and an inventor" or something to that effect. Of course, I know as well as you do that with your intelligence you will be just as well familiarized with the matter, if not better, in a few years than I shall be. For the time being, however, I have still a certain advantage on you and by and large, in the interest of the cause, it will be recommendable not to say too much but to refer the interested parties to me as far as possible. I would also like to broach another question here: You have an excellent imagination and it is just as good a thing for an author as for an inventor. But there is also a certain danger in it. I think that I have frequently pointed out that you often think of things all on your own, but then you make it appear as if it were I who said it.

[+)] J.F.A.G. = Junkers Flugzeugwek AG. (the Berlin Office).

In this repect I ask you be be very careful, otherwise it could give the impression that I contradict myself. Of course, no offense is meant with these remarks. But since you become more famous every day I thought that I ought to recommend to you a certain prudence and restraint in your assertions. Excuse the bad style, I am writing carelessly, moreover it will immediately improve.

I was very pleased with your letter of September 11. I think that the cause is, in actual fact, at such a point that we must give an account about some experiments if we do not want to be notorious as inventors on paper and make a ridiculous impression, as our brilliant Ganswindt did in his time. Have you heard anything else from him? In spite of repeated requests he has not replied to my letter which I wrote to him at that time, so that to this day, I still do not know how he actually conceived his rocket. Moreover sometimes no reply is also a reply.

If, contrary to your expectations, your discussions were to come to nothing I would be very glad if a few hundred marks can be rustled up at least by means of collections, etc. With this money I could build a small device here which could provide us at least with the first results on combustion in rockets and serve as proof for the fact that my principle is feasible.

At your request, I shall not enter into negotiations with any other company - let us say just until March, 1926. But from that time onwards your company should pay me if it does not want me to go over to the rival company . . . .

Enclosed I send you the memorandum and my reply to it. I would like to draw your attention to the observation concerning the economy of fuel by means of an added water content. This is the very thing which resulted from my investigations on the synergy problem. On the occasion of my letter to Wolf you still thought (more or less) that the whole synergy problem was a frivolous question. One should simply make the rockets as light as possible. At present, it can be a matter of extreme importance in rocket planes. One cannot declare any scientific investigation as useless in advance.

I think the launching device which you have proposed is not necessary. The rocket flying machine will take off one way or another. The difficulty lies in giving it the necessary velocity and in taking it to the high altitude which is required; for this no launching device helps. If we are to abandon the booster we must be able to influence the activity of the jet over a very wide range by regulating pins. The reaction to begin with must then amount to 3 to 4 times the weight, during free flight it then only needs to total 1/7 of the initial weight. That can be achieved. But for such a reaction we do not need a launching device . . . ."

What was the consequence of this discussion in the Berlin office of the Junkers Works?

We find nothing more about it in the collection of letters.

Concerning the discussion which took place in September, Valier wrote: "Of course only representatives of these groups were there, who therefore had to report back to their superiors about my statements in this memorable preparatory discussion." - One can imagine how the project of the inventor, who was unknown to the works, was pulled to pieces in conversations in the works. Each person mentioned his objections to it and what seemed dubious. Finally there was nothing which could have induced the executive gentlemen to put money for research into such a risky plan, since Professor Junkers himself had more progressive inventive ideas than money available for the development of new designs.

Therefore the plan to build an aircraft with rocket propulsion was temporarily brushed aside. - But somehow, in secret, the seed had taken root. - In July, 1929, the first tests took place on the Elbe at Dessau; they consisted in using the additional force of the rocket as a booster for heavily laden aircraft. The Junkers W33 took off from the water well with the help of booster rockets in spite of its excessive load. The result was satisfactory and the rocket booster was used often and in many places. -

On October 15, Oberth sent to Valier a 12 page treatise on the rocket-plane, as he imagined it. Unfortunately this cannot be found amongst the old letters. We can only conclude from Valier's reply how the one and the other conceived it.

> ". . . . 1) Therefore your solution no. 1 with the auxiliary rockets is out of the question because as early as September, the gentlemen in Berlin stated clearly that the dropping of any solid parts, even if they were provided with a parachute, could never be considered for a means of communication like the rocket plane. By way of an exception that could be permitted for a single first flight to the moon but not for a means of communication . . . ."

Valier mentions two further reasons which oppose Oberth's solution with auxiliary rockets. Then:

> ". . . . 4) Therefore only your second solution which has always been present in my mind, can be considered, a solution which does not suggest auxiliary rockets but rockets in the wings. But here in your text you again show an unfounded fear of <u>thick</u> wings. Already, at the present time, the Junkers G 23 has wings which are approximately 90 cm thick at the fuselage and they taper off to a thickness of 60 cm where the side engines are built in and they are extraordinarily strong cantilever wings. Therefore for this reason we do not need to be afraid . . . ."

Then he deals with the question of how the fuel should be stored.

Then he describes how he imagines the rocket-plane. Because he stuck to the idea that a rocket-plane was to be developed from the triple-engined Junkers aircraft, and because he stuck to the slogan: "Change over slowly from the familiar to the unknown," the passage in the letter where we find these words written for the first time, will be quoted here word for word:

"Therefore I imagine the whole ship very simply like a triple-engined Junkers G 23, only that the wings do not have as large a span. Moreover I imagine that the ship has a propeller engine in the center like the present-day central main engine in the fuselage axis in the Junkers G 23; this engine is so strong that the final mass of the aircraft could, in an emergency, fly horizontally with it and could also manage to take off from level ground, whereas two or three adjacent rockets, depending on the constructional requirements, are installed in each of the wings outside, where at the present time in Junkers aircraft an engine is installed; these rockets will be quite a long way away from the fuselage so that the trail of fire can, on no account, scorch the tail of the fuselage. I would not build any main rocket into the fuselage itself, only because this is not very practicable in front of the center of gravity and because the danger of scorching is too great. In addition the fuselage must have the control surfaces at the tail end since we have to reckon with glide and landing as for an aircraft.

As you have noticed my whole object is to pass over from the familiar to the unknown as slowly as possible.

But these external conceptions of the machine do not change anything in the calculations in your exposé. Therefore, with your permission, I shall change your exposé as follows before I send it to the gentlemen . . . .

I hope that with my modification of the rendering I have made the figures, which were excessive for the take-off weight, disappear so that the need to jettison solid parts disappears and that the whole thing is made more palatable to gentlemen by the greater similarity with the aircraft types which are already well known.

The take-off is still not clear to me personally. How do you intend to take off from the ground at an angle of 80°?? Even for the large 8 cm caliber ship rescue rockets a special gallows device is required, as the firm Sauer in Augsburg explained to me. There must also be enough space between the jet orifice and the earth's surface according to the tail of fire to be expected. According to all my inquiries it is impossible for you to be able to take off on the spot from the ground at an angle of 80° without a special device. In addition I do not understand how you have conceived the position of the engine at the moment before take-off from the ground. Is it to resemble an aircraft which has its tail on the ground and the nose directed at an angle of 80° upwards? No, that will not do at all. Even for the smaller rockets one

must mount the 1 1/2 - 2 m long rod on a batten between nails in such a way that the firing rocket can only pull it out upwards in its longitudinal axis and that is, therefore, has a direction on take-off, at least for a split second, until the rear end of the rod has passed the last pair of nails.

In my opinion there are therefore only two possibilities for the take-off of the rocket-plane. Either tangentially from the ground like a present-day airplane and then to climb steeply at an angle of 80^{o} or take-off from a special launching tower or a runway . . . ."

Then he explains why a parabolic runway is, in his opinion, technically feasible and why the starting acceleration is not an excessive burden for the occupants of the aircraft. (Good paying passengers should be conveyed!)

". . . . I imagine that the pilot then moves the throttle lever forward after leaving the runway and certainly goes up to the acceleration of 25 m/sec^2 in a few seconds, whereupon flight takes place exactly as Professor Oberth calculated.

With the fact that I have proposed a propeller engine which is capable of maintaining the final mass of the ship suspended horizontally above the ground in the dense atmosphere, in an emergency, I prove that from the operative point of view it is a bad thing if one is merely instructed in gliding and must land where chance decides. Without doubt, one can then say that the pilot can give a few more jerks of the throttle even when the rocket is gliding. But I think that this would be difficult and irrational since shortly before landing the machine will then only be flying at the speed of our aircraft which is very bad for the rocket engines. But if I have with me a propeller engine which only weighs approximately 300 kg, therefore not too much in comparison to the thousands of kilograms of fuel, I thus have, in my opinion, the enormous advantage of operating reliability, for the rockets may fail where they choose, I can still glide down and land where I desire, i.e. choose the spot . . . ."

In Oberth's reply of January 10, 1926, amongst other things it says:

"I like your idea of a propeller engine. Concerning rocket failure, however, I am far more optimistic than you are. There are at least 3 rockets on each side which are independent of one another. If only one on each side functioned that would be sufficient to keep the aircraft in a vertical position, i.e. for mere flying they would easily be sufficient.

I think that the counter pressure of 30 m/sec^2 must come directly. If you are overturned in slippery ice or drop from somewhere the counter pressure comes directly and the blow does not hit you. Moreover, in any case it lasts 2-3 seconds, until the jets function at full power.

Your idea of a runway does not seem disagreeable to me . . . ."

Oberth outlines and discusses the various launching possibilities. After the technical questions broached in Valier's letter have been discussed in this way, Oberth writes:

> "Finally I should once again like to emphasize that, in my opinion, all tests with rocket-planes are premature as long as we have not gained the necessary experience with simple rocket models. - Also I should like to ask you, dear Mr. Valier, to pose alone as the inventor of the whole thing (of the rocket-plane). In the first place, it is, after all, your only reward, if the whole thing materializes, moreover I have done nothing more than answer your questions. Secondly, it does not prejudice you at all as an author to have bold ideas. On the other hand I can only afford myself ideas which are not too new . . . ."

Valier complied with this wish expressed by Oberth. - In his next letter to Mediasch there were copies of letters which he sent to various places in the hope of obtaining money for preliminary tests, for the "friendly party" mentioned in the memorandum of September 7, 1925, in the Junkers' office had not sent any word. Valier had waited for long enough in vain. He now sought after other possibilities, i.e. after financial backers and on January 23, 1926, he wrote:

> ". . . . that the problem of the rocket-plane and the rocket space ship had already been theoretically advanced by the work of German scholars and engineers so far that it is, as it were still merely a question of the practical execution of the projects . . . "

Whereas up till then he had always spoken and written of Oberth's great idea he now avoided giving his name. However, the fact that he considers this behavior solely as changed tactics in accordance with Oberth's wishes and that inwardly he is precisely as loyal to Oberth as hitherto, is shown by the fact that he sent to him these copies and even writes about his further plans and now, for the first time, the letter ends with:

"Your ever faithful
Max Valier."

On February 1, 1926, Valier wrote to Oberth full of confidence. He hoped that finally the means for the initial tests would be placed at his disposal:

> "In the meantime I have received such news from Berlin that I hope that one will grant me the funds, at least for the first stage of my project. In order to make it as easy as possible for the financial backers I have already declared myself ready to do everything, as it were, all on my own so that they only need to grant me (1 person) my livelihood for a few months and the funds for the preliminary tests. If nothing emerges at the end of the limited period agreed upon, the financial backers are free to cry off (in which case the money risked is of course lost), if I

succeed in achieving so much that the continuation of the tests on a larger scale seems to be promising, the gentlemen have to enter into another contract with me for the second stage which I shall also make practically all one thing (of course with the possible assistance of a mechanician and a pyrotechnist or a pyrochemist). My plan, which provides for 5 stages, for the engine which you have already discussed with me in your exposé is arranged in such a way that at the end of the second stage one already knows whether it is worthwhile continuing the experiments which, from then on become more and more expensive. From stage 3 onwards I hope that the company, which, by then, will be well-established, will succeed in engaging even you, dear Professor, positively and surely. Therefore, in the meantime, after the second stage or even as early as after the first I take upon myself the risk of being thrown out again in the event of a failure.

I should like to begin my experiments by testing simple powder rockets scientifically and I should like to obtain three curves during their deflagration (the abscissa always the time). The first ordinate is the reaction in kg., the second ordinate the pressure in the combustion unit, the third ordinate the exhaust-gas velocity. To obtain the first ordinate, it suffices to deflagrate a rocket with a tail upwards on a device which, on principle, resembles one of the usual spring kitchen scales where the needle writes on a moving piece of paper. Therefore as a result we obtain a pressure-time graph. One can obtain the second ordinate if one bores the combustion chamber of the rocket laterally and if one connects a communication tube to a pressure gage with a recording needle. In this way we obtain a combustion chamber pressure-time graph. My common sense tells me that this, too, is very important, but I still do not have a clear view of what one can deduce from it theoretically about the capacity of the rocket. On the other hand for the third ordinate I still do not know any means of how one should measure the exhaust-gas velocity, whether in the throat of the rocket or directly at the outlet. Now it is certain that the static tests on the measuring apparatus yield values other than those which correspond to the rocket which actually flies. But on comparison of different rockets on the measuring apparatus under otherwise similar circumstances it will be ascertainable which rocket has more power and it is to be expected that this rocket will then climb higher in the actual ascent and will develop greater velocities.

Therefore I would measure the same rocket at a standstill and in the ascent, trigonometrically with two theodolites with automatic circle reading per whole second which is set going by the rocket, as it rises, by releasing the contact. The observers at the theodolite have only to keep the rocket continually in the reticle, which cannot be so difficult from a long enough distance. Thus we would be able to determine the climb per second or even per half-second. From this, the velocity curve of the climbing rocket, until it burns down, can be obtained . . . .

. . . . To begin with I imagine the tests themselves to be carried out with quite small calibers of rockets with all the possible types of gunpowder, combustion unit, jet forms and capacities, and in the ascent with various forms of rocket head. Only after one has obtained a sufficiently clear understanding of all the points which are common to the powder rocket and the liquid-fuel rocket, would I then pass over to the construction of liquid-fuel rockets. From then on your co-operation, even in practice, would be very desirable . . . ."

Oberth replied by letter to Valier's question's but also sent him a telegram immediately:

"First stage of your project outdated. Oberth."

Month after month there were new disappointments. The tests described above did not take place, for the hoped-for financial backers failed to appear. -

Even the film "Advance into Outer Space" was not made. -

An article from that period "The Space Ship" (Das Weltraumschiff) by Max Valier, which appeared in the supplement "Die Einkehr" of the Münchner Neuste Nachrichten of February 10, 1926, has been preserved for us. - The first part of this article is a short history of the development of the idea of space travel. Newton, Ganswindt, Ziolkowski, Goddard, Oberth and Hohmann are mentioned, the latter for his ideas on navigation. (In order not to interrupt the text of the chronicle for too long, this short historical study which is worth reading is published in the appendix; here we publish the last part only.)

- In his book "Rocket Travel" (Raketenfahrt), as in other books well-known to us, which he has written, Valier never says of himself "I" but "the author." Therefore everything is clear. On the other hand in newspaper articles the clarity suffers because Valier writes them like he wrote in those days the introduction to the "Mentor," he avoids both approaches, says neither I nor the author but sentences are ingeniously turned in the right place, as for example:

"Since then a certain change has taken place. The idea of building space ships to reach the moon could, of course, only find the money necessary for the completion of the experiments with difficulty in Germany under the present-day conditions because no one could mention a sum in advance even only an approximate amount and no one could state a date for the completion of the first machine. Therefore a course had to be attempted which gave promise of partial success of economic importance after a few steps only. The surplus could be used for the further development of the invention. This course was laid down with the intention of developing the later space ship from the present-day airplane. As the first transitional type a machine was thought of which was to climb like a rocket, to cover the main distance at a high altitude at a high velocity and finally to glide to a landing. Such machines would be able to cover distances such as Berlin to Munich in 12-14 minutes with a relatively low engine performance and, on further improvement,

they would be able to cover distances such as Berlin to New York in somewhat less than an hour. It is evident that such rocket airplanes would have an enormous economic importance, therefore it is also to be hoped that, even in Germany, industrial circles will be interested in this kind of rocket development. . . . ."

The Münchner Neueste Nachrichten published the article but otherwise nobody made a move.

Once again new hopes arise. He wrote to Oberth:

"March 1, 1926 . . . . On April 9, I shall speak about our cause in the clubhouse of an aero society before genuine experts. I shall say to the people honestly that I am merely the champion of the cause and holder of the ideas, but not a scientific expert in the individual special branches. I will initially impress the people with my conviction only. On April 24, I shall then lecture in the salon of the Baroness von Oheimb before a quite different audience. I hope to fill the interval with lectures in Jena, Weimar etc. so that the costs are covered. . . . ."

Valier remained undaunted even if one hope after the other "was frustrated in the abyss of the epoch."

On June 22, 1926, he informs Oberth:

"Enclosed are my letters of June 13 and 22 to the Society for High Altitude Exploration, with which I came into contact on June 1st, as you see with a certain success. - Otherwise I merely have to inform you that the Oldenbourg publishing house has cried off from publishing the third edition of my book+) so that, at present, I am in search of a new publisher. As a reason Oldenbourg affirmed that the specialized circles still ignore the affair of the rocket ship up to the present day and that they do not take it seriously. - As you can see, that has just changed. I hope to obtain the work of Professor R. von Eberhard and I shall then send it to you too. - Moreover I am hale and hearty, only from the financial point of view are the prospects not rosy for me, in any case they are worse than last year since the book-trade is quite stagnant. . . . ."

Oberth replied:

". . . . If Oldenbourg has cancelled your last edition he will presumably do the same thing with me. Never mind. At least I can then make a settlement with the "shop-talk in duodecimo format" as Hoefft calls it. I shall set to work immediately to write a chapter referring to this for the next edition.

+)This refusal was later cancelled again, Oldenbourg published the third and fourth edition and 2 editions of "Rocket Travel" (Raketenfahrt).

I thank you for having mentioned my name to the Society for High Altitude Exploration. I shall make an effort to satisfy the gentlemen. . . . .

. . . . The Society for High Altitude Exploration has not invited me to join them. In any case, I have no desire to be the first person to write. If you write to the Society for High Altitude Exploration please mention that, in the meantime, many simplifications and improvements of my tests have occurred to me and that with approximately 9000 M I am capable of carrying out all the preliminary tests which are necessary for the construction of a rocket-plane and of simple recording rockets. . . ."

After the plan of working together with the Junkers works had come to nothing and then the hope which he had placed on his lectures in the aero society club-house and in the solon of Frau von Oheimb was not borne out, Valier tried another approach. On October 11, 1926, he informed Oberth of the new project:

". . . . What I have done in the meantime and what I have in mind for the near future you can see from the circular enclosed, from which you can conclude as the most important thing that I have obtained the well-known aviator Udet for my projects of developing the rocket ship, in particular from the airplane. I have, as it were, more and more come to the conclusion that we can attract the general attention of the public at large solely by means of a somehow early, sensational attempt at ascent even if it is, intrinsically, a very big bluff; it is this alone which can lead to the financing of the tests which are really scientifically important and which will take place later. Moreover, you do not need to be afraid, I shall take the risk on myself and your name will not be involved with it, if I may put it in that way. . . . .

. . . . In any case, I have the feeling that soon something must happen if the cause is not to die a natural death. Enough writing has been done, the people now want to see actions and not words and if one person does not take the risk that does not happen, therefore one must just take the risk and I am quite prepared to do that and also Udet is the right person. It is evident that I am, now as ever, of the opinion that as soon as I have got on somehow or other I shall immediately call on you, dear Professor, and I shall make the fruits of my advance with the public available to you. Therefore I hope that you do not regard me as a rival, now or ever, and that you will lend me your valuable advice and theoretical assistance as usual.

As always after a journey I have heaps of work and my funds are running very low."

In the circular it reads:

". . . . I have recently succeeded in interesting the well-known aviator, Flying Officer Udet in the practical execution of my projects, provided that the financial and technical possibilities can be provided. To begin with, a model resembling an airplane with a wingspread of 2-3 meters was designed on which my rocket engines are to be put to the test. If these preliminary tests are as successful as I expect them to be, I intend to prove that it is possible for a human being to ascend with a rocket ship, by means of a personal ascent, at the sacrifice of my own life, as early as the coming summer. Later the altitude world record will be broken and the limit of the atmosphere will be reached until one succeeds in remaining in outer space for a few hours, a thing which, without doubt, would scientifically be of the greatest conceivable importance.

In order to finance these undertakings, at least at the beginning . . . . a tender for books . . . . to the credit of the funds for the experiments . . . ."

Oberth replied on October 26:

"I do not know whether it is advisable to chatter so much. Mr. Ronsdorf wrote to me that he had half and half won the Emergency Society for German Sciences over to my ideas. A part of our experiments has already been carried out by Kuehn. For the present we need nothing but approximately 2000 Marks for the combustion experiments which are still outstanding and for the first recording rockets. I think that if such a rocket were shot, let's say from Siebenbürgen to Berlin, that would just have a sensational enough effect to arouse public opinion for 2-3 months if, in the meantime the public were to have lost interest. In my opinion, it is not necessary for anyone to risk his neck before completely safe tests have been made in the model stage. Yes, I think that it can only harm our reputation if things go wrong. - However there is another thing which supervenes. Mr. Valier has, at the present day, such a renown that it is at least just as harmful to the reputation of astronautics, if you make a fool of yourself, as if I, myself, were to make a fool of myself. You yourself can see: you are always asked for advice and solicited for your expert judgement, you speak before the Societies of Engineers, you become a member of the Society for High Altitude Exploration, etc., whereas I am quite disregarded.

Of course I am ready and willing to give you my theoretical support, that means, as long as I am still capable of doing it, for I am at the present moment too poor and too far away from European culture to still go along with science and very soon I shall be of no use. May I ask you to cede to me on loan Crantz's book. Unfortunately my means are no longer sufficient to buy myself books. - Perhaps it would also be a good thing if you could send me a copy of your lecture for inspection, I would then write to you if something can be improved in it.

I do not know at the present time when my book will be ready. I have an awful lot to do and terribly little time for the rocket cause.

Might I know what kind of experiments Mr. Valier wants to carry out in the chemical laboratory of the Munich dispensary which you mentioned?

Yours very truly

Oberth."

Now Oberth had certainly assumed that the hoped-for result of the circular concerning funds for the tests had come to Valier. On December 11, he writes to him:

"I should like to set out on a lecturing tour throughout Germany in January or February and in doing so to give popular and scientific lectures in a few larger towns and to seek certain acquaintances.

Could Mr. Valier help me with this in any way, let us say by advancing me the money for the tour and for the organization of the first lectures as well as for the placing of a representative at the local high-school or by assisting me perhaps with diapositives and lantern slides, as you are accustomed to using in your own lectures. I would forward you a certain percentage of the eventual net profit for this, - less my own expenses. . . . ."

Valier who on December 15, had returned from a 6 week lecture tour, replied on December 27:

". . . . Unfortunately I cannot share your optimism regarding the construction of a moon rocket with 2000 Marks or even one which will fly from Rumania to Berlin. You will have to tack on to that sum of money one or two more noughts. Of course I sincerely wish you success.

However you overestimate my successes and my reputation considerably and for that reason you feel quite rejected unnecessarily. I still have a great deal to contend with and I feel that I am still at the beginning of my task. In addition I must, unfortunately, do "worthless work," as you say, too often in order to simply earn money. I would willingly lend to you Crantz's book but at the present time I unfortunately need it continuously, since I am still working on the new edition of my book "Advance into Outer Space." I always give my lectures freely and I do not have any copy of them so that, unfortunately, I cannot send you a copy. Unfortunately nothing has come off with the chemical laboratory in the dispensary of our gentleman friends. Up till now experiments could not be undertaken there.

As regards your letter of December 11, I must inform you that, unfortunately, on my last lecture tour I myself had very trying experiences so that the bit of money which I earned in the first 3 weeks I lost again in the last weeks. The evening of December 14, in Karlsruhe brought me a cash deficit of 421 Marks without the travelling expense.

As far as my lantern slides are concerned I spent 800 Marks for new originals (15 pictures) in November. In any case the public sets great store on the fact that each lecturer presents his own original series of pictures. Therefore it may be of little use to you but it would prejudice me a great deal if I were to put my series of pictures at your disposal.+) Since you have already found a support in the Society of Vienna, I think that it would be best if you simply make a settlement with this Society about your lectures, in such a way that the Society has the lantern-slides mentioned by you prepared and, moreover, it even takes the responsibility for all the costs of your lecture tour, in addition it guarantees you an adequate fixed sum. Moreover the Society of Vienna indeed seems to have at hand a quite remarkable propaganda man, for the news of the foundation of the Society for Space Exploration in Vienna ran through numerous newspapers in Germany in an excellent get-up, frequently in very conspicuous places in the most important papers. Many newspapers also published the portrait of Dr. von Hoefft. Unfortunately most of these articles, however, contained such attacks against my particular projects that it has therefore been made impossible for me to join the Society and to collaborate directly in your undertakings. Moreover, if you have read somewhere in newspapers that I want to have myself shot to the moon with a rocket you should know that this announcement in no way comes from me but from my opponents, who are trying to make my actual plans ridiculous.

With just as cordial Christmas and New Year greetings, even if they are belated

Yours
Max Valier."

In January, 1927, Oberth replied:

"Dear Mr. Valier,

To begin with, the observation that I do not feel neglected. I have no other ambition than to take part in inter-planetary travel and your promise to engage me as an associate, if the affair is a success, satisfies me completely. - It only depresses me that now

+) Unfortunately in the letter Valier has forgotten to mention to Oberth that his series of pictures represented his project: From the rocket-airplane to the space ship and for that reason was unsuitable for lectures given by Oberth, who planned only the small test rockets and recording rockets as the preceding stage to the space rocket.

when my personal intervention, as I shall show you in a moment, would be so extremely necessary I am to sit here and I cannot make a move and I must practically wear myself out if I am to spare 1/2 hour's working time for the rocket cause.

As far as your remarks on the Society for the Exploration of Space are concerned I must say that you regard the situation, especially my status in the Society, from an incorrect point of view. Hoefft had called in various people, who have a well-known name but who, in addition, do not have the faintest idea of the cause itself, to bring the Society more prestige. These people have now begun to voice all kinds of doubts . . . . Hoefft was not an equal for them in debate, to conclude from his last letters, and the Society is in danger of coming to an end. Before I was in Vienna the Society would not sponsor me. The private lecturer Dr. Körner, for example, is reputed to have said that it was now high time that the rocket affair passed from out of the hands of dilettantes into the hands of the universities and experts. Of course, I do not need to mention that naturally by dilettantes he did not mean himself nor Professor Wolf but that he was referring to Hoefft and myself. Moreover, Mr. Valier can deduce what kind of experts these are from the fact that Wolf considers exhaust-gas velocities above 1450 m/sec. as impossible. - Some time ago I measured 3700 m/sec. with an uncertainty of ±200 m/sec. in an oxyhydrogen blowpipe, - Böck will only allow exhaust-gas velocities of 500 m/sec. and Leitner manages to declare in one breath that the velocity at the throat is approximately the same as the speed of sound, - for my hydrogen rocket that would be approximately 3000 m/sec. - and Wolf is right. Moreover Wolf maintains that the wall of the combustion unit had to burn, which, in addition to many other things, also seems to prove to me that he is not at all familiar with my book nor my projects. In addition, they maintain that it is impossible to take along on the flight liquid gases in the tanks of the rocket - fortunately 2 years ago Director Linde certified to me that my design is absolutely feasible; well then, etc. These are only a few examples. -

Therefore I must come to Vienna of my own accord and press the Society hard if I want to bring them to their senses and to do away with a few superfluous people. Hoefft did not dare to submit to the Society a letter which I wrote to them and in which I pointed out why it lay in our mutual interest to make the journey to Vienna possible for me. . . . .

As far as the 2000 Marks are concerned this must be the first time that I have made a mistake in the rocket affair except for as regards people. When the third edition of my book on rockets is published, you will see that models A and C, on the whole, represent the simple work of a sheet metal worker.

If, in my lectures, I say that Mr. Valier was kind enough to let me have such and such a picture from his own collection, for I

am too poor to buy some for myself and If I had the money I would willingly place it into the rocket tests, I do not see how that will prejudice you.

I do not know how deep the reason for your unfriendly behavior lies but it would be desirable in the interests of the cause if you were just as sincere with me as I am to you.

Yours faithfully
Oberth."

On January 30, Valier replied. He informed Oberth of exhaust gas velocities from Scherschevsky's reports from Moscow and wrote:

". . . . The people (Ziolkowsky and his pupils) have already gone into so much detail that they are already working on the best wing sections for supersonic speed as the flight speed, etc. It is gradually becoming uncanny to me. That is to say, if Ziolkowsky has really received 400,000 gold roubles (from the government?) it will be difficult to regain the advantage. Moreover he is apparently working on both levels, as a rival, as it were, of not only my project (from the airplane to the space ship) but also of your project of the sounding rocket (according to him long-distance rocket missiles) and of the later moon rocket. On the other hand we have not heard about Goddard lately. . . . .

As far as my collection for the fund for the experiments is concerned, let what follows serve as an explanation to you. I had the idea in the middle of October, at a time when I hoped for technical assistance from Udet, if I were to succeed in raising the first few thousand Marks. Also at that time I brought out my old lecture program in its new form (which I am enclosing today) and I had the circular (likewise enclosed) produced and I sent both of these to approximately 1000 addresses, which has cost at least 150 Marks together with the envelopes and postage. My hope was to obtain orders for approximately 2000-4000 Marks; I could have credited the discount on these orders (i.e. approximately 35%) to the fund for my tests. But up to now the result has fallen very short of my expectations. In any case, up to the present day not once has so much come to hand that the expenses of this propaganda campaign could have come out of it. Therefore the campaign is to be considered as a failure in raising money in this way. . . . .

After some less important statements he wrote about his lecturing activities:

". . . . When I saw that my lectures on the theme of the advance into outer space, which I had given 2 years ago and up to the beginning of October, 1926, when I spoke mainly of you and your moon rocket projects, somewhat in line with the first and second edition of my book on the subject, were not taken seriously

I changed my tactics and in the middle of October, 1926, I came forward with my own project with the slogan "From the Airplane to the Space Ship," about which I have already corresponded with you for a good one and a half years. In several letters to me, you yourself clearly indicated to me that you did not want to take on the sponsorship of this project, i.e. that you did not want to even have your name associated with my idea, and that it would be my own concern to represent and defend this special project. I have now done that very thing. Just look, it is evident that the public has now begun to take me seriously! . . . .

I now hope . . . . that I shall be able to cover the deficit and the debts from my tour before Christmas by a better organized tour from the publicity point of view after Ash Wednesday and I hope to be able to earn a few more hundred Marks up to Easter as a result of my great effort. I have now entrusted, as it were, the agency for my lectures to a Berlin office. Of course I had to deposit 100 Marks security to begin with, I must now get new programs and posters printed, which will cost me approximately 250 Marks (I can only do that by credit and 6 weekly dates of payment), therefore I must still invest money. Of course, at the present time, no one knows for sure whether anything will come of it, whether there will be a net profit, but I hope so. It stands to reason that I myself must go on this tour in these circumstances and that I cannot sponsor and send another gentleman, for example you, Professor, with my pictures. Moreover, the whole propaganda since October is linked to my plan and my name and all of my new pictures only correspond to this, my own plan of arriving at the space ship from the airplane. . . . ."

Then he describes the painful experiences he had had, the losing transactions which he had often made on his lecture tours and he adds:

". . . . But if I were now to take it upon myself to sponsor you (but I would not know where to get the money with which I would sponsor you since I am up to the neck in debts with the designer, the printer, the office, etc. with a vengeance) I would perhaps nullify everything because, at the present moment, the cause may still not be able to bear this burden. I can only assure you, dear Professor, that I am ready, now as ever, to sponsor you and to engage you as soon as I can and as soon as it is desirable in the interests of the cause. For, in the first place, I should not like to lose your friendship, I would willingly like to collaborate with you later but on no account would I like to antagonize you. . . . .

I can understand you psychologically, dear Professor, it is not pleasant to stay down there in Rumania and not be able to make a move whilst the battle rages: But that cannot be changed in a second. Do the best thing that you can: write your book!

Yours faithfully

Max Valier."

Oberth did not reply to this letter.

The lonely man in Siebenbürgen was resentful.

He has to bear the full weight of the burden which a genius's talent places on the shoulders of a man obliged to earn a living.

Embittered he kept silent - but he wrote his book.

Accounts of Max Valier and his Plans.

The desire to be able to show in his lectures, by means of good, vivid lantern-slides, how he conceived the development from the propeller airplane with auxiliary rockets, via the rocket-plane with an auxiliary motor, to the stratosphere rocket-plane and further to the space rocket, took Valier to the atelier of the twin brothers, Hans and Botho von Römer in the fall of 1926. There soon developed a very good friendly collaboration. From December 1926 to 1930, many of Valier's articles were published in illustrated magazines; in these articles the last line of the caption reads:

"(According to the design of M. Valier, drawn by H. and B. von Römer)"

The von Römer gentlemen have sent us a compilation which shows how Valier had planned the progressive development from normal propeller airplanes to the space rocket (see Figure 9). A letter in which the two long-time associates of Valier describe his ebullient and genial character, will be inserted here.

> "Max Valier visited us frequently from 1926 onwards. He arrived like a rocket, full of plans and enthusiasm, flung his old bicycle into a corner of the passage of the house and stormed into the atelier. "I need a new form of an aircraft, a racing car, a rocket, a naviplane" he shouted and drew a few sketchy drafts from his pocket. The enclosed sketches (Figures 9-14 and Appendix 9) came into being in that way. The enthusiasm of this amiable person had affected us and thrilled us, and as an engineer and an artist we were very glad to be able to assist and help Valier in his work, . . . but, above all, it was a matter of interesting the public at large, and also science and technology, in the idea of rocket propulsion. Often Valier had said to us that he was able, just by means of our vivid and technically intelligible sketches which he displayed especially in his lantern-slide lectures, to obtain from his audience the necessary appreciation of his plans, which were very much ahead of their time. We ourselves have carried through the idea of rocket propulsion which, at that time, was only thought of for peaceful purposes, by means of numerous publications and technical articles.
>
> In addition, we were the creators of the first rocket poster. We like to remember our interesting creative collaboration with Max Valier, with whom we were friends up to his death.
>
> Botho von Römer, Engineer (Mechanical engineering and aircraft construction)
>
> Hans von Römer, Architect and graphic artist.
>
> Technical authors and press designers."

Even Valier's wife and his sister Martha always describe him as a happy, optimistic man, who had the power of arousing enthusiasm in others. He was constantly full of new ideas and yet firmly kept to his great, high objective. Almost every new idea first meets with rejection from the experts, and Valier's ideas were no exception to the rule. Propulsion by reaction was somewhat too strange an idea for the aircraft industrialists. They simply could not imagine how such tremendous forces as had been worked out by Valier could result from the expulsion of exhaust gases. Valier could not publish any articles in serious technical journals. Only the illustrated periodicals readily accepted them (see Münchner Illustrierte Presse 1926, Appendix 6, p. 295). However, these publications were not taken seriously by the experts of aircraft construction.

Nowadays, the aircraft with jet propulsion has become a matter of course. One can hardly imagine any more that in 1926 the man who explained that an airplane could be propelled by the reaction effect of the combustion gases expelled from jets at a very fast rate, instead of by the piston engine and propellers, was laughed at by the aircraft engineers.

The famous professor of aerodynamics Theodor von Kármán wrote a book in 1956 entitled "Aerodynamics, Chosen Topics in the Light of Historical Development" (Aerodynamik, Ausgewählte Themen im Lichte der historischen Entwicklung). In this book there is a paragraph (pp. 186/187) which we will quote here to show how Valier's idea which, at that time, the experts termed Utopian, is judged 30 years later by an outstanding scientist. Karman says:

"It seems to be generally agreed that the greatest progress in the field of methods of propulsion was made with the transition from propeller propulsion to jet propulsion."

Because Professor von Karman follows up this first sentence, which expresses the highest acknowledgement of a technical innovation, with a brief, personally experienced anecdote, this will also be published here:

"A few years ago - when the Allies were carrying on peace negotiations with several East European states - I stopped in Paris. In an interview, a Hungarian correspondent asked me what I considered to be the greatest progress made in aeronautics in the last decade. I replied: "Propulsion by reaction." Whereupon she said: "Professor, can you not give me another expression for it. I cannot possibly write in a progressive newspaper that progress takes place by reaction."

I found a Hungarian word for jet and she left me apparently satisfied."

In addition, another book which was written a long time after Valier's death gives an account of the realization of his ideas.

In 1964, the Econ-Verlag published the very noteworthy and informative work by Rainer Maria Wallisfurth "Russia's Path to the Moon" (Russlands Weg zum Mond) (see also Appendix 7).

In this book, which depicts how the development of the Russian space rockets came about, he proves that the Soviets have closely followed Valier's plan of progressive technical development - ". . . this bold and, at the same time, completely convincing program", says Wallisfurth.

However, back to Berlin: In spring 1927, the "Scientific Society of Aeronautics" announced to its members that Max Valier would be giving a lecture one evening on the subject: "Flight with rocket power in the stratosphere and in space."

Here we give an eye-witness account by I. Kober, Eng.:

"Flight with rocket power - it was only natural that we, the assistants of the German Test Plant for Aeronautics, assembled in the lecture hall. Such an exceptional subject was likely to arouse a heated discussion, like shortly beforehand when a speaker proposed constructing airplanes with retractable undercarriages for ocean crossings, in order to increase the speed and the range of flying by reducing the aerodynamic drag. The aircraft engineers present had strongly expressed their opinions to the speaker, not to mention the aviators!

On this occasion too, the lecture hall was overcrowded. Max Valier, tall and slim, dressed in a dark suit, stood at the speakers' desk and elaborated his projects:

'Civil aviation, as it stands today, is an undertaking which requires subsidization in all countries. New departures have to be made if it is to become a profitable business. Aircraft which take only a third or a quarter of the flying time usual for long distances at present would be greatly appreciated by paying air-passengers, particularly if they would no longer have to fear flying for hours through air-bumps and suffering from airsickness.

The way to fulfill these desires and to make civil aviation profitable leads through the stratosphere.'

A stir ran through the audience. Investigating the possibility of flight in the stratosphere had, at that time, not only been considered by the leading powers in Germany, but the problem had indeed already been taken up and funds made available for this purpose by the Ministry of Transport. In the German Test Plant for Aeronautics a department of Altitude Flight had just recently been set up and provided with a comparatively large research fund. The head of the department, Martin Schrenk, Eng., together with his assistants, was in the process of constructing a free balloon which was to carry observers and measuring instruments to a high altitude.+)

+) 7 years later, after a couple of successful calibration flights, Schrenk and his companions met with an accident during an ascent to a high altitude. The corpses and the debris of the balloon were found in Russia.

Valier continued: 'The stratosphere aircraft must of course be equipped with pressurized cabins and regulated oxygen for breathing. The aircraft should have the desired wing size for landing, for during long-distance flight in the rare air at high altitudes the aerodynamic drag is so slight that the aerodynamic drag of the wings during cruising constitutes no notable loss of energy. The fact that at high altitudes there are no air-bumps and no storms, no clouds and no thunder-storms is well-known.

It is thus a matter of devising the motor with the help of which one can fly in the rare air of the stratosphere.

For this we need the rocket engine, i.e. the motor which operates without a propeller. Propulsion must be attained by means of reaction, as in the ship's rescue rocket which is well-known to you.'

There now came loud interruptions: rockets, low efficiency. Valier replied: 'You are right; the rocket in use at present has a very low efficiency. Only a slight percentage of the potential energy dormant in the powder is changed into kinetic energy during the flight of the ship's rescue rocket. But in the first combustion engines or in the first steam engines was the efficiency not a great deal lower than it is at the present time? Is it then a natural law that in rockets, of all things, the position of technology must practically stand still?

The objective of my work has been pointed out to you by the title of my lecture; it is flight into space. In contrast to Professor Oberth, the author of the book "The Rocket into Interplanetary Space", I am of the opinion that this, our great common aim, can best be attained progressively.

For this reason, I have divided my work schedule into four stages:

First Stage: Investigation of the rocket types well-known up till now and systematic improvement of their efficiency.

Second Stage: Employment of rocket propulsion for the transport of humans in appropriately designed ground vehicles.

Third Stage: Installation of rocket engines in suitably designed aircraft.

At the same time development of rocket engines with constant thrust and liquid fuels.

Fourth Stage: Increasing the performance of the rocket motor, creation of a reaction-driven stratosphere aircraft which, on further perfection, will go up higher and higher into the atmosphere and develop progressively higher speeds, until some day the advance to the edge of space is possible.

Only when we have gained experience with an air traffic system duly operating in the stratosphere do I find it suitable to make the next step and to study the principles of construction for a space ship capable of taking humans

to the moon or to neighboring planets. Although the latter has been a popular subject for science fiction novels for a long time now, I do feel it would be more appropriate to first develop the stratosphere aircraft intended to provide reliable air transport between Europe and America.

This is a project the development of which economically minded men might reasonably be expected to finance.

From the propeller aircraft, which is unsuitable for high altitudes and high speeds, we have to develop the rocket plane propelled by reaction in accordance with Newton's principle.

The rocket was with us long before Newton; it came from Asia as an arrow of fire, and it is known to us from the history of sieges of the Middle Ages. Newton explained the mode of operation of the rocket and dealt with it mathematically by means of his law of the conservation of the center of gravity.

In the propeller airplanes, the piston engine uses up about 34% of the potential energy contained in the fuel. The efficiency of the propeller may reach approximately 85%. Consequently, only about one third of the energy contained in the fuel emerges as the kinetic energy of the aircraft.

I am convinced of the fact that by means of systematic investigations and improvements we shall succeed in raising the efficiency of rockets in such a way that we shall be able to develop a rocket engine with a liquid propellant (gasoline), which will attain the efficiency of the usual piston engines and will perhaps soon surpass it. It must be taken into consideration here that the efficiency of the rocket only becomes favorable at quite high flying speeds.'

Then Valier proposed that once model airplanes with rocket propulsion had stood the test, rocket engines should be installed in a trimotor Junkers aircraft behind the two external engines; these should be put into operation in flight at a safe altitude and at the same time the two external engines should be switched off. For the security of the return flight and the landing there would still be the middle engine which, for the time being, would operate in conjunction with the rockets. With lantern-slides he showed how he conceived this progressive development. These lantern-slides were illustrations which Valier had had sketched by the von Römer illustrators of Münich.

'First of all, the Junkers G 23 with two rocket engines in the wings is to be used. Then, when the reaction drive in this airplane has proved successful in flight in the first test, the next transition type, the rocket-plane with an auxiliary engine (the latter still retained for security) will follow. We now have 4, later 6, rocket engines in the wings. When we have gained enough experience in flight operations, the genuine rocket-plane with small wings and a pressurized cabin for flight in the stratosphere from continent to continent can be built. The next stage is the rocket ship, which rises into the air from the take-off tower and is further developed into the space ship.' - (For this, Valier showed the sketches Figures 9 to 13).

No sooner had he ended his lecture, than a great many members of the audience asked leave to speak. One could see how they had just been waiting for

the opportunity to tell him that his plans were nonsense. The feasibility of the entire project was called into question, indeed it was pronounced impossible. The illustrations which the speaker presented were said to be fit for science-fiction novels or illustrated magazines, but not for serious scientific discussions. One person pointed out at length that the propulsive thrust produced by the expulsion of the combustion gases of the rocket was much too small to ever be able to replace the propulsive thrust of the propeller. Another said that the thrust of the deflagrating rockets on the aircraft would endanger the stability of the wings and also the aerodynamic balance of the aircraft. He told Valier that he would not find any pilot willing to fly an aircraft with rocket propulsion. Valier replied to the first person that on that account he had called the first stage of his schedule the investigation of the powder rockets known hitherto, and the systematic improvement of their efficiency. Then the rocket thrusts would no longer be unreliable. Their propulsive thrust would be sufficient for a flight. 'If this then proves that the utilization of the combustion energy in accordance with the principle of reaction is possible,' he said, 'the liquid-fuel rocket engine will be developed which produces a uniform thrust and with the help of which flight in the stratosphere can be realized. As for your fear that no pilot will be found to fly this plane - in the war, I was detailed to the testing of new aircraft types more than once. Of course, one prefers to climb into an old tested machine rather than into a new one, in which one cannot tell whether the innovations will stand the test. But after all an operational sortie was no life insurance either, and in spite of this enough volunteers signed on in the air force. - I shall, of course, be a member of the first crew that flies a rocket-plane.

Flying with Propulsion by means of Reaction

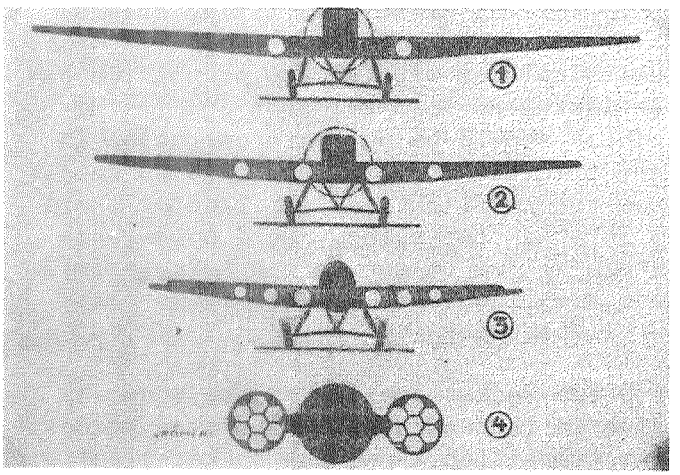


Figure 9.: The rocket-plane+) is to be progressively developed from the trimotor Junkers G 23.

(1) The 2 lateral engines are replaced by two rocket engines+).

(2) 4 rocket engines and smaller wings.

(3) 6 rocket engines, even smaller wings, and pressurized cabin.

(4) Rocket ship.

+)Where the reaction of exhaust gases is used as propulsion, Valier speaks of the rocket principle, rocket engine and rocket-plane not only when the oxygen is to be drawn from the atmosphere but also when it is to be carried alone as fuel - (there were not yet any power units in 1927). See also pp. 133/4 (original) . . . on precompression of the air with the oxygen of the air. . .

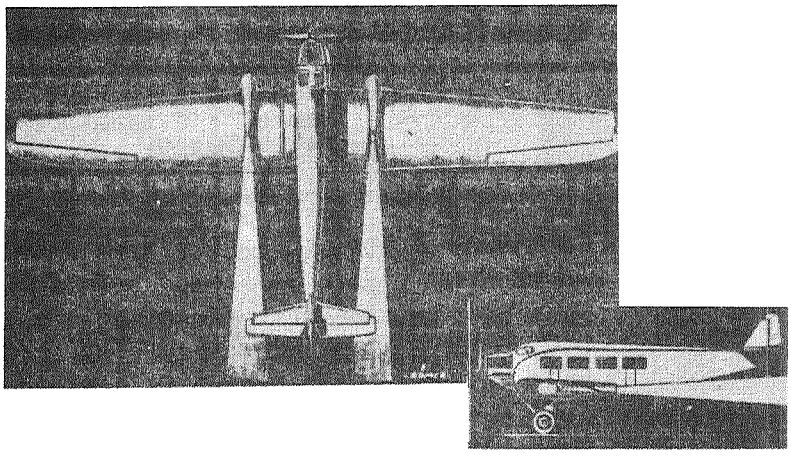


Figure 10.: In the test stage number (1) the central engine with the propeller is retained for take-off and landing, only the lateral engines being replaced by rocket engines[+)] (Side view: Ju G 31).

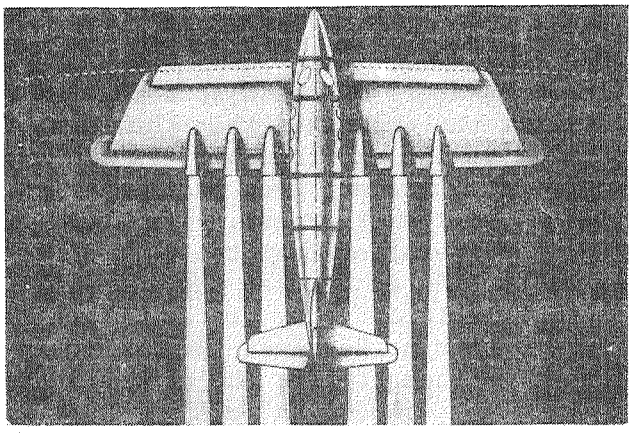


Figure 11.: Stage (3): With 6 rocket engines[+)], small wings and pressurized cabin, this rapid aircraft is planned for stratosphere flight.

[+)] Where the reaction of exhaust gases is used as propulsion, Valier speaks of the rocket principle, rocket engine and rocket-plane not only when the oxygen is to be drawn from the atmosphere but also when it is to be carried alone as fuel - (there were not yet any power units in 1927). See also pp. 133/4 (original) . . . on precompression of the air with the oxygen of the air. . .

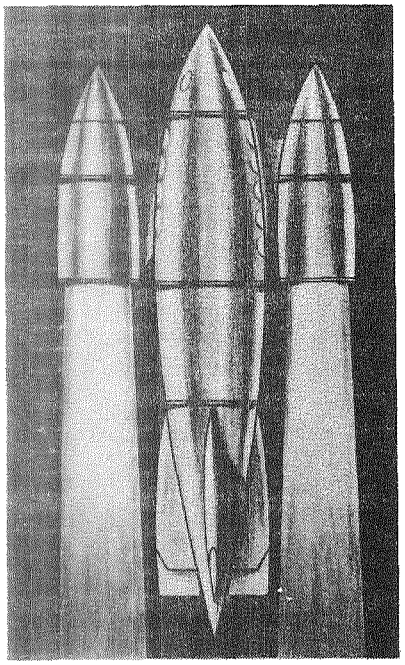


Figure 12.:

Stage (4): Rocket ship for the exploration of the highest zones of our atmosphere and for the testing of the take-off and landing technique (see Appendix 8, p. 303) (original)

Flight stability is attained by means of the disposition of the combustion chambers, because the propulsive thrust acts in front of the center of gravity of the ship's fuselage.

With regard to the illustrations: as long as the rocket-plane has not yet been built, I am unfortunately unable to submit to you any photographs or graphs.'

Of the many subsequent speakers in the discussion, we shall only quote three: The old rocket expert who explained that the idea of a liquid-fuel rocket was not new, but that it was not feasible, as his experiments had shown. The heat of combustion destroys the jet, even if the novice here did not know that, he should believe the old rocket expert. - Another said that the lecturer had indeed not taken into consideration that the cold of outer space (-273^{o}) very quickly causes all human life to freeze. No insulating layers help here. All metals become hard and brittle and they crack. Death from cold is inevitable for the so-called astronaut, when he has left the protective atmosphere of the earth. - The next said that he thought that the screening against the great intensity of the sun's radiation would be a much more difficult problem than the coldness of space. (I do not remember Valier's reply to these questions. Obviously time was too limited to give replies to everything.)

Then Mr. von Prondczinsky, a former naval officer and war aviator, now departmental head of the German Test Plant for Aeronautics, asked leave to speak. He proposed that all those who were concerned with rocket problems should team up in order to work together to the same end, exchanging their ideas, in order to avoid unnecessary wasting of funds, which after all, all come from the state's pocket, as a consequence of identical projects being worked on by various individuals at the same time. - To this Valier replied that he had never yet received a single penny from the state for his work and that everything he had invested in his rocket experiments so far was his self-earned money, and he presumed that he could indeed work with it as he wished. - This, of course, only made

this pale man, with his strange projects, appear even more dubious to the audience who all received their fixed monthly pay either directly or indirectly from state subsidies to the aircraft industry and to the airline companies etc. Could one take him seriously?

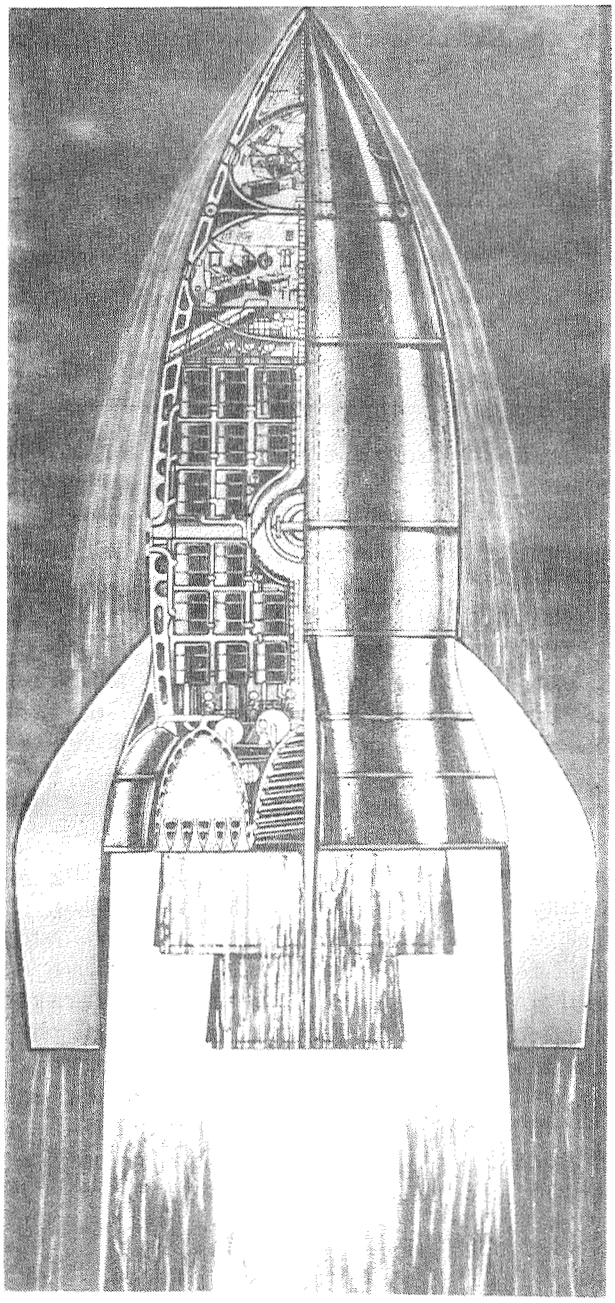


Figure 13. Final objective: The space ship
(Gyropilots here assure the flight stability)

Then yet another person impulsively asked leave to speak. It was the retired naval government surveyor Engberding. Having just overheard other listeners whispering, 'Isn't that Engberding, who is always talking about airships?' he began his remarks laughingly: 'You are quite right, Engberding is always talking about airships, about Zeppelin airships. I find that we should not take an interest in such out-of-the-way things as space rockets, but concentrate all our financial possibilities on the construction of Zeppelin airships. In this affair Germany has such an advantage over the other nations that it is here that we should concentrate our chief effort in order to reacquire Germany's prestige. Surely this is more important than the rocket planes which the speaker has proposed.'

Everyone laughed, for how often had such statements already been heard from the faithful disciple of the Zeppelin airship. In a happy frame of mind about Engberding, the stalwart, the audience left the lecture hall chattering.

For Valier, the evening at the Scientific Society for Aeronautics in Berlin was a great disappointment."

Max Valier found far more recognition abroad. A Russian newspaper wrote: "The previously mentioned committee of the Interplanetary Department of Inventors has now officially invited Max Valier, an authority in this field of work which concerns the whole of humanity, and one of the greatest fellow-workers striving to achieve the common ideal, to take part with his material in the World Exhibition at Moscow." Moreover, at that time, Valier had also received an invitation from a leading personality of the German Colony in Porto (Portugal) to go there and to give lectures on his project of the transocean rocket ship for high altitude flight. In addition, an influential person from a large Mexican mining company had got in touch with Valier. . . . - In New York, London, Paris, Zürich, Copenhagen, - everywhere, the leading newspapers published detailed reports on the brilliant projects of Max Valier.

Count Zeppelin had been ridiculed in Germany during his years of struggle at the turn of the century, whereas he received temptingly favorable offers from abroad, which, however, he refused. The same now happened in the case of Valier. He had sent in his projects for the progressive development (which he had already published in newspapers, in many illustrated magazines and lectures) at the invitation of the Moscow Committee of the International Astronautical Show. He felt that it should be shown there that work was being done on the problem in Germany too. But that he had refused offers from abroad specifically directed at himself can be seen from the letter written by his sister on March 21, 1960, in reply to another question (we had asked for information on the pronunciation of the name Valier).

She replied:

> "In Bozen the name was pronounced as follows for the whole Valier family: V like father and not W. And a long ie as in parlier. Uncle Gotthard himself, who lived for over 20 years in Paris, and who was

later a baker in Innsbruck, did not make his name French, although at that time it would have been a very obvious thing to do.

The abnormal urge of many Germans to be more attached to everything which is foreign than to the dear fatherland was really not felt by Max. But it was all the same to him whether Valier was pronounced in one way or another, since he did not attach importance to it.

Max Valier was German, personally he did not want to be anything else. When he received an offer from America to go there in order to be able to perfect his projects with financial assistance, he refused. Even Moscow had made him an offer at that time. But he wanted to make his inventions and his projects available to his fatherland without fail.

He said to me: 'It would be ridiculous if one could not even become great in one's own fatherland.' - and you yourself know how things went with him there.

If he had not been so considerate he would have certainly had an easier and better life. But, after all, I am pleased that he remained faithful to his fatherland."

With tremendous diligence and personal unpretentiousness Valier tried to raise the money necessary for the first fundamental rocket tests by writing articles and by lecture tours. In doing so, Mrs. Thea Lindemann facilitated matters for him considerably by her "Organization for Culture Lectures." Her letter-head read: "Society for the Promotion of German Culture Expeditions, Registered Association, Berlin-Wilmersdorf". She helped many a person who made expeditions through still unknown regions of Africa and Asia. She was called the "mother of explorers". (Her protégés included Filchner, who explored Tibet, the "sea-devil" Count Luckner, Colin Ross, Rolf Italiaander, who travelled through Africa, and the female aviator Elly Beinhorn.) She now also took care of Max Valier, organizing his lecture tours and making the necessary preliminary announcements. She had a great deal of experience in this domain and knew what appealed to the public. An attractive lecture program was printed according to her instructions and was sold at the entrance to the hall. One sees on this program a picture of Max Valier, flanked - somewhat showily, it is true, but nevertheless concisely and clearly - by an enumeration of the problems to be dealt with by the speaker. The inside pages of the program show four of his sixty lantern-slides, as well as a report which the Weser newspaper had published on December 9, 1926, about Valier's lecture; on the back there are further views of the press (see Appendix 8).

In 1958, Alfred Fritz wrote "Take-off into the Third Dimension" (Start in die Dritte Dimension) (Herold-Verlag).

From it we quote:

On June 5, 1927, in the parlor of an ale-house in Breslau, the "Society for Astronautics" was founded. Johannes Winkler took the chair - after Valier

had had to refuse on account of his many tours - and he became the editor of the first technical journal "Die Rakete" (The Rocket), which appeared until 1929. In the space of only six months the society, which was soon known all over the world as the "VfR", already had about 500 members. . . ."

On August 20, 1927, Valier, then in Munich, wrote the last letter which has been preserved in the Oberth-Valier correspondence:

"Dear Professor,

It is a pleasure for me to hear via Breslau that you have accepted our invitation to join the newly founded Society for Astronautics, but I would find it unworthy of your merits if you were to appear only as a simple member. For this reason I have, today, informed those in Breslau that I would greatly approve of your being elected to the executive board. .. I hear that you, too, will soon have finally completed the third edition of your book - and I hope the same thing for myself. I have not been able to write any more on the book from financial necessity, for I have had quite literally to keep on working from one day to the next so as not to starve, especially in the last weeks. No amount of idealistic success can blind me to this fact; it has cost me much privation. You can see how things stand at the moment with my project from the enclosed article. ... In addition, I have convinced myself, on the basis of the discussions and the tests in Rottweil, that powder rockets will suffice for the first take-off, and probably also for breaking the present-day altitude world record, and so I shall start by using these in order to quickly forge ahead with the first takeoff at all costs. I am doing this in the conviction that then all the world will believe in our projects and everyone will also support us when we wish to make further progress. - I should welcome it very much if we were, from now on, to collaborate more again, both in private and in public. ... I would also welcome your being represented in the "Rakete" with an article in the near future, for I am afraid to say that the last two issues were written almost exclusively by Mr. Winkler and myself.

You have been silent for a long time and I was beginning to fear that this might be due to some misunderstanding, but I very much hope that this letter will suffice to revive our friendly relations of the past.

With nothing more to say for today, allow me to express my respectful regard and my unchanging feelings of friendship.

Yours faithfully
Max Valier."

But there was no reply.

On May 23, 1930, in an aricle entitled "München und der Erfinder" (Munich and the inventor), the editor of the Münchner Neueste Nachrichten, who knew Valier and his aspirations and efforts well, gave a retrospective description of Valier's rocket years which began with his collaboration with Oberth:

> "In 1923, the young professor Hermann Oberth, a native of Transylvania, had come to Oldenbourg and had offered for publication the booklet which formed the prelude to Valier's new work. Oberth had the commendation of an eminent South German astronomer in his pocket, and the publishing house accepted the work on an off-chance. But the prospects of this off-chance actually coming off were rather bleak at first. A year later, Max Valier came to the same publishing house and declared that he wished to rewrite Oberth's book in a way which was intelligible to all, since it was of great consequence to him that Oberth's ideas be promoted.
>
> This, then, was originally Valier's aim when he set out to make propaganda for Oberth's ideas. Success did not fail to appear. With the publication of Valier's book "Advance into Space" (Vorstoss in den Weltenraum) interest in Oberth's book rapidly increased. The editions of the two books were out of print in no time. New editions were published. The last, third, edition of Oberth's book which, after further revision, had developed into a handsome volume with the new title "Way to Space Travel" (Wege zur Raumschiffahrt), even received the prize of a French learned society of astronomers, the value of which in money was, moreover, doubled in recognition of the great importance of the work. Thus in Munich Max Valier became the pioneer of Oberth's book, of the idea of rocket space travel.+)
>
> But Max Valier did not content himself with this, he himself began to design and to work out projects on the future form of the space rockets - for the rocket seemed to him, too, to be the only correct possibility of propulsion. In contrast to Oberth, Valier was of the opinion that the future form must be developed from the modern airplane. Moreover, Valier's aeronautical knowledge, acquired whilst serving in the Austrian flying corps during the World War, played a part. In the course of his experiments, Valier set up his own theory of the development of the space rocket, based not on visionary prototypes but on serious scientific activity." etc.

+)From then on, Oberth's physical considerations and calculations met with silent recognition from academic circles in Germany and Austria, and no one declared in public any more that Oberth 'proceeded from false physical assumptions' in his rocket project.

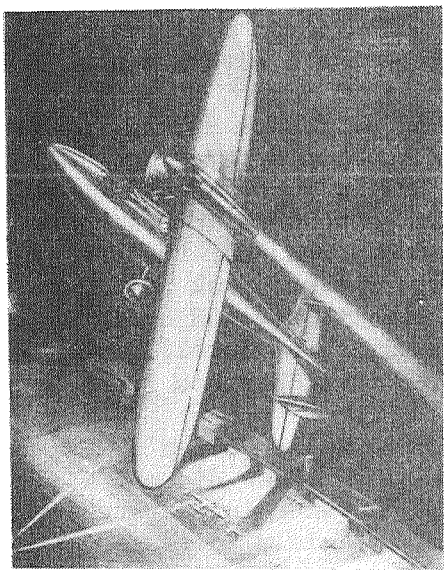


Figure 14.: Design of a sporting plane with propeller engine and rocket engine in tandem arrangement.

(For cross-country flight the propeller engine is sufficient, for a short taxiing takeoff and for acrobatic flight the rocket engine provides additional power.)

Fritz von Opel finances Valier's Project.

(a) Systematic Investigation and Further Development of Powder Rockets.

How the second section of his work for astronautics begins is related by Valier himself on pages 189/90 of "Rocket Travel" (Raketenfahrt):

"Unfortunately, the author lacked money just as much as he lacked the technical resources necessary for him to be able to produce evidence of the correctness of his assertions by means of a practical demonstration. In vain, he tried to provide the resources for completing the project on his own efforts, by means of far more than two hundred lectures given in all German-speaking countries, and by his literary activity. Moreover, in summer 1927, the reports that foreign countries would soon come forward with the first take-off tests in the field of rocket engines, increased. In this position, he finally decided in late autumn 1924 to abandon the idea of carrying the project through on his own, and to seek support from others.

The project as it stood at that time, and which had, initially without success, been offered to various distinguished persons and to people in influential positions, consisted of four stages of execution."

(These four stages have already been outlined on the occasion of the lecture at the Scientific Society for Aeronautics; see p. 239)

Valier continues:

> "In actual fact after a short explanation of his project, the author succeeded in finding the sought-after financer in the person of the well-known industrial magnate and sportsman, Fritz von Opel, and by inviting offers from pyrotechnical factories he found a competent collaborator in the person of Engineer F. Sander."+)

Thus in January 1928, Valier was able to begin with the first stage of his program, the systematic investigation of powder rockets. He describes the testing installation as well as the object and the result of the tests in:

"Rocket Travel" (Raketenfahrt) p. 200 ff. Verlag Oldenbourg, 1929

"The Development of High Performance Powder Rockets.

It is really incomprehensible how, in view of the general technical progress in the last decades, the scientific development of the rocket could have been so neglected that even at the present time we are still working altogether according to age-old principles. One cannot find in any textbook a formula with which the performance of a rocket may be calculated in advance in the same way as a bridge construction of a particular bearing capacity, or an engine of a specified horsepower.

This is why, on commencing the systematic tests at Sander's in Wesermünde in January 1928, after entering into association with Opel in the fall of 1927, the author first had to strike out on his own in quest of the laws governing rocket performance. Although the authentic results cannot be communicated, for reasons of secrecy, it is intended to give a general outline of the trend of the investigation.

To begin with it was necessary to build an appropriate measuring apparatus in order to obtain the curve of the jet reaction as a function of time. A device resembling a decimal balance (cf. Figure 15) proved suitable for this purpose. The rocket to be measured could be placed in a holder in various grooves along the top edge of the beam of this device, while the edge of the spring balance geared into similar grooves along the bottom edge of the beam (this permits arbitrarily large or small transmission ratios within the limits of variation of the power arm and the leverage of load). The spring balance moved both the customary pointer on the round instrument dial and a necessarily connected recording arm which recorded the pressure of reaction of the rockets in kilograms on a paper tape on a drum made to rotate steadily by a clockwork mechanism (cf. Figures 16 and 17). Obviously, the measuring apparatus is calibrated.

+)On December 8, 1927, the contract was made according to which Valier offered the Opel company his project of rocket propulsion to be jointly realized. In it, manned rocket flights were already scheduled as the third stage.

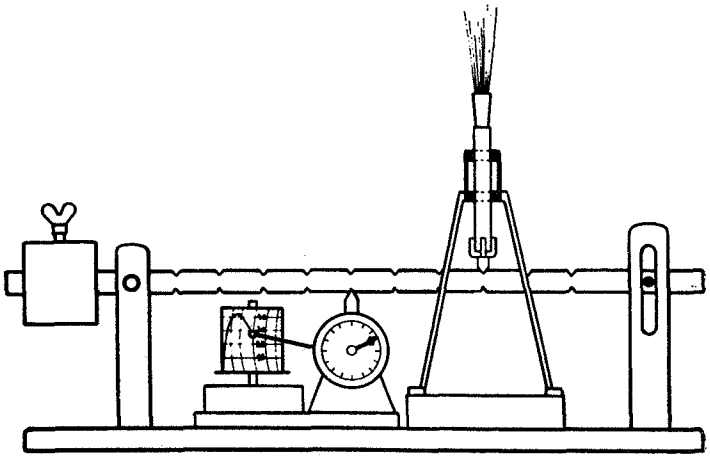


Figure 15.: Device for measuring the rocket force (from "Rocket Travel" (Raketenfahrt) Figure 51). This simple measuring device had already been planned earlier on by Valier, and on February 1, 1926 he described it to Professor Oberth in a letter.

From the graph one can immediately read off the powered phase in sec and the respective reaction in kg, the maximum value being recognizable as the highest point of the curve. The area enclosed by the curve (whereby one must

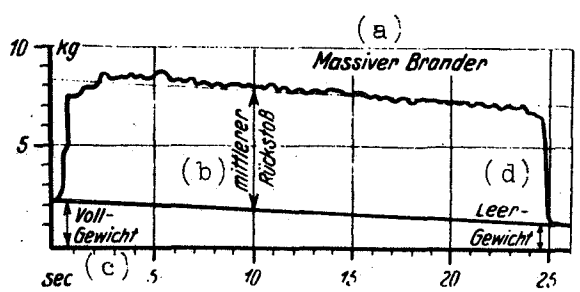


Figure 16.: Reaction force of the rockets.
Force-time recording of the above measuring device (from "Rocket Travel", Figure 52)

Key:
(a) Massive fuse
(b) Average reaction
(c) Weight full
(d) Weight empty

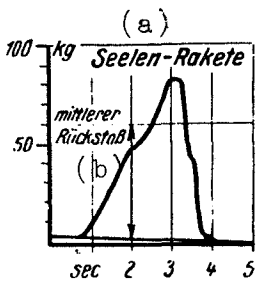


Figure 17.:
Key:
(a) Bore rocket
(b) Average reaction

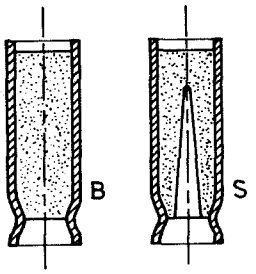


Figure 18.:
Fuse (B) and
bore rocket (S)

The fuse has a massive powder charge. During the whole of the burning-out time its incendiary area is equal to its cross-sectional area.

The bore rocket has, as a result of its cavity, a considerably greater incendiary surface. Therefore it burns out much more quickly than the fuse and it develops a considerably greater reaction force.

deduct the decrease in weight from the weight full to the weight empty), as the product of the reaction force in kg × the powered phase in sec, serves to some extent as a measure of the motive power of the rocket tested. (Just as a working engine, together with the supply of fuel which it carries along with it, can be said to effect so many meters per kilogram, so it can be said that a particular rocket effects so many kilograms per second until its propelling charge is consumed.) If one divides the area of the curve mentioned previously by the powered phase, one obtains the average reaction R. If, on the other hand, one divides the total weight of the propelling charge by the powered phase, one obtains the amount of powder m vaporized per second (in kg of weight and, by further dividing by g = 9.81, in the kg of mass necessary here). But from the last two, according to the fundamental equation of rocket propulsion R/m = C there results the exhaust-gas velocity of the combustion gases. This is again directly proportional to the dynamic efficiency, for the latter is equal to the exhaust-gas velocity actually attained, expressed as a percentage of the highest exhaust-gas velocity theoretically possible.

The systematic experiments for the development of high-performance rockets were suitably begun with fuses which were packed with powder and compressed under maximum pressure, because only with these fuses is the incendiary area exactly equal to the sectional area of the caliber in cm^2, and because it remains unchanged throughout the whole burning-out time. Proceeding from the full width of the caliber, reducing rings with different bore diameters were attached to the upper end of the cylindrical metal casings. The internal diameter of these rings is known exactly, so that the ratio of the incendiary area to the discharge openings can be calculated precisely.

Of course, the propelling charge must be accurately counterbalanced.

If, for example, the caliber were 50 mm, it would be appropriate to fit rings with the following inside diameters, beneath which are listed the corresponding ratios of the incendiary areas to the discharge opening:

ϕ = mm. .	50	40	30	25	20	18	16	14	13	12	11
$F:f$	1,00	1,56	2,78	4,00	6,25	7,72	9,76	12,76	14,80	17,38	20,65
ϕ = mm. .	10	9	$8^1/_2$	8	$7^1/_2$	7	$6^1/_2$	6	$5^1/_2$	5,25	5,00
$F:f$	25,00	30,9	34,6	39,1	44,5	51,0	59,3	69,5	82,7	90,60	100,0

Of course, one then begins the deflagration on the spring balance with the greatest opening, continuing down the scale until the explosion occurs. Since chance influences may easily have been involved just at the critical limit of this explosion, the measurements are repeated for purposes of verification with the two or three inside diameters lying closest to the explosion limit.

The result of such a series of measurements is as remarkable as it is instructive: From a full caliber opening down to half of the same, the burning time and reciprocal amount of powder vaporized per second only vary slightly and the reaction and the exhaust-gas velocity remain low. (Therefore in Figure 19 this section of the curve is omitted.) But if the contraction becomes less than 1/3 of the caliber, the incendiary surface ratio becomes 9:1 and more, in which case the burning time begins to decrease, perceptibly at first, and later more and more rapidly until, at an inside diameter of approximately 1/8 of the caliber, or an incendiary surface ratio of F:f = 64:1, an explosion occurs. By using well-molded nozzles instead of the contraction rings, one can of course push back the explosion limit to a neck diameter of 1/9 - 1/10 of the caliber or to an incendiary surface ratio of F:f = 81:1 or 100:1, but there will nonetheless come a point at which the explosion inevitably occurs, no matter how thick the walls of the casing may be. In the curve, this is illustrated by the point where the curve of the powered phase falls to zero, while the curve of the amount of powder vaporized per second rises up to infinity.

This behavior corresponds, in all respects, to what might be expected. The shape of the reaction curve and of the exhaust-gas velocity curve, on the other hand, seems strange. It is correct that the reaction increases as the opening is narrowed down, until the explosion limit is reached, but towards the end it increases only slowly, for - however paradoxical this may seem - the exhaust-gas velocity, which is calculated according to the procedure indicated above, already decreases again a considerable time before the explosion pressure sets in, and instead shows an initially unexpected maximum value when the opening is narrowed down to approximately 1/6 of the caliber, or when the incendiary surface ratio is approximately 36:1. This fact is just as important as it is encouraging for the construction of high-performance rockets, since the logical conclusion to be drawn from it is that one does not need to get as close as possible to the point of explosion by using very thickwalled casings, but that one can attain the highest possible exhaust-gas velocity for the type of powder concerned already with quite large openings and low chamber pressures, i.e. with quite low empty weights.

If one repeats the first series of experiments in the suitable range with well-formed nozzles, it becomes apparent that one can not only double the exhaust-gas velocity in the case of suitable neck diameters, but that one can also force the former explosion limit down, so that greater incendiary surface ratios become possible as a result of laminar flow. This of course means that, although the exhaust-gas velocity is already decreasing, a somewhat higher product might still be obtainable in the form of the reactive force, since the mass vaporized per second is increasing. (Rockets, just like aircraft engines, have a maximum economy ratio and a maximum performance ratio, which in this case pertain to the incendiary area.)

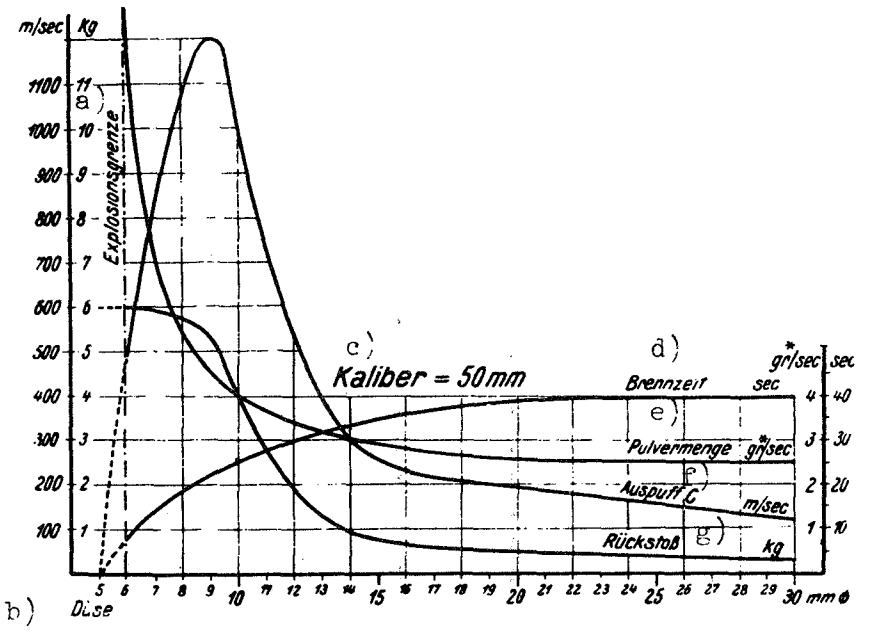


Figure 19.: Result of a systematic series of measurements: the maximum exhaust-gas velocity is before the explosion limit (from "Rocket Travel" (Raketenfahrt), Figure 53).

Key:
(a) Explosion limit
(b) Nozzle
(c) Caliber = 50 mm
(d) Powered phase
(e) Amount of powder
(f) Exhaust-gas velocity
(g) Reaction

With a fairly well-formed nozzle[+)] and black powder, one can count on obtaining 1/3 kg of reaction per square centimeter of incendiary surface. While this holds good initially for solid fuses, this formula also proves to be excellent for all hollow bore rockets, irrespective of whether these are beaten on a tapered mandrel, cylindrically bored, or cylindrically bored in stages. One then only has to take the respective incendiary surface into consideration."

There follow reflections on the ordinary rockets used in firework displays, and on ships' rescue flares, and also on the capillary fissures in the powder composition of the rocket, which cause explosions because the incendiary surface is suddenly enlarged incalculably by a fissure. - In order that the interest aroused in the reader for rockets does not cause accidents, Valier then stresses:

[+)] In the previous theoretical part of "Rocket Travel", Valier explained the effect of the nozzle in the section "Problems of Chambers and Nozzles" (pp. 132-139) and demonstrated by means of a numerical example how much the thermal efficiency of a rocket can be increased by fitting a good nozzle.

"Even here, one should not fail to warn any uninitiated person against carrying out rocket experiments. For if one wishes to attain high performances, one must deliberately go right up to the explosion limit. Even the author and the engineer Sander had to resort to conducting the experiments on a shooting range, where they were able to keep track of events from behind timbered walls several inches thick, looking through observation holes with scissor telescopes and film cameras. In the beginning, heavy explosions occurred almost daily, destroying expensive measuring apparatus. Sharp-edged fragments of the steel casing flew about and penetrated deep into the hardwood walls; sometimes even white-hot nozzles weighing several kilograms shot more than 100 m up into the air, and on one occasion the powder charge was catapulted out whilst still unburnt, almost causing a forest fire so that the fire department had to step in.

In view of these difficulties, many pyrotechnists in the past had come to be of the opinion that it would never be possible to attain ceilings higher than 2,000-2,500 m with powder rockets. Even Congreve was obliged to abandon the field 80 years previously in the face of the improved performances of the heavy artillery, because he no longer saw any way out of the alleged impasse in which rocket development had landed.

But that there <u>is</u> nonetheless a way out has been proved above all by the success of Professor R. H. Goddard in America, who apparently already in 1917-1918, conducted the same series of experiments that the present author and engineer Sander carried out in the winter of 1928, arriving at the same laws and findings."

These pages show that, as soon as he had the financial possibility to do so, Valier actually carried out and evaluated his already long-planned systematic series of tests. From these tests he obtained information on the exhaust-gas velocity and the force of reaction, and on how these are influenced by the ratio of the incendiary surface to the discharge profile. In particular, he observed the strange phenomenon that shortly before the explosion limit the reaction force, which has hitherto been rising, drops (Figure 19), and he also noted the great influence of the nozzles on the reaction force and the explosion limit.

Nowhere in the technical literature of that time was anything resembling what Valier published in his book "Rocket Travel" (Raketenfahrt) (Munich 1928, Oldenbourg Verlag, pp. 200 to 208) to be found.

After this technical report, he says in the last paragraph of the chapter "Development of the High-Performance Powder Rockets":

". . . In spite of everything which came to pass later and which led to the separation of the author from Opel and Sander by reason of scientific and personal differences, it should be pointed out here once again that it was indisputable to the merit of Fritz von Opel that he took up the author's project, that he recognized its significance and supported its realization with large sums of money, while Sander likewise worked to the best of his ability as a pyrotechnist in the common cause.

Only in this way was it possible to achieve in 2 months what it had previously not been possible to do in 50 years - namely, to create rockets capable of proving that rocket travel on the ground and in the air is possible for a human being. ..." (pp. 207/8).

(b) Rocket Travel (taken from the book of the same title by Max Valier p. 209 ff.)

"As early as in the middle of February 1928, the systematic tests carried out at that time by the author together with Sander in Wesermünde, on the development of high-performance rockets of a caliber of 5 cm or 9 cm, had turned out so well that he was able to announce to Fritz von Opel that, pyrotechnically, everything was ready for the first rocket-propelled car in the world to start.

But three more weeks were to pass before he could carry out his plan. For various reasons, the gathering of all the main people concerned could only be scheduled for March 11, in Rüsselsheim am Main, the head-office of the Opel works.

In the meantime, of course, nobody at Wesermünde remained idle in perfecting the rockets. But the author particularly insisted on personally undertaking a few trial trips in complete secrecy at Bremerhaven, in an ordinary 4 hp Opel automobile fitted with rockets, before going to Rüsselsheim, in order to be absolutely sure of success there, and also in order to safeguard their priority."

By means of starting and coasting tests, Valier had ascertained that:

at 18 36 72 km/hr the 4 hp Opel[+)] has a total resistance of about 12 22 63 kg, when the weight of the automobile (including the driver and rockets) = 800 kg.

It should be quite possible to accelerate this mass and to overcome the tractional resistance with bore rockets of 80 or 200 kg thrust and long-burning fuse rockets of 18 kg thrust. - Valier reports:

"Unfortunately, the author's intention to personally undertake the first rocket trip in the world failed because he did not have a car of his own in which to do so, and because Sander could not be persuaded to place his privately-owned 4 hp Opel at his disposal for this purpose."

Even on March 12, after arriving in Rüsselsheim, it was found that the special car, which had been under construction for a long time, was still not finished. But there were, of course, plenty of 4 hp Opel chassis to choose from. So a solid wooden firing platform was built on one of these chassis, onto which the rockets could be fastened, and the car was driven onto the Opel racetrack. At about three o'clock in the afternoon, the strange vehicle was ready to go. At the last moment,

+)4 hp means: 4 hp according to the rating formula (in actual fact 16 hp).

another small dispute broke out amongst the principal participants, over who should be the first to drive the car. Finally, the former racing driver Kurt C. Volkhart was entrusted with this honorable task.+)

In order to take no risks, only a 50 mm bore rocket producing a thrust of 80 kg and a 90 mm continuous fuse rocket producing approximately 18 kg thrust were built onto the car for the first trial run, and since there was no igniting machine available, they were ignited with the fuses which are generally used in pyrotechnics, after Volkhart had taken his place in the driving seat.

Seconds of tension passed whilst the fuses burned. Volkhart sat at the steering wheel as if he was going to be shot out of a cannon, ready to muster all the skill of an experienced racing driver to keep the car under control. All the other spectators sought protection in the event of an explosion and excitedly waited to see what would happen. Only Sander and the author had other worries: we were wondering whether the two rockets, with a combined thrust of only 100 kg, would be able to get the car, which was much too heavy for them (weighing 600 kg with the driver), moving at all! ...

Finally the fire set off the rockets, from which there instantly shot forth a huge cloud of smoke accompanied by a tremendous hissing noise, the two jets of fire scarcely distinguishable through the smoke. With a slight jerk, the car did indeed begin to move. But it had hardly attained a brisk walking pace (about 5-6 km/hr) when the thrust rocket burned out, leaving only the fuse rocket hissing, the subsequent burning of which was just enough to propel the car for half a minute more at the speed of a steamroller. The whole run had lasted about 35 seconds, covering a distance of little more than 150 m. This was the first rocket trip in the world.

Fritz von Opel, who was not pleased with this performance, had to make an effort not to laugh and Sander and the author had to stand his ridicule for a while, because von Opel quite seriously believed that the rockets were no good. For this reason we decided to sacrifice a 50 mm bore rocket and to send it up into the air. When this rocket rose to an altitude of a good 400 meters in about two seconds at a speed similar to that of a missile, even though the rocket was neither equipped with a conical head nor provided with a correctly dimensioned guiding rod, the confidence of the spectators in the power of rocket propulsion again increased considerably."

For a second test run, more powerful rockets were mounted onto the car, a bore rocket of 80 kg and one of 220 kg thrust. After an hour everything was ready to go. In order to avoid making the rockets start the car from a standstill, where they function with low efficiency, Volkhart first worked up a speed of 30 km/hr with the car engine, upon which he put the engine into neutral gear.

+)Opel had settled this dispute: "Volkhart will drive. He is a racing-driver."

"2 seconds later, or 20 seconds after the fuse had been lit, the rocket fired. This time the car shot forward with a tremendous burst of speed, like an arrow from a bow. In less than 1 1/2 seconds it increased its speed from 30 to approximately 75 kilometers per hour, so that the acceleration attained half the force of gravity. The large rocket then burned on alone for 1 1/2 seconds more, whereupon Volkhart let the car coast and then brought it to a standstill. On this run he had already felt the counterpressure of the acceleration very perceptibly, and considered it to be at least equal to the starting torque of the most powerful racing cars. ...

Thus the possibility of rocket propulsion for manned cars was incontestably proven by this remarkable run.

As it had been decided to continue the test runs with rockets only after completion of the special car which was already under construction, four more weeks passed. ...

On April 11, at 3 p.m. the new car (later called the "Opel Rak I"), externally still resembling a racing car, but provided with a bodywork to accommodate 12 individual 90 mm rockets, was ready to go. This time, an igniting machine with electric contacts was mounted on an insulating washer over which a clockwork-driven contact finger passed at regular intervals in order to ignite the rockets one after the other in the order in which they were connected to the contacts by the cables. The clockwork mechanism, however, could be started or stopped by means of a foot pedal operated by the driver according to his preference. Once again, just before the start, a serious dispute arose over who should have the right to drive, the author claiming that it should be he. But he was outvoted and the driving of the car was once again placed in Volkhart's hands.

Even the tests made that afternoon still took place in utmost secrecy on the cordoned-off Opel racing track at Rüsselsheim, neither the public nor representatives of the press being admitted. Aside from a few gentlemen from the Opel works, only Otto Willy Gail and Engineer Heinz Beck had been invited to witness the event on the part of the author."

During the following runs the cars were always started from a standstill with rocket power. For the first start, 6 rockets were installed (one of which did not ignite). A speed of 70 km/hr was attained in 6 seconds.

Of the second start with 8 rockets, Valier reports:

"This start was also successful and the car reached a speed of at least 80 kilometers per hour. Just as the third bundle of rockets was about to ignite there was an explosion. But the protective arrangement devised by the author together with Sander stood up to this explosion so well that neither the driver Volkhart nor the car suffered the slightest damage, and the car, which was propelled forwards with a jerk, travelled on smoothly immediately afterwards under the thrust of the

fuse rockets, and covered more than half of the oval Opel racing track. Once again a bore rocket had not ignited. The distance covered was now almost 1 km. In view of this success, the representatives of the world press were invited to the next run. ...

On the morning of April 12, in Rüsselsheim, in the secret test workshops of the Opel works and on the racing track, everyone was busy making preparations for the first official start of the first rocket-driven car in the world. ...

This time, the full propelling charge was used, 12 rockets, all of which were bore rockets arranged to be ignited in pairs, were to impart to the car a speed of 120 km/hr and - what was at least Fritz von Opel's desire - they were to propel the car once around the 1,500 m long course in an elegant run. Things turned out somewhat differently for, as was found out afterwards, several ignition wires fused prematurely, so that in actual fact only 7 rockets deflagrated, while the other 5 were not ignited at all. Nevertheless, the start was an impressive sight because, at the very second the starting signal was given, the car shot away with a breath-taking burst of speed. In 8 seconds at the most it had already exceeded a speed of 100 km/hr after the second ignition and it tore past the stand into the curve of the racing track. In doing so, the jet of fire disappeared, only reappearing when the car reached the second straight stretch of the Opel track, for Volkhart had "throttled down", if this expression is permitted here, and had only reignited on coming out of the curve. The fourth ignition took place when the car had already covered 3/4 of the Opel racing track; it was only weak, since only the seventh rocket set alight, the eighth already being out of action. Thereupon Volkhart allowed the car to coast and just made it to the starting point from which he had departed. Counting the coasting distance, therefore, the lap had been successfully completed."

The press now reported on this run in the headlines. -

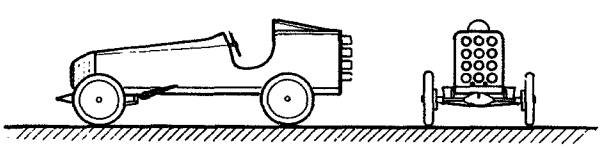


Figure 20.: Opel-Rak 1

The prospect of gaining publicity had induced Opel a few months ago, to enter into Valier's bold rocket projects. Now, success showed that his reflections and confidence in Valier's cause were correct. The name Opel was on the front page of all the newspapers and that meant a great deal to the manufacturer of passenger cars. - But it would be wrong to think that it was

only the prospect of publicity and profit that had induced the junior boss to take up the rocket cause. Fritz von Opel's sporting nature did also play some part in his decision.

Be that as it may, Opel had given the money for the tests and success now began to be forthcoming, on a greater scale than could ever have been achieved by the most expensive pages of publicity. The whole world was talking about Opel.

Of course, there were newspapers for whom Max Valier was the center of interest, for many editors had already got to know Valier and his projects in a lecture in times past.

For example, the Lahrer Zeitung of May 14, 1928 writes:

"Max Valier, the inventor of the rocket-driven car.
By Dr. Martin Ritscher - Wernigerode.

In addition to the valiant conquerors of the ocean on the east-west passage, who are mentioned again and again, another name has been attracting the attention of newspaper readers in recent weeks - once again the name of a German - Valier. This man, long known to a small circle of people as Germany's first pioneer in the field of spaceships, came to the knowledge of all with the news of the first successful test run of the Opel rocket-driven car. And unless we are mistaken, his name will still be mentioned frequently in the future; for this first big success is for him the first step on a precisely traced out path. In all modesty he speaks of what has been achieved so far; with every confidence and matter-of-factness he speaks of what is to follow. These are fantastic ideas which we here see striving towards the realm of reality - fantastic even if one does not consider the imaginary spaceship: for, in these projects which aim at a rocket plane, it is a question of attaining speeds which make our existing records, which have already been raised so high, pale into insignificance: Berlin-New York in barely an hour! And jet nothing whatsoever about this man is suggestive of his being a visionary or dreamer. On the contrary, his nature is based on the most level-headed objectivity. With his steady look and his clear mode of expression, this lanky person of only thirty-three years of age has all the traits of the technician or engineer calculating with facts.

Born of German parents (pronounced Falier) whose ancestors emigrated from Bavaria to Bozen, he received his scientific education before and after the war at the universities of Innsbruck, Vienna and Munich. During the war he was able, as technical officer in the Austrian Flying Corps, to gain wide practical experience with which to realize the ideas governing his whole life and works. He himself says that the only reason why he was not able, already years ago, to prove the practical applicability of the rocket as a driving force, which has now been demonstrated in the rocket-driven car, was that he lacked the necessary means. The attempt to raise the first comparatively small sum of 10,000 marks which was necessary for his projects, by writing articles, books (for example

"Advance into Space - a technical possibility") and finally by giving lecture tours, failed. What one year had produced dwindled away again in the next. Thus, what had been achieved up to now - which was made light of by many as being mere fanciful thinking - would still be on paper this very day if Valier had not found in Fritz von Opel a practical supporter of his ideas. ...

As is well-known, a new test is to be undertaken shortly on the Avus speedway in Berlin, with an improved Opel rocket-driven car built in the form of a grenade. But none of these tests are by any means intended for the creation of a new type of racing car; they are only a means to an end. With these tests conducted on the well-established solid earth, experience is to be gathered for the forthcoming transfer of the same principle to travelling in the air. The next stage is the sailplane with rocket propulsion; the preparations are already under way in the Rhön mountains for the flight of this sailplane. This will be followed by the all-metal airplane into which powerful rockets will be built; with this all-metal airplane Valier hopes to be able to prove the possibility of rocket flight before the end of this year. ..."

It may be that Opel was annoyed by these and similar press reports and said to himself, I have not placed all that money into the tests for Valier to be mentioned.

By the way of addition, an account must be given of how Valier made use of the waiting time, after the very first rocket trips on March 12, had succeeded, until the rocket-driven automobile designed by Volkhart was ready to be driven, in order to begin immediately at the next item of his program which was called: Aircraft with Rocket Propulsion.

On March 13, he went to the Rhön mountains with Sander to speak to Lippisch and Stamer and to inspect the sailplanes and model airplanes which were built there. For the installation of rockets into aircraft was now to be considered thoroughly and concretely.

Opel had agreed with them that no mention at all would be made of rocket propulsion until the run with "Opel-Rak 1" had taken place before the press. Fritz Stamer[+)] now relates how this strange discussion took place in "12 Years on the Wasserkuppe" (12 Jahre Wasserkuppe) (Verlag Pohl & Co., Munich 13).

[+)] Fritz Stamer, flying officer in the First World War, was on the Wasserkuppe from 1921 onwards, this high mountain in the Rhön Mountains, on which former war aviators had erected a few hangars in order to fly again. At that time, aircraft engines were forbidden for Germany. "Then one remembered the great German, Otto von Lilienthal, the founder of aviation. He flew without an engine! ... In spite of the most difficult times of distress, since 1920 German gliders have held their gliding competition on the Wasserkuppe in the Rhön Mountains, ..." - reported Stamer.
(Footnote continued on page 153.)

"One day, two gentlemen came to see Lippisch and myself. They explained that they had to have an aircraft after the type of the tailless machines for a very special purpose. The two gentlemen, who did not disclose their names, were evasive about the purpose for which they wanted the airplane. On our objections that for the utilization of models without tails we must know somewhat more, we then learnt that an engine with a very low weight but with as great a thrust as desired was to be installed in the airplane and tested. But behind the engine there were to be no more structural elements at all. These statements seemed rather fantastic to us, and so we did not take the matter very seriously. Nevertheless, we decided to remain in touch on account of such a machine. Several days later an illustrated journal fell into our hands by chance, in which were printed illustrations of Fritz von Opel's rocket runs. Amongst the gentlemen photographed in front of the rocket-driven car we again found our visitors. They were Valier and Sander. We now knew all about the mysterious engine. We now waited to see how things would turn out.

We soon heard of it again. Tests were to be under taken as soon as possible not only with models but also with manned aircraft."

We must now return to the subject: The rocket-driven automobile.

In "Rocket Travel", Valier reports on the conference held after the successful exhibition before the press in Rüsselsheim on April 12, and also on the following events:

"Fritz von Opel decided to abandon the test runs on the racing track of his firm in Rüsselsheim, the condition of which did not permit speeds higher than 120 km/hr, and he proposed making the next start of a rocket-driven car on the Avus speedway in Berlin. And for this a new, considerably heavier and lower special car was to be built for a capacity of 24 rockets. This, of course, would take quite a long time.

It was thus all the more surprising when it was suddenly announced, a few days after the middle of May, that Fritz von Opel would personally start a rocket-driven car on the Avus speedway on May 23, at 10 a.m. For, according to the agreement made immediately after the runs which took place in the middle of April in Rüsselsheim, the author had demanded the right to the first run on the Avus speedway for himself, after which Volkhart, as a racing driver, wanted to attempt to break the speed record. In actual fact, Fritz von Opel had already undertaken a short test run with the new car (named "Opel Rak 2") on May 21, during which a small

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The "Father of the Rhön Mountains" Ursinus has described the development of the sailplanes, which were built by the aviators in their primitive barracks, in series in his magazine "Flugsport". The wooden birds ... planed in the anabatic wind above the slopes of the Rhön Mountains. A completely new, perfect form of aircraft came into existence there, the narrow cantilever wings with a large span. - The theory of aerodynamics of the influence of the aspect ratio on the angle of glide was tested there on flying sailplanes.

explosion and ignition difficulties are said to have again occurred. Nevertheless, on May 23, he took his seat in the car before approximately 2,000 invited spectators, including representatives of the press, photographers and people from the film world, without showing a trace of agitation, in order to prove to the world that the progress of rocket propulsion could no longer be stopped.

The car was loaded with 24 bore rockets of a caliber of 90 mm and an average thrust force of approximately 250 kg each. The total amount of powder was about 120 kg, enough to blast a three-storied house into the air. The weight of the car, including the driver and the rockets, was well over 800 kg. It is difficult to give exact information on the firing order. ... In any case, all 24 rockets were burnt out at the end of the run, not one had exploded and there was not one rocket amongst them which failed to ignite - a real stroke of luck, for otherwise there would certainly have been some injured amongst the spectators, who crowded around the speedway in irrational unconcern.

That the run succeeded was due as much to the skill of the driver as to his incredible luck, for as the last series of rockets spat out their cones of fire the car began to skid dangerously, its front wheels lifting off the ground as a result of the sponsons having been fitted on the car the wrong way. ..."

It was a good thing for the rocket cause that Valier did not stay away from the race track resentfully, but appeared at the Avus speedway on May 23, for the great event, that he brushed aside his ill-humor and did not betray to the spectators how cheated he felt, but offered his hand to Opel in front of the press photographers. Thus, there were no outward signs of discord.

We have been told of the impression Opel's well-organized bold Avus run made on the sports world by Manfred von Brauchitsch, who published a series of articles in the Berliner Illustrierte in 1935: "Avus, the novel of a highway" (Avus, der Roman einer Strasse). The chapter on this rocket-driven run on the Avus reads:

"The Rocket-driven Automobile.

In those days in Munich there lived the astronomer and physicist, Max Valier. He had got the idea into his head that even if he could not realize a dream of humanity he would bring it one step nearer to realization...

The opinions of the scientists on Valier's ideas were divided, his books and lectures obtained approval and rejection to the same extent. Then the inhabitant of Munich made the acquaintance of Fritz von Opel, the junior boss of the large automobile works, and the enterprising sportsman who had won the first motor race on the Avus speedway seven years earlier decided to make an attempt to realize Valier's ideas.

For the time being, Valier and Fritz von Opel were content to prove the practical applicability of the new method of propulsion and to create

the first step on the path to the rocket-plane and to the space ship in the form of the rocket-driven automobile. ...

Rocket propulsion was to furnish proof of its efficiency on the Avus speedway. On May 23, 1928 everyone belonging to the close circle of automobilism in Berlin assembled on the Avus speedway. The mysterious vehicle stood there under a grey canvas.

Before the test began, Privy Councillor Schütte, the designer of the air-ship and the President of the Scientific Society for Aeronautics, spoke about the rocket problem and its pioneer, Max Valier. After him, Fritz von Opel began to speak and with remarkable enthusiasm announced the program of the group led by him. 'Today, like decades ago,' he explained, 'aircraft flounder with difficulty through very dense air layers which settle above the surface of the earth. We labor to plough through the thick mud of the air, as it were, with high engine performances, whereas a few kilometers higher up the stratosphere, with its low resistance and no bad weather, virtually invites us to fly at speeds increased tenfold. Why have we not made use of this possibility up till now? The obstacle lay in the internal-combustion engine, the enormous air requirements of which cannot be met at high altitudes, so that the engine performance and also the efficiency of the propellers decreases rapidly as the altitude increases. It was therefore a matter of finding a means of propulsion which can dispense with air as an oxygen carrier and with air as a means of converting motive energy into motional energy. This unique means is the rocket. The peculiar thing about the history of the rocket is that all of these facts have been established theoretically for decades. The construction of the first rocket-driven automobile is a great deal older still, deriving from a Latin cipher dated 1420, and the first rocket plane can be seen in an English caricature from the year 1840.'

Then Fritz von Opel described how he imagined the further development of the experiments from the rocket-driven automobile to the rocket plane; hereupon the vehicle was unveiled. The experts viewed it in amazement. On the track stood a black streamlined racing car, which only differed from its like by its raised back wall. Here, a number of iron pipes connected together emerged, from which electric leads ran to the driver's seat. On lifting up the hood it was found that there was nothing to see. The car had no engine and no gears. There was only a steering gear and footbrake and a hand lever serving to adjust two stabilizing surfaces situated at the sides of the car like aircraft wings in order to keep the nose of the vehicle, which is too light, on the ground at high speed. The ignition system for the 24 rockets was operated by means of a pedal, each movement of the foot firing one rocket.

Two thousand people lined the runway expectantly. They had the impression of being present at an important moment in the history of technology and at the same time they feared for the foolhardy sportsman who was risking life and limb in a dangerous experiment.

Fritz von Opel took his seat behind the steering wheel and stepped on the ignition pedal. For a moment one could see long flames darting forth from the end of the vehicle. A crackling and booming resounded like that of a battery of guns shooting drumfire. Then everything was covered with smoke. The car was hurtled forwards.

Again and again, for the third and the fourth time, Fritz von Opel pressed upon the ignition pedal. Everything disappeared sidewards, he could only see the smooth strip of track before him. Once again he stepped on the pedal four times in succession, now travelling with eight pipes blasting. Acceleration is intoxication, he stopped thinking, reality disappeared, untamed forces raged behind him, he acted merely with the instinct of an experienced sportsman. Already the gateway of the Avus speedway was drawing near; he let the car run down and turned sharply into the back straight.

Now it was important not to lose too much momentum! He already fired further rockets while still taking the curve, and he felt that his speed was very great and that the steering wheel was geared too high. The car was scarcely to be kept under control. The front of the car was lifting off, for the surfaces were not set for sufficient pressure. The spectators had the impression that at any moment the car would soar into the air.

Fritz von Opel could not lift a hand from the steering wheel. The track was already becoming narrower and narrower. Opel saw the judge's house in front of him, was carried over to the right towards another vehicle, steered in the opposite direction, shot off to the left and went into a bad skid. But he managed to pull the car out of the skid at the last moment. Once again he stepped on the ignition pedal, but no intensification of the roaring, no acceleration followed. All twenty four rockets were consumed.

The car rolled along for a further three kilometers. The people on the speedway cheered. At last the vehicle stopped; Fritz von Opel wriggled out from behind the steering wheel with difficulty. He was dazed, exhausted.

'Will I drive a rocket-driven automobile again?', he remarked to the journalists, 'perhaps later - the intoxication of speed is too enticing - but not under the same conditions. Our work has already gone further. What I have shown today is already outdated.'"

Otto Willy Gail reported:

"Valier was in disagreement with Fritz von Opel about the further continuation of the plan. These differences were basically insignificant, but obstinacy on both sides made every attempt at settlement hopeless."

(c) Rocket Flight

In autumn 1927, when it was a matter of filling Opel with enthusiasm for the project, Valier had revealed to him all his ideas and explained things so persuasively that Opel gained confidence in the feasibility of these plans, which were fantastic for that epoch, and he ventured to realize them.

Now, the collaboration which had brought such excellent progress and success for both Opel and Valier had come to an end. Each one now pursued the project on his own, and for both of them the next points on their program ran thus:

After ground vehicles with rockets:
Model airplane with rocket propulsion.
Manned aircraft with rocket propulsion.
Then, development of the liquid-propelled rocket engine.

It was Valier's program, which he had preached countless times in lectures and publications ever since 1926, and which had just been delivered very vividly by Opel on the Avus speedway.

The two men could now be likened to a great big motorship and a little one-man dinghy both setting out on a world trip.

To begin with there resulted an application for a patent from

Max Valier and Alexander Lippisch:

Automobile for high speeds with wing attachments, with aileron and elevator surfaces and with vertical tail fins and side rudders. -

This, then, was the idea of the "jumping car" which always remains stable at the rudder with or without ground adhesion. In the claim of the patent it reads that "the surfaces make the vehicle a system stable in the air". "... that the surfaces, like control surfaces of aircraft, can be adjusted by the driver... they can be connected with the wheel control ... (or claim no. 4) ... that this coupling is releasable."

On the patent it reads: "Day of Publication of the Patent: May 15, 1930." - Day of application: June 7, 1928.

Hardly had this patent been applied for than model tests and flight tests with rocket propulsion began on the Wasserkuppe, financed by Fritz von Opel.+)

+)For the sake of completeness it should be reported that at the suggestion of Valier, Engineer Heinz Beck and O. Trautenhahn had already made systematic tests with rocket-driven model airplanes previously, at the end of 1927 in the Erz Mountains. Rockets of the firm Eisfeld had been used, the thrust force of which was varied from 1/5 of the weight of the aircraft to 5 times its weight.
- Valier never spoke of the successful flight of his small model aircraft with pyrotechnic rockets over the valley of Innsbruck in spring 1914. At that time it had only been a joke, not serious systematic testing work.

An account has already been given of the first preliminary flight of Valier and Sander on the Wasserkuppe. - After that, Opel got in touch with the Raab-Katzenstein Works, who were to supply him with a "Grasmücke" converted into a canard-type aircraft. But then he decided to carry out these tests on the Wasserkuppe with the Rhön-Rossitten-Gesellschaft, whose chief designer Alexander Lippisch then prepared the tailless "Storch" model airplane for rocket propulsion. The exact technical description of these model tests with rocket propulsion can be found in the Z.F.M. 1928 no. 12, (Zeitschrift für Flugtechnik und Motorluftschiffahrt).

In pursuance of Valier's plan, with which Opel proceeded with Sander but without Valier, the first manned rocket flight then took place:

On June 11, 1928, after the model tests had been concluded, the chief pilot and flight instructor of the Rhön-Rossitten-Gesellschaft, Friedrich Stamer, boarded the test sailplane 'Ente', which had been fitted with rockets. These first test flights with jet propulsion are likewise described in the Z.F.M. Both technical reports can be looked up there. Here we wish to quote literally the continuation of the story begun previously of the appearance of rocket propulsion on the Wasserkuppe, for Stamer has written it gaily, describing not only the technical aspects but also the people with their distinctive characters.

> "The model tests with rockets burning for a short time showed us very high flying speeds with very high thrusts and with sometimes wild aerobatics.
>
> Then the flights with manned aircraft were to begin. We attached importance to a very systematic, progressive mode of procedure, but especially to having the flights take place in secret, without any sensationalism. (We perhaps always attached too little importance to a good press.) But in spite of this, owing to the fact that the matter had leaked out, there were many people on the mountain peak, who wanted to see the first rocket flight. Therefore it was late by the time the crowd had dispersed and we could begin. The thrust of the rockets at our disposal had originally been too great, for we had calculated that for the "Ente" a thrust of 12 to 15 kilos per rocket would be sufficient for the first tests. Two rockets were therefore drilled out in the nozzles. This resulted in the smaller thrust.
>
> These rockets consisted of steel cylinders about 50 to 60 centimeters long and approximately 15 centimeters in diameter, which contained almost 4 kilograms of blasting powder in a solidly compressed mass. The rockets had a powered phase of approximately 30 seconds each and were ignited electrically from the pilot's seat. The takeoff was to take place in the usual way by means of a launching cord. The rockets were to be ignited once the plane left the ground.
>
> Fritz von Opel had proposed installing rockets with a thrust of 360 kilograms each, a measure which we had to decline for reasons of stability, flight operation and systematics. This led to an amusing incident. Opel had hidden a group of itinerant musicians, who happened to be crossing the Wasserkuppe, behind the hangar. As we were setting

out to start the proceedings, he himself directed the "Stamer-Lippisch-12-Kile-March" to the tune of "Immer langsam voran". This was then followed by the "Opel-360-Kile-March" to the tune of the "Radetzki March".

There then followed a series of flights above the landing strip, lasting up to 80 seconds each. The "Ente" could only accommodate two rockets which were to be ignited one after the other. After everything had taken place satisfactorily, a climbing flight was to be undertaken with rockets of a thrust of 20 kilos each.

The takeoff went without a hitch. The first rocket was burning and I had already become accustomed to the very loud hissing of the jet flame spurting from the nozzle, when about 3 seconds after ignition there was an ear-splitting explosion. I had learnt in the war that there was no longer any great danger if, after the explosion, one was still all in one piece. A hasty examination showed me that this was the fortunate position in which I appeared to be. But the entire aircraft was burning away merrily and, judging by the violence of the explosion, a few things contributing to its stability must have suffered some damage too. I was particularly concerned about the wing suspension.

I decided not to force the burning bird down vertically, although in doing so the flames would be pushed back to the rear, but to let it glide down carefully so as not to break up in the air. I was further comforted by the thought that the second rocket was there behind me in the fire, likely to go off, one way or another, at any moment. Moreover, under my seat it was becoming first pleasantly, but then obtrusively warm. Fist-sized chunks of powder from the exploded rocket had come flying in all directions into the machine and had set fire to it. One such chunk was now appropriately situated under the thin plywood seat.

At last I grounded the machine. I made the finest landing of my life, because I was very much averse to making a crash landing and thereby possibly coming into closer contact with the second rocket. This was likely to go off at any moment as it was, and things would be in a bad way if I happened to crash right onto it.

No sooner had the machine stopped than I had already climbed out of it; I saw the ignition wire burning on the iron rocket casing and I tried to tear it away. But it was already too late. The second rocket ignited, but it fortunately burned out in the proper manner, despite the intense heating of the steel jacket. If it, too, had exploded, my prospects would certainly not have been very bright.

Now I wriggled about in the wet grass in order to extinguish and cool my smouldering posterior. After the second rocket had burnt out I was then able to extinguish the burning ship with the helpers who had arrived in the meantime. My need to fly with powder rockets was temporarily satisfied.

Apart from honorable burns, our 'Ente' did in fact have a breached rear spar element, so my cautious flying was justified.

In the evening, we organized a big firework display in Gersfeld to celebrate the 'historic moment' as Opel put it."

Opel had now taken a liking to flying and he decided to learn to fly himself.

Rocket-driven Rail Vehicle

First of all it was a matter of breaking the speed record for ground vehicles (which at that time stood at 334 km/hr). For this, three rocket-driven rail vehicles were built in succession in Rüsselsheim.

On June 23, "Opel Rak 3" started on a stretch of the German railroad cleared for the purpose. It weighed approximately 400 kg; 10 rockets of a total thrust of 2,750 kg brought it to a speed of 281 km/hr. For the second start, 30 rockets with a total thrust of 9,750 kg were used. Soon after the start, the vehicle left the rails and was wrecked, whereupon the rockets scattered in all directions, some of them exploding.

On August 4, Opel started the second rocket-driven rail vehicle "Opel Rak 4" on the same stretch of the German railroad. Like its predecessor "Opel Rak 3", it had a small negatively adjusted airfoil between the front wheels, which was to push it more and more onto the rails at the front as the speed increased. As in Rak 3, Rak 4 had its rocket casing with 30 powerful rockets above the rear axle. Its structural weight was double that of Rak 3 in order to achieve smooth running.

But already at the beginning of the run, the explosion of a rocket caused a short circuit in the ignition wires and ignited the whole propelling charge at the same time. Consequently even "Opel Rak 4" was completely shattered.

"Opel Rak 5" could no longer start, for the German railroads withdrew their permission for rocket test runs on account of the danger to the spectators, who had come along as early as 3 a.m. from all the villages.

Valier did not remain idle in the meantime either. In "Rocket Travel" he reports:

"After leaving Opel and entering into connection with the firm J. F. Eisfeld, Powder and Pyrotechnical Works in Silberhütte-Anhalt, owing to the obligingness of its senior partner, retired Captain Meyer-Hellige, the author began new systematic tests of his own on July 6, for the development of novel high-performance rockets and for the construction of a rocket-driven car: in doing so he was preoccupied from the very beginning by the idea of finding the form in which the vehicle to be invented was to be built, as defined by the nature of rocket propulsion. Moreover, contrary to Opel, the guide lines were the following:

1. The rocket-driven vehicle must be, so to speak, a rocket stick with wheels, which is pulled, not pushed, by the rockets.

2. The mass of the vehicle must be as small as possible in absolute terms, in order to keep its inertial resistance low, but it must also be as small as possible relative to the amount of propelling charge, so that the mass ratio M_o/M_1 which is decisive for rocket propulsion becomes as large as possible.

3. The ground adhesion of the vehicle should be the result, not of the pressure of its weight, but only of the arrangement of the rockets themselves and of the outer aerodynamic form.

4. The rocket aggregate must be composed of many comparatively small but highpowered rockets so that the explosion of an individual rocket can, on no account, cause grave danger; its units must be separated from one another in such a way as to make it impossible for an explosion to spread to further units." ...

"In order to realize these aspects systematically, after testing the rockets of a caliber of 35 mm and a length of 35 cm which were to be used in the tests to begin with, work began on July 9 on the construction of a first, extremely simple experimental vehicle for the 60 cm gauge works track."

The short axle boards, swivel-mounted in hinge joints, were attached to the 2.5-m-long baseboard from below, and the rockets were fastened to it on top, over the front axle. The wheel base was 1.8 m (Fig. 57). The axles consisted of thin-walled steel pipes with massive journals at the ends, and the wheels were pulleys with metal flanges. The moderately inflated inner tube of a bicycle tire was wrapped around the axle boards for shock absorption (Fig. 58). This type of suspension was found to function very well.

In two days this first provisional experimental vehicle was ready. It weighed 22 kg. Each rocket weighed 1,200 g including the casing and the nozzle for a powder charge of 400 g and it gave 22 kg thrust for 1 1/2 seconds.

On July 11, the test runs began on a 200-m-long stretch of works track. A speed of 45 km/hr was reached on the first run with 2 rockets, and a speed of 80 km/hr on the second run with 4 rockets.

"On the following days the tests were continued without a break, the arrangement of the rockets being changed daily. . . ."

The baseboard was made narrower and was provided with holding devices made of hoop-iron for side rockets.

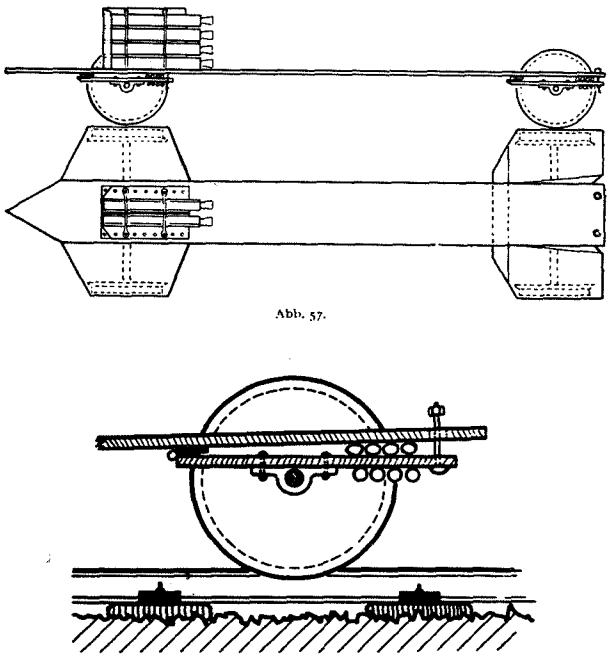

Figure 21.: Valier's first provisional rocket-driven rail vehicle.
(From "Rocket Travel," Figures 57 and 58)

Figure 22 shows the staggered arrangement. With an ignition sequence beginning at the rear, the staggering of the ends of the nozzles prevented unintentional reciprocal ignition. During the appearance of the jet reaction a component of compressive pressure directed downwards was produced by the inclination of the rockets.

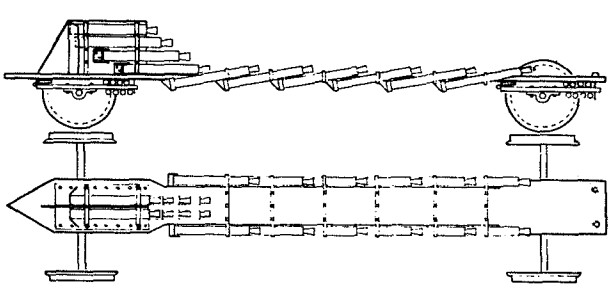

Figure 22.: Second provisional rail vehicle
(From "Rocket Travel," Figure 59)

"Since the works track was no longer sufficient, the directorate of the Harz railway was requested to cede to us a suitable stretch; this was very obligingly granted immediately thanks to the efforts of Cpt. Meyer-Hellige. A stretch approximately 500 m long, running from the railway station of Friedrichshöhe in the direction of Güntersberge, 12 km from Silberhütte, was chosen as suitable.

As early as Saturday, July 14, the first series of tests could be undertaken there at approximately 5 p.m. Laden with 6 rockets, the vehicle, again weighing 22 kg, reached a speed of almost 100 km/hr on the 1 m gauge track of the Harz railway. Up to this point all tests had taken place in absolute secrecy.

Finally, on July 17, another test run took place with a vehicle which had again been slightly changed. This time, the run took place in the presence of a few invited guests, amongst them gentlemen from the directorates of the German railroad and the Harz railway. The first run with only 4 rockets naturally produced only a moderate speed, but during the second run, when 2 and then 4 rockets were ignited at the same time, the thrust after the second ignition was equal to four times the weight of the vehicle and it swept the vehicle to a speed of over 100/hr. The rockets functioned just as they were supposed to, but the small, primitive wooden wheels were apparently no longer able to cope with the high number of revolutions. Probably because a wheel crossbar broke the vehicle was flung from the rails and wrecked.

After these experiments a completely new test vehicle was built in six days. The wheels had block pulleys made of double plywood glued crosswise and a tread like belt pulleys, and they turned on the axle journals with simple brass hubs without ball bearings. Inner tubes of bicycle tires again provided the suspension. This vehicle, built for the 1 m gauge of the Harz railway, weighed 42 kg in all without its rocket charge.

During the first test run, made in the afternoon of July 23, on the newly-chosen stretch of the Harz railway, Stiege-Thalmühle, approximately 1 km from the railway station of Stiege, this vehicle, propelled by 6 rockets which were set off in pairs and produced approximately 24 kg thrust each, achieved quite satisfactory results.

Figure 23.: Valier attaches rockets to "Rak 1"

Photographic report of the press: The inventor before the start of the "Eisfeld Valier Rak 1" at Stiege in the Harz Mountains, July 26, 1928.

It now seemed as if the moment had come to proceed to larger rocket propelling charges. For this reason within two days the superstructure of the vehicle was removed once again, leaving only the wheels and the axles, and it was replaced by a completely plane baseboard, 3 m long, 300 mm wide and 25 mm thick. ... The total charge capacity now amounted to 26 rockets for an empty weight of the vehicle of 44 kg. The weight of the rockets, which had been improved in the meantime, was only just 1 kg more per rocket for an increased performance.

Whereas representatives of the press and film reporters were invited to come on Thursday, July 26, the vehicle was taken to Stiege on July 25 for a final rehearsal on the starting stretch and was started with a propelling charge of 12 rockets. These rockets were ignited in 3 batches, each comprising 4 rockets of a total thrust of 120 kg, at two-second intervals. The success of this run surpassed all expectations, for after the third ignition the vehicle covered the 100 m long staked-off distance in 2 seconds, i.e. it had attained a speed of 180 km/hr.

When the hour had come for the first official test run, which had been announced, of the vehicle now called the "Eisfeld-Valier-Rak 1", the weather conditions were certainly considerably more adverse than on the previous day, for a sharp and very gusty wind was blowing across the direction of travel, as can be seen in the highly successful film shots of the Ufa ("Universum film company"). Three runs were made, the first two of which were only intended to give the guests, press photographers and film reporters present the opportunity to prepare themselves and to practise for the forthcoming third run. For the first run only 4 rockets were ignited, for the second run two batches, each of 4 rockets, were ignited. For the third run, however, 3 batches, each of four rockets and finally a fourth batch comprising 6 rockets were again ignited at two-second intervals.

During this last run the 'Eisfeld-Valier-Rak 1' again reached a speed of 180/hr, for it covered the third 100 m, calculated from the starting point, in 2 seconds only. But when, on top of this, the ignition of the fourth powerful batch took place, it seemed as if the vehicle suddenly doubled its speed once again. But the vehicle could no longer bear up against this development in power, which the author had declared to be too great from the first, and it shot off the rails to the left and was wrecked.-

After that, a new vehicle was built by the author completely out of light metal. For this vehicle Ultralumin was donated by Ravené Stahl A. G., Berlin, the ball bearings by Fries and Höpflinger, Schweinfurt, the wire-spoke wheels with special wooden rims by C. Braunsdorf, Zerbst."

Valier had thus written letters of request to various firms in order to get together the building materials for the new rocket-driven vehicle. And in return, he had promised to mention the name of the donors in his publications.

"The new vehicle had a driver's seat right at the front. To the rear, in 7 U-shaped grooves, were 10 sets of rockets one behind the other, the casings of which were used to increase the rigidity of the framework by means of cross bolting. Only in this way was it possible to accommodate 80 kg of rocket charge and 80 kg of actual load for 80 kg empty weight. With a fuselage width of 45 cm the 5 1/2 m long vehicle was built for a normal gauge.

Since the completion was delayed, the author made 5 test runs himself with an improvised truck on September 5, 7 and 12, all of which were successful."

Thus Valier was at last able to drive a rocket-propelled vehicle himself, to feel the counter pressure of the acceleration himself and to hear the rockets hissing behind him. After Volkhart, Opel and Stamer it was now the turn of Valier, the man whose initiative had brought rocket travel and rocket flight into existence.

About the first start of the new Ultralumin vehicle Valier reports:

"Contrary to the constructional specification that only 35 mm rockets with cardboard casings should be used until the car was fully laden, it was requested by the Eisfeld company that, for the first start, after 2 × 7 rockets with cardboard casings, one of the new 50 mm rockets with a copper casing and a thrust of 120 kg should be installed. In actual fact the first rockets burned down in due order, but the large rocket broke through the support which had not been calculated for this thrust, slid forward, crashed against the rear panel of the driver's seat and exploded there. Luckily, only 50 kg sandbag weight were loaded. The vehicle was still mobile, but it had been so badly buckled that the planned manned run which was to be made by the author could no longer be risked.

For this reason the gentlemen from the directorate of the Halberstadt-Blandenburg Railway, together with the Eisfeld company, decided to build a similarly shaped, but much stronger rail vehicle. On September 24, it was ready to go into action. Although this vehicle received the name "Eisfeld-Valier Rak 2" - Halberstadt-Blankenburg Railway, the author had nothing more to do with the direction of these tests. The first test runs which took place on September 25, and 27, and the first two demonstration runs of October 3 with small charge succeeded, but they did not produce any new results. When the full charge of 36 individual 50 mm rockets with copper casings was applied during the last test run on October 3, all 4 wheels broke away from the vehicle after the last ignition because the spokes snapped. Consequently, these tests were suspended. At the same time the author again parted company with Eisfeld."

This time, too, an objective observer will get a hearing; an editor sent off to Blankenburg for the runs of the rocket-driven vehicle, reports:

"The Rocket-driven Vehicle

which was demonstrated yesterday is made almost entirely of aluminum. A large grey thing, six meters long, with a red designation: "Eisfeld-Raketen", "Rak 2". It weighs approximately 275 kg and has wirespoke wheels, donated by the Braunsdorf company in Zerbst. The wheel base is 5 m, the gauge is suited to standard gauge. The shape of this new vehicle departs completely from the usual shape of an automobile. It only has a certain similarity with the streamlined shape of a drop. The driver's seat, which is completely built into the vehicle, is situated over the front axle. It was built in the workshops of the Halberstadt-Blankenburg Railway. The General Manager H. C. Steinhoff Dr. Eng. had offered the owner of the Eisfeld company, Captain Meyer-Hellige, the Halberstadt-Blankenburg stretch of railway for further tests already on the occasion of the tests at Stiege on July 26. Chief engineer Kosch undertook the construction of the vehicle in accordance with Valier's specification. ... A film camera was installed on the front seat of the vehicle which filmed the explosions during the run in all phases automatically.

The Test Runs.

In the golden October sunshine the rocket-driven vehicle rolled up on the Halberstadt-Blankenburg stretch. Cameramen and photographers went into operation. Engineer Valier, the author of the idea, was present in person. He gave explanations, answers and information. At 11 a.m. came the signal: "It's off!" With a thundering din the vehicle ran on the track, slowly at first, then faster and faster. Six thunder claps accompanied by brilliant showers of sparks followed one after the other. The surroundings were enveloped in thick smoke. The vehicle hurtled approximately 500 meters and stopped. It was not damaged in any way. The stop-watch registered: One hundred kilometers per hour. The second test began at 12 a.m. The whistle blew. Further explosions, once again flashes and smoke, until the vehicle came to a stop. This time its speed was 170 km. Unfortunately, shortly before the vehicle stopped, all the wheels came off their axles and the vehicle slid along with the hubs on the rails. The wheels, which had only bicycle spokes, were much too weak for the tests. But this time the automobile was again undamaged.

The rockets functioned correctly, consequently they were safe to use. Therefore it was proved that the rocket, arranged in rows, had indeed become a working material. Of course, the vehicle travelled without any driver, even without a cat because it is contrary to police regulations! A sandbag came into its own instead. At 1 p.m. everything was over. The charming town of Blankenburg was a wonderful background for this instructive and highly interesting display."

P. Dr.

Valier Alone.

Literary Work and Other Things.

The interest of the reading public in Valier's book "Advance into Space, a Technical Possibility" had increased a great deal. The fourth edition had been completely out of print for a long time, and the publishing house had declared already in 1927 that the printing of a new edition was necessary. A new edition with small additions could have been produced quickly, but Valier disapproved of this. He "preferred to go to the trouble of completely revising his work, rather than not have his book be truly up to date," and he tells of the race between the revision of the book and the progress of rocket technology:

> "Always when the author wanted to submit the manuscript as finally ready for the press there came in the meantime new revolutionary principles of construction ... . At Christmas in 1927, it was begun once again from the beginning, and ever since that time, in every interval which the tests and practical work and the lecture tours left, work constantly had to be done on the manuscript ..."
>
> "If the book now appears under the title "Rocket Travel", this is because the basic motive which inspires us at this moment is not so much the mere 'will to advance into space in order to conquer it', but the will to create the rocket engine which is the prerequisite for everything else.
>
> Friedrichsbrunn a. Harz, September 5, 1928
>
> Max Valier"

Apart from the fundamental principles: field of gravitation, propulsion by means of reaction etc., which his first books already contained, he now also included a great deal of material which had recently come to light. In the second edition which appeared in 1925 he only described Professor Goddard's two-stage powder rocket and then gave a very thorough account of Professor Oberth's planned 3-stage liquid-fuel rocket with all the accessories: artificial moon, space suit etc. In the meantime, other research workers had also published their projects. But, above all, Valier could now submit the results of his experiments; for in 1928, the first part of his 4-stage plan was realized. For this reason his book had an additional section:

> "III. The Present-day Projects
>
> 1. The interplanetary vehicle of Hermann Ganswindt
>
> 2. The projects of Dr. Franz von Hoefft
>
> 3. The Russian spaceship projects
>
> 4. The space rockets of Professor Hermann Oberth

5. The cathode-rocket ship of F. A. Ulinski

6. The research of W. Hohmann, Dr. Eng.

7. The rocket research of Professor R. H. Goddard

8. The rocket propulsion project of the author

9. The other rocket ship projects of the present time

Rocket Technology

1. The manufacture of powder rockets

2. The development of high-performance powder rockets

Rocket Travel

1. The achievements made so far by rocket-driven cars

2. The future of rocket-driven vehicles

3. The achievements made so far in rocket flight

The Future of the Rocket Plane Summary."

A few passages in this book merit particular attention.

1. To the section dealing with Professor Goddard's research and achievements, Valier added the following reflection in 1928 (p. 188):

> "Since Goddard already hinted in 1919 that he had recognized the military importance of rocket technology, one should not be surprised if, on the occasion of a new war, the United States come to the fore with modern rocket-driven missiles and weapons, ... according to authentic information from R. Lademann, simple, gunpowder-driven reaction engines of Goddard's design have reached altitudes of 100 km and more, from which there ensues a maximum range of 200-250 km. The previously troublesome inaccuracy of fire has been so well surmounted by means of radio control that Goddard's winged rocket shells can not only strike any ground-based target accurately, no matter how far away, but are even capable of shooting along behind an aircraft maneuvering in turns until they strike it, ..."+)

The second passage, which merits consideration as a reference for agriculture, runs (pp. 151-52):

> "Soon after the year 1900, the rocket advanced into new fields of application.

+)Here Valier was wrongly informed; at that time, radio control was an objective that was still far from being achieved.

Stimulated by the success of the meteorological firing cannon of Mayer Stieger, who protected the whole region of Windisch-Feistritz in Steiermark with such cannons in 1895, the pyrotechnic industry had the idea of combatting hail with rockets. It recognized the possibility of transferring the hail-dissipating vibratory effect of the cannon shot, which in the case of Stieger's cannon came from the ground, into the very midst of the hail-cloud. In this way the costs could be cut drastically whilst maintaining (or even improving) the efficacy. The Swiss hail rockets manufactured by the pyrotechnist Müller in Emmishofen, the altitude of which, measured by Count Zeppelin, reached 800-1,200 m, were the most successful.

At the present time hail is combatted everywhere in Switzerland with such rockets. Municipalities, agricultural associations, vineyard owners amongst others set off such rockets when there is a danger of hail; their radius of effect covers approximately one square kilometer. If a rocket is first set off when the first hailstones are already falling, according to the statements of Karl Birner in Constance, the movement of the air obtained after the detonation causes the hail to transform into snow flakes, which dissolve completely into rain after the second and third rockets. If the rockets are set off at the same time, there is only rainfall. It has been proved that whereas no hail falls within the area of the explosive effect of the rocket head, it does hail outside of this zone. In particular sections of Switzerland rockets are set off at intervals of one kilometer when there is danger of hail.+)

The really paradoxical thing about this effect produced by the hail rockets is that the melting heat which would theoretically be necessary to convert the hail ice in the rocket's sphere of influence into water exceeds the energy content of the rocket's explosive charge several hundred times. Therefore the effect cannot be an immediate one but must rather be based on a release of extraneous energies contained in the atmosphere. These hail rockets by no means belong to the largest types of rockets, but are manufactured in calibers of 3-4 cm, with a length of 25-35 cm and in most cases they still come in simple cardboard casings."

3. Then, on page 192, Valier, who always makes an effort to be objective, mentions two inventors who had already committed to paper the idea of an airplane with reaction drive before he did. René Lorin, who had proposed an all-metal aircraft with reaction drive in 1911 in 'Aérophile', and André Bing, who on June 10, 1911, received the Belgian patent no. 236 377 for a rocket device destined to attain maximum altitudes.

Since no-one amongst the experts of the twenties knew anything of these inventions, it is to be assumed that neither Lorin nor Bing endeavored to put these propositions into practice.

+)Many a farmer may say to himself: I can guard against damages caused by hail more easily and surely by means of an insurance against damage by hail. - However, the whole national economy is heavily prejudiced each year by hail, and this could be avoided.

- We suppose that Valier had registered his rocket plane ideas with the Imperial Patent Office in Berlin and that the patentor had discovered these two, Lorin and Bing, whilst searching for antecedent publications, and pointed them out to the applicant. This is probably how Valier heard of them.

The formation of the Society for Space Ship Travel (Verein für Raumschiffahrt) on July 5, 1927 has already been mentioned briefly.

The society's slogan and proclamation are:

"Help to create the spaceship!

Recently it has been repeatedly shown at length that with the present-day level of technology it must be possible to fly through the empty space which separates us from neighboring celestial bodies; it is a project unequalled in grandeur. All objections which have been raised against it up till now lack substance. Therefore it is a matter of fostering and promoting this great idea with every effort.

Of course, such a great work can only succeed if all the many desires for its realization unite into a common action. To this end the 'Society for Space Ship Travel Inc.' was founded on July 5, 1927 in Germany. Its executive board comprises the leading figures in this field (Professor Oberth, Mediasch; Max Valier, Munich; Engineer Hohmann, Essen; Dr. Hoefft, Vienna amongst others.) The Society has its own journal 'Die Rakete' (The Rocket) which appears on the 15th of each month and which is sent to members free of charge. The membership fee is 5 RM per annum..."

Johannes Winkler, cert. engr., was the president of the Society and the editor of the monthly journal. This journal published serious scientific papers written by Winkler, Oberth, Hoefft, Pirquet amongst others, and accurate technical reports on rocket runs made by Valier; moreover there was a "Critics Corner" where it was intended that a topic be examined from various points of view, as in the discussion subsequent to a lecture. (Unfortunately in the "Critics Corner" such a fierce dispute flared up between two old pioneers fighting doggedly for their different views that in November 1929 Winkler had announced in "die Rakete": "I call your attention to the fact that in the future I shall refuse contributions which do not preserve an academic tone, no matter who is the author.") But there were also genial contributions in "die Rakete". Willy Ley, for instance, in an article on Johannes Kepler's "Somnium", wrote: '...In this article Kepler says that funny little ethereal spirits live on the earth and on the moon, but in the true manner of spirits they avoid the sunlight and are only really at ease at night. They are indeed capable of flying through space ...' Who would have expected such charming ghost stories from the great astronomer Kepler!

"Die Rakete" also published a pleasant and entertaining article by another truth-seeking astronomer. The title and short preface read:

"On a Daring Trip to Mars (Auf kühner Fahrt zum Mars) A cosmic fantasy by Max Valier, Munich.

The following tale introduces the very interesting problems of space flight in an entertaining way. It will be particularly welcome to the reader who has not received a technical education. The numerical data referred to are based on accurate calculations. Of course, it will be a long time before we have such well-constructed rocket machines that we shall be able to risk a flight to a neighboring celestial body. The rocket ship will first of all have to give satisfactory results on the ground, but it is a good thing to keep distant perspectives in mind, even if one is only just making a first step."

A little less than 24 pages depict for us a spaceship voyage, disclosing to us many dangers which the earthly being must overcome if he wishes to leave his native planet and cross the solar realm.

The engineer, the designer and pilot of the spaceship has considered them in advance. He has the necessary equipment on board with him for everything. His wife and his friend are his travelling companions; the three of them master all the technical difficulties, but a psychological problem almost leads to their downfall.

The story is full of suspense. The reader has the feeling of taking part in the voyage himself and is in this way "initiated into the very interesting problems of space flight in an entertaining way".

"It will certainly be a long time before we shall be able to risk a flight to neighboring celestial bodies" - Valier must have said to himself that he would not live to see the flight to another star - nevertheless, he devoted all his work to this noble distant goal.

On May 11, 1928, Max Valier gave a lecture on spaceship travel in Köthen/Anhalt. (He was obliged to give lectures time and again in order to earn his living.) The majority of his audience were students from the Polytechnic there, but there were also others in the hall. Mr Paul Gentsch from Lahr in the Black Forest, who happened to be on a business trip in Köthen, saw the poster and attended the lecture, which made a great impression on him. At the end he bought himself a couple of books at the book-stall and asked Valier to sign his name in the booklet "On a Daring Trip to Mars" - After the war almost all of Mr. Gentsch's books got lost due to the requisition of his apartment; only this slim off-print of "die Rakete" in a green binding did not seem desirable to the garrison. It was left behind and was preserved for the owner. And if Mr. Gentsch had not been so generous as to donate the booklet to the "German Museum for Rocket and Space Flight" (Deutsches Raketen- und Raumfahrtmuseum) we would not have learnt anything of Valier's "Daring Trip to Mars", which he presumably wrote in 1927 and in this way at least experienced the trip himself in the spirit.

After Valier parted company with the Eisfeld company in October 1928, the next sign of life which we find of him is a photo from Coblenz. Where the Mosel flows into the Rhine the two rivers form a spit of land which is somewhat elevated and offers a vista over this region through which the rivers flow. There stands a statue of the former emperor, Wilhelm. The spit of land is called the "Deutsche Eck".

The photograph portrays an open Packard at the foot of this statue, in which Max Valier and his wife are sitting. We see the same picture enlarged in a Spanish illustrated magazine, and also on postcards which were sold. On the back of these postcards is printed: "Max Valier, the creator of the well-known Valier (Opel) Rocket-driven vehicle, with his six-cylinder Packard automobile." And below it reads: "Packard, ask the man who has one". One can see that the Packard agency was using Max Valier for publicity. Presumably they granted him particularly advantageous terms of payment for this.

"For a long time, Max had had the ardent desire to obtain his pilot's certificate," his sister tells us. "After his war experiences he thought that he too could quickly master the art of flying. He would have been only too glad to take a sports pilot's course, but it was just impossible. - Now, in his own fast car, he could at least acquire at the steering wheel the confidence that the experienced driver has." (We do not know the nature of the conditions of payment; but we have been told that after his sudden death the car did not pass to his widow but had to be returned.)

The picture showing him in the large expensive Packard gave rise to the rumor that Valier was in the pay of an American firm.

Professor Oberth had now been awarded the "Prix International d'Astronautique" which the French scientist and aircraft designer Robert Esnault-Pelterie[+)] had donated together with his friend, the banker Hirsch (5,000 Fr.)

[+)] We quote from Heinz Gartmann's "Visionaries, Researchers, Engineers" (Träumer-Forscher-Konstrukteure) about Esnault-Pelterie (page 108):

"Three days after the founding of the society in Breslau the French pioneer of aeronautics, Robert Esnault-Pelterie, gave a long lecture in Paris on problems of space flight before the time-honored "Société Astronomique de France" founded by Camille Flammarion. 'Since aeronautics has advanced from the realm of dreams into that of reality, I, who had already seen the automobile come into being before my eyes, realized immediately to what further developments aeronautics would advance and I wondered what progress could indeed follow: once the atmosphere is conquered, ...there is nothing left to do but to penetrate into outer space... Would this be possible? The reply was given to me by the theorem of impulse. However, since I only envisaged exhaust-gas velocities below 2,000 meters per second, I was astonished by the great initial mass which is necessary to project a certain end mass from one place to another. Therefore - let this be said right away - I shall regard the voyage to the moon as a purely theoretical possibility, at least for the present moment.'"

for his book which had appeared in the third, revised and enlarged edition under the title "Way to Space Travel" (Wege zur Raumfahrt).- Now Oberth was requested by the Ufa to ask for leave from the teaching profession and to take a part in the making of the film "Woman on the Moon" (Frau im Mond) as scientific advisor. The Ufa director, Fritz Lang, who had a good instinct for what the public would like to see at the present time, shot the film. Professor Oberth was thus to assist, in an advisory capacity, in the creation of the spaceship and of the lunar landscape.

At the end of October 1928, Valier went to the Rhön Mountains to see for himself rocket-propelled airplanes flying, and to observe how the thrust of the rocket affects the stability of the aircraft. In the second edition of "Rocket Travel" we can read about it:

"Independent of this (of the rocket-driven model aircraft tests which Lippisch carried out in Opel's name from June 9 to 11, 1928), the author has also made takeoff tests with Lippisch on October 28, 1928, on the Wasserkuppe with exactly such a "Storch" model provided with Eisfeld rockets of a caliber of 35 mm and a thrust of 22 kg, which led to similar results. However, the author felt obliged to draw another conclusion from them, namely that the tailless types of sailplane are not all very suitable for rocket propulsion, and that, on the contrary, models of the normal type with a particularly long fuselage will be more suitable."

Rocket-driven Sleds

"My plan to build a rocket-driven sled goes as far back as the first months of autumn when, at the start of the last rocket-driven rail vehicle at Blankenburg in the Harz mountains on October 3, 1928, all four wheels flew off the vehicle as a result of the spokes having broken" writes Valier in the "Rakete of February 15, 1929. Here, he is talking, as it were, to a circle of friends, also mentioning personal matters which he always avoids in his books "Rocket Travel".

> "But in the case of a sled, all these factors are eliminated, as it has no such rotating parts and only needs to be designed so as to bear the thrust and transfer it from the body to the system of runners. Because in the case of a sled, in contrast with the vehicle on wheels, one can dispense with a special suspension, the type of construction meeting these requirements makes do with a much lower empty weight while at the same time retaining the same capacity and the same useful load, so that the ratio of the full starting weight to the empty weight, which is of prime importance in rocket technology, can be made far better than in the wheeled vehicle.
>
> All this had been clear to me for a long time when, at the end of November, I began to negotiate with the sports directors of the B.A.C.

(Bavarian Automobile Club) in Munich in order to interest them in financing the construction of the first rocket-driven sled in the world, and in its demonstration at the winter sport's festival to be held on the Eibsee on February 3, 1929. But when these negotiations had not led to any positive result by mid-January, I decided to build the sled in any case, partly from my own resources and partly assisted by a few enthusiasts of my projects - amongst them Engineer Franz Spreitzer in Pasing near Munich and Attorney Professor Dr. Rheinstrom, Munich, in particular. Since the resources, especially for the acquisition of the rockets, were still very scant, I had to make considerable simplifications with regard to the construction designed in November. I dispensed with the electric ignition system and an accurately geared steering in order to economize in whatever way possible on the empty weight and therefore on the costs of the rocket. In addition, the body of the sled was reduced to a cross-sectional area of 40 cm × 40 cm with a simple back protective board for the occupant, so that I could just barely sit down (without a coat) in the driver's seat which was virtually made to measure. Thus in comparison with the original projects, my "Rak Bob 1" can be described as a model two-thirds the actual size, ... The sled has proved to be excellent in all the test runs up to now. The high-performance jet rockets supplied by the J. F. Eisfeld Powder and Pyrotechnical Factories in Silberhütte/Anhalt, have a thrust of 120 kg for a caliber of 50 mm during 1.5 to 1.8 seconds.

The following test runs have been made so far:

On January 22, a first workshop test took place in secret at the aerodrome of Schleissheim. In spite of the worst sodden snow on which the sled could hardly be drawn along by a man, it shot like an arrow from a bow, propelled by 4 simultaneously ignited rockets, and reached a maximum speed of 110 km/hr over a total distance of 130 m assisted by the effect of a second ignition of three rockets and a third of one rocket. ...

In spite of these apparently insignificant performances, the tests of January 22 were very instructive for me and gave me cause to make several modifications in the construction. Like in the earlier vehicles, I had made the bottom of the sled horizontal by means of 3 sled runners and had arranged the 5 batteries of rockets proposed here in such a way that the noses of the two at the very bottom were tilted downward in order to press the sled well down to the ground in the beginning. Only the last 3 batteries were horizontal. In view of the great friction in the snow, however, this precaution - necessary in the case of wheeled vehicles - proved to be uncalled-for, and so the tail skid was omitted for the Eibsee test and the whole floor of the fuselage was inclined upwards to the fore in the proportion of 1:15 so that the tail end itself, which was only provided with a sharp cutting edge, could trail after it in the snow. In this way the first two batteries of rockets would then be horizontal but the last three would be tilted upwards to the fore in the proportion of 1:15 in order to produce a lifting force which was to cause the sled to virtually float at high speeds, in order to bring the friction on the snow almost to zero.

The two following test runs on February 3 at the winter sports festival of the B.A.C. on the Eibsee proved that this end had been attained. Although this club did not participate in the financing of the costly tests, I offered my services in assisting in the winter sports festival concerned, in order to be able in this way to make propaganda for the idea of rocket propulsion in an official position.

This time my wife, as the first woman in the world to venture out in a rocket-propelled vehicle, set off on the first test run with a propelling charge of six rockets, which were ignited in pairs. All of the rockets burned down in due form at two second intervals bringing the sled to a speed of 40-45 km/hr. The distance covered was not much more than 100 m.

After that I myself started the sled with a propelling charge of 12 rockets: initially two batches each of four rockets, and then two more batches of two rockets were ignited simultaneously. The first two batteries burned down correctly and, as the subsequent measurement showed, gave me a maximum velocity of 95-100 km/hr within three seconds from the moment of departure. Unfortunately, during the third ignition, a rocket exploded, also ripping open the two rockets of the fourth ignition, so that the thrust was lost and the sled came to a halt after only 160 meters. The ripping open of the rockets probably looked very dangerous from a distance, but it was in no way serious for me, the occupant, since the protective board behind my back afforded me adequate protection from the flash of the explosion. I was only sorry that the thrust no longer took effect, for the sensation of great acceleration during the first two ignitions had already been so delightful that I only wished that a dozen more ignitions would follow. (My wife had had exactly the same impressions during her run.)"

On February 9, on the occasion of an ice festival on the lake of Starnberg, Valier continued the runs with the rocket-propelled sled.

"The sled had received an improved aerodynamic form; even the tail edge had again been changed so that, in view of all the constructional changes undertaken, the designation "Valier Rak Bob 2" seemed justifiable.

While on the Eibsee, the police had shown almost too much caution in cordoning off the test area, so that the test had to take place at such a great distance from the spectators that most of them were not able to see clearly enough, there were no barricades at all on the lake of Starnberg, and with my assistants I was scarcely able to at least keep the smokers away from the crates of rockets and the fuse cords. When the time came for the start at 4 p.m. the approximately 3,000 spectators could hardly be held back, so that I seriously considered calling off the test at the last minute. Contrary to my original request to clear the lake completely, the public had been allowed as close as 50 m from the starting point and even there it still threatened to break through the extremely thin chain barriers at any moment. Therefore all I could do was to have the sled brought forward another 50 m at the last moment and then carry out ignition immediately.

This time, the burning down of the rockets functioned perfectly, for the two-way thermal radiation of the copper tubes was prevented by the insertion of asbestos interlinings (it was this two-way thermal radiation that had been the sole cause of the explosion of the last rockets during the Eibsee run).

The ignition system, as in Schleissheim and on the Eibsee, had again been perfectly installed by Mr. Sauer jun. from Augsburg with stop pins+) and intermediate charges, this time set to go off at 1 1/2 second intervals.

The run itself was such that the sled travelled 20 meters between the first and second ignition, 50 meters between the second and third ignition, 80 meters between the third and fourth, and finally 90 meters between the fourth and fifth, each time in 1 1/2 seconds; from this it follows that in the last period the sled already reached a speed of 60 m/sec or 216 km/hr. But after the fifth ignition it covered a distance of 210 m in two seconds, i.e. a speed of 105 m/sec or 378 km/hr on an average. If one considers, however, that the last 50-60 meters were already part of the stopping distance, as the rocket thrust lasted barely 1 1/2 seconds, it follows that the maximum speed must have been about 400 km/hr.

Unfortunately, the stopping distance proved to be too short, for, having veered off to the right, the sled turned to the lake's edge too soon and finally ran into a landing stage, losing its tip in the process. The actual body with the set of rockets, however, remained undamaged, as did the sled runners, so that it could be towed away by a motorcycle without any trouble.

From the technical point of view it was of great interest to measure the distance travelled and to examine the traces; Engineer Heinz Beck assisted me in this task. Just as I had expected, it was found that after the termination of the third ignition the front sled runners had already lifted up so far from the snow that their tracks became imperceptible, whereas there were still very clear indications of the scratch made by the tail runner in the snow. But after the fourth ignition this, too, became indistinct and could no longer be seen at all after the fifth ignition; hence it must be concluded that at this moment the sled was gliding along just above the ground. This, then, would account for the extraordinary increase in speed immediately after the fifth ignition, as the surface friction had by then been completely eliminated.

The total propelling charge of 18 rockets had been ignited in the following sequence: first three rockets, then 4 then 4 again, once more 4, and finally 3. But if one bears in mind that the priming continued to burn for another 5 seconds it follows that at the end of the fifth major thrust the priming of the third and fourth ignitions was still in effect; hence, in view of the empty weight of 130 kg, the acceleration from 60 to 150 m/sec in the fifth ignition is very well explained in terms of the theory of energy.

+)No translation found for the German "Stoppinen".

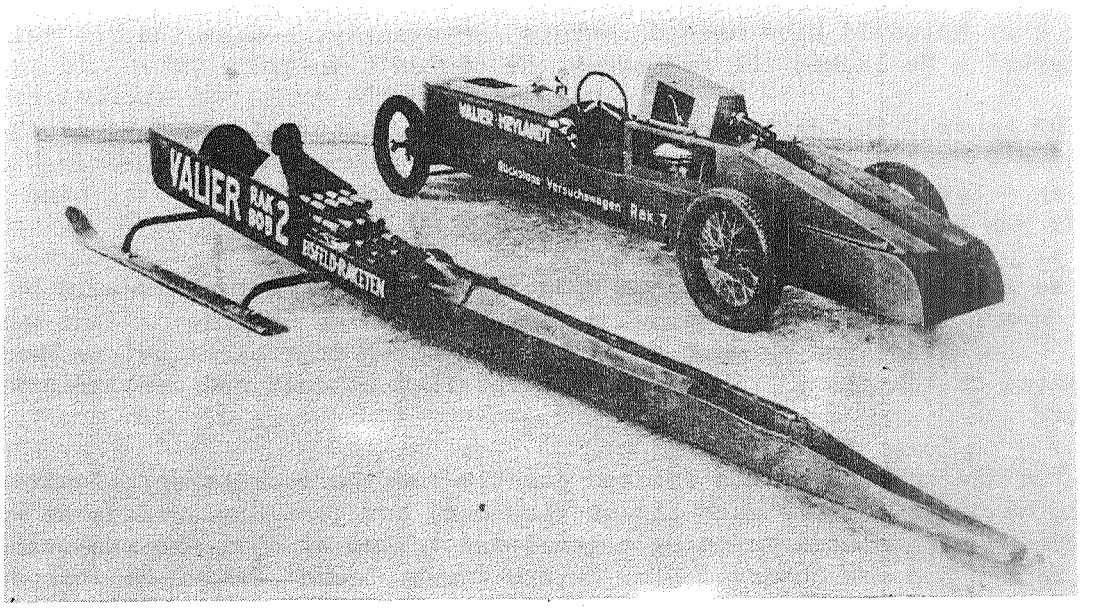

Figure 24.: In the German Museum in Munich stand the historic rocket-driven sled "Rak Bob 2" and Valier's reaction-driven experimental automobile "Rak 7".

Thus this last test adduced the proof that quite high speeds can be produced with rocket propulsion, and that, comparatively speaking, this can be done most cheaply and most safely for the driver by using sled-type vehicles. (The construction of the sled had cost approximately 600 marks, the set of rockets 900 marks, a total of 1,500 marks, whereas Segrave's world-record automobile will cost 400,000 marks.)

I could no longer give the signal to start the announced test run of a new kind of rocket-driven aircraft model in Starnberg, as the public had again come swarming out over the entire expanse of ice after the high-speed run of the rocket-propelled sled, and all thought of another attempt at cordoning off the area had to be abandoned. Therefore this model plane test will shortly be made in secret in another place. Moreover, I then intend to discontinue the powder-rocket runs in order to devote myself completely to the liquid-propellant rocket engine, as it is in this alone that the future of rocket propulsion lies."

This report is somewhat longer, but from it we also learn something about the constructional costs and the costs of the rockets. (It has been reported that on the occasion of the run of the rocket-driven automobile at Rüsselsheim Opel had exclaimed: "Every minute of the run costs a small fortune!") For the author Valier it was impossible to continue the promising sled experiments; i.e. to repair the damaged sled the next day and to repeat the run on a longer stretch, solely in the presence of sports officials, without the troublesome public, and to reach a speed of 400 km/hr, thus setting up the speed record.

To do that he would have needed rockets immediately, before the ice melted. 900 marks! - He lacked the resources, he couldn't do it!

Of course, the daily newspapers published pictorial accounts of the first woman to undertake a rocket trip. One can see the courageous Hedwig Valier, wearing a fur coat and sitting in the sled smiling cheerfully. Behind her stands Max Valier.

We asked Mrs. Valier who hit upon the good idea that she should be the first woman in the world to drive a rocket-propelled vehicle. "That was my idea," she said, "and oh what a lot of persuasion it took me before Max finally consented to the plan." She gave us a detailed account and concluded with the words:

"In his reports he has related exactly how the rockets were ignited one after the other and how much thrust they had, but just how anxious he was during my run was related to me by a gentleman friend of ours who was standing next to him and who observed him. - His 'never again', which he whispered to me as he gave me his hand and helped me out of the sled, revealed it to me, too."

She also related how he had only hesitatingly told her of Mr. Glück's offer. Mr. Glück, the head master of a private school, wanted to acquire Valier as a mathematics and physics teacher and was prepared to grant him a very good salary as well as several special requests, because he had discovered Valier's pedagogic talent and wanted to put it to use, so he said. Mr. Glück had noticed the keenness with which his pupils voluntarily assimilated the theories of mechanics from "Advance into Outer Space", understood them and were able to render them correctly. Thereupon Glück undertook a fairly long journey to listen to an evening lecture given by Valier, in order to find out whether this man who could captivate the young with his writings could also do so with his lecture. The result: Valier must by all means be acquired as a teacher for his private school. It did not matter if Valier were to pose conditions: they would be accepted. - "Think of your wife!" Glück had cried out to him. Of course he was thinking of his wife, and also of his mother and his sister in Southern Tyrol. A new, much more carefree life could begin for them all. After a sleepless night he went to Glück and said: "No, I cannot turn what is my life's task into a pleasant holiday occupation." And Hedwig understood her husband and agreed with him.

It seems to us that Mrs. Hedwig Valier showed even more greatness and courage then than during the rocket run on the Eibsee.

Valier in the Industrial Region

Steam-jet Reaction Engine

From now on Valier turned his attention to the high-pressure steam-jet reaction engine, which he merely considered as a transition to the liquid-fuel rocket engine. In his many lectures, which always provided the audience

with an opportunity to ask questions and to express contrary opinions in the subsequent discussion, Valier had frequently come across the idea that, while the reaction of powder rockets could indeed propel a vehicle, it was surely very doubtful whether this could also be done by means of the reaction of liquid-fuel rockets and gas-powered rockets. He wanted to contradict this view.

He decided to build a steam-jet reaction engine, for tests which demonstrate the facts are most certain to convince people.

The 4-stage plan had already been laid down for a long time. The next objective was the rocket engine with liquid fuel. The necessary funds for the development of this engine were to be furnished by the intermediate stage, the steam-jet reaction engine, thought Valier. He used the libraries of Munich to find out about the fundamental physical principles for his new task. Then he acted upon the advice of his friends to try his luck in the industrial region, for where numerous large industrial plants have come into being on the basis of the mineral wealth, there are many rich people who could provide the necessary funds for the speedy development of rockets. This was Valier's hope.

From Bochum he sought after a firm for the construction of the planned reaction-driven experimental vehicle. This was now to be used for the demonstration of the riskless steam-jet reaction drive; later it was to be used as the demonstration vehicle for the rocket engine with liquid fuel.

On May 9, in Duisburg, an air display was organized; Valier was there and made contact with Gottlob Espenlaub.+) He spoke to him about the constructional points of view which he had deduced from the rocket-driven flights of the model aircraft 'Storch' in the Rhön Mountains in October 1928, and which he now wanted to put into practice.

Photos and a newspaper article of March 10, 1929, inform us of the result of these discussions.

+) In the First World War, the Swabian joiner's apprentice Gottlob Espenlaub was smitten by the love of flying. When the sailplanes later showed their accomplishments in the Rhön Mountains, one of the flying enthusiasts present on the Wasserkuppe was Espenlaub who, in the meantime, had learnt his trade thoroughly. He built himself his first sailplane and competed with the others. Many of the gliders were students at Colleges of Science and Technology and had an understanding of aerodynamic calculations, statics, and stress analysis. Espenlaub, on the other hand, knew more about timbers and wood jointing than anyone else, and soon became the acknowledged timber expert. Whenever the judgement of a timber expert was needed, 'Eschpe' was called in for his opinion. - But he did even more for gliding. Of course he soon took his gliding certificate and became a good sailplane-builder and glider. And then came his courageous step into new territory: Gottlob Espenlaub was the first to risk a towed flight. A power plane towing along a sailplane has today become something of a matter of course; but somebody first had to risk it and prove to the others that it works. - The name Espenlaub became very well-known as a result of this feat.
Then the Espenlaub brothers opened a factory for small aircraft at the aerodrome of Düsseldorf.

"Max Valier's new rocket-plane.

Preliminary tests in Düsseldorf.

The untiring inventor Max Valier has continued his research work on the quiet. Known only to a few initiated people, he has now been staying in Bochum for several weeks. Finally, last night, the first preliminary tests with the new rocket-plane 'Valier Rak 3' could be made on the airfield in Düsseldorf. On inquiry, the inventor Valier himself communicated to us the following:

'It is well-known that I have at all times championed the cause of the rocket-plane, for the rocket-propelled automobiles can only serve as a preceding stage to the testing of rocket propulsion and we are still too far away from rocket-driven spaceships. But the rocket-plane today lies within the range of technical possibility and could be immediately developed for economically significant achievements if the means were available to continue the tests according to my well-studied plan, without delay and on a large scale.

It is now no longer a question of priority alone - for the first manned rocket flight has already been made by Friedrich Stamer on June 11 of last year on the Wasserkuppe, as a result of my collaboration at that time with Opel and Sander. It is now a question of developing a really serviceable rocket-plane which will permit us to take advantage of the special features of rocket propulsion.

For this purpose, I entered into partnership a few weeks ago with the Espenlaub brothers, who manage an aircraft construction workshop at the aerodrome of Düsseldorf. We already reached agreement some time ago on the design of the unprecedented rocket-propelled high-speed aircraft which is to be built. It was solely for lack of resources that we could not proceed directly with this prototype, which will have a wingspan of only 6 1/2 meters for a length of 11 meters, and which will be built in the form of a high-wing airplane with very backswept and slightly V-shaped wings.

For this reason, the first tests yesterday had to be made with an earlier tow plane made by Espenlaub, which was provisionally adapted for this purpose. Their sole purpose was to test whether the main spar of the wings could support the rocket thrust (for the rockets are built into the wings in my design), and also to determine how far the jet of flame goes and to what extent it endangers the tail unit at the end of the fuselage. The aircraft was on the ground and was secured with appropriate anchorage. Ordinary powder rockets were used as propulsion; these will also be retained for the subsequent tests until the rocket engine with liquid fuel, on which I am working at present in the laboratory, is sufficiently developed to replace the powder rockets. ...

What is regrettable is that, as a result of insufficient funds, the tests must be suspended again and again and the results which would otherwise progress daily are protracted over weeks and months. If I

could at long last keep on working uninterruptedly, I would prove to the world in but a few weeks that all the speed records set up so far in flight can be broken with rocket propulsion. Both I and the Espenlaub brothers are quite ready to risk our lives for the development of rocket flight, if only we were given a chance to do so.

Perhaps these lines may help me get through, here in the heart of Germany - the industrial region, which, by its very nature, ought to have the keenest interest in the realization of my project - to those people whom it concerns, those who are able and in a position to ensure the financial means for the continuation of the tests."

The appeal to the industrial captains faded away without any effect. (Only after the successful run of his steam-jet reaction-driven automobile did he occasionally receive a few hundred marks donated by industrialists for his rocket projects, as is reported later.) - To be fair, it must be said that in 1929 the industrialists themselves were going through bad times. Unemployment was becoming more and more menacing so that the captains had to think first of all about the security of their own ship.

Fortunately the 'mother of researchers', Mrs. Thea Lindemann, sometimes helped Valier along with credit when he was in financial need, as we have mentioned before, just as she often helped many other researchers.

The designation 'Valier Rak 3 - Espenlaub' was intended for the rocket-plane conceived with Espenlaub. At the same time 'Valier Rak 4' was under construction at Firma Möllers, Essen-Stoppenberg. (The abbreviated form "Rak" had been coined by Valier as early as January 1928; it was then also adopted by others.)

Let us hear what Valier says in the second edition of his book 'Rocket Travel' on how his "Rak 4" came about (p. 227, 228 and 229):

"Even if, in the opinion of the author, the possibilities of the automobile propelled by powder rockets were far from exhausted in the past year and in the present one, it was, above all, necessary to show the world that one can succeed in propelling reaction-driven vehicles reliably without powder and explosive fuels. Therefore, in spring 1929, the author applied himself to the high-pressure steam-jet rocket-propelled automobile, since the development of the reaction engine with liquid fuel was not yet sufficiently advanced.

By a steam-jet reaction engine one understands a machine in which a propellent liquid which is carried along with it is transformed into steam by the appropriate measures, and as such, is made to discharge directly through a jet (whilst the combustion products of a possible firing vanish without producing any reaction).

Isaac Newton already discovered this possibility. In a sketch drawn at the end of the 17th century, which is ascribed to him, one can see a spherical boiler over an open fire on a kind of chaise; on top of

the spherical boiler is a steam-exhaust pipe with a regulating cock, so that the whole thing gives the impression of a huge retort in a small horseless hackney coach."

Valier then explains why this steam-driven vehicle cannot move - and also why a steam locomotive cannot function as a reaction engine - the amount of steam produced per second, at best 2 kg, would only give 240 kg thrust for an exhaust-gas velocity of 1,200 m/s, and would be unable to budge an 80 ton locomotive. - Valier continues:

"... It is simpler to choose a propellent liquid, the boiling point, critical temperature and critical pressure of which are considerably lower than those of water, and which has a low specific heat and a low heat of vaporization. The gas constant, on the other hand, should be as high as possible. With such a fuel, which one can describe as a liquefied gas because at room temperature and at the pressure of open air it is gaseous, the author has propelled his high-pressure steam-jet reaction-driven test vehicle. The test vehicle, 5 1/2 m long with a body width of 60 cm, which was built according to the author's specifications by the Firma Möllers in Essen-Stoppenberg in accordance with the constructional drawings of Mr. Hans Möller jun., again has the driver's seat at the front and was fitted out with a steering gear and a set of tires, like an automobile. But as its completion was retarded for almost two months, starting from the middle of July, a thing which was unforeseen, a series of preliminary tests were made by the author beforehand.

The first blowoff test from one of the high-pressure fuel containers with the special valves supplied by the Dräger works in Lübeck took place on September 5, in Essen in the laboratory of the firm which supplied the fuel. But on September 18, a similar container was mounted in a very simple way onto 4 wheels, and was placed (unmanned) on the highway between Kettwig and Werden, and started. It reached a high speed but because it was not steered it ran into a tree beside the road. In order to avoid this, for the next test a new improvised small carriage was used. It was 2 m long, had a frame width of 80 cm and a wheel diameter of 18 cm and could reach a maximum speed of 35 km/hr. In order to prevent the danger of exceeding this maximum permissible speed it was harnessed to an automobile with a steel cable. In the tests made on September 21 and 25, on the same highway with 10 kg of fuel, the author's assistant, Miss Lucia Kuhr, sat at the steering wheel of the carriage described, because it could not support a driver who weighed more than 100 pounds. The tests were successful.

Finally, on September 28, the large new test vehicle was ready. Owing to the obligingness of the competent authorities in Essen, the first secret test was able to be carried out on the upper Norbertstrasse, next to the Gruga, at approximately 4 p.m. The automobile was fitted out with 3 fuel containers, each with 20 kg of propellent charge, and each equipped with its own exhaust pipe and nozzle. The three main valves therefore had to be opened simultaneously by assistants. The start was

successful and the automobile reached a speed of approximately 60 km/hr on the concrete road. The distance covered was 1,200 m. The same run was then repeated in public on Sunday, September 29, and it went off just as well. The initial pressure in the containers did not exceed 60 atm, although discharge experiments had already been undertaken with 120 atm on the test stand.

The next test run of this automobile called "Valier Rak 4" then took place on October 13, on the occasion of a motorcycle race in Gelsenkirchen. This time the automobile had 4 fuel cylinders which, by means of special pipes, were now all joined up to form a common collecting reservoir with a nozzle which could be controlled by the driver by means of a needle valve. The initial pressure on this occasion was somewhat lower than it had been in Essen, i.e. 50 atm, as the pipes could not be pressed out any more, but in view of the more favorable proportion of fuel, the maximum speed was higher than in Essen, approximately 70 km/hr. Although this speed seems low, it is entirely in accordance with the mathematical expectations for the given weight and pressure ratios. ...

The test runs up till now have, at any rate, temporarily contributed to dispelling the mistrust of rocket propulsion and consequently they have fulfilled their moral mission.

It should not be forgotten to point out here that the reaction drive with a high-pressure steam jet appears to be twenty times cheaper per unit of power than powder propulsion."

The reaction drive by means of the effluent gas had fulfilled Valier's expectations, but from an article in the Essen newspaper we can see how disappointing the attitude of the public was on the occasion of a demonstration run:

"Valier's Start Successful.

The inventor is satisfied with the technical result.

Essen, November 29, 1929. Max Valier's run with his new reaction-driven automobile, due to take place this afternoon, was just as successful as the one undertaken on Saturday afternoon. ...

One cannot report about the development and the attendance of this display without mentioning that, unfortunately for the inventor Valier, it was not a financial success, despite the fact that several thousand visitors were present and watched the test run attentively. Being a public thoroughfare, the stretch could not be cordonned off; only the vehicular traffic was interrupted on account of the road repairs which are underway there at present. So it was that the public did not make use of the admission tickets which had to be paid for. Since Mr. Valier can only finance his tests with funds which he obtains from his lectures and demonstrations, such a loss is naturally of great consequence. The heavy attendance, however, has shown that there is a keen interest in the continuation of this idea in the widest circles. ...

... Valier kept the automobile with the brakes on until the valves of the individual cylinders had been opened by means of handwheels; this perhaps took 20 seconds. Then Mr. Valier released the brakes and the automobile set off with a good acceleration; after about 200 m of the run he reached the calculated speed of 60 km/hr. The steam trail was thick, etc."

The months in Bochum had brought Valier a great deal of unpleasant experiences. We learnt this partly from a letter which he wrote to his mother on November 5, in which he says:

"Now things are getting better again; that is, I am now more able to get down to my correspondence. But in August it was dreadful; I went until the end of September without money, charged with debts which increased daily, in addition I was often prejudiced in my working capacity, first of all by stomach troubles and then by boils.

However, things have improved somewhat since the run of my new rocket-driven automobile on September 28/29 in Essen. A few industrialists give me a couple of hundred marks every now and then, just enough for me to be able to honor those of my bills which are most urgently due, and to keep my creditors at bay. It is indeed still no joke, but things are now also improving again with the lectures. This evening I am lecturing in Düsseldorf, tomorrow in Essen, the day after tomorrow in Brandenburg, then Friday in Berlin, on Saturday I am coming back here, next week the schools recommence, So in the course of time and with some help I shall again be able to work my way out by means of extra allowances. Particularly since I have been feeling hale and hearty again for a month or more. ...

I have never had such a yearning to come home once again as I have this year, but it was just not possible, now more than ever before. I must now continue at my post. ..."

Then he speaks of "habilities which amount to approximately 3,000 marks per month for my experiments and so on. For October I managed it, but for November only about 2,000 marks are accounted for; that leaves 1,000 marks which I do not have. And so it is nothing but a struggle to find money."

The summer in Bochum brought him yet another disappointment. The other members of the Society for Space Ship Travel did not like Valier's method of publicizing the rocket issue by demonstrating reaction-driven vehicles. They found it questionable and annoying that his name appeared so often in the newspapers.

Indeed, Oberth's name too has often appeared in the press recently. As has already been mentioned, he had been requested by the Ufa to ask for leave from the teaching profession, to go to Berlin and to take part in the making of the film 'Woman on the Moon' as the scientific adviser. At his request, the Ufa had now granted him funds for the construction of a liquid-fuel rocket. This rocket was to ascend to a high altitude on the

day of the film's world premiere. The advertising department was hoping for a very successful publicity campaign in consequence of the takeoff of a genuine Oberth rocket.

To begin with, Oberth was highly elated about being able, at long last, to actually build a first test rocket according to his ideas and calculations. In order to advance the affair, the Ufa granted him the salary for a technical assistant, Rudolf Nebel, cert. eng. He also had at his disposal the necessary mechanics and a workshop.

But Oberth had underestimated the difficulty of realizing the construction which he had had in mind for years. It was presumably because, in spite of all his good inventive ideas, he was a stranger to the actual technology involved, that he had rejected Valier's plan of progressive technical development on the grounds that it was a futile detour. -

Whilst Oberth worked away with tremendous energy, the advertising department saw to it that Professor Oberth and the rocket he was engaged in building were mentioned again and again in the press.

The day of the world premiere, October 15, was drawing nearer and nearer. But the rocket was far from ready. Only a small wooden model which Oberth had had built for aerodynamic tests stood in the courtyard, but no rocket that was ready for takeoff.

In order to console the public, the advertising department invented an excuse: Because the season was already too far advanced, the takeoff must be postponed. In spite of this slight disappointment, the Utopian film "Woman on the Moon" was a world-wide success.

The advertising department was then no longer interested in the genuine Oberth rocket, and it stopped the payments. Then the Society for Astronautics proved its worth by encouraging the completion of the rocket with both ideas and funds. After many futile approaches, the rocket builders finally found someone who was willing to help. Dr. Ritter, director of the Chemice-Technical Laboratory in Plötzensee near Berlin, placed a workshop at their disposal. Now Oberth and Nebel were able to continue their work; other members of the Society, the young engineers Klaus Riedel and Rolf Engel and the graduate Wernher von Braun, went along as voluntary helpers. (Condensed from Heinz Gartmann in "Visionaries, Researchers and Engineers" pp. 114-126.)

Considering what possibilities of success Oberth and Valier had, it is a wonder that the penniless author in the Ruhr district ventured to embark upon stage three of his plan, the development of liquid-fuel rocket engine, and ran into debt for the preliminary tests.

"He was not concerned with his own gain; if he had been, he would have lost his nerve already a long time ago", wrote O. W. Gail of the deceased Max Valier in May 1930. -

In the hope that the test flights with the actual rocket plane in the process of construction in Espenlaub's factory could soon begin, and in order to justify his step-by-step mode of procedure, Valier wrote an article for the Recklinghäuser Zeitung on August 20, 1929.

"My Objective for 1929: A rocket flight over the English Channel."

(Why exactly choose the Calais-Dover route if one wants to show that reaction is a fit means of propulsion for aircraft?

20 years before, in 1909, when the first aircraft began to make short flights, and when airplane engines were still very unreliable so that the aircraft and even Count Zeppelin's airship were frequently forced to make emergency landings as a result of engine defects, the French aviator Blériot ventured to fly across the English Channel from Calais to Dover in the airplane he had built himself - and his engine held out! Thus the flight succeeded. This bold exploit was admired throughout the whole world and was considered a milestone in the development of aviation. - Moreover, it was on this same route that the bold Montgolfière pilot, Pilâtre de Rozier, had met his death in the 'days of yore' when he set out to cross the Channel in 1785. His ill-starred novel construction, a combination of a hydrogen balloon and a hot-air balloon with sparking firing, was responsible for the fact that he, the first aeronaut of humanity, also became the first victim of aeronautics.)

Therefore, in response to attacks in the press, Valier wrote:

"... first of all I have set myself a far more modest aim in the development of rocket propulsion: the crossing of the Channel with an aircraft propelled solely by jet reaction. ...

My association with the Espenlaub brothers in Düsseldorf, and the rocket tests of July 9, represent my first preparations for the undertaking of this Channel flight with rocket power. Unfortunately, for lack of funds, things are only proceeding very slowly, ...

The time will come when rocket propulsion[+)] will surpass the hitherto existing propeller aircraft in range and economy of operation."

Even this appeal died away without having any effect. At that time no aircraft expert thought that Valier's technical prediction would one day come true.

It was only in 1936 that Heinkel jumped at the idea which a young physicist, Pabst von Ohain, proposed to him at that time, of building a jet unit for aircraft. He hired von Ohain, who was thus able to develop the jet unit in the Heinkel works quite without financial worries and

[+)]At that time Valier wrote rocket propulsion for reaction drive, for words like jet unit and jet-propelled aircraft were not yet known (See also p.

assisted by engineers. - In 1937, the unit was built into a normal production aircraft, the He 112, and the first test flights succeeded in exactly the way Valier had suggested in 1927 in lectures and articles: takeoff with a propeller engine, then changing over to the jet unit in flight. - After ceaseless further development the first actual jet-propelled aircraft in the world, the He 176, took to the air in August 1939. (Adapted from Ernst Heinkel, "Wild Life" (Stürmisches Leben) Editor: v. J. Thorwald, Preetz, Gêrdes-Verlag).

The co-operation between Espenlaub and Valier came to an end even before the "arrow-shaped aircraft with the long fuselage", planned in May and agreed upon in June, such as was considered by Valier to be the right form for powerful reaction drive, was built.+)

Thus Valier's hopes of rocket flight were frustrated. He was obliged to admit that when one does not have the money to commission an aircraft from an aircraft builder according to one's own principles of construction, then there is no chance of seeing those principles realized. - Valier could not even build the rocket engine for liquid fuel from his own resources, even if he ran up even more debts for the continuation of his preliminary tests. - This he just had to admit.

At this time, Fritz von Opel, who in the meantime had himself learnt to fly, had his rocket-plane, which had been built by Hatry on his instructions, loaded with Sander rockets and he flew it after Hatry had made a preliminary test flight in secret with a crash-landing.

"The first rocket-plane roars above our heads."

This was the title of the lively and gaily written report by Erich Boyer in the Osnabrücker Volkszeitung of October 3, 1929.

"The spring of last year saw the first rockets whizzing along in manned vehicles. A former dream, a former fantasy of talented authors had, of late, assumed more concrete forms: serious researchers like Oberth and

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+) In the second edition of "Rocket Travel" we read:

"... Later, Espenlaub himself continued the tests, partly with the advisory co-operation of Engineer K. C. Volkhart. On October 22, 1929, the first rocket flight succeeded. Having been towed to an altitude of 20 meters by a power plane, Espenlaub released the connecting cable and ignited the first rocket. The aircraft bucked under its pressure, shot upwards a little way and then covered a distance of approximately 300 m horizontally with the rocket burning. The second ignition failed. Consequently the pilot was obliged to land, which he was able to do without a hitch in a normal glide." ("Rocket Travel", Second Edition, p. 239)

Herr v. Römer informs us of "Espenlaub's last flight with his rocket-driven tailless airplane. As a result of a rocket explosion Espenlaub had to climb out of his seat in the burning aircraft, which was about to crash, and jump into the marsh from an altitude of about 30 m. In doing so he contracted cerebral concussion, which hospitalized him for a long time."

Goddard had established the science of rocket propulsion. The vigor of a man like Fritz von Opel. firmly rooted in reality, rose to the occasion immediately. The man is himself a rocket, full of determination, courage and youthful impetuosity. All he needed was to be sparked off. Then, only a few weeks later, the first rocket-driven automobile was seen tearing along the track in Rüsselsheim."

(Here we may ask: Who was the person who "sparked" him off? - The worthy journalist does not say.)

"When Opel had made the decision to tackle the rocket problem practically, he got in touch with all Germany's pyrotechnists and looked for the man who was cut out to master explosives in such a way as to make them a ready tool in human hands. This man came forward. His name was Sander.

And then came the day which was the greatest technical experience for most of the eyewitnesses:

Opel's run on the Avus speedway. Behind a roaring column of smoke and fire he travelled his 250 kilometers per hour in an automobile which had all the teething troubles of the firstborn."

There then follows a short report of the run of the rail vehicle at Burgwedel and the statement that Opel had learnt a wise lesson from it: The rocket belongs in the air. And it goes on:

"But the rocket in the form developed by Sander had shown that it is quite suitable as a means of propulsion. The next stage was the <u>rocket-plane</u>.

The first tests were made in the Rhön Mountains with small models. They succeeded. Then the chief pilot, Stamer, tested the Sander rocket on the gliding sailplane. This test was also successful. So Opel could now set out to prepare the first rocket-plane for takeoff."

Boyer goes on to give a very lively account of how Opel learned to fly in 'manageable', patient power planes and how he then had a machine built by Engineer Hatry, which conformed to the requirements of the rockets.

"On Tuesday, September 10, the first aircraft tests were carried out. And they were successful - as they should have been, considering the pains taken in their preparation."

(The fact that Hatry himself had made the first rocket takeoff is not mentioned.)

"On the eve of this day, which our grandchildren will call 'historical', the aircraft was disassembled, loaded onto trucks and taken to a forest glade." ...

Then he describes how the few invited guests got the aircraft into the air with the help of the launching rope:

"Pull! Run! Let go! The rope came away. The machine was airborne. Then there was hissing, roaring, fire. White steam.

The first rocket-plane roared above our heads. ...

Man's first rocket flight had been made." etc. ...

What was the purpose of making such false reports? Why act as if this flight of Opel's were the first human rocket flight, although, on June 11, 1928, Friedrich Stamer had flown his "Ente" in exactly the same way with rocket propulsion after a shock cord launching on the Wasserkuppe?

Yet another Valier idea was adopted and put into practice - without Valier.

In "Rocket Travel" (p. 240) he says:

"The idea always advocated by the author, that auxiliary rocket power could serve to boost heavily loaded normal aircraft at takeoff, has been adopted in the meantime by the Junkers Works in Dessau.

According to the information available, a cargo-transport aircraft of the 'Bremen Typ Junkers W 33' was used for this purpose. The tests took place on the Elbe near Dessau. Eisfeld's metal casing rockets were used; their caliber has not been made known. Even the exact design was kept secret. On the occasion of the first takeoff on July 25, 1929, however, the two rockets burst open on the sides. Only on August 8, did the well-known high-altitude aviator Schinzinger, cert. eng., make a successful takeoff with 6 rockets which were rapidly ignited in pairs one after the other. The impression was so favorable that people were convinced that it would be possible with this machine to lift 5,000 kg operating weight from the water into the air, a feat which would be unachievable by any other means.

Although the Junkers works have since aimed at the greatest secrecy about the continuation of the tests, it can be safely assumed that work is going on there not only to perfect the takeoff with booster rockets, but also to realize the actual rocket flight of large machines for future high-speed and long-distance purposes.

Since, however, the direct rocket jet of small mass and high exhaust C would yield too low an efficiency for the objectives in view (i.e. flights to an altitude of 12,000 to 15,000 m at speeds of 300-600 km/hr, an obvious

conjecture to make[+)] would be that Junkers will resort to using the outside air as an oxidant as well as for transforming the jet into an air stream of great mass and of a speed similar to the flying speed.

Thus, at the time of writing these lines in conclusion to the present book, it is very much to be expected that the problem of reaction drive in the domain of aviation will soon come into prominence with performances which will overshadow all previous flying machines by far. Even if individual inventors may suffer many let-downs, the problem of rocket flight can, on the whole, only continue to make progress."

On November 10, 1929, Valier terminated the manuscript for the new edition of his book 'Rocket Travel'. The preface and concluding chapter had been re-written and they give an account of the "valuable petty work" which had been done since September 5, 1928, the day he had completed the preface to the first edition, as well as the rail vehicle tests.

He always took great pains to describe all vital matters completely and impartially. He mentions what had been accomplished with rocket power on the ground and in the air up to November 1, 1929, and what was to be said about the development of the freely ascending, wingless high-performance rocket as well as about the reaction engine with liquid fuel. In words of approval he speaks of Sander's progress in the field of the powder rocket. By using another kind of powder, which has a far greater energy content than black powder, he succeeded in

> "boosting the exhaust-gas velocity, which was previously 1,200 m/s, to 1,800 m/s, and also in increasing the weight ratio of the fuel weight to the empty weight, which is so important in rocket theory, to 8:1 in the case of large calibers. This he did by using high-strength light-metal pipes instead of the former heavy steel or copper casings and, above all, by replacing the former cast-iron or bronze nozzles which were screwed on externally by nozzles made of specifically light, infusible rare earths, which were pressed into the casing. In this way the 'ideal propulsive performance' of the best Sander rockets (see p. 8 and 199 for further details) increased to 4,000 m/s, a figure which was still considered to be impossible a year ago.
>
> At present, Sander indicates an average thrust of 180 kg for his bore rockets of a caliber of 5 cm, 300 kg for a caliber of 9 cm and 1,680 kg for a caliber of 15 cm, with a rocket length of 1.80 meters. But he obtained the best results with rockets of a caliber of 22 cm, which were able to lift loads of 400-500 kg to an altitude of 4,000-5,000 m, after which these loads could then be landed smoothly with parachutes separately from the burned-out rocket. With these

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[+)] What he here calls an "obvious conjecture', was a very promising construction principle.
Ten years later this was put into practice for the first time in the Heinkel aircraft works. On July 3, 1939, He 176 took to the air. This first-ever jet aircraft reached a speed of 850 km/hr, which at that time was unheard of.

high-performance large-scale rockets Sander would not have had any difficulty in rising into the stratosphere or in sending recording instruments up in them, but it turned out that the meteorological measuring instruments are too sluggish to record the atmospheric elements which change rapidly in the course of the ascent and descent. Therefore it is the fault of the measuring instruments, not of the rockets, if the hopes placed upon the recording instruments for the investigation of the stratosphere have, for the time being, not been fulfilled. With the tremendous thrusts of his large-caliber rockets it would most certainly be possible for Sander to launch a manned, wingless rocket ship to an altitude of a few thousand meters by means of an aggregate of such high-powered rockets (cf. pp. 153/154) and to bring the occupants down again in hermetically closed cabins or provided with vacuum diving suits with parachutes, but it seems to be questionable whether they would be able to stand the acceleration during the ascent."

Valier does not hesitate to describe these achievements of Sander's in the further development of powder rockets objectively and in words of approbation and indeed even of admiration for his accomplishments. (Another writer would have drawn the reader's attention to the fact that this great progress of the powder rocket is actually a result of the incentive he himself had given to rocketry by his initiative.) Valier had shown the pyrotechnists how improvements are possible - the nozzle, the ratio of the incendiary surface to the discharge opening, the energy content of the powder.

Valier had already formulated the research program for his systematic measurements as early as in 1925; he had also invented the measuring device and had, at that time, described both of these to Oberth in his correspondence. After he had succeeded in filling Fritz von Opel with enthusiasm for the rocket idea, and Opel had given him the money necessary for his rocket research, Valier was able to accomplish with Sander in Wesermünde what he had planned three years before. He now assembled the test readings in a curve diagram (Figure 19) and published this in "Rocket Travel". With a few accompanying sentences he explains the findings obtained in a way which is so intelligible to everyone that the pyrotechnists and the many readers of his book were also actually able to understand this new knowledge. Consequently, the level of powder rocket technology in Germany had made great headway.

The author (as Valier calls himself in his books) must have found it much more difficult to write about Sander's success with rockets with liquid fuel in the subsequent sections than he did to write the approving sentences for Sander's achievement in the field of powder rockets. The reaction engine with liquid fuel was the end to which Valier himself aspired (as he had declared openly already at the end of the sled run). In order to convince financial backers of the technical possibility, he built and drove the high-pressure steam-jet rocket-driven automobile. He ran into debt for the sake of his objective and put his wife off with fine words when the 350 marks which he had promised to send to Munich for her every month, often only came little by little: If my liquid-propellant rocket motor functions, then I will have built the machine which air traffic needs in order to make progress; then all our troubles will be over.

Was someone else now beating him to it?

The conflict of joy and chagrin may have hit Valier hard. - It was perhaps one of the most difficult trials which life had brought him. How he repressed egoistic desire and how he came round to a higher point of view can be seen from the last paragraph of his preface. Therefore we must quote his report about Sander's achievements:

> "Sander is likewise to be mentioned as the most successful researcher of the year in the field of the rocket with liquid fuels, for he was the first to succeed in bringing such a rocket to a free ascent on April 10, 1929. According to his statements, the rocket had a caliber of 21 cm and weighed 7 kg empty and 16 kg when full for a missile length of 74 cm. The powered phase was 132 seconds, the propelling force at the maximum value was 45-50 kg. The propellant, which Sander has kept secret, contained 2,380 calories per kilogram; it thus appears that he used gasoline and a suitable oxidant in specific combustion conditions. Part steel, part light metals were used as construction materials.
>
> This first liquid-propellant rocket left the stage so very swiftly that it was impossible to keep track of it and to find it again. For this reason Sander repeated the test two days later and attached to the rocket a line 4,000 m long and 3 mm thick; the test of course took place with all the precautionary measures which were well-known to him from the ships' rescue rockets. In spite of the heavy pull of the line, the rocket again shot up into the air like a bullet, taking with it 2,000 m of the line, which then snapped, whereupon both line and rocket disappeared, never to be seen again.
>
> After this success, Sander again turned with particular enthusiasm to the rocket engine for the propulsion of manned aircraft. As early as in May he succeeded in producing a thrust of 200 kg for longer than fifteen minutes and in July he was even able to attain powered phases of more than thirty minutes for thrusts of 300 kg at Opel's works in Rüsselsheim. Moreover, Sander focused his attention above all on the cheapness of the propellant, in addition to the constancy of performance. By using a by-product of the chemical industry as an oxidant, he succeeded in forcing down the price per kilogram of fuel mixture to 20 Pfennigs. In view of this state of affairs, an economical rocket flight performance over a distance of several hundred km should become possible in the foreseeable future, once the defects still inherent in Sander's rocket engine have been successfully made good."

(Strangely, nothing more was heard about a liquid-fuel rocket engine developed by Sander. Perhaps Sander did not succeed in rectifying the defects still inherent in his rocket engine? Or, perhaps the whole report was only a hoax, which Valier was taken in by, a thing which seems to us to be more likely. Otherwise people would have heard something about the continuation of Sander's initial success. - In any case, at that time Valier believed the account about Sander's success.)

Valier goes on to describe what Oberth and Goddard had done for the rocket cause that year, and what had been published by Winkler, Hoefft and Pirquet in the way of basic physico-chemical research, as well as what had been announced by the Russian research workers.

Then he writes that at present more and more people are dealing with the problem of rocket propulsion. (He had heard about it from applications for patents concerning entrainment effects. These applications were rejected by the patent office on the ground that similar patents had already been applied for just recently, by inventors who were as yet quite unknown in the field of rockets).

The conclusion to his preface reads as follows:

"Research into reaction propulsion has thus attained quite unexpected dimensions during the last year, and is now receiving such tremendous financial backing in at least three places that there can be absolutely no doubt that, sooner or later, further successes will also be scored openly before the whole world.

The expression "high-speed traffic with rocket power" will then no longer be an idle saying, and even the "advance into interplanetary space" may actually take place. Which of the various researchers makes the decisive inventions is basically immaterial to the world; for the researchers themselves, though, it is a harsh struggle, in which each one must use all the means at his disposal - even staking his own life - and do so gladly, for everyone knows that this greatest of technical problems can only be mastered by striving with might and main in a noble contest between minds.

Bochum, November 10, 1929.
Max Valier."

It is typical of Valier that he should call the contest with his financially strong rivals a noble contest between minds, and this at a time when it was highly probable that he was being outstripped by the others.

Almost anyone else in his position would have stopped the costly preliminary tests for the rocket engine, declared himself insolvent to his creditors, and taken up another occupation, so long as his most important possession, his working capacity, was not exhausted. (Mr. Glück's offer was still standing, for despite the economic depression there were still well-to-do families with sons who could only manage to graduate from high school with the aid of a private school.)

His friend O. W. Gail had this situation in mind when he wrote in the obituary:+)

"... He then even built rocket sleds and new vehicle models on his own account; he sacrificed his last reserves, ran into heavy debts and found himself

+)Illustrierte Technik - Das Industrieblatt Stuttgart, May 25, 1930.

in personal privation. Anyone else would now have given up the game and looked after his own interests for a change. (He was capable of doing so: he could easily have earned a good income by means of his literary activity.) But not so Valier! He had nerves of platinum if he had any at all, and he would exert himself time and again to do new tests..."

At that time, Valier wrote to his wife:

"... Who knows if the others really will make it? If they experience a setback, won't they perhaps lose the desire to reach for the stars? Sander will return to his ships' rescue rockets, Oberth to his schoolboys and Opel to another sport. And I should be the first to forsake the stars? No, nothing doing! ...."

In the first half of November, Valier had to give a series of lectures in big cities. Then, after once more showing his high-pressure steam-jet reaction vehicle on a road near Duisburg at the end of November, as can be seen in a press photograph, Valier left the Ruhr district and moved to Berlin.

There we again find him on the speaker's platform in the lecture hall. The Urania in Berlin had discontinued its previously so renowned lecturing activity because of external and internal difficulties. Now, 2 1/2 years later, a new start was to be made in reviving the old tradition. Max Valier was engaged for the first lecture. The subject he spoke on in that overcrowded lecture room was entitled "Travel and Flight with Rocket Power". In the introductory historical outline he named the men of ages past, who, giving rein to their imagination, had ventured out into the universe astride the winged steed of poetical inspiration. But then, he went on to say, in the 1870's even before Jules Verne's "De la Terre a la Lune"+) (From the Earth to the Moon) appeared, Hermann Ganswindt took up the problem here in Berlin. However, it was not Pegasus, but physical considerations, which brought this ingenious man to develop his project of a "Weltenfahrzeug" (interplanetary vehicle) to be propelled by the reaction force of powder cartridges. Valier showed an illustration (see Fig. 34 in appendix 5, p. 232) that Ganswindt had presented during his lectures in 1883 to 1893, and said that there was reason to be proud that the first spacecraft project that was physically feasible had been presented to the public here in Berlin. Ganswindt's audience had not appreciated this; the plan was too far in advance of the level of technology at that time. But in the name of <u>his</u> audience, Valier now voiced his pleasure at being able, on this occasion, to salute Hermann Ganswindt, the first champion of space travel, there in that very hall. - The old man was honored with a round of rousing applause.

Then Valier continued, the tenor of his speech being as follows:

But it was not until the present century that the idea of space travel genuinely took shape thanks to Hermann Oberth's valuable theoretical work. His calculations were convincing evidence of the desired flight to other planets with Oberth's 3-stage rocket being a technical possibility.

+)Translator's note: Valier was probably referring to the German translation of this work, as the original work was published in 1865.

Valier then said that he and other experts concerned with the practical aspects of the matter were striving towards the technical realization of Oberth's pioneering theoretical work. There were always many different ways of arriving at a remote goal, he said; his way was that of progressive technical development. The speaker than described his own plans, showing illustrations and filmstrips of the preliminary stages he had already realized: the rocket-propelled automobile, rocket-propelled rail vehicles, rocket-propelled sleds, the steam-jet reaction engine and the rocket-propelled model airplane. Valier then ended his lecture with a preview of how he thought air traffic would be further developed by means of stratosphere airplanes with reaction engines which, on being continually perfected, would constitute the final stage in the preparation for space flight.

The press published the following statement on this lecture evening of December 6, 1929: "Thus the Urania has made the first and most difficult step - that of winning back the confidence and love of the inhabitants of Berlin." (Summary account of the press reports published in the Berliner Morgenpost on December 8, 1929, and in the evening issue of the Berliner Illustrierte on December 7, 1929.)

Rocket engine with liquid fuel

Financial backing by Dr. Heylandt

Max Valier, who had hoped in the spring that he would find in the industrial region people interested in the development of a high-speed airplane with rocket engines, stuck to his 4-stage plan despite the disappointments he had experienced. It was impossible to make any headway without point three of the plan - the development of the rocket engine.

He now returned to a former idea: In the summer of 1924 he had advised Oberth that, once enough financial backers had declared themselves willing to support the construction of the rocket, he should begin his work in the vicinity of a large liquid air factory, firstly because this would spare him the very high costs of transport for liquid oxygen, and secondly because such a factory would be interested in the rocket as a prospective large-scale consumer of liquid oxygen and might therefore support the project. At that time he proposed Linde's Eisfabrik in Munich.

Did Valier now first turn to Linde for the development of his own rocket plan, or was it not possible for this firm to support the project in the adverse economic conditions of the time? We do not know. We only know that when Valier asked Dr. Heylandt if he would be interested, he did not do so in vain.

Paul Heylandt had been a simple locksmith; now he was head of the Gesellschaft für Industriegasverwertung (industrial gas utilization company), a large works in Britz near Berlin, which built the producer units that generate gaseous and liquid oxygen according to Heylandt's gas liquefaction process. His invention had made him a rich man and an honorary doctor. It is rare for inventors to be so successful in terms of remunerativeness. In

addition to great technical talent and the courage to follow one's own ideas, it is also necessary to have courage and discernment in the commercial field. Technically talented people are usually lacking in the latter.

Heylandt appreciated Valier's plans, and after thinking the matter over well he was prepared to make it possible for Valier to develop a liquid rocket engine on his factory grounds, and even to give the project financial backing.

We have drawn the result of the discussion with Dr. Heylandt from a letter that Valier wrote to his relations in Southern Tyrol at Christmas.

> Mr. Renneberg, his mother's second husband, had bought himself a lovely villa in Seis am Schlern in 1921. He also had some farmland there which he planned to have worked by farmhands according to his instructions. Over the past twenty years, during which he had held executive commercial posts in various frims in Bozen, he had earned and saved enough to treat himself to an old age fashioned after his own taste. As a nature lover, he wanted to live in a lovely house in the hills, and as an amateur of innovations he wanted to have a farm on which he could show the Tyrolese peasants how to work efficiently with the knowledge and machines of modern times. But in the space of a few years, Renneberg's money had dwindled away. Farming had cost him a great deal, but had brought him little in return. The family was now having a very hard time in the lovely villa in Seis am Schlern.

The fact that he could not help his mother weighed heavily upon Valier. In order to explain to her that he was not able, at the moment, to support her, but that he hoped to be able to help her once the work he was engaged in was successfully concluded and his rocket engine was functioning, he described his present financial situation to her. His letter heading and excerpts from the letter itself read as follows:

Max Valier

Research Laboratory for
Rocket Propulsion
Berlin-Wilmersdorf,
December 29, 1929

"Dear Mother,
Dear Aunt,
Dear Sister,

> I must write to you at once, I cannot do otherwise. I thank you, mother, for your explicit letter. ... I am now in Berlin, ever since December 1, for I have again managed, as in 1927, to find a company willing to support my research under certain conditions. Of course, unlike in the case of my past association with Opel, I shall not receive any personal expenses; only the costs of the tests will be paid, provisionally for a period of three months and up to a total of 6,000 marks. I, on the other hand, must fend for myself in earning a living and paying off my old debts. Getting through this December and honoring all my obligations to pay was no easy matter. But I did manage to do so by yesterday

evening; once again a sum of more than 2,000 marks for December. Of course, here I am on the eve of the new year, pretty well without a penny, and January is just around the corner with further liabilities, while I have virtually no assured income whatsoever with which to pay them. But I am quite used to this, after all; so long as I remain in good health and my brain is in working condition, there is no cause for despair.

I am enclosing a few press cuttings concerning my latest test runs which, of course, were scarcely duly understood and appreciated by the press. But that will soon take a turn for the better once I really start driving with liquid oxygen and gasoline, which I hope will be quite soon.

This time I spent Christmas alone in Berlin, at Mrs. Lindemann's, the lady who has been running my lecturing affairs for 3 years. My wife and stepdaughter are in Munich. ....

The camera is safely packed away in our attic in Munich, mother. As such, it was impossible to sell it. But once my financial situation eases up a bit, I shall take it over myself and pay you for it. - Don't any of you lose heart; that way, everything will turn out alright in the new year. ...

On New Year's Eve my Rak vehicle is going to be set up at a New Year's party in the Berlin Philharmonic, where (for a 50 mark fee) I am to give a little speech in order to usher in the new rocket year 1930 in a worthy manner.

Here's wishing you all a gay and happy new year, in the course of which I hope we shall all meet again soon.

Your
Max."

The news that Valier was to make a speech on the rocket year at a New Year's Eve party soon spread among the other members of the Society for Astronautics, and they found it very unseemly. "He just can't shut up" said some, and the others believed it and thought that Valier was like a circus performer who is only happy when he can hear the public's rousing applause.

Nobody bothered to consider that Valier was doing everything he could to pay off his old debts. He had to earn his living too. In consequence, he had to give lectures. If Mrs. Lindemann arranged something for him, even if it was only a New Year's speech for a 50 mark fee, he would have found it incorrect to refuse. It was in his power to word his speech in such a way as to put an end to the flippant amusements of New Year's eve. And this is indeed what he did. All of sudden, a great tall man appeared. His full, melodious voice filled the room. He had the gift of gripping his audience. When he spoke to them, a change came over his listeners without their being aware of it. They listened to him in silence, trying to follow his train of thought. And so the rocket year 1930 was ushered in in a worthy manner.

Although he had no money, only debts, and often had to do without a hot meal, one would never have thought so on seeing him. Never did he have an air of poverty about him. Valier was always very bold and liberal. His Packard cost him quite a lot each month, but he needed a presentable car. It would not do to turn up on foot at the executive board of the Avus speedway in order to arrange a demonstration run for the rocket-propelled vehicle.

At that time in Berlin, Valier also occasionally encountered Dr. Hans Wolfgang Behm, an old acquaintance from the Hörbiger circle. This author, who had written several books and essays on the natural sciences, booklets on the cosmos, and the great Hörbiger biography, parts of which we have cited in the previous chapters, recounted this meeting to us:

"... Valier was as sound as a bell, but was, by nature, the kind of person who consumes himself prematurely. I was rather shocked on meeting him again in 1929, after not having seen him for some years. He had aged a great deal and become much more nervous, but he masked (or rather, he tried to mask) his nervousness behind an air of stubborn drive. As I then went to Vienna for several months, I unfortunately did not see him again; I was still in Vienna when he died. - His most prominent features were his highly reputable character, his absolute sincerity and resoluteness. No matter where Valier went, he immediately made it plain what he wanted. - Everything he did took him a third of the time it would have taken an ordinary mortal to do. ..."

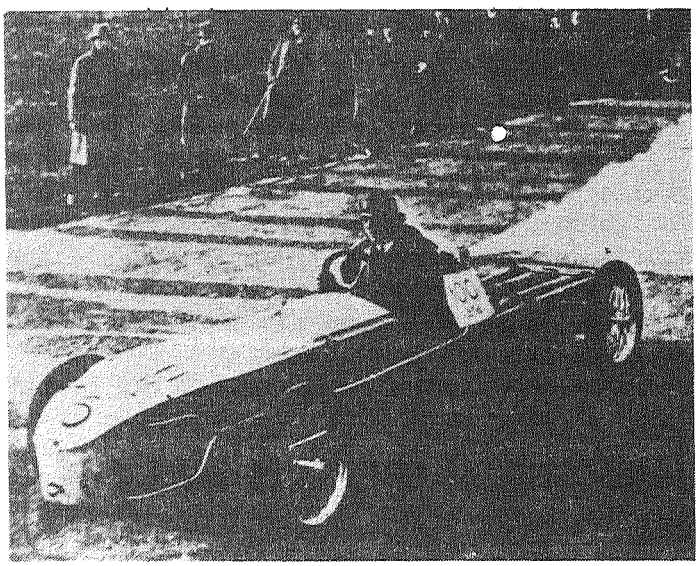

Figure 25.: Valier driving his steam-jet reaction-driven vehicle "Rak 6" on the Avus speedway.

"Die Welt" accompanied the press photograph of January 5, 1930, with the following text: "On the Avus speedway in Berlin, Max Valier recently demonstrated a new rocket vehicle propelled with carbon dioxide."

Up to these demonstration runs on December 22, 1929 and January 3, 1930, Valier had kept secret what fuel he was using, Although in his book "Rocket Travel" he had cited the considerations that determined what fuel was to be chosen for the high-pressure steam-jet reaction-driven engine (i.e. low boiling point and high gas constant), no mention was made there of the word carbon dioxide. It was a good choice. The many breakdowns which occurred again and again when driving and flying with powder rockets did not take place with the carbon dioxide carburetor. The reaction force, which could now be called safe, sufficed to propel the vehicle forward at such a speed that its wheels began to wobble. It was thus not possible to drive with the throttle wide open for long. On one occasion, however, the carbon dioxide fuel had posed some problems on a demonstration run, because of the winter cold. How quickly these problems were overcome can be read in Gartmann's "Visionaries, Researchers, Engineers" (p. 150):

> "Two days before Christmas, Berlin's press representatives made their way to the Avus speedway to watch Valier, the rocket-man, drive once again. He, in the meantime, was feverishly busy with his helpers. It was cold, and so the pressure in the bottles was too low. An innkeeper placed a tub of hot water at their disposal, shaking his head. Queer fellows, these rocket people, driving with hot water. On top of which, they then just leave it standing there unused!
>
> The heat of the water made the liquid carbon dioxide in the bottles gasify. The manometers began to climb gaily. Eighty, ninety, one hundred atmospheres. Enough! The bottles were hastily placed in the vehicle and connected up. Quick! Get a move on! The valves were opened, the pressure was checked once more, and the signal came "All clear!". Valier climbed into the driver's seat certain of victory. This time, nothing could go wrong. A tap on the foot pedal opened the main valve. The automobile began to move, a tremendous train of condensated atmospheric humidity in its wake. Once again, good photographs could be taken."

Walter Riedel, who was at that time research engineer at the Gesellschaft für Industriegasverwertung, was assigned by Dr. Heylandt to be Valier's assistant. From an account that Walter Riedel wrote about these months, which was published in the journal "Weltraumfahrt" in 1953 (p. 86-90), we cite the following:

"In the years around 1930, there were basically two groups (in Germany) that were practically active in the development of liquid rockets. The first group, known through the names of Hermann Oberth, Klaus Riedel, von Braun, Nebel, etc., had their site of operation at the rocket launching site in Berlin-Reinickendorf. The author Willy Ley, in whose books detailed accounts of the development work on the rocket launching site have been given, was also a member of this group.

The other group, with the well-known Max Valier and Dr. Heylandt, worked on the factory grounds of the Heylandt firm in Berlin-Britz. The present author (who later worked on the development of liquid rockets in collaboration with Dr. von Braun, from the very beginning to the end of the development of the

V2 - in the army institution at Peenemünde) also came from this group. Max Valier, the "spiritus rector" of the group in Britz, was a true pioneer of rocket development. He stood up for the idea wholeheartedly, giving it all his energy and untiring zeal. He was irreproachable in both his behavior to others and in his personal bearing, and was thus well-liked and held in the highest esteem by all. ...

In January 1930, work was seriously begun on the development with combustion chambers for liquid propellants. On the basis of previous experience,+) a standard combustion chamber was built in the course of two months of testing work. The chamber consisted of a normal steel tube. The exhaust nozzle was fixed onto one end, and the propellant injector onto the other. The oxygen was conveyed from the storage room to the furnace through a number of small bores. The fuel entered the combustion chamber in the face of the stream of oxygen gas. A resistance disk retarded the velocity of flow of the stream of oxygen gas by forming rotational fields. The tests were carried out in the experimental laboratory of the Heylandt firm; photos taken at the time show with what naïve disregard for the risks involved these tests were made. One of these pictures shows Valier engaged in research work.

The tests were generally conducted as follows: After filling the containers with alcohol, the tank was subjected to pressure and tiny amounts of fuel were conveyed into the combustion chamber by opening the alcohol valve and the pressure reducing valve on the oxygen side. The mixture was then lit at the nozzle exit with the flame of a normal blowtorch, so that a small flame appeared in the combustion chamber. By slowly opening the fuel valves still more, the combustion chamber pressure, and therefore the reaction, could be increased, the latter being measured by placing weights on the weighing dish of a scale. Considering the precautions taken today when conducting rocket tests, one can only wonder at the happy-go-lucky way in which they were approached in the very beginning."

Gartmann, in "Visionaries, Researchers, Engineers" (p. 151, 152), also gives a very lively and vivid account of this research work:

> "The test stand was actually nothing other than an ordinary workbench in the workshop. There was not a sign of the incredible safety measures of later years.
>
> The inventor simply set himself up in front of the combustion chamber, which radiated straight up into the air. The heat of the flames made his face as red as a lobster. Concrete walls, bulletproof windows, observation slits, photocells, pressure switches, safety relays - my eye! There was no time for all that, and even less money!
>
> The major unit of the tests was a scale. An ordinary, everyday, run-of-the-mill scale on which one could just as well weigh a hundredweight of turnips. Valier weighed the thrust of his combustion chamber with weights!

+) Experience gathered by Valier in the course of the research work he had begun in Bochum, and also even earlier while he was developing the high-performance powder rockets.

So he literally threw his life into the balance without a thought, as if it were not worth a penny. Unsuspectingly, as if oxygen and alcohol were tap water. Riedel applied pressure to the alcohol container. That is to say, he simply turned the control valve on a bottle filled with compressed air. Valier then opened the pressure-reducing valves for the two liquids a little. Liquid oxygen and alcohol flowed into the combustion chamber, where they mixed. They could not flow out of it, because the exhaust nozzle was directed vertically upwards. Rudolph had the blowpipe flame ready. He handed it to Valier and stepped back briskly. But the inventor did not blink an eyelash. He acted exactly as if he were about to light a candle at Christmas. And in actual fact the mixture did ignite quite gently, like a candle. Valier smiled. He opened up the valves still more. The liquids flowed into the chamber, the flash of fire roared furiously up to the ceiling, where a black patch testified to earlier experiments.

The reaction pressed the scale down. Valier placed weights on the other side of the balance: ten, fifteen, twenty kilograms. Then he fiddled with the valves again. Again, the scale pan dipped down. Still more weights were added: twenty-five, thirty. 30 kg of thrust! ..."

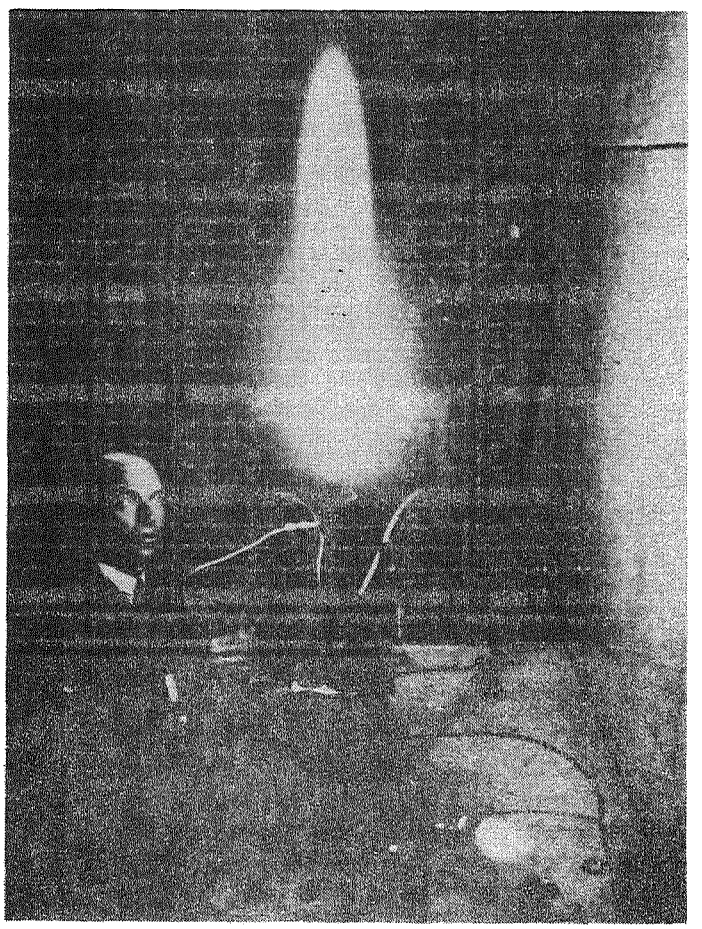

Figure 26.: Max Valier measures the reaction of his liquid rocket

One can see the simple testing installation. Instead of the spring balance used for the powder rocket measurements, he here uses a scale with weights, as this enables the necessary measuring accuracy to be obtained over a greater range.

Some remarks have to be made about these accounts: As a good author, Gartmann naturally cannot allow himself to bore his readers with a detailed report of long research work spent groping about in new territory. The inventor turns the valves, and the thrust increases from ten to thirty kilos - it all takes place as easily as in a movie.

But here, in the authentic biography, it is this very work that has to be recounted accurately. Anyone who has himself been engaged in technical research work will then realize just what Valier accomplished in the last months of his life. In addition to his research work, he had, among many other things, to write press articles, give reaction-driven demonstration runs, go on lecture tours, engage in nerve-racking negotiations for the financing of the rocket airplane. But the main thing was that the reaction motor for liquid fuel (Rak motor, as he called it for short) was developed!

Let us now turn to Riedel's remark, which we also encounter in Gartmann: "with what naïve disregard for the risks involved these tests were made." Gartmann says quite rightly that "there was no time for all that (for safety measures), and even less money!"

Let us now recall what Valier wrote in his preface to "Rocket Travel" on November 10, 1929, when he referred to three places where research into reaction propulsion was now "receiving such tremendous financial backing ... that there can be absolutely no doubt that, sooner or later, further successes will also be scored ..." (The three researchers receiving great financial backing, to whom he was alluding, were Goddard (USA), Ziolkowsky, Fedorow and others (USSR) and in Germany Sander (Opel)).

"Which of the various researchers makes the decisive inventions is basically immaterial to the world; for the researchers themselves, though, it is a harsh struggle, in which each one must use all the means at his disposal - even staking his own life - and do so gladly, for everyone knows that this greatest of technical problems can only be mastered by striving with might and main in a noble contest between minds."

Accordingly, Valier surely did not take the risk "unsuspectingly" and "in naïve disregard". When conducting tests on the test stand, he naturally always took up the most dangerous positions - that in front of the scales with the burning rocket - himself.

Development and Testing of the Rocket Motor

Although Valier's diary of the work done at Britz, as well as his photo album, have been lost, we can nonetheless trace the progress of the tests from January to May 1930. Walter Riedel's report (in the journal "Weltraumfahrt" 1935) is here complemented by information given in letters Valier wrote to his wife and his mother, and to the R.W.Z. (Rheinisch-Westfälische Zeitung), where Heinrich Weinz kept track of Valier's development work with great interest. He published the information in an article in the R.W.Z. on May 2, 1931 (appendix 10).

As Riedel reports, Valier built a combustion chamber in January 1930. It consisted of a piece of steel tube, on one end of which the propellant injector was attached, and on the other the exchangeable exhaust nozzle. This simple combustion chamber (also called furnace) weighed 3 kg. It was first set into operation for 5 minutes on January 1, producing a reaction of 130 gm. This was very little: the injected fuel had far more than this in it. The mixture therefore had to be improved. A period of reflection, groping and testing began. Only the burning test could show whether a change really did make an improvement. All considerations and improvements had to be decided by that incorruptible judge - the much smiled-at scale.

On January 27, it showed	300 gm reaction
on January 28	850 gm,
on January 29	1,300 gm,
on January 30	2,150 gm.

Pleased about the progress he was making thanks to the systematic testing work, Valier wrote a short letter to his friends on the staff of the R.W.Z. on January 31, in which he gave an account of the test results.

He continued the work zealously, and on February 11, he was able to report an increase of the reaction to 3,400 gm.

He then had to stop the work in Britz and make a trip to Switzerland. A big lecture evening was to be held in Zurich. The "Neue Züricher Zeitung" reported on it with many press photographs: "Valier's step-by-step procedure shows promise."

On February 26, Valier went to St. Moritz, where he was to have an important meeting with Sir Henry Deterding, the financially powerful Director-General of Shell. But the Director-General kept him waiting. For days, Valier sat around in the smart luxury hotel, the money he so badly needed for other things just running through his fingers. At last, Deterding turned up. Valier explained to him his plan, the promising development of rocket motors which was already under way, and his intention to install these reaction engines in an airplane once he had improved them still more. The first thing he intended to do with this rocket airplane was to fly Blériot's historic Calais-Dover route, in order to prove the efficiency of reaction-drive to the whole world. After this, in collaboration with an aircraft works, the stratosphere high-speed commercial airplane was to be built.

Deterding said he would consider participating in the financing of the development, and that he would get in touch with Valier.

How often in the past had Valier tried to interest aircraft constructors in his idea and to build a reaction-drive aircraft in a German aircraft works:

In 1925 he had tried it with the Junkers works,

in 1926 with the retired flying officer Udet,

in 1928 with Lippisch and Stamer (Rhön-Rossitten-Gesellschaft),

in 1929 with Espenlaub.

Always he had lacked the necessary money.

One has to learn from experience. As Dr. Heylandt was interested in the rocket motor on the oxygen side, and was financing the test in Britz, Valier now hoped to arouse interest and obtain financing on the fuel side too. This was why he had turned to the Director-General of Shell.

He now returned to Britz, glad to be able to continue the test with the Rak engine. In only a few days, from March 1 to 8, he was able to increase the reaction from 3,200 to 4,300 gm, then to 6,300 gm, and finally to 8,000 gm. In these tests he had varied:

1) The mixture, i.e. the proportional quantities of alcohol, water and oxygen;

2) The injection into the combustion chamber, and the atomization;

3) with and without the eddy-current disk;

4) the length of the combustion chamber;

5) the nozzle diameter (increasing progressively from ϕ 20 to ϕ 40 mm).

Valier's new Rak engine had also been built in February; eight atomizers opened into the far bigger combustion chamber. On March 5, this second model was placed on the test stand for the first time. It only showed a reaction of 1,600 gm. Valier wanted to increase this unexpectedly low performance of the big combustion chamber by means of systematic series of tests, the moment he had time to do so. But the first thing to be done was to develop the small combustion chamber still further. - In addition to this, money had to be procured for an airplane.

Valier went to Holland for a further consultation with Deterding. Deterding promised him that on March 20, experts would come to Britz to check Valier's assertions.

However, March 20 came and went, but the experts did not turn up. And there was no word from Deterding. - It was a nerve-racking wait.

But Valier, who had already experienced and overcome so many disappointments in his years in the rocket field, did not allow his work group to become despondent. Work was begun on a new project. The worthy little Rak engine was provisionally installed in the "Rak 6" reaction-drive test vehicle. Then, on March 22, the first run with a liquid-fuel rocket motor took place. It was Saturday afternoon. Work had stopped in the factory. In the factory yard in

Britz, Valier drove around with his jet whizzing away for 22 minutes, which was as long as his fuel lasted. The next day, he was sitting in the airport restaurant at Berlin-Tempelhof. On a picture postcard showing the lovely wide maneuvering field, Valier wrote to his wife:

Berlin, Sunday, March 23, 1930

... Yesterday at 4 p.m. I was able for the first time to drive the Rak 6 vehicle with the new engine in the factory yard, and to keep it going for 22 minutes. Today, I am here at the airport, in order to enter into technical relations. I should like to make the first driving tests here on the maneuvering field at the end of the week, as it is close to the factory (2 km); the Avus is 20 km away. ..."

(The brief message on the card opens and closes with warm greetings to the woman who is so far away.)

Riedel reports that on March 26 the small Rak engine was operated on the test stand with liquid oxygen for the first time. It functioned well. The first test run with liquid oxygen on March 29 also went off perfectly.

The reaction-propelled vehicle was then completely converted. The carbon dioxide bottles were replaced by an alcohol tank and a bottle of nitrogen pressure gas for forcing the propellants into the combustion chamber, and by a container for liquid oxygen, and the pipelines were connected to the Rak engine, which was now definitively installed behind the driver's seat. After this reconstruction the reaction-propelled vehicle was called "Rak 7".

A photograph shows it in the process of refueling with oxygen. The liquid oxygen flows from Heylandt's big storage tank into the funnel of the vehicle below, like water from a fountain. Some of the jet of oxygen evaporates on coming into contact with the air, which is of no importance (Figure 28).

Suddenly, on April 2, Deterding's experts unexpectedly appeared in Britz. They had Valier show and explain everything to them in detail. They thoroughly examined everything. Then on April 5, they left again, satisfied.

Valier now certainly hoped to receive a positive answer from Deterding. But he, once again, did not send any word.

In order to pay his bills and drafts, Valier had to borrow another 1,500 marks, so that his total debts now amounted to 10,000 marks; this was a heavy load to bear!

On April 11, the "other group" held a lecture evening. The Oberth rocket was set up in a corner of the room. Valier suspected that Oberth was going to launch his rocket during the aeronautics week at the end of May.

- Valier and Oberth had now been in Berlin for months. In earlier years, when they used to write each other long, weighty letters, when Valier proclaimed to the world, both in speech and on paper, that Oberth's inventions and

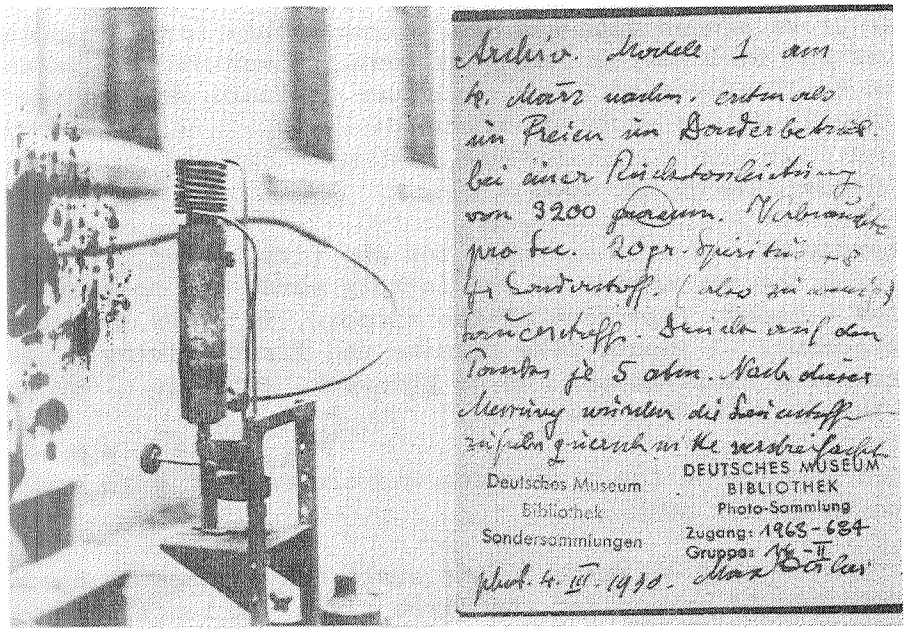

Figure 27.: Model 1 on the test stand.

On the back of this photograph, Valier wrote the test report.

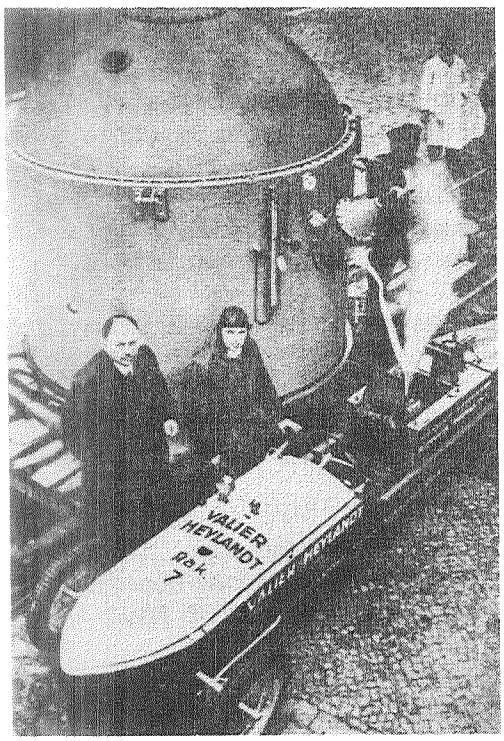

Figure 28.:

"Rak 7" in the process of refueling liquid oxygen.

On the left: Dr. Heylandt;
beside him: Max Valier.

calculations made the advance into interplanetary space a technical possibility, and when Valier's enthusiasm, spreading to others, set off the snowball that was to turn into an avalanche, the two men had often wished they could meet and exchange ideas verbally. Now they could do so, but neither of them took the opportunity. A misunderstanding had divided them, and even Valier's last letter had not been able to put things right. So Valier had to strike out alone on the path he considered necessary - the path of progressive technical development, with the preliminary stages based on the earth, and the "intermediate type", the rocket airplane. (Oberth, the physicist, loathed the poor efficiency that the rocket had in these terrestrial intermediate stages.)

So the former fellow combatants now worked individually, each on his own rocket development. It was a hard contest. Who would be the first to achieve success?

We can tell from a few lines that Valier wrote to his wife how much this combat oppressed him. But he mustered all his courage and forced himself to go about his work coolly, calmly and objectively - and it worked. The next lines in the letter read:

> "... what did I last write you about the little furnace - was it 16,000 gm reaction force? Well, today we reached 21,000 gm ..."

On April 14, he then informed her:

> "... today, 28,000 gm reaction! That little furnace! ..."

Walter Riedel's essay also gives an account of the little combustion chamber, which was now again installed in the "Rak 7":

> "... The reaction amounted to between 20 and 30 kg, and the driving time was 8 to 10 minutes, in accordance with the fuel charge. Demonstration runs were made with this vehicle before the press on the Heylandt factory grounds on April 17, 1930, and on the Tempelhof aerodrome on April 19; they were successful. These dates should be noted, because they are of some historic importance, Indeed, it was the first time that a rocket propulsion with liquid propellants was demonstrated in Germany, and these days can be considered as the starting point of all of the subsequent rocket development based on these propellants. While this propulsion was of no significance for practical use in a vehicle, this beginning provided the proof that it was possible, by burning liquid propellants, to produce a reaction force that could be used to propel aggregates. ..."+)

+) Valier had suspected that Oberth's rocket would be launched at the end of May. He was mistaken. It was only on July 23 that Oberth's rocket was demonstrated on the test stand to Dr. Ritter and the representatives of the press.

As agreed, Dr. Ritter recorded the values measured in the course of the demonstration: Powered phase 96.5 seconds, thrust 7 to 7.7 kg, exhaust velocity 756 m/sec, fuel consumed: 1 kg, gasoline and 6.6 kg oxygen. (From Gartmann's "Visionaries, Researchers, Engineers", p. 127.)

The following newspaper report shows that the press representatives had correctly understood and correctly rendered Valier's explanations.

"Test runs with a new rocket vehicle

A new rocket vehicle, built by the well-known rocket researcher Max Valier in collaboration with Dr. Heylandt, the leading researcher in the field of liquefied gases, has just recently been tested on the Tempelhof airfield. The few witnesses to the first test run, which took place at night, were not a little taken aback to see that the vehicle could be filled up with liquid oxygen (which was brought up alongside the vehicle in a big tank truck) just as easily and simply as it could with fuel. Max Valier drove twice round the maneuvering field of the aerodrome, in spite of pouring rain and darkness, but then he had to discontinue the run as it was impossible to distinguish the driving lane.

Another test run took place before representatives of the press on Saturday, on the grounds of the Gesellschaft für Industriegasverwertung in Britz. The most important feature of the new rocket motor is the fact that a liquid fuel (alcohol, gasoline or crude oil can be used) with liquid oxygen is made to burn up so completely that there are no fumes or noxious vapors, and the jet of flame emerging from the nozzle does not become longer than a few decimeters, i.e. it does not endanger the surroundings and the area behind the vehicle. The fact that the fuel and oxygen tanks are kept quite separate, being installed in front of and behind the driver's seat, respectively, and that the combustible mixture only actually combines in the furnace+) of the motor, is intended to preclude all danger of fire or explosion, and the throttling of the feed lines is to assure complete control of the drive unit.

The motor model demonstrated weighed not quite four kilograms. The significance of the invention naturally solely lies in the field of high-speed aircraft travelling in the stratosphere, as the efficiency of the reaction motor only becomes extremely favorable at speeds of more than 1,000 kilometers. For ground-based vehicles, rocket propulsion only comes into question for racing purposes and high-power sports performances."

Valier's small Rak motor was a reaction engine of the simplest kind which, with a net weight of 4 kg, produced a static thrust of 28 kg, and which worked reliably and without any trouble at a constant thrust for as long as the propellant lasted. A few such reaction engines mounted on the wings of an airplane could have served, without any technical difficulties, as the propelling force for the Calais-Dover flight. But Valier was unable to overcome the difficulty of financing the project without aid. Therefore there was only one thing for

+) Combustion chamber

him to do, and that was to pin his hopes on the financially powerful Director-General Deterding, and to set out to fulfil the condition set by the latter. This condition was that the fuel used be Shell oil, i.e. kerosene.+)

At the beginning of May, Valier had to interrupt his work in Britz in order to earn money. Mrs. Lindemann had organized for him a week's lecture tour in Upper Silesia. He spoke in Zakopane, in Kattowitz and in Hindenburg, among other places. He wrote to his mother, saying that the sight of the mountains on this trip had again made him yearn tremendously for the hills back home, for the lovely Southern Tyrol.

Once the lecture tour was over, Valier resumed his testing work.

Let us hear what Riedel goes on to recount:

"... Instead of the alcohol used hitherto, use was now to be made of Shell oil (kerosene). Alcohol is a fuel which can be mixed with water in arbitrary proportions in order to lower the temperature of combustion and to fix it at whatever level desired. With kerosene, this cannot be done without further ado. When water is poured into kerosene and shaken, an emulsion forms briefly, in which the kerosene and water mix, but soon separate again. However, it was necessary to keep the temperature of combustion within certain limits, in order to preserve the walls of the combustion chamber. The problem was solved by passing the kerosene through an emulsion chamber before it entered the combustion chamber. ..."

On Friday, May 16, Valier interrupted the tests in Britz for a few hours in order to speak on the Berlin radio about the development of rocketry and the aim: space travel.

Of the following day, Riedel reports:

"After a number of previous experiments, further tests using kerosene as fuel were conducted on (Saturday), May 17, 1930. These tests were fatal to Valier. The tests were begun early that afternoon. The first two were successful; a good combustion process could be recorded. During the third test, however, jolts occurred, owing to which the traverse and the scale balance were deformed. The liquid oxygen tank had been emptied in the course of the tests. In view of the jolts that had occurred during the last burning, and as it would be quite a long time before the installation would be ready for combustion again, I proposed to Valier that he call it a day. But he was so encouraged by the successful findings that he wanted to carry on the work. So the combustion chamber was assembled again. While the exhaust nozzle worked with before had had a diameter of 28 mm, for this test a nozzle 40 mm in diameter was already to be used. At nine in the evening everything was ready. The combustion chamber was ignited and the pressure in it raised to 7 atm gauge pressure

+)Translator's note: The German word used is "Paraffin" (i.e. paraffin), but it is not quite clear whether it is this that was meant, the German for kerosene being "Paraffinöl".

by the old, well-known procedure, by regulating the hand valves for the propellants and water. Just as the combustion chamber had attained this pressure, there was a violent explosion. I immediately closed all the propellant valves and sprang over to Valier, who collapsed. I was only just able to catch him as he fell, and laid him on the floor. While a machinist and my colleague Arthur Rudolph looked after him, I went off in search of a car. When I came back 10 minutes later, Max Valier had already died. A tiny splinter had struck him in the pulmonary artery."

After his death

On Monday, May 19, 1930, almost all German newspapers, and also many foreign ones, reported Max Valier's death. Strangely enough, the press depicted the fatal accident in a number of different versions.

Let us cite just a few examples:

Küstriner Zeitung:

> "M. V. was killed in an accident while experimenting with his new rocket vehicle ... The domed cover of a tank penetrated M. V.'s chest... . Valier lost his life through his own imprudence. ... It is held to be quite possible that the inventor did not screw in the nozzle firmly enough. ..."

Dresdner Nachrichten:

> "Max Valier, who was killed in an accident while experimenting with his new rocket vehicle."

Leipziger Zeitung:

> "... in Britz, Max Valier was experimenting with an oxygen bottle filled with liquid gas. Suddenly, the gas bottle exploded, and Max Valier was found dead beneath a heap of debris from shattered steel cylinders."

With what astonishing accuracy the transmission of information functions in the 20th century! It can be seen from this that much that was said about Valier was untrue.

Luckily, we do not have to try to figure out which of the many different newspaper reports available might actually be true, as we dispose of the previously cited report by engineer Walter Riedel, who, being a co-worker, was an eyewitness of this unfortunate experiment. What Riedel then writes in the final paragraph of his essay on the cause of the explosion is the result of a conscientious investigation by experts:

"The presumed cause of the explosion can be explained as follows: The emulsion of kerosene and water entered the combustion chamber through an

atomizing cone. During the period of regulation of the propellants up to the maximum combustion chamber pressure, part of the emulsion burned while another part was not involved in the combustion. The part that was not involved mixed with liquid oxygen, and as the latter has a very low temperature the emulsion was able to change into a jelly-like mass in which the oxygen was enclosed. This mass was deposited on the inner wall of the combustion chamber. Just before the explosion took place, part of the layer detached from the wall and dropped into the combustion zone, so that the jelly-like mass, which, chemically, is a highly explosive mixture, immediately burnt off explosively.

This tragic accident paralyzed further development for a long time - all the more since it had cost the life of one of the best and most successful of men." (From the journal "Weltreumfahrt" 1953.)

It does not matter whether Valier lost his life during a test run in the factory yard, or in an explosion on the test stand. But it is important to know that he did not cause the explosion through his own imprudence, e.g. by not screwing in a part firmly enough. Neither a research worker nor a mechanic should ever allow himself to be guilty of such carelessness on the rocket test stand.

The explosion was the fault of a risk - still unknown at that time - inherent in the new propellant.

However, certain editors who had been personally acquainted with the late Max Valier recounted some true facts about him. Thus, for instance, it was to be read in the "Kieler Zeitung" that the monthly astronomic almanac, which offered not only dull figures, but always also an interesting discussion of the stars, had for years been written by Max Valier. The editor of the "Münchner Neuesten Nachrichten" wrote a long article entitled 'Der verstummte Träumer' (The Silenced Dreamer), in which he said:

"... It is not intended here to give technical appraisal of Valier's achievements and aspirations; rather, we feel compelled to mention a particular quality that this young man had.

It was in the columns of our publishing house that Max Valier obtained what was probably his first lasting support, in that he was able there to write about his work and aspirations to the public at large. All this came about not so much because we believed that roaring rockets signalled the ultimate word of wisdom, but because we felt an, as it were, irresistable respect for the drive, the tough fighting spirit, and the power of belief in himself with which the victim of this accident was able to put himself across to those listening to him. How he charged about the building! How well he knew how to enthrall his people! How he could beg and captivate, speak and write, be funny, cheerful, busy and valiant in the service of his cause! ...

He was not concerned about himself, about the name Max Valier; he did not act out of vanity, out of a need to feel important. He was not even concerned with building a particular vehicle. The only thing that mattered to

APPENDICES

Appendix 1

The following essay by Max Valier was published in 1913 in the school newspaper "Mentor" which he had founded, run, edited and printed:

The Sun (Die Sonne)

"In the tropics, the ball of fire rises up all of a sudden, while in our cooler latitudes it climbs majestically over the horizon.

The sun diffuses light and warmth, strength and life over the earth. The Egyptian fell to his knees in worship and entreated it as his divinity.

And our sun has something divine about it; when we contemplate it in all its might and splendor, we are struck with wonder at the omnipotence of the creator who produced such a thing.

In primitive times, man already had a presentiment of the importance of the daystar for his existence; for thousands of years, the scholar had aligned armillary spheres, measured in terms of gnomons and tried to determine the orbit of the sun.

But only in modern times, since the invention of the telescope, could information be acquired about the solar bodies as such, and in spite of all the spectroscopes and photograms in calcium light, even today the enigmas are not all solved and the opinions of the most notable scholars often differ greatly from one another on many points, especially in solar theories.

Those extremely interesting solar phenomena which are to be explained in what follows are, on the other hand, facts which are confirmed, and only the causa primaria of their origin is often obscure.

To understand the significance and range of these phenomena, we must first get an idea of their dimensions, for which purpose the known distance of the earth from the sun and the known apparent size of the disk of the sun provide the necessary basis.

The angular diameter of the sun's disk is just over half a degree, i.e. precisely 31'59.26". From the distance of the earth from the sun, which is 149,000,000 km, the true diameter of the sun is found to be 1,383,000 km, compared with which the diameter of the earth (12,756 km) is only 1/109. Indeed, even the distance of the moon from the earth, which is 385,00 km, is only 1/4 of the sun's diameter; in other words, if we were to place the earth right in the middle of the sun (supposing the latter to be hollow), then the moon orbiting around it would be almost as far away from the surface of the sun as from the surface of the earth.

The smallest element of the surface of the sun which can still be perceived with good telescopes corresponds to an angle of 1" (1 second of arc = 1/3,600 of one degeee). As the diameter of the sun is equal to 31'59" or 1,919, but

in actual fact amounts to 1,383,000 km, the angle of 1" on the sun corresponds to a distance of $\frac{1,383,000}{1,919}$ = 720 km.

It must therefore always be kept in mind that the tiniest and most trivial phenomena must have the dimensions of, say, the island of Madagascar, and that more or less conspicuous phenomena often correspond to areas many times larger than the entire surface of the earth.

Seen through the telescope, the sun is a very sharply defined circular disk. Even telescopes of moderate optic power clearly show the reduction in brightness towards the rims. The rim only emits 40% of the total radiation of the middle. This is in line with the behavior theoretically expected of a luminous sphere, and is in any case a circumstance from which it can be assumed, even in the absence of any other evidence, that the sun is a sphere and not a disk.

The luminous surface of the orb of the sun is called the "photosphere". Its brightness is extremely great and is to be equated with 60,000 standard candles, according to the latest research. Compared with Drummond's exceedingly bright calcium light, the sun is 146 times brighter, and compared with the full moon it is 570,000 times brighter. Compared with the star Capella in Auriga, it is found to be 55,760 million times brighter - and yet, if we were able to view our sun from the same distance from which we see that twinkling star, it would not even be visible to the naked eye, but would appear as a star of the $6^{o}5$th magnitude. As Capella's spectroscopic similarity to the sun has been proven, its diameter can be worked out to be 10 times the diameter of the sun, and its volume to be 1,000 times the volume of the sun. What a speck of dust our sun is in the cosmic system!.

A good telescope shows that the photosphere not only diminishes in brightness towards the sun's edge, but that it consists of many small bright grains, separated from one another by darker interstices. The smallest of these grains measure 200 km, the larger ones 6-700 km in diameter; they are usually roundish in shape and the distance between them is normally a little smaller than their diameter.

This commonplace phenomenon of "granulation" on the sun (so called because of the resemblance these bright points bear to cereal grains) is the foundation for the occurrence of sunspots. In the normal granulation there are some places where a few grains are missing. If such a place becomes larger, so that about 6-8 grains are missing, it darkens noticeably, becoming virtually black, relatively speaking. A "pore" has formed. The pore may soon close up again, but often several pores unite to form a large dark spot, the sunspot, as it is known.

When Fabricius, in 1610, studied the edge of the sun with the newly invented telescope, he discovered a spot which he was initially inclined to take for a passing cloud. He was soon able to ascertain that the spots appeared on the eastern edge, crossed the sun obliquely, and disappeared again on the western edge about 10 days later. In doing so, their aspect changed in the same way

that one would expect an infundibuliform depression to change when viewed in perspective, although often rapid and extensive changes could also be observed. Sometimes the spots appear singly and sometimes in groups, and large spots often appear to be composed of smaller ones that have coalesced. But in all normally developed spots one can distinguish two zones: the center[+)] itself and the penumbra, the shaded region surrounding it.

The darkness of the centers of the sunspots is so striking only because of the way they contrast with the brilliant photosphere; in actual fact, even the darkest spot is very bright indeed. When the spot has reached its maximum dimensions (sunspots of an area 5 to 20 times that of the surface of the earth have been seen), it begins to close up, usually as a consequence of bridges of light shooting forth, in most cases from the penumbra over the center, until the latter is completely covered. This shooting forth of tongues of light is often incredibly rapid; a spot with a diameter of 10,000 km can close up in an hour.

Actually, the spots are not permanent formations. While spots that disappear on the western edge quite frequently reappear 13 days later on the eastern edge, cases of sunspots lasting more than three months are very rare indeed.

A definitive answer to the question of the ultimate origin of sunspots is still pending at present. Nothing certain is known about the nature of sunspots either, e.g. why some have a spiral structure (giving them the appearance of a vortex), why sunspots only appear in certain zones, and what laws they obey in performing a proper motion on the surface of the sun. This is still a field wide open to research.

Aside from the photosphere, the sun's orb is also surrounded by an envelope, the chromosphere. This upper layer of the solar atmosphere, which is only visible to the naked eye as a reddish margin during total solar eclipse, is the agent of a spectacular solar phenomenon. Protuberances from the normal level - prominences, as they are known - have been seen repeatedly with the naked eye during total eclipses of the sun. Thanks to spectroscopy, these great phenomena can nowadays be observed at any time; even the matter of which these eruptions are composed is known: hydrogen, helium and calcium. Normally, the chromosphere is about 10,000 km thick, but the prominences, which take on all kinds of forms, often attain heights of 80,000 - 100,000 km. These pillars of fire shoot up at an inconceivable speed, often in but a few minutes, so that it must be assumed that pressures of millions of atmospheres are involved.

On June 11, 1892, Trouvelot observed a particularly prominent case, which quite overshadowed all previously known eruptions. An immense prominence 200,000 km high rose to a height of 427,000 km in the space of five minutes,

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[+)] Translator's note: The word "Stern" (star) in the original text would appear to be a misprint for the word "Kern" (nucleus, core).

i.e. 714 km per second. After eight minutes, everything had disappeared again and the chromosphere was level. A similar fountain of fire is depicted in the illustration, the earth also being sketched in for comparison.

While sunspots occur only in certain zones, prominences appear everywhere. However, they appear to show a preference for the region of vigorous solar activity, i.e. the region of spots and faculae.

These faculae are formations of the photosphere; in contrast to the sunken spots, they are elevated streaks of greater brightness. They often surround the spots like veins, but also occur elsewhere quite frequently. Scarcely anything certain can be said about their nature and particularly about their relationship to the sunspots.

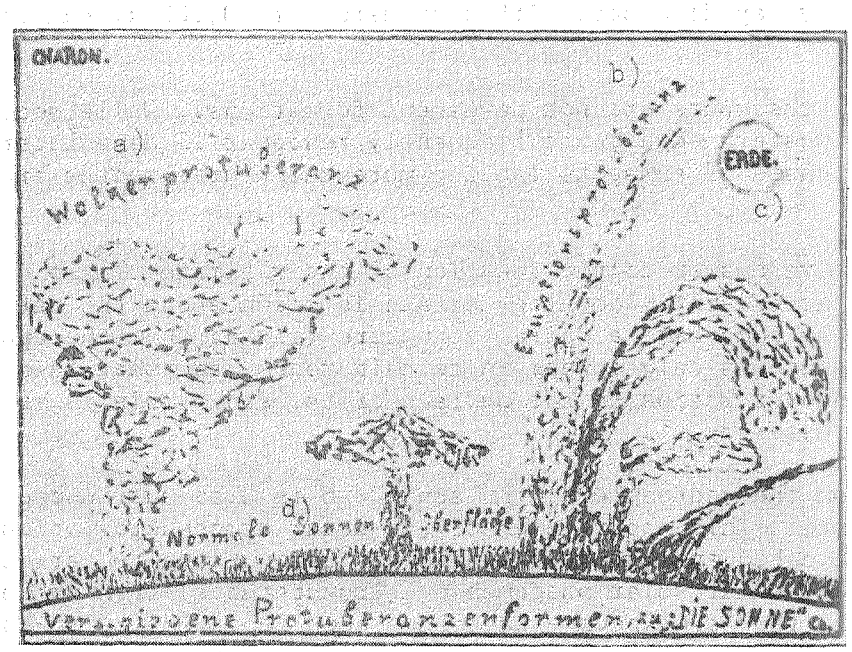


Figure 30. Forms of prominences; illustration in the essay "The Sun" written by Max Valier under the pseudonym Charon, for the class newspaper "Mentor" in 1913.

Key: a): Cloud prominence.
b): Eruption prominence.
c): Earth.
d): Normal surface of the sun.
e): Various forms of prominences, in "The Sun".

However, the chromosphere is not the outermost layer of the sun's atmosphere. During total solar eclipses, the solar corona is seen shining in the silver light around the red rim of the chromosphere, its rays often extending to distances of many solar radii.

All of these phenomena have been found to take place over a period of about 12 years, but which can vary between 9 and 14 years. Solar activity was at a distinct minimum in 1912, but a small spot already formed in May, and now increasing numbers of prominences are shooting out with increasing violence, the number of faculae is going up and sunspots are becoming more frequent. If this striking minimum is followed by an equally striking maximum, readers who are this way inclined may expect to be able to see sunspots even with the naked eye, protected only by a dimmer, in 4-5 years time. Such large spots, though rare, are not impossible. Solar observation, though extremely interesting, is very tiring. Taking photographs is easier. Of course, good and large pictures of the sun can only be obtained with long-focus telescopes. However, a good focal-plane shutter camera with which 1/1,500 to 1/2,000 sec exposures can be made can also be used."

Bozen, 1913.

Appendix 2

Rotating Celestial Chart

As a pupil at the "Gymnasium", Max Valier devised this celestial chart with a revolving aperture and offered this patentable idea to the Verlag O. Maier/Ravensburg on July 30, 1912.

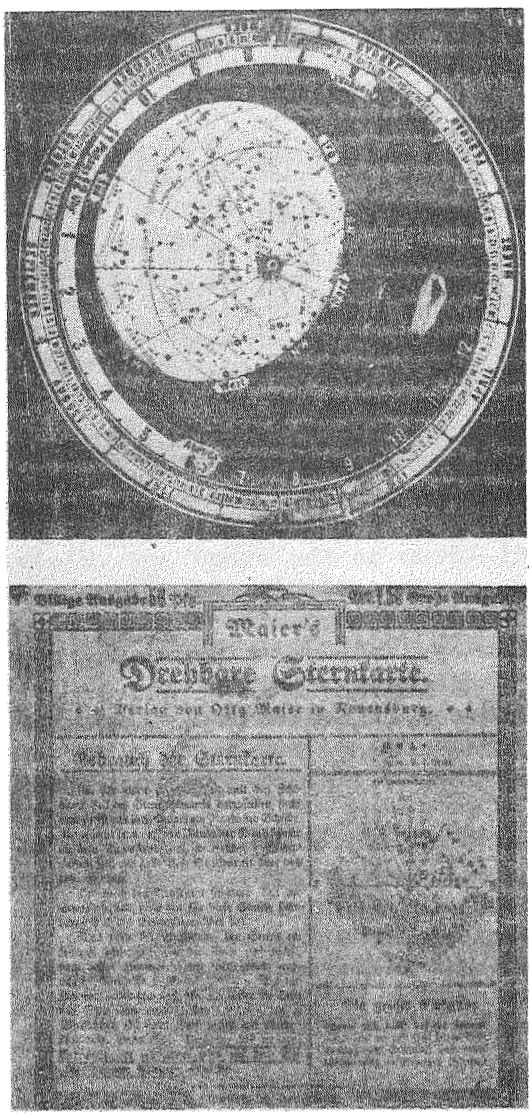


Figure 31. Celestial chart with rotating aperture.

Appendix 3

Hanns Hörbiger (1860 to 1931)

From accounts by Mrs. Martina Hörbiger and E. Kurzel-Runtscheiner, Dr. rer. tech. (from "Osterreich. Naturforscher, Ärzte u. Techniker", Verlag der Gesellschaft für Natur und Technik):

"Die Hörbig" is the name of the big farmhouse over the Unterinntal valley near Wörgl, whence Alois Hörbiger, who later became a famous organ builder, came. He bought himself a farmstead in Atzgersdorf, just outside the city boundary of Vienna. His grandson, Hanns Hörbiger, was born there in 1860.

Education: Nonclassical secondary school at Klagenfurt, engineering school in Vienna. Active as an engineer in Budapest and in Brünn, then in the "Maschinenfabrik L. Lang" in Budapest, whence he was sent to repair a compressor in the Lothringtan mining enterprise at Mezières. It was here that, in 1894, Hanns Hörbiger had the underlying idea of the invention that was to bring him fame and wealth: It was he who invented the low-mass, non-friction plate valve for blowers, pumps and compressors. The first patent stems from the year 1895. But it was only at the turn of the century that Hörbiger was able, with financial help from Siemens and Halske, to found his own enterprise in Budapest.

The Hörbiger valves were then developed further to ever greater perfection. Later on, Hanns Hörbiger's most valuable co-workers were his sons Hanns and Alfred, who had likewise become engineers. (His other two younger sons, Paul and Attila, became well-known on the stage and in movies). Since the turn of the century, virtually no automatic intake or outlet valve for blowers, pumps and compressors has been built anywhere in the world that was not influenced by the underlying principle of Hörbiger's invention. Hörbiger lost his fortune as a result of the inflation after the First World War, and had to contend with severe material difficulties. In 1931 his son Alfred set up a valve factory in Simmering; this has since produced innumerable valves of the Hörbiger design for markets at home and abroad, and supplies the most highly industrialized countries all over the world.

Hanns Hörbiger was not only a genial engineer, constructor and inventor, however; he also occupied himself at great depth with astronomic studies and speculations. The result of these many years of effort was his glacial cosmogony, in which he applied all the experience he had gained in the various fields of the heat technology of water in all its states - ice, liquid, vapor - to the cosmos as a whole. Hanns Hörbiger also called his cosmogony cosmotechnology. Its simplicity and its apparent ability to explain anything and everything in one fell swoop had the effect of fascinating a great many people in the first decades of the twentieth century. The teacher and astronomer Phillipp Fauth pinned down this theory in a voluminous work entitled "Hörbigers Glazial-Kosmogonie" (Hörbiger's Glacial Cosmogony) in 1913, while other experts already rejected it at the time of its conception, and still continue to do so vehemently today. Hörbiger himself was so sure of the value of his glacial cosmogony that he placed it high above his technical achievements.

Philipp Fauth

(Essays and personnal communications by his son, Hermann Fauth, assistant master at a secondary school.)

Philipp Fauth was born in 1867, the son of a potter in Bad Dürkheim. After going to elementary school there, he went up to the teacher training college in Kaiserslautern. He showed a talent for drawing, inherited from his father, very early on, and also had a predilection for all natural sciences.

He worked in the service of primary education for 40 years, 30 of which he spent at Landstuhl.

His reputation was based above all on the success he achieved in his hobby, selenology and planetary research. He built his first observatory near Kaiserslautern in 1889, the second on the Kirchberg near Landstuhl in 1895 (the first high-altitude observatory in Germany). Fauth used the medial telescope - for a long time the only one of its kind - from 1911 to 1940. (The inventor of the medial telescope was Professor Schupmann of the polytechnical institute in Aachen.)

It has often been written of Fauth that "his love belonged to the stars". This only partly true. His love belonged to the life of his homeland, of his people and not least of all, of his schoolchildren. "I was always glad to be a teacher" he admits without exaggeration in his mémoires. When, in 1896, he was offered the post of observer at the observatory in Mexico, one of the reasons for his refusal was this pleasure he took in teaching.

But if one were to ask what Fauth's favorite pursuit really was, the answer would be, without any reservation: music. He played the violin every day, ever since his first primary school class, and by dint of great practice had developed a considerable skill.

His violin has fallen silent, but the results of his astronomic work - charts, essays, books - remain. Of these many works, only three will be picked out here: In 1913, Hörbiger and Fauth jointly wrote the great basic work of glacial cosmogony, entitled "Glazial-Kosmogonie" (Glacial Cosmogony), (R. Voigtländers Verlag, Leipzig); in 1932, Fauth's Atlas of the Moon+) was published, with the very detailed local charts drawn from his own observations, and the general maps of the moon; in 1936 he published a big book "Unser Mond" (Our Moon).

How fruitful Fauth's selenologic and planetary research of over fifty years' standing was - all that difficult observatory work in the course of which thousands of substantial diagrams were made - is shown by the lasting tribute

+) Fauth, "Mondatlas", new edition completed by the addition of further map material still produced by Ph. Fauth, Bremen 1964 (Olbers-Gesellschaft), 22 large detail maps and 6 general maps, plus 38 pages of text.

paid to the German primary school teacher: In 1932, the International Astronomic Union in London named a ring of lunar mountains near the crater Copernicus "Fauth" in honor of his services in the elucidation of many problems pertaining to the moon.

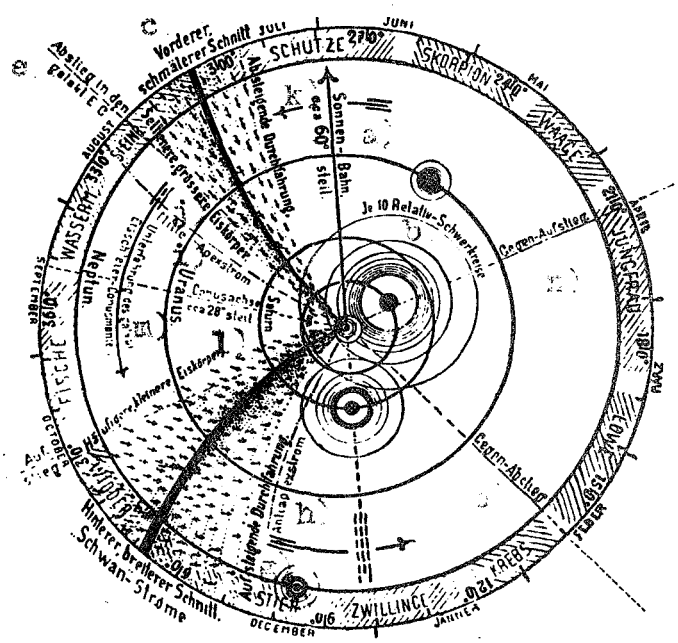
Appendix 4

From "Der Sterne Bahn und Wesen"
(Orbit and Nature of the Stars)
(Cf. our pages 55 ff. and 94)

According to Hörbiger's glacial cosmogony, the bodies of ice accompanying our solar system ever since it came into being are chiefly to be sought at the outermost limits of our solar realm. Hörbiger calls the horn-shaped zones, in which such lumps of ice that have been set into motion and are hurtling towards our sun are to be found, the "ice-haze horn" (see Fig. 32). The smaller lumps of ice evaporate on approaching the sun. But Hörbiger's calculations show that in the case of large ice bodies rushing towards the sun, steam forming on the illuminated side is pushed back by the repulsive force of the sun's rays, freezing up again on the unilluminated side of the ice body. Hence, an ice body nucleus can indeed reach the fiery orb of the sun, giving rise to faculae, prominences or even sunspots, depending on its size (cf. our pages 56-58).

Based on many observations, Hörbiger ascertained that solar activity exerts the greatest influence on the general meteorological situation on our earth, and hence also on plant growth.

The way the gravitational forces of the great planets Jupiter and Saturn accelerate or deflect the ice blocks hurtling towards the sun, depending on the location of these planets in the solar system at the time, is described by Valier in "Der Sterne Bahn und Wesen" (Orbit and Nature of the Stars) (p. 423/424). A brief excerpt from the same is given here, with illustrations.



Schnitt durch das Eisichleierhorn, geführt in der Ebene der Großwandelsternbahnen. Grundlegendes Schaubild für die Erklärung des Zusammenhanges der Sonnenflecken, der Großwetterlage und der Ernteerträgnisse auf Erden mit den Stellungen der großen Wandelsterne.

Figure 32.
Ice zones in our solar system (from Hörbiger's glacial cosmogony).

Section through the ice-haze horn, in the plane of the orbits of the great planets. Basic diagram for explaining the relation between sunspots, the general meteorological situation and crop yields on earth, and the positions of the great planets.

SCHUTZE	=	Sagittarius	ZWILLINGE	=	Gemini
SKORPION	=	Scorpion	STIER	=	Taurus
WAAGE	=	Libra	WIDDER	=	Aries
JUNGFRAU	=	Virgo	FISCHE	=	Pisces
LOWE	=	Leo	WASSERMANN	=	Aquarius
KREBS	=	Cancer	STEINBOCK	=	Capricorn

Key:
a Sun's orbit approx. 60° steep.
b) 10 relative gravity circles, respectively.
c) Anterior narrower section.
d) Posterior broader section. "Swan" currents.
e) Descent into the galactic ice-haze conical mantle.
f) Ascent. Frequent smaller ice bodies.
g) Ascending traverse.
h) Anti-apical current.
i) Middle apical current.
j) Fewer larger ice bodies.
k) Descending traverse.
l) Cone axis approx. 28° steep.
m) Underrunning the ice-haze conical mantle.
n) Counter-ascent.
o) Counter-descent.

"On reflection, this relatively simple picture answers all the enigmas of the sunspot curve and its interrelations with the general meteorological situation on earth.

So if "astrology", that much scorned art of divination of the influences of the stars, possesses ancient rules according to which there will be very "wet" years with imminent floods when Jupiter and Saturn are in the "watery signs of the zodiac" Aquarius and Pisces, then this interpretation is now fully justified by glacial cosmogony, though of course it is at the same time divested of all its mystical magic.

A "great conjunction of Jupiter and Saturn in Aquarius and Pisces" simply means that the two giant planets are virtually in the axis of the ice-haze horn. They then combine all of their tremendous power in order to accelerate the largest ice bodies hurtling towards the sun and to hurl them on their way after gathering them together from distant regions. No wonder, then, that in such years a real deluge can occur, for all sluices of the sky are opened by the lock keepers Jupiter and Saturn. On the other hand, a quadrature of Jupiter and Saturn in the signs Taurus and Leo or Leo and Scorpion signifies exactly the opposite, for then the two giant planets summon all their power to retard the influx of ice bodies towards the sun, dispersing the paths of the ice bodies so that most of them miss the sun, only coming to glide down towards it by making some detours. Jupiter and Saturn thus really do have positions in

the zodiac which must cause "wet" years for the earth and also positions bringing about "fiery" years in which the relentlessly scorching sun burns everything.

It was probably these very experiences that led to the formulation of astrological weather rules and to the designation of the signs of the zodiac in the first place. Certain signs of the zodiac were given "wet" names because it had been noted that the years became very wet whenever Jupiter and Saturn were in these regions of the zodiac. Similarly, other zodiacal regions were given "fiery" names because it had been found in the course of thousands of years of continuous observation and comparison of the general meteorological situation on earth with the positions of the planets that whenever Jupiter and Saturn were in those regions, the harvest dried up and the rain so earnestly desired did not fall. Whether one is willing to admit it or not, astrology simply happens to be an empirical science, perhaps the oldest at that, for the formulation of its rules necessitated thousands of years of continued "systematic" observation and scientific evaluation of the wealth of experience thus obtained. Who knows if the ancient Egyptian astrologers were not perhaps really in a position to predict the "years of great plenty and the years of famine" on the basis of such calculations (i.e. to make annual forecasts of the country's harvests)? Since crop failure in their country depended exclusively on the degree to which the Nile swelled, the case was particularly clear-cut for Egypt if only they somehow knew the laws of cosmic effects. We are now able to grasp this without any difficulty, for glacial cosmogony itself provides us the means with which we can easily work out, again today, Egypt's crop failures years in advance. .."

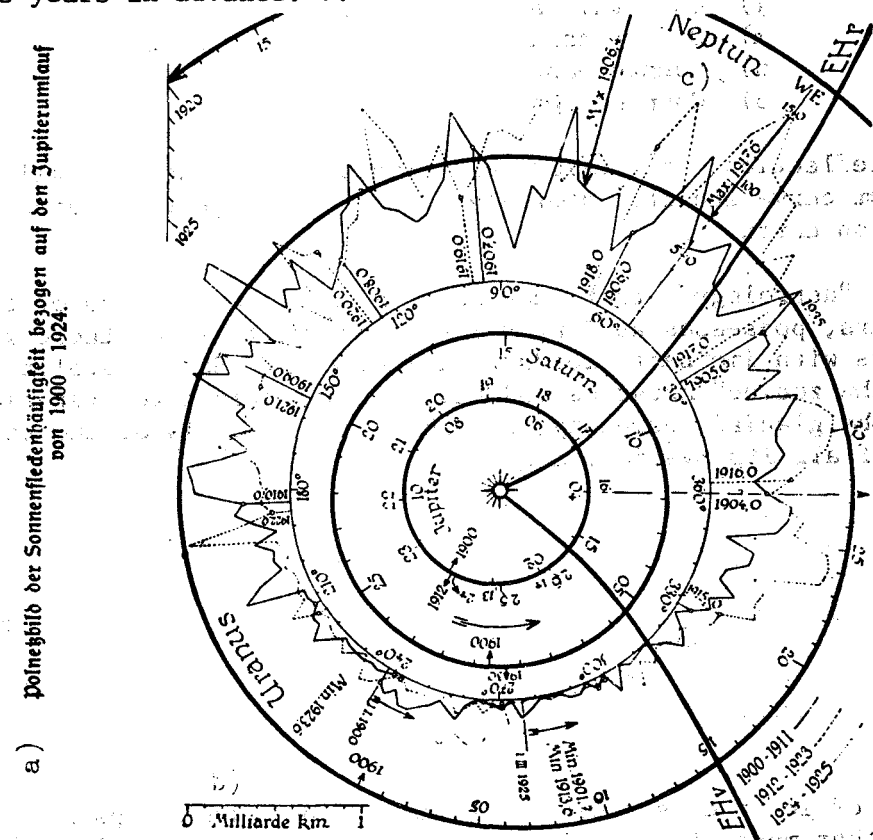


Figure 33a. Jupiter's influence on the frequency of sunspots from 1900 to 1924.

(Fig. 33 continued ...)

(Jupiter's orbital period is 11.86 earth years; Saturn's orbital period is 29.45 earth years).

From 1913 to 1923, Saturn covered a stretch of orbit which was very distant from the ice zones, so that this time interval on the sunspot curve can be seen to lie solely under the influence of Jupiter.

(For the consideration of falling time and many other details see "Der Sterne Bahn und Wesen" (Orbit and Nature of the Stars) pp. 418-432).

Key: a) Nimic polar network of sunspot frequency relative to Jupiter's orbit from 1900-1924.
b) Billions of km
c) Neptune

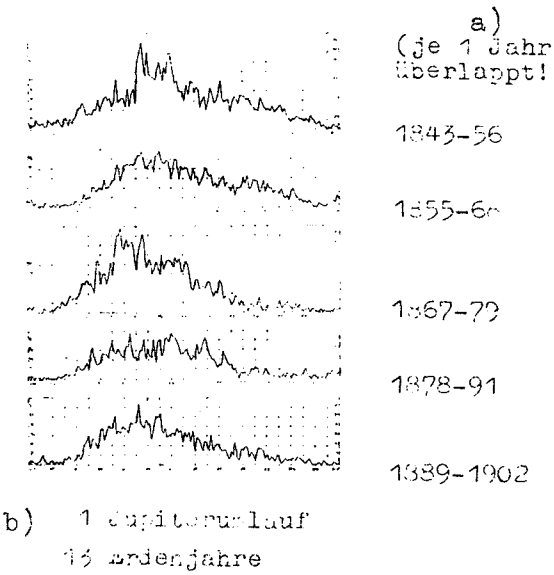


Figure 33b.
Fig. 97 from "Der Sterne Bahn und Wesen".

In this long time interval (1843-1902) one can see particularly clearly that the sunspot frequency curve shows the same period as Jupiter's orbit.

5 Jupiter years = 5 peak values of the sunspot frequency curve.

Key: a) (In each case there is a one-year overlap)
b) 1 orbit of Jupiter = 13 earth years.

Appendix 5

Hermann Ganswindt's "Weltenfahrzeug"
(interplanetary vehicle)

a) Copy of Ganswindt's letter to Valier:

"Schöneberg bei Berlin, March 25, 1925
Tempelhoferstr. 7

Mr. Max Valier, physicist,
Munich

Dear Sir,

I have learned from retired lieutenant-colonel von Laffert (author of the novel "Fanale am Himmel" published in the Berliner Lokalanzeiger) - whom I called to account because he copied in his novel all the essential details of my invention, made public several decades ago and known all over the world, of a rocket vehicle for travelling to other planets, without any reference to me, the actual inventor - that Prof. Oberth has used this idea in his recently published book "Die Rakete zu den Planetenräumen", although he may have done so indirectly, and that von Laffert made use of his book in writing his novel.

However, he wrote to me saying that, having been convinced by the documents I sent him that these were my inventions, which have simply leaked out all over the place (my son-in-law, for instance, previously a professor of physics and now head of a department in this town's biggest firm of world-wide reputation, told me that at the scientists' conference in Innsbruck last summer, where he gave a lecture, he also heard someone there speaking about the rocket vehicle, who referred to my invention, albeit ineptly) - he would have made good the omission of my name had not his novel already been printed out. But he will in any case do so in future editions.

While looking for Prof. Oberth's book in the book stores I also found your book, from which I see that you follow Oberth and also mention Professor Goddard, but that you too make no mention whatsoever of me. I daresay that you too, in accordance with the conventions in scientific circles, will mention me as the first and only inventor of the rocket vehicle in the copies of your book which are still attainable, but in any case in the next edition, if necessary by appending an additional page. The American professor Goddard is of course also only another plagiarizer of my invention; whether or not he makes any mention of my name still remains for me to ascertain. In any case, in the enclosed newspaper "Der Berliner Westen", in which I read an announcement about him, I showed him to be a charlatan ad absurdum.

When in 1891 I began to give a series of several hundred public lectures (I had already given a number of sporadic lectures on the subject ever since 1883) on the three problems: the dirigible balloon, the airplane and the rocket vehicle, which latter I called the "Weltenfahrzeug" or interplanetary vehicle (this will never be able to become a ship, but at most a long train coupled up outside of the atmosphere), all three problems were then still held

to be unsolvable. A few individuals were willing to listen to reason so far as the dirigible balloon and the airplane were concerned, but an aircraft able to travel to other stars was inconceivable to all. Nobody had ever yet seriously considered such a flight to be possible - not even Jules Verne, who, by the way, came forward with his purely fantastic view of a human cannon later than I did with my serious project of a rocket vehicle, which I made known to my circles of acquaintances in the seventies.

Virtually all the newspapers in the world reported on my lecture on these three problems given on May 27, 1893, in the Berlin Philharmonic Hall before an audience of about 1,000 for an entrance fee of 1-5 marks, but most did so skeptically. The "Berliner Lokalanzeiger" of Sunday, May 28, 1893, gave what was by far the most objective account, entitled 'FLIEGENDE MENSCHEN - Ein Blick in die Zukunft' (Flying men - a glance into the future), in which one can read what follows: ... 'The ancient myth tells of the valiant inventor Icarus. ... Icarus did not die ... and yesterday (Saturday) we saw him in the flesh and as large as life, that valiant and ambitious spirit, who soars up beyond the realms of time and space, seeking to storm the skies. As common sense would have it, this is excentric, to put it mildly! But anyone who knows the history of mankind and who is blessed - or rather, punished - with a more fertile imagination, will be very hesitant about adopting such an expression. For after all, everything is possible; mankind has experienced quite a few surprises and has seen many things thought to be inconceivable and impossible come true in the finest of manners. He (the new Icarus) is known by the civil name of Hermann Ganswindt. As the inventor of a dirigible balloon and a flying machine he invited the public to the Philharmonic Hall yesterday in the most up-to-date manner, by using large posters. ... Those who turned up were highly stimulated by much that they saw and heard. Mr. Ganswindt is the very embodiment of what one would expect an inventor to look like. A slim, sinewy figure of a man with an interesting head. His physiognomy, with its sparse, deep-blonde beard and flashing, quite deep-set eyes, has a rather sullen but very energetic expression. The forehead is strikingly high and prominent, a real thinker's brow, behind which a very lively imagination is at work. This imagination has led him far beyond the confines of this world. It is coupled in unusual audacity with dry, matter-of-fact learning; the fruits of this union make the dreams of a Jules Verne look like mere child's play. As we have already pointed out, Mr. Ganswindt has invented flying machines, but he is in the process of perfecting and constructing these flying machines in such a way that he hopes to be able to venture upon a stupendous flight through outer space; indeed, he is quite confident about this and is thinking of visiting Mars and resplendent Venus some day, which are millions of miles away. According to his calculations, a journey to Mars will take only a few days. The vehicle is quite comfortable, a steel cylinder surrounded by steel pipes containing compressed air. In the warm compartment of the cylinder one is protected from the cold of outer space, travelling through space at the speed of the heavenly bodies, the necessary momentum being imparted to the vehicle by means of centrifugal force on leaving the earth's atmosphere. As the ether does not pose an obstacle, the astronaut may even rush towards his destination at a speed faster than that of the heavenly bodies. For the modern Icarus this is no dream, but blunt fact and firm resolution. ... It would be very rash to form an opinion on Mr. Granswindt's invention on the basis of the models demonstrated. The models did what they were supposed to do (i.e. they flew up into the air!).'

This lecture was printed in my book "Das jüngste Gericht", a presentation copy of which was requisitioned from me by the royal library. It was also reprinted in full by the "Volkserzieher", the "Kritik" and a series of journals. The book is still available in the national library and is much read. I was unfortunately unable to publish further editions of this book, as I had to promise my friend and wealthy patron, Baron von Gorsdorff, chamberlain and owner of entailed property, etc. (for information on him see: "Briefe Nietzsches", Vol. I) not to do so, since I had, through my rocket vehicle, incurred the displeasure of the Emperor and of the nobles, and so too, being my patron, had the baron. Indeed, the baron later even threw himself out of the window for this very reason, and the baroness shot herself! -- Because of my rocket vehicle invention, the Ministry of War ceased to show any interest in my other inventions too, and proceeded to ruin me by all the means and trumped-up denials it could muster. Even on October 17, 1901, when my helicopters had long been flying in the air with people on board, the ministry wrote to me under No. 454/10.01 Al.u.A: The Ministry of War cannot possibly seriously consider your idea of flying to the planet Mars and back in a vehicle in 48 hours. ... The Ministry of War therefore suggests, in your own interest, that you desist from addressing any further petitions containing such unworkable plans to this or other military authorities in the future. Nota bene: I had merely mentioned in passing that I could not make the purchase price for my aircraft - which was already airborne and carrying people on board - any lower than 20 million marks, because I also wanted to build the rocket vehicle with this money. So, in order to prevent my aircraft from possibly being bought by another country (France), I was simply cast into prison "pending trial", by a police inspector who, it has been proven, had been bribed, and I was abused beyond all bounds by the corrupted press. The "Berliner Tagesblatt" regularly had to print defamatory articles quoting the Ministry of War, in which it was said, among other things, that one could gather "how the 'inventor' Ganswindt frittered away money" from the way he, unlike everyone else, fired his cannon downwards rather than forwards in order to shoot himself up to Mars. The "Ulk" brought out a long satirical poem on my rocket vehicle, recounting how I wanted to spit down upon my enemies from the moon, etc. This all happened in 1902, even though the physics professor Roman Baron Goszkowski had already written in the Viennese "Die Zeit" of July 28, 1900, a five-column article on my interplanetary vehicle, entitled "Ein moderner Ikarus", in which he said, among other things: 'These arguments (in my book) are of a nature that attracts our attention. Following them, no contradiction can apparently be found, and yet it is difficult for us to think of it being possible for his ideas to be realized. We instinctively feel that Ganswindt is striving toward something quite singular and altogether unusual, and that he is trying to persuade us that he is thinking unthinkable things. But our judgement lacks certainty. The flaw which must be present in the reasoning of Ganswindt's arguments if our hunch is true, is simply not evident.' Prof. Goszkowski then attempts to limit the action of radius of my rocket vehicle by computation, but he proceeds from false assumptions since at that time (1900) he did not yet take into account my auxiliary agent, the airplane, which is to lift the rocket vehicle right up to the edge of the atmosphere; I had already invented this aircraft at that time, even though it only became airborne in practice a year later (1901). In the same journal on August 25, 1900, engineer Ludwig Loos then wrote an equally erroneous reply to Goszkowski's article, entitled 'Ikarus auf der Rakete'.

What a sensation my invention created throughout the scientific world can also be deduced from the fact that in August 1900, the "Verein zur Förderung des physikalischen Unterrichts" (society for the promotion of the teaching of physics), to which all prominent people in this field belonged, visited me in corpore in my establishment, where I explained my inventions with practical experiments, as far as possible. This awakened so much interest in many physicists that they remained to discuss matters from 3 p.m. to midnight, finishing off the evening in the restaurant in my exhibition; among those present were Counsellor Spiess, the later director of the Urania, and Reinhold Begas, who visited me frequently. I regularly gave such lectures for many years.

On January 25, 1920, I had four witnesses - the author Dost, the manufacturer and former member of the Reichstag Jakobsen, the reciter Labios and the government architect G. Hippel - certify that it was I who first had the idea that in the course of centuries of rocket traffic between the various stopping places around the earth, the supplies and waste products left behind at these stopping places would form rings around our earth which - viewed from the neighboring planets - would look like the rings around Saturn, which must have formed in the same way since, for the astronomical reasons adduced by me, they could not be of geological or saturnological origin, but must be of intellectual origin.

Finally, on April 21 and May 5, 1920 I gave public lectures on this invention, which were also mentioned in the press (see the appended printed account), and on March 5, 1924, in the enclosed newspaper "Der Berliner Westen", I published the criticism of Prof. Goddard's shot to the man. I had been interviewed a few weeks earlier at the beginning of February by American journalists, one of whom gave me a copy of the account he sent to American newspapers, entitled "Dirigible of Tomorrow", in which my rocket vehicle is also mentioned: 'Given to fantastic schemes, the claims and projects of Hermann Ganswindt have often gone almost beyond the range of imagination. His pet fancy is to build some complicated flying machine to carry passengers on a round trip to the moon and other planets. -- It can be done, he says. To the lay mind his system for touring the starry vault seems merely a breathtaking fiction to be smiled over. But it is dangerous to laugh at inventors. You never can tell. Solomon would probably have laughed at a Marconi born out of his time. -- The first requisite for a vacation sightseeing among the stars, according to Ganswindt, is an airship built to whizz out to the dim borders of the atmosphere surrounding the earth. This outpost reached, the propeller is drawn in and a series of explosions sends the machine forward like a rocket.'

There follows a description of my vehicle and of the events occurring during the trip and on the stopping places. Of Saturn's rings he then writes humorously: 'One quaint hypothesis the inventor holds is that the ring around Saturn is merely a line of air ship stations established by enterprising Saturnites through the ages. They, he intends, revolve around the planet along with the sardine cans, peanut hulls and orange peels which the travellers have thrown from their machines!' --

I simply cannot allow my priority in this invention, for the sake of which I have battled against stupidity for 40 years, suffering greatly, losing

millions of gold marks and sustaining the most dreadful tragedies, to be simply brushed aside. It would be as if Cortez or Pizarro, or those others who sailed to America and pillaged the country were to say that it was they, not Columbus, who had discovered America.

I presume that you will most certainly do me justice already in the still accessible copies of your book, by inserting an explanation in a supplementary appendix, which will spare me the trouble of taking further steps to look after my interests.

What Berlin's "Zeit" said on November 12, 1924 about my relationship to Zeppelin also holds for my relationship to whoever deals with the rocket vehicle problem after me. It is written in the "Zeit" under the title "Deutsche Tragödie" (referring to me): 'Meanwhile, however, there were and are men in the background, without whom Zeppelin could not have become what he is - men who, before him, fought and suffered for the idea, who discovered its first laws, who popularized the idea and engendered the belief in it which alone is capable of bringing about its accomplishment. Hermann Ganswindt was one of these men.'

Many novels depicting travel in the universe appeared after my lecture given 32 years ago in the Berlin Philharmonic Hall; so too, later on, did the movie picture 'Das Himmelsschiff'. This also led thinkers to show interest in the problem, who would otherwise never have done so. By the way, the method of rocket propulsion which you propose is not yet the most efficient. But this I can only make public once I have applied for the patents.

Looking forward to hearing from you soon, and in the hope that you will be so kind as to return the enclosures, I remain

Yours Truly,

Hermann Ganswindt."

As in this letter Ganswindt named his major publication and also a library in which the book was available which contained his lecture of the year 1893 with authentic data from the previous years, Valier was able to verify Ganswindt's assertions. He satisfied himself that Ganswindt really had asked himself, already in the previous century, whether space travel was technically feasible, and that he had based the project he had worked out in that time upon explosion reaction as the propulsive force.

This is why, in the chapter entitled "Projects of the Present" in his book "Raketenfahrt" (Rocket Travel) (p. 161-163), Valier described Ganswindt's plan in detail as follows:

"The man who is now to come first on our list is still alive today and has by no means given up the battle for success in the contest between researchers.

b) Hermann Ganswindt's interplanetary vehicle (since 1881).

The private research Hermann Ganswindt, born on June 12, 1856, already unfolded his plan of an interplanetary vehicle propelled by rocket power (see Fig. 42) in 1881, on the occasion of a lecture given in the Philharmonic Hall in Berlin. This probably makes him the first man to have supported the idea that an interplanetary vehicle is technically feasible and to have presented a fully thought-out construction for the same:

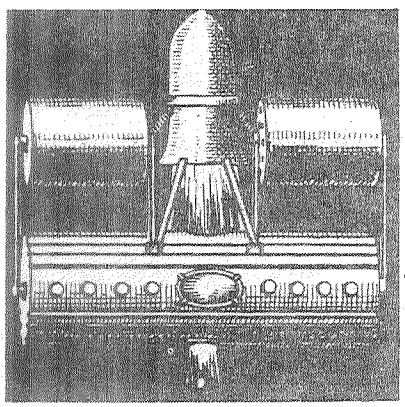


Figure 34. (from "Raketenfahrt", Fig. 42).

The propulsion system Ganswindt had in mind consisted of a thick-walled block of steel hollowed out in the shape of a bell, which was intended at the same time to act as a gyrating mass for absorbing and equalizing the shocks of the individual explosions. The propulsive force was to be provided by the exhaust of gases from an explosive (initially thought of as solid but also possible in the liquid form) of the greatest possible energy content, accommodated in cartridges made to explode in rapid succession inside the cavity of the gyrating block. Ganswindt keeps the chemical composition of the propellant charge secret. The same also holds for the device intended to automatically hurl the thousands of cartridges carried along in large revolving drums on either side of the gyrating block into the center of the gyrating bell in rapid succession, where they are to be exploded by a reliable ignition. Further cartridge supplies are not to be kept in an enclosed space but are to be trailed in the vehicle's wake, strung in bunches on cables. From this description, Ganswindt's contrivance is of the intermittent powder rocket type.

With this propulsive system the passenger chamber which in the form of a cylindrical, hermetically sealed tube with windows and outer shells, should be as narrow as possible owing to the internal excess pressure, was to be attached to the gyrating bell by a spring suspension in order to equalize the still very jerky and irregular motion of the bell still more. The chamber was to be heated by the explosion gases passing through it in a kind of stovepipe. Ganswindt was also quite aware of the need to maintain normal atmospheric pressure and to provide for renewal of the air used up in breathing.

The equilibrium of the vehicle is stable at all times as the point of application of force always lies before the center of mass; Ganswindt considers this to be essential and has based his construction upon it. He also lays

claim to the priority of the idea of making up for the occupants' sensation of weightlessness, which sets in after the explosions have ceased, by rotating the whole ship about its longitudinal axis so that the centrifugal force presses the occupants against the surfaces of the cylindrical chamber, which thus become floors, with a force equal to their weight on earth. If the ship had several occupants, therefore, the case could arise where they would be standing diametrically opposite one another, head to head, i.e. with their heads in the ship's longitudinal axis.

According to Ganswindt, the necessary longitudinal rotation of the ship is to be brought about by a few explosions exhausting laterally, and is to be halted by similar but oppositely orientated explosions, since otherwise the ship would continue to rotate all the time.

Ganswindt also already thought of the possibility of connecting up two spaceships by a cable of appropriate length and of setting them spinning about their common center of mass in order to produce a centrifugal counter-pressure.

Ganswindt pictured the takeoff to space flight as follows:

The machine was first to be carried up as close as possible to the edge of the atmosphere by helicopters. He said that this was necessary because his interplanetary vehicle was not able to ascend through the atmosphere at high speed on its own power, owing to its unfavorable aerodynamic form. The explosion apparatus was then to be put into operation. Ganswindt knew, already in 1881, that the efficiency of a rocket-like prime mover is only favorable at very high flight speeds, but that these can only be reached gradually, in consideration of the counterpressure to be borne by the occupants. He therefore did not wish the starting acceleration to become greater than twice the force of gravity.

Further penetration of interstellar space can be made possible, according to Ganswindt, by setting up supply stations on the way. He considers our real moon to be rather unsuitable for serving as a fueling station, as compared with the advantages of small artificial moons, the proper gravitational fields of which are imperceptible. If sufficient provisions were to be made, Ganswindt even thinks it would be possible to reach other fixed-star systems such as Alpha Centauri, but the acceleration would then have to be ten times the force of gravity and would have to be maintained for a very long time. For this reason he doubts whether the occupants would be able to endure such a flight.

Hindered by adverse circumstances, Ganswindt was unable even to complete a model of his interplanetary vehicle. But he confirmed, as late as 1927, that he had nothing essential to add to his original project, but that the diagram first published in 1881 was to be considered merely as a sketch and not as a working drawing, and that he reserved himself the patent rights for a series of special component parts."

Appendix 6

Important newspaper articles by Valier

Valier's newspaper article in the "Münchner Neuesten Nachrichten" of April 7, 1925, as an example of the many articles he wrote in the press campaign for Oberth's interplanetary rocket.

"Der Vorstoss in den Weltenraum (advance into interplanetary space)

The advance into interplanetary space as a technical possibility is today a problem which, one may well venture to say, has increasingly preoccupied everybody over the past year or so. Although the idea was still banished to the realm of Utopias until only recently, isolated scholars in all civilized countries - astronomers and engineers alike - are now inclined to think that reaching the moon and the nearby planets is not only possible in the abstract, but that it can already be done with our present technical means, if only the propulsive forces latent in our strongest energy carriers, the solid and liquid fuels, can be transformed into motion in appropriately built machines.

The first to write a book on 'A Method of Reaching Extreme Altitudes' was the American scholor Rob. H. Goddard of Clark College in Worcester. There, in faultless calculations, are developed the formulas which govern the motion and aerodynamic lift of rocket-like machines, if only the exhaust-gas velocity is known with which the rocket gases leave the so-called jet nozzle, from which they whizz forth in the form of a fiery tail. Goddard also carried out comprehensive tests with various gunpowders, attaining exhaust-gas velocities as high as 2,234 m/sec by selecting the best mixture and the most suitable forms of combustion chamber and nozzles for his rocket machines. The calculation then shows that with an average performance of 2,100 m/sec, a rocket machine which is intended to reach the moon (without any guarantee of its returning) would, when fully charged and ready to go, have to carry with it powder weighing 800 times the final remaining mass of the rocket on reaching the moon. If the rocket is also to fly around the moon and to return, the weight ratio rises by many powers to immense figures, so that Goddard is obliged to recognize that his rockets are hardly suitable for carrying people to the moon and back; but they could, perhaps already in a few years, be made powerful enough to reach the moon unmanned, equipped with a luminous signal, so that their arrival on the face of the moon would be signalled by the flaring up of a Bengal light. -

Prof. Goddard's work was followed later by the publication of a book by a German scholar, the physicist Prof. Hermann Oberth. In contrast with Goddard, Oberth in his book 'Die Rakete zu den Planetenräumen' (The Rocket into Interplanetary Space) immediately struck out in quest of those propellants yielding the most powerful exhaust-gas velocities ever heard of on earth, although their technical control is still not quite within our power today and will cost us a great deal of hard work yet. Oberth however, in the spirit of German thoroughness, asks himself what is the good of a rapid apparent success such as will

probably be achieved by the powder rockets of the American Goddard, if it is then found, after all, that the relentless figures of involution are technically unfeasible for the construction of powder-rocket-propelled air ships capable of carrying men to the moon and back, as the ratio of the machine's takeoff weight to its empty weight turns out to be altogether impossible. Oberth thus feels it is better to set out along the longer and technically more difficult path of liquid-propellant rockets, for while this only holds modest initial successes in store at a much later date, it ultimately really can and must lead to large manned spaceships reaching the moon and even the planets.

Prof. Oberth likewise follows up his initially purely theoretical reasoning with experimental results. He shows that by burning a gasified mixture of alcohol or ether with liquid oxygen it is possible to obtain exhaust-gas velocities of as much as 3,400 m/sec, while pure hydrogen with oxygen has produced the terrific explosion speed of 4,200 m/sec already in the laboratory, which may be able to be raised to about 5,000 m/sec.

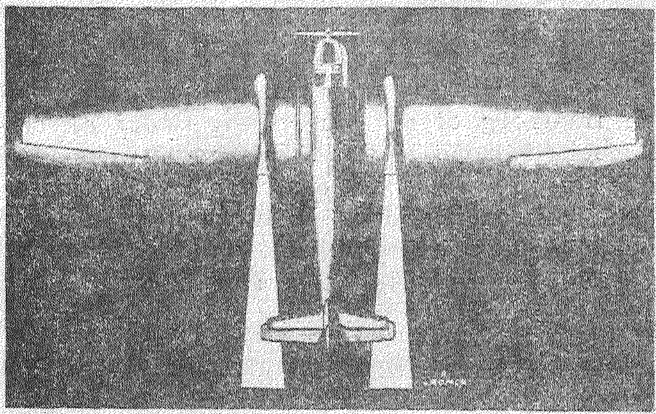
What this means to astronautics has been explained by me in detail in my book "Der Vorstoss in den Weltenraum" (Advance into Interplanetary Space), which is written in a manner intelligible to all. Let it only be said here that the technical possiblity of manned ships reaching the moon and other planets does in fact depend solely and exclusively upon this exhaust-gas velocity. If this figure can be raised to more than 3,500 m/sec, then travel to the moon is but a question of time, indeed of but a few years; if it cannot be increased beyond 3,500 m/sec, then the technical difficulties in the construction of the machine will remain completely insurmountable.

It is not the cold of the universe or the lack of air that poses the major obstacle to our ascent from earth to the heavens. It is the precinct of the force of gravity which is the shield we have not yet been able to break through in any way. But we already know where the trouble lies. We know what speed a spaceship must develop in order to break away from the earth and ascent to the astral realm. Calculation shows that its accelerative force must suffice to impart to it a final velocity of about 12,000 meters per second in vacuum; 11,182 m/sec fall to the theoretical gravity, the rest is used to break through our native planet's atmosphere and to counterbalance the loss due to gravitational retardation, since the ship's acceleration - i.e. the velocity increase per second - may not exceed 30 m per second, as the human organism simply cannot endure a stronger acceleration. But if the spaceships leave the earth in observance of the acceleration limits, there is no doubt that the occupants will be able to bear even the high cosmic final velocities of more than 10,000 m per second. A source of greater concern than this is the thought of how the human brain will function when, on commencing free flight in interplanetary space, once the rocket engine is turned off, there ceases to be any counterpressure whatever, and the term "top" and "bottom" lose their meaning. Travellers in the spaceship's chamber will be able to glide about like angels. not a drop of wine will flow from an upturned bottle, but also no liquid will remain in wide-open containers. Soup, for instance, will form a ball on the plate and float about the chamber like a balloon, and wine will rise up out of the glasses and do the same. To fry meat in a flat pan one would have to screw it fast in the pan; all the furniture in the chamber would have to be screwed into place and all walls covered with bars and leather loops in order to allow

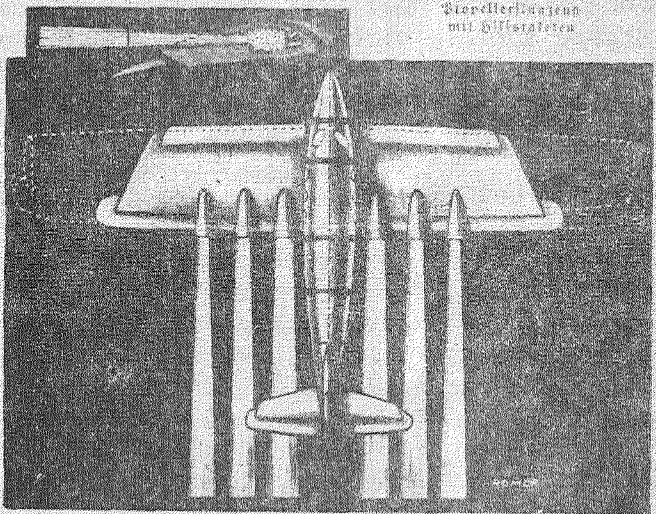
the occupants to move about. Rather peculiar circumstances, to say the least, and man would first have to accustom himself to them. Prof. Oberth, however, ventures to think that the human brain would be able to endure and bear up against this onslaught of novel sensations (in his book, he deals with these very problems in comparatively great detail).

The idea of rocket travel into stellar space seems to be spreading like wildfire. A newcomer has already arrived on the scene, the engineer Hohmann who, aside from working on general rocket theory, especially centers his investigations on spaceship navigation. The ascent from earth, flight in space, orbiting around celestial bodies and landing on them, and especially the return to earth, are subjected to minute investigation, convincing proof of the dirigibility and deceleration of rocket-propelled spaceships even in vacuous interplanetary space being advanced with an exact calculation of the expenditures of energy necessary for the "aiming" shots. Hohmann likewise arrives at the conclusion that it is already possible to build a spaceship with the technical means available today, and that reaching the moon and the planets, orbiting around them and landing on them, is technically feasible, as is the return to earth."

Vom Flugzeug zum Weltraumschiff



Propellerflugzeug mit Hilfsraketen



Das Raketenflugzeug
Oben links: Schnitt durch den Spaltflügel

Der Münchner Astronom und Flieger Max Valier tritt in der „Münchner Illustrierten" mit einem neuen Plan eines Weltraumschiffes vor die Öffentlichkeit.

Wir leben in der Zeit der sich überstürzenden Rekorde. Was heute Phantasie, kann morgen Wirklichkeit sein. Schon wagt niemand mehr, in technischen Dingen von einem „Unmöglich" zu sprechen. Wo die eine Maschinenart nicht mehr weiterkann, schafft der Erfindergeist eine neue. Das bisherige Drachenflugzeug mit seiner motorgetriebenen Schraube z. B. nähert sich nun seiner Weltform. Es hat sich zur reinen Tragfläche hin entwickelt, in der die Fahrgäste wohnen. Es wird in Kürze Europa mit Amerika in eintägiger Fahrt verbinden. Noch größere Geschwindigkeiten sind ihm aber verwehrt. In den geringen Höhen, wo die Luft dicht ist, die Schrauben gut ziehen, die Tragflächen gut tragen, erfordert große Schnelligkeit ungeheuren Kraftaufwand; das Gewicht der Maschine verschlingt die Nutzlast. In den großen Höhen aber, wo die Luft dünn, der Widerstand gering ist, dort versagen wieder die Tragflügel und Schrauben. Hier kann nur ein ganz neues Prinzip helfen, der Motor muß von der Dichte der umgebenden Luft unabhängig sein.

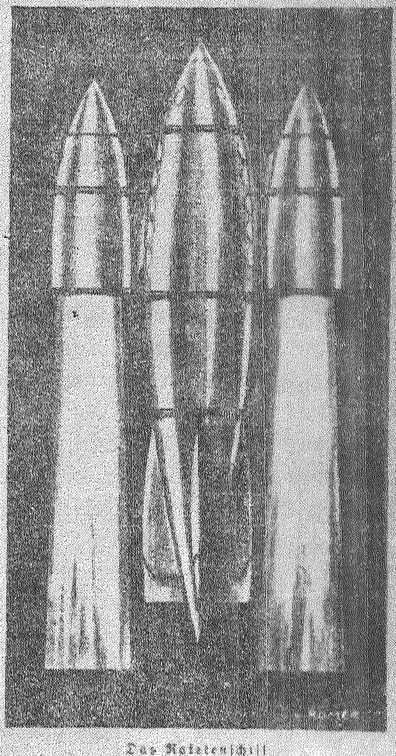
Schon der große Newton hat erkannt, daß das Raketenprinzip diese Bedingung erfüllt, und hat deswegen sogar in einer Vorlesung ausgesprochen, daß raketenartig sich bewegende Maschinen auch im völlig leeren Weltenraum ihre Lenkbarkeit behalten. Seit drei Jahren aber liest man, daß der amerikanische Professor R. H. Goddard dem Monde einen Gruß in Gestalt einer Pulver-Doppelrakete zu senden gedenkt. Von der schon oft angekündigten Auffahrt dieser Mondrakete hat man aber noch nichts gehört.

In der Tat scheint der Sprung von den bisherigen schwachen Zier- und Kriegsraketen zur Mondrakete zu groß, als daß man an ein [illegible] zu entwickeln.

Anscheinend [illegible] denke man sich die beiden seitlichen [illegible] durch [illegible] Raketen ersetzt. Dann erhalten wir das Propellerflugzeug mit Hilfsraketen. Darum werden die Raketen verstärkt und verdoppelt und wir bekommen das Raketenflugzeug mit Hilfspropeller, das schon viel größer und schneller aussieht, als die heutigen Flugzeuge, im übrigen aber ebenso fährt und landet wie diese. Seine äußere Form entspricht unserem heutigen [illegible]. Abermals werden die Raketenmotoren verstärkt und vermehrt, sodaß der Propeller nun ganz fortfallen kann. Wir erhalten das Raketenflugzeug, so genannt, weil es immer noch flugzeugartig startet und landet und mit Hilfe von Tragflächenwirkung fliegt. Das reine Raketenschiff hat sich schon ganz von jeder Tragfläche losgelöst. Es zeigt mehr die bekannte Granatenform, die für die ganz großen Geschwindigkeiten im Luftreich notwendig ist. Sein Start erfolgt steil von einer Startschanze, die Landung (bezw. Wasserung) senkrecht, mit Raketengegengas zum Abbremsen.

Solche Maschinen würden schon geeignet sein, Strecken wie Berlin–Rom in 30–40 Minuten, von Europa nach Amerika in 2–2½ Stunden zu bewältigen und bei senkrechter Ballonfahrt nach oben einige hundert Kilometer hoch zu bringen und in den Weltraum vorzustoßen.

Max Valier



Das Raketenschiff
nach der Konstruktion Valiers

Figure 35: Short article by Max Valier, 1926.

Historical development of the idea of space travel

From an article by Max Valier in the "Münchner Neuesten Nachrichten" of February 10, 1926.

"The Spaceship

The invention of the spaceship, with which the whole world is preoccupied at present, has recently produced such strange phenomena in the accounts of a certain press that it seems fitting to give here some of the details of the true history of its evolution.

The honor of having been the first to think of rocket-like machines and the theoretical possibility of interplanetary aviation falls to no lesser person than that great Englishman Isaac Newton. In a lecture on his third law of mechanics he remarked that it ought to be possible, with the aid of rocket-like machines, to steer ships even in vacuous interplanetary space. The technical execution of such plans was of course quite out of the question in Newton's day.

However, so far as can be determined, it would seem that the much misjudged German inventor Hermann Ganswindt, a septuagenarian still living in Berlin today, was the first proponent of the practical execution of rocket spaceships able to be manned. Before a close circle of friends, Ganswindt expounded his basic ideas on the construction of dirigible airships, heavier-than-air aircraft and spaceships already in the seventies, at a time when even the possibility of the first two types of machines was still a matter of general controversy. In the eighties he then delivered numerous lectures in public, without of course gaining much belief and recognition. At the turn of the century Ganswindt was on the point of actually building some of his models, when an inimical stroke of fate robbed him of the fruits of his scientific labors. Even though he has had no tangible success to this very day, Hermann Ganswindt, going far beyond Newton's purely theoretical considerations, certainly correctly recognized many essential points which will be determining for the practical execution and construction of dirigible airships, aircraft and rocket spaceships for all time.

In 1891, Dr. Franz von Hoefft in Vienna also began to occupy himself with the advance into interplanetary space. His first design concerned a machine which, although properly speaking only an airship, was based on the principle of the rocket in so far as the forward motion was to be produced by aspiration of air at the foremost tip and exhaustion of the same at the rear. From 1895 on, von Hoefft turned to the ether ship, i.e. to that particular type of spaceship intended to obtain its motion from the zero point energy of the ether of space. Until recently, such considerations were scarcely taken seriously at all. But since scholars as eminent as Prof. Nernst and Wiechert have become proponents of the zero point energy of the ether, people appear to have adopted a different view of these things. If the latest reports from Vienna are true, it would seem that a certain Mr. Schappeller has even managed already to virtually render ether energy effective in a machine. Aside from the ether ship, von Hoefft also worked at great depth on the solenoid gun and placed great importance particularly on the ideological aspect of interplanetary aviation.

A Russian likewise voiced his views on the subject. In 1896, a book by Ziolkowski was published, the title of which, translated into German, was "Die Rakete zum Planetenraum" (The Rocket into Interplanetary Space), while in France an American by the name of Sargent, who lived in Paris, caused a great stir. Of course, neither of these inventors was ever heard to have produced any practical successes whatsoever. The time simply was not yet ripe, and the general development of technology and especially of engine construction was not far enough advanced for it to be possible for the ever increasing number of inventions to materialize. Things are different today!

Already in 1919, the American professor Robert H. Goddard of Clark College, Worcester, published a paper entitled "A Method of Reaching Extreme Altitudes" in the publications of the Smithsonian Institution, in which he made known encouraging test results with powder rockets. Such machines were even to be able to reach the moon, and indeed Prof. Goddard even hoped that the flash of light produced by the ignition of 2-3 kilograms of magnesium powder when the rocket struck the moon would be spotted by the telescopes of the big observatories. But Goddard did not think of conveying people by means of his powder rockets.

It falls to the merit of our compatriot, Prof. Hermann Oberth, whose book published in 1923 by the Verlag R. Oldenbourg (Munich), entitled "Die Rakete zu den Planetenräumen" (The Rocket into Interplanetary Space), has become a pioneering work for all more recent astronautics, that he tackled this latter, far more difficult, problem, putting it across in a scientific and convincing manner. In contrast to Goddard, Oberth bases his work on liquid propellants. Although he too describes a quite small, unmanned sounding rocket as his model B, which is only intended to carry recording instruments to great altitudes of several hundred kilometers, his principal aim is nonetheless the conveyance of human beings into space. He adduces evidence that it is possible to reach the moon already with the technical means which we dispose of today..."

Appendix 7

Abstract of "Russlands Weg zum Mond" (Russia's Path to the Moon)

by R. M. Wallisfurth

After outlining the projects of Ziolkowski and Zander, Wallisfurth describes the consequences of the Treaty of Rapallo:

It is known that in the dictatorial Treaty of Versailles the victors of the First World War (England, France, USA) forbade Germany to build and to possess effective implements of war. Submarines, heavy artillery, powerful aircraft engines, fighter planes, tanks etc. were all prohibited. The possibilities opened up by the Treaty of Rapallo, voluntarily entered into by Germany and the USSR in April 1922, resulted in close technical military collaboration between the German army and navy and the Soviet army. The war material was built in Russia under German control, following German designs and in most cases with German money and German machines, and was jointly tested by German and Russian officers. In the lecture halls in which courses of instruction were given, German and Russian officers were taught together by German military trainers.

In addition to this, Prof. Junkers, for whom the pacific duties of the aircraft lay in a worldwide international air traffic system, which he set out to build up, soon set up the Berlin-Moscow route. For the level of technology as it stood at that time, this was a great and daring enterprise, in which the Junkers all-metal airplanes stood the test remarkably well, despite their low engine power. Engineers, foremen and skilled workers from the Junkers aircraft construction and engine construction works went to Russia, where a Juniers subsidiary was soon established in Moscow. Russian engineers came to Dessau and Berlin. In the course of this close coperation, the Germans communicated their knowledge to their Russian comrades in all innocence. They had no idea that somewhere in Russia there was an institute in which the Russians had embarked upon rocket developments which they took the greatest care and precautions to conceal from the Germans, and indeed from everyone else.

The first Valier biography[+], which was written by Brandecker on behalf of the Union Verlag in 1961 on the basis of our Valier chronicle, acquainted Wallisfurth with Valier's letters which provided him with important information for his historic work. On July 16, 1924, Valier expounded to Prof. Oberth his idea of the stepwise technical development of the known airplane to the space rocket via the rocket-plane (we know the letter and the plan). Wallisfurth makes the following comment on this (p. 40):

> "This venturesome and, at the same time, completely convincing program was repeated by Valier, who could not find financial backers for it anywhere, in the course of an interview with executives of the Junkers works."

[+] "Ein Leben für eine Idee, der Raketenpionier Max Valier", Union Verlag, Stuttgart.

This interview, which took place in the Berlin office of the Junkers works on September 7, 1925, is known to us from Valier's letter to Prof. Oberth, which Wallisfurth also cites. The Junkers aircraft engineers had declared that they were, in principle, interested in Valier's suggestion that tests be made to see if the reaction force of rocket motors would be economically advantageous as the propulsive force for the G 23. But they pointed out that their firm could only take up the issue once the rocket motor had actually been built and tested somewhere. "I think it can be assumed that Mr. Valier will receive support for this test from friends of ours" - thus reads the last sentence of the memo of that discussion, which was written for all the participants by an engineer of the Junkers aircraft works.

Valier's letter to Oberth likewise mentions the "representatives of another group of interested persons" which "is already interested in adopting and developing the rocket principle right up to the engine design stage. This group, which disposes of great means and laboratories, .. would thus be prepared to carry the rocket issue to the point where the heads of the aircraft industry declare that they too will join in. ... If it then turns out that the results obtained are quite satisfactory and that they are in accordance with your calculations, Prof. Oberth, they will not hesitate to bring you to Berlin in order to engage you to take care of all that remains to be done."

Valier, and probably also Prof. Oberth, believed that the "friends" of the Junkers works were really the Junkers subsidiary in Russia, where work could be done unimpeded by the Versailles restrictions.

Wallisfurth, who has thoroughly studied the development in Russia, sees things differently and writes (p. 41):

> "Without introducing themselves as such, representatives of the Moscow offices which had in the meantime made secret arrangements with the German army and navy, had taken part in the discussions. This Soviet group noted Valier's proposals with great interest. They explicitly declared that they were prepared to take up the "Rak principle", as Valier called it, and to carry it out 'right up to the engine design stage'." ...

(p. 42):

> "The Soviets did what they had discussed with Valier - they followed the stages in the order which he had proposed -, only they needed neither Oberth nor Valier to do so." ...

(p. 45):

> "Shortly after the talks held in September 1925, the Soviets commenced the systematic investigation and determination of all types of rockets known hitherto, in the ZAGI in Kutschino."

This was the first stage of Valier's program.

All that trouble Valier had gone to, in order to find people interested in his clear and technically reasonable plan in Germany: press articles, public lectures, a lecture before invited experts at the Airmen's House, personnel letters to influential people - all in vain.

We know, and his sister testifies, that he turned down very tempting offers from abroad. Above all, he never wanted to work for purposes of war, nor for foreign states.

This is why it is saddening to learn that his interlocutors had been the Soviets in disguise, and that they adopted and carried out his plans while Valier believed he was dealing with engineers of the Junkers subsidiary in Moscow.

It has to be admitted though, that even if the Junkers people had not allowed those representing their "friends" to take part in this discussion, the Soviets could have deduced the principles of Valier's plans from his publications and lectures, and Oberth's calculations from his own book. Presumably, though, this personal discussion in the Junkers office strongly stimulated the Russian engineers.

Wallisfurth stresses many times that the Russians followed Valier's development plan (working via the rocket plane to the interplanetary rocket).

On thinking over the facts made known by Wallisfurth in his book, one can only bitterly regret that none of the men in power in Germany in the twenties had Lenin's farsightedness. We read in Wallisfurth (p. 37):

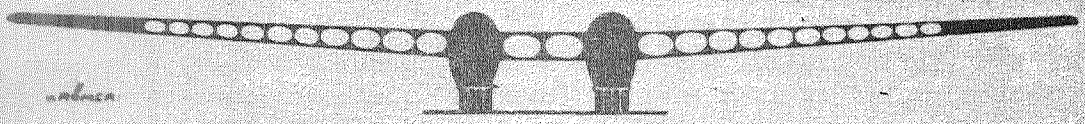
> "... in that catastrophic year of 1918, the first year of the Soviet state, and in the complete breakdown of the Russian economy, administration and public order, a rubber factory was shut down in Moscow for lack of fuel. The engineer F.A. Zander, who had worked in this factory, lost his job.
>
> The public had never heard of this man. When he sat in his little room in candlelight - often he did not even have candlelight to work in - bowed over sketches, writing out calculations or jotting down thoughts in shorthand, nobody watched him. Indeed, nobody would have understood what he was jotting down: trajectories from star to star, performance charts of rockets which did not even exist at that time, sketches of propulsive systems that had never yet been built - a fantastic world in the truest sense.
>
> On a winter day of this black year of 1918, Zander reported his plans to Lenin and asked to be provided with equipment. 'Will you also be the first to fly?', asked Lenin. Zander did not hesitate to answer: 'Yes, I shall!'.
>
> By order of Lenin, F.A. Zander began his practical research work in 1918. He was soon joined by the congenial J. W. Kondratjuk ..., but many years were still to pass before the crucial technical difficulties were overcome."

It is in this decision of Lenin's in 1918 that we see the root of the great interest with which the Soviets viewed the rocket and all its possibilities. Even after Lenin's death, his authority continued to protect and promote rocket development. In spite of all the famines which the country suffered,

Lenin's successors did not restrict research; on the contrary, in compliance with the technical necessity, they extended it ever more - and they kept it secret. Among the great and surprising outcomes of these purposeful operations are the "Stalin Organs", i.e. the rocket launchers first used by the Russians in July 1941, and the first advances into space by Sputnik I (Oct. 1957), Juri Gagarin's space flight (April 1961) and many other things both past and, probably, yet to come.

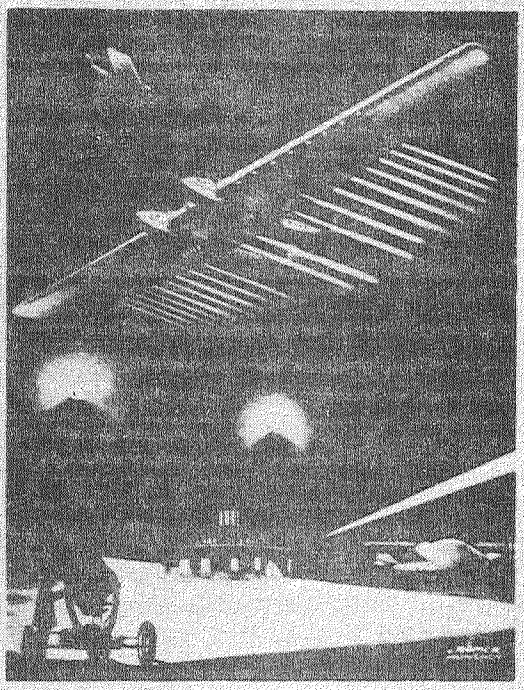
DER VORSTOSS IN DEN WELTENRAUM

VOM FLUGZEUG ZUM WELTRAUMSCHIFF • DER PLAN DES VORTRAGENDEN MAX VALIER



Der Skeptiker lächelt und der Optimist jubelt, der eine sieht die Grenzen und der andere die Möglichkeiten. Den Flug in den Weltenraum als technische Möglichkeit hinzustellen, ist kühn und erregt Widerstand, Zweifel, Spott, aber es erweckt auch Glauben, Hoffnungen. Die Erde ist uns zu klein und der Phantast strebte schon lange über sie hinaus, nun will der Techniker folgen, er rechnet kühl und sachlich mit, nachdem er den Schlußpunkt unter seine Rechnungen gemacht hat, sagt er ruhig: es ist möglich! Wir leben in einer Zeit der Erfindungen und Über-Erfindungen, was gestern Märchen war, ist heute Wirklichkeit, und dabei gibt es Menschen, die behaupten, wir stehen erst im Anfang des technischen Zeitalters. Möglich!

Die Vorhersage der Zukunft kann man ruhig den Phantasten überlassen, der Techniker sieht nur die Realität und rechnet mit dieser.



Raketen-Flugzeug, welches die strecke Berlin—Newyork in 50 000 m Höhe in 1½ Stunden bewältigen könnte.

Es gibt heute viele Menschen, die sich mit dem Problem des Weltfluges beschäftigen, einer davon ist der ehemalige Fliegeroffizier Max Valier, der am Dienstag in Bremen war und im großen Saal des Museums einen Lichtbildervortrag über einen Flug in den Weltenraum hielt. Keine Hirngespinste, sondern Zahlen, Kurven und Konstruktionen wurden erörtert und Möglichkeiten wurden gezeigt, eine Grundlage, auf der man aufbauen kann. Valier greift einen alten Gedanken auf, den kein geringerer als Newton ausgesprochen hat, ein Raketenschiff zu bauen, denn die Rakete steigt auch im luftleeren Raum, ihr Abstoß erfolgt von den eigenen ausströmenden Gasmassen und nicht von der Luft.

Das Problem, das zu lösen ist, besteht darin, Betriebsstoff zu finden von geringem Gewicht und größter Explosivwirkung, der eine Endgeschwindigkeit von 12 km in der Sekunde erteilt.

Und dieses Problem läßt sich bei Verwendung von flüssigem Betriebsstoff lösen, wenigstens theoretisch. Die Konstruktion des Schiffes selbst geht von Junkers G 24 aus, Schritt für Schritt will Valier die Tragflächen verkürzen und immer größere Raketenmotoren einbauen, bis auf diesem Wege das reine Raumschiff entstanden ist, bei dem die Tragflächen gänzlich verschwinden und das Steuer eine untergeordnete Rolle spielt. Der Abflug von der Erde müßte natürlich mit kolossaler Schnelligkeit vor sich gehen, um ihre Anziehungskraft zu überwinden, umgekehrt müßte die Landungsgeschwindigkeit eine sehr geringe sein, da das Schiff sonst zerschellte, dies ist durch Gebrauch von Gegengas zu erreichen. Die Konstruktion eines solchen Raumschiffes würde sich verhältnismäßig einfach gestalten. Mit Vorversuchen soll in der nächsten Zeit schon begonnen werden und man hofft auf diesem Wege fürs erste wenigstens ein Flugzeug für irdische Verhältnisse herstellen zu können, mit dem man ungleich größere Geschwindigkeiten erreichen

Figure 36: Rocket plane (from Valier's lecture program 1927, p. 2).

kann, als dies bisher der Fall war. Sollte sich diese Type bewähren, wird man versuchen, in den luftleeren Raum emporzusteigen, um hier Erfahrungen zu sammeln, auf Grund derer man dann die Reise in das Planetensystem wird wagen können.

Valier steckt sich nicht gleich zu Anfang den Mond oder einen Planeten als Ziel, langsam und schrittweise will er aufbauen, versuchen, prüfen, um endlich den kühnen Vorstoß zu wagen. Kein Phantast, der ins Unermeßliche seine Hände ausstreckt, sondern ein kühler Konstrukteur, der mit dem rechnet, was vorhanden ist. –

Hinter dem großen Gedanken, den Menschen in technisches Neuland hinüberzuführen, verstummt die Frage nach dem Wozu. Es ist nicht das Zweckmäßige, das ein solches Werk verstehen läßt, die Tat als solche ist Selbstzweck und führt sie zu nichts anderem als dazu, daß unsere Kenntnis um die Naturgesetze bereichert wird, so wäre dies schon Lohn genug.

Der Optimist jubelt und sieht sich schon frei schwebend im Weltenraum, tanzend von Stern zu Stern, und der Skeptiker lächelt ungläubig und sieht die Grenzen, die Widerstände und spricht sein Verdammungswort: „Unmöglich". Wir sind keine Propheten und wissen nicht, wohin die Zukunft geht. Zwischen dem starren Zweifel und dem jubelnden Bejahen liegt das kühle, sachliche „Möglich". Und mehr sagt der Techniker nicht. Alles andere müssen wir der Zukunft überlassen, ruhig abwartend. Daß die Möglichkeit [illegible] werden wird, ist vorläufig genug, denn das ist viel, sehr viel.

ZUM THEMA GEHÖREN DIE BEIDEN SOEBEN NEU ERSCHIENENEN SCHRIFTEN VON MAX VALIER

DER VORSTOSS IN DEN WELTENRAUM

VOM FLUGZEUG ZUM WELTRAUMSCHIFF

„BEACHTEN SIE BITTE DIE BÜCHERANZEIGEN AUF DER FOLGENDEN SEITE"

ALLE GENANNTEN WERKE LIEGEN AM BÜCHERTISCH IM VORTRAGSSAALE AUF

Figure 37: Rocket ship, takeoff and landing (from Valier's lecture program 1927, p. 3)

Appendix 8: Translation of Figures 36 and 37.

THE ADVANCE INTO INTERPLANETARY SPACE
From airplane to spaceship
The plan of the lecturer, Max Valier

The skeptic smiles and the optimist shouts with joy, the former seeing the limits and the latter the possibilities. To aver that flight into interplanetary space is a technical possibility is audacious and arouses resistance, doubt and ridicule, but also belief and hopes. The earth is too small for us. The visionary has long sought to transcend it and now the technician is following suit. He calculates everything coolly and objectively and on terminating his calculations he calmly says: It can be done. We live in an age of inventions and superinventions where yesterday's fiction is today's reality; yet some say that the age of technology has only just begun - which may well be!

It can be left to the visionary to predict the future; the technician only sees what is real, and it is with this that he calculates.

Today, many people are occupied with the question of space flight. One of them is the former flying officer Max Valier, who was in Bremen on Tuesday and gave a latern-slide lecture in the big hall of the museum, on a flight in interplanetary space. No chimera were discussed here, but figures, curves and constructions, and possibilities were pointed out - a foundation upon which to build. Valier catches up on old idea advanced by no less a person than Newton, that, namely, of building a rocket ship, for the rocket ascends even in a vacuum, deriving its thrust not from the air, but from its own effluent quantities of gas.

The problem to be solved lies in finding a fuel of low weight and maximum explosive action, capable of imparting a final velocity of 12 km per second.

This problem can be solved, theoretically at least, by using liquid fuel. The construction of the ship itself is based on the Junkers G 24. Valier intends to reduce the airfoils step by step, installing ever larger rocket motors, until the pure spaceship will have taken shape, in which the airfoils will have completely disappeared and the control surfaces only play a subordinate role. Takeoff from the earth would naturally have to take place at immense speed in order to overcome the force of gravity, and conversely the landing speed would have to be very low indeed, since otherwise the ship would crash; this can be done by reversing the thrust. Such a spaceship would be built along relatively simple lines. Preliminary tests are to be begun in the very near future and it is hoped to obtain in this way, at least to begin with, an aircraft for terrestrial conditions, capable of attaining far greater speeds than ever before. If this model stands the test, an attempt will be made to ascend into vacuous space in order to gather experience there which can be used for the subsequent venture into planetary space.

Valier does not set out with the immediate objective of reaching the moon or a planet. He intends to proceed slowly and progressively, building up, testing, checking, and only then to venture upon this bold advance, not in

The manner of a visionary, stretching forth his hands into the realms of the incalculable, but as a hardheaded engineer who reckons with what actually exists.

The great idea of leading mankind into a completely new domain of technology simply silences any question as to the why and wherefore. It is not by its utility that such a feat is to be understood; the deed as such is a goal in itself,f, and even if its only outcome would be to enrich our knowledge of the laws of nature, this would be reward enough.

The optimist shouts with joy, already picturing himself sailing about in space, dancing from star to star, and the pessimist smiles cynically, seeing the limits, the obstacles, and utters his word of condemnation: "Impossible", We are no prophets and we do not know where the future is heading. Between the set disbelief and the joyful affirmation there lies the cool and objective "possible"; the technician says no more. All else must be left to the future; we must simply wait and see. That the venture has been pronounced possible at all is already quite enough for the time being; indeed, it is a great deal. ...+)

+)Translator's note: Rest of text, as well as legends of figures, illegible in the original copy.

Appendix 9

Other designs by Valier, drawn by H. and B. von Römer

We have learned from a letter to Oberth that in November 1926 Valier commissioned 15 new latern slides for his lecturing evenings. This was his first collaboration with the brothers Hans and Botho von Römer, who subsequently drew many a design of his in their very realistic manner with light and shadow and perspective. Our Figures 9 to 14 were produced in their atelier, as were Figures 35, 36 and 37.

In addition to these diagrams depicting his great program of development - From Airplane to Spaceship - and which also skilfully illustrate his ideas concerning the takeoff and landing of a rocket ship, Valier also thought of a number of other forms for a rocket plane, which the von Römers illustrated for him in their concrete manner. For instance, the long-fuselage rocket plane:

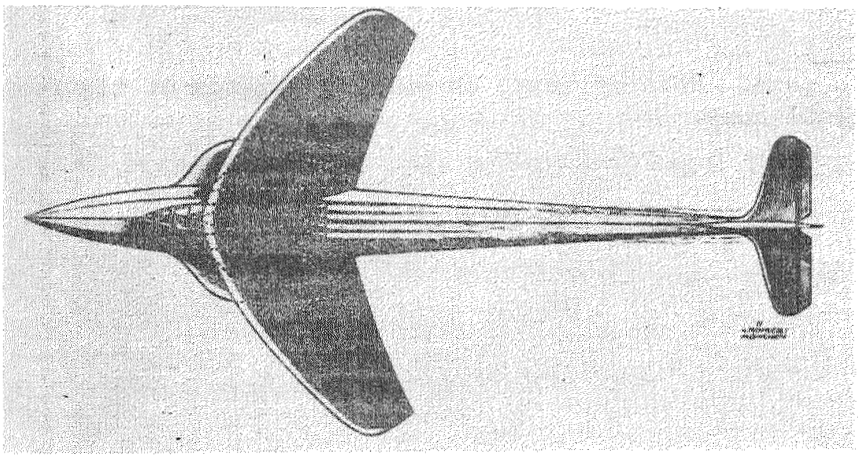


Figure 38. High-speed rocket aircraft for the Europe-America service. Note the trim form of the hull and the small-span parabolic wings.

They also made graphic illustrations of ground vehicles with rocket propulsion, working from Valier's plans, e.g. a rocket-propelled rail vehicle and a rocket-propelled sled (Fig. 40).

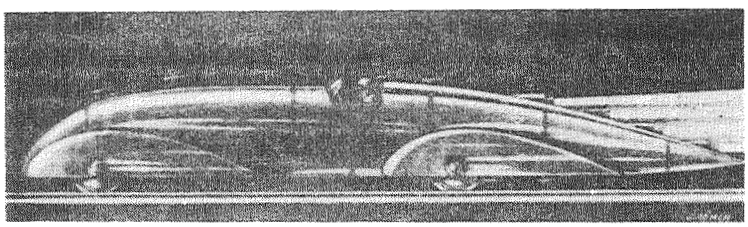


Figure 39. Rocket-propelled rail vehicle planned for speed record; streamlined form, echeloned rockets.

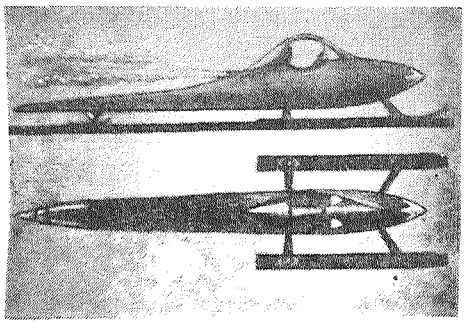


Figure 40. Rocket-propelled sled, planned for speed record.

Compare the primitive rocket-propelled rail vehicles (Fig. 21 and 22) and rocket-propelled sled (Fig. 24) with the streamlined forms in these illustrations, i.e. the financially restricted possibility with these optative forms. What a dire contrast!

But is not the actual execution more valuable than the most beautiful figment of the imagination on paper? It was for the execution that Max Valier went all out; this is why he deserves to be called a champion of space travel. His primitive rocket vehicles have been given a place of honor in the "Deutsche Museum".

Appendix 10

Valier was quickly forgotten

A year after Valier's death, posters invited the people of Berlin to the demonstration run "of the greatest liquid-oxygen reaction motor in the world", as was reported by the RWZ on May 2, 1931:

"Today, in the maneuvering area of the Berlin-Tempelhof airport, the greatest liquid-oxygen reaction motor in the world will be demonstrated, which runs on liquid oxygen and liquid fuel. The designer of the vehicle is chief engineer Alfons Pietsch. The research work is being done under the patronage of Dr. Heylandt, the well-known oxygen expert and technical director of the Aktien-Gesellschaft für Industriegasverwertung in Berlin-Britz. In the announcements of this demonstration one misses a name which has to be mentioned in connection with the reaction motor. Max Valier, who on May 17 of last year was the victim of a fatal accident which occurred while he was testing his first large reaction motor with liquid fuel, is to be considered as the actual inventor of the reaction motor. We are in a position to present to the public a number of documents showing how far Max Valier had already progressed with his work. It may be of interest to some to learn that Valier worked on the final stage with Dr. Heylandt in the workshops of the A.-G. für Industriegasverwertung in Berlin-Britz, right up to his death."

The author, Heinrich Weinz, here rightly denounces the unkind forgetfulness of those who took up Max Valier's work, which was extremely successful technically and experimentally, and developed it just a little further, without making any mention of the man whose suggestion it had been, and who had laid the foundations.

Consequently, the RWZ editor gave a 1 1/4 page illustrated account of the dead man's life, including excerpts from letters which, thirty years later, would serve us as fragments in the great mosaic of the Valier chronicle.

Weinz closed his article with the words:

"He was considered as a Jules Verne of the 20th century - but he was more than a Jules Verne. He did not only write, but he tried to execute his plans himself."

List of sources

Documents and accounts were kindly made available by:

a) Mr. A. Fritz, from the archive of the Deutsche Rakentenund Raumfahrt-Museum, Stuttgart

b) Mrs. Hedwig Valier, Max Valier's widow, who died in 1959

c) Mrs. Martha Zorbach, Max Valier's sister

d) Dr. O. von Gschliesser, university Professor, and Dr. G. Hohenauer, counsellor of a ministerial department, schoolfriends of Max Valier

e) Dr. H. Hochenegg, chief librarian at the national library, a wartime comrade of Max Valier

f) Mrs. Leopoldine and Mrs. Martina Hörbiger

A. von Weiss-Trostprugg, engineer
Eng. D. Rolf Eichacker
Hermann Fauth, assistant master at secondary school
H. Lang, cert. eng.
I. Kober, cert. eng.
H. and B. von Römer, graphic artists

(all acquaintances of Max Valier)

g) Parson Endres/Pfronten im Allgäu and
Parson Traut/Bidingen ü. Kaufbeuren/Swabia
(extracts from the parish registers)

h) Austrian record office/war archive, Vienna,
(Max Valier's personal file)

Further documents referred to were:

i) Biography, written by Valier's mother

k) Obituary by Dr. Reinhold Eichacker

l) 10 books in which mention is made of Valier's work (see Bibliography B)

m) 31 newspaper and journal articles on Valier's rocket work, especially Walter Riedel's article in the journal "Weltraumfahrt" 1953

n) 9 newspaper articles written by Valier in the years 1924-1930

o) 16 letters from Valier to his relations, 1915-1930

p) Hörbiger-Valier correspondence 1915-1924 (partly from the Hörbiger archive, partly from H. W. Behm "Hörbiger, ein Schicksal")

q) Valier-Oberth correspondence 1924-1927 (conserved by Prof. Oberth and kindly placed at our disposal)

r) 25 books and pamphlets written by Valier himself (see Bibliography A).

BIBLIOGRAPHY A

Max Valier's writings (as far as known to us)

Year	Title	Publisher
1909 till 10.5.1910	1st astronomical journal	(manuscript)
10.5.1910 till Jan. 1911	2nd astronomical journal	
1.17.1911 till April 1911	3rd astronomical journal	
1.1.1912 till Feb. 1915	Personal diary	
1912-1913	"Mentor" (school magazine)	Edited and published by Max Valier
1910-1913	Poems III	(manuscript)
New Year 1914/1915	Die Mondfee, Singspiel, Dichtung und Musik (The Moon Fairy, operetta, poetry and music)	(manuscript)
Easter 1915	Das astronomische Zeichnen (Astronomical Mapping)	Verl. Natur und Kultur, Munich
1917	Sternbüchlein für Jedermann (Booklet of Stars for Everyone)	Verlag Natur und Kultur, Munich
2nd ed. and 3rd ed. 1922	The above bearing the title "Sterngucker" (Star Gazer)	
Easter 1919	Spiridion Illuxt, science fiction	Deutsche Buch-druckerei, Innsbruck
1919	Grundlagen der Kosomotechnik (Fundamentals of Cosmotechnology)	Deutsche Buch-druckerei, Innsbruck
Christmas 1920	Das transzendentale Gesicht (The Transcendental Vision)	Faustverlag, Munich
Easter 1921	Dinge des Jenseits (Things of the Beyond)	Faustverlag, Munich

1921	Des Urseins Dreifaltigkeit (Trinity of the Original Being)	Faustverlag, Munich
-	Verborgene Gewalten im Weltgeschehen (Hidden Forces in World Affairs)	Faustverlag, Munich
Jan. 1, 1922	Okkulte Weltallslehre Physik und Metaphysik (Occult Theory of the Universe, Physics and Metaphysics)	O.W. Barth Verlag
1922	Untergang der Erde (End of the World)	Verlag Natur und Kultur, Munich
-	Millionenwerte aus den Sternen	Verlag Natur und Kultur, Munich
1923	Die Entwicklung unseres Sonnensystems nach der kosmotechnischen Lehre Hörbigers (The evolution of our solar system according to Hörbiger's cosmotechnological theory)	Hermann Paetels Verlag, Neufinkenkrug b. Berlin
1923	Panik (Panic) (with Reinhold Eichacker)	Universal Verlag, Munich
1924	Die Fahrt ins Nichts (The Journey into Nothingness) (with Reinhold Eichacker)	Universal Verlag, Munich
1924	Der Sterne Bahn und Wesen (Orbit and Nature of the Stars)	R. Voigtländers Verlag, Leipzig
1924	Der Vorstoss in den Weltenraum, eine technische Möglichkeit (Advance into interplanetary space, a technical possibility)	R. Oldenbourg Verlag, Munich
1925 2nd edition	Der Vorstoss in den Weltenraum, eine technische Möglichkeit (Advance into interplanetary space, a technical possibility)	R. Oldenbourg Verlag, Munich
1926 3rd edition	Der Vorstoss in den Weltenraum, eine technische Möglichkeit (Advance into interplanetary space, a technical possibility)	R. Oldenbourg Verlag, Munich

1927	4th edition, Vorstoss in den Weltenraum, eine technische Möglichkeit	R. Oldenbourg Verlag, Munich
1928	Auf kühner Fahrt zum Mars (On a bold voyage to Mars)	Journal "Die Rakete"
1928	Raketenfahrt (Rocket Travel) (5th ed. Advance)	R. Oldenbourg Verlag, Munich
1929	Raketenfahrt (Rocket Travel) (6th ed. Advance)	R. Oldenbourg Verlag, Munich

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11. R.M. Wallisfurth - Russlands Weg zum Mond, Düsseldorf 1964 (Econ)

+) This biography was written using the present Valier chronicle which we handed over to the Union Verlag, Stuttgart, in 1960. Our purpose in doing so was to finally make Valier's achievements dating from the beginnings of rocketry accessible to a larger circle of readers.

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Figure 33.	Jupiter's influence on the frequency of sunspots from 1900 to 1924.	Figure 99 from Valier's "Der Sterne Bahn und Wesen"
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Figure 35.	From airplane to space ship. Short article in the "Münchner Illustrierte Presse" 1926,	Privately owned
Figure 36.	Rocket plane - from Valier's lecture program 1927.	Privately owned
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