IGOR WITKOWSKI

# DIE WAHRHEIT ÜBER DIE WUNDERWAFFE

TEIL 1

Igor Witkowski
The truth about the miracle weapon

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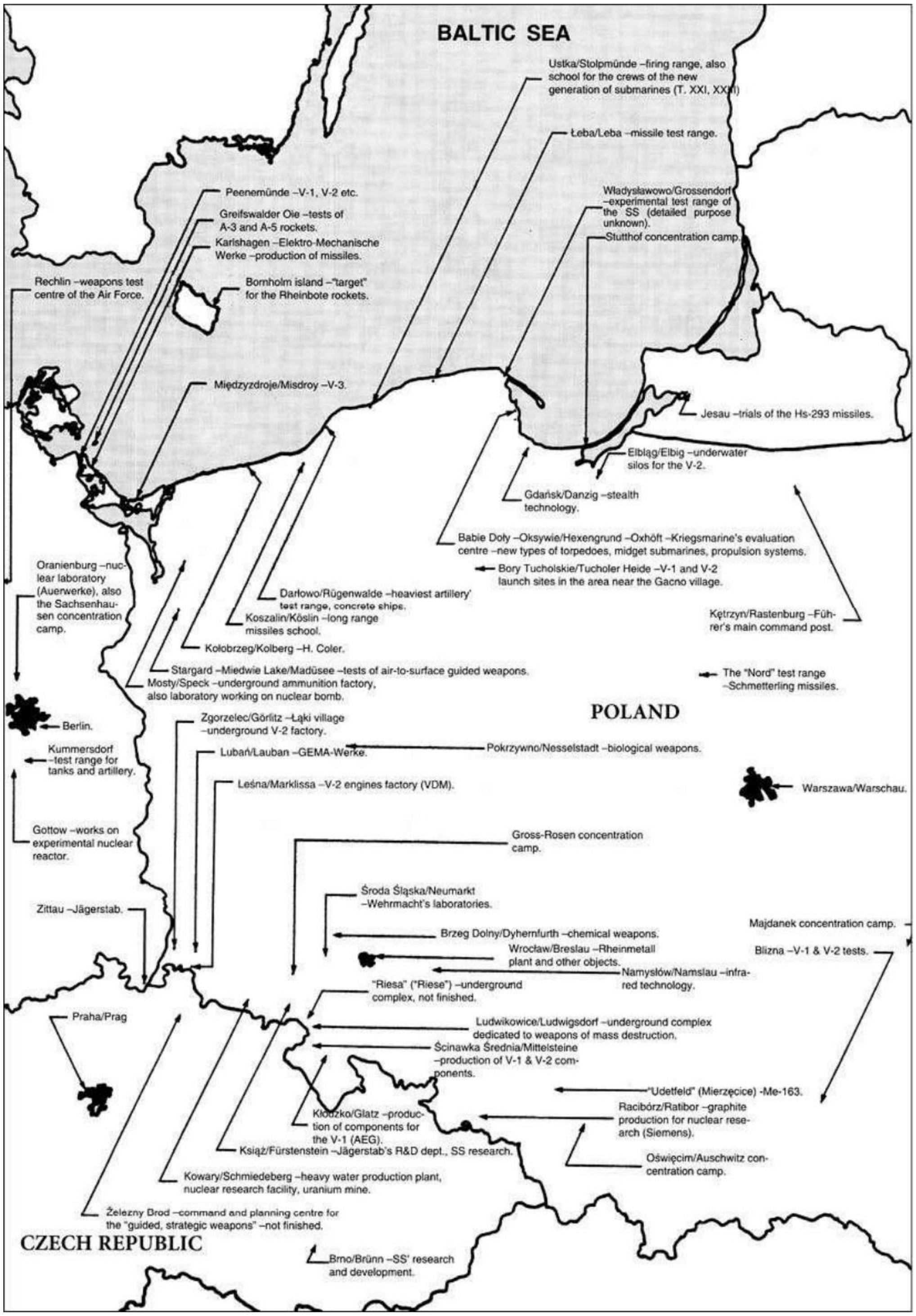
# THE TRUTH ABOUT THE MIRACLE WEAPON

## Secret weapons technology in the Third Reich

## Part 1

## Weapons turning point in military technology


BALTIC SEA
Ustka/Stolpmünde –firing range, also school for the crews of the new generation of submarines (T. XXI, XXIII)
Łeba/Leba –missile test range.
Władysławowo/Grossendorf –experimental test range of the SS (detailed purpose unknown).
Stutthof concentration camp.
Peenemünde –V-1, V-2 etc.
Greifswalder Oie –tests of A-3 and A-5 rockets.
Karlshagen –Elektro-Mechanische Werke –production of missiles.
Rechlin –weapons test centre of the Air Force.
Bornholm island –"target" for the Rheinbote rockets.
Międzyzdroje/Misdroy –V-3.
Jesau –trials of the Hs-293 missiles.
Elbląg/Elbig –underwater silos for the V-2.
Gdańsk/Danzig –stealth technology.
Babie Doły –Oksywie/Hexengrund –Oxhöft –Kriegsmarine's evaluation centre –new types of torpedoes, midget submarines, propulsion systems.
Bory Tucholskie/Tucholer Heide –V-1 and V-2 launch sites in the area near the Gacno village.
Oranienburg –nuclear laboratory (Auerwerke), also the Sachsenhausen concentration camp.
Darłowo/Rügenwalde –heaviest artillery' test range, concrete ships.
Koszalin/Köslin –long range missiles school.
Kołobrzeg/Kolberg –H. Coler.
Kętrzyn/Rastenburg –Führer's main command post.
Stargard –Miedwie Lake/Madüsee –tests of air-to-surface guided weapons.
Mosty/Speck –underground ammunition factory, also laboratory working on nuclear bomb.
The "Nord" test range –Schmetterling missiles.
POLAND
Berlin.
Zgorzelec/Görlitz –Łąki village –underground V-2 factory.
Kummersdorf –test range for tanks and artillery.
Lubań/Lauban –GEMA-Werke.
Pokrzywno/Nesselstadt –biological weapons.
Leśna/Marklissa –V-2 engines factory (VDM).
Warszawa/Warschau.
Gottow –works on experimental nuclear reactor.
Gross-Rosen concentration camp.
Środa Śląska/Neumarkt –Wehrmacht's laboratories.
Zittau –Jägerstab.
Majdanek concentration camp.
Brzeg Dolny/Dyhernfurth –chemical weapons.
Wrocław/Breslau –Rheinmetall plant and other objects.
Blizna –V-1 & V-2 tests.
Namysłów/Namslau –infrared technology.
"Riesa" ("Riese") –underground complex, not finished.
Praha/Prag
Ludwikowice/Ludwigsdorf –underground complex dedicated to weapons of mass destruction.
Ścinawka Średnia/Mittelsteine –production of V-1 & V-2 components.
"Udetfeld" (Mierzęcice) -Me-163.
Racibórz/Ratibor –graphite production for nuclear research (Siemens).
Kłodzko/Glatz –production of components for the V-1 (AEG).
Książ/Fürstenstein –Jägerstab's R&D dept., SS research.
Oświęcim/Auschwitz concentration camp.
Kowary/Schmiedeberg –heavy water production plant, nuclear research facility, uranium mine.
Železny Brod –command and planning centre for the "guided, strategic weapons" –not finished.
CZECH REPUBLIC
Brno/Brünn –SS' research and development.

# Introduction

The Third Reich's most secret and technically advanced weapons are a complex topic that forces us to consider fundamentally different things. These considerations relate to the structure of the arms industry as well as to science itself, to the barbaric plan to return to slavery, and even to the role of the SS in the overall system of the war economy. Although this book is dedicated exclusively to technical questions, it is worth being aware of these larger contexts. It is not a purely historical problem; The conclusions that arise from the considerations are timeless and could also be important for the future. When we focus on the technical issues, a predominant feature of the entire scientific and economic system becomes apparent: its incredible efficiency. This feature is often interpreted and presented as a kind of “trump card” of National Socialism. However, this is not only a fallacy, but also a convenient escape from an objective analysis of the facts.

I can in no way justify such conclusions, which can only have been arrived at through superficial considerations. While evaluating the functioning of science and economics in the Third Reich, I did not come across any arguments or circumstances that would confirm these assumptions. I have the feeling that technological progress was not brought about *by* fascism, but *in spite of* its dominance. Hitler once said: “I don’t want intellectual education.

With knowledge I spoil my youth.”

The only typical Nazi element that appeared in the system controlled by Hitler and left its mark on the organization of science and technology was the party. However, it did not promote any particular constructiveness - on the contrary: the blind terror and ignorance of the unscrupulous, incompetent rulers, who were endowed with excessive power, are incompatible with such a claim.
Not only victims of the system shared this view, but also many

Employees of the Reich Ministry for Armaments and War Production headed by Defense Minister Albert Speer. In the NARA archives I found the report of a post-war interrogation of Kurt Weissenborn, the head of the weapons department in Speer's ministry. He described the influence of the “ideological element” on the war economy as follows:

Albert Speer and Field Marshal Erhard Milch. (Photo: Federal Archives Koblenz)

„… A strange 'Mitropa' train is waiting under steam at the Potsdam train station. The third car is the restaurant. It is the *Hubertus* train , which belongs to party member Saur - the head of the technical department in the Ministry of Armaments and War Production of the Third Reich. Engineers and industrialists of all kinds, as well as civil servants from Speer's ministry, have been sitting on this train for half an hour. Then a small man with a tense, 'ascetic' face, typical of these pompous brown shirts, rushes through the barrier, followed by members of his personal staff. The train departs. It attacks the centers of the arms industry like a storm. Saur's technical staff storms through the factory workshops, with him personally at the head. He brandishes his weapon and shouts in his piercing, sometimes cracking voice. It only takes him a few minutes to fire the factory directors, replace the senior engineers and, in the presence of everyone present, appoint members of his own staff reprimand. Along the long route of his train (where he has all right of way), many more engineers and industrialists wait for hours on platforms until they are finally allowed onto the train 'for questioning', only to be released again like schoolboys shortly afterwards. As soon as the interrogations and questioning are over, the train driver receives an order by telephone to stop at the next station, and all of a sudden the released people are standing on an unfamiliar platform and watching *Hubertus'* departing train . There wasn't an hour during the day or night in which people who had previously waited hours were not 'processed' within a few minutes. No technical intelligence or intellectual excellence was allowed to speak here - only the brutal treatment of the individual spoke here. Saur introduced a caste system into the industry. But the industrial machine, extremely sensitive in other cases, repelled these attacks, trained and learned to endure Gestapo interrogations and daily contacts with the party apparatus.

If anyone tried to defend themselves, they would be mercilessly silenced and removed from their post.
If he was young enough, he found himself a soldier the next day. It was not the fear of a lack of government orders, but the fear of each individual for himself and his family that caused this obedience and made him endure even the most degrading treatment. Saur ruled his zoo in a masterful manner and regularly used brutal methods.

Karl Otto Saur

> I personally saw 60-year-old engineers burst into tears in front of everyone because, despite all their hard work day and night, they were treated like dogs. At the same time, in the vast majority of cases the problems were impossible to solve. However, it was all too easy for the incompetent, higher-level technical office to absolve itself of any responsibility by simply implicating an innocent person."

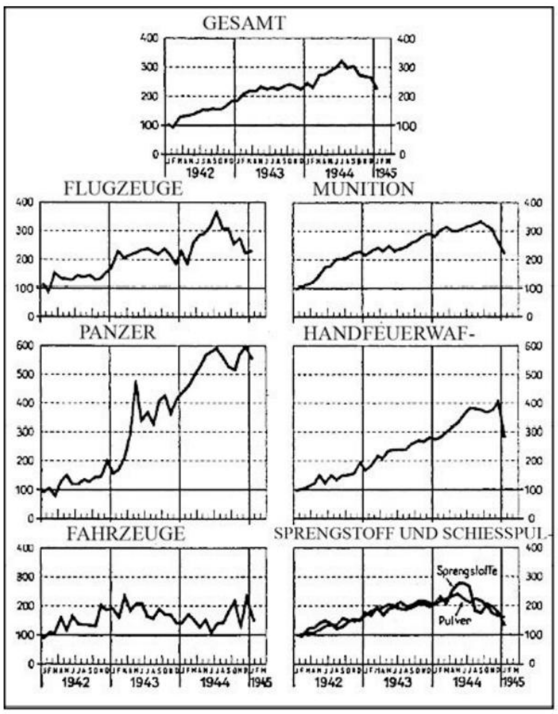
As I have already mentioned, this was the only typical Nazi element in the entire system that exerted its influence in every respect. Of course there was the SS, but the influence of this organization was of a different nature. She ensured that the economic structure had sufficient slave labor available. It was precisely this factor that was undoubtedly instrumental in ensuring that economic output rose rapidly and continuously - despite immense supply bottlenecks, an enormous shortage of strategic raw materials and the infernal destruction caused by the Allies' aerial bombardments. Overall, the economy grew three to four times, with products becoming more and more modern. The time of the crisis and at the same time the peak of production fell in the summer of 1944. The contrast between the political situation and the performance of the German economy becomes particularly clear when one considers that the carpet bombings had been falling on Germany since the spring of 1942 and despite this In 1943, almost twice as many aircraft were produced for the Luftwaffe than in the previous year. This development was repeated in the following year 1944 - the corresponding numbers are: 15,409, 24,807 and 40,593 aircraft. This contradiction was best described in the "Memoirs" of Albert Speer, the main culprit and undisputed organizational genius of this paradox:

[1]

> "Just six months after I took office, we had significantly increased production in all of the areas entrusted to us. According to the 'index figures for German armaments final production', August 1942 production increased by 27 percent for weapons and 25 percent for tanks compared to February production, while ammunition production almost doubled to 97 percent.

Total armament performance increased by 59.6 percent during this period. We had obviously mobilized reserves that had previously lain idle.

After two and a half years, despite the bombing war just beginning, we had increased our total armaments production from an average index number of 98 for 1941 to a peak of 322 in July 1944. The workforce only increased by around 30 percent. It was possible to reduce the workload by half. We had achieved exactly what Rathenau had predicted in 1917 as a rationalization effect: 'Doubling production with the same equipment and the same wage costs.'




Production in the main branches of the German war industry. (Figures from: "German industry during the war…")

Below he writes:

"The exhilaration of the first few months, in which the development of the new organization, the success and the recognition had given me, soon gave way to a time of great concern and growing difficulties. Not only

> These concerns focused on the workers' problem, unresolved material issues and court intrigues. The bombing raids by the British Air Force with their first impact on production made me temporarily forget Bormann, Sauckel and central planning.
> At the same time, however, they were one of the prerequisites for my growing prestige. Because despite the outages that occurred, we didn't produce less, but more."

The influence of the concentration camp system on the success of the war industry was significantly less than is generally assumed.
A total of nine million people passed through the camps; Apparently only a small proportion of them were exploited for industry.
Apart from that, these people usually only worked for short periods of time as the tragic living conditions led to an enormous death rate. For these reasons, the effectiveness of such workers was also low.

Nevertheless, the industry could only implement technical achievements that had already been achieved. The key question of this book is therefore not about the organization of the war machine as such.
Rather, we will be interested in various aspects that have to do with the function of science - after all, it was the origin of the most important and significant discoveries from today's perspective. And this science produced truly extraordinary things.

We must remember that this period was a period of unimaginable scientific and technological progress. In principle, the technology at the beginning of the Second World War was not very different from the state of technology at the end of the First World War. Let's take a look at aviation: Airplanes, mostly made of wooden components covered with canvas, dominated the field. Just a few years later, however, the first all-metal jet fighters appeared, equipped with radar and remotely guided weapons.
The way was also paved for the production of supersonic aircraft with an even newer generation of engines - for example with the ramjet engine for aircraft or rockets. The concept for vertical take-off and landing fighter jets was tested in practice (the *propulsion wing,* the *Wasp).* In addition, technologies for improved protection were developed

researched on enemy radar. Submarines were built that could remain under water for several weeks in a row, and a number of navigation systems (target search methods) based on semiconductor detectors appeared. The material in Part 2 of this book proves that even a further step forward was taken. Similar developments also took ...

place with armed vehicles.

The beginnings of the war took place under the banner of tanks, which were used to support the infantry and were armed more symbolically. Their armor was so poor that a rifle with armor-piercing ammunition could penetrate them. Horses still formed the core of most armies. Already at the end of the war it was just a question of production capacity to put a tank into operation that could be used day and night, had a cannon, was powered by gasoline, had a hydraulic steering and drive system and had defenses against chemical and chemical attack equipped with biological weapons

...

Prisoners of a concentration camp in an underground factory. (Photo: Imperial War Museum)

The situation was similar in most other areas.

Not only was the technological progress greater than that seen between the 1920s and 1930s, it was also greater than anything that had occurred in the 50 years from the end of World War II to the present day! Virtually all modern trends in weapons development were initiated precisely during this time. It seems as if this was the greatest technological leap in the history of our civilization -

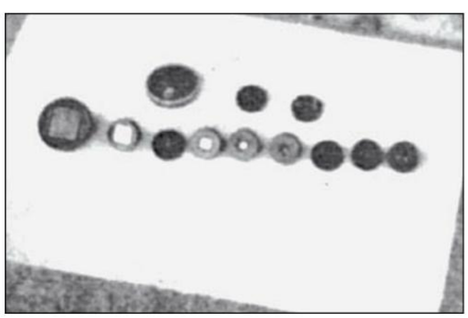
undeniably a topic that deserves a closer look. The importance of these achievements is evidenced by the enormous volume of German scientific and technical ideas that were adopted by the USA and the USSR after the war (almost 340,000 patents). Around the end of 2001, I had the opportunity to be one of the first independent researchers to extensively analyze historical documents from the US National Air Intelligence Center at Wright Patterson Air Force Base. Immediately after the war, the headquarters of the technical intelligence service was located there. It was clear from conversations with some senior employees at the base that after the end of the war - when various German prototypes and plans were examined and tested - a period of "technological gold rush" began in the USA. In the air base documents I came across a comment from General Hugh Knerr, commander of US forces in Europe in 1945:

[2]

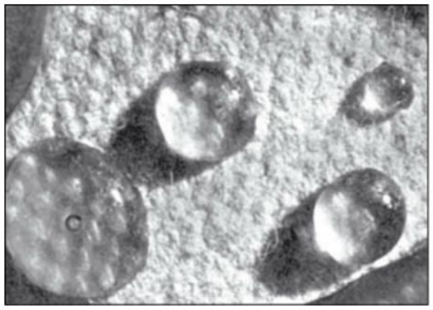
"The takeover of German scientific and industrial institutions has shown that we are alarmingly behind in many research areas. If we do not seize this opportunity and take advantage of the devices and their inventors, we will be left behind for many years while doing work that has long been accomplished."

Subsequently, American President Eisenhower declared that

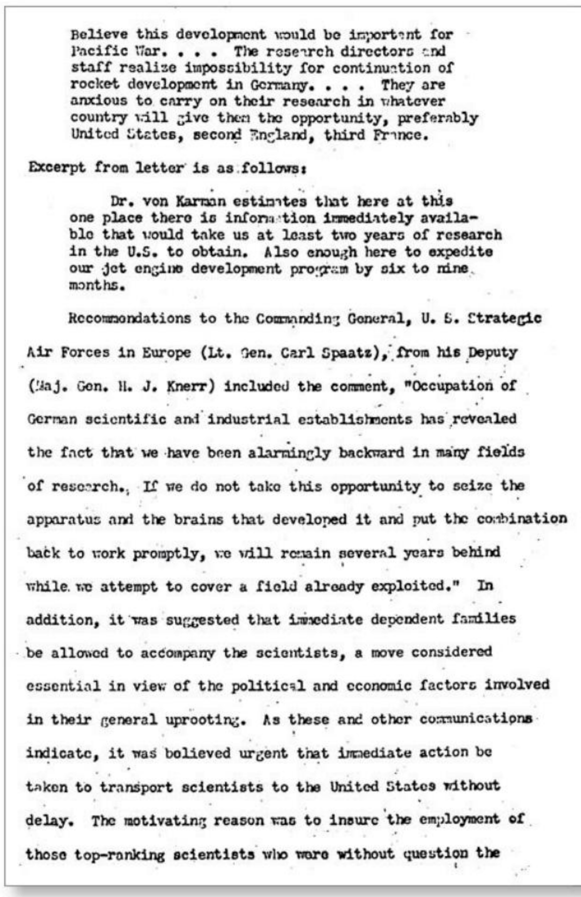
„… German technology was a good ten years ahead of the Allies. Fortunately, the German commanders took advantage of this Superiority and only realized too late what opportunities this would have offered them."



German infrared semiconductor detectors manufactured during the war. (Photo: CIOS)



Synthetic fibers in the water permeability test. (Photo: IG Farben)



Believe this development would be important for Pacific War. . . . The research directors and staff realize impossibility for continuation of rocket development in Germany. . . . They are anxious to carry on their research in whatever country will give them the opportunity, preferably United States, second England, third France.

Excerpt from letter is as follows:

Dr. von Karman estimates that here at this one place there is information immediately available that would take us at least two years of research in the U.S. to obtain. Also enough here to expedite our jet engine development program by six to nine months.

Recommendations to the Commanding General, U. S. Strategic Air Forces in Europe (Lt. Gen. Carl Spaatz), from his Deputy (Maj. Gen. H. J. Knerr) included the comment, "Occupation of German scientific and industrial establishments has revealed the fact that we have been alarmingly backward in many fields of research. If we do not take this opportunity to seize the apparatus and the brains that developed it and put the combination back to work promptly, we will remain several years behind while we attempt to cover a field already exploited." In addition, it was suggested that immediate dependent families be allowed to accompany the scientists, a move considered essential in view of the political and economic factors involved in their general uprooting. As these and other communications indicate, it was believed urgent that immediate action be taken to transport scientists to the United States without delay. The motivating reason was to insure the employment of those top-ranking scientists who were without question the

A document from the archives of the US National Air Intelligence Center at Wright Patterson Air Force Base.

This topic also provides us with a number of valuable insights for the future Conclusions if we look at it from the perspective of development theory: Why did this process happen so quickly - or to put it another way: Why was it relatively slow after the war?

The simple answer is: it leads to nothing, everything with that

to justify the existence of total war. After all, there were dozens of other countries involved in the war that did not experience such a development, and besides, there have been many wars in history.
Let's remember that in a period of about five years, several generations of technological progress have been achieved in devices.

Today, the average development time for a new tank or aircraft is 15 years.

I must admit that I have never come across a comprehensive analysis of this phenomenon. Therefore, I will present my own opinion on the reasons for the rapid progress.

Of course, there were various reasons for this, and the strong pressure from state institutions was undoubtedly one of the most important. In the Third Reich, however, an additional factor was at the forefront. Research and development work has proven to be quite profitable for both small businesses and large companies.

A German electron microscope from the 1930s that, among other things, enabled genetic research by observing changes in chromosomes. Thanks to this research, a cancer prevention program was launched that was around 30 years ahead of other countries. For example, even before the war there were strict standards for the maximum permissible concentration of carcinogenic substances in the workplace. (Photo: AEG)

Karl Otto Saur, who was responsible for organizing the

Industrial production, explained during an interrogation on August 9, 1945 that the fixed price system imposed by those in power significantly reduced the cost advantages of mass production.
In his opinion, "the

> consortia earned money not by the quantity [of goods produced], but by the constant development of new and complex types [of weapons]."

In this case, profits were not so strictly limited because there was no way to determine the exact cost of labor.
A crucial but rarely mentioned driver of technological progress in the Third Reich was also the need to rationalize technical processes caused by labor and raw material shortages. For example, to a greater extent than anywhere else, machine cutting was replaced by plastics processing (molding, pressing, pressure welding, and the like), which required significantly less material and energy. This led to breakthroughs such as the introduction of the MP-43 automatic carbine, which was manufactured almost entirely using plastic technology, and the reduction of vacuum tubes to the size of a thimble.

In addition, the production of plastics was promoted. But these are not the most important reasons either. Two other rarely mentioned factors played an important role: 1. It is

worth thinking about how progress itself comes about.

> I am certainly not alone in the opinion that it can be defined as a projection of a culture - by that I of course do not mean the way cutlery is placed on the table, but rather a structure of thought created by a civilization. In this case, Europe's most valuable achievement over the last few centuries comes into play, namely the tradition of intellectual criticism and its main manifestation: the relativism of ideas. From a moral perspective, this is often viewed negatively (and ultimately the technological achievements of the Third Reich have at least a questionable moral dimension, even if one has to ask oneself whether pure scientific and technological progress can even be evaluated from a moral standpoint). The

However, relativism of ideas is a necessary condition for progress. Without it, a culture tends to stall. However, this alone was not enough, but only represented the starting point for a certain process that requires another factor:

2. When analyzing Germany's performance during the war, what is surprising is the rather unusual way in which science was controlled and harnessed for the arms industry. Research was carried out in many different directions at the same time, and this meant that "pre-selection" by academic science was handled much less rigorously than it is today. Research and science were not controlled by professors, at least not to the extent that they had complete control over science. The academic exclusion of new ideas was abolished or at least severely restricted. Otherwise the V2 rocket probably wouldn't have been built.

   Originally, the British Intelligence Service, based on the opinions of various professors, considered it impossible to build such a large liquid-propellant rocket. The first fragments of the rocket fell into the hands of the Polish Home Army (the AK, the largest military resistance organization in occupied Poland), where they caused a lot of excitement. Today, these achievements do not seem particularly extraordinary to us; At that time, however, the invention of the delta wing represented an important psychological breakthrough. Let us realize how long the decisive advantage of armored forces was overlooked in most armies until the turn of the 1930s and 1940s. Tanks wasted their potential by being used only to support infantry (France had more tanks than attacking Germany).

   The same applies to the dive bomber concept, and countless other examples could be found.

The more unusual an idea, the greater and more irrational the resistance to putting it into action. Einstein probably would never have been able to convince Roosevelt to build the atomic bomb if there had been no information about such efforts in Germany. As late as 1923 Robert Millikan concluded, general recognized authority and Nobel Prize winner, categorically ruled out any possibility that an atomic nucleus could ever be split. Following the same principle, the outstanding American astronomer FR Mouton denied the possibility of manned space flight in 1932.

Anyone who has ever spoken to professors knows that resistance to new ideas is very high. The main criterion is whether these ideas can be explained with existing knowledge. Science does not concern itself with what it does not know, and especially not with what it does not understand. This is the biggest obstacle to development today. As a result, research into phenomena such as “separation of magnetic fields,” described in Part 2, is currently almost impossible. It's just something completely new.

The prevailing rule in these things is that we only ever see those things in the world that have already been laid out in our heads. Or to put it another way: If the idea doesn't already exist in our heads, our eyes miss the facts. According to popular belief, breakthroughs happen suddenly, almost as an immediate realization. In reality, however, this is never the case. Information about a certain aspect of reality is always there, but it is not always perceived. From here it is only a small step to adapt reality to existing theories.

The realignment of science that the Third Reich was forced to undertake not only entailed an optimization of the existing structures, but also developments that must simply be described as revolutionary. Without such a realignment, we will continue to spin in a magic circle today, no matter how much money we have at our disposal. Apparently, such developments can only take place under certain conditions, at a certain level of social consciousness. We need something that goes against our current mass culture (which tends to suppress real information) – we need that tradition of intellectual criticism, the “positive relativism of ideas”. And although it may seem like this, such an attitude of mind does not require war, and certainly no National Socialism either!

# The concept of revenge weapons

Contrary to expectations, the weapons that are hidden behind the title of this chapter are not just the V1, V2 and V3. The concept of a retaliatory weapon has evolved over time and also includes a number of projects that can be described as “second generation of retaliatory weapons”. What distinguished them?

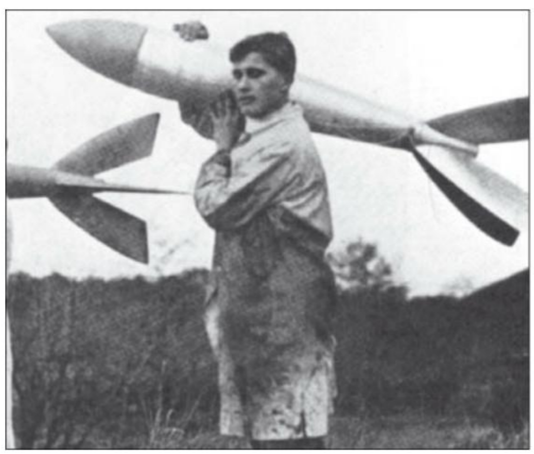
This question can of course be easily answered by referring to the German classification - and only looking at the “V” series projects. However, the question is not so easy to answer, as there have already been a number of further developments that were not listed under this classification, even if they have many similarities with the V1 and V2. We must therefore agree on a regulation that distinguishes “retaliatory” weapons from “conventional” weapons. It appears that the retaliatory weapons were designed primarily as long-range weapons, intended to attack enemy civilian populations rather than military targets. Of course, such a demarcation can never be completely clear, and this also applies more or less to many of the weapons described in the following chapters, but especially to strategic post-war missiles.

For this reason, this program should be seen as a historic achievement. At the beginning we want to look at where the concept of “retaliation” and “deterrence”, which was so important for the post-war period, came from. This may surprise some readers, but the originator of these concepts was Hitler, although the meaning, possible goals and principles for the use of retaliatory weapons were not initially clearly defined. The main reason for the Führer's interest in them was simply their modernity. The army needed a boost with the latest technology, which would make up for its numerical inferiority with its qualitative superiority and, through its radically new operational possibilities, would have the direction of the shifting borders on the map of Europe can turn back. In short, they were purely military reasons, motivated by new operational possibilities.

Over time, as the hard technical facts came into play in the development of retaliatory weapons, a second predominant aspect emerged: the terror factor. This aspect can largely be attributed to the specific perspectives and characteristics of Hitler's character, who often favored offensive actions rather than simple military strategies and tended to favor the psychological effects of a weapon rather than considering purely military and rational effects. This can be seen in the course of numerous operations. The man who perhaps knew Hitler best was Albert Speer. After the war he wrote: “... even as a leader he considered primarily [1]

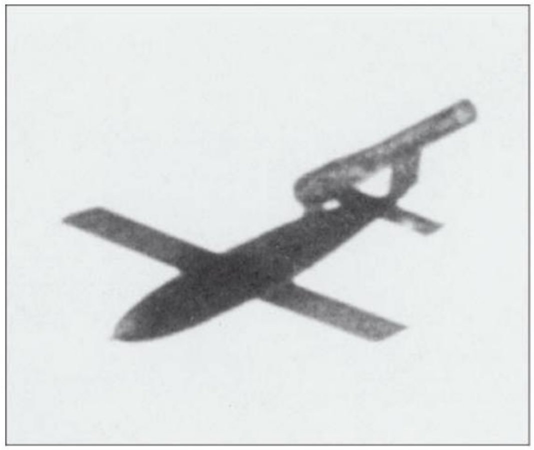
the psychological effect, rather than the military effect, of a weapon.

An example of this was his idea to attach sirens to the bombs dropped by the Stukas, whose demoralizing effect was more important to him than the explosive power of the bombs[1] themselves.



Wernher von Braun in the early 1930s. Who would have guessed back then that his rockets would one day take people to the moon? (unknown photographer)

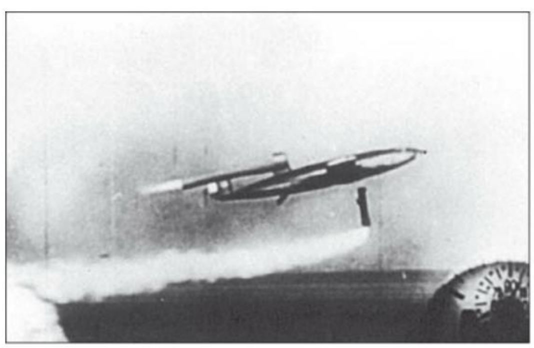
The issue of retaliatory weapons took on a more realistic shape as the Germans threatened to lose the battle for Britain. Regardless of the psychological factors already present, a weapon was required that could take over the task of the Luftwaffe bombers to carry out air strikes at long distances. All of this was to happen without air superiority and completely without the cover of our own fighter pilots to be possible. Hitler insisted on sustained and grueling attacks, which would become a psychosis of permanent, inescapable and unpredictable danger for the enemy.



The V1 in flight. (Photo: Federal Archives)

He originally wanted to realize this concept with the help of a new bomber. That would have been at least a very peculiar form of air warfare: The flight engineer Ernst Heinkel believed that for this strategy to be successful, only 40 to 50 aircraft were necessary, which could fly at a speed of 750 - 800 km/h at an altitude of 14,000 meters, out of reach of the Allies would have been fighter pilots.

In any case, this became possible relatively quickly - with the introduction of jet bombers towards the end of the war.



V1 launch from a catapult. (Photo: Federal Archives)

To achieve the greatest possible “intimidation,” they would have had to fly by day and night (Hitler was downright enthusiastic about this idea that millions of people would jump out of their beds just because of a few bombers); However, each bomber was only supposed to drop a single large bomb. As incredible as this may sound, Hitler sincerely believed that his troops could reverse the course of the war using this minimal but modern "terror effect." It is strange that this belief lasted for so long, even though the Allied air raids, which fell on German cities on an incomparably larger scale, could not break the German will to fight.

The first weapon in the retaliatory weapons repertoire is of course the V1, although work on the V2 took a considerably longer development period.

## The V1

The inventor of the concept of the "winged remote bomb" – or as we would say today, the first cruise missile – was Dr. Fritz Gosslau, test engineer at Fieseler-Werke. The idea itself came about shortly before the outbreak of war. Right from the start it was rejected by the Luftwaffe, but Gosslau nevertheless decided to continue research with the aim of constructing a prototype towards the end of 1941.

To power the bomb, he wanted to use a simple and inexpensive engine, such as the deflagration jet engine that his company had developed in 1939 on behalf of the Aviation Ministry. Despite the high fuel consumption of this drive, its simple design and the absence of scarce materials were decisive advantages under wartime conditions. The drive was built without a rotor, i.e. without a compressor and turbine. It was based on the principle of the piston engine with a compression, combustion and exhaust cycle, only this worked in a completely different way. The combustion chamber consisted of a steel pipe with a diameter of around 0.5 meters, had an opening on one side and an air inlet with a valve system on the other side.
In order for the engine to work, a certain initial speed was necessary, and it worked in the following way: the air pressure at the front opened the spring-mounted ones

valve intake seals, and the combustion chamber filled with the fuel. This was followed by ignition, which caused a sudden increase in pressure in the pipe, which closed the valve suction seals again. The exhaust gases escaped under the force of their own pressure, giving a recoil. The great length of the pipe and the inertia of the gasoline created a negative pressure in the combustion chamber; the intake valves opened and the whole cycle started again. The spark plug was only used to start the engine. The cycle then repeated automatically until either the fuel was used up or the supply was interrupted. In the Argus As-109 engine, this cycle repeated 40 to 45 times per second, producing a noise similar to that of a running piston engine. On the other hand, due to the strong vibrations, this placed considerable strain on the structure. Based on this engine, Gosslau developed his “flying bomb” with a one-ton warhead. The fuselage and wings were made of steel with wooden elements (especially the wings).

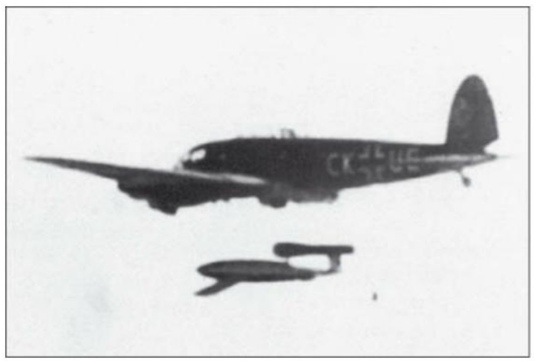
The metal cladding consisted of a thin layer of steel, less than three millimeters thick. In contrast to the V2, the construction of the V1 and especially its drive was extremely inexpensive and simple. The first draft was submitted for assessment to the technical department of the Aviation Ministry under the working title “Fieseler Fi-103” on June 5, 1942.
The constantly deteriorating military situation and mainly the defeat in the Battle of Britain changed the military's previous attitude towards this type of weapon. Hitler demanded retaliatory weapons that could be produced and used in large quantities. That same month, Project Fi-103 was given top priority.
At the same time, the rocket was given the military “code name” *Flakzielgeräte 76* (FZG 76). Marshal Milch had great hope in the project for which he was responsible on behalf of the Luftwaffe. The previously serious disadvantage of limited accuracy, which was decidedly too low with regard to “normal” targets, became less important as the military situation changed. The technical demands and the specificity of the expected military deployment fit Hitler's characteristic view: limited resources - and great psychological impact.

With the further development of the Fi-103, the testing site became the

Luftwaffe in Karlshagen near Peenemünde, where Major Otto Stams was appointed commanding officer in August 1942. A launch facility for the rockets was set up at a local airport.

In order to meet military requirements, many components had to be overhauled or developed from scratch. This work was integrated into a larger program called *Vulkan ,* which developed long-range missiles for the Air Force. In addition to improving the engine and airframe, the gyroscopic autopilot and launch device were completely redesigned. For this purpose, specialists from Askania (Autopilot) and Rheinmetall-Borsig AG were hired. The Germans managed very quickly to complete the first prototype for in-flight testing by September 1, 1942, although the engine had not yet been fully tested and caused numerous problems, especially at high speeds.

On May 26, 1943, a conference of the “Research Council for Long-Range Rockets” was organized in Peenemünde, attended by generals from the air and ground forces, including Milch, Keitel, Olbricht and Fromm as well as Admiral Karl Dönitz as a representative of the Navy and Albert Speer, the Reich Minister for Armament and ammunition. The aim of the conference was to evaluate the two previously “rival” retaliatory weapons, the Fi-103 and the A4. After a long discussion, it was agreed with the head of the German missile weapons program, Dornberger, that both types of weapons had their advantages and disadvantages, which were not mutually exclusive but rather should be viewed as complementary. In this context, both projects received top priority. This was a great success for the Luftwaffe, as the two attempts with the Fi-103, in contrast to the A4, had failed embarrassingly in front of the council members' eyes: one rocket crashed shortly after take-off, the other failed to take off at all. It was obvious that the “flying bomb” needed further improvements and many months of research. In the meantime, the means and options for building launch pads suitable for war were investigated. It was not yet clear whether solid concrete structures that would be well protected against air raids should be used, or whether simple, but more numerous, field ramps that were easy to erect should be preferred. In June 1943 it was finally decided as a compromise to have four fortified concrete launch pads and to build 96 field ramps off the coast of the English Channel. The formation of the first combat units had begun. Meanwhile, there was no indication that the technical problems with the rocket could be resolved quickly. Of the 68 rockets fired during the first two months after the Peenemünde Conference, only 28 completed a flight classified as successful (41%). Many of the rockets crashed shortly after launch for unknown reasons. The Germans still had not managed to check some of the targeting systems, including the important navigation system.



Test drop of the V1 from a He-111 bomber. (Photo: Military Archives)

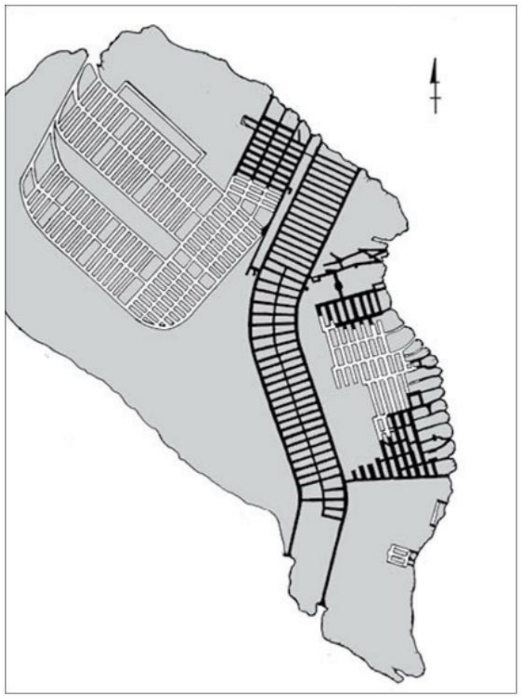
The desired timetable for the attack on London on December 15, 1943 therefore seemed completely untenable. The production plans looked similarly unrealistic: they planned to deliver 100 rockets in August 1943, 500 in September, 1,000 in October, 1,500 in November and later gradually 2,000 to 5,000 per month to the Luftwaffe.
At the same time, the impacts of the tested rockets were so far apart that no reasonable guarantee could be given of a direct hit on London. On September 10, Marshal Milch said:

> “I will be satisfied if the Fi-103 will work at all so that we can use it in combat.” This contradicted his extremely

optimistic expectations about its military effectiveness. He speculated that London would not be able to withstand a mass attack for longer than two to three days - a completely illogical assumption, since German cities had often functioned under heavy attacks that were at least equally powerful.

The Volkswagen factory in Fallersleben was the first factory that was supposed to produce the Fi-103. But it soon became necessary to re-examine the research, testing and production plans for the V1 as well as the problem of countering enemy espionage. In order to eliminate enemy espionage, foreign workers were not used.

As a result of the construction defects on the Fi-103, production in Fallersleben was stopped in November.

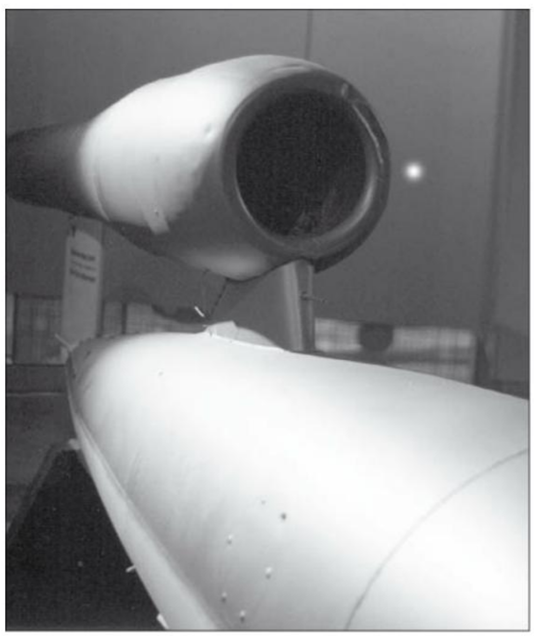


Map with the system of the underground factory complex under the Kohnstein. The tunnels that were actually built are highlighted in black, the planned ones in white. (I. Witkowski)

Later, the underground facility “Mittelwerk” near Nordhausen in the Harz Mountains was chosen for the production of the V1 and V2. In this context, the newly created company Mittelwerk GmbH took over the factory. Two parallel tunnels were drilled through the Kohnstein, the main supply tracts of which were 10 m wide and 7.5 m high. Between the main tunnels there were 50 transverse production halls for the individual construction phases, each with a length of 140 m. When the factory was taken over by Mittelwerk, its volume was 875,000 $m^3$ and the area of the tunnels and tunnels was 125,000 $m^2$. The workers were prisoners of the concentration camp

Nordhausen, mostly Poles, French and Russians. The assembly of the "V rockets" and the production of various components also took place in other underground facilities, including the production facilities of Askania Werke AG near Helmstedt (responsible for the control system) or the underground factories of the AEG consortium near Hadmersleben and Hersbruck, in in which electronic components were produced.

The beginning of 1944 brought another "change" in Hitler's plans – to the advantage of the V1. The technical design deficiencies could only be remedied through intensive research. From now on, the rockets were tested in large numbers and no longer exclusively on the Baltic Sea, e.g. B. at the Udetfeld airfield in Upper Silesia and in mid-March also in the area around Blizne in occupied Poland, from where only the V2 had previously been launched. "Flying bombs" were also launched in the region between Lublin and Chelm in Poland. One of the German reports reads:



The V1, close-up of the air intake opening. (Photo: I. Witkowski)

"In one incident, people and animals were killed directly by the explosion. In addition, houses and other buildings burned down. As a result of the 12th launch, the village

Adampol partially reduced to rubble and ashes."

The V1 at the National Air and Space Museum in Washington. (Photo: I. Witkowski)

Eventually the Germans managed to reduce the dispersion of impacts to an acceptable level. Between August 18th and August 26th
In November 1944, almost 260 rockets were launched, of which only 17% hit the target area 225 km away (diameter: 30 km) or the target area 100 km away (diameter: 15 km). However, in October the rate reached 32%, which increased to 46% by November. Production in the Mittelwerk factories in Nordhausen was now fully underway.

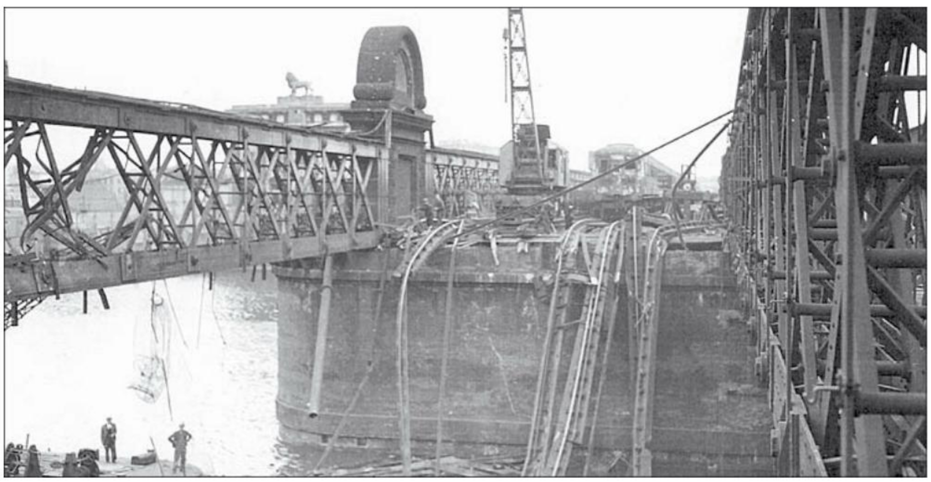
A crashed V1 rocket found by American soldiers in France. (Photo: US Army)

In connection with the invasion of Normandy the order was issued ordered the attacks to begin “as quickly as possible” on June 12th, a deadline that could not be met. The combat units were still not adequately prepared and there were problems with supplies due to the opening of a new front and the bombing of many railway junctions. The Germans never managed to deliver concentrated perhydrol in time to power the launchers. As a result, only ten rockets were fired towards London that day, of which only four reached England; five crashed immediately after takeoff.

Remains of the V1 in one of the halls of the Mittelwerk. (Photo: I. Witkowski)

Finally, it was decided to repeat the start of the operation three days later, just before midnight. 55 launch pads opened fire, which continued until the afternoon of the following day (June 16, 1944).
During those 24 hours, nearly 100 V1 rockets were launched, rising to 500 by June 18. Depending on the location of the launch pad and other factors, the flight time to London was approximately 25 minutes.
After ten days of attacks, the English had already registered 370 direct hits on London. On June 28, a V1 hit the Air Force Ministry building, killing 198 people. A short time later, the number of victims and destroyed and damaged buildings numbered in the thousands. The output of London's war factories fell by around a sixth. 3,4,5

All in all, the Germans managed to launch 6,046 rockets by the end of the year, of which 1,681 (27.8%) crashed, 795 of them in the immediate vicinity of the launch pad. The greatest intensity of operations was recorded in the initial phase: 1,000 V1 rockets left the launch pads during the first few days of the operation until June 21st. In the following and final year of the war, 1,279 rockets were launched, of which 986 reached Britain. The significant number of failed flights revealed the hectic nature of the production, preparation and deployment of this innovative weapon. It is evidence of the technical deficiencies and deficits that could have been eliminated if time had not been so pressing. A relatively large percentage of “losses” were due to poor maintenance of the catapults despite their simple design. By August 6th, within the first two months of the operation, 34 rockets exploded during launch.



Hungerford Bridge in London after being hit by a V1 rocket. (Photo: US Army)

After a short time it was decided to look for the causes of the failure. The 245 rockets that had crashed as of July 24 were categorized based on the cause of their crash. Most crashes, 70 (28.6%), were caused by errors in airframe design, 62 (25.3%) by incorrect catapult operation, 40 (16.3%) by engine problems, 34 (13.9%) ) due to malfunctions in the navigation and control systems (missiles "circling" in the air around the launch pads occurred), and five (2.0%) were due to errors by maintenance personnel. The cause of 34 incidents could not be determined.

During the final months of the war, the Germans could no longer direct their retaliatory weapon 1 against Great Britain, instead they now set their sights on Belgium.

Finally, the actual impact of the missile after a year of combat use should be summarized. In total, all ground ramps fired 20,880 missiles; According to available records, only 18,435 actually hit their target. The following numbers reflect the hits on individual cities: 7,796 hits on London, 44 on Southampton, 7,687 on Antwerp, 2,775 on Liege and 133 on Brussels. In addition, around 1,600 V1 rockets were dropped by KG-3 and KG-53 bomber squadrons in the direction of London, Southampton, Gloucester and Manchester.

### Technical details of the V1 (Fi-103 A1)

| | |
|---|---|
| Takeoff weight: 2,152 | kg |
| Warhead mass: 830 kg | |
| Length: 8.35 m Range: | |
| | 240 km |
| Engine length: 3.66 m | |
| Hull diameter: 0.84 m | |

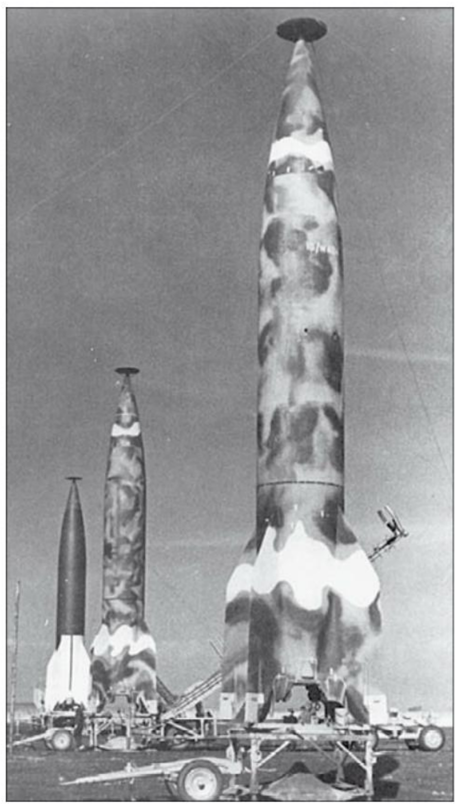
# Die V2

From a purely technical standpoint, the V2 rocket was a much more interesting design. Although it represented the pinnacle of technology at the time, it was essentially a very advanced development of the amateur rockets of the early 1930s. 3 Rudolph Nebel, Klaus Riedel and a group of

rocketry enthusiasts built the first experimental rocket in 1930 called *Mirak* – an abbreviation of the word “minimum rocket”. In this group was the 18-year-old Baron Wernher von Braun, who was completely unknown at the time. For the test flights, these enthusiasts rented an old Reichswehr firing range in Reinickendorf on the outskirts of Berlin. It was September 1930.

At the end of 1938, the Wehrmacht staff specified the first requirements for the not yet designed A4, which also became known as the V2. It was expected to be operational by the end of 1942. To this end, plans were made to expand a research base, the location of which had already been finally selected in April 1936: Peenemünde. General Becker (who represented the Army Weapons Office) and General Kesselring (from the Luftwaffe) signed an agreement about the joint construction and use of a large research center on the island of Usedom. 20 million marks were earmarked for this goal, and just one year later the rocket experts moved to Peenemünde. Your options were now incomparably greater. First and foremost, the Germans concentrated their efforts on building a supersonic wind tunnel, which was still missing. With the previous one, only relatively small models could be examined: It had a cross section of 10 x 10 cm. However, a second one was soon built with a cross-section of 40 x 40 cm, in which flow speeds of up to five Mach could be achieved.

The number of employees in this complex rose continuously from 50 initially to 15,000 people in 1943.



V2 rockets with military camouflage paint, placed on mobile launch pads. (Photo: National Air and Space Museum, Washington)

The progress made in the rocket tests carried out in Peenemünde slowly convinced the military of the military importance of rockets and the huge development potential of this new weapon of war.

In the foreseeable future, they could leave behind not only the Paris gun from the First World War, but even any other modern means of transport (including airplanes). The arms race, set in motion by the Germans' intensive preparations for war, enabled the scientists in Peenemünde to realize their boldest projects.

In November 1938, General von Brauchitsch ordered preparations for serial production of the A4 rockets to begin so that this phase could be reached immediately after the trials were completed. A special group from the research and development department of the Army Weapons Office was commissioned to supervise this work and was headed by Colonel Dornberger.

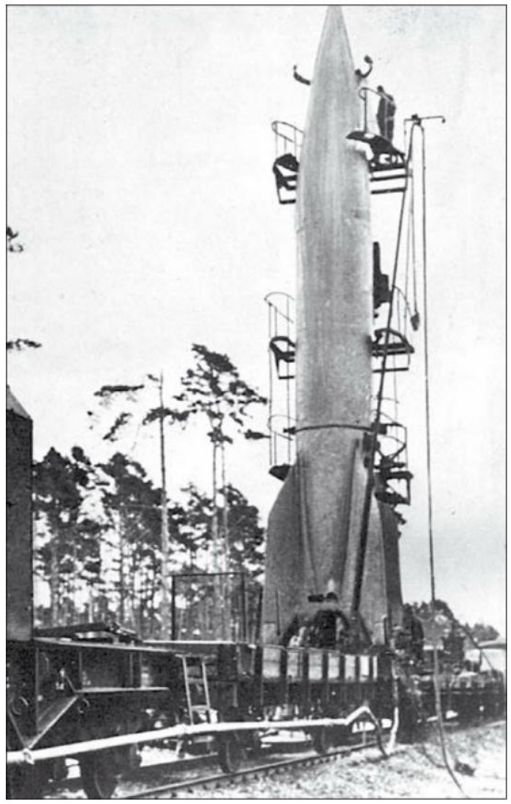
The development of a final engine for the A4 rocket, which was extremely modern at the time, was in its final phase at this point. It was the achievement of Dr. Walter Thiel, engineer Pöhlmann and many of their employees. As a result, an engine was developed with a thrust of 25 tons, but very small dimensions (the length of the combustion chamber was only 30 cm) and very high efficiency (approx. 95%). This engine completed its first tests on the test bench in the spring of 1939. A key stage on the way to constructing prototypes of the later V2 had now been reached.

As it turns out, Wernher von Braun, known as the “Father of the V2,” had almost nothing to do with the development of the engines for the “A” rockets. The true originator of the “heart” of the rocket was the forgotten genius of German rocketry, Dr. Walter Thiel, who also became famous for developing a powerful engine with a thrust of 200 tons for the A9/A10 assembly.

Thiel himself died during an RAF air raid on Peenemünde on the night of August 17th to 18th, 1943. It was probably the Germans' greatest loss of the night; The research and production buildings were not particularly damaged (although many forced laborers died, including Poles).

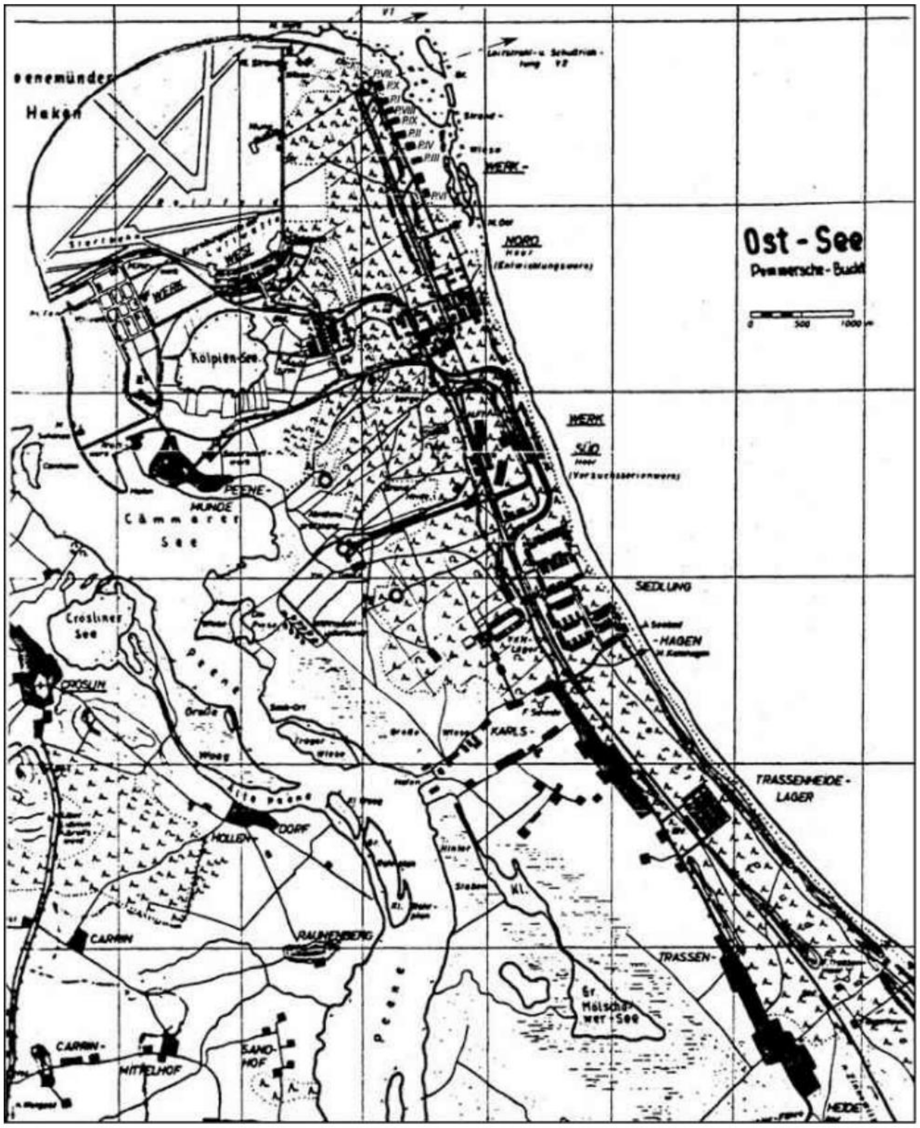
Research into liquid fuel engines, using oxygen as an oxidizer, was initiated before the war. The first success was the development of an engine with a single injector and a thrust of one ton. The injector was here at the same time

Pre-combustion chamber for the fuel and the oxidizer.



Preparations for the launch of a V2 rocket from a railway launch pad (Photo: military archive)

This system became the basis of the V2 engine. During the entire development history, the key element, the injector, was hardly changed; only their number and the size of the combustion chamber and the nozzle were increased. First, an engine with three injectors and a thrust of four tons was built, and finally the final version of the engine for the V2 with 18 such injectors.




An original German map of the facility near Peenemünde.

The enlargements of the rocket also raised the problem of sufficient cooling, because the larger the engine, the higher the heat produced. In practice, several kilograms of fuel and oxidizer per second flowed into the rocket's engine during the first five to seven seconds; initially only by their own weight. This was the “warm-up phase” of the engine. After the pump started, 60 kg of fuel (alcohol) and 75 kg of oxygen reacted with each other within one second. Paradoxically, solving the heat problem also required a lot of fuel, as it was best used as a coolant for the nozzle. This also proved to be the case for future ones

Space rockets as a reliable method. 6.7 The rocket's nozzle consisted of two layers, between which the alcohol fuel flowed.

In this way, the requirements for the inner wall of the nozzle in terms of mechanics, service life and heat resistance were significantly reduced, because it only had to withstand the pressure difference - between the pressure of the fuel and the pressure in the combustion chamber. Thus, a number of serious problems were avoided and the rocket could be made “only” from mild steel.

At almost the same time, people were also working on rockets in the USA. However, the scientist Robert Goddard did not find an appropriate solution, so the rockets usually burned out completely after just five seconds! However, the soft metal of the V2 engine worked extremely well, apart from temperatures of up to 3,000 °C in the combustion chamber, which fell to around 1,650 °C in the nozzle opening. However, tests showed that the efficient cooling meant that the temperatures on the inner wall of the nozzle did not exceed 950 °C.

Another factor was crucial to the fact that the previously mentioned engine was highly valued after the war - namely its low weight, which only made up eight percent of the take-off weight. In comparison, the weight of the seemingly simple V1 engine was 24%. Thanks to this, fuel took up up to 69% of the V2's weight, which remained an unbeatable value for a long time.

When discussing engine characteristics, it should be mentioned that research in this area in Germany was two-pronged.

Independent of the work on the V2, Dr. Walter conducted his own research. His famous engine for the Messerschmitt Me-163 had many similarities to the V2 engine, but ran on a different fuel.

The next A pioneering achievement “Thrust to vectoring” control system developed for the V2 that allowed the nozzle exhaust jet to be deflected. This meant that stability could be achieved even at very low flight speeds, for example shortly after takeoff. This meant that the rocket could be launched vertically from a small and simple launch pad. The lack of a large, stationary launch pad was one of the most important advantages of the V2 over the V1. Such a ramp would have had to be large enough to make it easy to manufacture such a rocket would no longer have been worth it. The four hydraulic thrusters were made of heat-resistant graphite and were mounted immediately behind the nozzle opening. Using a simple chain transmission, they were connected to the aerodynamic air rudders at the tail.

[7]

Along with the development of the first large rockets, most notably the V2, a whole series of groundbreaking research programs were launched. They laid the foundation for the future development of rocket technology, on the basis of which the nuclear missile race continued for several decades after the war. The V2 was one of the first rockets to be equipped with an inertial navigation system and controlled by an electromechanical flight sequence system. This principle was later used in all ballistic missiles with nuclear warheads. Among other things, the flight sequence programming device did not allow the warhead to explode directly on the ramp or near it, for example after a possible engine failure, which was quite common in the beginning. The warhead was only armed in flight after the program was completed. If a rocket crashed onto the launch platform and was loaded with explosives, the warhead would still end up exploding due to the burning fuel and the very high temperatures. The personnel then had about 20 minutes to evacuate and escape with their lives.

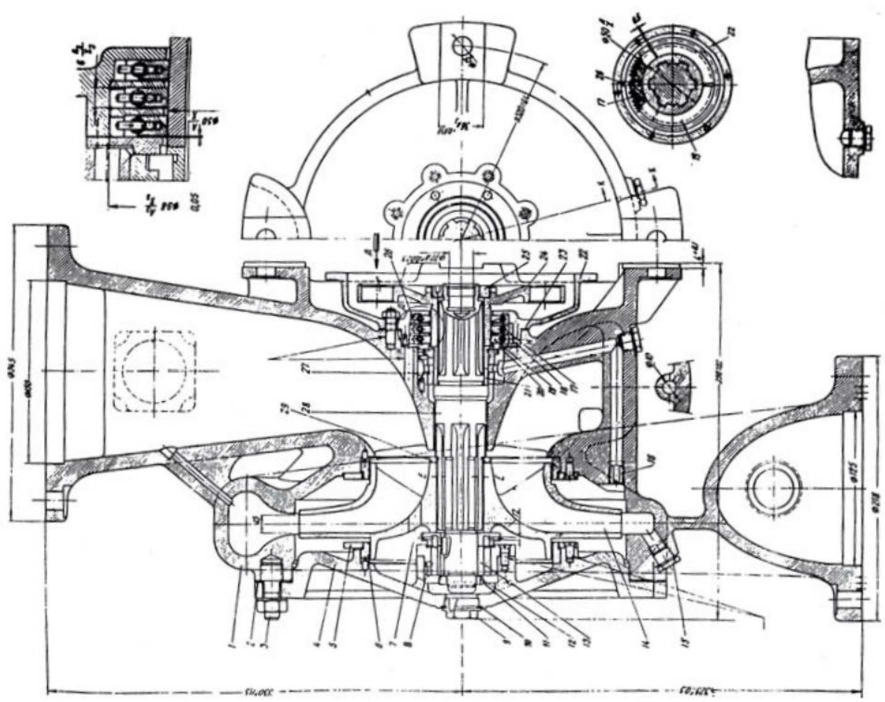
At least “theoretically” there was also the possibility of extinguishing the fire - but if the rocket and warhead exploded, it could destroy the entire infrastructure of the corresponding facility. The warhead had such great explosive power that it usually destroyed entire residential areas. This was the first problem that had to be solved during the research and development work.

The next and similarly important problem was to study the conditions to which the rocket was subjected during re-entry into the Earth's atmosphere (with a near-vertical flight orientation a maximum altitude of 172 km was reached, with an altitude of 100 km being considered the limit of the Earth's atmosphere ; the maximum speed exceeded 5,000 km/h). It was clear from the start that these conditions were unlike anything previously known.

Above all, there was a risk that the outer skin would melt and the hot one

The steel it was made of could become soft or even oxidize due to the friction of the hot air. Efforts were therefore made to determine the temperature distribution on the nose of the “falling” rocket.
First, the maximum temperature should be calculated, or rather estimated, based on the test results in the supersonic wind tunnel. For this purpose, a special model was manufactured with bimetal sensors embedded in the outer skin directly beneath the surface. Based on the experiments, it was estimated that the outer skin of a real rocket should heat up to a maximum temperature of around 600 °C.

Later, special sensors were constructed that were installed in a measuring device version of the V2 warhead. There were a lot of these sensors - miniature disks attached to the outer skin, each with a slightly different melting temperature. They were connected via cables to an electrical sensor that emitted an electrical pulse when the disk melted. The sensors, in turn, were connected to a telemetric device on board the rocket, which transmitted the relevant parameters directly to the ground station via radio without any delay. The knowledge gained in this way showed that the temperature actually rose to 650 ° C (- which suggested that the rocket would have been visible at night: entering the dense layers of the atmosphere at top speed it would have been in a bright orange). After these tests, it was decided that no major modifications to the design were necessary. However, later confirmed ruptures in the fuel tank and leaks in the internals caused by the “pressure” of the shock wave made it clear that the extent of these problems had been underestimated. As a result, development of the rocket was halted for several critical months - just when pressure to bring it into production was at its greatest.



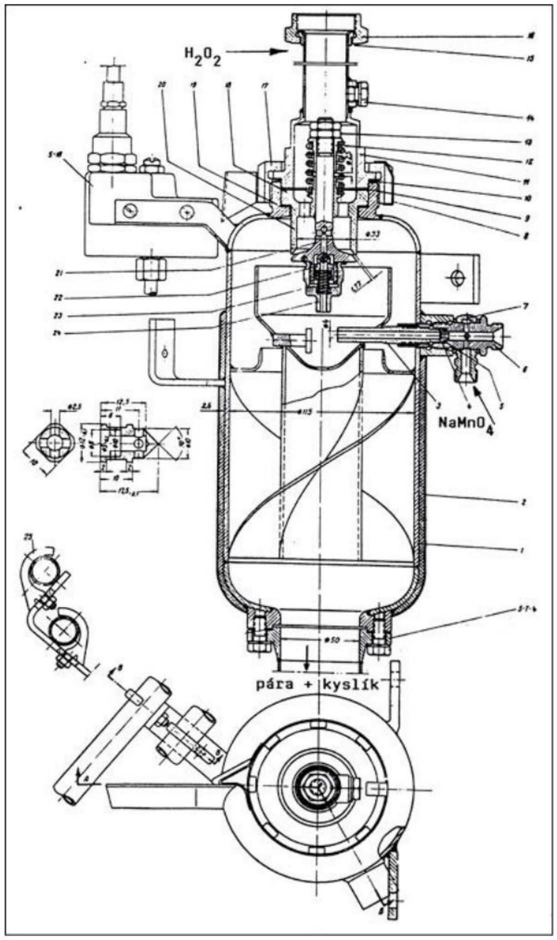
A cross section of the V2 fuel pump. (original drawing)

Almost a "cosmic" challenge was the problem of designing a suitable fuel system with a functioning pump that could withstand such extreme demands - a problem that British and American experts classified in advance as insurmountable. They only changed their minds when the secret service of the Polish People's Army handed them parts of the V2. It was a device that was supposed to be small, light and reliable and capable of pushing 150 kilograms of fuel per second (!) into the combustion chamber (which was already under gigantic pressure) within about two seconds of activation.

Despite these hurdles, a pump was finally built that met these requirements and was so small and light compared to the five-story-high rocket that it could be lifted by a single person. It was a relatively flat turbine with a diameter of 47 cm and a power of 500 - 600 hp (the Walter drive, developed by the HWW company from Kiel). Their extremely efficient energy source consisted of 80 percent hydrogen peroxide, which was catalytically decomposed using an aqueous potassium permanganate solution.

The reaction proceeded at a temperature of 460 °C and produced a

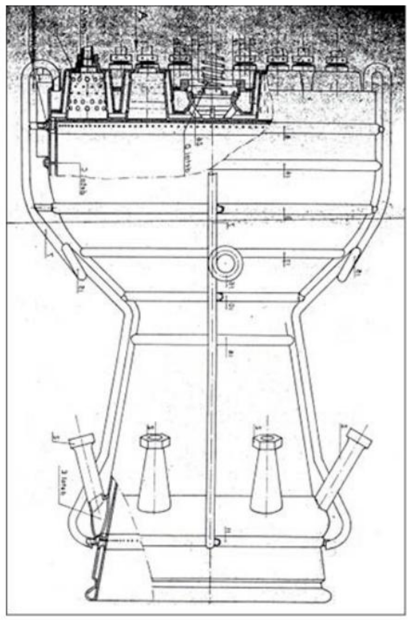
Mixture of water vapor and oxygen under a pressure of 24 atmospheres. [6,7]




The reactor in which the catalytic decomposition of hydrogen peroxide took place.
Its diameter was only 12 cm. (original drawing)

The outbreak of war in September 1939 coincided with significant advances in research work, which is why the project was given top priority. This guaranteed adequate financing and a regulated supply of strategic raw materials, even if the allotted time until the research was completed was shortened twice. From now on, the scientists had a deadline of September 1941, when the A4 rocket was to go into mass production. For this purpose, a large number of researchers and civilian designers were supported by around 4,000 technically trained soldiers, who, once the work was completed, would form the core of the missile combat units

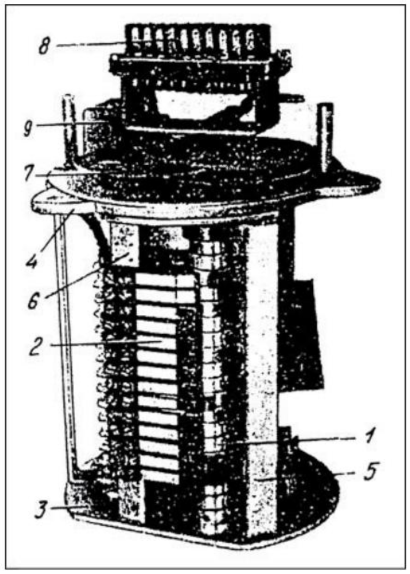
Wehrmacht should form. Soon there was an explicit demand for further acceleration of the work and additional workers were sent to Peenemünde. The research and development program was given the highest priority, although at the same time preparations for mass production were interrupted by Hitler's intervention. 6



The engine of the V2 rocket.

The first months of 1940 were a poor time in the development history of the German rocket program. The supply of raw materials was significantly restricted, which was due to Hitler's aversion to any long-term research programs for new weapons. He relied too much on the experience of the first Blitzkrieg and expected relatively quick results in the development of the military situation in Europe.

Therefore, he viewed such programs as, in a sense, “resource consuming” – an attitude that would have a decisive impact on the course of future campaigns. Many programs fell victim to this short-sighted policy, including the program to develop a nuclear weapon, which the Germans were several years ahead of the Americans in realizing by 1941.




The flight sequence programming device of the V2.

The second unfavorable influence came in the form of Reich Minister for Armaments and Ammunition Fritz Todt, who was hostile to long-range missile projects. Like Hitler, but with different arguments, he was of the opinion that the V2 project was a gigantic waste of material and scientific and technical potential that promised no useful results from a military point of view. It should be remembered that at its peak, around 200,000 people in Germany were working on implementing the guided missile program. As early as the spring of 1940, ongoing work was focused on overcoming two fundamental problems: ensuring sufficient accuracy of the rocket and improving the technology for engine production, as engine failures increased at maximum thrust.

Regarding the problem of the rocket's accuracy, research in Peenemünde revealed that the errors in the inertial navigation system occurred mainly during the initial phase of flight - during acceleration to flight speed and alignment to the intended trajectory.

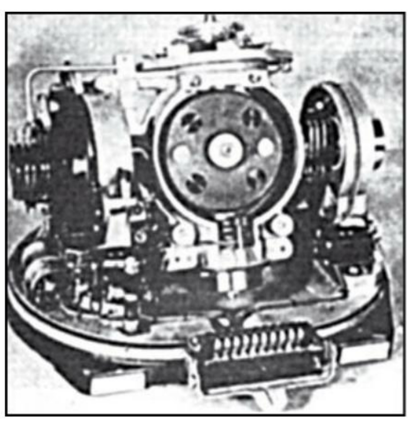
This could be prevented by an additional radio guidance beam *(Viktoria guidance beam)* , which corrects the navigation commands of the ballistic missile's flight computer during this flight phase could become.

However, the first opportunities for military application of this version (1944) revealed the considerable susceptibility of the *Viktoria* system to failure, even though the actual concept of flight correction was assessed as functional during the first and relatively unstable flight phase.

The Germans wanted to improve the system by significantly increasing the frequency of the beam to around 600 MHz. This work was carried out by a military test facility in Peenemünde under the “care” of a specially appointed “Representative for High Frequency Research” (BHF).

Under the command of the BHF, the development of two new radio guidance systems codenamed *Libelle* and *Gloria* began, probably in the fall of 1944. The work was carried out by a small team led by Dr. Faulstisch and engineer Battac executed. The above code names referred to a coherent unit, so to speak: *Gloria* referred to the modified equipment of the rocket, *Libelle* referred to the associated ground transmitter. While the second component was completely new, the components “on board” were only revised. The antenna system and receiver remained completely unchanged, only a high-frequency converter was added (the original amplifier now served as a preamplifier). This was due to the tight schedule and limited space in the densely packed rocket fuselage, which after all had not been designed for this equipment

war.



A component of the V2 inertial navigation system.

The ground system, on the other hand, was practically fixed from the start. At the time of the evacuation of the facility in Peenemünde, almost all plans had been completed; However, the Germans never managed to build a prototype. 8 (The plans and possibly some equipment were confiscated by the Russians and used in connection with the Russian replica of the V2, the R2 rocket, which entered service in 1950.) However, let us return to the interrupted account of the initial work

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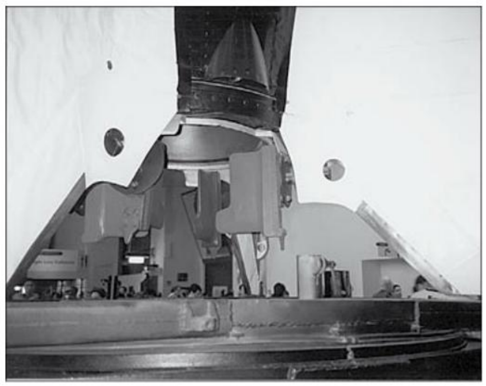
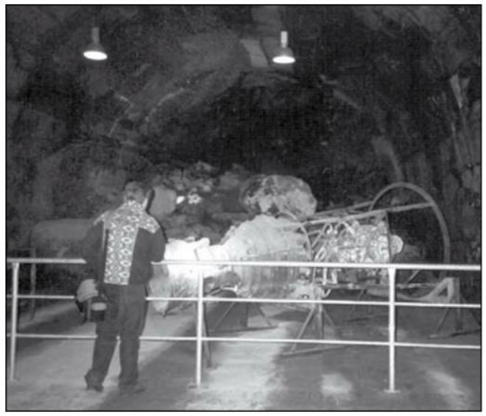


The rear of the V2 with noticeable graphite controls. (Photo: I.Witkowski)

In the summer of 1940, the rocket program fell further down the priority list. By now Hitler had lost all interest in it. He did not consider the missile to be competitive with the long-range bomber, which could carry much larger “combat loads.” 8 Regardless, the increasing counter-espionage operations led the Peenemünde management to release around 1,000 Polish forced laborers.

Although the development of the A4 rocket was nearing its end, the facilities on Usedom were almost shut down.



Both photos show a V2 engine in the underground Mittelwerk complex. (Photo: I.Witkowski)

Only the intervention of Field Marshal von Brauchitsch changed the situation. At the end of July / beginning of August he gave the order to classify the missile program (under the name *Smoke Tracker)* as one of the most important programs for the development of new weapons, which brought it back to the top of the priorities. Dismissed workers were brought back and the decision was made to expand the research and production base in Peenemünde.

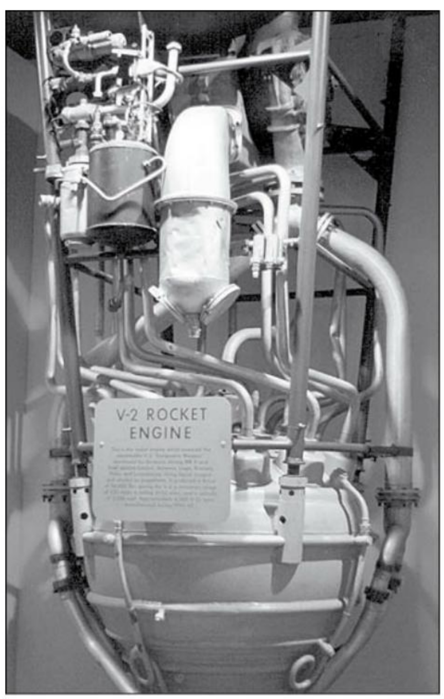
In early March 1942, the Germans managed to assemble the first prototypes of the A4 rocket - the future main weapon of retaliation of the Third Reich. Although the work on the engine had not yet been completed and cracks continued to appear frequently in the combustion chamber, it was decided at the end of March to attempt the first takeoff. However, the rocket exploded during a first stationary test on the test bench.
The competition with the Luftwaffe and its Fi-103 as well as the pressure to quickly "prove" that the development of the rocket was complete - because without a final design, series production could not be carried out

beginning -, should indirectly trigger numerous future accidents.

The work was delayed considerably by the bombing in August 1943, but not nearly as much as the Allied commanders would have liked. Despite the deaths of numerous important scientists (including Dr.

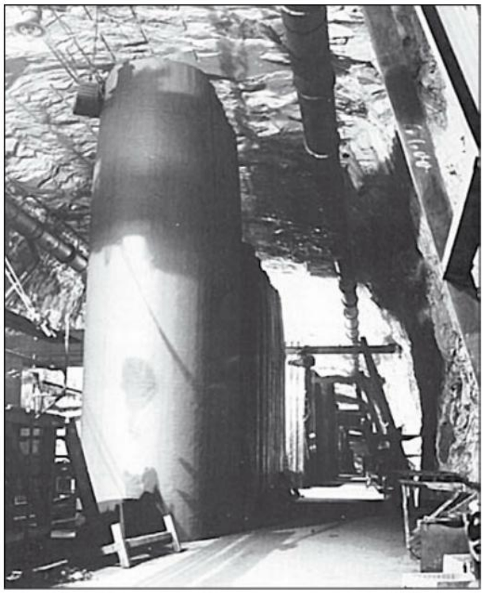
Thiel), there was no major damage to the research infrastructure as a result of the air raids. Above all, the workers' "small town" and the forced laborers' barracks fell victim to them. Work was quickly resumed. The launch of the fourth A4 prototype took place on October 3, 1942. It was the first and for a long time only test flight that was completely successful. The rocket reached a maximum altitude of 60 km and a range of almost 200 km. The engine operated as planned for 61 seconds. The speed in the final phase was over 1,200 m/s - around Mach 3.75. It seemed as if the technical hurdles had been overcome, but in reality they were still a long way away.

The successful start at least proved that it was theoretically possible to get the problems under control.




The main part of the V2 engine: injectors with lines that supply them with oxygen and the fuel pump. (Photo: I. Witkowski)

On December 22, 1942, Hitler confidently signed the order to start mass production. Shortly thereafter, a special committee was formed in Speer's ministry (Development Commission for Long-Distance Shooting) tasked with overseeing the research, production and use of the retaliatory weapons. The committee included representatives from the Army Weapons Office, the Air Force Ministry and the companies involved in production. The first production schedule based on realistic possibilities was drawn up, with the first examples planned primarily for further research and test series. Production was scheduled to begin in April 1943 with five rockets. As the process progresses, this number should slowly increase to 10, 20, 60, 105, 200, 400 and 700 experimental specimens. It was assumed that a significant increase in production could only be achieved at the beginning of the following year. The still relatively small quantities were divided between three production factories: the main assembly line in Peenemünde, where the technical staff of private companies were supposed to gain experience, the Zeppelin factories in Friedrichshafen and the Henschel factories in Wiener Neustadt. Mittelwerk GmbH, which was supposed to take over the “Mittelwerk” underground facility (which previously served as a central storage location for fuel and lubricants), was only founded on September 24, 1943 in order to then guarantee the majority of V2 pro



The aisles in the center plant were high enough to accommodate the V2's main fuel tanks vertically to set up. (Photo: Federal Archives, Koblenz)

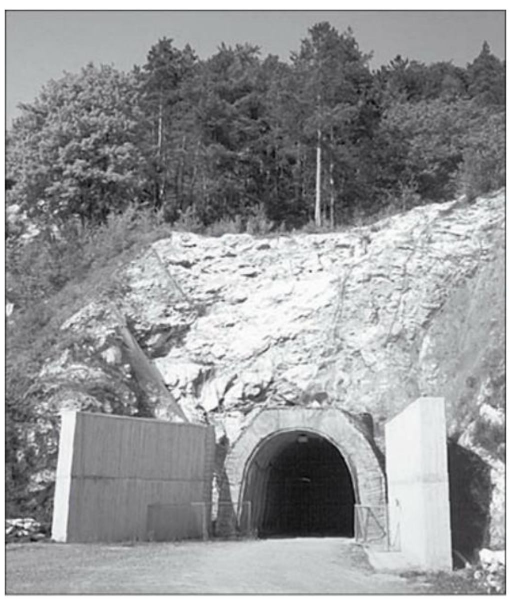
Hitler demanded that production plans be doubled to 2,000 rockets per month, but this was made almost impossible by the bombing of the Zeppelin and Henschel production factories. The situation could only be saved by the gigantic Mittelwerk, in which around 3,000 prisoners from the Nordhausen concentration camp were already working at the end of September 1943 to produce the retaliatory weapons. A year later this number had already risen to 13,000.
In addition, production began in two underground factories in the Niedersachswerfen region near the towns of Lehesten (prisoners from the Buchenwald camp worked here) and Dernau (with prisoners from the Natzweiler camp).

Mittelwerk, main transport tunnel. The railway tracks can be seen on the left. (Photo: M. Banaÿ)

During this time, Wehrmacht units were also intensively trained.
A long-distance rocket school was set up in Köslin, in which both officers and ordinary soldiers were taught primarily theoretical knowledge in a six-week course. An SS military training area on Polish territory, a former artillery training area of the Polish army with the code name *Heidelager, was used for combat training.* It was located near Blizna at the foothills of the Vistula and San rivers, about 150 km northeast of Kraków. By mid-November 1943, two artillery regiments with a total of six field batteries had been set up there, each of which had three mobile launch pads under command. The location of the training area behind the one for the

The area of interest to the Allied air forces seemed to guarantee security. However, the Germans underestimated the fact that the rockets fell in an area largely controlled by enemy partisans. This is precisely why, thanks to the Polish People's Army, the British intelligence service got its hands on the first relatively detailed information about the construction of the V2. The amateurishly planned air raid on Peenemünde actually only revealed how little the Allies really knew about German rocket research (around 80% of the bombs fell outside the facility).

The experiments in inhabited areas provided the Polish People's Army with extensive opportunities for espionage. Rockets launched from the Blizna missile test site flew in a northerly direction and fell in an area near the town of Sarnaki near Platerowo.
Both Blizna and Sarnaki had been infiltrated by the Polish People's Army's secret service. The first example of a V2 detonated - to celebrate Hitler's birthday in April 1944 - near Sarnaki (between the villages of Mÿÿenin and Ogrodniki). However, the Germans quickly reached the impact site and removed all debris.



Mittelwerk, today's entrance (Photo: I. Witkowski)

The resistance movement had expected this for a long time. Already in 1943

She had a detailed map of the Blizna rocket test site, which she had purchased from a German employee for 2,000 Reichsmarks. She wanted to capture an entire rocket and even considered attacking a transport train and "hijacking" a rocket. However, a more favorable opportunity soon arose. During the first days of May 1944, a V2 crashed into the Bug River without exploding. She didn't even suffer any serious damage. During this operation, experts from Warsaw, led by Professor Groszkowski from the Warsaw Polytechnic, were even able to examine the electronic circuits (not even the valves were shattered!). It was decided to bring the recovered and dismantled rocket to England. On July 25, a DC-3 landed at a forest airfield near Tarnau and "snatched" the valuable goods "from under the noses" of the German units stationed a kilometer away. It was already relatively late, but before the rocket was used in combat operations. 11,14,15,16,17 However, let us return to the turning point of 1943/1944.

In Peenemünde, however, research continued, mainly with the aim of reducing the rocket's technical susceptibility to failure.
They also wanted to change the design so that production could be made simpler and cheaper. The updated plan called for the production of 200 experimental rockets in December and 300, 600 and 900 per month in the first quarter of 1944. But these requirements were not met either: by the end of January only 56 rockets had been produced. In addition, the rockets that left the Mittelwerk were not complete. They were missing the electronics, which were only installed later in the DEMAG factories in Falkensee near Berlin, and also the warhead, which was only assembled shortly before launch. The first production series also had serious technical defects.

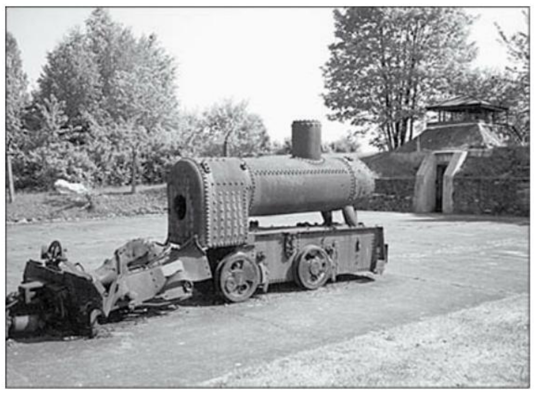
The next "surprise" came after further test flights from the test site in Blizna. Apart from the fact that only one of the eight launches carried out was successful, it later turned out that the majority of the rockets, instead of falling into the intended target area, had already exploded several kilometers above the ground. This was obviously a mistake that had not been discovered during the tests on the open sea - there was no possibility of it there. The impact site was determined at this time using colored tarpaulins on the surface swam in the water. If they were in the expected zone, it was concluded that the flight was successful. In addition, no tests were carried out with a warhead, which is understandable considering the number of rockets that fell in the area around Peenemünde or in the immediate vicinity of the facility. The investigation concluded that the difficulties were caused by excessive heat stress on the outer skin of the center fuel section, which tore apart, causing the liquid oxygen and alcohol tanks to heat up and explode. Since the rocket was already warming up in the dense layers of the atmosphere, the explosion occurred relatively close to the ground. To reduce the load, layers of glass wool were placed between the outer skin and the fuel tanks, which had the desired effect. The next unresolved problem was the sudden and unexplained engine failures during various phases of flight (usually shortly after takeoff). The results of static research were used, which showed that the operation of the drive unit was accompanied by strong vibrations, which were mainly due to the engine.

It was suspected that this caused the pipes in the fuel system (including the nozzle cooling) to rupture and become severed, and they were then reinforced.

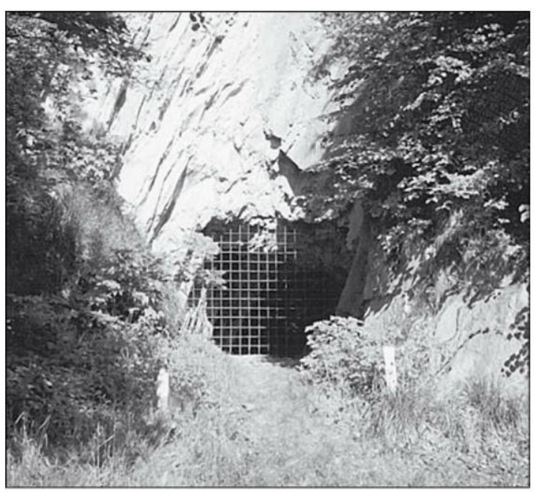
Only now could it be claimed that the V2 was at a technological level that allowed its military use. It was already spring 1944. The tests with the new solutions were no longer carried out at the Blizna rocket test site because the Russian summer offensive had made this impossible. At the end of July, a new missile launch station codenamed *Heidekraut* was built in the Tuchel Heath, a few dozen kilometers east of the city of Tuchel. The research program was completed there. The first information that aroused the interest of Polish reconnaissance and ultimately led to the discovery of the site were reports from the local population about soldiers occasionally wrapping themselves in sheepskins and wearing thick gloves, even though it was the middle of summer. It later emerged that they were refilling the liquid oxygen tanks.

The year 1944 was a time in Germany in which the SS continued to expand its dominant role and gradually gained control took over more and more institutions.

After the failed assassination attempt on Hitler in July 1944, Himmler repeatedly tried to gain control of the rocket program. The influence of the SS continued to increase. Since these actions were now supported by Hitler, they also led to success. SSgruppenführer Hans Kammler was appointed leader responsible for all matters relating to the A4 rocket. He held this position almost until the end of the war, when, like many other high-ranking SS members, he "disappeared" under mysterious circumstances.



The remains of a narrow gauge railway for transport within the underground factory. On the right you can see a punishment bunker for the prisoners. (Photo: I. Witkowski)



An entrance to the underground factory in Lesna (Marklissa) - one of the many places where components for the V2 were manufactured. (Photo: I. Witkowski)

The data on the production of the V2 is incomplete. In Peenemünde

It is estimated that over 300 rockets were produced, and in the Mittelwerk factories in the months of 1944 the following numbers were produced: January - 50, February - 86, March - 170, April - 260, May - 440, June - 132, July - 86, August - 375, September - 629, October - 668, November - 662 and December - 613. In the first two months of 1945, 600 - 700 rockets were produced each, and in March, the last month of production, about 400.

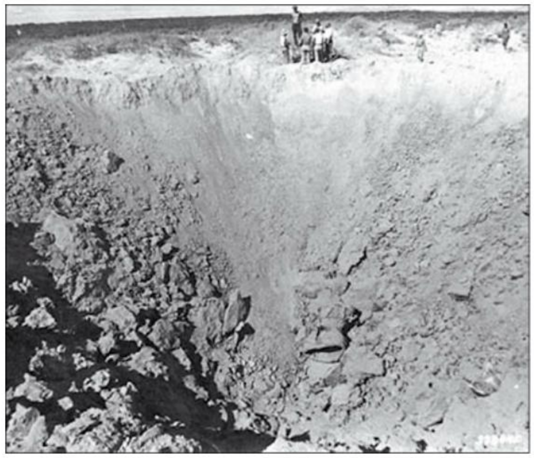
Initially, the Germans planned military operations exclusively from large bunkers protected from air raids, as they assumed that such a complex weapon system as the V2 would require an extensive infrastructure of workshops and facilities that were essential for operational preparation. Military operations from the open field could not (wrongly) be imagined. On Hitler's orders, the construction of four huge bunkers along the English Channel began in August 1943: the “North-West Power Plant” in Watten, the “Nord-West Gravel Plant” in Wizernes (in the Calais region), and the “West Reserve Camp” nearby from Sotterast and the “Oil Cellar Cherbourg” in Hainneville (both in Normandy). The latter was eventually converted into a V1 launch pad.

They were gigantic, completely self-sufficient bunkers, but were easy to discover during construction. These fears were confirmed when the Allies carried out around 100 attacks on the installations between summer and autumn 1943, dropping tens of thousands of tons of bombs. With the Allies having complete air supremacy, it was considered unrealistic to be able to hold the bunkers despite their five meter thick walls. Therefore, it was decided to launch all missiles from mobile ramps, aiming for effective camouflage rather than protection from bomb explosions

to set.

When SSgruppenführer Kammler took command in August 1944, there were 45 camouflaged bases, 20 different depots and a number of facilities for the production and storage of fuel.

The Normandy landings forced the Germans to move further north even before the first rocket launches.



The crater created by the explosion of a V2 on the ramp - at the White Sands Missile Range after the war. (Photo: US Army)

Hitler gave the order to begin the attacks on September 15, 1944. In contrast to the V1, whose launch equipment was large, immobile and easy to detect, the V2 could rely on small movable launch platforms that were virtually undetectable. The rockets could therefore be launched not only from carefully selected positions, but also from stretches of road, forest clearings and any other accessible location protected from enemy military columns

were.

In contrast to the V1, the V2 was not only indestructible in its final flight phase due to its high speed of around 3,500 km/h, but also extremely difficult to detect shortly before its launch thanks to the high mobility of the rocket ramp. The average flight time from the west of the Netherlands, where most of the rockets were launched, to London was about five minutes. 60 - 70 seconds after takeoff, the engine switched off at an altitude of about 35 km. In ballistic flight, the missile continued to climb to a maximum altitude of approximately 100 km. The V2 was the first space rocket.

Using a simple navigation system (gyro only), the spread, that is, the degree of deviation from the specified trajectory, ranged up to 20 km. The use of a guidance beam or an inertial navigation system (gyro plus accelerometer plus flight line calculator) allowed for a 5- to 10-fold reduction in scatter. This last option was originally used against

Standard military targets constructed and used in the late phase of operations against targets in Belgium and France.

In contrast to the V1, the V2 warhead only detonated after it hit the ground. In the event of an impact on open ground, the damage caused was usually not great, but a direct hit on a specific structure - such as a building - almost always resulted in complete destruction. This happened, for example, when a London Underground station used as a shelter was hit directly, killing over 1,000 people instantly. If the warhead exploded inside a building, it literally tore it apart and also damaged surrounding buildings. The first two rockets were launched towards London on September 9, 1944, and the number of attacks continued to increase. The number of targets also increased over time; from the end of September, cities in Belgium, France and the Netherlands were also attacked.

By October 3rd, a total of 156 V2 rockets had been launched, 52 of them towards Great Britain (London: 30, Norwich: 22), 42 towards Belgium (mostly on Liege: 17 and Hasselt: 10), 45 on France (mostly on Lille : 15 and Paris: 10) and 17 to the Dutch city of Maastricht.

On October 12, Hitler gave the order to direct all rocket attacks on London and Antwerp.

By the end of military use of the rockets in late March 1945, no fewer than an estimated 3,170 V2 rockets had been launched, of which the majority of 1,610 rockets were aimed at Antwerp.

Second on the list of targets was London with 1,359 missiles.

In total, 1,664 were fired at cities in Belgium, 1,400 at Great Britain, 73 at France and around 20 at the Netherlands.

Based on conservative estimates, it can be assumed that about 70% of the missiles launched reached their predetermined target.

However, the arsenal of V-weapons is not yet exhausted.

Essential tactical and technical details of the V2 rocket (version B)

| | |
|---|---|
| Starting weight: | 12.700 kg |
| Weight without fuel: | 4.008 kg |
| Warhead mass: | 1.000 kg |
| Long: | 14,04 m |
| | |

| | |
|---|---|
| Fuselage diameter: 1.65 m | |
| Maximum engine thrust: 25,200 kg | |
| Range: approx. 300 km | |

# The V3

The V3, the Third Reich's next "weapon of retaliation", embodied a completely different concept than in the case of the V1 and V2.

The V3 was a long-range gun and a true pioneering project from a technical point of view. In contrast to the other “weapons of retaliation,” Hitler thought highly of her from the beginning to almost the end of her short life. The main developer of the V3 was engineer Coender, technical manager of Röchling Eisen- und Stahlwerke. 3.9

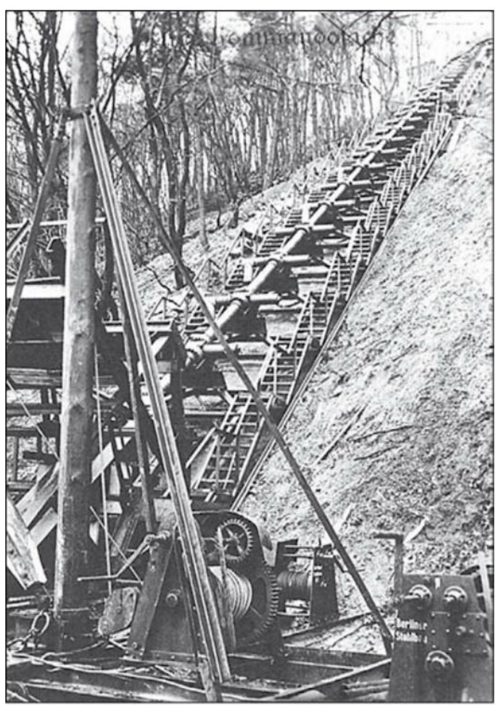
Basically, the Germans pursued the goal of increasing the range by increasing the muzzle velocity of the projectile. This was to be accomplished by maintaining a high pressure in the barrel of a long gun barrel, not only during the initial phase but also throughout the entire firing process.
This could only be achieved by continuously igniting a powerful powder charge or by attaching several powder charges that would have to be ignited depending on the movement of the bullet within the barrel. The V3 worked exactly according to this second principle. The ignition charges were placed in special side chambers along the entire length of the pipe. Only the first charge was ignited conventionally behind the projectile.

The V3 was a so-called multi-chamber cannon, officially christened by the Germans with the code name *high-pressure pump* . Because of its shape, it was also unofficially called *a centipede* . The 150 mm caliber cannon was built to fire at just one target: London.
For this reason, and because of its length and generally complicated construction, it had to be built on a solid reinforced concrete foundation so that its gun barrel was permanently aligned at an elevation angle. The idea of such a construction had already been born in France at the end of the First World War, as a response to the so-called Paris gun; However, it was not implemented in Germany until a quarter of a century later.

In May 1943, Speer initiated a meeting with Hitler, at which he appeared with the owner of Röchling-Werke, Hermann Röchling, to present Hitler with the draft of the new “weapon of retaliation”. Hitler liked the concept immediately and demanded that prototypes be built. It was planned to eventually deploy 25-30 units in combat, operating at a total rate of fire of 300-600 rounds per hour.

The V3 was a smoothbore gun. It was also the first cannon to develop small caliber projectiles with in-flight control fin stabilization. Standard tank ammunition is still based on this principle today. The projectile had a diameter of 100 mm, a length of 2.5 m and weighed 140 kg - 25 kg of which was explosive charge.

The bullet was aimed within the barrel using guide fins attached to the rear of the projectile. In addition, elements attached to the front third of the missile ensured stabilization within the long barrel - the so-called "wooden shoe", which was thrown off after launch. A short sealing cylinder was placed behind the projectile to act as a piston. A firing range of around 160 km was planned. Prototypes were to be installed at two special firing ranges: in Hillersleben, about 20 km northwest of Magdeburg, and on the Polish island of Wollin near Misdroy.



The first version of V3. (Photo: Federal Archives)

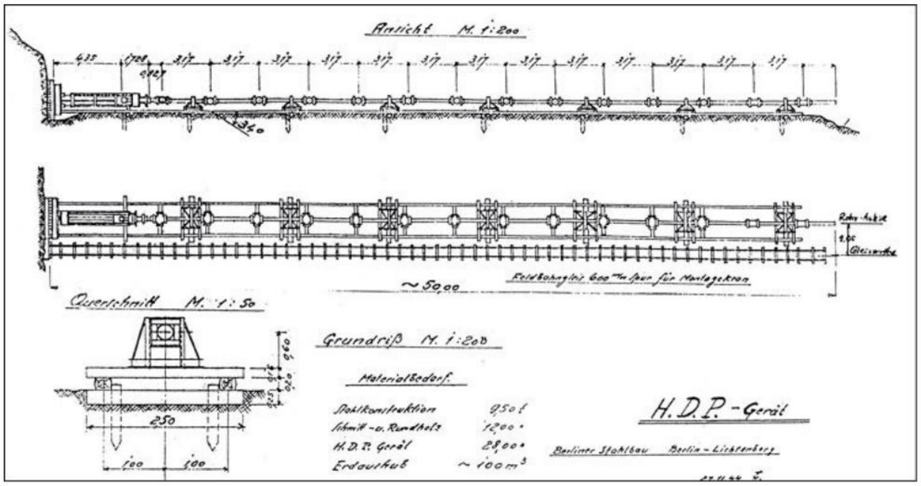
Due to increasing problems with the V1 and V2, Hitler's interest in the weapon increased. At a meeting with Speer in August 1943, he requested that a site be designated for combat operations, even though not even a prototype had been tested up to that point. It was decided to build a large bunker near the town of Mimoyecques in northwestern France, which would house ten battle batteries underground, each with five cannons. The distance from this base to central London was 153 km.

In the fall of 1943, the first parts of the *millipede* were assembled in Hillersleben. The first tests took place in October, but they could not provide reliable information for future combat versions. At the same time, tests were carried out with a 20 mm miniature cannon, but with similarly modest results. The first full-length prototype was only completed in Hillersleben at the beginning of November. A second experimental cannon followed in January 1944 in Misdroy, Poland. Small caliber bullets began to be fired immediately.

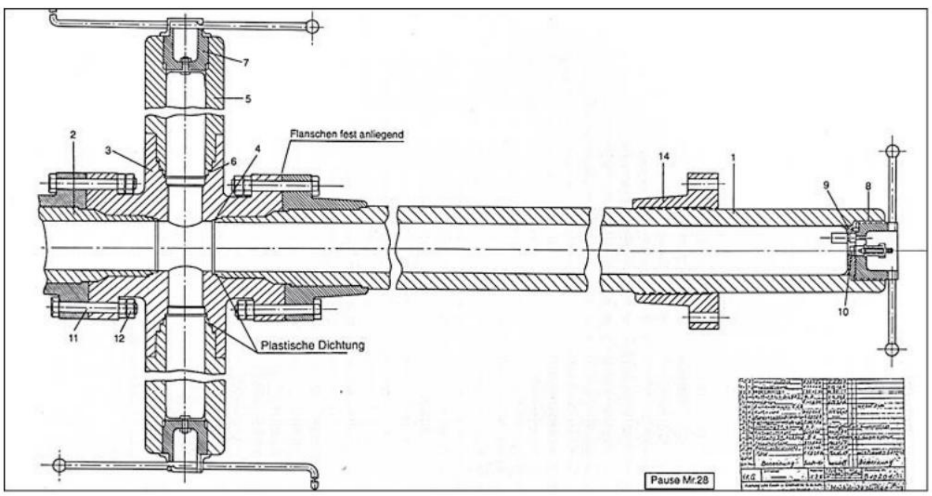
The successful design of the projectile was confirmed and paved the way for an increase in production to 10,000 units per month. However, the design of the cannon itself had not yet been fully checked, as it had only been fired with reduced powder charges. Despite all this, the mood was optimistic and Hitler was convinced that the hopes pinned on the V3 were fully justified.

It was not until March 1944 that it became apparent that these hopes were a little premature. In full, the cannon consisted of 32 segments with a total length of 130 meters. When all chambers were filled with reduced gunpowder charges, the projectile achieved a muzzle velocity of approximately 1,100 m/s. However, in order to achieve the desired range, a muzzle velocity of 1,500 m/s was required, which was to be achieved with a full charge.

But serious problems arose with this.




A German design drawing of the V3 from November 1944.




Original technical drawing of one of the sections of the V3.

It asked The out that the durability of the gun barrel sections was simply too low. Many sections were simply torn apart when fired. From today's perspective, it can be said that the pipe would not have been able to withstand the prevailing pressure. This would have required a layered tube that would have had to be manufactured using the autofrettage process. In this way, better load distribution and even greater durability would have been achieved than was necessary for the *millipede .* However, during the Second World War this technology was still in its infancy.

The next problem was the lack of accuracy. It was found that the projectile was not stable in flight at the high speeds.

So far the Germans had produced around 20,000 bullets. Hitler's indulgence towards Röchling, who had insisted from the beginning not to inform the Army Weapons Office about the existence of this project until tests were carried out, was now taking revenge. He had feared that the military would be hostile to such an unconventional design and would reject it based on simple considerations.
A project with obvious errors was approved for implementation without expert review by experts. At least this was the conclusion reached by a group of military experts who later took part in the test firings with General Leeb from the Army Weapons Office. It was March 1944. The military was in favor of canceling the project, which would certainly have happened if Hitler hadn't been so committed to it.

So the work continued. Although the Institute of Aerodynamics in Göttingen was commissioned to design a new projectile that would be significantly lighter, weighing around 80 kg, a smaller number of the original projectiles continued to be produced. It was decided not to inform Hitler about the extent of the numerous problems. In the meantime, important improvements were made to the design. The side chambers were no longer mounted perpendicular to the pipe, but at a certain angle of inclination. The projectiles have also been improved. Despite the efforts, the resumption of firing near Misdroy in July revealed further malfunctions. Almost a third of the pipe was torn apart. Work continued, although it was obvious that the target muzzle velocity was not achievable. However, this only finally became clear when the gigantic combat bunker in Mimoyecques was already completed.

At the same time, a special Wehrmacht regiment was on the island Wollin in the final phase of training for the use of the V3 cannons.

A V3 grenade casing as an American trophy. (Photo: US Army)

The regiment consisted of approximately 1,000 soldiers and was under the command of Lieutenant Colonel Bortt-Scheller. 18 The problems that arose in reaching the target distance did not mean that the project was finally doomed. At the same time, but probably independently, a new type of long-range ammunition was being developed and tested that could have cast the entire enterprise in a completely new light. Tests with this new type of ammunition were carried out in Hillersleben, among other places. This was an artillery shell with an additional ramjet engine. There were several versions of this so-called Trommsdorff bullet 20 , including 105 and 150 caliber bullets. The latter corresponded exactly to the caliber of the V3 “super cannon”.

A close-up of the V3 prototype. (Photo: Federal Archives)

I don't know if there was any thought about combining the advantages of both weapons, but it would have been possible. The Trommsdorff bullet will be described in more detail in one of the following chapters.

Apart from the fact that the work on the V3 itself was extremely interesting, the construction of the gigantic underground complex in Mimoyecques also provides a rather curious story. The construction was kept so secret that even the head of the Army Weapons Office, Leeb, only stumbled upon the whole undertaking by chance when he was inspecting fortifications on the coast of France at the end of 1943.

The Germans originally planned to place 50 cannons underground, but ultimately decided on 25. 430 miners and an estimated 5,000 experienced workers from the Ruhr coalfield were assigned to the huge construction of the underground facility in the fall of 1943. The core of the complex consisted of five large tunnels, each 150 m long, which led into the mountain at an angle of 45 degrees. Five cannons were to be placed side by side in each of the tunnels. The Krupp company supplied the armored covers for the tunnel openings so that only the tips of the pipes protruded. Additionally, it was decided to protect the entire surface of the mountain with a layer of reinforced concrete six meters thick. Together with the hard rock, it was intended to protect the structure against any weapons of the time.

The main complex of horizontal tunnels with storage rooms and a rail line lay at a depth of about 30 meters, a good 10 stories down. From this level there were elevator shafts leading down through which the ammunition was to be provided. At the lowest level, at a depth of 80 to 110 meters, there were further tunnel systems.
Directly above, only the muzzles of the 25 cannons and narrow ventilation shafts revealed the existence of the facility. Even two high-voltage lines from France ran underground into the complex. The construction consumed a total of one million tons of cement, steel and gravel. Nevertheless, it proved to be quite destructible.

Here too, Polish espionage provided invaluable services to the Allies, particularly the groups of Major Grabowski (“Lille”) and Wÿ. Waÿny (“Tiger”). Grabowski received an order from London to cut the power line leading to Mimoyecques. A group of commandos was sent to support the mission (Raszka, Bronicki-ÿoziÿski, Fijak, Kral and others). There was a reference to a place where the line ran above ground. Because the Germans repaired the electrical supply lines after each sabotage, they were cut a total of 16 times. However, these were only preliminary operations, as a devastating counterattack was already being planned in England.

On August 12, 1944, that is, already after the Normandy landings, an unusual "liberator" (a *Liberator bomber)* rose from a base in Norfolk - carrying ten tons of high explosives on board. It was commanded by Lieutenant Joseph Kennedy, brother of the future President of the United States. Before reaching the English coast, the crew was supposed to parachute out; then an aircraft escort should take control via radio. In the end, the “liberator” should hit the V3 complex.

However, that never happened. 28 minutes after takeoff, the flash of a huge explosion lit up the sky over Britain. The “liberator” no longer existed. It was never clarified whether it was an accident or the result of German secret service activities.

Shortly afterwards, an alternative plan was launched: the cannon complex was to be bombarded with the heaviest bombs at the time, the five-ton *Tall Boys.* It was to be the first combat use of these bombs. How much the British feared the V3 is shown by the fact that just a few weeks later the entire complex was attacked. One of the German witnesses to the bombing, Colonel Walter, remembers the effects of the first use of the “earthquake bomb”:

> “It was as if the whole mountain was shaking and would collapse at any moment. Large and small stones rained down from the ceiling, everything cracked. Even people with strong nerves couldn’t stay underground for long.”

When Churchill later saw the construction at Mimoyecques he said:

> “From this place London should have expected the most decisive blow of all.”

Let's remember that a warhead was supposed to fall on London every twelve seconds. Minister Sandys, Churchill's future son-in-law, later wrote to Churchill in a report on the V3 cannon:

> “It could have been completed and used to shell London. As long as it exists, it represents a potential danger to England." He recommended "the destruction of the bunker while our troops are still in France." Apparently the French did not trust the British any more than the

British trusted the French. Despite possible protests from Charles de Gaulle, the British decided to destroy the complex in Mimoyecques. On May 9, 1945, British sappers detonated explosive charges at several locations on the upper level of the underground complex - probably in the same way that the Russians had attempted to destroy the Mittelwerk complex. A few days later, both railway entrance tunnels were blown up with 25 tons of explosives.

Despite this, most of the underground facility is probably still intact. Maybe one day it will be possible to get inside and open this “sealed museum”? 3,9,18,19 The various derivatives of the “V” weapons as well as numerous

alternative designs are a relatively unknown topic. Below is a brief summary.

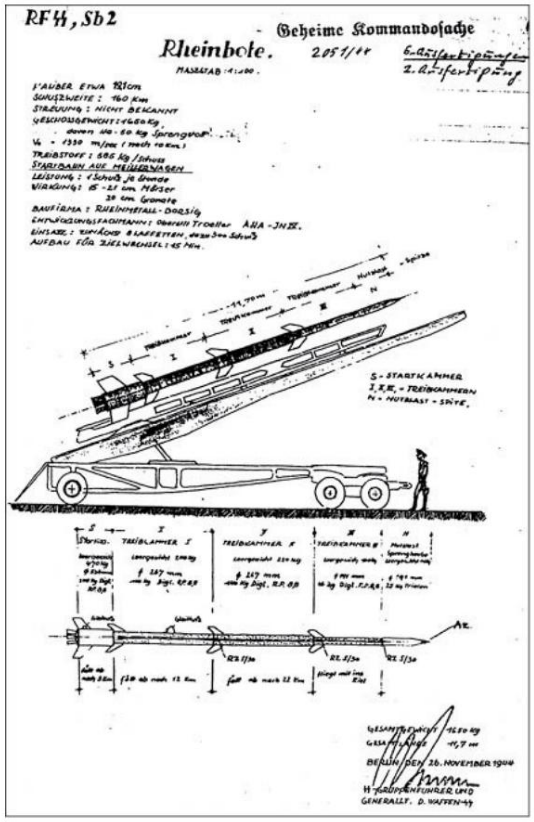
## The Rhine Messenger

Although the *Rheinbote rocket* presented below did not receive an official V number, it should still be included because it represented an attempt to create a rival to the V1 and V2 in the form of a long-range solid propellant rocket.

It was an initiative of various designers at Rheinmetall Borsig. In June 1941, the artillery department of the Army Weapons Office commissioned the company to implement the plans. The project grew out of experiences in the late 1930s with engines for solid propellant rockets and launch engines for gliders.

In the summer of 1941, Rheinmetall presented three designs of four-stage long-range rockets to the Army Weapons Office for assessment and selection. The lightest variant of the missiles was expected to weigh 1,750 kg, including 625 kg of fuel, a 200 kg warhead and a predicted range of 100 km. The “medium-sized” rocket was supposed to be twice as heavy at 3,500 kg, with 1,220 kg of fuel and a 500 kg warhead. The estimated range was 110 km.

The heaviest variant was a true giant in its rocket class for the time and was comparable in size to the A4. The Germans envisaged a take-off weight of eight tons, 2,800 kg of fuel, a 1,250 kg warhead and a range of around 120 km.




A German document containing the first drawing of the *Rheinbote rocket.*

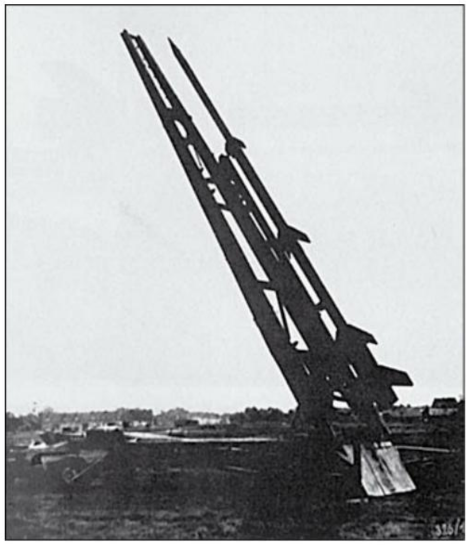
However, Wehrmacht officials and especially Dornberger viewed the whole project rather skeptically. The missile's military usefulness has been questioned primarily due to the high consumption of scarce fuel and the missile's predicted poor accuracy.

Therefore, only the “light” variant was accepted for further implementation, also helped by the problems that arose during the development of the A4 rocket at that time. However, the decision was made in favor of significantly reducing the warhead mass to just 40 kg, as calculations showed that the range could be doubled in this way. This is exactly why the *Rheinbote* was classified from the outset as another “psychological weapon of retaliation” whose purely military use was not necessarily the main focus. Since the missile had no navigation or guidance system, it could only have been used to attack large surface targets.

A close-up of the six nozzles of the *Rheinbote rocket's main engine.* (Photo: Imperial War Museum)

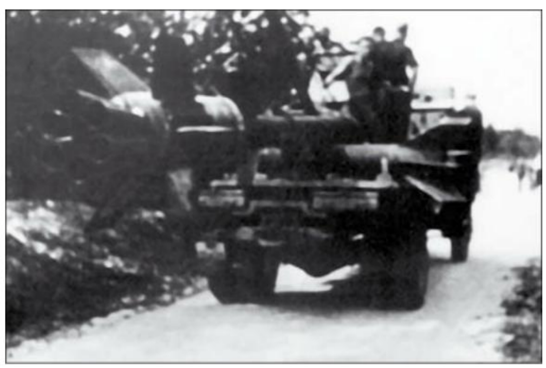
Their range, which roughly corresponded to that of the A4, also suggests that they were intended for such a use. A 40-person research team was put together at the Rheinmetallfabriken in Berlin to construct a prototype. The rocket was given the working designation Rh-Z-61. The first examples were ready for range tests in November 1941, which were carried out at a facility on the Baltic Sea coast in Leba, Poland. This was a Luftwaffe missile base, which was also called “Klein-Peenemünde” at the time and was already used by Rheinmetall for tests with various air weapons. The rockets were launched in the direction of the German-occupied island of Bornholm, 170 km away, where evaluation devices were set up.

Initially, however, only individual stages of the rocket were fired independently of one another. Material procurement problems (the project had not been given priority) meant that full rockets could not be tested until April 1943. The tests were considered successful, and the final stage of one of the rockets even fell near the observation post on Bornholm so that it could be examined later.



The *Rheinbote* in firing position. (Photo: German Museum)

Although the *Rheinbote* was still not assigned to a major armament program and was therefore not given priority or an adequate supply of raw materials, the research group managed to unofficially "organize" the materials from the long-range missile program to build the next 30 prototypes.

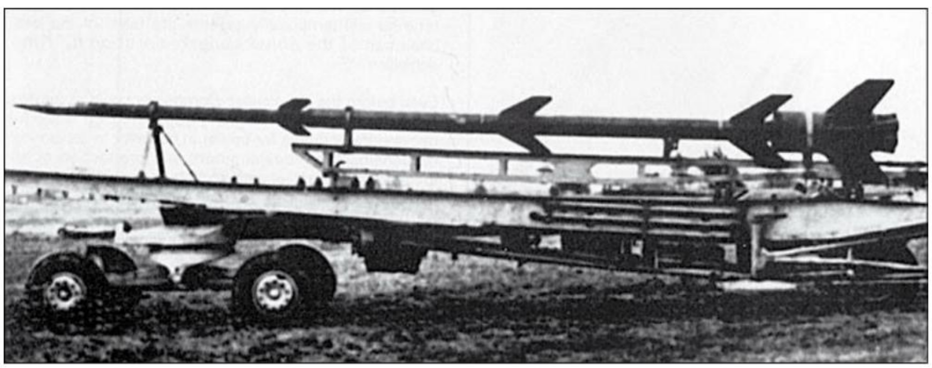


A unique photo that shows the *Rheinbote* dismantled for transport. (Photo: Imperial War Museum)

For unknown reasons, the rocket parts were not delivered until the beginning of 1944, and in the wrong dimensions. Due to the considerable delays, it was decided to significantly speed up the work. Production of the first batch of 200 rockets was commissioned. A special artillery unit was created, the training of which took place in Leba. In the meantime were

Rocket tests were conducted, but they revealed fundamental malfunctions in all rockets fired. The problems were caused by irregular burning of the powder, which in several cases caused the rocket to explode. There have also been cases where the fins broke off once the speed of sound was exceeded.

It took until the end of 1944 before the research group was able to overcome the problems. Just as with the V2, the SS took control of the Rheinbote project after the failed assassination attempt on Hitler in Rastenburg on July 20th. Surprisingly, despite the skeptical attitude of the Army Weapons Office, Kammler and other SS officers became enthusiastic supporters of the new rocket. The flight test site was moved from Leba to the Tuchel Heath (Poland). By mid-December, just 100 rockets had been produced.



The *Rhine messenger* on the rocket launcher. (Photo: German Museum).

Another 220 were to be delivered by the end of January 1945. At this time, attempts to improve the rocket continued, but the results were still far below expectations. Of 12 rockets launched in the first half of December, five all but failed, mostly due to explosions. The rest showed a considerable spread of 50 to 160 km.

Parts of the *Rheinbote rocket* that exploded after launch near the test site in Leba. (Photo: I. Witkowski)

Although the *Rhine messengers* were not fully developed, some (the experimental series) were used in combat operations on the Western Front. The only confirmed use took place during Christmas 1944: a few dozen were fired at Antwerp from a distance of 165 km.
However, calculation errors caused them to fly over 220 km! Since the project was controversial, not very successful and did not promise any particular benefit, it met a similar fate as the unfortunate multi-chamber cannon.

On February 6th, SSgruppenführer Kammler decided to stop the work. 3

## Essential tactical and technical details of the ***Rheinbote rocket***

| | |
|---|---|
| Total weight: 1,656 kg Weight of the individual stages: I - | |
| 710 kg, II - 380 kg, III - 360 kg, IV - 166 kg Warhead mass: 40 kg Total length: 12.9 m Maximum flight speed: | |
| approx. 6,000 km/h Thrust duration (total ): Range: | |
| | |
| | |
| | that. 15 s |
| | 200 – 230 km |
| Flight altitude: | 70 km |

# Other Vergeltungswaffen

The long-range weapons projects presented testify to the enormous scientific and productive potential of the Third Reich. These weapons and especially the V2 set the world with their modernity and

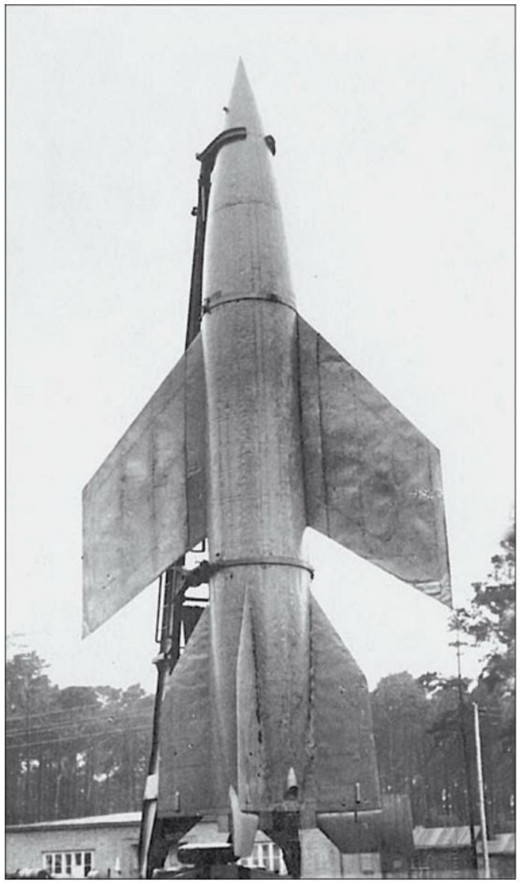
Innovation in amazement. In many cases they, and especially the V2, were further developed and perfected after the war in other countries such as the USA, France or Russia. But the German program from which they emerged had even more to offer. There were numerous other projects, but in most cases they only made it to the prototype stage. They were far more revolutionary and were simply one of the most interesting group of weapons developed during World War II.

What direction did the work take? After the lack of effectiveness of the “retaliatory weapons” had been realized, the aim was not only to increase the range, but also to improve accuracy. When analyzing these even more advanced projects, it becomes apparent that the Germans did not intend to limit their “retaliatory attacks” only to European territory.

Attempts to implement the stated goals were initially undertaken in conjunction with existing weapons. This was first seen in the modernization of the V1 rocket, of which a version with higher range and flight speed was produced. In 1944 the order was placed to produce a new jet engine for the V1. BMW and Porsche presented their designs. With this engine the range would have been increased to 500 km. With a flying speed of 800 km/h, it would also have been an extremely difficult target for British fighter aircraft. The Germans also planned to equip the rocket with a remote control system similar to that already used in guided aerial bombs. The missile was to be equipped with a camera installed in the nose section, which would transmit images of the target via a radio transmitter. A receiver should receive the control commands via the same signal path. This version would have been a “real” cruise missile that could also hit small targets precisely. Intensive efforts were also made in the spring of 1945 to install a guidance beam for the first phase of flight, similar to that used on the V2. The V1 was also intended to be the first “retaliatory weapon” that the Germans wanted to use against the United States.

A suicide version of the V1 (the Fi-103 Re.4, without the nose section). (Photo: Imperial War Museum)

There were even plans to equip the most advanced Type XXI submarines with launchers for the V1, but the Germans were no longer able to do this either. However, an unknown number of V1 launchers were fitted to older submarines. During the *Elster* mission in 1945, an attempt was made to use them against America, but the mission was a fiasco. According to some intelligence reports, the American countermeasures were so rapid and effective because the Americans feared that the missiles were carrying biological warheads. It was April 1945, and the last attempt to realize Hitler's great dream - or rather nightmare - had failed: the destruction of New York, the "capital of Judaism". The *Ursel unguided rockets,* developed in Peenemünde in 1942, served the same purpose, but it is unknown whether they were ever used. 3,22,23

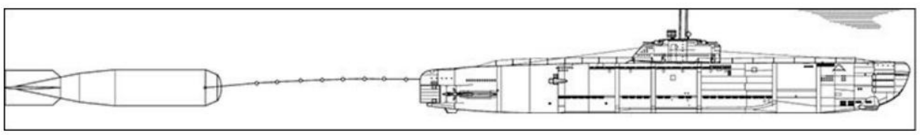


The A4b rocket in early 1945. (Photo: Deutsches Museum)

Towards the end of the war, the dying Third Reich, in an act of desperation, planned to convert some V1 rockets into suicide planes by installing a cockpit, which the pilot would direct to particularly important targets. However , this version of the V1, known as the Fi-103 Re.4 *Reichenberg,* faced resistance from the Luftwaffe leadership, who described the design as a “suicide plan for the Luftwaffe”. Even Hitler treated the plan with extreme caution. Nevertheless, pilots were trained to use the rocket and 175 copies of the suicide V1 were built. However, they were never used. The main purpose of the training was to gain additional information about the flight characteristics of the rocket.

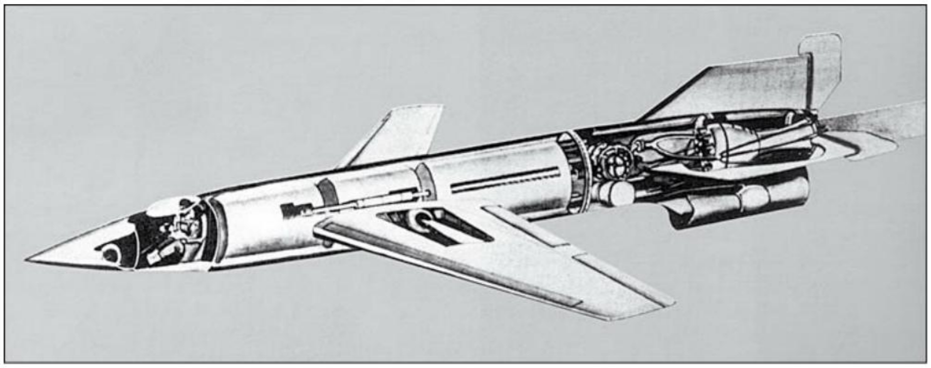
An extensive program was also initiated to further develop the V2. The Germans also wanted to use this weapon against American cities. For this purpose, “underwater silos” with the code name *life jacket* and a water displacement of 500 tons were developed.

Each housed a rocket, technical equipment and a cabin for the crew. After the launch preparations, the crew should leave the silo shortly before the rocket's automatic launch. A new Type XXI submarine could have towed up to three such silos behind it. However, the plans were scrapped because there was no way to control the location of such a floating launcher.
However, it would have been possible to determine the exact target coordinates - in the last months of the war, American counterintelligence fell into the hands of a group of German agents who were carrying directional transmitters (beacon transmitters). By the end of the war, however, the shipyard in Elbig had only managed to produce a single silo.



A silo with the V2 rocket towed by a Type XXI submarine. (Drawing: M. Lynx)

Based on the A4, a new, much more revolutionary missile with an even greater range was developed. This was a completely new design, although the name given to it A4b suggests that it is “only” a descendant of the A4. The name was chosen to ensure resources for conducting experiments. The A4b was intended to have greater range, mainly through the installation of...wings. After the ballistic flight phase, it should switch to gliding flight and thus achieve a range of 600 km. To improve control while gliding, her rear tailplane was enlarged and aerodynamic control surfaces were added. In flight, the A4b, like the A4, was controlled by graphite controls that deflected the gas flow from the nozzle. In December 1944 it was decided to build 20 prototypes of the rocket.



A manned version of the A4b with an additional engine. On their basis, the manned version of the A9 was developed. (original drawing)

Although the first two launches failed, work continued. The first successful launch finally took place on January 24th. Everything looked promising until one of the wings broke apart during the transition to glide, preventing the planned range from being achieved. A version of the A4b with a cockpit was also developed. This even had a retractable landing gear and an additional small engine to increase the flight range. However, this version never made it past the paper stage.

Although no flight tests were undertaken with the A4b until 1945, production plans for it had existed for some time. The A4b concept was developed almost parallel to the work on the A4. Based on this project, work had been underway since 1941 on an even more groundbreaking rocket called Aggregat 9 (A9), which was to be equipped with a new aerodynamic system ("Delta") without tail fins. Even then, the Germans planned to use it as the second stage of the A9/A10 rocket ("America Rocket"), which was still under development and was intended to destroy the most important cities in North America. However, this version of the A9 was not intended to hold a ton of explosives, but rather to carry a massive nuclear load. General Dornberger wrote the following about the work on the A9 in his memoirs:

> "[…] Hundreds of calculations were made to determine the trajectory that would allow the greatest range. Ultimately, it was determined that the rocket should reach a maximum speed of 4,500 km/h at a maximum altitude of 19 km and then enter a slightly inclined trajectory

Peak height would be almost 29 km. After reaching the target area, it would then enter a dive at an altitude of 5 km like the Fi-103 (V1).

We were one step away from developing an unmanned A9 rocket with a fully automated guidance system into a pilot-controlled version. This extremely fast aircraft with wings that only had about 13.5 square meters of total surface area had no military significance. Special wing flaps allowed it to land at a speed of just 100 mph (160 km/h), having previously covered about 400 miles (640 km) in just 17 minutes. However, the development of the A9 could not satisfy our ambition. We wanted to cover an area of several thousand kilometers. Our own private and exclusive area of activity only began beyond the reach of the heaviest aircraft.

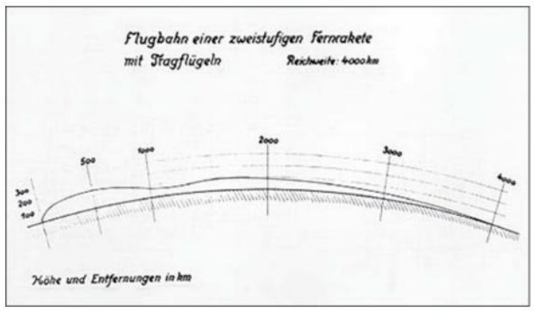
Only by abandoning the single-stage system in favor of a multi-stage rocket, that is, by jettisoning the 'dead' mass that had already done its job and thereby improving the weight ratio of the rocket, could we hope to achieve such an incredible increase in range.

So this was the origin of the A9/A10 project. The goal in this case was that the engine of the second stage (A9) should only start working and thus serve as an auxiliary engine after the rocket had reached a sufficiently high speed via the first stage.

An alternative would have been a catapult, which gave the A9 a sufficiently high initial speed. Building on calculations and practical experience with the V1 launch pads, a long, sloping catapult was designed that could accelerate the A9 rocket to an initial speed of 1,290 km/h. This speed would have been enough to allow the fuel-filled rocket to take off smoothly.

However, a better plan that significantly increased range was to build the A10 - the first stage of the A9/A10 system - which would have weighed 87 tons with a total fuel mass of 62 tons.

The A9 was placed on top of the A10, which would then have given the A9 an initial speed of 4,350 km/h with a 50-60 second sustained thrust of 200 tons. After the first stage's fuel supplies were exhausted, the A9 engine was scheduled to start and separate. Soon afterwards, the A9's climb angle was to increase to reach a maximum altitude of 56 km. A long glide at supersonic speed should then begin."




An original drawing of the flight path of an A9/A10.

The Germans wanted to achieve a range of around 5,500 km with the basic version. For understandable reasons, the only weapon variant should be a nuclear warhead. The A9 missile program was the first effort to directly combine a long-range transport vehicle with a nuclear weapon. Work on this construction in the Third Reich was almost complete. However, the effective use of this rocket requires a new approach to what is still a major problem: accuracy. At the time, this problem posed an even greater hurdle, seemingly insurmountable even when taking into account the warhead's radius of destruction and the size of the metropolitan areas of New York or Washington. The Germans planned to solve this problem with a manned version of the A9, similar to the manned version of the A4b. The rocket was supposed to fly over the Arctic and approach the American east coast from the northeast. The pilot was supposed to fly at high altitude the entire time, drop the nuclear bomb at the target and continue the flight south using the auxiliary engine alone and finally land in Argentina, which was traditionally peaceful to the Germans was minded.[24,25]

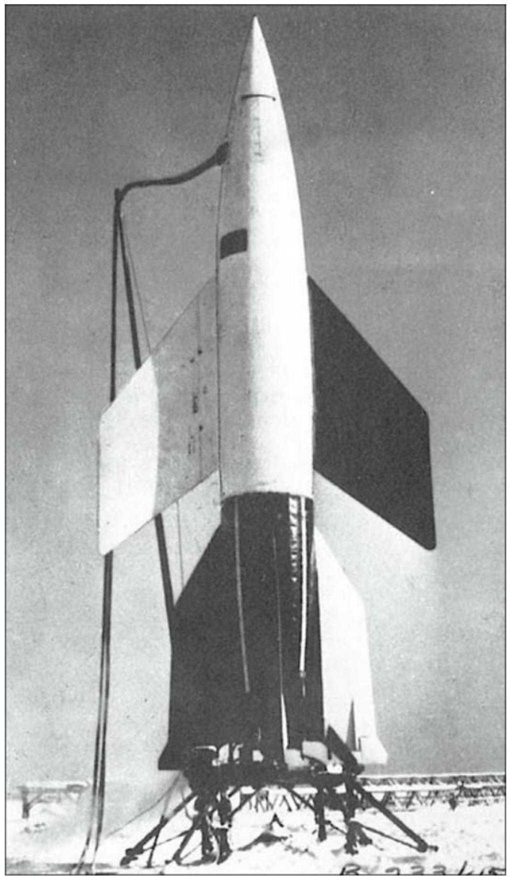
Formally it was a neutral country, but in reality it cooperated closely with the Third Reich. This close bond was due in particular to the Argentine military attaché Juan Domingo Perón, who was in Berlin at the time and was supposed to become President of Argentina.

Thanks to him, Argentina was at the service of the German “special weapons” program after the war, because on his orders, diplomatic missions in Austria and Italy issued around 2,000 passports from 1945 to 1947, which enabled the evacuation of many persecuted people, including scientists valuable documents about new weapons.

However, the problem of accuracy was not as big as it might seem from today's perspective. The trajectory correction in the final stage of the flight could also be accomplished without a pilot. On the 30th

In November 1944, for example, the U-1230 brought a group of agents equipped with beacon transmitters to the United States as part of Operation *Elster* .

However, let's go back to the A9/A10 project.



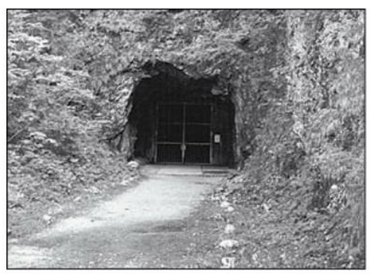
The A4b in January 1945. (Photos: Deutsches Museum)

The Germans did not manage to complete a prototype until the end of the war. However, all of the theoretical work that had begun in 1941, as well as all of the documentation in the form of technical drawings, was completed. Dr. Thiel, who later died in an air raid, and Dr. Walter had suggested using six sophisticated A4 engines with a combined thrust of 180 tons to drive the A4

A10 to use. However, it was later decided to develop a single engine with a thrust of 200 tons. In its final version, the rocket was supposed to reach an altitude of 180 km within a minute.

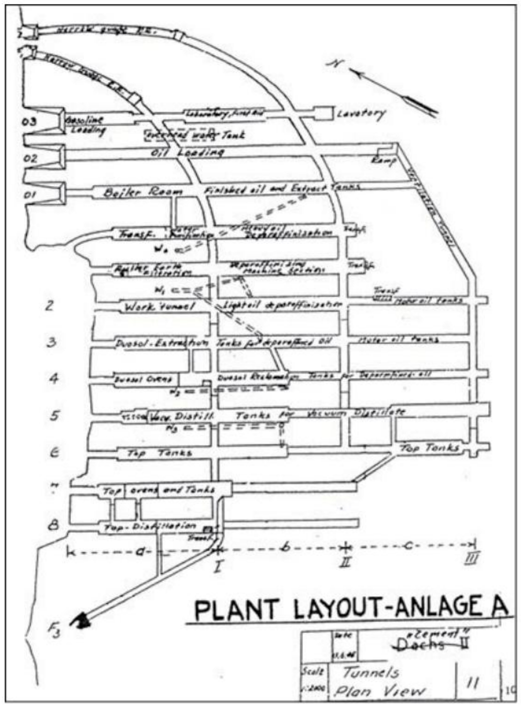
To meet the research and production needs of the A9/A10 project, construction of a huge, multi-story underground complex codenamed “Cement” began under the direction of the SS at the end of 1943. This factory with a total area of 65,000 m2 was located under a mountain range on Lake Traunsee, near the town of Gmunden in northwest Austria. Around 3,000 workers were to be employed there. Test stands for the new engines and launch pads for the rockets were to be built in a neighboring valley.

If it had been completed on time, the “America Rocket” would have been the first “retaliatory weapon” that actually had a chance of significantly influencing the course of the war. 7,21,24,25



One of the entrances to the “cement” plant. (Photo: I. Witkowski)

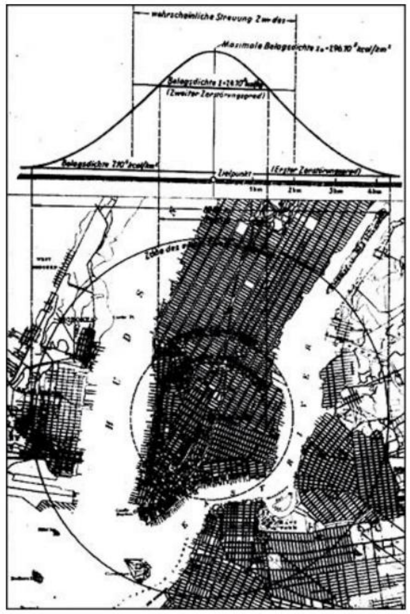
“Cement” – a passage. (Photo: M. Banaÿ)




Overview plan of the “Cement” plant – Annex A. (BIOS)

At the end of this discussion of German long-range weapons projects, one cannot help but emphasize their influence on the history of arms competition and their importance for the course of the Second World War.

From today's perspective, these projects had a very large impact on the overall development of military technology.
Paradoxically, the opposite is true when it comes to their influence on the course of the Second World War.




This diagram from 1944 shows the destruction radius of an A9/A10 nuclear warhead. Manhattan is in the center. (original drawing)

In particular, the wrong strategic decisions and the limited potential of these weapons due to the high dispersion contributed to this. Of the models used in combat, in reality only the "precision version" of the V2 with inertial navigation system and additional guidance beam could have threatened many important facilities, but its potential was misused.

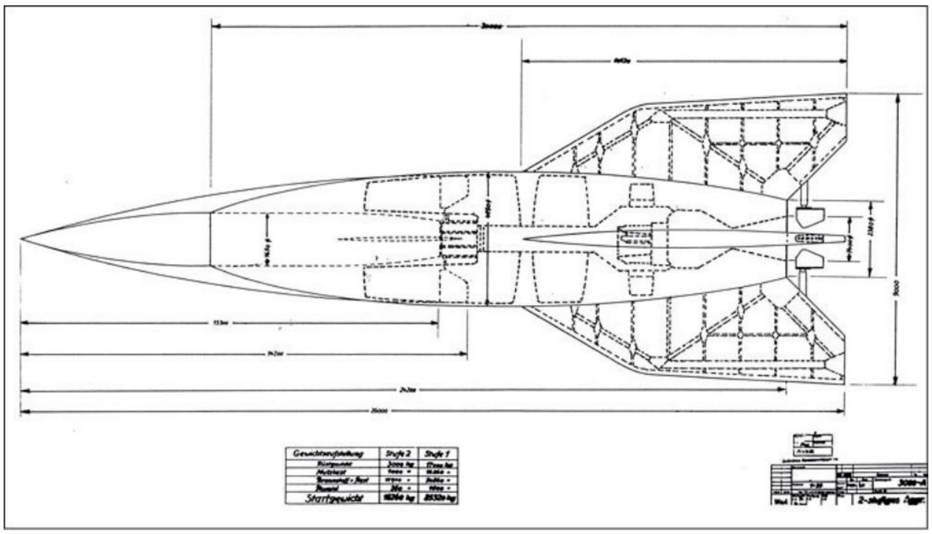
Only certain weapons, which the Germans were never able to bring into mass production in time, had real and significant military potential - such as the V1 version with a new engine and camera remote control system or the A9/A10 rocket. In practice, there was a huge disproportion between the amount of resources used and their influence on the military situation. The maxim “small resources, big effect” promoted by Hitler had in reality changed into the principle “huge resources, little effect”.

In his “Memoirs,” the Reich Minister for Armament and Ammunition, Albert Speer, attempted to trace[1] the internal history of these operations:

“Again we were two years too late. The Russian winter offensive had led to our troops retreating; the situation was critical become. Hitler, as often astonishingly short-sighted in emergencies, explained to me at the end of February that the 'Korps Meister' had been ordered to destroy railway lines in order to stop the Russians from supplying supplies. My objections that the ground in Russia was frozen hard, that the bombs could only have a superficial effect and that, in our experience, the much more sensitive German railway lines were often restored after hours: everything remained fruitless. The 'Korps Meister' was used up in a pointless operation, of course without being able to hinder the Russians' operational movements.

Hitler's continued interest in the idea of the point strategy was also consumed by his stubborn retaliatory intentions against England. Even after the destruction of the 'Korps Meister' we would still have had enough bombers for such plans. But Hitler gave himself up to the unreal hope that a few massive attacks on London could persuade the British to abandon their offensive air warfare against Germany. This was the only reason why he demanded the development and production of new, heavy bombers in 1943. That they could find far more worthwhile targets in the East. d. Authors: Key parts of Soviet industry were concentrated in huge, monopolistic colossuses], made no impression on him, although he occasionally agreed with my arguments, even in the summer of 1944: He and our air force staff were incapable of fighting an air war based on technology rather than on technology outdated military perspectives. The other side initially also […]

It was Hitler again who, despite all the Allies' tactical mistakes, made the moves that helped the enemy's air offensive in 1944 to be a success: he not only inhibited the development of the jet fighter and later had it transformed into a fighter-bomber - he wanted to also take retaliation against England with the help of the new large missiles. On his orders, from the end of July 1943, huge industrial capacity was allocated for the 14-meter-long and over 13-ton long-distance rocket known as the V2, of which he produced 900 units per month wanted. It was absurd to give the enemy bomber fleets of 1944, the average of several months with 4,100 four-engine Airplanes dropped 3,000 tons of bombs on Germany every day, to want to counteract a retaliation that 24 tons a day would have transported explosives to England: the bomb load of one Attack from just six Flying Fortresses.



A cross section of the A9/A10 rocket. The rocket was placed vertically on the launch pad as high as a ten-story building.

It's probably one of my most serious mistakes in management the German armament, not this decision by Hitler only agreed with it, but advocated it - while we got better "We would have concentrated our efforts on producing a surface-to-air defense missile."

Tactical and technical details of the A4b missile

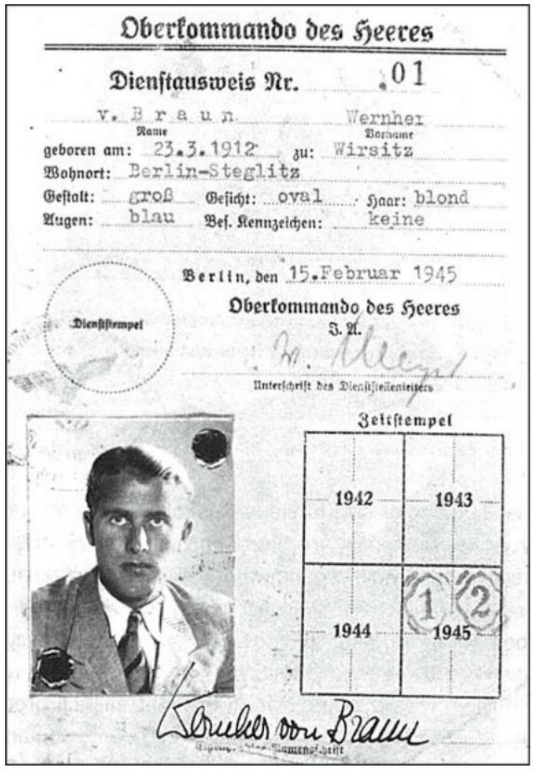
| | |
|---|---|
| Starting weight: | 13.000 kg |
| Warhead mass: | 975 kg |
| Engine thrust: | 27.500 kg |
| Total length: 14.06 m | |
| Hull diameter: 1.65 m | |
| Wingspan: 6.2 m | |
| Maximum speed: 5,500 km/h | |
| Range: | 595 km |

Tactical and technical details of the A9/A10 missile

| | Version I | Version II |
|---|---|---|
| Starting weight: | 85.320 kg | 100.000 kg |
| Fuel mass level I: | 51.700 kg | 62.000 kg |
| Stage II fuel mass: | 11.850 kg | 8.800 kg |
| Thrust force level I: | 200 tons | 200 tons |
| Thrust force level II: | 28.1 tons | 28.1 tons |
| Total length: | 26 m | – |
| Fuselage diameter: | 4,15 m | 3,5 m |
| Wingspan: Range | 9,3 m | – |
| (version without pilot): | approx. 8,000 km | approx. 8,000 km |
| Maximum flight speed: | approx. 11,900 km/h | – |
| Warhead mass: | here. 1,000 kg | ca. 1,000 kg |

There was an interesting one about the “America rocket”, at least in theory Alternative developed under the codename Thor's Hammer. 26 It was a so-called rocket-powered aircraft, or more generally: about a space shuttle.

Since 1936, under the leadership of Dr. Eugen Singer at that the Trauen rocket test center he founded on this space shuttle worked. It was the first specific design of a spacecraft in... would have been able to carry a human crew above the atmosphere to carry out of the earth.



Oberkommando des Heeres

Dienstausweis Nr. 01

v. Braun Wernher
Name Vorname
geboren am: 23.3.1912 zu: Wirsitz
Wohnort: Berlin-Steglitz
Gestalt: groß Gesicht: oval Haar: blond
Augen: blau Bes. Kennzeichen: keine

Dienststempel

Berlin, den 15. Februar 1945
Oberkommando des Heeres
I. A.

Unterschrift des Dienststellenleiters

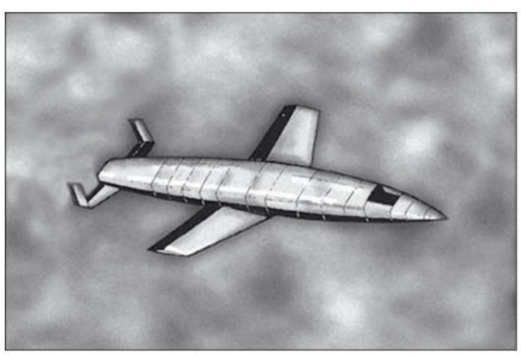
Zeitstempel

| | |
|---|---|
| 1942 | 1943 |
| 1944 | 1945 |

Wernher von Braun

Wernher von Braun's military ID card.

Thor's Hammer, like today's space shuttle, was intended to have an unusually flattened fuselage that would provide additional aerodynamic lift and facilitate deceleration upon re-entry into the atmosphere. It should also enable a subsequent gliding flight and thus ensure a long range. The hull should have the shape of a flattened spindle measuring 28 x 3.60 x 2.10 m. The crew's cockpit should be located in the front part, but completely hidden under the fuselage.

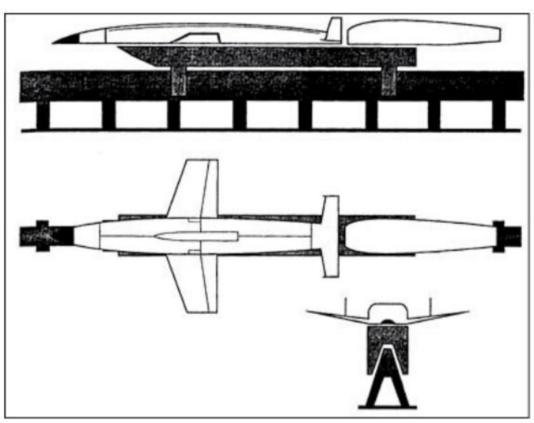


Thor's Hammer (photo from the author's collection)

It is very likely that a full-scale prototype was never completed, but it is known that assembly of a 1:20 scale model began as early as 1938, which was intended to be used for aerodynamic tests. Singer's design was originally planned for civilian use, but under pressure from the military in 1939 he changed the intended use of the "spaceship" to a type of intercontinental space bomber that was to be powered by liquid fuel. Singer planned to use a massive rocket engine with a thrust of 100 tons, as well as two much smaller engines mounted on the sides.

The Me-264, the “America Bomber,” was intended as an alternative to the “America Rocket.” (Photo: Federal Archives)

It may be surprising that, unlike the A9/A10 rocket and the American space shuttle, which have two additional detachable solid propellant engines, this was a single-stage spacecraft. However, this was not a mistake, but rather proof of the superiority of Singer's design, because according to the plan, the launch would not have required any components that would have been irretrievably lost. A launch pad was even designed, a type of catapult or launch rail with a planned length of three kilometers. Although this sounds like a gigantic structure, it would still have been shorter than the 3.6 km long runways of modern airports. The spacecraft was to be accelerated on the platform by a “launch module” that would have been significantly larger than the “bomber” itself supporting launch unit, equipped with rocket engines and a thrust of 600 tons. These should operate for eleven seconds and give the primary object a speed of 1,850 km/h. The final section of the ramp had a pitch angle of 30° and would have put the spacecraft into a climb right from the start. (It would probably have been cheapest to build such a launch rail on the slope of a mountain with a corresponding profile.) The engines would not have been activated immediately after takeoff, but only after several seconds at an altitude of 1,200 m. They would have eight Continuous propulsion was provided for minutes and Thor's hammer was propelled at a speed of 22,110 km/h to the point where ballistic flight would have been initiated at an altitude of 145 km above the earth's surface. At this point all fuel would have been used up. After spanning a few thousand kilometers, the space bomber would have started approaching the thin layers of the atmosphere again. Only here could it have used its flat surface and small wingspan of 15 m. It would then have "bounced" off the layer of air and entered ballistic flight again for some time. (The calculation of such a trajectory was still difficult even in the 1960s, when the Apollo spacecraft was being designed under the direction of Wernher von Braun. If the landing module had entered the atmosphere at too steep an angle, there would have been a risk of it burning up ; conversely, if the re-entry angle was too shallow, it could have been pushed back into space.)



Thor's hammer in starting configuration. (Drawing: B. Rduÿtowski)

A multiple “bounce” would then have had the following advantages: Firstly, it would have increased the range. Secondly, this would solve the problem of the outer skin overheating, as it would have been repeatedly cooled down in the higher areas. In the final phase of flight, the rocket plane would have had a sufficiently reduced speed so that this problem would not have exceeded the technical capabilities of the time. Third, each phase of “low flight” offered the practical opportunity to drop a bomb. However, the possibility of using an atomic bomb was not considered until 1944.

After developing a preliminary draft, Dr. Singer focused on studying design heating caused by air resistance.
It is known that research in this area was already at an advanced stage in 1939. Singer also worked on an engine with a thrust of 100 tons, but without much progress. This work was interrupted in 1942 because another team from Peenemünde designed an analog engine for the A9/ A10 rocket.

# The Air Force

## A time of searching

### The Me-262

Of all the Third Reich's advanced missiles, the Messer Schmitt 262 probably had the greatest influence on the course of the Second World War. It was one of the few aircraft that made it into series production and combat use from the large mass of often unconventional aircraft.

Although it was not the first jet aircraft, the Me-262 became in some ways a symbol of the huge technological leap that took place during the war in aviation and technology in general.

A total of five jet engines were constructed in the Third Reich, four of them during the war. The BMW-003, which underwent several modifications between 1941 and 1943, the relatively analogous Junkers Jumo-004 and the slightly larger HeS-011 from Heinkel-Hirth. Compared to the Jumo-004, it had an increased thrust force from 8 to 9 kN and was a further development of the not very successful predecessor HeS-08. In 1945, another engine was to go into production, which was significantly larger and more modern than the previous BMW 018 engine. However, that didn't happen. A thrust of 34 kN would have enabled the implementation of large jet bombers.

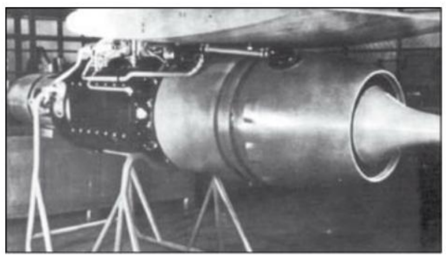
The first BMW 003 engines were delivered on July 27, 1941. They were installed in one of the Me-262 prototypes, but both failed just seconds after the aircraft took off. The entire program would certainly have been canceled if the Junkers factories, which were also working on jet engines at the same time, had not stepped in to “rescue” it. They provided their latest Jumo-004 engine, which was similar to the BMW engines but slightly larger. The installation required some redesign of the engine nacelle and wings, but these measures proved to be the case right out. The new engines did not have as many problems as the BMW engines and finally replaced them.

The basic equipment of the aircraft was therefore fixed, even if the results of subsequent flight tests required further changes. Through improvements to both engines, the weight was reduced by 180 kg and a total thrust of 1,800 kg was achieved. In this configuration the aircraft easily exceeded a speed of 800 km/h. The V9 test version with a smaller cockpit windshield was even faster than 1,000 km/h in a steep descent.

However, it was abandoned due to the limited field of vision.

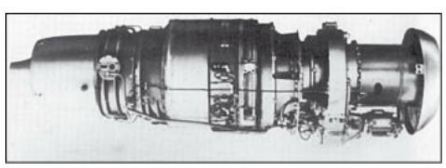
The time had come to make a decision regarding series production

…



The BMW 003 engine on a test bench. (Photo: Military Archives)

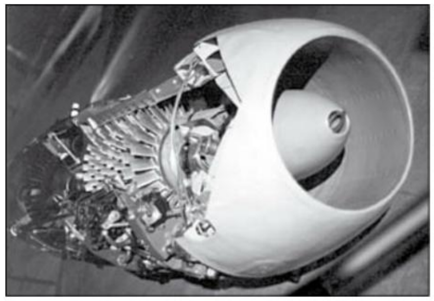
It was decided to hold an official demonstration of the aircraft, to which Hitler, Göring and other high-ranking Luftwaffe officers were invited. The date was set for November 26, 1943. After an impressive demonstration of the capabilities of the new fighter pilot, Hitler became its most zealous advocate and gave the order to begin preparations for series production, although these had actually begun earlier.



The HeS-011 without housing. (Photo: NARA)

In addition to the Messerschmitt works, a number of subcontractors from various industries were involved in the construction. For the assembly of the

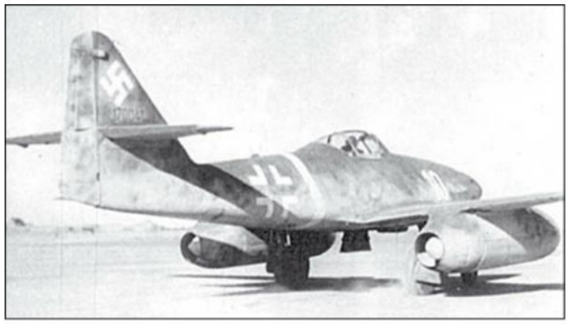
The aircraft identified two underground complexes near Weimar and Nordhausen. 26-30



The Jumo 004 jet engine with the housing partially dismantled. This specimen was examined at Wright Field Air Force Base after the war. (Photo: I. Witkowski)

At least these were the plans for 1943. When the Me-262 was included in the so-called “fighter program” a year later and thus the priorities were shifted to new air weapons, there were already several such factories. The devastating Allied air raids of that time increased the importance of underground factories. The following underground factories were used for the production of the Me 262: “Bergkristall” near Linz (the only completed factory produced 987 aircraft, most of them within a month) was considered one of the most modern factories in the world, “Lachs” in Thuringia,[31] 32 which was 40%completed and whose tunnels reached a total length of 26 km, as well as at least one factory in the “Weingut” series in Bavaria, which consisted of huge semi-underground bunkers (“Weingut II”).[33] There would even have been room for a launching catapult for the aircraft built under the 362 m long, 97 m wide and at least five meter thick ceiling.

In addition, a number of components were or should be for the Me-262 are manufactured in other underground factories, including:[34] “Salamander” (Przyÿÿk/Poland),[35] “Mittelwerk” (1,463 engines),[36] “Zechstein” (Rabstein/Czech Republic) and the “Flugzeugwerke[34] Eger” (Cheb/Czech Republic). As with other types of aircraft or missiles, the Third Reich's secret weapons were closely linked to its underground economy, which I have written about in a separate book. 37



The Me-262. (Photo: Military Archives)

Let's go to 1943 and the work on the Me-262
to return. When everything looked as if a successful weapon system had finally been developed that could have brought a positive change in air combat to the Third Reich, whose industry had been largely paralyzed by enemy area bombing, new problems arose: namely political ones.

Die Me-262A-1a/Jabo. (Photo: NAIC)

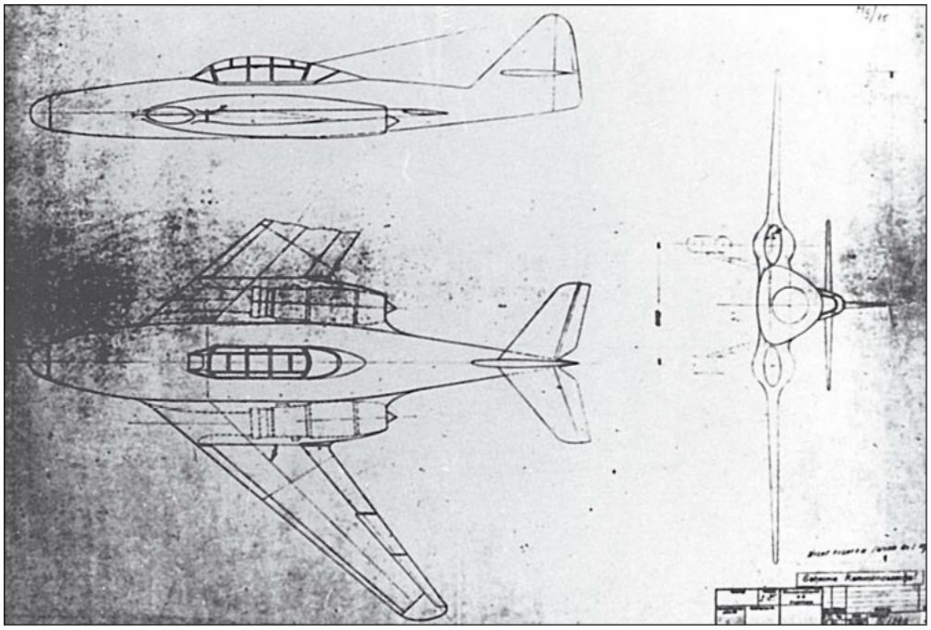
Hitler always thought only about attacking and not about defending, even if this contradicted the actual situation. He now demanded that the Me-262 be "converted" into a bomber. After the invasion of Normandy, this trend increased even further.

He believed that this model of bomber was too fast and too "elusive" for the enemy and could therefore stop the enemy attacks that were penetrating deeper and deeper into France. In reality, the Me 262 was completely unsuitable as a bomber and the additional weight significantly degraded its performance. Although Hitler originally insisted on completely abandoning the designation "Jäger" for the Me-262,

A compromise was reached that turned the aircraft into a fighter-bomber variant. The Me-262A-1a/Jabo was used as a basic version and had two holders for 500 kg bombs under the fuselage.
Apart from that, there were no differences to the “normal” A-1a fighter version. Independent work was carried out on a special version of the bomber, which would make it possible to drop bombs while diving.
This variant had a modified nose section that housed a small cockpit with a new bomb sight called “Lofte 7H”. It was given the designation Me-262-2a/U1 or Me-262-2a/U2 (later changed to Me-262A-4).

The Me-262V-1a/U1 – a two-seat night plane equipped with radar. (Photo: Military Archives)

In the fall of 1944, however, a completely new version was built - a night fighter. It was equipped with an on-board radar and an antenna system on the nose of the aircraft. The night fighter was developed based on a two-seat training version, in which the seat behind the pilot now had space for a radar technician and other equipment, including friend-or-foe detection. The fuselage was lengthened slightly to increase the capacity of the fuel tanks, which in the training version was up to 1,650 liters less than the original version. There was also the option of hanging additional fuel tanks. The Lufthansa workshops in Berlin-Staaken were commissioned to convert the training aircraft into night fighters.



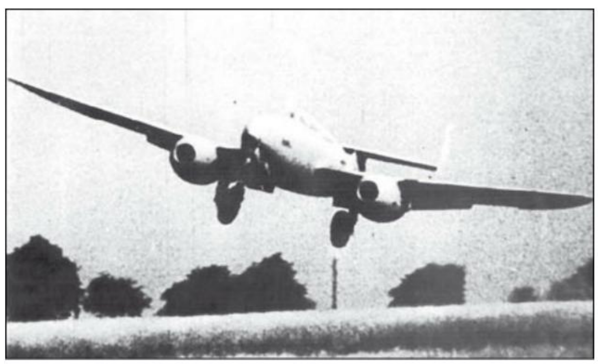
Original plans of the Me-262 HG III. (Photo from the author's collection)

The modifications were carried out as follows: The B-1a/U1 and the B-2 were equipped with the FuG-218 radar as well as an extremely useful system called the GuG-350 *Naxos* , which detects the radiation of British H2S bomber radar signals could.

Of the night fighter aircraft mentioned, only the first made it into combat. Several examples delivered between January and April 1945 took part in the defense of Berlin and achieved some spectacular victories. The unit's commander alone, First Lieutenant Walter, shot down 29 aircraft, including two four-engine bombers. 38

The Messerschmitt 262 Schwalbe versions described above were actually built, but in addition several very interesting and unusual versions were found on construction plans, some prototypes of which also existed in various stages of development. First and foremost, the aerodynamics were refined. For this purpose, three versions with new wings were designed, which were named HG I, HG II and HG III (HG stands for “High Speed”). The HG-I version was limited to the installation of a new tail section and improved rounding of the wing leading edges (as on the "high-speed" test version Me-262V), as well as a large wing

Fuselage connection in front of the wings, which reduced drag and improved lift. Completely new wings were then used in the HG-II version. It was characterized by an increased lifting surface of the wings and further improved rounding of the leading edges. The Me-262 HG III was the continuation of this development.
The curves on the leading edges reached up to 49°, and at the same time the engines were installed in the streamlined wing-fuselage transitions. This was one of the many German solutions that were adopted by designers from other countries after the war. However, the HG versions did not make it beyond the drawing board versions, although smaller model tests took place. Professor Lippisch, who was known for his unconventional designs, proposed a modified version in which the cockpit was moved to the tail, where it would be housed in a large triangular vertical fin - but this proposal was no longer implemented.



The Heinkel He-280 was the rival of the Me-262, but had significantly worse flight characteristics. (Photo: Federal Archives)

Among other things, research was also carried out into alternative drive options. The Me-262C3 was intended to be a fighter with an additional rocket drive in addition to the engines used up to that point.
To do this, a container was to be placed under the fuselage, in which part of the liquid fuel rocket was located, as well as fuel tanks and the oxidizer. After reaching the desired height, the container should be dropped and returned to the ground with the help of a parachute, where it should be collected and prepared for reuse.

The Me-262 *Lorin* project represented an even more valuable design. In addition to the standard Jumo engines, they were also planned Attachment of two large but lightweight ramjet engines (one Type of engine without turbine and compressor) after reaching the appropriate speed should be switched on. This version was probably the furthest ahead of their time. This plane should, just like them HG-III version, reach Speed in the limit range the speed of sound.

Finally, another drive variant should be mentioned. After the delayed improvements to the “rival” BMW 003 engine An aircraft with a combined propulsion system was tested handed over, which consists of the engine in question and the BMW 718 rocket engine (both housed in a single housing). The latter was mixed with a mixture of concentrated nitric acid, Sulfuric acid (oxidizing agent) and an aniline solution. The Burning time of around three minutes made it possible to achieve one on steep climbs A height of 7,500 meters can be reached in just 90 seconds! A height of 12,000 meters was reached in less than four minutes. In total Approximately 1,500 examples of all variants of the Me-262 were produced.

Finally, we should realize that the Me-262 and the individual solutions that were used in it became a role model for many Post-war designs were built - including the Russian Su-9. German Engines were also closely examined in various countries.

## Tactical and technical details of selected versions of the Me-262

| | A1a | B2A | HG III |
|---|---|---|---|
| Wingspan (m) | 12,65 | 12,65 | 12,65 |
| Length (m) | 10,60 | 10,75 | 10,60 |
| Height (m) | 3,85 | 3,85 | 3,85 |
| Wing area (m²) | 21,70 | 21,70 | 28,50 |
| Leather masses (kg) | 4.000 | 4.764 | 4.323 |
| Takeoff mass (kg) | 6.775 | 7.700 | 6.697 |
| Maximum speed (km/h)* | 870 | 841 | 1,100 |
| Range (km) | 845 | – | – |

* when flying horizontally at an altitude of 6,000 meters

# The Me-163

The Second World War was the time in which not only jet aircraft, but also rocket aircraft made their debut. The only German model used in combat was the Me-163.

The Me-163, the fastest fighter of World War II and the first aircraft used in combat without a tail tail, was, like the Me-262, the result of work that had begun before the outbreak of World War II.

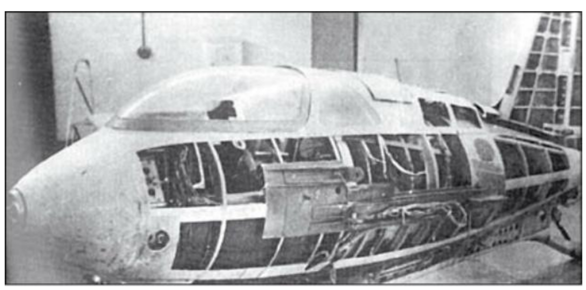
The work consumed a huge amount of resources that were disproportionate to the military benefit. 364 examples of the *Komet* were delivered to the Luftwaffe, but only about a dozen enemy aircraft were confirmed to have been shot down.

The Me-163 was intended to be an interceptor based on preliminary work by designer Prof. Alexander Lippisch on aircraft without a tailplane that were powered by a rocket engine. The rocket engine was designed by Helmuth Walter, a chemist from Kiel. During development, the drive was gradually improved so that its thrust increased from the original 135 kp to 1,500 kp.

The Me-163's direct predecessor was a test aircraft called the DFS-194, designed by Lippisch in the late 1930s. Because of problems with the drive, a piston engine was initially installed in the aircraft. In 1940, the DFS-194 completed a successful test flight with the “Walter RI-203” rocket engine and became interesting to the Aviation Ministry, which ordered the development of the aircraft later known as the Me-263A. It was equipped with the new and improved RI-203 engine with a thrust of 17.5 kN. The first gliding flight was carried out in the spring of 1941, with the prototype towing an Me-110. In the summer, test flights were carried out with four aircraft that were already flying under their own power. During a test flight on October 2nd, H. Dittmar exceeded the world speed record in horizontal flight with a flight speed of 1,004 km/h at an altitude of 3,600 meters.

The Me-163 in combat readiness. (Photo: German Museum)

Based on these results, the Air Ministry ordered a prototype of the Me-163B fighter, which used a Walter 109-509A (R-II-211) engine with a regulated thrust of 3 - 15 kN, powered by a mixture of " T-Stoff" and "C-Stoff" (hydrazine, methanol and water) were operated. To avoid spinning at high speeds, slats were installed on the wings and the shape of the fuselage was adjusted. In April 1941 the first prototype of the Me-163 BV 1 was built. A short time later, Messerschmitt AG began series production of 70 Me-163 B-0 aircraft. From February 1943, Test Command 16 was tasked with training pilots and developing optimal war tactics.



A prototype Me-263 during assembly and at an airfield with incomplete fairing. Photos from the spring of 1944. (Photo: Military Archives)

The shockingly simple cockpit of the Me-163. (Photo: NARA)

The fighters from series production were given the designation Me-163 B 1a. Their armament consisted of two MK-108 30 mm cannons with one Stock of 120 pieces of ammunition (the B-0 version had two 20mm cannons).

It is hardly known that units located in Poland today Territory played a large role in the training of the Me-163 Pilots played. In Rudniki, north of Czÿstochowa mainly carried out training with gliders. On the present The planes were already arriving at the military base in Mierzÿcice near Katowice for use (at that time the base was called "Udetfeld", in memory of the deceased pilot Udet). In Mierzÿcice, among other things Versions of the Me-163 tested with multiple rocket launchers.

## Technical data of the Me-163 B

| | |
|---|---|
| Learning masses: | 1.905 kg |
| Starting mass: | 4.110 kg |
| Long: | 5,69 m |
| Wingspan: | 9,32 m |
| Buoyancy surface: | 19,62 m² |
| Maximum thrust: | 17 kN (1,700 kp) |
| Rocket engine burning time: approx. | 8 min |
| Maximum speed: | at sea level: 835 km/h<br>at an altitude of 3,000 meters: 960 km/h |
| Steigrate: | ca. 60 m/s |
| Rise time: | to an altitude of 2 km: 1 min 46 s<br>to an altitude of 6 km: 2 min 26 s |

| | |
|---|---|
| | to an altitude of 12 km: 3 min 45 s |
| Flight altitude: | 12.000 m |
| Range: | ca. 100 km |

# Die He-162

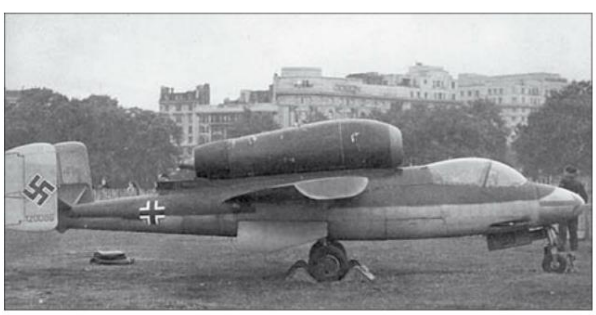
The Me-262 and Me-163 were not the only innovative fighter aircraft with which the Luftwaffe was upgraded. There was another one

...

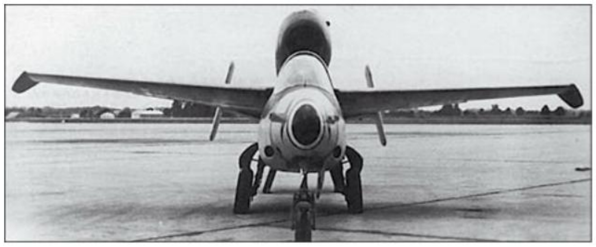
As the Luftwaffe quickly lost control of German airspace and the German defense industry was devastated by the many thousands of Allied bombers, the Germans were forced to take swift and immediate countermeasures.

In March 1944, the framework for the corresponding “fighter program” was defined, the aim of which was to supply the Luftwaffe with a fighter that was relatively easy to produce and maintain and, above all, that would not consume too many strategic raw materials. The comparatively small single-seat fighter was to be produced in large numbers and powered by the single jet engines available at the time.

At the end of August 1944, the basic technical guidelines were defined and handed over as a list of requirements to the companies Heinkel, Arado, Blohm and Voss, Focke-Wulf and Junkers. The aircraft was to be equipped with a BMW 003 engine and reach a speed of around 750 km/h. The surface load should also not be higher than 200 kg/m². With a takeoff mass of less than 2,000 kg, the aim was to achieve a takeoff distance of 500 meters. Since the “Volksjäger” was supposed to operate from simple, densely distributed airfields, a flight time of 20 – 30 minutes was considered sufficient. The aircraft was only to be equipped with two MK-108 cannons.



The He-162 at the Schwechat airfield in Vienna. (Photo: NARA)



It suited the simple structure of the fighter that the time until the designs were presented on September 20, 1944 was very short. Series production was scheduled to begin on January 1st of next year.
In practice, only Heinkel managed to stick to this tight schedule. On the 23rd In September, the company presented a mock-up and a preliminary design of its aircraft to the Inspector General of the Air Force. As a result, even before prototypes and individual solutions were presented, Heinkel was rewarded with a contract for the production of the aircraft, which was signed on the same day it received its name: He-162. The construction was technically practically risk-free – it was just very simple. To simplify the design of the fuselage and reduce the risk of foreign objects being sucked into the engine, it was mounted on the outside - on the fuselage. This also reduced the risk of the wooden hull catching fire.

The planning work was finally completed at the end of October. Four prototypes were built. The first took off from Schwechat airfield in Vienna on December 6th. Although the flights initially went without major problems and took advantage of the amazing mobility of this simple design, the first prototype crashed in early December 1944. Most of the other prototypes also crashed.
One of the main reasons for this was certainly sabotage by forced laborers. I have a report from a relative who was involved in assembling an aircraft that was tested in Schwechat. For example, he remembers that drills with a slightly larger diameter were usually used to make the holes for the bolts, which the Germans did not notice.

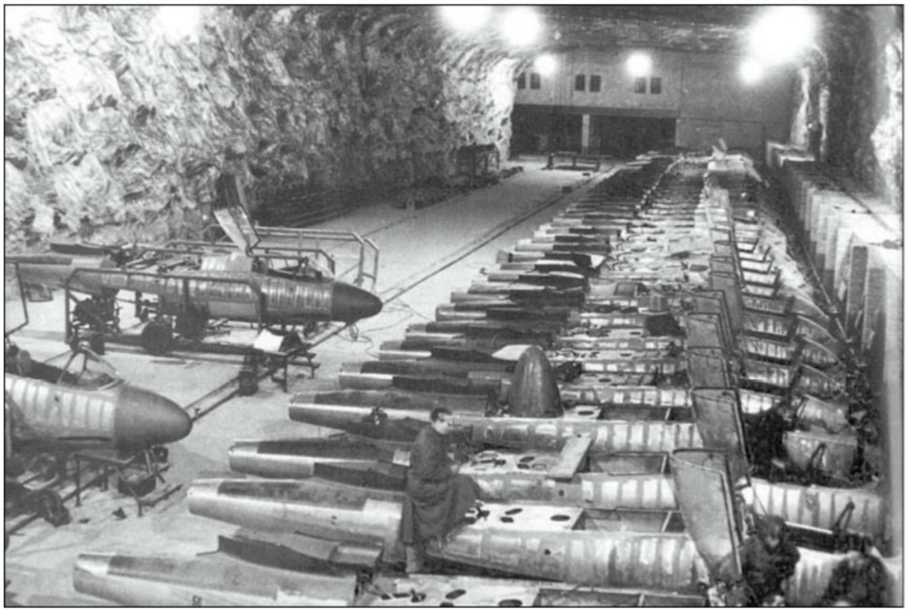
After the test flights, certain modifications were made: the wing structure was strengthened, a more powerful version of the

A BMW 003 engine with a thrust of 800 kp was installed and the fuselage design was changed. The companies were commissioned with series production.

Many of the guidelines and expectations surrounding the fighter were unrealistic in every way - a fact repeatedly pointed out by Air Force officers as well as numerous industry professionals. The main criticism concerned the poor combat characteristics of the Volksjäger, which made it unable to compete with Allied aircraft, and the at least questionable use of extremely poorly trained and inexperienced pilots from the Hitler Youth. Instead, the Luftwaffe generals called for an increase in production of the Me 262, which enjoyed a very good reputation as a tried and tested aircraft.
Professor Willi Messerschmitt took the same stance in his report to the Air Force Ministry: “From a technical

> point of view, the He-162 is a step behind,” and added that “the demands that the Volksjäger is supposed to meet are based on false foundations, since those that already exist today “Combat aircraft can perform all of these tasks better.”

However, the years 1944 and 1945 were a period in which arguments based on reason rarely met with Hitler's approval. The SS and incompetent ideologues from the inner circles gained ever greater influence over the war machine of the Third Reich and supported even the most absurd concepts in their competition for the Führer's goodwill.



Unfinished He-162 fuselages in the gallery of an underground factory - probably "Tortoise"

The program to design the Volksjäger was therefore continued. The unfortunate situation of the German economy, however, became more and more noticeable. It wasn't until February 1945 that mass production was considered; definitely too late for the He-162 to play a decisive role. There were currently no doubts about the implementation of the plans for series production. However, production plans from 1945 with 1,000 - 5,000 BMW 003 engines produced per month remained mere paper tigers. In March, a critical month for He-162 production, only 100 examples were built. In total, only around 250 - 270 Volksjäger were produced by the end of the war. Of the few air battles in which the fighter took part, the first took place on May 2nd.

Many development versions of this fighter remained only drawing board designs, including examples with more powerful engines, Argus Resojet Engines from the V1 and negatively swept wings. [26,27,29,30]

## Tactical and technical details of the He-162 A2

| | |
|---|---|
| Long: | 9.05 |
| Wingspan: | m 7.20 |
| Starting mass: | m 2,805 |
| kg Maximum speed: approx. 840 km/ | |
| h Range: | ca. 600 km |

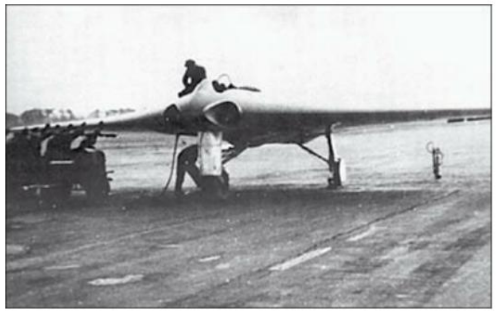
| | |
|---|---|
| Armament: | two 20mm cannons |

# Die Ho-IX

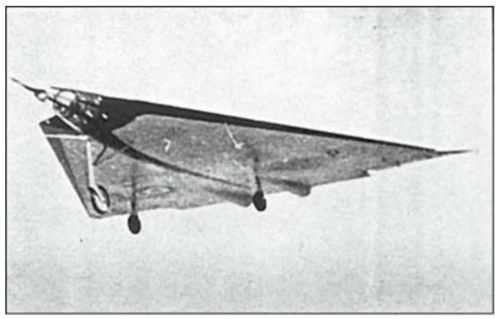
Of the many German fighter jet models, including those that did not enter serial production, one deserves special attention. This is the Horten brothers' flying wing: the Ho-IX. This aircraft was the crowning achievement of the fast but successful career of the young designers from Bonn.

The brothers' first design, already described, was the Me-163 rocket fighter and its further development, the Me-263. However, this was just one of many designs of this kind. The famous brothers Reimar and Walter Horten from Bonn were pioneers in this field not only in Germany but throughout the world.

Their first self-powered aircraft was the Ho-V, whose origins date back to 1936. It was an experimental design that allowed many new solutions to be tested, such as control using flaps on the wing tips, but this did not prove advantageous at the time and caused the prototype to crash. In addition to its unconventional aerodynamic system, the Ho-V was a groundbreaking design in other respects. It consisted mostly of plastic and the remaining parts of wood. With a celluloid coating on the outer skin and only small amounts of metal in the construction, the aircraft would have been very difficult to detect in a future war mission. If the radar-absorbing coating (in the form of plastics and paint - see the last chapter in this book) later developed by the Germans had been used here, we would have the first "real" stealth aircraft before us. But the Germans didn't go that route. The Ho-V was a two-seater, powered by two Hirth HM-60R piston engines with 80 hp. It was built with financial support from Dynamit AG.

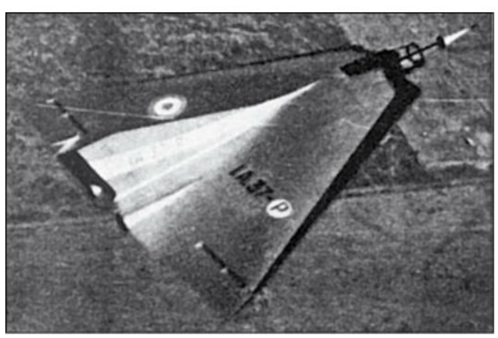


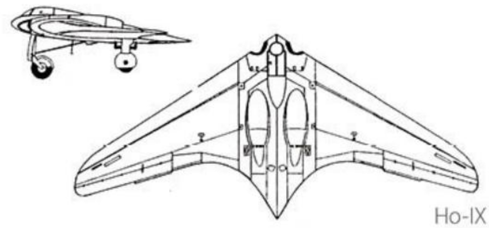
The Ho-IX. (Photo from the author's collection)



The Hortens aircraft completed in Argentina – the I.Ae.37. (Photo: Instituto Aerotecnica).

In the early 1940s, information reached Germany from the United States that Northrop, an exceptionally talented designer, was working on an aerodynamic “flying wing” system. The Air Force Ministry then provided the Horten brothers with unlimited funding for research projects in 1942.






The Ho-IX was a further development of the concept that had been pursued until then. However, in view of the use of jet propulsion and the likely military use, the airframe was completely redesigned. The construction was reinforced and a profile designed for high speeds was used. For this purpose, calculations and research results from Professor Busemann, who had already dealt with this problem in the late 1930s, were used. The middle section of the wing was widened and the rear edge also had a slight negative curve, so that a relatively “thick” profile could be used in this section. This “fuselage set” housed both engines, the air intake vents in the front section and the cockpit, relatively heavy armament (four MK-108 30 mm cannons plus ammunition) and, in the night fighter version, an on-board radar. The aircraft was to be powered by two Jumo 004 engines. The takeoff weight was 7.5 tons. After Göring's personal intervention, where the aircraft made a lasting impression at an air show in January 1945 (the prototype reached a speed of 800 km/h), it was transferred to the Gothaer Waggonfabrik for production. The aircraft received the designation Ho-229. It was by far the most sophisticated design of the aircraft type discussed up to that point, but only a small group of prototypes could be built by the end of the war. Therefore, the Ho-IX was never used in war, which is a shame as a comparison of this aircraft with classic designs would have been very interesting. In 1945, based on the version described, a fighter bomber variant with a bomb load of 2,000 kg and a night fighter version were built. Both variants had two-man cockpits instead of the single-seaters in the simple fighter variants. After the war, one of the Ho-229 prototypes was brought to the USA, where it was examined extremely thoroughly. The Ho-IX was probably the first

Prototype on which the technology to reduce “radar visibility” was tested. The insides of the wings were coated with a mixture of wood dust, charcoal and glue to absorb the radar beam and thus shield the metal framework to some extent.
However, I do not know the results of these experiments. They could have been very promising, as the shape of the aircraft alone was very favorable in this respect.

At the beginning of 1945, the Gotha and Klemm companies received the first orders for series production of the Ho-229 fighter - the first for 53 and the second for 40 units. A night fighter equipped with the FuG-224 “Bremen” radar should be built with second highest priority. The execution of these plans had only just begun when the end of the war interrupted them. 40-42

At the same time, from 1944 to 1945, the Horten brothers had also developed a number of different and interesting aircraft, all of which remained at the model stage or existed only as plans and calculations.

These were:

• the Ho-VIII intercontinental passenger aircraft, which was developed with the post-war period in mind and was to be powered by six Jumo 222 aircraft engines, each with 3,000 hp, mounted on the trailing edges of the wings. Looking back, they should probably have been turbocharged engines. The passenger cabin was to be housed in the middle section of the wings and form the fuselage of the aircraft. The take-off mass would probably have been 120 tons, quite a lot for the time. In 1945 a 1:2 scale model was built; • the Ho-X as a response to the program to build the “Volksjäger” – a single-seat fighter that, like all other Horten brothers’ designs, was obviously designed in the “flying wing” style. With a wingspan of 9.2 meters, it was much smaller than the Ho-IX with a 16-meter wingspan and was somewhat reminiscent of the Me-163 rocket fighter. The Ho-X would not be ready for series production until 1946;

• the Ho-XII training light aircraft, which was a further development of the older Ho-IV glider and represented the latest achievements of the

Aerodynamics should be combined, including findings from airframe tests with the American *Mustang.* The wingspan should be 16 meters;

- the supersonic fighter Ho-XIII, whose development began at the beginning of 1944 and which was supposed to reach a speed of up to 1,800 km/h at high altitudes. The aircraft's wing design was very interesting as it was different from any design previously used. A particularly strong sweep of the leading edges of 60°, very thin wing sections (camber of about 10% of the wing width), an extremely acute angle of the front sections and the exact placement of the aircraft nozzle at wing height should all contribute to reducing aerodynamic drag when flying at supersonic speeds . The aircraft had a fin and rudder with a strong sweep. In the first version of the fighter there was supposed to be a narrow cockpit in the middle section of the rudder. Later it was planned to place the cockpit and the disposable substructures (with additional wheels on the wing tips) in a housing under the wings. The original idea was to accommodate a single, large engine with an afterburner in the center section of the wing. However, it was ultimately decided to use two "hybrid" BMW 003R engines, which would be mounted under the central section of the wings. Such an engine consisted of a standard jet turbine engine, which provided a thrust of 1,000 kp, and a liquid-propellant rocket engine with a thrust of 400 kp. At the end of the war, the first Ho-XIII prototype was in the first phase of construction. It should then be ready for flight tests in mid-1946. The wingspan was planned to be around 12.5 m;

- the Ho-XVIII long-range fast bomber. It was to be powered by six modernized Jumo-004H engines. It had no fuselage; instead, the crew, bomb load and much of the on-board equipment were housed in the wings. The engines were to be mounted under the wings. The armament was to consist of a four-ton bomb load and two anti-aircraft guns, one on the nose and the other on the end of the tail fin. At a flight speed of 800 km/h, a range of around 8,000 km was aimed for. Part of the bomb load and the main landing gear should be able to be retracted into the wings. The Ho-XVIII should be characterized by the following characteristics: wingspan - 30 meters, lifting area - 156 m², take-off mass in the order of 34,000 kg (slightly less in a future variant with four HeS-011 engines). Work on the aircraft began in early 1945 and was expected to be completed two years later.

The Horten brothers were not the only Germans who worked on the aerodynamic system described. They had strong competition from Professor Dr. Alexander Lippisch from Munich - one of the world's outstanding scientists in the field of aerodynamics and aviation technology at the time. Lippisch's work is described in the second part of this book. It is also worth mentioning that, contrary to popular belief, there were many other German designs for flying wings.



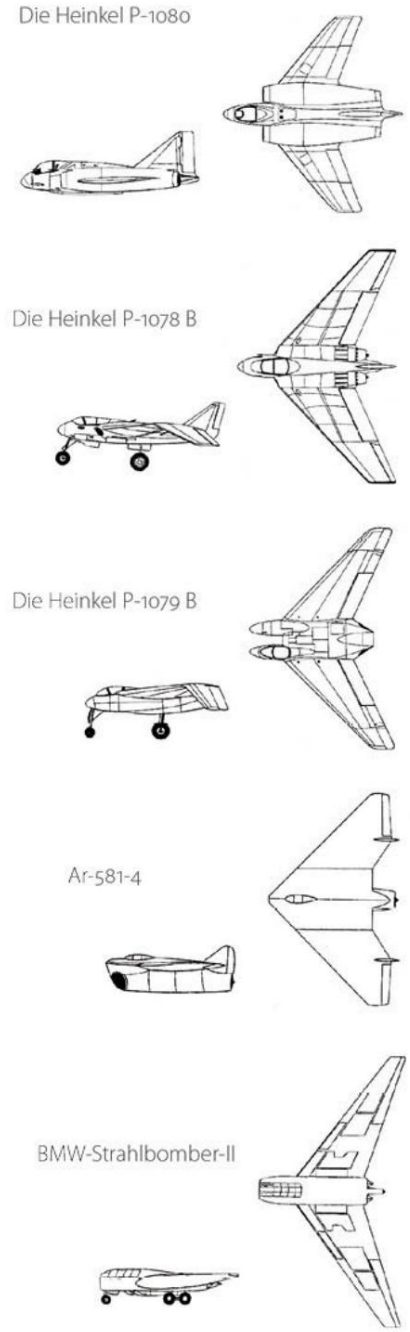
The P-1111 was one of several aircraft developed at the Messerschmitt factories. It was to be powered by a single HeS-011 engine. Both the P-1111's wings and its fin featured an exceptionally high leading edge sweep of approximately 45°. It is estimated that the aircraft could have reached a speed of 1,000 km/h in this way.

The production facilities of the Heinkel aircraft factory were, alongside the Horten brothers and the institutes headed by Professor Lippisch, the third important source of interesting constructions from the series of flying wings. The number of units they delivered was rather modest, but nonetheless ambitious.

Three models of these aircraft were built there in the last ten months of the war. The first was the P-1078, of which two versions existed. The first (P-1078 A) was classic and powered by one engine. Their design was similar to Kurt Tank's Ta-183 and the Messerschmitt P-1101. The second version (P-1078 B), however, was characterized by a flying wing design (without a tail section and a significantly reduced fuselage) and a drive system consisting of two engines.

The P-1708 B was to be a single-seat fighter with a takeoff mass of 3,900 kg and capable of reaching a speed of up to 1,000 km/h.
The large wings (around 20.5 m² with a wingspan of 9.4 m) would have made it possible to fly at high altitudes of around 13,500 meters.

A further development of this project was the design of the P-1079, which was available in two versions developed in parallel - classic and without a tail, each marked A and B. The second version differed from the P-1078 B in that it completely omitted the fuselage and fin. The pilot sat in the cockpit, which was housed in the front left part of the wing center section, a similarly shaped housing on the right side was intended for the on-board radar and cannons. This version was designed as a single-seat night fighter.




The P-1080 concept, however, represented a slightly different development path. In terms of its general construction it differed less from the P-1078 than from the P-1078 B, but there were two new ones, designed by Dr. Singer developed ramjet engines with a large diameter (90 cm) for use. However, these should be powered by conventional fuel. After the aircraft was accelerated by four solid propellant rocket engines, the main engines were to be ignited to achieve a thrust of 1,170 kg at a speed of 500 km/h and 4,370 kg at a speed of 1,000 km/h. A serious problem that was never solved before the end of the war was the extremely high temperature in the combustion chamber, which reached 2,500 °C. The P-1080 was designed as a fighter aircraft and was equipped with an onboard radar hidden under the nose windshield. Before the end of the war, not even a single prototype was completed.

The Arado company also tried to design its own aircraft without a tailplane (this time as a fighter variant), which was named Ar-581-4. It was to be powered by just one HeS-011 engine.

This model was supposed to have triangular wings with a span of approximately 10 m, which resembled an isosceles, right-angled triangle in outline.

Known as the Strahlbomber-II, BMW's concept was similar in design to the Junkers EF-130. It was to be an aircraft with a take-off mass of 31,500 kg, powered by two BMW 018 jet engines placed in the rear center section, each with a thrust of 3,450 kg.

A very large combat load of well over 10 tons was planned for the time. It was one of several bombers being considered as part of a program to design a new, long-range, fast bomber. To conclude the description of jet fighters in the Third Reich, the work on their second generation - related to the Me-262 - should be mentioned. This concerns the P-13b aircraft from Lippisch, the Ta-283, the Triebflugel (which is described in the second part of the book) as well as the P-1101 and P-1110 from Messerschmitt and the Ta-183 from Kurt Tank. Of the last three, only the P-1101 and the Ta-183 probably reached the prototype stage.

## Messerschmitt P-1101

The P-1101 was developed from July 1944 until the end of the war based on an Air Ministry order placed in mid-1944. Based on the test results of this design (after any necessary modifications), a new tactical fighter aircraft was to be created that could have complemented the Me-262. It should be better

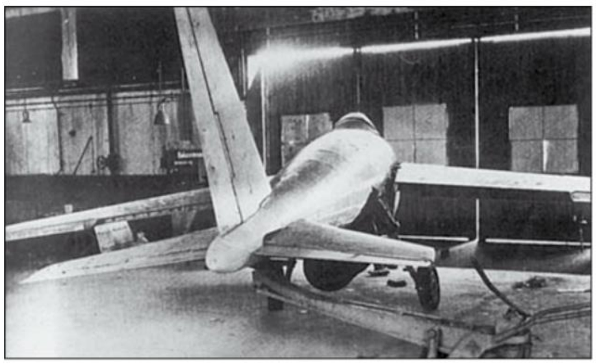
Be suitable for conducting air battles with enemy fighters, be characterized by greater maneuverability and - what was extremely important - reach a speed of not less than 1,000 km / h in horizontal flight. However, the design was significantly simpler compared to the Me-262. The aircraft was also less demanding in view of the increasingly scarce raw materials.

The P-1101 with engine and dummy cannon mounted (probably only after the war), but without engine casing, wing-fuselage transitions and rear fuselage section. (Photo: US Army)

It was intended to be powered by a single HeS-011 jet engine, but due to production bottlenecks the BMW-003 engine was temporarily used. The engine was located in the lower center section of the fuselage, with the air intake placed in the nose. Above the engine and behind the cockpit was the fuel tank, which was sufficient for a flight of about half an hour. Additional fuel tanks were housed in the wings.

The most important key to the success of the P-1101 was the use of the latest advances in aerodynamics, especially the strong wing and control surface sweep. One of the prototypes constructed during the early months of 1945 had the wings installed on "adjustable" mounts, allowing the wing sweep to be changed between 35° and 45°. However, this could only happen on the ground.

By the end of the war, the first prototype of this aircraft was 80 percent complete (only the engine had not yet been assembled). After it was taken over by the Americans, it was taken to Bell Laboratories - similar to the Ta-183, Germany's surrender did not mean the end of the project. However, on the Americans, the wings were mounted on bearings, which allowed the geometry to be changed during flight.



The P-1101 – rear and front view. (Photo: US Army)

After its completion it was given the designation Bell X-5. During the flight tests it became clear that a large part of Messerschmidt's plans could be realized. However, certain deficiencies remained. The first was the relatively strong flight instability, which resulted from the “offset” position of the engine axis to the center of thrust.

It was also very difficult to get the aircraft out of a spin, which led to a serious accident. The program was then ended.

The short maximum flight duration also posed a problem. An attempt was made in Germany to remedy this by designing a development version (P-1106), in which the cockpit was moved significantly backwards. This created enough space in the front part of the fuselage for an additional fuel tank, which could have extended the flight duration to around an hour.

Despite certain shortcomings, the P-1101 remains one of the groundbreaking designs of the Second World War era.[29,43]

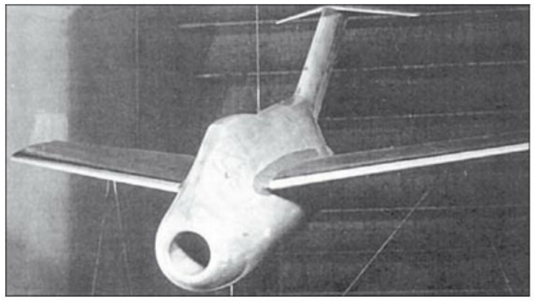
Tactical and technical details of the P-1101

| | |
|---|---|
| Length: 9.17 m Wingspan: | |
| approx. 8 m (adjustable) | |
| Takeoff weight: 4,070 kg | Maximum |
| speed: approx. 980 km/h | Flight range: |
| approx. 500 km Armament: | |
| | four 30mm cannons |

## Focke-Wulf Ta-183

In the Focke-Wulf factories, under the leadership of Kurt Tank, the company's main designer, a very interesting design was created that competed with the Messerschmitt P-1101. It was the Ta 183, one of many Third Reich-era designs that would play an important role in the development of jet aviation immediately after the war. 27.43-45 Their plans, which fell into the hands of the Russians in 1945, were used, among other things, for the design of the MiG-15. The Ta-183 was a significant step forward not only for the development of aeronautics, but also for technology in general, since, as in many other cases, the Germans were forced by austerity and the need to simplify technical procedures. The labor required to build this aircraft was even estimated to be 25 percent lower than the Me-262.

Work began in early 1942 when the Air Ministry showed interest in Tank's concept for a single-engine, jet-powered fighter, although neither the general design nor the aerodynamic specifications had been determined at that time. The engine had not yet been selected either although the Jumo 004 engine was initially favored because it was technically the most sophisticated at the time.

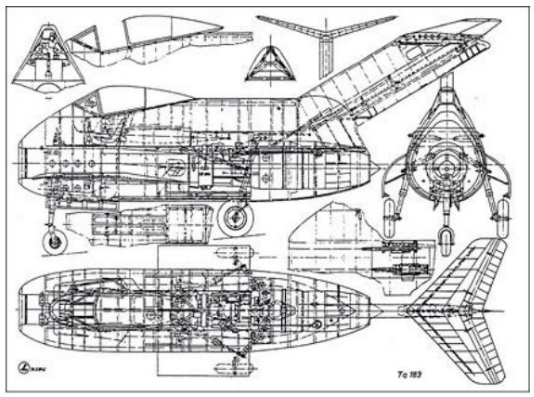


Dummy of the Ta-183 in the wind tunnel (Photo: DVL)

The design office, led by engineer Mittelhuber, received the contract and began designing many different versions of the aircraft. Since a completely new construction was to be created here, only limited use of previous experiences could be made; There was also a lack of developed and tested theoretical foundations. This ultimately led to nine different versions of the Ta-182 being designed before the final configuration was chosen.

A groundbreaking feature was the very strong sweep of both the wings and the control surfaces. The fuselage of this last variant was short, while the control surfaces were lengthened by their strong sweep and now resembled the sloping outline of the letter “T”. This exact design method was later introduced in both the West and the East - including the MiG-15. Only sloping aerodynamic surfaces made it possible to fully exploit the advantages of jet propulsion. After introducing certain modifications, particularly to the control surfaces, and moving the cockpit further back, the final configuration of the Ta-183 fighter emerged. Powered by an HeS-011 engine, it was expected to reach a speed of around 1,000 km/h. The wing had a sweep of 32° and the aircraft was to be armed with two MK-108 30mm cannons. Construction of the prototypes began in January 1945, using the Jumo 004 engines for technical reasons. It was not possible to complete it before the end of the war. On February 23, 1945, a contract for the series production of the Ta-183 was signed in Bad Eilsen, which of course never came into practice was implemented.

However, work continued after the end of the war... in Argentina, where Professor Tank, his team of engineers and the documentation were relocated in 1947. Based on the results of work on the Ta 183, the Pulqui-I and Pulqui-II models were built there, the flight of which was demonstrated during a military parade in 1952. Although this aircraft was considered one of the best jet fighter models at the time, it did not go into series production. Incidentally, work on the Horten brothers' flying grand pianos also continued in Argentina.




Original plans of the Ta-183 V1.

It was certain events in Buenos Aires that led to Kurt Tank's design being further developed. Its main protagonist was Gallardo Valdez, a major in Argentina's military intelligence service and a former research fellow at the Caltech Institute in California. Shortly before Christmas 1947 he prepared for a research trip to Moscow, but this was soon called into question because he received orders via the “military channel” to take over the position of air attaché in Stockholm. Before the contradictory instructions could be clarified, he had to cancel all plans.

In late autumn of the same year (i.e. spring in Argentina), an intelligence service in Madrid received a report that there was a group of outstanding German scientists and designers in Norway who were to be smuggled into Argentina immediately. The group used fake, am

Papers issued at the end of the war and could be exposed at any time.
Major Valdez was personally entrusted with the mission of their transfer. In the last days of 1947 he went to Sweden - not to take up his new position, but to wait for more detailed information about a meeting with the Germans.

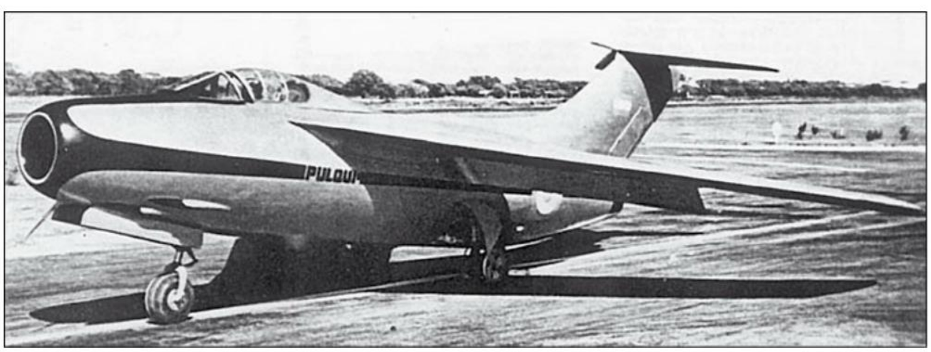
Afterwards he was supposed to travel to Oslo. Since the meeting had already been arranged by Muret, the Argentine consul in Norway, everything happened very quickly. In order to give the enemy no time to react, the Germans and Valdez went to the airfield immediately after the meeting, where a plane was already waiting for them.

It took off on a 40-hour flight to Buenos Aires (almost 13,000 km), punctuated by short stops for refueling. With the exception of a few meaningless utterances in English, the major had almost no conversation with the Germans during this entire time. He could only remember that a name like “Matias” or “Matthies” was mentioned. This was actually Pedro Matthies - the code name of Kurt Tank, one of the most prominent aviation designers of the 20th century. He had with him two of his most important employees and a suitcase full of microfilms of technical drawings. Originally, more of the professor's employees were supposed to be on board, but some had been arrested in Denmark and the plane had to take off without them. However, thanks to the help of the Argentines, Tank was able to quickly select new employees and thus “reconstructed” his research team. The aviation operations near Córdoba were made available to him. There he was supposed to finish work on his very promising project - the Ta-183. In 1948, the no less prominent Reimar Horten also came to Córdoba, the co-designer (together with his brother Walter) of the famous German “flying wings”, including

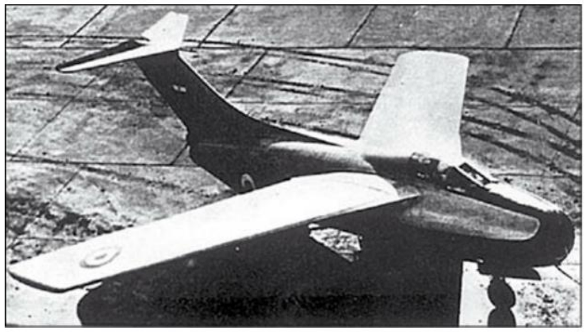
the super-modern jet fighter Ho-IX/Ho 229, which reached a speed of over 800 km/h in 1945 .

Another prominent aerospace designer from the Henschel Group also appeared in the Córdoba facilities - Julius Henrici. Specialists from other well-known companies such as Fieseler, Messerschmitt and Focke-Achgelis were also present. The latter made pioneering achievements in the production of helicopters.

The arrival of Tank was a significant event even for Perón, the tank soon submitted a memorandum describing his country's technical capabilities, including general guidelines for aviation development. In return, Tank proposed to design four types of aircraft - a light training aircraft, a reconnaissance aircraft, a medium bomber (these three types were to be equipped with propeller engines) and a modern jet-powered fighter. The latter type of aircraft met with great interest from the Argentine President and secured his immediate goodwill. The basis was to be the design of the Ta-183, which had been worked on in the Focke-Wulf project department in Bad Eilsen during the last weeks of the war. In this case it was about the version with a high tailplane (in the shape of the letter "T"), which the well-known aerodynamicist Hans Multhopp had worked on. This project had progressed to the stage of wind tunnel model testing in Germany, but unlike the Messerschmitt P-1101, a full-scale prototype was never built. A rival twin-fuselage version (similar to the British Vampire fighter) never progressed beyond this stage. However, it was precisely their authors - Ludwig Mittelhuber and the engineer Ulrich Stampa - who were supposed to support Tank in his work in Córdoba. Paradoxically, Multhopp was later hired by the British and continued to develop their project.




The Pulqui-II – a post-war development of the Ta-183. (Photo: Instituto Aerotecnico)



However, the Argentine fighter I.Ae.33 Pulqui-II was not supposed to be just a finished Ta-183. Significant changes were introduced, which meant that it was characterized by better flight performance than the model designed in Bad Eilsen. In addition, completely different components inevitably had to be used. The Ta-183 was originally supposed to be powered by an engine that no longer existed - the Heinkel HeS-011, which could not be completed by the end of the war and, according to very optimistic estimates, would develop a speed of almost 1,000 km / h in horizontal flight should. In Argentina, however, a Nene-2 engine from Rolls-Royce was used, which was characterized by similar dimensions and was considered very modern at the time (despite the unpromising use of a centrifugal compressor). This version was very similar to the model that the Russians copied and subsequently used to power their MiG-15. Along with the American F-86 Sabre, it was one of two counterparts to the Pulqui-II. By the way, this comparison alone gives a very high credit to Kurt Tank's team, who had largely developed his project during the war, from a technical point of view in a completely different era and using much simpler means than those used later by the design offices were available in the USSR and the USA. Tank was judged similarly by the British, who interrogated him shortly after the war but, strangely enough, did not try to get him to cooperate. This was also

expressed by Tom Bower, one of the best experts on the Allies' “hunt” for German scientists: 48

> “Tank and his aviation design team were proud of theirs achievements and upset that the British simply sent him back to Germany instead of immediately

> to reward his talent with a permanent position. Handel Davis [British aeronautical designer – ed. Author's] - one of many who had talked to Tank for hours was not at all surprised that Tank was not hired by the British: 'He was such an important person, so great, that it would have been incredibly difficult to keep him in one to accommodate the construction team. He probably wouldn't have been able to submit.'"

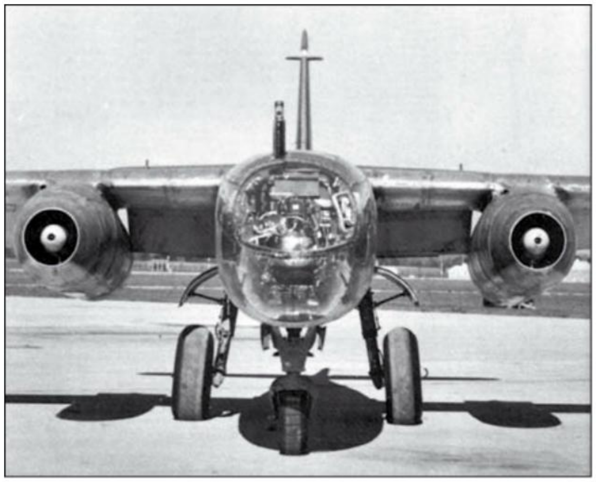
In addition, it should not go unmentioned that the "Argentinian sequel" also took place because many well-known pilots – air force flying aces – found themselves in Argentina, including Hans Ulrich Rudel, General of the Fighter Pilots Adolf Galland and General of the Fighter Pilots Werner Baumbach, who was in Argentina died while testing a development version of the Hs-293 long-range missile.

# Jet bomber

The Third Reich also produced a number of jet-powered bomber designs, although only one type entered the arsenal (apart from the Me-262 bomber version).
It was the Arado Ar-234 *Blitz.* 26,27,29,39

The Ar-234, similar to the Me-262 and the Me-163, is described at the beginning of this book, contrary to an alphabetical or chronological order, as these machines are among the only highly advanced German flight designs that were still able to be used in time still be used in combat on a significant scale.

The Ar-234 was originally designed as a fast medium-range reconnaissance aircraft, but over time bomber missions became its primary purpose. She was the first jet bomber to be used.
Between summer 1944 and April 1945 a total of just over 200 pieces were produced in a few versions.



Die Ar-234 B. (Photo: NAIC)

Work on this aircraft began at the turn of the year 1940/1941. It was to be powered by two engines that the reader already knows from the description of the Me-262: BMW-003 or Jumo-004 (depending on the version). Ultimately, however, the decision was made to mount four engines (a pair in a common engine nacelle under each wing), as the BMW engines were characterized by less thrust, but on the other hand were also lighter

were.

A prototype with four BMW 003 engines. (Photo: Military Archives)

This is how the later versions B (2 x Jumo) and C (4 x BMW) were created, which could fly up to 20% faster with the same range.
In the C5 version it could even be increased to over 1,000 km. The main differences between these aircraft came from the different numbers of different engines. With the Heinkel Hirth HeS-011 engines, a concept by Hans Joachim Pabst from

Ohain, a P version was also designed, which was interesting in terms of construction, but technically not entirely well thought out. Due to ongoing problems with correcting various deficiencies, only 28 aircraft were built with these engines. Consideration was also given to using two Daimler-Benz twin jet engines (with the final designation DB-007), but the work could not be completed in time. They were probably the most modern jet engines ever designed in the Third Reich. An addition to the propulsion components described above were additional rocket engines that helped aircraft with Jumo-004 engines take off.

The Ar-234 after the war. (Photo: US Army)

The typical combat load of an Arado-234 consisted of two bombs suspended under the fuselage weighing 500 kg or a single bomb weighing one ton.

Until the end of the war, the possibilities of using this aircraft to transport remote-controlled weapons were investigated, including the guided high-explosive bomb *Fritz* X, the air-to-ground missile Hs-293 and the V1 rocket.

Firearms (for defense) were modest. They consisted of two mounted MG-151/20 20mm cannons. This simply arose from the fact that the best means of defense against enemy fighters was the high speed of the jet bomber, which flew several hundred kilometers per hour faster than the enemy's propeller-driven aircraft.

If the *Blitz* hit hunters during a combat mission, it could be in the Usually escape safely. With two type air cameras installed in the fuselage Rb 50/30 and Rb 75/30 were able to carry out reconnaissance tasks become.

## Tactical and technical details

| | Ar-234 B2 | Ar-234 C5 | Ar-234 P3 |
|---|---|---|---|
| Length (m) | 12,16 | 12,90 | 13,30 |
| Wingspan (m) | 14,41 | 14,41 | 14,41 |
| Height (m) | 4,28 ) | 4,28 | 4,28 |
| Lifting area of the wings ($m^2$ | 27,0 | 27,0 | 27,0 |
| Leather masses (kg) | 4.900 | 6.570 | 5.995 |
| Starting weight (kg) | that. 10,000 | 11,150 | 10.675 |
| Top speed | | | |
| at 6,000 m altitude (km/h) | 735 | 870 | 820 |
| Flight range (km) | 770 | 1.020 | - |

The area bombings, particularly since the beginning of 1944, increased Allies led to a far-reaching reassessment of the concept of air war. Due to the small number of night fighters, the Combat British bomber formations conducting their combat operations carried out at night presented a particular problem. For the most part, Hitler's carried Ignorance contributed to this, as he opposed the use of the Me-262 as a fighter aircraft was reluctant and work on the He-219 Uhu night interceptor delayed. It was not until October 1944 (when it was already too late) that the Conversion of the Me-262 training and combat fighters into night fighters has begun. The same requirements were also placed on the Ar-234. Because this However, the aircraft was designed as a single seater and needed additional space for a second crew member, namely the radar technician, was created become. This was done by removing the just behind the cockpit attached cameras possible. However, the Ar-234 wasn't particularly good suitable for the new role, mainly because of the lack Cockpit armor. The end result was a completely new version with armored cockpit (the mentioned P version) and seats for three Crew members designed. The decision for this final However, the configuration was not released until February 1945, which is why it was not used Series production went.

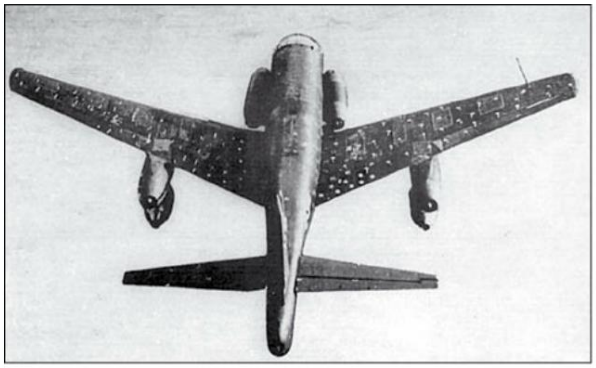
Many alternatives to the Ar-234 emerged, of which there are two to date

Prototypes and the corresponding test flights. These are the Heinkel He-343 - an aircraft very similar to the Ar-234 - and a completely different and unconventional design: the Junkers Ju-287. This was much heavier and had a much greater combat load than the Arado. 27,29,30 However, this aircraft never went into series production; only a few prototypes were built until the end of the war (i.e. until 1944). This was because it was developed later compared to the Ar-234, namely only since the beginning of 1943.

In order to speed up the design work, many elements and assemblies were used that had already been put to the test in other aircraft - including the modified (and later further converted) fuselage from the Heinkel He-177 Greif heavy bomber, control surfaces *from* the Junkers Ju-388, the main landing gear from the Junkers Ju 352 and the front landing gear from a captured American B-24.

The Ju-287 was the Third Reich's heaviest jet bomber. (Photo: Federal Archives)

Four Heinkel-Hirth HeS-011 jet engines with a thrust of 12.75 kN (1,300 kp) were used to power the first prototype; However, since these were still not fully developed, six BMW 003 A-1 engines with lower thrust were used for the remaining prototypes. All of these solutions had already been tested - but the aerodynamic system was used for the first time and made the Junkers 287 a real novelty: the aircraft was equipped with negatively swept wings. You should check the flight characteristics of the machine improve, mainly by maintaining good controllability both at a critical speed of up to 0.85 Mach and at lower flight speeds. On the other hand, problems with the wing stiffness arose; But during flight tests with the prototype, the innovative aerodynamic concept was able to clearly demonstrate its advantages.



The Ju-287 during flight. (Photo: Federal Archives)

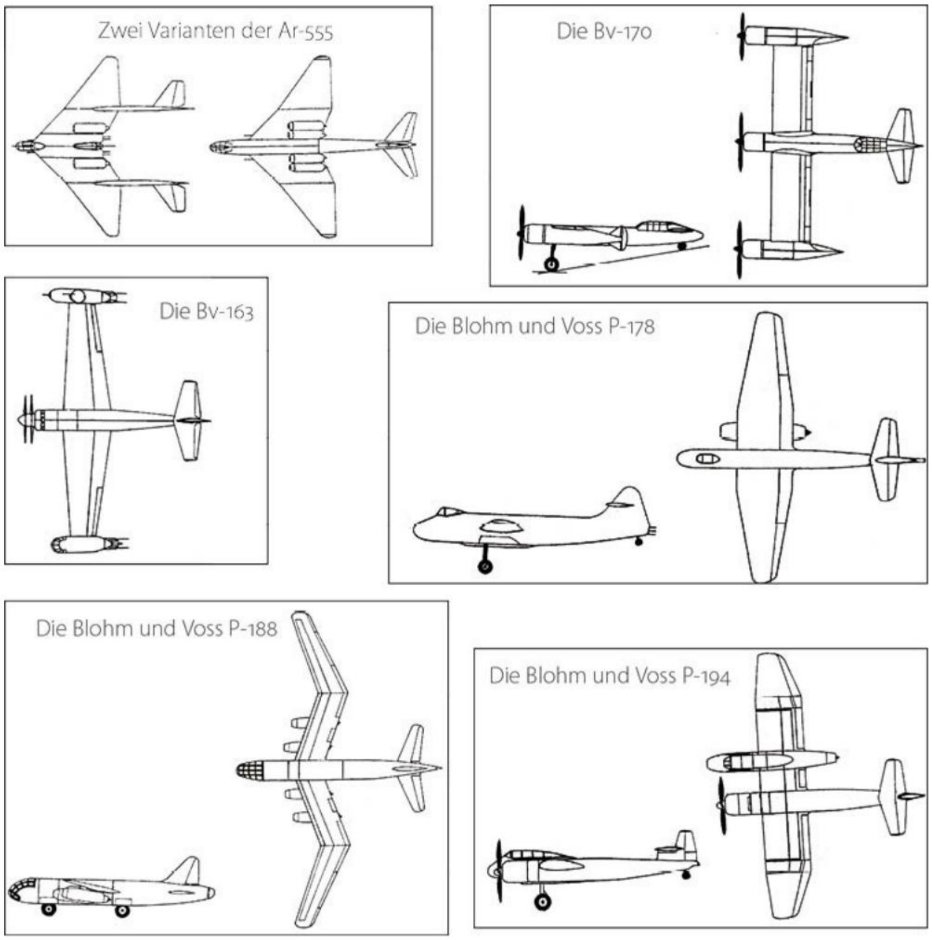
As a bomber that could reach a speed of 650 km/h in level flight, the Ju-287 would have been particularly dangerous for the Allies. With a combat load of two to four tons, it would have e.g. For example, it can effectively attack targets in Great Britain and thus represent an alternative to the V1 and V2 rockets.

## Tactical and technical details (V-1 prototype)

| | |
|---|---|
| Long: | 18.28 m |
| Wingspan: | 20.10 m |
| Learning masses: | 12,510 kg |
| Take-off weight: 20,000 kg | Maximum |
| speed: 650 km/h Combat l | oad: 2 – 4 |
| tons Flight range: | |
| | bis ca. 4,500 km |

A very important inspiration for the development of innovative aircraft designs - not just for bombers - was of course the introduction of jet propulsion. Although in the early days only the engine itself was basically new and traditional aerodynamic concepts were relied upon, a second generation of jet aircraft soon emerged that was able to fully exploit the advantages of the new type of engine.

It's worth taking a closer look at some of these unfinished projects, if only as a contrast to the aircraft technology of the period immediately before outbreak of war. [27,43]




An example of this generation would be: E.g. designs for jet bombers from Arado, which were intended to replace the Ar-234 in the future.

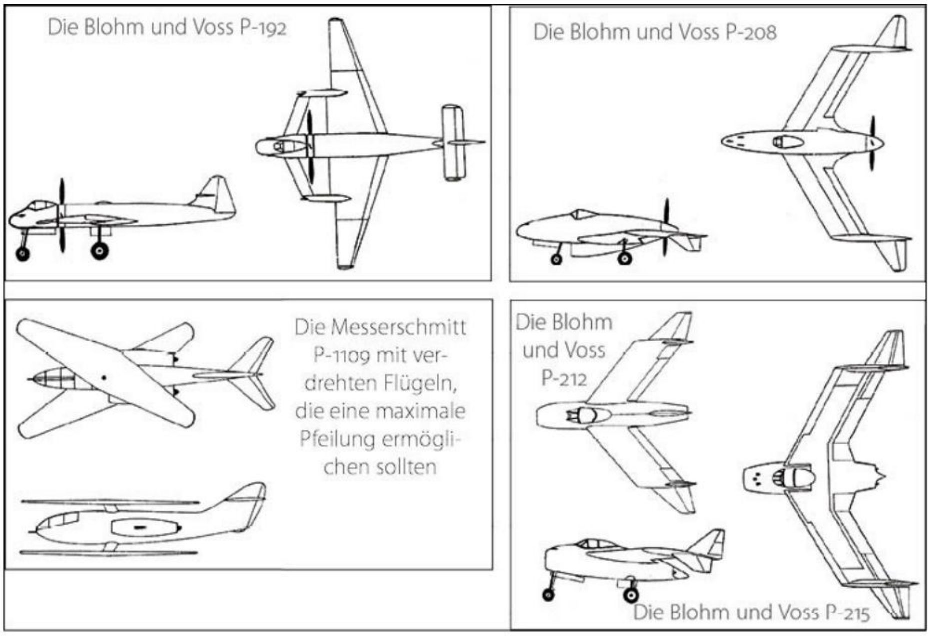
First the E.560 was created. The main difference to the Ar-234 was the use of new delta wings with a leading edge sweep of approximately 20°.
In early 1945, a model of this aircraft was tested in the wind tunnel.

In addition, at least three more advanced projects emerged: the Ar-555 (two projects) and the Arado II, which was a further modification of the E.560, with the wing sweep being increased even further. A tail unit with a similarly pronounced sweep was also used. The hull construction was redesigned and adapted to a more streamlined shape. In the nose there should be four MK-108 30 mm

Cannons could be accommodated, which would have made it possible to use it as a fighter pilot. The propulsion unit was limited to two HeS-011 engines.

The next stage of development was the Ar-555 project, of which there were two basic modifications. Common features included a wing with a folded leading and trailing edge sweep - the sweep was larger on the fuselage and smaller on the outer section. Two to four jet engines of an undetermined type were planned, which were to be suspended under the wings in the immediate vicinity of the fuselage. The first version was characterized by a fuselage and control surfaces similar to the Arado II; However, their further development was based on a completely different concept. The actual fuselage was abolished and only the middle section of the wings was enlarged. In the front part there was a small cockpit for the pilot, in the middle a bomb chamber, and in the back - on the trailing edge of the wing - the cockpit of the gunner, who could also perform the duties of the bombardier. The remaining rear fuselage section including the control surfaces was “split” into two narrow tail beams that were connected to the central area of the wings. The advantage of this concept was that the gunner's position “responsible” for protecting the rear part of the aircraft was moved to the central area of the aircraft, which significantly reduced the mass of the rear (“split”) part of the fuselage.

In the area of innovative bomber designs, it is also important to mention a concept that Daimler-Benz tried to realize in 1944. 21,27,43 This was about solving the problem of transporting weapons of mass destruction (including chemical weapons) to distant destinations such as. B. America to solve.




In 1944, Daimler-Benz AG began to operate in this area. It concentrated its efforts on design plans for huge strategic aircraft - carriers of jet bombers or remotely piloted or kamikaze piloted aircraft - flying bombs, in other words, built on a similar principle to the Mistletoe project.

This resulted in projects for two carrier aircraft:

The Fa-233 was one of the many helicopters built in the Third Reich. (Photo: Military Archives)


The FL-282 helicopter. (Photo: US Army)

Project “A” was based on an aircraft that would be powered by six HeS-021 jet engines, each with a thrust of 3,300 kp, mounted in engine nacelles above the wings. The design of the chassis was solved in an interesting way, considering that the bomber was supposed to be transported under the fuselage. The chassis consisted of only two legs - high pylons placed under the central section of the wings. It's quite possible that there were plans to put fuel tanks inside. In its lower sections, three wheels arranged in rows were to be accommodated in long panels.

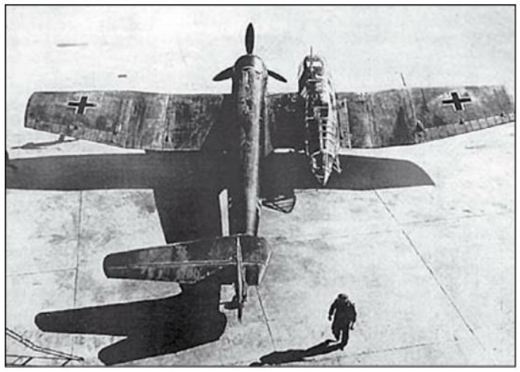
An innovative design meant a great deal of risk, although sometimes superior designs emerged this way. An example of this is the Dornier Do-335 *Pfeil* with two propellers - at the nose and at the stern. (Photo from the author's collection)

For obvious reasons, the carrier's flight range could not be precisely predicted according to Project "A", but it was intended to enable it to attack targets in the eastern United States. He was unarmed, as the bomber's separation was still relatively safe

Atlantic Ocean should take place.

The bomber itself was supposed to have a simple and relatively classic design, apart from the “V”-shaped control surfaces and the lack of landing gear. The latter arose from the specific conception of this system. The carrier's task was simply to "deliver" the bomber to the limits of the carrier's range, disconnect it and return to base as quickly as possible. After switching on its engines, the bomber should reach close to the speed of sound as it descends towards the target in the coastal area, which should make it possible to dispense with defensive armament. After dropping the bomb(s), he was supposed to perform a “belly landing”. The crew was then supposed to be evacuated by submarine. The expected carrying capacity of the bomber is unknown, but it is certain that it was planned to be powered by two BMW 018 jet engines with a thrust of 3450 kp.

The Blohm and Voss company, a pioneer in the introduction of unusual aircraft types, produced, among other things, a small series of asymmetrical BV-141 aircraft.

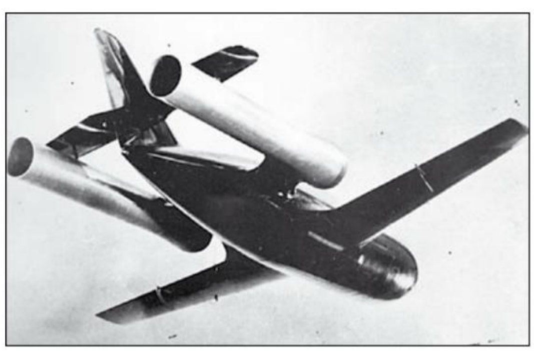


This concept was based on a tremendous waste - the combat potential envisaged was disproportionate to the complexity and expensiveness of the entire system. In the case of the transport of a nuclear bomb the situation would be different, but in 1944 this remained only a theory.

Project “B” was a certain modification of the above concept: the plan was to have a carrier with slightly redesigned wings and a more economical piston drive: six DB-603 engines with an output of 1,750 hp each, four propellers placed under the wings and two pusher propellers driven. As in the “A” variant, this carrier was supposed to transport bombers or up to six smaller kamikaze aircraft or machines remotely controlled from on board the carrier.

Both projects were presented to the Luftwaffe command in 1944, but not accepted for implementation.

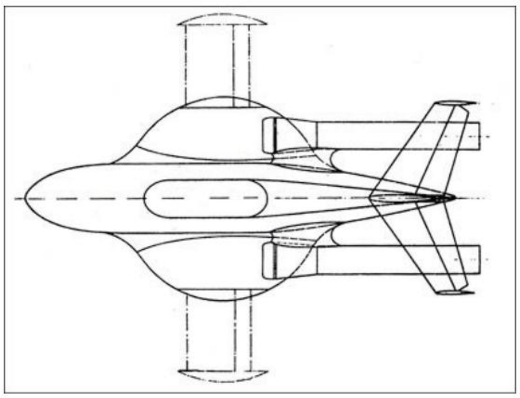
Work on a modern and equally unconventional jet-powered bomber was also underway at the Blohm and Voss factories, which had previously made a name for themselves with the production of seaplanes. 27.43



The end of the war was marked by simple and cheap aircraft projects. In the picture:

a model of the Me-328 in the wind tunnel. It was to be powered by two exhaust jet engines. (Photo: DVL)

The Me-328 (a copy without engines) on its first flight. (Photo: DVL)



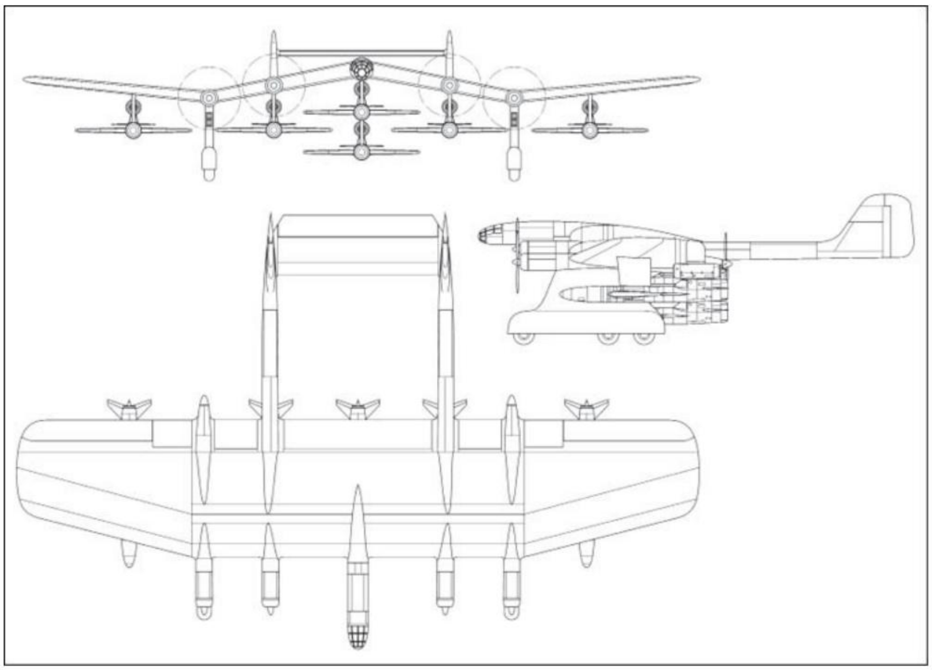
Original drawing of one of the planned further developments of the Me-328.

The P-188 is an example of a bomber that was intended as a counterpart to the Ar-234, but did not enter series production. There were two versions: the first, powered by four separately suspended jet engines (P 188.01), and the P-188.04, in which the engines were placed in pairs in two nacelles. The characteristic features of this bomber were positively swept wings in the middle area with simultaneous negative sweep in the outer sections. It also had an atypical landing gear - both main legs were located exactly under the fuselage axis in the extended position; To stabilize the aircraft horizontally, two additional legs with smaller wheels were to be used, which were extended from the outer sections of the wings. It was planned to use four Jumo-004-C engines, which were already known from the Me-262 and the Ar-234. Apart from the bomb load carried in the bomb chamber, there were four 20 mm

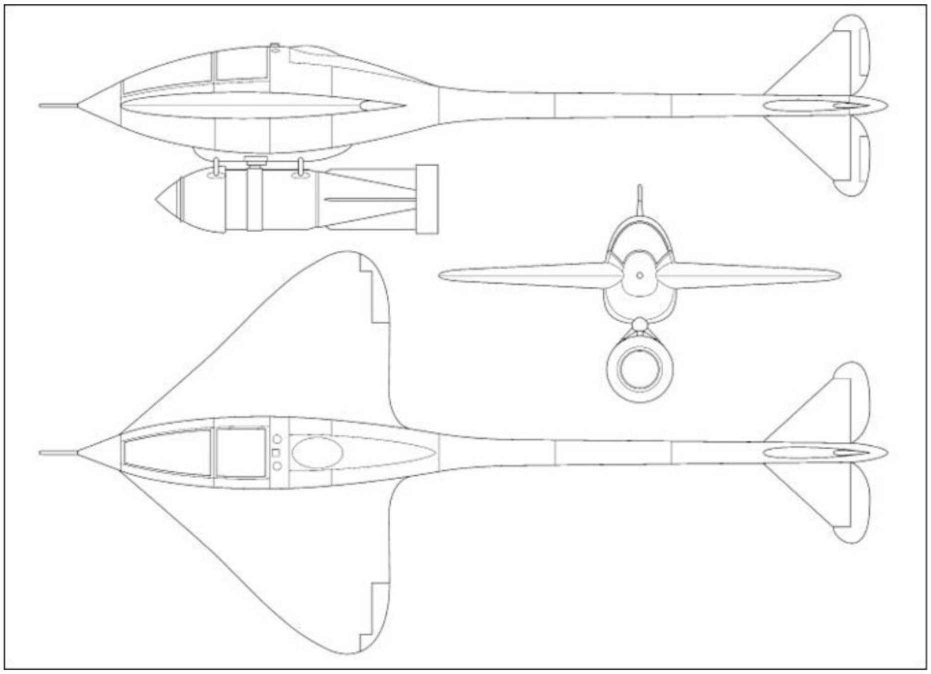
Cannons as well as two to four 13mm machine guns in one or two Machine gun turrets are provided, located in the rear part of the fuselage should be located.

Tactical and technical details of the P-188.01

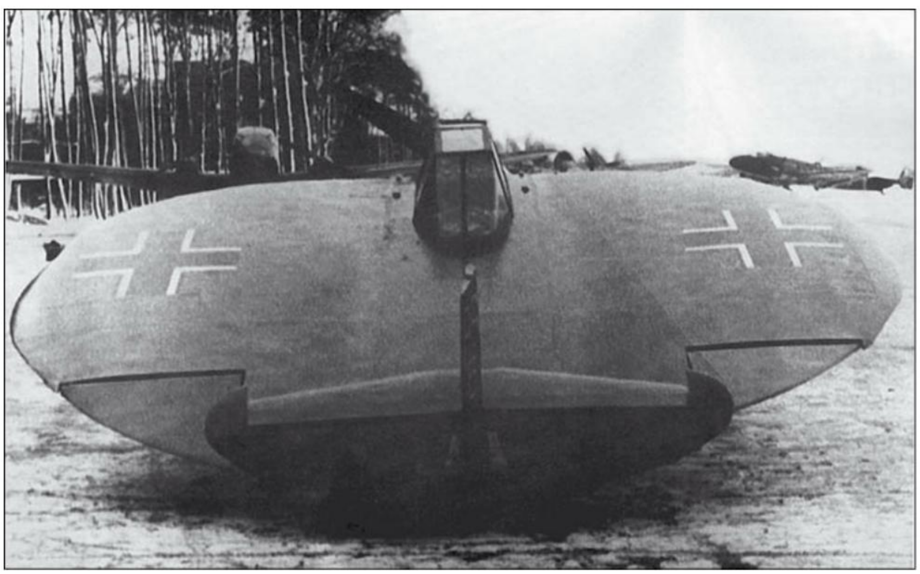
| | |
|---|---|
| Length: | 17,5 m |
| Wingspan: | 27 m |
| Takeoff weight: 23,800 | kg |
| Maximum speed: appro | x. 820 km/h |
| Flight range: up to 1,500 | km |



The Daimler-Benz projects “F” and “C”. (Drawing: M. Ryÿ)



Glider bomber plane / glider bomber (drawing: M. Ryÿ)



In Germany, a few projects with round sashes also came about. In the picture the AS-1, built before the war in Leipzig.

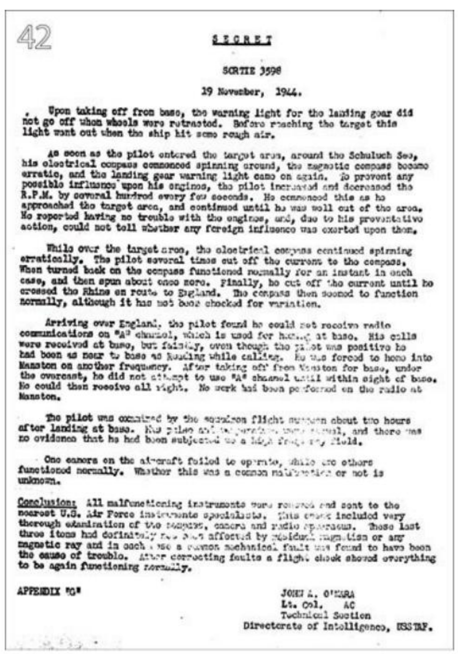
# Electromagnetic weapons

# and alternative solutions

Despite all appearances, the title of the present chapter refers covering a very extensive field with a rich and well documented Story. Already at the beginning of the war, the Allied secret services received information numerous reports on this.

Proof of this is, for example, one from the British Summary written by the intelligence service, in which already on 11. November 1939 these weapons are mentioned. Your author – Dr. RV Jones, an Oxford physicist and head of the scientific Intelligence service at the British Air Ministry - mentioned in his report, among other things:[5]

> "… bacteriological weapons, new combat gases, flamethrowers,
> Glide bombs, aerial torpedoes, pilotless aircraft, and
> Long-range guns and missiles, new torpedoes, mines and submarines,
> death rays, engine-killing rays,
> "Magnetic mines".



42

SECRET

SORTIE 3598

19 November, 1944.

Upon taking off from base, the warning light for the landing gear did not go off when wheels were retracted. Before reaching the target this light went out when the ship hit some rough air.

As soon as the pilot entered the target area, around the Schaluch See, his electrical compass commenced spinning around, the magnetic compass became erratic, and the landing gear warning light came on again. To prevent any possible influence upon his engines, the pilot increased and decreased the R.P.M. by several hundred every few seconds. He commenced this as he approached the target area, and continued until he was well out of the area. He reported having no trouble with the engines, and, due to his preventative action, could not tell whether any foreign influence was exerted upon them.

While over the target area, the electrical compass continued spinning erratically. The pilot several times cut off the current to the compass. When turned back on the compass functioned normally for an instant in each case, and then spun about once more. Finally, he cut off the current until he crossed the Rhine en route to England. The compass then seemed to function normally, although it has not been checked for variation.

Arriving over England, the pilot found he could not receive radio communications on "A" channel, which is used for homing at base. His calls were received at base, but faintly, even though the pilot was positive he had been as near to base as Reading while calling. He was forced to home into Manston on another frequency. After taking off from Manston for base, under the overcast, he did not attempt to use "A" channel until within sight of base. He could then receive all right. No work had been performed on the radio at Manston.

The pilot was examined by the squadron flight surgeon about two hours after landing at base. His pulse and [illegible] were normal, and there was no evidence that he had been subjected to a high frequency field.

One camera on the aircraft failed to operate, while two others functioned normally. Whether this was a common malfunction or not is unknown.

Conclusion: All malfunctioning instruments were [illegible] and sent to the nearest U.S. Air Force instruments specialists. This check included very thorough examination of the compass, camera and radio apparatus. These last three items had definitely not been affected by residual magnetism or any magnetic ray and in each case a common mechanical fault was found to have been the cause of trouble. After correcting faults a flight check showed everything to be again functioning normally.

APPENDIX "G"

JOHN A. O'HARA
Lt. Col. AC
Technical Section
Directorate of Intelligence, USSTAF.

As it turned out, this was just the beginning of large-scale research programs. I must say that during my archival search I never set out to find material that referred to such research. Nevertheless, I came across numerous documents on this topic almost by chance. The impression inevitably arises that these works, which have now been practically forgotten, were designed on a large scale.

Many American intelligence reports were made available to me in the form of copies by Fr. Henry Stevens from the USA (unfortunately without signatures). The entire first part of this chapter is based on these documents.

The first "serious" report that forced the officers of the Western secret services to take a closer look at this topic can serve as a starting point for describing this complex of topics. The event took place in mid-November 1944, and its first reasonably accurate description was part of an appendix to a special report dated November 16, 1944 (Document 42). This refers to the American P-38 reconnaissance aircraft. Here is the translation:

SECRET
FLIGHT 3598
November 19, 1944

After takeoff from the air base, the landing gear retraction warning light did not go off even though the landing gear had been retracted. It only went out when the pilot encountered bad weather before reaching the destination. When he reached the target area near Schuluchsee, his electric compass began to spin in circles, the magnetic compass display malfunctioned, and the chassis warning light illuminated again. As the pilot approached the target area, the pilot alternately reduced and increased the speed of the aircraft engines by several hundred revolutions per minute every few seconds to eliminate any possible influence on the aircraft's propulsion system. He only completed this maneuver when he had left the target far behind him. He stated that he had had no problems with the engines. However, because of his precautionary measures, he was able to cannot say whether an attempt was made to influence the propulsion system.

During the target overflight, the electric compass rotated chaotically in circles the entire time. The pilot repeatedly interrupted the power supply to the compass. Each time the compass was turned back on, it would function normally for a moment, but then start spinning in circles again. Finally, the pilot switched off the power until he had flown over the Rhine and headed towards England. The compass then functioned normally again, although it was not checked for possible deviation.

As the pilot approached England, he realized he was unable to establish a radio link on channel “A,” which is used when approaching the air base. His messages could only be received very weakly at the base, even though he was in the immediate vicinity. He was forced to continue his flight towards Manston and had to use a different frequency.

After taking off from Manston and returning to his base, the pilot refrained from using channel “A” until he was within visual contact. He was then able to conceive normally again.

The radio system was not examined during the stay in Manston.

About two hours after landing at the base, the pilot was examined by the squadron doctor. His pulse and body temperature were normal and no evidence was found that he had been exposed to radiofrequency fields.

[The Americans clearly knew what they were looking for! – Note d. author]

One of the plane's cameras was out of order, but the remaining two were working fine. It could not be determined whether this was one of the usual defects.

In conclusion, all onboard instruments that failed during the flight were dismantled and sent to the nearest qualified American Air Force specialist for examination. This inspection included a very thorough examination of the compass, camera and radio equipment.

The three instruments showed no traces of magnetization or exposure to any magnetic radiation. In all cases it was determined that the malfunction had purely mechanical causes. A subsequent flight test showed that the devices functioned correctly after the faults were eliminated.

Exhibit “G”
John A. O'Mara, Colonel AC
Technical Division
Head of Intelligence, USSTAF

Exactly at the same time as the aforementioned report was written, namely on November 16, 1944, the American War Department (Department of Defense) summarized for the first time information about possible new German weapons that were related to the “adventures” of the aforementioned reconnaissance aircraft could. Only now did it become clear that it was not the first report on this topic and that the Americans knew very well the direction in which the Germans' work was heading. Here is the mentioned summary (Document 1):

SECRET
MINISTRY OF WAR
MILITARY INFORMATION SERVICE, WASHINGTON November 16, 1944

SUBJECT: Analysis of reports of radiation or charges used to neutralize aircraft engines.

AN: Major F. J. Smith, Postfach 2610, Washington, D. C.

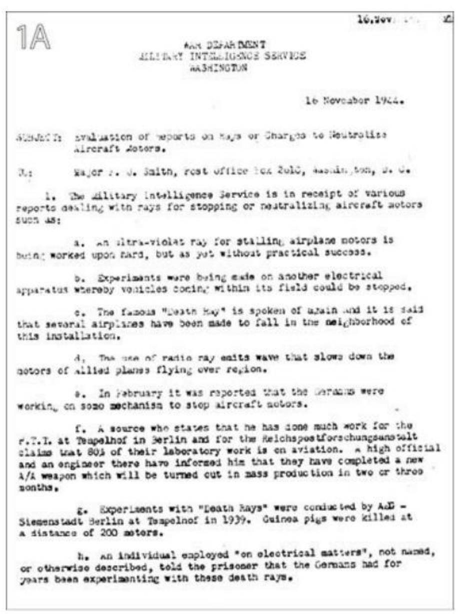
1. The military intelligence service receives various reports about radiation for deactivation or neutralization [damage? – Note d. Author] of aircraft engines.
Examples:
    a) Intensive research is being carried out on the ultraviolet ray [a bundle of ultraviolet rays - note d. Author's] designed to bring aircraft engines to a standstill. This work has so far not been successful.

b) Work has been carried out on another electrical device that is intended to stop vehicles that come into the area of the field generated by this device.

c) Rumors about the infamous “death ray” are emerging again; It is claimed that many aircraft have been shot down near this facility (which produces this beam). d) Use of radio waves to reduce the engine speed of Allied aircraft flying over the area.

e) In February (1944) it was reported that the Germans were working on a (new) method of shutting down aircraft engines.

f) A source who claims to have long worked for the PTT (Post, Telephone and Telegraph) in Tempelhof (Berlin) and for the Reichspostforschungsanstalt states that 80% of the laboratory work of these companies concerns aviation. A senior official there and an engineer have informed this source that work has been completed on a new anti-aircraft weapon that will be put into mass production within two to three months.



1A

16 Nov

WAR DEPARTMENT
MILITARY INTELLIGENCE SERVICE
WASHINGTON

16 November 1944.

SUBJECT: Evaluation of Reports on Rays or Charges to Neutralize Aircraft Motors.

TO: Major J. J. Smith, Post Office Box 2610, Washington, D. C.

1. The Military Intelligence Service is in receipt of various reports dealing with rays for stopping or neutralizing aircraft motors such as:

a. An ultra-violet ray for stalling airplane motors is being worked upon hard, but as yet without practical success.

b. Experiments were being made on another electrical apparatus whereby vehicles coming within its field could be stopped.

c. The famous "Death Ray" is spoken of again and it is said that several airplanes have been made to fall in the neighborhood of this installation.

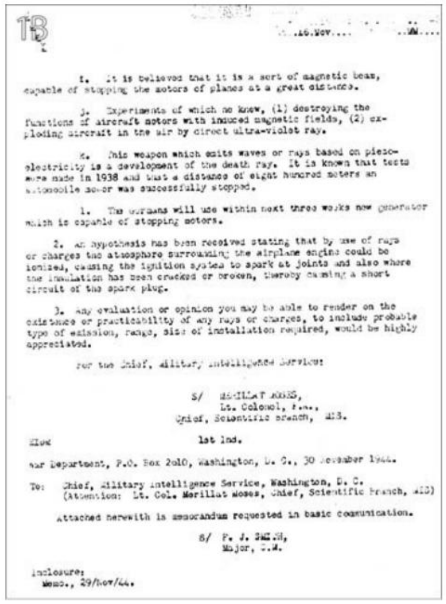
d. The use of radio ray emits wave that slows down the motors of allied planes flying over region.

e. In February it was reported that the Germans were working on some mechanism to stop aircraft motors.

f. A source who states that he has done much work for the P.T.T. at Tempelhof in Berlin and for the Reichspostforschungsanstalt claims that 80% of their laboratory work is on aviation. A high official and an engineer there have informed him that they have completed a new A/A weapon which will be turned out in mass production in two or three months.

g. Experiments with "Death Rays" were conducted by AEG - Siemenstadt Berlin at Tempelhof in 1939. Guinea pigs were killed at a distance of 200 meters.

h. An individual employed "on electrical matters", not named, or otherwise described, told the prisoner that the Germans had for years been experimenting with these death rays.



..16.Nov.... ..[illegible]....

i. It is believed that it is a sort of magnetic beam, capable of stopping the motors of planes at a great distance.

j. Experiments of which he knew, (1) destroying the functions of aircraft motors with induced magnetic fields, (2) exploding aircraft in the air by direct ultra-violet ray.

k. This weapon which emits waves or rays based on piezo-electricity is a development of the death ray. It is known that tests were made in 1938 and that a distance of eight hundred meters an automobile motor was successfully stopped.

l. The Germans will use within next three weeks new generator which is capable of stopping motors.

2. An hypothesis has been received stating that by use of rays or charges the atmosphere surrounding the airplane engine could be ionized, causing the ignition system to spark at joints and also where the insulation has been cracked or broken, thereby causing a short circuit of the spark plug.

3. Any evaluation or opinion you may be able to render on the existence or practicability of any rays or charges, to include probable type of emission, range, size of installation required, would be highly appreciated.

For the Chief, Military Intelligence Service:

S/ MERILLAT MOSES,
Lt. Colonel, [illegible]
Chief, Scientific Branch, MIS.

[illegible] 1st Ind.

War Department, P.O. Box 2010, Washington, D. C., 30 November 1944.

To: Chief, Military Intelligence Service, Washington, D. C.
(Attention: Lt. Col. Merillat Moses, Chief, Scientific Branch, MIS)

Attached herewith is memorandum requested in basic communication.

S/ P. J. SMITH,
Major, C.E.

Inclosure:
Memo., 29/Nov/44.

g) Experiments with “death rays” were carried out by AEG Berlin-Siemensstadt in Tempelhof as early as 1939. Guinea pigs were killed at a distance of 200 meters.

h) A person, whose identity or further description is not available, who dealt with “electrical questions,” told a prisoner (or a prisoner of war) that the Germans had been conducting experiments with these rays for years.

i) It is believed to be a type of magnetic beam that can stop aircraft engines from a long distance.

j) The above-mentioned person knew that the following experiments had been carried out: (1) destroying aircraft engines by induced magnetic fields, (2) producing explosions in flying aircraft using a directed beam of ultraviolet rays. k) This weapon, which emits waves or beams

based on the piezoelectric effect, is a further development of the death ray. It is known that corresponding experiments were carried out in 1938; This made it possible to detect a running vehicle engine from a distance of 800 meters to stop.

l) The Germans will deploy a new generator capable of stopping engines within the next three weeks.

2. It was hypothesized that the rays or charges could ionize the air surrounding the engine, resulting in sparking at ignition system junctions and locations of damaged insulation, which in turn would cause short circuits in the spark plug supply circuits.

3. If you could provide any analysis or assessment relating to the existence or usefulness of any rays or charges, taking into account possible types of emissions, the range and the size of the installation required, that would be of great benefit.

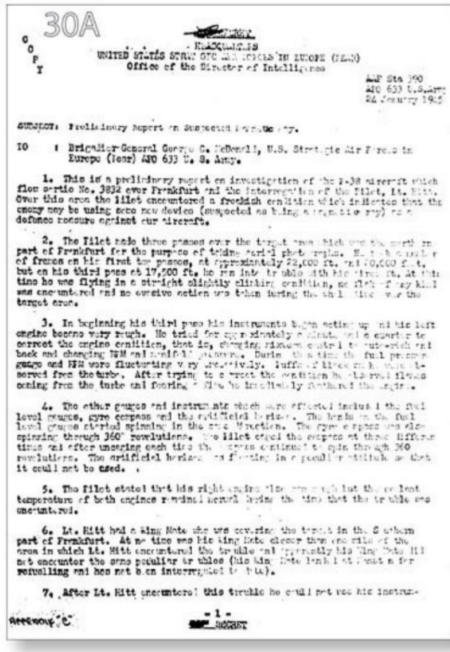
To the Head of Military Intelligence:

Merillat Moses,
Oberst FA

Head of the scientific department

The US military intelligence service analyzed and collected information about the German “death rays” until the end of the war – and even afterwards. Even the case of the above-mentioned P-38 reconnaissance aircraft (whose pilot was a certain First Lieutenant Hitt) led to detailed analyzes in January 1945 (see Document 30). The most important result of these investigations was the creation at the end of 1944 of a comprehensive research project that was intended to provide possible physical explanations for the observed effects (Document 51).

Although virtually all possible explanations were initially considered - even substances sprayed in front of the aircraft - a hypothesis emerged relatively quickly. It was agreed that, from a practical point of view, the only plausible solution would be to design an electromagnetic wave generator (at radio frequency) that induced currents in all the aircraft's circuits.



30A

C O P Y

[illegible] SECRET

HEADQUARTERS

UNITED STATES STRATEGIC AIR FORCES IN EUROPE ([illegible])

Office of the Director of Intelligence

AAF Sta 390
APO 633 U.S.Army
24 January 1945

SUBJECT: Preliminary Report on Suspected [illegible] Ray.

TO : Brigadier General George C. McDonald, U.S. Strategic Air Forces in Europe (Rear) APO 633 U. S. Army.

1. This is a preliminary report on investigation of the P-38 aircraft which flew sortie No. 3832 over Frankfurt and the interrogation of the Pilot, Lt. Hitt. Over this area the Pilot encountered a freakish condition which indicates that the enemy may be using some new device (suspected as being a [illegible] ray) as a defence measure against our aircraft.

2. The Pilot made three passes over the target area which was the [illegible] part of Frankfurt for the purpose of taking aerial photographs. He [illegible] of frames on his first two passes, at approximately 22,000 ft. and 20,000 feet, but on his third pass at 17,500 ft. he ran into trouble with his aircraft. At this time he was flying in a straight slightly climbing condition, no flak of any kind was encountered and no evasive action was taken during the [illegible] over the target area.

3. In beginning his third pass his instruments began acting up and his left engine became very rough. He tried for approximately a minute and a quarter to correct the engine condition, that is, changing mixture control to auto-rich and back and changing RPM and manifold pressure. During this time the fuel pressure gauge and RPM were fluctuating very [illegible]. Puffs of black [illegible] observed from the turbo. After trying to correct the condition he observed flames coming from the turbo and fearing a fire he immediately feathered the engine.

4. The other gauges and instruments which were affected included the fuel level gauges, gyro compass and the artificial horizon. The [illegible] on the fuel level gauges started spinning in the same direction. The gyro compass was also spinning through 360° revolutions. The Pilot caged the compass at three different times and after uncaging each time the compass continued to spin through 360 revolutions. The artificial horizon was floating in a peculiar attitude so that it could not be used.

5. The Pilot stated that his right engine [illegible] but the coolant temperature of both engines remained normal during the time that the trouble was encountered.

6. Lt. Hitt had a Wing Mate who was covering the target in the Southern part of Frankfurt. At no time was his Wing Mate closer than one mile of the area in which Lt. Hitt encountered the trouble and apparently his Wing Mate did not encounter the same peculiar troubles (his Wing Mate landed at [illegible] for refuelling and has not been interrogated to date).

7. After Lt. Hitt encountered this trouble he could not use his instru-

- 1 -

[illegible] SECRET

30B

TOP SECRET

(Ltr. to Brig. Gen. George C. McDonald, USSTAF (Rear), Dtd. 24 Jan. 1945. Subject: Preliminary Report on Suspected [illegible] Ray.)

ents and radioed to his Wing Mate for orientation and his Wing Mate accompanied part of the way back. His radio apparently functioned properly.

8. The instruments on Lt. Hitt's ship continued acting up for a period of eight to ten minutes; after this time they appeared to be functioning properly.

9. Preliminary examination of the left engine showed the following: compression of all cylinders was normal and there were no metallic particles in the sump which indicates that there is probably no internal failure. However, both the intake and exhaust plugs in the right bank (intake and [illegible]) were very badly fouled including metallic lead pickles, white ash, and carbon and all the plugs in the left bank both intake and exhaust were very clean. The fact that both the intake and exhaust plugs in the right bank have [illegible] lead fouling indicates that there was probably intermittent firing of these cylinders.

10. The ignition system on this engine consists of a dual magneto and two distributors, one on the right bank and one on the left bank. One side of the magneto services all the exhaust plugs on both banks through the distributor of the right bank, and the other side of the magneto services all the intake plugs on both banks through the distributor on the left bank and the fact that both the intake and the exhaust plugs on only one bank were so badly fouled makes it very puzzling in trying to analyse any part of an ignition break down due to a magnetic ray. The ignition system will be checked thoroughly in detail by the Engineering Officer and a report of any trouble rendered to this office. No instruments were at hand at the time of the initial inspection for checking the aircraft for any evidence of residual [illegible]. However, a check of this nature is being followed through immediately by Captain [illegible].

11. The photographs which Lt. Hitt had taken indicate that the camera heating system had not been functioning properly. The camera is heated by the coolant from the left engine through the fan arrangements but since all the frames were taken prior to the time of the engine failure it is supposed that the electric fan which blows hot air over the camera was not functioning properly. All of the frames are either badly [illegible] due to the prevailing haze and cloud condition or badly under-exposed indicating an iced condition of the lenses and no images are discernible.

12. A preliminary medical check of the Pilot did not show any peculiar symptoms or conditions.

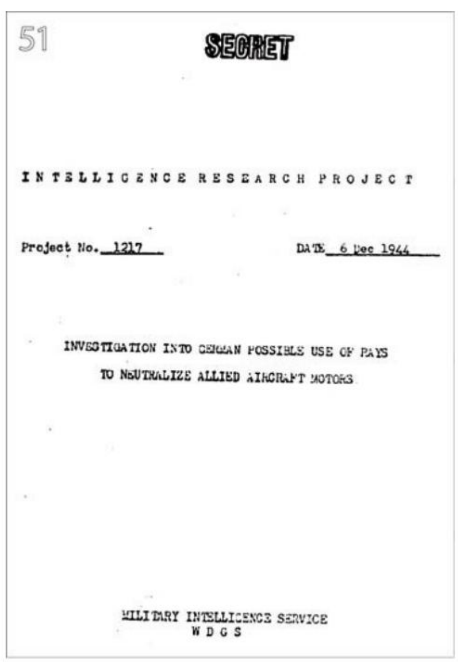
13. The fact that Lt. Hitt's Wing Mate was as close as a mile to him at the time of this trouble indicates that whatever peculiar ray the Germans may be using is being beamed.

14. With further examination it may be possible that the engine trouble may be explained by some normal ignition mal-functioning, but the way the flight instruments and fuel gauges acted up indicate that there is definitely something to the supposition that the Germans may be using some type of magnetic ray and it should be followed up without delay so that countermeasures may be developed.

V. K. [illegible],
Captain CE
Asst. to the D. of I

TOP SECRET

The calculations carried out showed that with a one millimeter thick aircraft outer skin (duralumin) the greatest "penetration" of the radiation beam could be achieved by a wave with a frequency of 75 kHz (i.e. in the long wave range). However, in order to provide sufficient energy to destroy aircraft circuitry in the area of 5 square miles (approx. 16 km2 ) would require thousands of tons of cables and a power consumption of several hundred megawatts. This referred to the variant analyzed by the Americans (long waves), in which there would be practically no possibility of bundling and focusing this energy on selected targets. The American analysts left out another possibility: a significant increase in the frequency of the beam of radiation up to the "radar" frequency means that the aircraft's outer skin increasingly reflects the electromagnetic wave, but at the same time the wave is easier to focus - despite being worse “Penetration” can therefore achieve a stronger effect with lower power consumption. The Americans did not know at the time that the Germans had chosen exactly this path. However, as part of the aforementioned analysis, it was found at the same time that even in the case of long waves, a beam of radiation with a power a hundred times lower than that resulting from initial calculations was sufficient would have to create sparks in the aircraft's circuits (instead of destroying them).


51

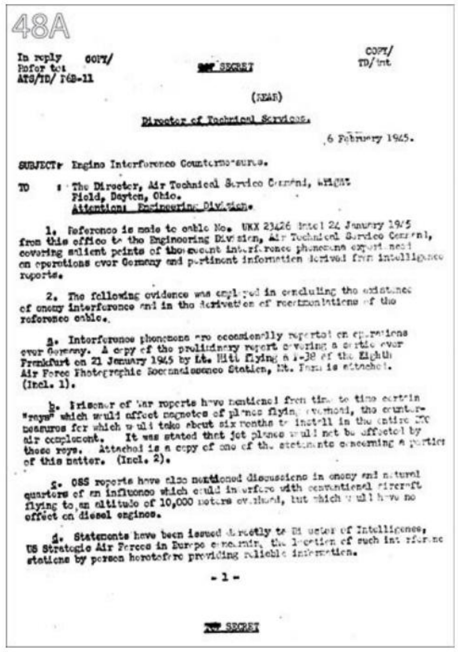
SECRET

INTELLIGENCE RESEARCH PROJECT

Project No. 1217 DATE 6 Dec 1944

INVESTIGATION INTO GERMAN POSSIBLE USE OF RAYS
TO NEUTRALIZE ALLIED AIRCRAFT MOTORS

MILITARY INTELLIGENCE SERVICE
W D G S



48A

In reply
Refer to:
ATS/TD/ 768-11

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TD/int

(REAR)

Director of Technical Services.

6 February 1945.

SUBJECT: Engine Interference Countermeasures.

TO : The Director, Air Technical Service Command, Wright Field, Dayton, Ohio.
Attention: Engineering Division.

1. Reference is made to cable No. UKX 23426 dated 24 January 1945 from this office to the Engineering Division, Air Technical Service Command, covering salient points of the recent interference phenomena experienced on operations over Germany and pertinent information derived from intelligence reports.

2. The following evidence was employed in concluding the existence of enemy interference and in the derivation of recommendations of the reference cable.

a. Interference phenomena are occasionally reported on operations over Germany. A copy of the preliminary report covering a sortie over Frankfurt on 21 January 1945 by Lt. [illegible] flying a P-38 of the Eighth Air Force Photographic Reconnaissance Station, Mt. [illegible] is attached. (Incl. 1).

b. Prisoner of War reports have mentioned from time to time certain "rays" which would affect magnetos of planes flying overhead, the counter-measures for which would take about six months to install in the entire [illegible] air complement. It was stated that jet planes would not be affected by these rays. Attached is a copy of one of the statements concerning a portion of this matter. (Incl. 2).

c. OSS reports have also mentioned discussions in enemy and neutral quarters of an influence which could interfere with conventional aircraft flying to an altitude of 10,000 meters overhead, but which would have no effect on diesel engines.

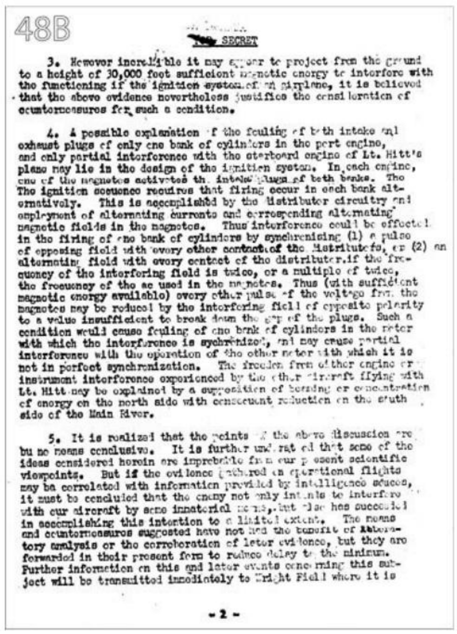
d. Statements have been issued directly to Director of Intelligence, US Strategic Air Forces in Europe concerning the location of such interference stations by person heretofore providing reliable information.

- 1 -

TOP SECRET

Following the aforementioned report, work soon began on possible countermeasures to this new German weapon. As a result, on February 6, 1945, the head of the technical services of the American Air Force, Colonel Bunker, prepared a comprehensive document with recommendations for air formations with the aim of reducing the sensitivity of aircraft to the described energy (Document 48). Its addressee was the head of the technical intelligence service of the American Air Force at Wright Field air base near Dayton in the state of Ohio.

However, this letter argues that the most effective strategy under the current circumstances is to collect information about the locations of the German installations and avoid them until more data is available. It was assumed that jet-powered aircraft would be immune to the effects of the aforementioned energy, which was taken as a suggestion that in the future this type of aircraft could operate over the areas in question. In the meantime, attempts were made to obtain more intelligence information in order to better assess the danger. However, the information obtained was still only fragmentary: it consisted of short reports that did not provide a basis for a more or less comprehensive explanation of the phenomenon until the end of the war could. An example of such a report is Document 5 of January 25, 1945, a summary of the testimony of a German prisoner of war who stated that work in this area had already been carried out in 1934, and with success. At that time, it was possible to bring an internal combustion engine to a standstill at a distance of 150 meters. A little later, but before the outbreak of war - in 1938 - two German aircraft manufacturers were commissioned to develop an analog weapon that would affect the engines of enemy aircraft. This work was carried out somewhere "between Augsburg and Munich".



48B

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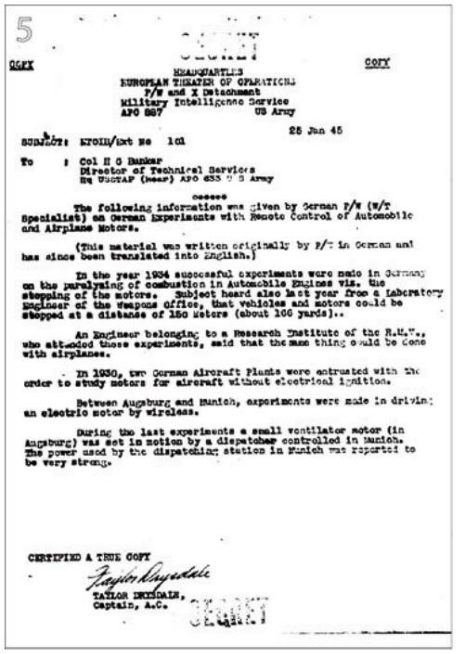
3. However incredible it may appear to project from the ground to a height of 30,000 feet sufficient magnetic energy to interfere with the functioning of the ignition system of an airplane, it is believed that the above evidence nevertheless justifies the consideration of countermeasures for such a condition.

4. A possible explanation of the fouling of both intake and exhaust plugs of only one bank of cylinders in the port engine, and only partial interference with the starboard engine of Lt. Hitt's plane may lie in the design of the ignition system. In each engine, one of the magnetos activates the intake plugs of both banks. The ignition sequence requires that firing occur in each bank alternatively. This is accomplished by the distributor circuitry and employment of alternating currents and corresponding alternating magnetic fields in the magnetos. Thus interference could be effected in the firing of one bank of cylinders by synchronizing (1) a pulse of opposing field with every other contact of the distributors, or (2) an alternating field with every contact of the distributor.if the frequency of the interfering field is twice, or a multiple of twice, the frequency of the ac used in the magnetos. Thus (with sufficient magnetic energy available) every other pulse of the voltage from the magnetos may be reduced by the interfering field of opposite polarity to a value insufficient to break down the gap of the plugs. Such a condition would cause fouling of one bank of cylinders in the motor with which the interference is synchronized, and may cause partial interference with the operation of the other motor with which it is not in perfect synchronization. The freedom from either engine or instrument interference experienced by the other aircraft flying with Lt. Hitt may be explained by a supposition of beaming or concentration of energy on the north side with consequent reduction on the south side of the Main River.

5. It is realized that the points of the above discussion are by no means conclusive. It is further understood that some of the ideas considered herein are improbable from our present scientific viewpoints. But if the evidence gathered on operational flights may be correlated with information provided by intelligence sources, it must be concluded that the enemy not only intends to interfere with our aircraft by some immaterial means, but also has succeeded in accomplishing this intention to a limited extent. The means and countermeasures suggested have not had the benefit of laboratory analysis or the corroboration of later evidence, but they are forwarded in their present form to reduce delay to the minimum. Further information on this and later events concerning this subject will be transmitted immediately to Wright Field where it is

- 2 -



5

SECRET

COPY COPY

HEADQUARTERS
EUROPEAN THEATER OF OPERATIONS
P/W and X Detachment
Military Intelligence Service
APO 887 US Army

25 Jan 45

SUBJECT: ETOIII/Ext No 101

To : Col H G Bunker
Director of Technical Services
Hq USSTAF (Rear) APO 633 U S Army

oooooo

The following information was given by German P/W (W/T Specialist) on German Experiments with Remote Control of Automobile and Airplane Motors.

(This material was written originally by P/W in German and has since been translated into English.)

In the year 1934 successful experiments were made in Germany on the paralysing of combustion in Automobile Engines viz. the stopping of the motors. Subject heard also last year from a Laboratory Engineer of the Weapons Office, that vehicles and motors could be stopped at a distance of 150 Meters (about 160 yards)..

An Engineer belonging to a Research Institute of the R.M.T., who attended those experiments, said that the same thing could be done with airplanes.

In 1930, two German Aircraft Plants were entrusted with the order to study motors for aircraft without electrical ignition.

Between Augsburg and Munich, experiments were made in driving an electric motor by wireless.

During the last experiments a small ventilator motor (in Augsburg) was set in motion by a dispatcher controlled in Munich. The power used by the dispatching station in Munich was reported to be very strong.

CERTIFIED A TRUE COPY

Taylor Drysdale
TAYLOR DRYSDALE,
Captain, A.C.

SECRET

As can be seen, despite investigations lasting over a decade, the information about the total scope of the work never fell into the hands of the enemy, at least not the enemy in the West...

The mystery of the German “death rays” could only be solved long after the war. The information currently available suggests that the work followed two main directions. The first (although not the only one) is associated with the mentioned effect on engines and other systems of enemy aircraft. We know that this work is inextricably linked to research on radar devices and, to a certain extent, represents a side effect of this research. We know this because the laboratories that designed one of these powerful systems primarily designed radar systems. We are talking about the so-called GEMA works in the town of Lubaÿ (then Lauban) in Lower Silesia. Leszek Adamczewski - a journalist who has been working on this topic for a long time - wrote: 49

> “After I published an appeal in the newspaper Przeglÿd Lubaÿski for people to come forward who had been in Lubaÿ during the war or shortly after and had heard or seen something about mysterious phenomena, we received tips from our readers . They linked a fountain discovered in the park to the super-secret activity of GEMA.

Works in connection.

The GEMA armaments company was moved from Berlin, which was bombed by the Allies, to Gustav Winkler's then modern factories in Lubaÿ. According to the information I have, an extremely secret radar technology program was developed there. Next door was the city's largest labor camp, the 'GEMA dormitory camp', where mainly Russian and Polish women stayed.

The recently deceased Stanisÿaw Siorek, explorer and officer of the Security Service of the People's Republic of Poland, claimed shortly before his death that the fountain discovered by chance in the park near Esperantystów Street was nothing more and nothing less than an old ventilation or recovery shaft of the underground one Part of the GEMA works, which were most likely flooded at the end of the war.

One who responded to the call was Józef Bujak from Lubaÿ. He came to the city shortly after the war and worked in an engine wrapping shop that also employed an old German named Glaubich, who informed Bujak about mysterious experiments being carried out at the GEMA works in the final stages of the war.

They were based – Bujak remembered – on the creation of some kind of electromagnetic field because the vehicles driving past the GEMA works stopped! This could be observed over a distance of around 300 meters. Previously, a section of the road between Lauban and Görlitz was closed to traffic. When the attempt was aborted, the vehicles simply continued driving as if nothing had happened. Glaubich swore that he saw not only spark ignition vehicles stalling, but diesel vehicles as well!

I can't explain this in any way ...

Bujak went several times to the ruins of the GEMA factory, which had been set on fire by the retreating Germans. On the factory site there were still metal structures about 15 meters high with a cabin attached below. These structures were rotatable and the cabins were packed with electronics.

'Of course these electronics cannot be compared with today's ones,' adds Bujak, 'but they looked like complicated radio devices.'" Everything indicates that in connection with this work there is a large underground research and production complex, which until could not be discovered today. And most likely this was not the only complex involved in this research.

However, the above-mentioned work, i.e. the construction of systems for emitting concentrated radio waves, which, due to their power and frequency, could interrupt or damage electrical circuits of overflying aircraft, was not all that the Germans were working on in the area of so-called "electromagnetic weapons".

It is known that, among other things, work was being done on a type of "X-ray laser" - a source of coherent X-ray or gamma radiation, which is known to be fatal to living organisms at high intensity.

A search of German archives revealed that in the spring of 1944 a special air force research facility in Großostheim had been commissioned to develop such a weapon. The documents relating to this work are currently in a civilian facility - the Karlsruhe Research Center - and were disclosed several years ago, including a comprehensive study on the subject dated July 12, 1944, which was prepared for the Luftwaffe command. Unfortunately, the copy of the report is in such poor condition that much of it is illegible.

Nevertheless, it can be seen that the Germans were working on three different versions of the deadly ray and that it would have been entirely possible for the Third Reich to build such an anti-aircraft weapon. It would also have been ready for use within a relatively short period of time, ie before the end of the war. The third and most sophisticated version of the weapon was intended to irradiate a target at a distance of five kilometers at an intensity of seven rads per second for 30 seconds, which - as the report stated - would have been completely sufficient to kill the entire crew of an aircraft to put out of action. In the case of a target located at a different altitude, a correspondingly shorter or longer irradiation time would be required. Interestingly, this report also noted that the aluminum outer skin of the target aircraft reduced the effectiveness of the new weapon on living organisms would increase rather than decrease. In this case, the outer skin would have the effect of a microwave oven. The question of the use of X-ray generators in combat remains unclear to this day. However, if this weapon was ever used, it was certainly only on a small scale. However, similar to the other revolutionary concepts described in this book, one question still remains relevant: Are – and if so, to what extent – such weapons part of modern arsenals?

Despite the pioneering nature of these developments, it turns out that the scientists of the Third Reich were working on an even more advanced weapon - the so-called "particle beam weapon" - a emitter for high-energy particles or ions that, like invisible "micro-projectiles", hit living targets and their kinetic Energy would only be converted into deadly radiation at the moment of impact. In the case of atoms of heavy elements, even single ions would most likely be enough to kill the victim.

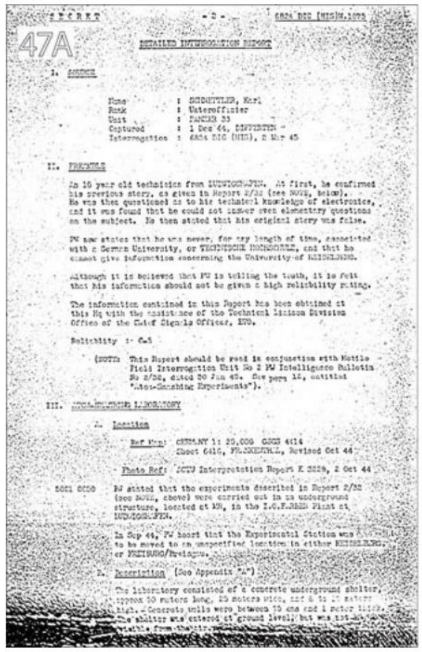
As far as I know, no calculations have been made for such a variant; However, it is no secret that even a single quantum of high-energy gamma radiation (i.e. a single photon!) could kill a person and even increase the brain temperature by several degrees when it hits the head, regardless of any secondary radiation that may be present. However, electromagnetic radiation with such gigantic power can only be generated at enormous cost and on the smallest level, namely in the largest particle accelerators.

However, a heavy metal ion could perform this task much better and would be one of the best candidates for the “perfect weapon of the future”. Of course, only heavy ions that would be accelerated to a speed close to the speed of light would come into question. By the way, some time ago I received information about the very mysterious death of two people (which happened today, but not in Poland).
During the investigation, microscopic holes were discovered in window panes whose diameter was only about 0.5 mm. Its edges were melted, but there was not a single crack in the glass. So perhaps someone has already mastered this deadly technology to a much higher level than the Germans did during World War II...

Documents from the US military intelligence service provide solid information about the work they carried out. The first relatively comprehensive report is the testimony of a German prisoner of war - a certain Karl Schnettler, who was captured on December 1, 1944. His statement (the minutes are reproduced in this book as Document 47) necessarily refers to an earlier time. Schnettler explained that tests with the particle beam weapon were carried out in an underground laboratory near Ludwigshafen that belonged to the IG Farben group. In September 1944 it was to be relocated to the Heidelberg or Freiburg region. However, the prisoner knew nothing about the experiments carried out there.

To do this, he described the laboratory near Ludwigshafen in detail. The tests were carried out in an underground bunker with an internal dimension of 25 x 50 meters and a height of eight to ten meters. The bunker walls would have been up to one meter thick. Above the ground, at a height of about two meters, there was a long, four to five meter wide platform, covered with a three to five centimeter thick plastic layer of Igelite. At one end of the bunker there was a niche where "electron tubes" (ion cannons?) stood on special trolleys, called capture *poles* and *spray poles .* Before the experiment began, these "tubes" were placed in the "bundling zone," which was shielded with a semicircular quartz plate. The electrical measuring and control systems were housed in a niche at the other end of the bunker, which were also protected by such a plate. In front of it was the actual target area of the "tubes", which were probably ion or particle cannons. It was a 1.25 - 1.5 m high cuboid column that was surrounded by massive, five centimeter thick quartz slabs. The text indicates that these plates formed a kind of "aquarium" connected to a vacuum pump. All elements of the target were covered with a thin layer of Igelite plastic.

The statement also includes a description of an experiment carried out on rats in April 1944: they died immediately, with phosphorescence of their bodies observed for a fraction of a second during the time they were exposed to the effects of the rays.



SECRET - 2 - 6824 DIC (MIS)M.1079

47A

DETAILED INTERROGATION REPORT

I. SOURCE

Name : SCHNETTLER, Karl
Rank : Unteroffizier
Unit : PANZER 33
Captured : 1 Dec 44, [illegible]
Interrogation : 6824 DIC (MIS), 2 Mar 45

II. PREAMBLE

An 18 year old technician from LUDWIGSHAFEN. At first, he confirmed his previous story, as given in Report 2/32 (see NOTE, below). He was then questioned as to his technical knowledge of electronics, and it was found that he could not answer even elementary questions on the subject. He then stated that his original story was false.

PW now states that he was never, for any length of time, associated with a German University, or TECHNISCHE HOCHSCHULE, and that he cannot give information concerning the University of HEIDELBERG.

Although it is believed that PW is telling the truth, it is felt that his information should not be given a high reliability rating.

The information contained in this Report has been obtained at this Hq with the assistance of the Technical Liaison Division Office of the Chief Signals Officer, ETO.

Reliability : C-3

(NOTE: This Report should be read in conjunction with Mobile Field Interrogation Unit No 2 PW Intelligence Bulletin No 2/32, dated 30 Jan 45. See para 12, entitled "Atom-Smashing Experiments").

III. [illegible] LABORATORY

A. Location

Ref Map: GERMANY 1: 25,000 GSGS 4414 Sheet 6416, [illegible], Revised Oct 44

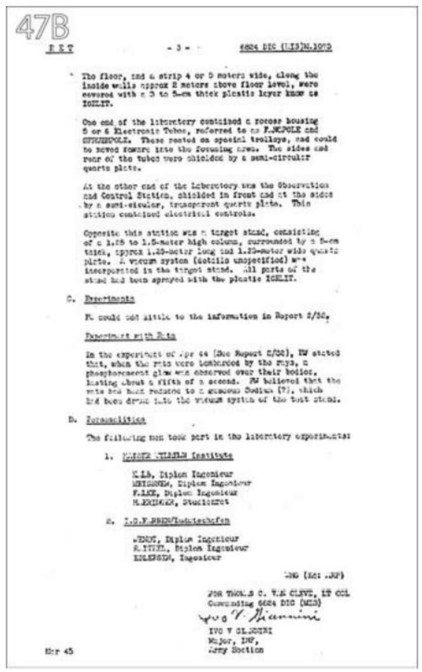
Photo Ref: ACIU Interpretation Report K 3229, 2 Oct 44

[illegible] PW stated that the experiments described in Report 2/32 (see NOTE, above) were carried out in an underground structure, located at [illegible], in the I.G.FARBEN Plant at LUDWIGSHAFEN.

In Sep 44, PW heard that the Experimental Station was to be moved to an unspecified location in either HEIDELBERG or FREIBURG/Breisgau.

B. Description (See Appendix "A")

The laboratory consisted of a concrete underground shelter, approx 30 meters long, 25 meters wide, and [illegible] meters high. Concrete walls were between 75 cms and 1 meter thick. The shelter was entered at ground level, but was not [illegible] visible from the air.



47B

[illegible]RET - 3 - 6824 DIC (MIS)M.1079

The floor, and a strip 4 or 5 meters wide, along the inside walls approx 2 meters above floor level, were covered with a 3 to 5-cm thick plastic layer know as IGELIT.

One end of the laboratory contained a recess housing 5 or 6 Electronic Tubes, referred to as [illegible] and [illegible]. These rested on special trolleys, and could be moved forward into the focusing area. The sides and rear of the tubes were shielded by a semi-circular quartz plate.

At the other end of the laboratory was the Observation and Control Station, shielded in front and at the sides by a semi-circular, transparent quartz plate. This station contained electrical controls.

Opposite this station was a target stand, consisting of a 1.25 to 1.5-meter high column, surrounded by a 5-cm thick, approx 1.25-meter long and 1.25-meter wide quartz plate. A vacuum system (details unspecified) was incorporated in the target stand. All parts of the stand had been sprayed with the plastic IGELIT.

C. Experiments

PW could add little to the information in Report 2/32.

Experiment with Rats

In the experiment of Apr 44 (See Report 2/32), PW stated that, when the rats were bombarded by the rays, a phosphorescent glow was observed over their bodies, lasting about a fifth of a second. PW believed that the rats had been reduced to a gaseous Sodium (?), which had been drawn into the vacuum system of the test stand.

D. Personalities

The following men took part in the laboratory experiments:

1. KAISER WILHELM Institute

KALB, Diplom Ingenieur
MEISSNER, Diplom Ingenieur
FALKE, Diplom Ingenieur
[illegible], Studienrat

2. I.G.FARBEN/Ludwigshafen

[illegible], Diplom Ingenieur
[illegible], Diplom Ingenieur
[illegible], Ingenieur

[illegible]

FOR THOMAS C. V[illegible] CLEVE, LT COL
Commanding 6824 DIC (MIS)

Ivo V. Giannini

IVO V GIANNINI
Major, INF,
Army Section

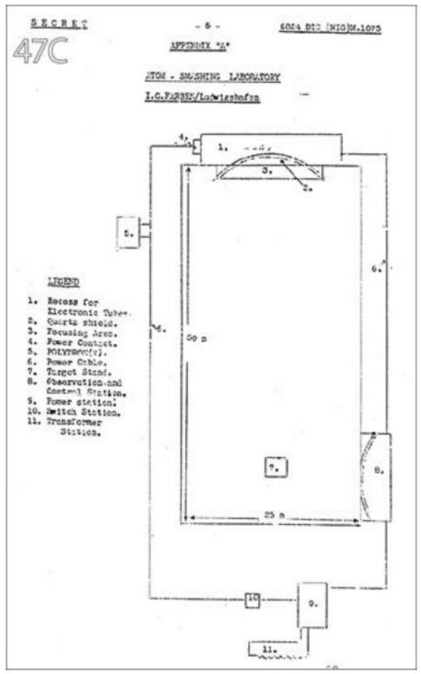
Mar 45

Schnettler claimed that their bodies were immediately decomposed and sucked out by the vacuum pump in the form of gas (literally: sodium vapor). This claim was obviously met with skepticism by the interrogating officers, who placed a question mark in brackets at the end of this sentence.

The prisoner also gave a number of names of scientists who had taken part in these works. These were the engineers Kalb, Meissner, Falke and the intern from the Kaiser Wilhelm Institute

Haeringer, from the IG Farben group in Ludwigshafen the engineers Wendt, Raithel (or Raitrel) and Edlefsen.

In Document 47C you can see a sketch of the laboratory in Ludwigshafen, which was attached to the American report.

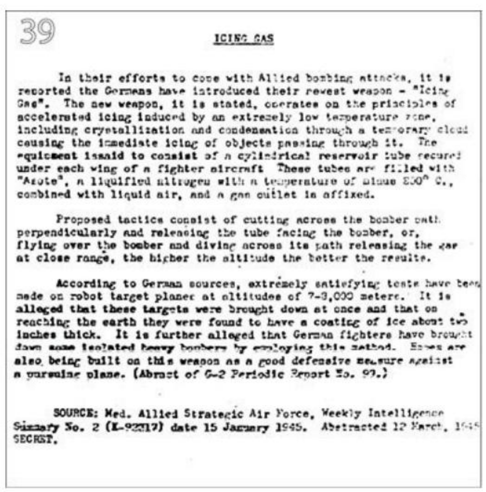



In their search for new, unconventional anti-aircraft weapons and in the hope that these very unusual methods would prove effective against the incessant flood of American and British bombers, the leadership of the Third Reich even resorted to such a strange "weapon" as clouds to cause enemy aircraft to freeze over. This is of course about artificially created clouds.

As is well known, aircraft icing is a very serious problem and the effectiveness of the de-icing system (electric heater) is a prerequisite for a safe flight.
Even in summer, at an altitude of several thousand meters, temperatures are always below zero, and there is always a certain amount of water in gaseous form in the air, regardless of the presence of clouds. Under certain circumstances, depending on humidity, air pressure and temperature, this water can condense. These circumstances can be influenced by adding additional water to the atmosphere

brings in; The process also becomes significantly more efficient if substances that promote the condensation of the water are used instead. The most effective are various types of free radicals, which form a condensation nucleus, as well as crystals of certain substances or gases that crystallize in the air, which form microscopic "grains" around which water vapor condenses and then becomes water droplets and ultimately ice crystals. At certain altitudes, even smoke becomes a very effective agent that condenses water vapor. If meteorological knowledge is used for this purpose and favorable weather conditions prevail, a serious threat to enemy aircraft can be created at surprisingly low cost (compared to complex weapon systems). Such methods were developed and used in various countries after the war - but never as a weapon, as the available data shows.

In the Soviet Union in the 1960s, light, unguided rockets were developed (very simple and cheap) whose warheads were filled with powdered silver iodide (AgI). They were used as very effective protection for sensitive cotton fields from thunderstorms and hailstorms. With this method, a “barrier” of condensation nuclei was built in front of an approaching weather front, which meant that the clouds “got rid of” their ballast before reaching the fields.


39

ICING GAS

In their efforts to cope with Allied bombing attacks, it is reported the Germans have introduced their newest weapon - "Icing Gas". The new weapon, it is stated, operates on the principles of accelerated icing induced by an extremely low temperature zone, including crystallization and condensation through a temporary cloud causing the immediate icing of objects passing through it. The equipment is said to consist of a cylindrical reservoir tube secured under each wing of a fighter aircraft These tubes are filled with "Azote", a liquified nitrogen with a temperature of minus 200° C., combined with liquid air, and a gas outlet is affixed.

Proposed tactics consist of cutting across the bomber path perpendicularly and releasing the tube facing the bomber, or, flying over the bomber and diving across its path releasing the gas at close range, the higher the altitude the better the results.

According to German sources, extremely satisfying tests have been made on robot target planes at altitudes of 7-8,000 meters. It is alleged that these targets were brought down at once and that on reaching the earth they were found to have a coating of ice about two inches thick. It is further alleged that German fighters have brought down some isolated heavy bombers by employing this method. Hopes are also being built on this weapon as a good defensive measure against a pursuing plane. (Abract of G-2 Periodic Report No. 97.)

SOURCE: Med. Allied Strategic Air Force, Weekly Intelligence Summary No. 2 (K-92317) date 15 January 1945. Abstracted 12 March, 1945 SECRET.

This phenomenon is currently also being exploited in the Republic of South Africa, but using much simpler means. Dense clouds over dry and, under normal conditions, barren fields move away, are “forced” to rain down with the help of ordinary fog candles. Several such smoke candles are hung under the wings of a light aircraft, which then flies into the clouds, where the pilot ignites them electrically. This method is so effective that two to four candles are usually enough to produce precipitation during a flight.

But what were the Germans working on?

We find the answer to this question again in the declassified documents of the US military intelligence service. One of the reports relating to new German weapons also contains information on this topic (Document 39). The following description is included there:

> "It is reported that the Germans, in their efforts to counter the Allied bombing raids, introduced their newest weapon - 'ice gas.' The new weapon is said to be based on the phenomenon of accelerated icing, where condensation and crystallization processes are caused by a cloud in a zone with extremely low temperatures. Any object that passes through this cloud immediately becomes iced over. The equipment necessary to create such an effect consists of two cylindrical containers suspended under the wings of a fighter aircraft, filled with liquid nitrogen (mixed with liquid air) at a temperature of minus 250 ° C and provided with a gas outlet opening.
>
> The proposed tactic is based on cutting vertically through the flight line of bombers and releasing the gas in front of them, or flying above the bomber and then diving, which would allow the gas to be released at a closer distance to the target. The higher the altitude, the better the results would be.
>
> According to German sources, extremely successful tests were carried out with remotely controlled target aircraft at an altitude of 7,000 - 8,000 m. These targets are reported to have crashed immediately; After the crash, an approximately 5 cm thick layer of ice was discovered. It is also assumed that German fighter planes had

In this way a certain number of heavy bombers detached from the squadron were 'shot down'. It is also hoped that this method will provide effective defense during pursuit flights."

Other American documents contain information about experiments with other substances that, when sprayed in the air, were intended to damage the engines of enemy bombers. Document 52 describes these substances as follows: "Two types of gases are known that

could be used against aircraft. One of them is intended to cause premature ignition, which would lead to the cylinder heads tearing off, the second is intended to reduce the viscosity of oils used to lubricate the engine. If operational findings are ignored, these gases give the impression under laboratory conditions that their use would actually be possible. However, it is doubtful whether the enemy, with appropriate fighter escort, would be able to use one of these means in a concentration that would have serious consequences. If projectiles from anti-aircraft guns were used for this purpose, the concentration that could be achieved would probably be no more dangerous than the accurate fire of conventional anti-aircraft artillery."

44

SECRET

EXTRACT

Letter from John [illegible] [illegible], Director, [illegible], Advanced Service [illegible] Laboratory, [illegible] - U. S. ARMY to Dr. L. A. DuBridge, Director, Radiation Laboratory, Massachusetts Institute of Technology, Cambridge, Massachusetts

"New Weapons"

Probably inspired by the German development of V-1, V-2, and other military devices such as the jet aircraft and rockets, there appears to have developed a very strong "new weapons" psychosis which leads to reports of new and amazing phenomena every other week. I have recently been looking into the evidence for a reported enemy radiation capable of interfering with aircraft ignition up to [illegible],000 meters and operating [illegible] certain high-priority target areas. There is also the reported German pro-knock gas capable of minute concentrations of removing aircraft engine heads. Not so long ago several pilots reported flying through thousands of transparent glasslike bubbles which, although they had no adverse effect, were thought to be a new weapon. A considerable number of ground and air observers saw new-weapon possibilities in an unusual pink cloud phenomenon which persisted for about an hour over the front line, but without any noticeably adverse effects. The explanations for the latter two items seem to be bundles of window dropped by a preceding high-altitude bomber formation and an actual pink-colored cloud respectively. There is the report of a "freezing gas" for icing up aircraft, and a host of others. Most of them have little effect and are quickly discredited. On the whole, they illustrate the interesting attitude of mind which has developed—but, with V-1 and V-2 as daily evidence, one has to be careful.

However, the list of unusual German concepts in the field of anti-aircraft weapons is by no means exhausted. The last of the documents presented (Document 44) reveals even stranger ideas, the meaning and exact purpose of which we can only guess at. Here's a short one

Detail:

> “[…] I recently saw evidence of reported hostile radiation capable of affecting aircraft ignition systems at a distance of 3,000 meters and used near certain high-priority targets. […] It wasn't long ago that many pilots reported that they had flown through thousands of transparent 'bubbles' that looked like glass. Although they had no negative impact, it was believed that this was a new weapon. Many ground and aircrew observers also see the unusual phenomenon of pink clouds hovering over the front line for approximately an hour as a new weapon, although these clouds also appear to have no discernible negative impact.”

It seems as if the “ice gas” was even used in combat. At least that's how Otto Skorzeny described it in his memoirs, who was fighting in the SS *Das Reich* division at the time, around the turn of 1941/1942 : “To our left is [50]

> the city of Khimki, the river port of Moscow. From here it is only eight kilometers to Moscow. Without a single shot being fired,
>
> marched on the 30th.
>
> The 62nd Reconnaissance Regiment, part of Hoepner's Panzer Corps, arrived there in November. Nobody knows why this opportunity was not taken. Our motorcyclists withdrew.
>
> Here begins the next mysterious episode of the battle for Moscow, which escaped the attention of many historians. In order to be able to stand up to the terrible rockets from the 'Stalin Organ', a new rocket projectile was used that was filled with liquid air. The shells resembled huge bombs, and their effect - as far as my knowledge allowed me to judge - was unparalleled. Their use had an immediate impact on the enemy's defensive strength. The enemy used huge loudspeakers for (seemingly extremely banal and crude) propaganda purposes. A few days after the first use of our missiles, the Russians threatened us over these loudspeakers that they would respond with a poison gas attack

> if we continued to use rockets filled with liquid air. From that moment on, these missiles were never used again, at least not in our sector. I don't think they were deployed to other sectors of the front either."

However, the "ice weapon" also had a counterpart – a "firearm".

In the early 1970s, the Americans used a "new," previously unknown weapon in Vietnam. The effects of the first application were horrific, but also highly unusual: when the Vietnamese inspection arrived at the scene of the attack, they found bodies scattered in a haphazard manner, frozen in strange postures... but showing no signs of any external injury. All that could be seen was that blood had flowed from the mouths of the dead. The unusual nature of these traces led to allegations that a banned biological weapon had been used. The Americans rejected these accusations, and the whole truth about the "new" weapon only came to light much later (many years later). As it turned out, this was actually the first time that this unusual weapon had been used on a large scale - an unusual weapon, but one that belongs to the arsenal of conventional weapons. They were so-called aerosol bombs - aerial bombs, but they bear little resemblance to classic bombs because they do not have a thick steel shell. The bomb is more of a bulbous, thin-walled, cylindrical container made of thick sheet metal. Apart from the detonator, it does not contain any explosives, but contains compressed methane or another volatile hydrocarbon (ethane, hexane or a special mixture). The special feature of the "new" weapon was that the explosive device was only formed after the bomb had been dropped by mixing the contents with air (in an appropriate ratio).

The fundamental technical turning point is that the resulting mixture does not burn, such as B. in the cylinder of an internal combustion engine, but detonates. This difference requires an explanation:

Combustion or deflagration (the burning of black powder or low-smoke powder in the barrel of a weapon, the explosion of a firecracker, etc.) is characterized by the fact that the heat...

The main agent of the reaction expansion is - or in other words: the flame, ie the spreading medium that was heated due to the reaction. The combustion rate is usually relatively low - it rarely exceeds 2,000 m/s. The basic property of explosive combustion is associated with this parameter - its low destructive power.

The main agent of detonation transmission, however, is the so-called shock wave, something completely different. It has no direct connection to the propagation of the medium - there is a difference between a shock wave and an air blast. The shock wave is more similar to a sound wave (whose propagation is characterized only by an oscillation of air density, but not by a spatial displacement), but by definition always moves faster than sound and only becomes a sound wave when it is weakened. It reaches a speed of around 9,000 m/s, which is why a huge density oscillation occurs - and if matter had no atomic structure, this density would be infinite.

A typical aerosol bomb produces both a strong shock wave and a very strong expansion and heat wave. A container containing half a ton of methane produces an explosion that is comparable in destructive power to the explosion of approximately 1.5 tons of TNT (a powerful explosive), i.e. about three times as powerful. In practice, however, it is much stronger, as in a classic bomb the casing usually makes up most of the mass. So if we now compare the pure explosives, an aerosol bomb can be five to ten times more effective than a “normal” aerial bomb. The difference is therefore almost colossal, although it should be borne in mind that this result can be achieved at relatively low cost and in a relatively simple way (on the other hand, increasing effectiveness by increasing accuracy would certainly have been enormously more expensive).

The aerosol bomb has another “interesting” property: since the explosion occurs in a large volume, a phenomenon occurs that has no counterpart in the explosion of explosives. The expanding gas bubble creates a zone of negative pressure in the center during its expansion - after the expansion, a type occurs

Implosion. It was precisely this phenomenon that was responsible for the trickles of blood from the mouths of the killed Vietnamese - the blood from ruptured alveoli had been sucked out by the "implosion".

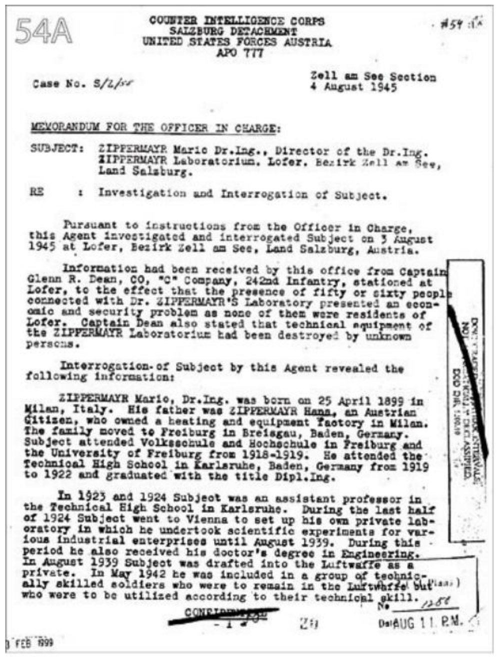
In short, this is an extremely dangerous weapon. An unusual incident from the Second Gulf War, which occurred in 1991, may serve as a very good example of their possible use. One of the British reconnaissance troops (SAS) in Iraq was able to observe the explosion of an aerosol bomb from a distance and inevitably interpreted it as the explosion of a small nuclear device. The report forwarded to headquarters led to a great deal of confusion: it was taken seriously, as the SAS troops are meticulously trained to recognize different weapons by the nature of their impact and therefore no one expected such a “blunder” from them.

However, this description says a lot about the capabilities of this weapon. Without much exaggeration, the aerosol bomb can be described as an “intermediate link” between classic ammunition and low-capacity nuclear explosive devices.

As it turns out, they also worked during World War II
Germans on such a weapon...

This work was carried out under the code name *Hexenkessel* .
The laboratory for ballistic research in the Berlin district of Gatow, the laboratory of a certain Dr. Zippermayr and the company Dynamit AG Krümel. However, the Germans did not use volatile hydrocarbons for these purposes, but rather fine coal dust.
This material has higher demands, but is characterized by similar effectiveness. Current research into coal dust explosions in mines provides some information on this topic: millimeter-sized coal grains can form an explosive mixture if their “concentration” exceeds twelve percent of the air mass. The approximate explosion limit is 45 to 1,000 g of dust in one cubic meter of air. The strongest explosion occurs at a content of 300 - 500 g of coal grains in one cubic meter of air. 51 Certain data about the *Witch's Cauldron* project could be obtained due to access to the files of the aforementioned Dr. Ing. Zippermayr can be won. In August 1945 he was taken over by an American agency

Counterintelligence interrogated in Austria. The essential information about the work in which he was involved can be found in the interrogation protocol (Document 54). Here is an excerpt that relates to this work:



54A

COUNTER INTELLIGENCE CORPS
SALZBURG DETACHMENT
UNITED STATES FORCES AUSTRIA
APO 777

#54

Case No. S/2/58

Zell am See Section
4 August 1945

MEMORANDUM FOR THE OFFICER IN CHARGE:

SUBJECT: ZIPPERMAYR Mario Dr.Ing., Director of the Dr.Ing. ZIPPERMAYR Laboratorium, Lofer, Bezirk Zell am See, Land Salzburg.

RE : Investigation and Interrogation of Subject.

Pursuant to instructions from the Officer in Charge, this Agent investigated and interrogated Subject on 3 August 1945 at Lofer, Bezirk Zell am See, Land Salzburg, Austria.

Information had been received by this office from Captain Glenn R. Dean, CO, "C" Company, 242nd Infantry, stationed at Lofer, to the effect that the presence of fifty or sixty people connected with Dr. ZIPPERMAYR'S Laboratory presented an economic and security problem as none of them were residents of Lofer. Captain Dean also stated that technical equipment of the ZIPPERMAYR Laboratorium had been destroyed by unknown persons.

Interrogation of Subject by this Agent revealed the following information:

ZIPPERMAYR Mario, Dr.Ing. was born on 25 April 1899 in Milan, Italy. His father was ZIPPERMAYR Hans, an Austrian Citizen, who owned a heating and equipment factory in Milan. The family moved to Freiburg in Breisgau, Baden, Germany. Subject attended Volksschule and Hochschule in Freiburg and the University of Freiburg from 1918-1919. He attended the Technical High School in Karlsruhe, Baden, Germany from 1919 to 1922 and graduated with the title Dipl.Ing.

In 1923 and 1924 Subject was an assistant professor in the Technical High School in Karlsruhe. During the last half of 1924 Subject went to Vienna to set up his own private laboratory in which he undertook scientific experiments for various industrial enterprises until August 1939. During this period he also received his doctor's degree in Engineering. In August 1939 Subject was drafted into the Luftwaffe as a private. In May 1942 he was included in a group of technically skilled soldiers who were to remain in the Luftwaffe but who were to be utilized according to their technical skill.

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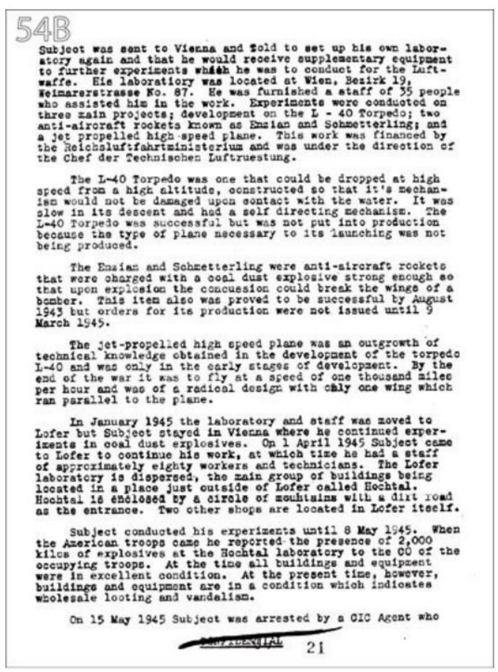

54B

Subject was sent to Vienna and told to set up his own laboratory again and that he would receive supplementary equipment to further experiments which he was to conduct for the Luftwaffe. His laboratiory was located at Wien, Bezirk 19, Weimarerstrasse No. 87. He was furnished a staff of 35 people who assisted him in the work. Experiments were conducted on three main projects; development on the L - 40 Torpedo; two anti-aircraft rockets known as Enzian and Schmetterling; and a jet propelled high speed plane. This work was financed by the Reichsluftfahrtministerium and was under the direction of the Chef der Technischen Luftruestung.

The L-40 Torpedo was one that could be dropped at high speed from a high altitude, constructed so that it's mechanism would not be damaged upon contact with the water. It was slow in its descent and had a self directing mechanism. The L-40 Torpedo was successful but was not put into production because the type of plane necessary to its launching was not being produced.

The Enzian and Schmetterling were anti-aircraft rockets that were charged with a coal dust explosive strong enough so that upon explosion the concussion could break the wings of a bomber. This item also was proved to be successful by August 1943 but orders for its production were not issued until 9 March 1945.

The jet-propelled high speed plane was an outgrowth of technical knowledge obtained in the development of the torpedo L-40 and was only in the early stages of development. By the end of the war it was to fly at a speed of one thousand miles per hour and was of a radical design with only one wing which ran parallel to the plane.

In January 1945 the laboratory and staff was moved to Lofer but Subject stayed in Vienna where he continued experiments in coal dust explosives. On 1 April 1945 Subject came to Lofer to continue his work, at which time he had a staff of approximately eighty workers and technicians. The Lofer laboratory is dispersed, the main group of buildings being located in a place just outside of Lofer called Hochtal. Hochtal is enclosed by a circle of mountains with a dirt road as the entrance. Two other shops are located in Lofer itself.

Subject conducted his experiments until 8 May 1945. When the American troops came he reported the presence of 2,000 kilos of explosives at the Hochtal laboratory to the CO of the occupying troops. At the time all buildings and equipment were in excellent condition. At the present time, however, buildings and equipment are in a condition which indicates wholesale looting and vandalism.

On 15 May 1945 Subject was arrested by a CIC Agent who

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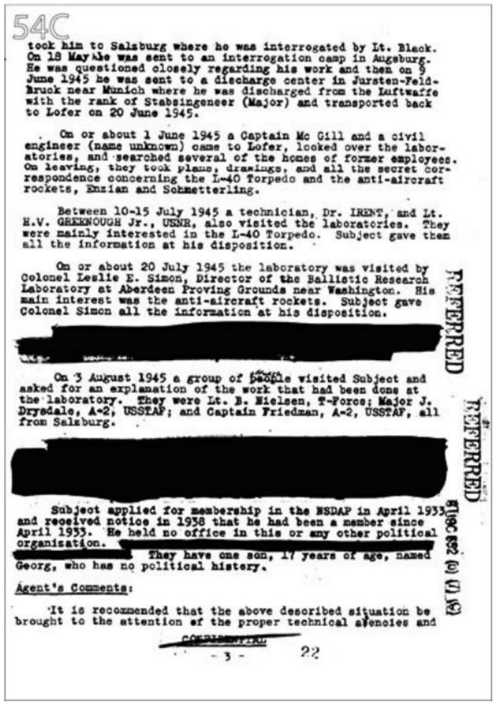
“In the years 1923 and 1924 the interrogated man (Mario Zippermayr) Assistant professor at the Technical University in Karlsruhe. In the

In the second half of 1924, Zippermayr went to Vienna, where he founded his own private laboratory and worked there until August 1939 various scientific studies for industrial companies carried out. At this time he also received his Doctorate in engineering. In August 1939 Zippermayr served in the Air Force as a simple soldier convened. In May 1942 he joined a group of technically gifted people Soldiers assigned who remain with the Air Force, however should be used according to their technical talent. Zippermayr was then sent to Vienna with instructions sent back to his laboratory for the Air Force commissioned to reconstruct the given investigations. He should for that receive additional equipment. This laboratory was located in Vienna District 19, at Weimarer Straße 87. In this context He got the appropriate staff - 35 people to help him with his work supported work. There were three tests Main projects carried out: the development of the L-40 torpedo; from two anti-aircraft missiles, known as *Enzian* and *Butterfly;* as well as a high-speed aircraft Jet propulsion. This Work that became through Financed by the Reich Aviation Ministry and headed by the Chief of Technology Air armament directed. The L-40 torpedo was designed to be released from a Airplane flying at high speed and at high altitude be suitable and its mechanism should withstand impact on the Can withstand water surface. He slowly sank downwards and kept the given direction with the help of a navigation system at. Attempts with the L-40 torpedo were successful, but he left not in production as no aircraft suitable for his were manufactured transport would have been suitable.



54C

took him to Salzburg where he was interrogated by Lt. Black. On 18 May he was sent to an interrogation camp in Augsburg. He was questioned closely regarding his work and then on 9 June 1945 he was sent to a discharge center in Jursten-Feld-Bruck near Munich where he was discharged from the Luftwaffe with the rank of Stabsingeneer (Major) and transported back to Lofer on 20 June 1945.

On or about 1 June 1945 a Captain Mc Gill and a civil engineer (name unknown) came to Lofer, looked over the laboratories, and searched several of the homes of former employees. On leaving, they took plans, drawings, and all the secret correspondence concerning the L-40 Torpedo and the anti-aircraft rockets, Enzian and Schmetterling.

Between 10-15 July 1945 a technician, Dr. IRENT, and Lt. H.V. GREENOUGH Jr., USNR, also visited the laboratories. They were mainly interested in the L-40 Torpedo. Subject gave them all the information at his disposition.

On or about 20 July 1945 the laboratory was visited by Colonel Leslie E. Simon, Director of the Ballistic Research Laboratory at Aberdeen Proving Grounds near Washington. His main interest was the anti-aircraft rockets. Subject gave Colonel Simon all the information at his disposition.

[redacted]

On 3 August 1945 a group of people visited Subject and asked for an explanation of the work that had been done at the laboratory. They were Lt. B. Nielsen, T-Force; Major J. Drysdale, A-2, USSTAF; and Captain Friedman, A-2, USSTAF, all from Salzburg.

[redacted]

Subject applied for membership in the NSDAP in April 1933 and received notice in 1938 that he had been a member since April 1933. He held no office in this or any other political organization. [redacted] They have one son, 17 years of age, named Georg, who has no political history.

Agent's Comments:

It is recommended that the above described situation be brought to the attention of the proper technical agencies and

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- 3 - 22

REFERRED

REFERRED

5 USC 552 (c) (7) (C)

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CONFIDENTIAL

and that in the event that the personnel of Dr. ZIPPERMAYR'S Laboratory are not to be utilized in any way [redacted]

It is also recommended that the proper technical agency remove from Dr. ZIPPERMAYR and his associates any other plans, sketches, models and data connected with his former experiments. It is the opinion of this Agent that Dr. ZIPPERMAYRS experiments are of value and that all informations concerning them be controlled; that a check be made if possible of Captain McGill to ascertain whether he had the proper authority to remove the plans of the L-40 and the anti-aircraft rockets and whether or not he has turned them over to the proper agency.

[redacted]
Special Agent, CIC

Approved: [redacted]
W.J. Kaufmann, Jr.
Major, MI

Distribution:

2 - G-2 (CI) USFA.
1 - G-2 II Corps, USFA.
1 - G-2 42nd Infantry Division.
1 - File

REFERRED

*Gentian* and *Butterfly* were anti-aircraft missiles that had warheads equipped with coal dust. Their explosive power was so great that they could tear off the wings of an attacked bomber. These rockets were also successfully tested in August 1943, but the order to start production was not given until March 9, 1945.

The high-speed jet-powered aircraft was designed based on the technical knowledge gained in the development of the L-40 torpedo and was at an early stage of development. At the end of the war there should be one

Complete flight at a speed of 1,000 miles per hour (1,609 km/h). It was an uncompromising design with only one wing parallel to the aircraft [fuselage? – Note d.
Author's] went.

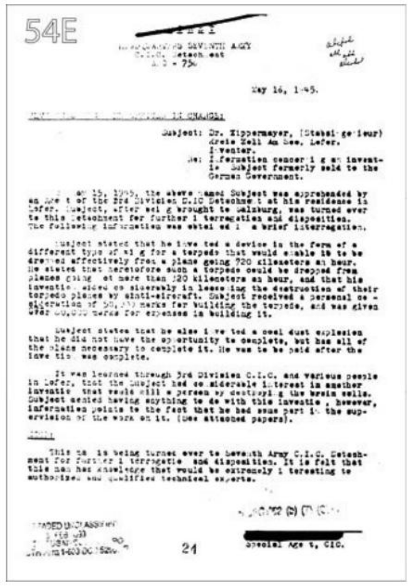
In January 1945, the laboratory and its staff were moved to Lofer, but Zippermayr remained in Vienna, where he continued his experiments with aerosol bombs based on coal dust. To continue his work, Zippermayr came to Lofer on April 1st, where he had a staff of 80 workers and technicians. The laboratory in Lofer is scattered, with the main buildings located just outside of town in a place called Hochtal. It is a valley surrounded by mountains with a dirt road leading to it. Two other workshops are located in Lofer itself.

Zippermayr carried out his experiments until May 8, 1945. When the American occupation troops arrived, he reported to their commander that 2,000 kg of explosives were stored in the laboratories in Hochtal. At that time all the buildings and equipment were in excellent condition; Today the complex is witness to mass looting and vandalism.

On May 15, 1945, Zippermayr was arrested by an agent of the CIC (the military counterintelligence service), who took him to Salzburg, where he was interrogated by Lieutenant Black.

The American documents indicate that this person's work was by no means limited exclusively to the above-mentioned questions, although he himself was unwilling to admit this (it cannot be ruled out that the reason for this was human experimentation). Here is an excerpt from Document 58, which contains information about this:

“With the help of the 3rd Division of the CIC and with the participation of various people in Lofer, it was determined that Zippermayr was very interested in another invention for killing people by destroying their brain cells. Zippermayr denied having anything to do with this discovery, although information suggests that he was involved in leading this work.”



54E

HEADQUARTERS SEVENTH ARMY
C.I.C. Detachment
APO - 758

May 16, 1945.

[illegible] IN CHARGE:

Subject: Dr. Zippermayer, (Stabsi ge ieur)
Kreis Zell Am See, Lofer.
Inventor.
Re: Information concerning an invention Subject formerly sold to the German Government.

On May 15, 1945, the above named Subject was apprehended by an Agent of the 3rd Division C.IC Detachment at his residence in Lofer. Subject, after being brought to Salzburg, was turned over to this Detachment for further interrogation and disposition. The following information was obtained in a brief interrogation.

Subject stated that he invented a device in the form of a different type of wing for a torpedo that would enable it to be dropped affectively from a plane going 720 kilometers an hour. He stated that heretofore such a torpedo could be dropped from planes going at more than 320 kilometers an hour, and that his invention aided considerably in lessening the destruction of their torpedo planes by anti-aircraft. Subject received a personal consideration of 50,000 marks for building the torpedo, and was given over 60,000 marks for expenses in building it.

Subject states that he also invented a coal dust explosion that he did not have the opportunity to complete, but has all of the plans necessary to complete it. He was to be paid after the invention was complete.

It was learned through 3rd Division C.I.C. and various people in Lofer, that the Subject had considerable interest in another invention that would kill a person by destroying the brain cells. Subject denied having anything to do with this invention, however, information points to the fact that he had some part in the supervision of the work on it. (See attached papers).

[illegible]

This man is being turned over to Seventh Army C.I.C. Detachment for further interrogation and disposition. It is felt that this man has knowledge that would be extremely interesting to authorized and qualified technical experts.

[redacted]
Special Agent, CIC.

24

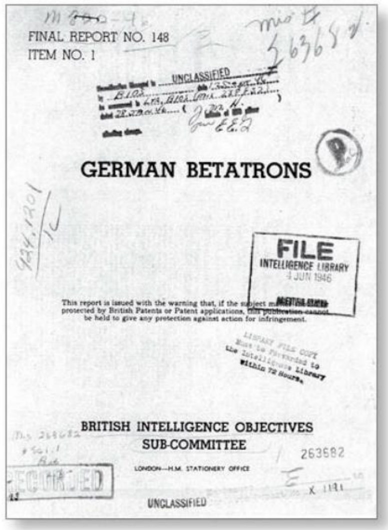
So here we have another mystery that has so far escaped the attention of researchers studying the history of the Second World War. Perhaps this mystery can also be solved at some point.

I found many documents on the subject of "death rays" in American archives between 2000 and 2001, especially among the material that relates to the so-called "ALSOS mission," which directly after the war initiated the German nuclear program and those associated with it should clarify the questions that arise. 52 The "death rays" are also mentioned in the analysis by the British intelligence service dedicated to particle accelerators, specifically the so-called betatrons.[53] With their help, a high-energy directed X-ray beam could be generated. The British report states: 53

"The Air Force authorized the work in the hope of using death rays to combat enemy aircraft."

The ALSOS mission documents prove that the betatron was seen as the starting point for the construction of a weapon system. Many research groups were commissioned to carry out this task, the most important of which were probably the group led by Dr. Wideröe and the BBC company from Mannheim. Wideröe leaves the impression of an extremely active and imaginative scientist. By September 1943 alone, his research resulted in at least ten patent applications.

The latest available report from Dr. Commentary on the progress of the work from September 15, 1944 suggests that there were still around four months left to complete a "weapon". It should be an accelerator that uses electrical discharges with a voltage of 200 MV (million volts).


FINAL REPORT NO. 148
ITEM NO. 1

UNCLASSIFIED

GERMAN BETATRONS

FILE
INTELLIGENCE LIBRARY
4 JUN 1946

This report is issued with the warning that, if the subject m... protected by British Patents or Patent applications, this publication cannot be held to give any protection against action for infringement.

BRITISH INTELLIGENCE OBJECTIVES SUB-COMMITTEE

LONDON—H.M. STATIONERY OFFICE

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A German document from the files of the "ALSOS mission" with a brief description of the "death ray project" that was connected to Großostheim.


Kurzer Bericht über die Arbeiten, welche vom Unterzeichneten und seinen Mitarbeitern im Institut für röntgenologische Roh- und Werkstofforschung im Rahmen des Forschungsauftrages DE 6224/0109/43 seit 20. April 1943 durchgeführt wurden.

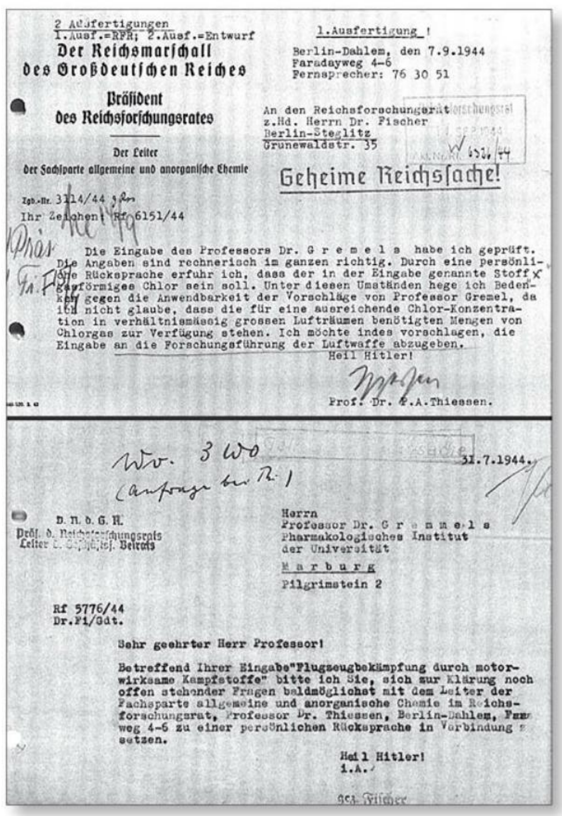
1. Ausarbeitung der Grundlagen des Projektes für die Besprechung mit dem Herrn Generalfeldmarschall am 20.4.43.
2. Verschiedene Denkschriften und Berichte an GL/St mit Einzelheiten meiner Planung und Vorschläge für die Durchführung.
3. Mitarbeit bei den technischen und organisatorischen Vorarbeiten über die Auswahl des Platzes und der Einrichtung der Versuchsstelle Groß Ostheim.
4. Exposé über die Bedeutung des Wideröeschen Strahlentransformatore für die vorliegenden Pläne und maßgebende Beteiligung an Verhandlungen mit Herrn Dr. Wideröe.
5. Ausarbeitung der Pläne betr. Auf- und Ausbau der großen Halle in Gr. Ostheim, gemeinsam mit dem Büro Prof. Tamms (Arch. Sander) und den zuständigen Herren vom Luftgau XII.
6. Aufstellung der Pläne für Installation, Telefonanlage usw. für die zunächst vorgesehenen Laboratoriumsbaracken und den Ausbau der Unterkunftsräume.
7. Versuch zur Einrichtung wissenschaftlicher Arbeitsräume nebst Feinmechanikerwerkstatt, zunächst mit dem Inventar des Institute für röntgenologische Roh- und Werkstofforschung zum Zwecke der Vornahme dringlicher Vorversuche. Diese Einrichtungen wurden auf Veranlassung der Forschungsführung inzwischen wieder aus Ostheim entfernt.
8. Schulung der aus der Truppe herausgezogenen wissenschaftlichen und ingenieurtechnischen Mitarbeiter.
9. Zusammenstellung der für die Arbeiten wichtigen Literatur und Ausarbeitung eines zusammenfassenden kritischen Berichtes über die bisherigen Ergebnisse ~~auch~~ auf dem Gebiete der Physik durchdringender Röntgen- und Gammastrahlen, sowie Elektronen.
10. Aufstellung von Inventarlisten und Geräten für die erste Einrichtung von Laboratorien und Werkstätten.
11. Beschaffung der 1,2 Mill.Voltanlage vom Hamburger Staat.
12. Bestellung einer 2,2 MV-Röntgenanlage bei der Fa. C.H.F.Müller in Hamburg.
13. Entwicklungsauftrag an die Firma C.H.F.Müller-Hamburg über einen 15 MV-Strahlentransformator Bauart Wideröe..
14. Beschaffung von Laboratoriumsbedarf und Geräten aus Beutestellen der Luftwaffe.
15. Wissenschaftliche Arbeit theoretischer Natur über die Ausbreitung und Schwächung harter Röntgenstrahlen in Luft variabler Zusammensetzung, Dichte und Temperatur für verschieden hohe Primärenergien
16. Projektierung einer Großanodenröntgenröhre nach eigenen Vorschlägen.
17. Projektierung einer Anlage zur Erzeugung hoher Spannung und großer Stromstärke nach dem Kaskadenprinzip auf Grund eines eigenen DRP.

Leipzig, den 4. Mai 1944.

Prof.Dr.E.Schiebold.

The report from May 1944 by Prof. Dr. E. Schiebold, head of the Air Force research laboratory, which is also entrusted with this task, points to a similar progress in the work. 52 This mentions, among other things, the use of the Air Force's resources, the construction of a "large hall" for research purposes on the laboratory complex in Großostheim and the training of specialists who were released from the military.

One might get the impression that the whole thing has not progressed beyond the experimental stage, but the data is largely incomplete - it stops at one point and obviously does not cover the entire complex of questions. For example, there is nothing about the work of the previously mentioned company GEMA. In addition, the large number of people and institutions involved is something to think about. Against this background, it seems strange that this topic is simply ignored in current treatises.



2 Ausfertigungen
1.Ausf.=RFR; 2.Ausf.=Entwurf

1.Ausfertigung !

Der Reichsmarschall
des Großdeutschen Reiches

Präsident
des Reichsforschungsrates

Der Leiter
der Fachsparte allgemeine und anorganische Chemie

Berlin-Dahlem, den 7.9.1944
Faradayweg 4-6
Fernsprecher: 76 30 51

An den Reichsforschungsrat
z.Hd. Herrn Dr. Fischer
Berlin-Steglitz
Grunewaldstr. 35

Geheime Reichssache!

Tgb.-Nr. 3114/44
Ihr Zeichen: Rf 6151/44

Die Eingabe des Professors Dr. G r e m e l s habe ich geprüft. Die Angaben sind rechnerisch im ganzen richtig. Durch eine persönliche Rücksprache erfuhr ich, dass der in der Eingabe genannte Stoff gasförmiges Chlor sein soll. Unter diesen Umständen hege ich Bedenken gegen die Anwendbarkeit der Vorschläge von Professor Gremel, da ich nicht glaube, dass die für eine ausreichende Chlor-Konzentration in verhältnismässig grossen Lufträumen benötigten Mengen von Chlorgas zur Verfügung stehen. Ich möchte indes vorschlagen, die Eingabe an die Forschungsführung der Luftwaffe abzugeben.

Heil Hitler!

Prof. Dr. P.A.Thiessen.

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31.7.1944.

D. R. d. G. R.
Präs. d. Reichsforschungsrats
Leiter d. Geschäftsf. Beirats

Herrn
Professor Dr. G r e m m e l s
Pharmakologisches Institut
der Universität
M a r b u r g
Pilgrimstein 2

Rf 5776/44
Dr.Fi/Gdt.

Sehr geehrter Herr Professor!

Betreffend Ihrer Eingabe "Flugzeugbekämpfung durch motorwirksame Kampfstoffe" bitte ich Sie, sich zur Klärung noch offen stehender Fragen baldmöglichst mit dem Leiter der Fachsparte allgemeine und anorganische Chemie im Reichsforschungsrat, Professor Dr. Thiessen, Berlin-Dahlem, Faradayweg 4-6 zu einer persönlichen Rücksprache in Verbindung zu setzen.

Heil Hitler!
i.A.

gez. Fischer

Two documents from the Reich Research Council on chemical agents that could disable the engines of Allied bombers. (from the "ALSOS mission" documents).

This is all the more striking when we know that in the files of the Personal Staff of the Reichsführer-SS there was a special briefcase in which correspondence about a "weapon" that used directed energy to combat enemy aircraft was found (these documents 54 Also Here we my hands in 2001). highest find traces of the ones that came into circles involved in the whole thing. This file folder contains, among other things, letters from the companies ELEMAG and AEG as well as the Reich Research Council. However, it is not clear from them whether there was any practical application - it was, among others, the head of the planning office of the Reich Research Council, Prof. Dr. Werner Osenberg, who noted on February 7, 1945 that although the work had been carried out "for several decades," it had not yet produced any concrete results.

It would also be interesting in this context to hear the statement from the representative for high-frequency research, which should be decisive in this matter. A document from January 1945 contains such a statement.[54] This shows that due to the "great burden" placed on the research institutions under the authorized representative's authority, they are not in a position to address this complex of questions.

So I couldn't find any clear confirmation of the combat use of directed energy beams in the German sources, although the number of institutions appearing in this context is surprising and does not particularly fit a project with no practical relevance.

When we talk about "electromagnetic weapons," another project should be mentioned, which was also directed against Allied bombers.

Among the hundreds, if not thousands, of reports from Allied secret services about "new weapons" from the Third Reich, many referred to revolutionary or simply unusual concepts in the field of artillery armament. Sometimes these reports contained errors or exaggerated assessments that made the new German solutions seem scarier than they really were. Here is an example - a description that appears in Document 4 of December 29, 1943:

"According to reports from France, seeking information

Based on industrial circles, the new German weapon is a heavy, long-range cannon. It fires projectiles containing phosphorus and other chemical substances that deplete the oxygen in the atmosphere within several hundred meters of the impact point, creating deadly conditions for all living organisms."

Of course, the Germans were actually working on a heavy long-range cannon, but a projectile fired from it would certainly not have the effect described. The sheer flood of similar, highly contradictory reports meant that a certain proportion of them were not given adequate attention. These documents contained similarly unusual details, but related to a weapon that only after the war could it be said with certainty that the Germans had actually worked intensively on it (this fact is not widely known to this day).

It's about the "electromagnetic cannon" - a weapon in which the projectile is accelerated not by gases generated by the burning powder charge, but by an extremely strong magnetic field maintained for a fraction of a second. The operating principle of the electromagnetic cannon is relatively simple - it works in a similar way to an electric linear motor. However, the technological requirements for building a fully-fledged device are so high that such a weapon is still considered forward-looking today, precisely because it removes many technical barriers could be overcome, which are insurmountable in the case of a classic cannon. Such a

The fundamental obstacle that engineers and the military dream of overcoming is the muzzle velocity of the bullet - a key parameter on which the penetration power of core bullets (the basic form of armor-piercing ammunition) depends. No modern tank fires projectiles with an initial velocity of over 2,000 m/s.
Exceeding this "magic" limit on the basis of classic solutions would be extremely difficult and would entail costs that would be disproportionate to the achievable effect. Above all, this would lead to a drastic shortening of the barrel life - probably only 100 - 200 shots would be possible (the lifespan

The barrels of modern tank guns with a caliber of 120 - 125 mm are about 500 - 1,000 shots, although it should be borne in mind that such a barrel costs on average several tens of thousands of dollars). New solutions would also be required in the area of the powder charge itself - the powder would probably have to be replaced by a completely different material, with a correspondingly higher combustion rate and energy, which in turn would increase the risk of such a material exploding (harming not only the cannon, but the entire tanks could be destroyed). The pipe tensile strength limit is also difficult to overcome - it is precisely defined. The strength of steel can no longer be increased significantly, and "thickening" the pipe achieves very little - its inner layers would still burst. Due to tactical requirements, the tube length itself is also limited.

The problem presented above can also be summarized much more simply: It is generally known that the design of classic barrel weapons has not changed significantly since the end of the Second World War. The modern basic weapon of the infantry, the automatic rifle (a self-loader for so-called medium cartridges), does not differ significantly from the first design of this type, the MP-43 from 1943. This illustrates the problem described, as well as the fact that until... Today, the Wehrmacht's basic machine gun - the MG-42 (currently MG-3) - is produced without any major changes for the needs of the Bundeswehr and at least ten other armies.

As time goes on and other types of weapons develop, the need to abandon the classic barrel weapons, which, as can be seen, had essentially reached their limits half a century ago, becomes ever stronger. This necessity is accompanied by ever greater efforts in the search for analogue, but qualitatively completely new solutions.

Although such solutions have been on the lookout for some time, I am convinced that the vast majority of specialists, when asked about the best future-oriented “successor” to the classic cannon, would clearly name the electromagnetic cannon.

**Paradoxically, the 63 years that have passed since the war research described above was interrupted have not caused it to lose any of its relevance. On the contrary – this period of time**

**It is important to look at them with particular attention, as they continue to be a source of inspiration.**

So let's go back to the wartime sources. The available ...

data clearly shows that the Germans had no intention of using the new armament in their tanks - there was simply no energy source with the corresponding power that could have been installed in the tank. So only a stationary weapon was possible.

The electromagnetic cannon was therefore attractive to the leadership of the Third Reich for a simple reason: it was the only launcher weapon that could have provided an effective alternative to the guided V1 rocket and the (particularly expensive) V2 rocket (especially given the problems with the unrealistic concept of the V3 cannon). One must not forget that a similar potential was invested in the development, production and use of the V1 and V2 as was invested in the development of the atomic bomb in the United States - the “Manhattan Project” had assumed mythical proportions there. A competitive solution in this area therefore opened up access to enormous resources that could not be obtained today for such a goal. Regardless of the advantages of the “electromagnetic ...

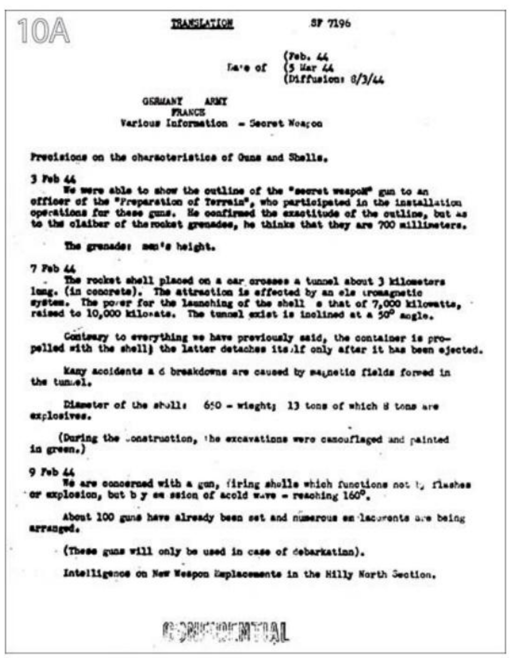
cannon” mentioned, it should be taken into account that the high flight speed of the missiles not only means a long range, but also also results in high targeting accuracy - especially with moving targets, as shortening the bullet flight time is key here. These same factors probably ensured that the new German solution was also used in anti-aircraft defense. But that only became apparent after the war.

Another intelligence document, this time from March 30, 1944, contains information exclusively about the electromagnetic "supercannon": "New launcher

device: It consists of

selenoid [a magnetic coil - note from Author's] with a length of approximately 900 - 1,000 meters, which was buried at a shallow angle on the edge of the Cotentin district. The selenoid coil is connected to a high-voltage cable with a transmission capacity of 10,000 kilowatts (10 MW), which was moved by the CCM." A slightly earlier report - from March 5, 1944, but based on information from February (Document 10) - contains much more information. The projectiles are therefore equipped with an additional rocket engine (whose mass makes up a small part of the projectile mass). This is interesting information that finds its parallel in current research; However, it requires an explanation: In the case of projectiles with a very high flight speed, such a drive can have a decisive influence on the range, even if (paradoxically!) it does not provide much thrust. This is a physical effect that is based on the fact that under the conditions described, a large part of the aerodynamic resistance arises due to the vacuum that is created directly behind the flying projectile. In addition to its basic function, an additional rocket engine (or even a larger tracer set) fills this vacuum with combustion gases.

Here is the translation of this very interesting document:



10A

TRANSLATION SF 7196

Date of (Feb. 44 (5 Mar 44 (Diffusion: 8/3/44

GERMANY ARMY
FRANCE
Various Information - Secret Weapon

Precisions on the characteristics of Guns and Shells.

3 Feb 44

We were able to show the outline of the "secret weapon" gun to an officer of the "Preparation of Terrain", who participated in the installation operations for these guns. He confirmed the exactitude of the outline, but as to the claiber of the rocket grenades, he thinks that they are 700 millimeters.

The grenade: man's height.

7 Feb 44

The rocket shell placed on a car crosses a tunnel about 3 kilometers long. (in concrete). The attraction is effected by an electromagnetic system. The power for the launching of the shell e that of 7,000 kilowatts, raised to 10,000 kilowats. The tunnel exist is inclined at a 50° angle.

Contrary to everything we have previously said, the container is propelled with the shell; the latter detaches itself only after it has been ejected.

Many accidents a d breakdowns are caused by magnetic fields formed in the tunnel.

Diameter of the shell: 650 - wieght; 13 tons of which 8 tons are explosives.

(During the construction, the excavations were camouflaged and painted in green.)

9 Feb 44

We are concerned with a gun, firing shells which functions not by flashes or explosion, but by emission of a cold wave - reaching 160°.

About 100 guns have already been set and numerous emplacements are being arranged.

(These guns will only be used in case of debarkation).

Intelligence on New Weapon Emplacements in the Hilly North Section.

CONFIDENTIAL

“Specification of the characteristics of cannons and projectiles:
February 3, 1944

We were able to learn the basics of the 'secret weapon' (a cannon).

to an officer who was responsible for the 'site preparation' and was involved in the placement of these cannons. He confirmed that this information was true, but regarding the caliber of the missile, he said it would be 700 mm. The missile is as tall as a man.

February 7, 1944

Each missile travels on a sled through a tunnel lined with concrete that is approximately three kilometers long. An electromagnetic system ensures its acceleration. The power required to launch the missile is 7,000 kW (7 MW), increasing to 10,000 kW. The tunnel mouth is inclined at an angle of 50°.

Contrary to what we had previously established, the missile is transported together with the container [the so-called shoe - an element that centers the missile in the tube or in the slide rail - Note d. Author's] accelerated. This container is only separated from the missile after it has been launched.

The magnetic fields that arise in the tunnel cause numerous accidents and incidents. Diameter of the missile: 650 [mm], weight – 13 tons, of which the explosives make up 8 tons.

During construction, the earthworks were camouflaged with a green paint. […]

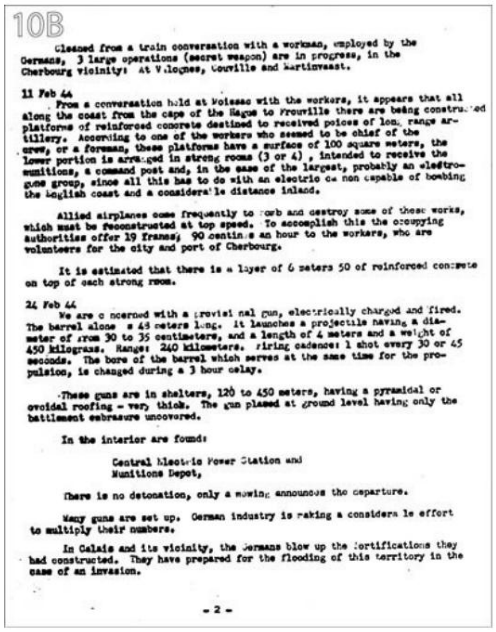
Intelligence material on the position of the new weapons in the mountainous northern

zone: According to a conversation with a worker hired by the Germans during a train journey, work is being carried out on three large installations (secret weapons) near Cherbourg: in Valognes, Couville and Martinvaast.

February 11, 1944

From discussions with workers in Moissac, it appears that reinforced concrete platforms related to long-range artillery are being built all along the coast from Cape Hague to Frouville. According to one of the workers who is a

Foreman or master appeared to be, these platforms have an area of approximately 100 m2 ; underneath there are reinforced bunkers (three or four) in which ammunition is to be stored and command posts are to be housed. The largest of these probably also houses an electroguns group. Author's], as all this involves an electric cannon capable of shelling the English coast and a large inland area. […]



10B

Gleaned from a train conversation with a workman, employed by the Germans, 3 large operations (secret weapon) are in progress, in the Cherbourg vicinity: At Valognes, Couville and Martinvast.

11 Feb 44

From a conversation held at Voisses with the workers, it appears that all along the coast from the cape of the Hague to Frouville there are being constructed platforms of reinforced concrete destined to received pieces of long range artillery. According to one of the workers who seemed to be chief of the crew, or a foreman, these platforms have a surface of 100 square meters, the lower portion is arranged in strong rooms (3 or 4) , intended to receive the munitions, a command post and, in the case of the largest, probably an electroguns group, since all this has to do with an electric canon capable of bombing the English coast and a considerable distance inland.

Allied airplanes come frequently to bomb and destroy some of these works, which must be reconstructed at top speed. To accomplish this the occupying authorities offer 19 francs, 90 centimes an hour to the workers, who are volunteers for the city and port of Cherbourg.

It is estimated that there is a layer of 6 meters 50 of reinforced concrete on top of each strong room.

24 Feb 44

We are concerned with a provisional gun, electrically charged and fired. The barrel alone is 48 meters long. It launches a projectile having a diameter of from 30 to 35 centimeters, and a length of 4 meters and a weight of 450 kilograms. Range: 240 kilometers. Firing cadence: 1 shot every 30 or 45 seconds. The bore of the barrel which serves at the same time for the propulsion, is changed during a 3 hour delay.

These guns are in shelters, 120 to 450 meters, having a pyramidal or ovoidal roofing - very thick. The gun placed at ground level having only the battlement embrasure uncovered.

In the interior are found:

Central Electric Power Station and
Munitions Depot,

There is no detonation, only a mowing announces the departure.

Many guns are set up. German industry is making a considerable effort to multiply their numbers.

In Calais and its vicinity, the Germans blow up the fortifications they had constructed. They have prepared for the flooding of this territory in the case of an invasion.

- 2 -

It is estimated that the ceiling of each bunker consists of a 6.5 meter thick layer of reinforced concrete.

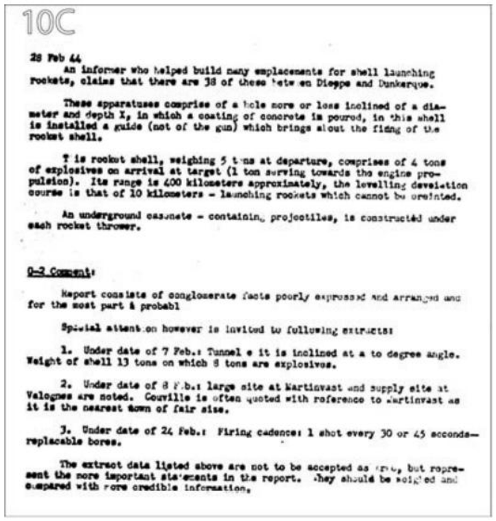
February 24, 1944

We are concerned about the proposed [new] cannon, which will be electrically charged and fired. The cannon barrel is 48 meters long. It fires missiles with a diameter of 30 to 35 centimeters, a length of four meters and a mass of 450 kg. Range: 240 km. Rate of fire: one shot every 30 – 45 seconds. The inner tube layer, which also serves to accelerate the missile, is replaced in a three-hour break. […]

Inside [the bunker] are the main power plant and an ammunition depot.

There is no detonation [when fired], the launch is only accompanied by a whirring noise.

Many cannons are brought into position. German industry is doing everything it can to drastically increase their numbers. […]“



10C

28 Feb 44

An informer who helped build many emplacements for shell launching rockets, claims that there are 38 of these betw en Dieppe and Dunkerque.

These apparatuses comprise of a hole more or less inclined of a diameter and depth X, in which a coating of concrete is poured, in this shell is installed a guide (not of the gun) which brings about the fiing of the rocket shell.

T is rocket shell, weighing 5 tons at departure, comprises of 4 tons of explosives on arrival at target (1 ton serving towards the engine propulsion). Its range is 400 kilometers approximately, the levelling develation course is that of 10 kilometers - launching rockets which cannot be oreinted.

An underground casmate - containing projectiles, is constructed under each rocket thrower.

G-2 Comment:

Report consists of conglomerate facts poorly expressed and arranged and for the most part & probabl

Spesial attention however is invited to following extracts:

1. Under date of 7 Feb.: Tunnel e it is inclined at a to degree angle. Weight of shell 13 tons on which 8 tons are explosives.

2. Under date of 8 F.b.: large site at Martinvast and supply site at Valognes are noted. Couville is often quoted with reference to Martinvast as it is the nearest town of fair size.

3. Under date of 24 Feb.: Firing cadence: 1 shot every 30 or 45 seconds—replacable bores.

The extract data listed above are not to be accepted as true, but represent the more important statements in the report. They should be weighed and compared with more credible information.

This document raises more questions than it provides answers. If the information contained therein can be considered fact at all, then what happened to these gigantic cannons when the Germans were forced to leave that area? Could such cannons ever have existed?

Their construction would undoubtedly have been very difficult, but it is clear that they may actually have existed. Despite its spectacular nature, such a challenge did not exceed the capabilities of the German economy.

If the underground objects (bunkers) built in connection with the cannons had been blown up and camouflaged by the retreating Germans (as they certainly would have been), it is not at all certain that they would have been discovered and investigated later. It is enough to look at the history of German underground industrial facilities whose entrances (exits and entrances to communication and installation tunnels) were blown up and camouflaged - such operations could be carried out extremely professionally. That is why many such objects have not yet been discovered and in many cases have not even been located. Today they are huge graves because of those in them

Working people (prisoners) were not allowed out before the explosion due to a special order from the Reichsführer-SS. Any deviations from this principle were very rare.

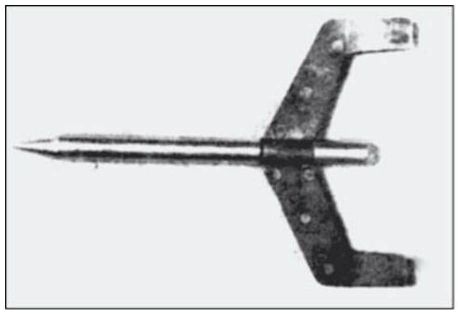
So could it be that the Allies are only telling part of the truth about the... German electromagnetic cannons had discovered?

Other data also indicate this: a special report on research into the electromagnetic cannon, which was prepared at the beginning of 1946 by a special committee of the American intelligence service, 55 also lacks information that we only know today from other sources. Essentially, the report describes the role played by a particular facility - one of many - in the research of these weapons: the Army Weapons Office laboratory in Berlin. We now know that the facility in Peenemünde played a key role in the project mentioned (incidentally, even its code name remains a secret), because after the war, projectiles for an experimental electromagnetic cannon were found there. The work described in this chapter is one of the numerous examples of a complex of questions that we know exists - but we certainly only know part of the truth. What exactly does the report mentioned contain? It is divided into two main parts: one contains general analyses, the other describes work on an electromagnetic (relatively small) anti-aircraft gun with a very high rate of fire.

Here are some detailed excerpts from the American report: 55

> “Attempts to replace gunpowder with electrical energy are not new. Many concepts were worked on in this laboratory [the aforementioned Berlin laboratory] - ultimately using a method that had been developed by Fauchon-Villiplee during the last war. A major difficulty is, of course, achieving high enough power to fire the projectile. The experiments carried out here showed that it was possible to accelerate a body with a mass of twelve grams to 1,100 m/s - in a two meter long tube [a surprisingly good result, comparable to the results of many experiments carried out in the 1980s !

– Note d. Author's], which corresponds to an acceleration 30,000 times greater than the acceleration due to gravity. The coupling of two such pipes did not turn out to be particularly successful - a value of 1,200 m/s was achieved.



A projectile for an electromagnetic cannon found in Peenemünde

The projectile is accelerated by a 'linear motor', which in the simplest version consists of two conductors (rails running parallel to each other), between which the projectile is located, which closes the circuit with the help of its rear tail unit [they decided on such a solution Germans also in the case of the bullet found in Peenemünde - note from author]. When current flows through the circuit, the bullet moves forward. The classic electromagnetic equations apply to this process.

This method was demonstrated to me using the example of a 50 cm long accelerator and projectiles discussed in this report. After firing, the copper edges of the tail unit were melted. The muzzle velocity of the bullet was low in this demonstration. It is very difficult to find an appropriate voltage source. Lead-sulfuric acid batteries with very thin electrodes that delivered an output of 9,000 kW were used for the experiments. In addition, capacitors with a capacity of 20,000 microfarads were used, which delivered a voltage of 2,000 V.

Major advantages of an electromagnetic system would be: 1) the ability to do without a tube, 2) higher speed than using powder,

3) a higher energy yield than with powder, 4) lower energy costs.

It was planned to start work on a projectile with a diameter of one centimeter and a mass of 60-70 grams and to build an electromagnetic anti-aircraft gun (see attached report) with a caliber of 40 mm. For this purpose, a current of 1,500,000 amperes and a voltage of 1,300 volts would be necessary [i.e. an output of almost two gigawatts! – Note d. author]. Three unipolar generators, each weighing 150 tons, were provided for the power supply.

Electrically launched projectiles would have to be equipped with stabilizing fins as they cannot be rotated. This suggests that work should begin in a wind tunnel and at the same time explains the close cooperation between this laboratory and the personnel from Peenemünde who had worked in the wind tunnel in Kochel.

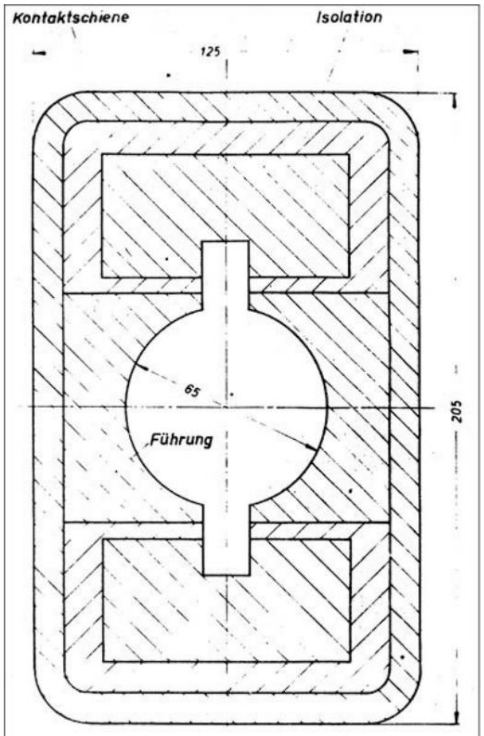
## BRIEF DESCRIPTION OF ELECTROMAGNETIC ANTI-AIR CANNON WITH A CALIBER OF 4 CM

### I. Introduction

Projectiles that are fired using powder have a limited speed, which according to van Langweiler can theoretically be 2,810 m/s. He confirmed this value through experiments in which he reached a speed of 2,790 m/s.

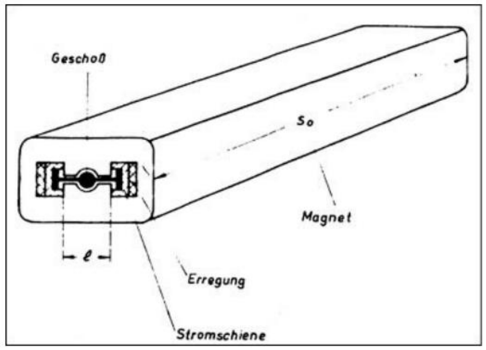
However, such a speed can only be achieved with a certain mass. For heavier objects (bullet) the actual speed is lower and is usually less than 2,000 m/s. In any case, many practical factors prevent the theoretically possible speed from being achieved. The only known method of achieving higher speeds (i.e. higher accelerations) is based on electrical approaches. Some such solutions have been designed and information about them published - mainly in the German patent literature. The most promising solution was developed by the Frenchman Fauchon-Villiplee; Corresponding models were constructed and examined by the Gesellschaft für Gerätebau. The

Experiments continued throughout and were only interrupted shortly before the end of the war. The above-mentioned company published the results in the form of reports, the last of which appeared on January 18, 1945.




LM 76
Rohrquerschnitt des eisenlosen Linearmotors

Using electrical methods it is not possible to store energy in such a concentrated form as in powder. Therefore, an electromagnetic cannon cannot compete with a conventional cannon within the speed limits that can be achieved with classic launcher systems. However, beyond these limits there are good potential uses for electromagnetic weapons. These could include anti-aircraft guns and acceleration systems (launch systems) for large missiles. Long-range artillery




General design draft of a German electromagnetic cannon. (via "ALSOS")

Initial considerations for an electromagnetic cannon focused on the possibility of building a long-range cannon that would fire projectiles with a muzzle velocity of 2,000 m/s. However, once V1 and V2 rockets were developed, this idea was abandoned or shelved until much higher muzzle velocities could be achieved.

Due to advances in aviation, which have allowed increases in altitude and speed, as well as the inability of conventional anti-aircraft artillery to keep pace with this development, the possible use of electromagnetic cannons in this area is becoming quite real. Increasing the projectile muzzle velocity increases both the probability of hitting and the range. Even if they had to be stationary cannons, this would not be a significant disadvantage, since the majority of anti-aircraft artillery used on our own territory today is of the stationary type.

Another possible application of this phenomenon, which has already been realized in the electromagnetic cannon, is launch pads (launching catapults) for large rockets. Due to the sensitivity of their control systems, these rockets cannot handle extreme accelerations and therefore require relatively long ramps to achieve the required launch speed within their acceleration limits. The more uniform the acceleration, the shorter the starting ramp can be. The

Limiting the 'parameter spread' and vibrations during the acceleration process makes it possible to get even closer to the targeted load limit. An electromagnetic accelerator can therefore be viewed as a competitor to other methods of accelerating large rockets, which are subject to tight constraints.

II. The core of the problem, specifications

The rapid development of science made it possible to practically address the issue of electromagnetic projectile acceleration. The Society for Device Construction published on the 10th. September 1944 presented the preliminary design of an electromagnetic anti-aircraft gun with a projectile muzzle velocity of 2,000 m/s and an average rate of fire of 6,000 rounds per minute. Based on this draft, discussions were held with the heads of the OKL (Air Force High Command), the TLR (Technical Air Armament) and the air defense, as a result of which the following requirements were formulated: A) Muzzle velocity: 2,000 m/s B) Projectile payload: 500 Gram [this is about the

mass of the explosive; in the next section of the report the bullet mass is given as 6.5 kg – note d. author]

C) The gun was not intended to fire rapid series of six shots at very high speeds, as was intended in the original design, as there was concern that wear and tear on the ramp ('tube') would be too severe. Instead, six cannons firing simultaneously should be connected to a power supply.

D) The battery [meaning a battery made up of six “rails” in the sense of a tactical group – note d. Author's] should fire a volley of projectiles every five seconds; this results in 6 x 12 = 72 shots/ min.

E) As calculations showed, the ramp rails should have a length of ten meters, although due to time constraints they should be mounted on a standard anti-aircraft mount. It was proposed to use a mount for anti-aircraft guns of 128 mm caliber.

F) The head of the TLR at the OKL demanded that an experimental anti-aircraft system with its own power supply system and an experimental cannon with three rails (“tubes”) be completed as quickly as possible. […]

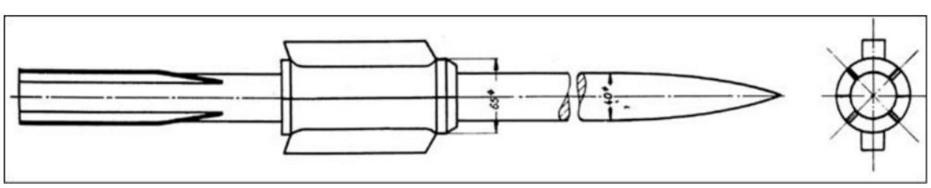
V. Considerations on combat application and further development of the cannon [after the war]

Based on the above, it can be concluded that the arrangement of the six guns of a battery on a circle with a diameter of 40 meters [as was originally proposed] would be incorrect, especially if they were connected to only one power supply: 1) If this If the system fails, the entire battery also fails.

2) Because they are arranged in such a small space, the cannons - and especially the connections - are not adequately protected from air attacks.

3) The cable lengths [with a large diameter] between the individual guns (battery elements) of 20 meters each required in the above variant lead to excessive raw material consumption.

4) When further developing the cannon, the necessary mobility of the entire installation must be taken into account. When connected to a single external power supply, relocation is impossible. From the outset, the aim is to equip each cannon with its own system. This would also allow the weight of the entire installation to be reduced.



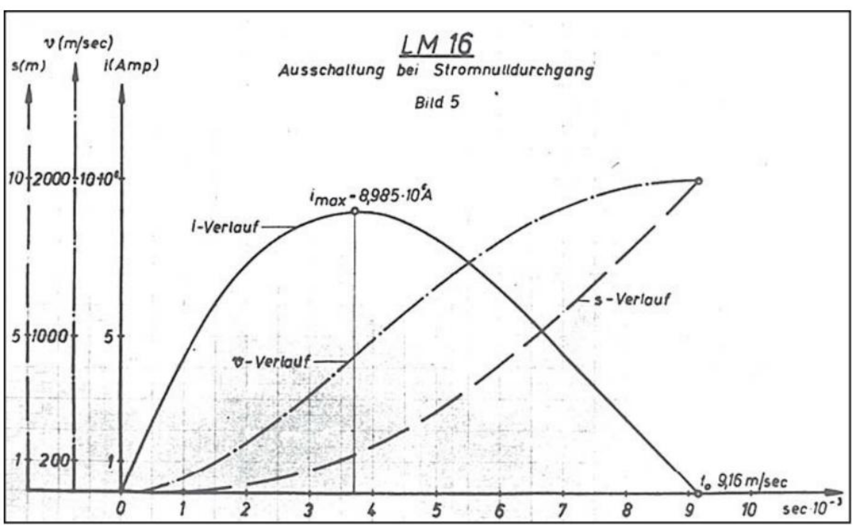
Final version of a projectile for the electromagnetic anti-aircraft gun.

Tests have shown that the speed drop of the rotor in the power generator after firing six shots is only 4.8%.

Even double the value, i.e. around 10%, would still be the case unproblematic. This would improve energy utilization by a factor of two and a weight reduction by a further 50% enable. If each cannon had its own generator, this could be reduced by a factor of six. Through the Combining these two approaches could reduce the weight of the Power supply system [i.e. the main problem of system mobility – Note d. Author's] can be reduced from 450 to 37.5 tons.

those already planned have newer ones, one The generator Angular velocity of the order of 200 m/s. It should However, it can easily be possible to increase this speed to 300 m/s increase - especially with unipolar generators - what the amount the energy generated per generator mass unit more than doubles would. In this way you could change the power supply systems "make" another 50% leaner.

Verification of these concepts will require further intensive research require that will take several weeks. Ours However, in my opinion it will be possible to use mobile guns this "To build a type."




A diagram demonstrating the progress of one of the experiments. From this it follows that the bullet reached a speed of 2,000 m/s. (via "ALSOS")

So much for the American report from 1946 ... An addition to the one in it The information contained provides information about the people in Peenemünde (according to certain sources also in the town of Schlosskranzbach).

This shows that a modified version of the anti-aircraft gun described was also developed with a shortened rail ("tube") up to eight meters long, which was intended for lighter projectiles weighing 2.88 kg. However, this achieved a much higher muzzle velocity, exceeding 2,500 m/s. The estimates formulated in 1944 came true. This cannon was equipped with a set of capacitors that delivered a gigantic current of three million amperes in a short pulse. The capacitors, in turn, were fed by an electricity generator driven by two turbine engines. Most recently I found an original German report about this work. In terms of content, it agrees with the American version (or rather the translation). However, it contains original technical the ALSOS mission documents [52] drawings - including those representing the final version of the 40mm ammunition. These plans were printed on the previous pages. Even a cursory glance at it gives you an idea of why work was being done on it in Peenemünde. The projectile is a miniature version of the projectile for the V3 cannon, which was tested on the neighboring island. Maybe the electromagnetic cannon was intended as one of the alternatives to a multi-chamber cannon?

# The unknown face of armored vehicles

The armed vehicles of the Third Reich are rarely described as an area in which major breakthroughs were made. But that was certainly the case, even if it was more related to the final phase of the war.
The projects created at this time sometimes remind one more of the level of development in the 1960s or even 1970s, rather than the 1940s. They very clearly exceeded comparable achievements of other countries, although this fact is very little known.

At the beginning of this chapter I quote verbatim one of the analyzes of the American intelligence service from 1945 because it contains very interesting comments on the trends in the field of tank construction that emerged in the last months of the war.

Information on this is extremely rare - however, this period, in which the Third Reich was already disintegrating, is of immense importance, as it simply anticipated developments in the field of armored vehicles that would often only become reality after a few decades after the war!
Here is the quote: [56]

> "Even in 1945, the firepower of German tanks was still being increased (by mounting larger-caliber or longer-barreled guns). Plans were drawn up to use more powerful armament in all tanks and gun battle vehicles.

The Pz. Kpfw. IV was for a long time the most important tank in the German army. (Photo: Federal Archives)

From year to year, more and more armored vehicles were equipped with guns, the movement of which was limited in the horizontal plane. These measures were supported by infantry and artillery units, but met with resistance from the armored troops themselves.

A light, full-fledged tracked vehicle on which various cannons and howitzers could have been installed was about to enter production. It was intended to be used by self-propelled field artillery units.

The trend towards building larger and heavier tanks was almost completely halted towards the end of the war. The design of vehicles with a mass of 150 and 200 tons, which had begun in 1942-1943, was very slow due to the lack of interest at the top.

The opinion among the ground forces and in the tank weapons industry was that the *Tiger II (King Tiger)* tank was much more complex to manufacture due to its size and mass than its equivalent as a weapon would have justified.
The development cycle of a German tank, from the development stage to the start of production, was around 2.5 years before the war and was shortened to around 15 months during the war.

The *Ferdinand / Elefant* self-propelled cannon – the first mass-produced

Combat car with electric drive transmission. (Photo: Tank Museum)

## The Hull

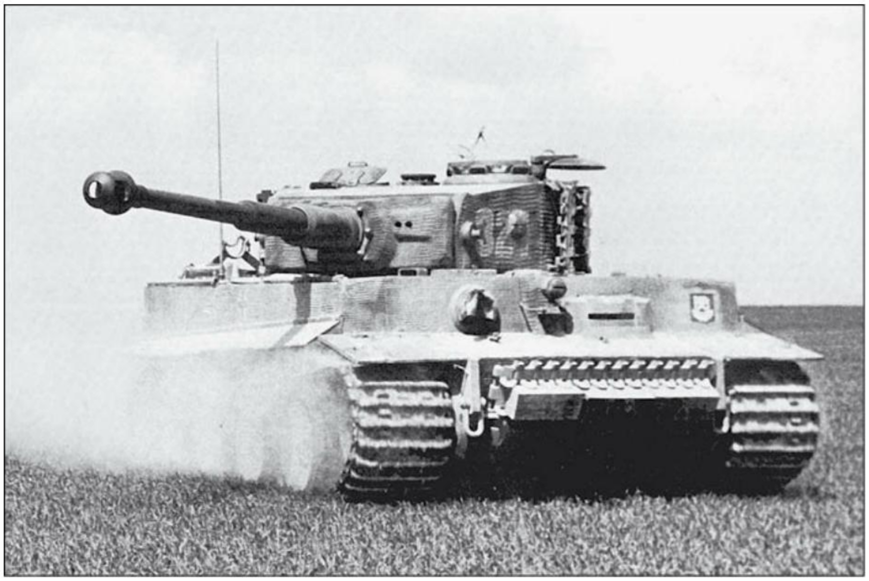
When looking at the hulls of modern German tanks, you might get the impression that ballistic considerations were at the forefront of their design. The [rolled] flat plate is used almost exclusively and all surfaces are inclined at the greatest possible angle. Plates of all sizes are connected to each other by interlocking; the mutual special connection points are additionally reinforced with profiles.

In many cases this must have led to a significant increase in manufacturing costs. There is currently a lack of information as to the extent to which such methods improved armor protection. [The American officer may have lacked information on this, but the concept arose from very concrete considerations.
After the Russians introduced the IS (Josef Stalin) series of tanks with a 122 mm cannon, there was a sharp increase in bullet mass. Even if the bullet did not penetrate the armor, the force of the explosion was so great that it often caused the welds to crack. author]

There is nothing to indicate that significantly thicker armor than the *Tiger II* tank was planned. The super-heavy tanks that were being designed had approximately 30% thicker plates compared to the *King Tiger .*

## The drive

Gasoline engines were replaced by air-cooled diesel engines. Such engines for vehicles weighing 15-20 tons were scheduled to go into production in 1945. However, they were only developed for larger vehicles and there was still a lot of work to be done before they were ready for series production.



The *Tiger* I tank fighting vehicle. (Photo: Federal Archives)

The use of radiators located outside the waterproof part of the hull (i.e. outside the propulsion cell) has a number of advantages on *Tiger* and *Panther* tanks and is worth considering when developing new vehicles.

Under development were fully automatic manual transmissions and [hydrokinetic] torque converters, which were considered promising by German engineers.

Hydraulic control circuits for transmitting the power to the individual tracks using hydraulic pumps were built and tested [so-called hydrostatic slewing gears, which allow curves of any radius to be driven without having to interrupt the kinematic connection with the engine - note.
author]. The results were rated as very satisfactory.

The chassis

All modern vehicles use large diameter wheels.

The overlapping wheel suspension used on the *Panther* and *Tiger I* tanks and half-tracks caused many problems due to the additional resistance when the wheels sank in the mud or iced up. It

The need was recognized to develop chassis in which friction between the wheels would be ruled out from the outset.

Wheels with rubber coatings, which in turn were surrounded by steel rings, were rated very positively. The latter protected the rubber layer and at the same time significantly extended the life of the wheels.

Bakelite and other composites used for suspension [as pads for friction shock absorbers, which are still used for this purpose today - ed. Authors] have proven themselves in many applications and require further research.

The use of suspensions based on torsion shafts has not become widespread in recent years [the principle of operation is based on the fact that a torsion shaft acts as a shock absorber, ie a spring in the form of a twisted rod. This torsion wave runs through the fuselage near the ground. On one side it is firmly connected to the vehicle side wall and on the other side it leads through a bearing to the outside, where it ends with a swing arm at the end of which is the wheel. This solution is currently used as standard, but is slowly being replaced by hydropneumatic suspension (as in modern buses) - note. author]. The Germans wanted to design a cheap suspension that would not take up space inside the fuselage.

The tower

The design of the turret for the *Tiger II* tank was considered outstanding compared to all other types; The turret of the Panther tank was redesigned according to the same *criteria .* […]

Stabilizers for sights and cannons were under development. [They enabled effective firing while driving – note d. author]. […]

various

In the *Tiger II* tank , all devices including the cannon mount were only attached to the floor or ceiling. This practice seems worth imitating.

Tanks were being prepared to overcome water obstacles with a depth of 6 meters. However, this project was no longer implemented as it was not urgent enough to justify additional costs and laborious preparations."

The development of armored vehicles proceeded simultaneously in four

directions: 1. Tanks already in production were modernized. This particularly affected the Pz. Kpfw. V *Panther* and the Pz. Kpfw. VI *Tigers.*

2. Concepts of super heavy tanks were reviewed (prototypes of the Panzerkampfwagen *Maus* and the Panzer *Rat).*

3. Tanks were designed that followed the previous line of development should continue: the Pz. Kpfw. IX and the Pz. Kpfw. X[57]

4. Vehicle prototypes of the "E" series were built - it was an alternative to the series mentioned in point 3. [58]

One might think that the most advanced designs would be found in points 3 and 4, but this was not entirely true. For example, it was planned to significantly modernize the *Panther* tank so that in reality it would have been almost equal to its eventual successors (E-50, Pz. Kpfw. IX).

It was planned to modify the armor, introduce a system for effective firing at night and while driving (gun stabilizer), replace the classic gasoline engine with a completely new generation engine with almost 50% more power (maneuverability was the weakest point). of tanks from this period) and to equip the *Panther* with a completely new drive transmission system and innovative slewing gear. Despite all appearances, this work was already very advanced and there was not much left until the plans were fully implemented. The main obstacle was the collapse of the economy caused by the air raids at the turn of 1944/45, and not the technical implementation. One of the few elements that would remain unchanged was the cannon. Despite the smaller caliber (for example in comparison to the *Tiger tank),* it was considered sufficient for a vehicle of this weight class

held. In this regard, the *Panther* did not even need to hide from the heavy Russian tank IS-2 (Josef Stalin). I quote excerpts from an article on this topic written by an expert on Russian armored vehicles. The article is about the IS-2 tank:
[59]

> “Paradoxically, the tank’s biggest weakness was its armament. One of the demands placed on the vehicle designers was an armament system that would make it possible to combat all of the enemy's current and future tanks.
> As we know from articles in *Nowa Technika Wojskowa,* issues 2 and 3/01, many types of cannons were tested with the IS, but from the beginning the preference was given to the 122 mm D-25 cannon. It was actually characterized by significantly better parameters in terms of penetrating power than the 76 mm and 85 mm cannons available at the time, but compared to the enemy cannons it was still by no means a revelation.
> It should not be forgotten that the D-25 had the same ballistics as the A 19 fuselage cannon, which was intended primarily for attacking targets with indirect fire, since the initial projectile velocity did not play a particularly important role when shelling fortifications.

The *Tiger II / King Tiger* tank in a version with a Porsche turret. (Photo: Tank Museum)

> The situation is completely different when fighting armored targets.

Here the initial speed has a decisive influence on the kinetic energy that the bullet hitting the target has.
Therefore, an anti-tank projectile fired from a D-25 cannon weighing 25 kg and having a muzzle velocity of 781 m/s has comparable armor penetration performance to a 4.75 kg projectile fired with an initial velocity of 1,120 m/s. s was fired from a *75mm Panther cannon* - not to mention the 88mm *King Tiger* or *Jagdpanther cannon .* So the capabilities of the IS-2 cannon weren't all that fantastic: at typical distances at which tank battles were fought (i.e. up to a maximum of 1,000 m), completely penetrating a Panther's front hull plate was *unrealistic .* However, I do not deny that even without penetration, a hit with a 25 kg projectile (including a fragmentation projectile) rendered the tank, and especially its crew, incapacitated for a certain period of time. The situation changed with the introduction of the HEAT anti-tank shells, but this only happened after the war. […]

Another area related to the armament of the IS tank is the ammunition supply and the rate of fire. The stock was only 28 pieces, almost three times less than the *Panther* and the *King Tiger!* Additionally, the ammunition was not integrated, resulting in the gun being loaded in two cycles. Incidentally, this was unavoidable since a complete bullet weighed over 40 kg. This in turn limited the rate of fire to two to three shots per minute, while the corresponding rate for German tanks whose guns were loaded with integrated ammunition was two to three times higher. On the battlefield, something like this cannot be valued highly enough. Considering that at a distance of 1,000 m and less, the IS tank did not provide protection from 88 mm KwK-43, 75 mm KwK-44 or PaK-40 shells, this created a situation , in which the opponent had tactical superiority."

However, all of this does not mean that the firepower of the *Panther* and

other already manufactured tanks should remain at the same level.
As can be read in the intelligence analysis cited above, work was underway on tank gun stabilizers. In small numbers, the tanks mentioned were also equipped with so-called “active” night sights (night telescopes) that worked in the infrared band. Of the dozens of devices developed in the Third Reich, only two were intended for tanks.

Both the FG 12/50 and the FG 12/52 were initially only mounted on armored personnel carriers (with this equipment they were given the code name *Falke),* but shortly afterwards a modification intended for the *Panther* tank was created, which was given the code name *Puma .* The aiming device, which was previously mounted on 7.92 mm caliber machine guns, was adapted to the 75 mm tank cannon. A small number of these systems were used in combat - with very good effect, which was certainly also due to the surprise effect.
Nevertheless, this equipment had many opponents in the Wehrmacht, probably for purely irrational reasons.

The first sharp exchange of views occurred in August 1944 during one of the staff meetings of the Army High Command (OKH), when the future counteroffensive in the Ardennes was being planned. Based on the first clashes on the Western Front alone, most generals came to the conclusion that tank formations could only operate successfully at night - provided, of course, that they were equipped with appropriate targeting and observation devices. It was mainly about the devices FG 12/50 and FG 12/52. The facts were shocking: In July of this year, the Allied air forces destroyed around 400 German tanks within just one week (July 23rd - 31st). Therefore, not only night vision systems were prepared, but even special camouflage uniforms for the infrared range (which ultimately turned out to be unnecessary because the enemy did not have the appropriate vision devices).
These measures were undoubtedly very appropriate, potentially representing a classic example of gaining superiority through the surprising use of new weapons at the right time - the Ardennes counter-offensive was supposed to take place in winter, when observation conditions were best at night.

One of the senior officers of the

However, to the surprise of the rest of those present, the General Staff stated: 63 “Gentlemen, I cannot understand what you are actually talking about with this modern stuff, the front is satisfied with our measures so far.”

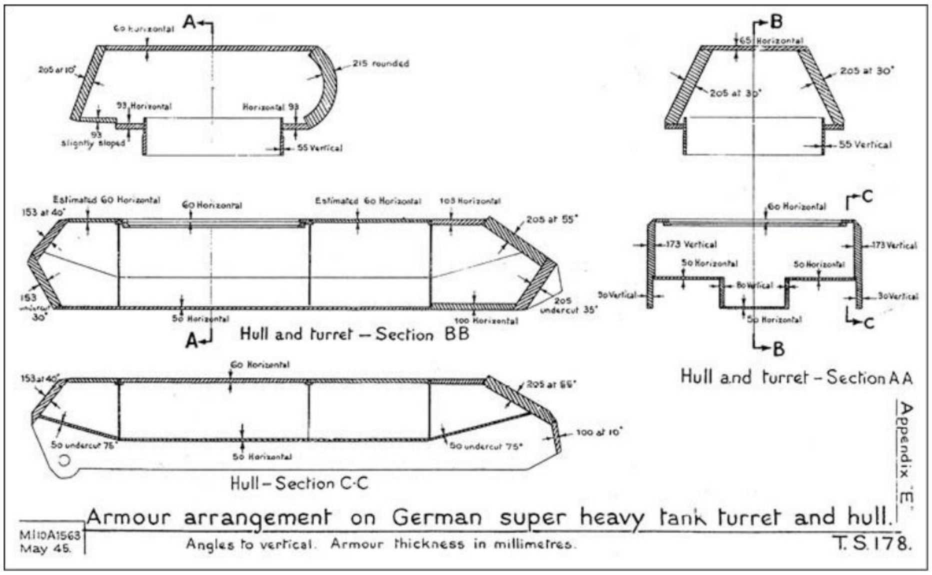
Panzerkampfwagen *Panther,* a medium-sized tank. (Photo: Federal Archives)

Some generals then left the meeting room and the expensive night vision devices that had already been installed in the vehicles were dismantled and stored in a disused mine in Austria. Only a symbolic number remained, which could not have a decisive influence on the situation. As I have already noted, the available information indicates that this equipment was used only once in combat in the West - and that was only on April 9, 1945: in the battles near Wietersheim an der Weser, when a few Panthers decimated a group of British *tanks ,* who defended a bridgehead. The new invention could no longer reverse the course of the war. The US intelligence material shows that this invention was used to a somewhat larger extent on the Eastern Front together with the Uhu system described later. It is unknown how many *Panthers* were modernized in this way, but it was probably one or two companies.

The results of their combat operations exceeded the wildest expectations, including the destruction of 67 “blind” Russian tanks in just one night. 64

So it's not difficult to imagine what would have happened if, according to the original plan, not just a few companies, but two or three

Divisions would have been reequipped. The course of the Russian January offensive, for example, would no longer have been so inevitable.




Cross sections of the *Maus armored fighting vehicle.* (Drawing from the author's collection)

One of the lesser-known areas associated with the development of armored vehicles in the Third Reich concerns the broad (but apparently unintriguing) complex of hydraulic propulsion transmission systems. This involves both a type of hydrokinetic coupling (non-rigid connection) that transmits the torque from the engine to the manual transmission, as well as comparable devices that guarantee a smooth change in the turning radius with almost no loss of power from the drive unit, in contrast to previous ones Solutions in which the driver switched off the drive of one of the tracks in order to be able to drive around curves. On the one hand, the goal was to minimize power losses: If the kinematic connection to the engine is not interrupted when changing gear, e.g.

B. the vehicle acceleration is considerable. On the other hand, it was simply the result of the search for the most sensible method to replace the classic coupling, which has limited resistance and cannot work under arbitrarily large loads - in locomotives, for example. B. There is usually no rigid coupling because when it is switched on at high engine speed, it simply burns out and the train does not would drive off. With the hydrokinetic counterparts, however, the problem of friction does not occur because there is no rigid contact surface. The simplest variant of such a torque converter is a type of double turbine. In a hermetic, approximately cylindrical housing filled with oil, there are two rotors equipped with corresponding blade rings (which are not connected to each other, although they are on one axis). When one of them starts rotating, it sets the fluid in motion, which in turn forces the second rotor to move. Contrary to expectations, the losses are not particularly high and - except at low speeds - no greater than two to four percent.

The *Maus* tank at the military training area in Kummersdorf at the end of 1944. (Photo from the author's collection)

The *mouse* in profile. (Photo from the author's collection)

Such devices were not a German invention - the Americans and English were already working on them before the war. However, the German company Voith from Heidenheim was the first to begin developing a whole series of models intended for combat vehicles.

*Drive transmission systems* in

Hydrokinetic tanks were to be used in the *Panther, Tiger II / King Tiger* tanks (in both versions) and the E-25. This work was not completed - it was interrupted by an administrative decision of August 8, 1944. However, if we take into account that at the same time work was being done on an electrical drive transmission (alternator - electric motor, as in the self-propelled cannon *Ferdinand / Elefant* and in the super-heavy tank *Maus) ,* hydrostatic slewing gears were being developed and it was also planned to use diesel engines that were relatively modern at the time use, it's more reminiscent of the 1970s.

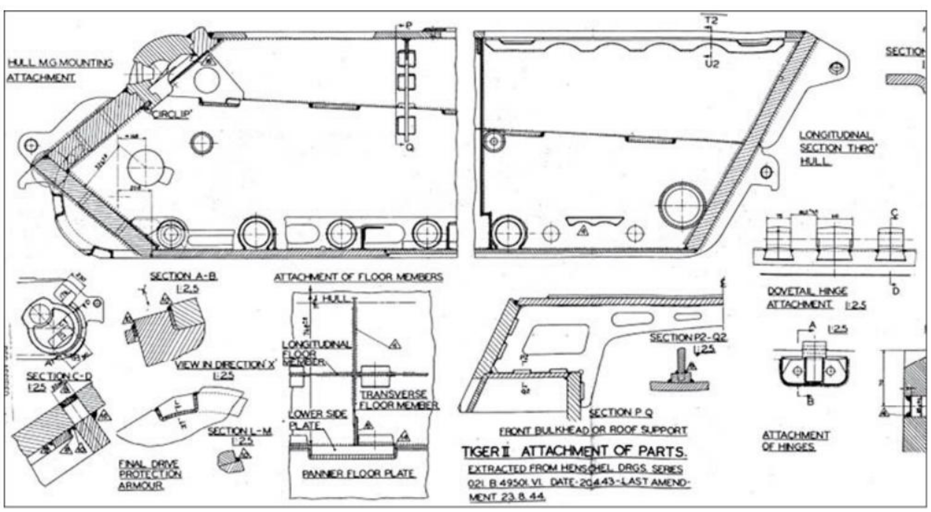
At the time of the Second World War, however, the only hydrokinetic drive system manufactured by the Voith company that was widely used was a solution intended for locomotives with a power transmission of up to 1,800 hp. 56.60 In addition to the

hydrokinetic and electrical system for power transmission, another alternative was created that made it possible to make better use of the increasing engine power. It was an automatic transmission with magnetic (electromagnetic) clutches that was developed by the company ZF (Zahnradfabrik in Friedrichshafen) under the designation G/EV/75 - a six-speed transmission. Its application was considered on the new Panther versions, while modified versions were to be installed on the E-10 and E-25 vehicles. 62 The engines themselves in all tanks used in combat were petrol engines; in

the near future they should be replaced by diesel engines.

Unfinished E-100 fuselage on a special transport trolley. (Photo: NARA)

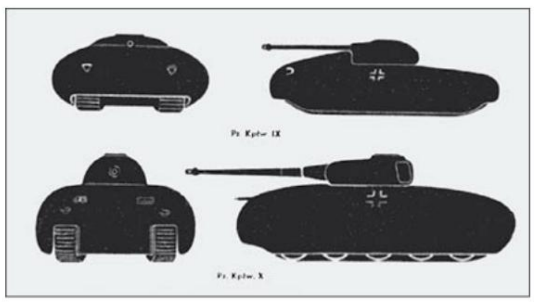
At the same time, the companies Daimler-Benz, BMW and Heinkel Hirth took a completely different path: They were already working on the next generation of diesel engines, namely turbine drives. This step, in conjunction with other measures, would have led to a true revolution on the tank battlefield. It was e.g. For example, an engine with an output of 1,000 hp was developed whose turbine (!) had a diameter of just 32 cm. The *Königstiger* tank fighting vehicle (Pz. Kpfw. VI), for example, was to be equipped with such a drive system, designated GT-102 . 61 The Germans managed to overcome some fundamental problems - including producing "hollow" turbine blades for cooling and effective ceramic protective coverings for these blades, which increased their service life approximately tenfold.



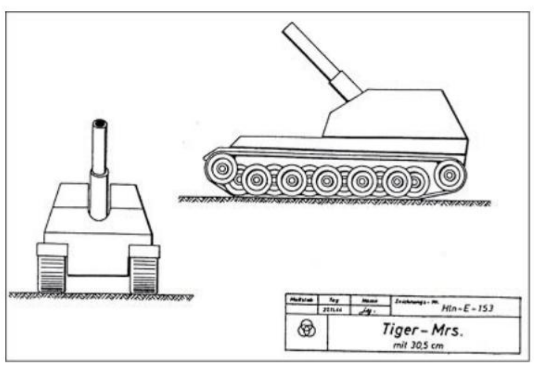

Cross sections of the *Tiger* II hull. (Drawing: CIOS)

The only disadvantage of such an engine is that it is on average twice

fuel consumption was so high compared to its classic counterpart, but its superiority over the gasoline-powered piston engines used at the time was colossal. What was particularly noticeable was a significant increase in performance while at the same time reducing engine weight and overall engine volume. In addition, there was the elimination of the cooler and the avoidance of vibrations - and the latter influenced the aiming.
This eliminated the main disadvantages of World War II tanks, which made it seem impossible to balance three basic characteristics: firepower, armor and maneuverability. With the exception of light tanks, the last feature usually fell victim to compromises - for example, the Tiger tank powered by a 600 - 700 hp engine (depending on the respective version) had a top speed of only 30 - 40 km / h.

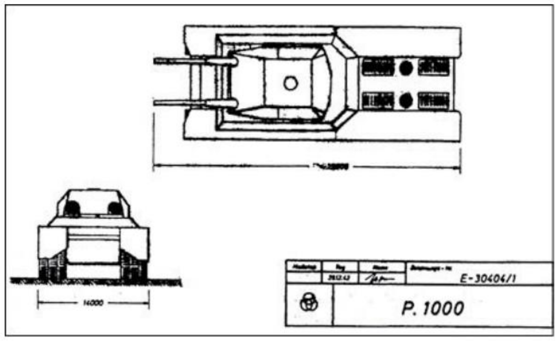



Concepts of the vehicles Pz. Kpfw. IV and Pz. Kpfw. X. (Photo from the author's collection)

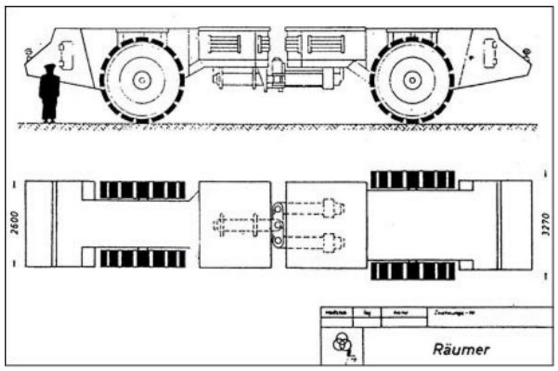



Project of the 305 mm self-propelled mortar on the hull of the Tiger tank.

At the end of the 1960s, the “revolutionary” German-American tank Kpz-70 / MBT-70 (which did not go into series production) was introduced to a small circle of military personnel.




The Rat Tank project.




The *clearer-S.* (original drawing)

This "super tank", which was half developed by the Krauss-Maffei companies that dominated during the war, was equipped, among other things, with a stabilized large-caliber cannon, a turbine drive, a hydrokinetic system for power transmission, hydrostatic slewing gear and a protection system equipped with weapons of mass destruction. All this seemed entirely new, but in reality this technology was already a quarter of a century old, and this case was not the only one.

At the same time as existing vehicles were modernized further concepts developed:

Two new types (Pz. Kpfw. IX and Pz. Kpfw. X) were in development, intended to be successors to the *Panther* and *Tiger* .
They should be characterized by fully cast hulls and towers in the form of monolithic elements. Very little is known about them other than tentative plans. 57 A

whole series of “E” series fighting cars was developed, furthermore the so-called *Maus* and *Rat* super-heavy tanks - enlarged development versions of the *Tiger* and the E-100.

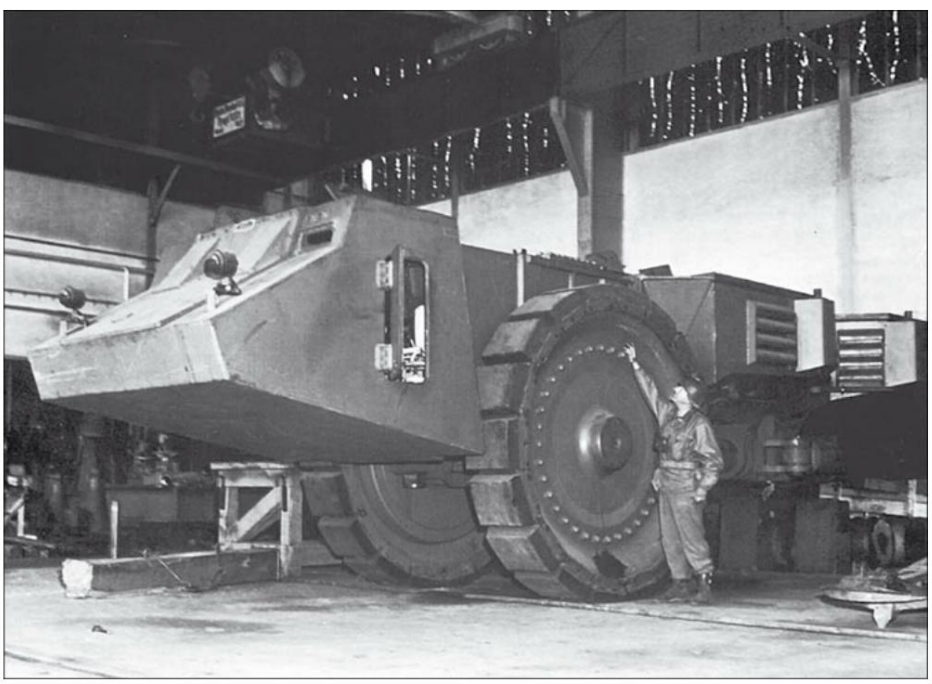
The "E" series is a new generation of combat vehicles consisting of five types: 58 1) the

lightweight E-10 weighing 10 – 15 tons; 2) the E-25 vehicle weighing 25 - 30 tons, similar to Jagdpanzer 38(t) *Hetzer;*

3) the E-50 tank weighing approximately 50 tons, which was intended to replace the *Panther ;*

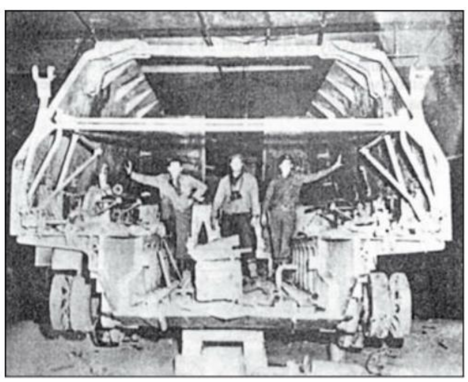
4) the E-75 tank – the successor to the *Tiger.* This would have been the first mass-produced armored fighting vehicle with with hydromechanical drive transmission; 5) the super-heavy tank E-100 with a weight of 130 – 140 Metric tons.

Although the latter was the least useful from a military point of view, its development was the most advanced.

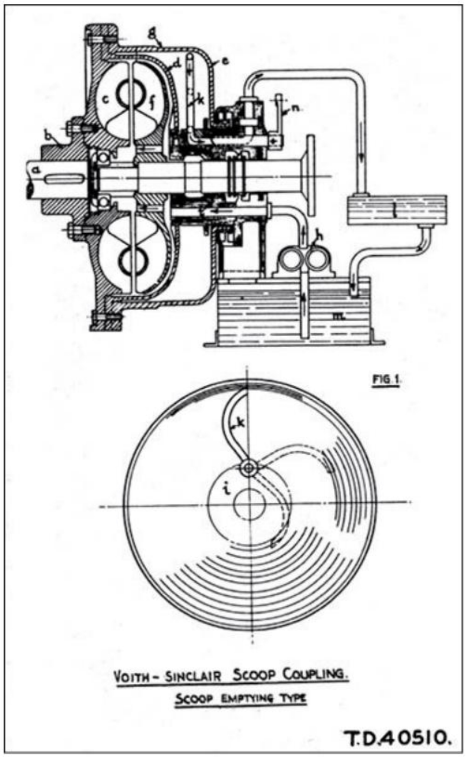


The *Raumer-S* fell into the hands of the Americans. (Photo: NARA)

Shortly before the completion of the first prototype, production began the E-100 is omitted. In 1943 it was planned to produce the remaining models around the turn of the year 1944/1945. The E-100, christened *Adler ,* was 40 tons lighter than the *Maus,* although it used almost exactly the same turret and similar frontal armor and the hull, although slightly lower, was even wider - despite the heavy armament! The main reason was a shift of heavy armor forward. Undoubtedly , its greatest strength was its armament, which was intended to be even heavier than the *Maus* ' 150 mm cannon (although its usefulness in real combat can be questioned). The drive, on the other hand, was rather backwards - the engine from the *King Tiger ,* which was half as heavy and still not particularly mobile and had an output of 700 hp, would only have enabled a speed of a good 20 km/h on the road. In June 1944, the order came from Hitler himself to interrupt the assembly work on the Adler prototype, although it was carried out at a very slow pace (the Henschel company, where the assembly took place, assigned this task to only three people; there were also missing parts) *until* were continued until January 1945. The E-100's direct competitor was the *Maus* super tank with a combat mass of almost 200 tons, ten test examples of which were in various stages of construction. The *Maus* was probably the strangest combat vehicle of the Second World War.



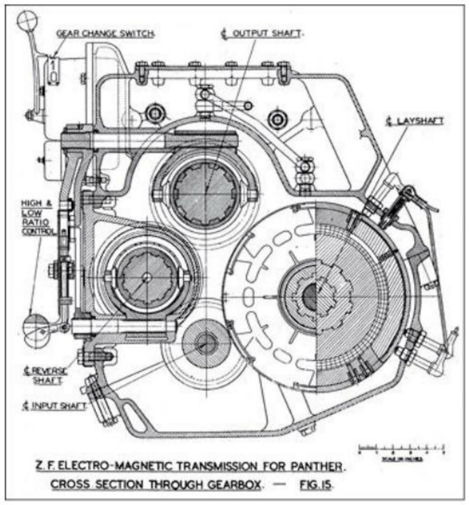
The unfinished prototype of a self-propelled 170mm cannon mounted on the enlarged hull of the *Tiger* II tank. (Photo: NARA)



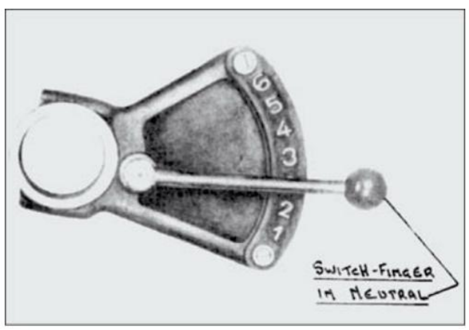

Cross section of the Voith hydrokinetic propulsion transmission system designed for tanks during the war. (Photo: CIOS)

The vehicle was designed by Professor Ferdinand Porsche. The decision to start planning this unusual construction was made on November 29, 1941 by Hitler (who was known to have fallen for gigantomania - it was not his last word on the subject), directly after an “inspirational” conversation with the professor. He presented the first plans for the vehicle to Hitler as early as June 1942 - at this point the question of possible armament was also discussed. Two variants were considered - in both cases two cannons were to be installed in the turret: a 75 mm cannon and a 150 mm cannon or a 105 mm long-barreled cannon (the tube should be almost 7.5 m long ). Ultimately, however, the decision fell on a medium-sized solution: the 128 mm KwK 44 L/55 cannon, which became the vehicle's basic armament. The contractors were also selected: the Kruppwerke was responsible for manufacturing the towers and hulls, the Siemens-Schuckert company was responsible for building the electrical devices, the Skoda company was responsible for the suspension, and the Berlin company Altmärkische was responsible for assembling the finished vehicles

Chain factory commissioned.




Cross section of the electromagnetic drive transmission system for the *Panther tank.* (Photo: BIOS)

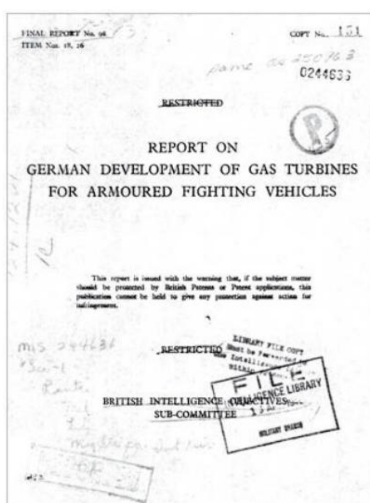



A fragment of the electromagnetic drive transmission system for the *Panther* armored car - the gear change switch. (Photo: BIOS)

It should be noted that neither the *Maus* nor the other super-heavy tanks were intended to be classic “breakthrough vehicles”, although their design and general appearance did not differ from the design of typical tanks. Due to the expected low maneuverability (which arose both from the traction parameters themselves and from fuel consumption, the ability to overcome terrain, and the use of bridges and roads), they were simply unable to perform the tasks intended for “normal” tanks . Instead of forming typical battle formations, they were intended to serve more as moving lines of fortifications that are constantly changing move and how heavily armed and armored bunkers were moved. In a sense, this was an attempt to return to the positioning strategy of the First World War, similar to the gigantic and expensive but ineffective rail guns. Ultimately, the attempt was probably just an expression of certain preferences and personal weaknesses.

Incidentally, the mistake was made here of reducing its purely defensive capabilities - in its first version, the *Maus* was not equipped with a single machine gun!

Nevertheless, a whole series of original and interesting solutions were used in this tank, one of the most important of which was certainly the drive system, which was based on an electromechanical system: the power was not transmitted directly - i.e. through gears and clutches - from the engine to the wheels the track chains were driven, but transmitted by an electric generator and two side electric motors. This was not an entirely new solution: as early as 1940, Porsche designed an electromechanical drive system for the VK 3001(P) tank prototype, which did not go into production because it was inferior to the *Tiger* . After a redesign, however, it became the self-propelled cannon *Elefant,* better known under the unofficial name *Ferdinand,* which was included in the arsenal in a limited number (88 pieces). It was the first vehicle with such a drive transmission to be used in combat.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REPORT ON
GERMAN DEVELOPMENT OF GAS TURBINES
FOR ARMOURED FIGHTING VEHICLES

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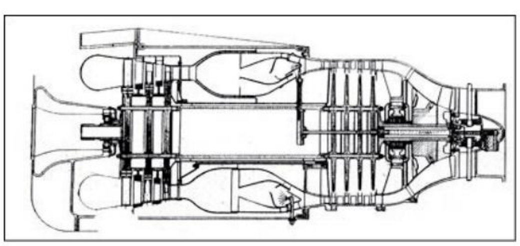
Cover page of the report mentioned in the text.

The construction of the Maus tank, including the preparations for its production, consumed huge resources and was associated with major problems that were disproportionate to its real combat value. These problems arose from the unusual size of the vehicle and the dimensions of its armament - the almost one meter long barrel return of the main gun, as well as projectiles with a length of 1.52 meters, required a huge turret, the weight of which exceeded 50 tons, with the weight of the *Tiger* Tank was comparable.

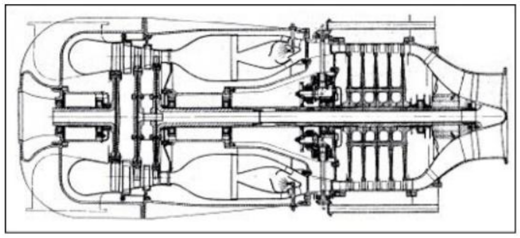
The main cannon alone weighed seven tons. The turret accommodated four crew members - the tank commander, the gunner and two loaders. Incidentally, they had to carry out particularly “heavy” tasks, as the (integrated) projectile for a 128 mm cannon weighed around 56 kg.

It was one of the most heavily armored combat vehicles - the front part of the hull was formed by 205 mm thick armor plates with an inclination of 35 ° and 55 °, and the front part of the turret was a profile plate with a thickness of 215 mm. The remaining armored elements were also more than 150 mm thick and extremely puncture-resistant (which best illustrates the role of this vehicle as a “moving bunker”). Only the tower ceiling was made of a 65 mm plate.

A very interesting side effect of the electromechanical propulsion system was the way the vehicle handled water obstacles. The *mouse* was able to overcome it to a depth of 6 meters, i.e. at full draft (assuming, of course, that it did not bury itself in the swampy bottom). All that would have been necessary was a second tank of this type with the engine switched on, from which cables would run to supply the electric motors.



Selected types of German turbine engines for tanks. (Photo: BIOS)



The first examples of this tank were ordered in mid-1942 and the first series batch of 180 units in March 1943. But although the construction program was given the utmost priority and was enthusiastically supported by Hitler, the practice remained far from the plans: in addition to construction difficulties, the air raids also contributed to this. The first prototype was not ready until the end of 1943, although it was still incomplete - the turret was missing. The second and only complete prototype was not delivered until November 1944. Before the end of the war a few more were in various stages of assembly. The *mouse* remained just a curiosity

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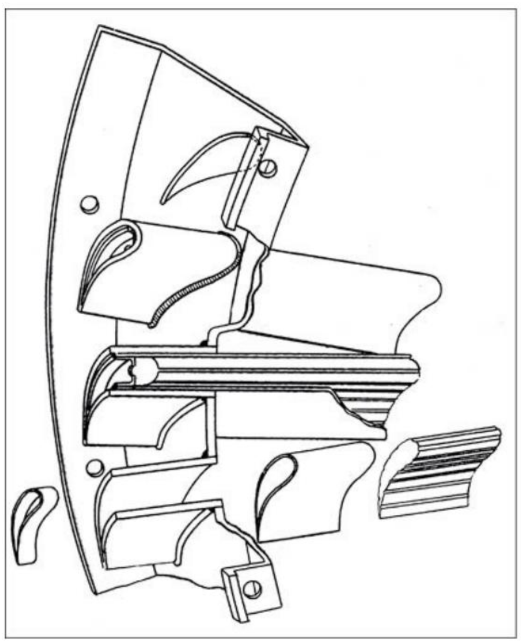


Part of one of the engines - method of making blades. (Photo: BIOS)

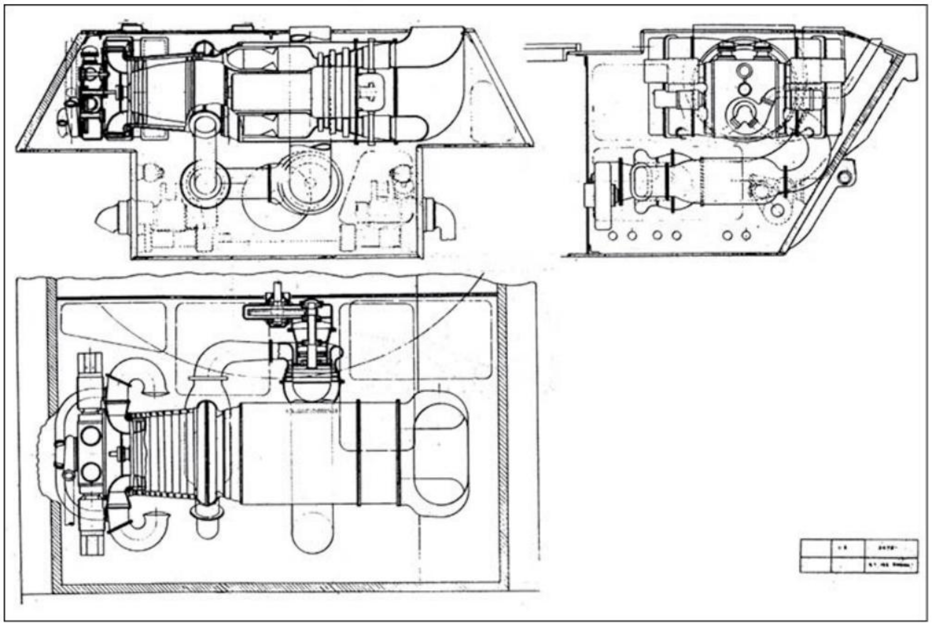
However, the gigantic *Maus* and *Adler* tanks, which did not make much sense from a military point of view, were not the pinnacle of Hitler's armored vehicle aspirations. They were truly miniatures compared to a tank weighing 1,000 tons with its design

On June 23, 1942, he commissioned the two engineers Grote and Haker during one of the meetings dedicated to the future of tank production. This “super giant”, which was quickly given the name *rat* (similarly teasingly as in the case of the *mouse) ,* was to have a classic design, apart from the turret armament, which was to consist of two (same) large-caliber cannons (around 200 mm). With a length of around 32 meters and a height of almost ten meters, the *Rat* would be a kind of “land cruiser”, but let us not be fooled - the design problems associated with its eventual construction were completely insurmountable for the German war economy. Hitler's idea was a virtual collision of utopia and reality, which is why work on this tank was interrupted before the design phase was completed.

However, the German achievements also included numerous much more useful innovations in the field of armored vehicles. Mention should be made here, for example, of the introduction of HEAT anti-tank projectiles and impact projectiles into the tank armament (including the very acceptable 45/55 mm cannon with a conical barrel, which was mounted on the Pz. Kpfw. IV vehicles).

A similarly groundbreaking step was the introduction of projectiles with uranium cores into production - this was to use several hundred tons of uranium, which were dispensable as part of the nuclear weapons program, which was plagued by delays.

Also worth noting are the little-known achievements of the Third Reich in the field of artillery armament.



Installation position of the GT-102 turbine engine in the fuselage of the *King Tiger.* (BIOS)

In addition to the development of rail guns that were just as huge as the "super tanks", a series of ground-breaking control fin-stabilized balancing projectiles with a dropable jacket were also designed (mainly in Peenemünde), which were used for several new smoothbore guns - initially primarily for the long-range multi-chamber cannon V3, the famous *centipede* – were planned. However, a new 800 mm cannon (!) was also in the design phase, for which a particularly technically advanced projectile was designed. This gun, weighing approximately 1,500 tons, was intended to be mounted on a modified hull of the Ratte tank. The hull of the *Tiger* II tank was intended to serve as a base for a self-propelled cannon, this time with a caliber of 170 mm. The prototype of this cannon was built during 1945 - it was marked 17 cm K44 Sf/Gw-IV. It was planned to also install a 210 mm and a 305 mm mortar *(Bear)* on the same chassis. 65

So as you can see, the *Maus* was n't the only "super heavy" vehicle weighing over 100 tons. There was even another one, although it wasn't a tank but a mine clearing vehicle.
Apart from the weight itself (130 t), its construction was also very unconventional. The vehicle consisted of two hulls connected by a

Joints were connected to each other. Each fuselage had only one pair of wheels, but the wheels had a diameter of almost three meters. The wheels were made of steel and had very thick rubber coatings, making them insensitive to exploding mines. But only a few prototypes of the *Raumer-S* existed.[65]

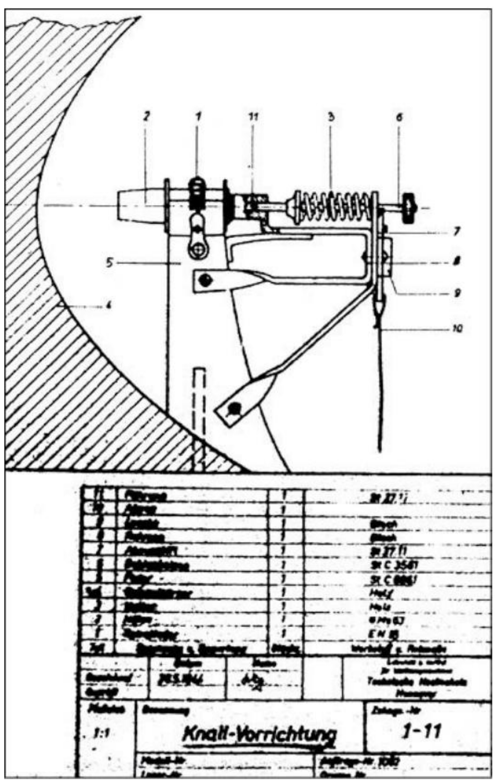
Cross sections of the *Maus armored fighting vehicle.* (Drawing from the author's collection)

# Conventional weapons: completely new concepts

This chapter is not dedicated to all the innovative concepts in the field of conventional weapons that were introduced or simply tested in the Third Reich, but only to the most interesting and least known.

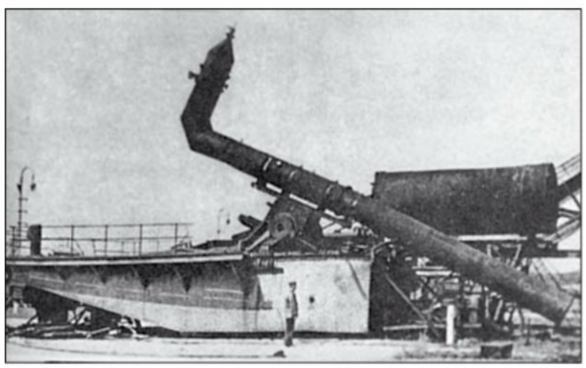
## Energy radiator

Let's start with the truly unusual inventions - the "sound cannon" and the "wind cannon", a generator of directed air shock waves. 65

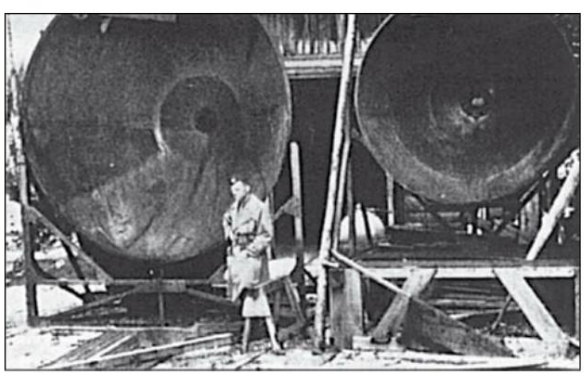



Original technical drawing of the “sound cannon”.

The sound cannon was the incomparably simpler construction: a large massive paraboloid mirror with a diameter of 2.3 meters, at the focal point of which a small explosive charge was detonated (it is known that, among other things, nitroglycerin charges weighing 19 kg were used). A little later it was decided to use a mixture of methane and oxygen, which was detonated in a chamber placed on the paraboloid axis, with the paraboloid being a quarter as long as the sound wave generated. The advantage of such a solution was to achieve a high explosion rate (800 or 1,500 explosions per second), as well as the continuous operation of the device. Its effect on humans was mainly based on anesthesia and paralysis of the nervous system (it was found that the affected person perceived point-shaped light sources as lines, among other things). The work was carried out in a research facility near Lofer in Austria, which is subordinate to the Speer Ministry.



An experimental generator for directed air shock waves. (Photo: NARA)



Two models of the “sound cannon” for generating a directed shock wave. (Photo: NARA)

Dr. Richard Wallauscheck was responsible for them. The operation of this invention was based on the fact that a shock wave behaves like any other plane wave, that is, it can be focused at one point, it is subject to interference, wave diffraction, etc. – in short: it is completely predictable from a geometric point of view. It should be borne in mind that a shock wave is the most effective energy carrier outside of nuclear physics. In contrast to the sound wave, the jump in density at the shock wave front occurs completely suddenly (non-linearly), and in the case of powerful explosives this pressure change can be a million-fold, resulting in a very high density of destructive energy.

This "cannon", with an effective range of several hundred meters, was intended to be used against humans - and probably was - but never in combat. A “light cannon” was supposed to be based on a similar principle, but was probably never completed.

A further development of the “sonic cannon” was a tube device that produced a powerful, relatively directed air shock wave. It was developed by a Stuttgart company and tested at the Hillersleben test site. As the American intelligence service found out, it was possible to shoot through a 25 mm thick steel board at a distance of 200 meters, but the effectiveness decreased very quickly as the distance increased. For this reason, at the end of the war the planned use of the prototype for anti-aircraft defense to defend a bridge over the Elbe was abandoned. However, not all areas of scientific and technical search turned out to be dead ends after the war.

## “Invisible” planes and ships

Some of them were the beginning of promising or even future-oriented trends in weapons technology, although they have remained practically unknown to this day. A perfect example of this is the German research program to develop materials that improve detection by radar devices, echo sounders, etc. should prevent – an area that is now described with the English term “stealth”.

Only recently did I manage to come into possession of relevant sources - documents that describe these works. It concerns the work already mentioned by institutes that were subordinate to the Reich Plenipotentiary for High Frequency Research (BHF). [8] It states that the company IG Farben was primarily responsible for this work, collaborating in this area with, among others, the Gdaÿsk University of Technology. The head of the university's chemical laboratories, Prof. Dr., was in charge of this work. Clamp. The management of the "purely radar-related" matters was the responsibility of qualified engineer Karl Roewer, whose institution it is not known exactly which institution he belonged to.

It is stated that two code names were used for the mentioned project, at least the first of which sounds very modern: *Black Plane;* the second was *a chimney sweep.* Another blank spot in the history of the Second World War!

Unfortunately, I will only be able to partially fill it out.

Information on this subject was obtained through interrogations of the above-mentioned persons. American intelligence officers also found Klemm's laboratory in Schmalkalden, Thuringia, where he had worked during the final months of the war. In Travemünde near Lübeck, an apparatus for analyzing new materials and corresponding samples were discovered - pressed plates that consisted of powders of an unknown (at the time of writing) composition. The substances themselves were in small quantities in the IG laboratories
Farben Group in Höchst.

Basically, this area of research was looking for materials with magnetic conductivity and electrical permeability that should correspond as closely as possible to the properties of air. During the war, materials that mainly absorbed waves in the medium frequency range (up to 100 kHz) were examined and produced in small quantities in Travemünde. In the development stage were substances that were intended to protect against detection by radar devices that worked at higher frequencies (i.e. were of a more modern design) - shortly before the end of the war, a device was completed in Travemünde with which substances could be checked for these properties.

Although these works were extremely innovative, they were never considered a priority in the Third Reich. The materials described

were used almost exclusively for experiments. The only exception that I know of is Type XXI submarines, which were standard equipped with snorkels covered in materials of this type.
The end of the war meant that interest in “stealth technology” temporarily waned. It was only in the second half of the 1950s that Americans remembered the German investigations, when they developed anti-radar paints for the SR-71 *Blackbird* supersonic reconnaissance aircraft - the first flight of which took place in 1962. This area is currently experiencing rapid development, as radar detection is considered one of the most important problem areas for modern fighter aircraft.

As I had already begun work on this book, I came across further Allied intelligence on this subject, and these reports were quite unusual. In addition to those already mentioned, as it later turned out, there were at least four 66,67,68,69 This of course testifies to further such elaborations!

Significance of this complex of questions for the “conquerors”. Additional information is occasionally included in the report on the American espionage operation *Lusty,* which is described in detail in the second part of the book. It is clear from this report that the IG
The Farben Institute near Frankfurt (in Höchst) was not the only important institution in this field. The following were also mentioned: 1) the

Danzig Institute for Inorganic Chemistry (Prof. Klemm) 2) the

company Osram - “Study Society for Electrical Lighting” - Berlin (Dr. Friederich) 3) the

laboratory of the Degussa Group - 8 km from Konstanz away, near Lake Constance (Prof. Fuchs and others) 4) the

laboratory for ceramics of the Lutz and Co. company in Lauf/Pegnitz in Bavaria (Dr. Franz Rother - inventor of the material used for submarines of the

type XXI was used) 5) the Technical University

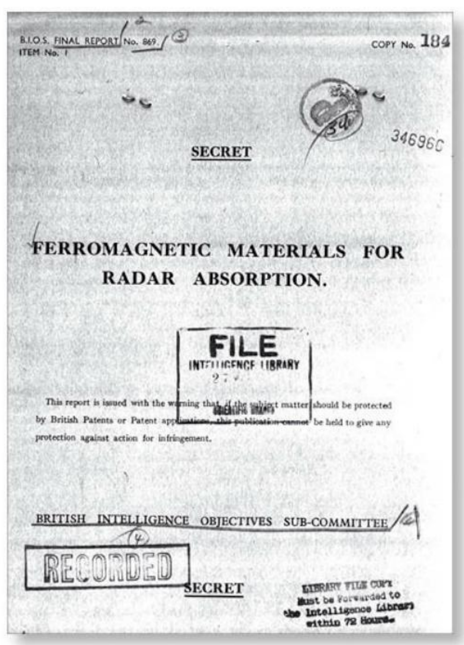
of Stuttgart (Dr. Fricke) 6) the Technical University of Prague (Prof. Hüttig)

There were also other clues, such as: B. the report of a Polish soldier who served at the former German Sorau (ÿary) airport near Zielona Góra shortly after the war. He described how one of the

Airplanes were painted with some gray, porous “quasi-paint” that was in an abandoned barrel. It caused the light *stork* to become completely invisible to radars.

In addition, the Third Reich also developed materials that were intended to protect submarines from detection using sound methods (ASDIC - echo sounder) by absorbing sound waves propagating in the water. Here, too, there are striking similarities to post-war developments, including the Polish submarine “Orzeÿ – III” (“Adler”), which was purchased by the USSR in 1986 and was equipped with an identical protective layer as some submarines at the end of the Second World War.

The IG Farben Group was also able to achieve groundbreaking successes in this area, especially its laboratories in Höchst on the outskirts of Frankfurt am Main.[70] The investigations began in 1940 and were completed in 1944 with the launching of twelve submarines with an “anti-noise layer”. This project had the code name *Alberich.*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FERROMAGNETIC MATERIALS FOR RADAR ABSORPTION.

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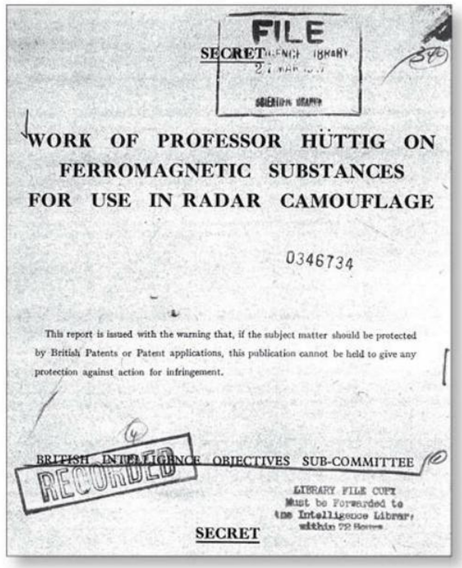
Cover pages of selected intelligence reports on German “stealth” technology.



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WORK OF PROFESSOR HÜTTIG ON FERROMAGNETIC SUBSTANCES FOR USE IN RADAR CAMOUFLAGE

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Although certain preparatory work had been carried out before 1940, it was only then that one could speak of the beginning of a "serious" program. This year is associated with the realization of a completely new concept, the originator of which was Professor Meyer from the Heinrich Hertz Institute. It was based on the use of many appropriately shaped layers of specially selected rubber, with a key advantage compared to previous ideas being that the outer layer remained smooth - so hydrodynamic resistance did not increase. It was an effective yet simple solution. Most of the variants examined can be described as follows: Two thin rubber flaps (approx. 2 mm) were glued one after the other to a steel plate that imitated the outer fuselage skin. The outer layer consisted of a closed, smooth flap. As expected, the most important role was played by the layer that adhered directly to the fuselage. It was perforated and provided with a large number of smaller (up to 2 mm) and a slightly smaller number of larger (approx. 5 mm in diameter) holes, in which a large part of the sound wave was supposed to be attenuated due to interference; the diameter of the holes was inversely proportional to the frequency. The whole thing therefore formed a soft, almost sponge-like shield that was intended to blur the "sound image" of the boat.

Despite its simplicity, this panel, if designed correctly, could be very effective - the maximum measured

Attenuation level (for a few kHz) was 95%. However, that is only one side of the coin. Such great effectiveness could only be achieved if the hole diameter was ideally “matched” to the sound frequency used by the enemy. The Germans feared that by using devices that worked in different frequency ranges, Meyer's invention would become significantly less important. (By the way, this is exactly the same problem as with the “stealth” coating for aircraft; for example, the “invisible” American F-117A bombers can be detected relatively easily with the help of old types of radar devices that operate in the medium wave range). In the case of the “anti-sound coating” there was another problem: it was obvious that it would only be effective to a depth where the “air bubbles” would not have the same density as water due to the pressure. Calculations and measurements in a special pipe that was set up vertically like a chimney showed that this limit is around 70 meters deep. Nevertheless, the invention was valuable because it enabled effective protection during combat operations when the boat was at shallow depths and close to enemy units (although Type XXI boats were the first to be able to launch an attack without the periscope over the To push out the surface of the water, they still had to maintain a shallow diving depth). At greater depths, this problem was not so precarious, especially because a sound wave does not propagate “into the depths” in the same way as horizontally. The sea is by no means a homogeneous mass of water, but has a specific structure and is divided into many “layers”, which are characterized by different salinity, oxygen content, etc. distinguish. This manifests itself in almost sudden differences in density, which sometimes leads to reflection, refraction and ultimately the dispersion of the sound wave. In the ocean (that is, without the influence of the seabed), these phenomena take place at a depth that exceeds the height of the waves (water mixing) by an order of magnitude, that is, below, say, 100 – 200 meters. Submarines, on the other hand, reached a depth of up to 300 meters. Of course, they could also be discovered at this depth, but the diving depth is generally a parameter that has the greatest influence on their ability to be discovered. The second important parameter is of course the maximum

Despite everything, the invention turned out to be relatively valuable and "definitely worth owning" – at least that was the conclusion reached by the American report.

The snorkel of a Type XXI submarine, covered in "stealth" material.
(Photo from the author's collection)

The Germans equipped twelve of their submarines with the Alberich coating. The majority of these were merely tested, and only two took part in combat operations. One of them was sunk, but it had no snorkel and was probably discovered by radar.

It was not specified what type of boat it was. When discussing this material, a neighboring, important and little-known area should not go unmentioned: the plastics of the Third Reich. Another intelligence report allows us to do this.



## Plastics

Plastics are primarily associated with the 1960s, when they revolutionized industrial design and found their way into a range of everyday items.

However, as with much of the "news" from this period, it was really about introducing revolutionary achievements in science and technology from World War II to the mass market. Plastics were one of them

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Its appearance is often attributed to the Americans, the inventors of nylon fiber (Du Pont concern), which was then called synthetic silk and came into fashion due to new seamless stockings, although it turned out to be most valuable primarily as a cheap raw material for parachutes, which one could now be produced in practically any quantity.

The Germans also had nylon, and they mastered its production not much later than the Americans; They also developed many new plastics - around a dozen different types in total.

We now know most of them from our own experience.

Of course, the earliest to appear were chemically hardened plastics based on phenol, such as Bakelite, which was widely used even before the war in the manufacture of additional elements for small arms - stock linings and butt flanges - as well as electrical insulators. Its production began in small quantities before the First World War on the basis of a Belgian patent. However, when it comes to the work carried out during the Third Reich, the following turning points can be distinguished:

- June 1938: the first composite material (highly robust fabric laminated with plastic)
- January 1939: Synthesis of the first thermoplastic polymers. At the same time, polymer bearings were developed, production of which began in September 1939 • January 1942: first

production of elements made of thermoplastics using the casting process, which was replaced four months later by the injection molding printing process

- May 1942: Development of a specification for the manufacture of Rolling bearings made of

composite materials • March 1943: Specification for the production of plastic elements in Punching process

During the Third Reich, the IG Farben group was a monopolist in the development and production of composite materials, and the most important role was played by its factories and laboratories in Bitterfeld, in Höchst (near Frankfurt am Main) and in the Berlin district of Oppau, where the headquarters of the " “Nitrogen Syndicate”, a department of IG Farben that specialized in this area. This area played a key role

- which was also reflected in the appointment of a special representative in the Speer Ministry who was responsible for the implementation of the government's priority war projects ("Special Representative for the Nitrogen Industry"). The Germans also commissioned the realization of their ambitious tasks to a number of companies in the European countries they occupied, mainly in France, Belgium and Holland, including the Phillips works in Eindhoven and Venlo, the Cogebi company (Compagnie Generale Belge d'Isolants) in Loth near Brussels and the "Institute for Plastics" in Delft.

Overall, the following plastics were developed: •

Polystyrene – this material was produced in small quantities under the name "Trolitul" and was considered uncompetitive; • Polyvinylcarbazole – a

composite material formed by injection molding, i.e. technologically advantageous, which is characterized by very good load parameters and very low electrical and thermal conductivity due to its fibrous structure. This material was considered promising;

• Polyvinyl chloride – manufactured in many varieties, including in Venlo, for various applications (PVC); •

Plexiglass (polymethyl methacrylate) – commonly known as "organic glass." Because of its low tendency to burst, it was used to make glazing elements for aircraft. An alternative was standard vinyl laminated (glued) glass manufactured by the Société de Verreries des St. Gobain in Lyon. The Germans planned to produce elements for simple optical devices from Plexiglas, but ultimately only lenses for flashlights were made from it; • Polyvinyl Acetate (PVAc) – a very durable substance tested as a concrete additive; perhaps

it should be used in concrete armor cladding;

• Polyamide (nylon) – a material used during wartime different variants were produced;

• Polyethylene – despite intensive research, the investigations could only be completed after the war in the Federal Republic of Germany. Polyethylene is a plastic that is now used to make plastic bags, hypodermic syringes, etc.

getting produced;

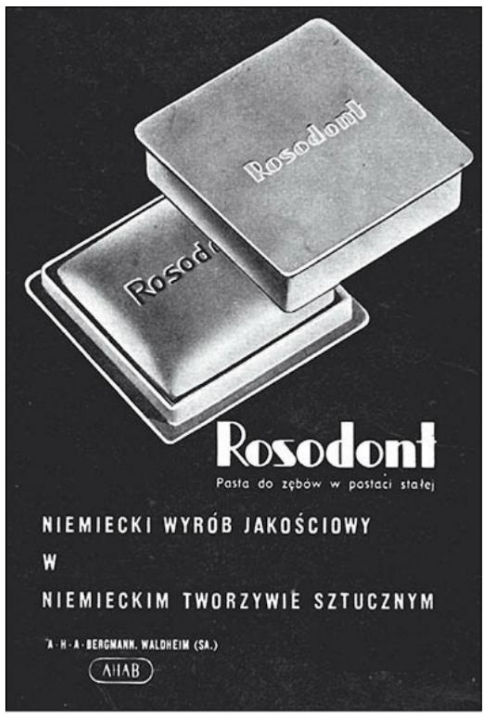
• Polyisobutylene – a material used as a rubber substitute during the war;

• Aldols – form an

alcohol group which is a polyvinyl derivative from which

Among other things, cable insulation was produced.

In addition to the synthetic materials mentioned above, further research was also carried out on some new substances that had already been discovered before the war. Various cellulose compounds have been synthesized, including celluloid photographic films, cellophane packaging film, and the l




A German advertisement from 1944.

Due to their insulating properties, the Germans mainly used the plastics in the electrical and electronic industries. However, it became clear that these materials were becoming increasingly popular in other areas as well - in the form of plastic containers, nylon camouflage nets, and PVC tiles and buttons. A polyamide film with high tear resistance was produced in small quantities - among other things for the production of audio tapes (which were mainly used by the GESTAPO). The Germans also mastered the technology of the

Manufacture of synthetic fabrics... this area is important simply because it initiated the industrial use of composites - e.g. B. in aviation. 71

## The war under water

Another and little-known area, which has already been hinted at in the previous pages, is technologies related to “war under water”. The problem was simply that the war was fought at sea with the help of submarines that had (with certain exceptions) been built before the war.

The results of the research carried out during the war have therefore remained practically unnoticed.

So it is somewhat paradoxical that despite the huge sums invested in research, the Germans began to lose the war in the Atlantic.

Even “news” like this didn’t help. B. an acoustically controlled torpedo (the T-5 torpedo Zaunkönig, which was added to the arsenal in 1943), as the Allies quickly learned how to counter this danger - with devices that were towed behind the ship and making a much louder noise than the ship itself. The losses of the submarine fleet became greater and greater. The reason for this was that the enemy used two revolutionary inventions that are very well known today: the sonar device (echo sounder) and a radar device that was able to detect not only surfaced submarines, but even their periscopes and snorkels.

It should be borne in mind that the main types of submarines used by the Kriegsmarine (in versions VIII and IX, which were included in the arsenal) were characterized by an underwater range of around 60 nautical miles and were therefore only a type of “submersible”. . There was therefore an urgent need to make truly radical changes and to design entirely new submarines that would be able to carry on the fight with means that the Allies could not defend against.

Such submarines were designed and actually represented the pinnacle of what was technically possible in this area. Many

Post-war constructions were based on them. These included types XVII, XXI and XXIII.

Although the Type XVII submarine was based on solutions that had emerged before the war, it was one of the most interesting. The breakthrough compared to older Type VII and IX units was based on the use of a new propulsion system that was independent of the air supply: the Walter turbine. This invention was already being investigated in the early 1930s. Its inventor was the engineer Hellmut Walter, a chemist from Kiel. It was a turbine engine that used a classic fuel (diesel fuel) that burned in a special chamber in an atmosphere of oxygen and water vapor. The oxygen came from the catalytic decomposition of 80 percent perhydrol (concentrated hydrogen peroxide – H2O2 ). It was a special modification of an ordinary hydrogen peroxide solution, although the solution available in pharmacies has a concentration of only three one percent. The perhydrol for the turbine drive was named "Ignolin" by Walter in honor of his eldest son.

He initially considered using concentrated nitric acid as an alternative oxidizing agent, but quickly abandoned it because of its corrosive properties and the toxic effects of its decomposition products (mainly nitric oxide). B. inside the ship could never be completely ruled out. It should be mentioned that in Germany, at the time of the construction of the Type Since production capacity was limited and the substance was relatively expensive, both submarines and torpedoes that were to use the same engine competed with the V2 rockets, which were also the top priority.

Work on the Walter turbine to power a future submarine began in 1933 and led to the construction of an engine with an output of 4,000 hp in the mid-1930s. The temperature in its combustion chamber was around 450 during operation

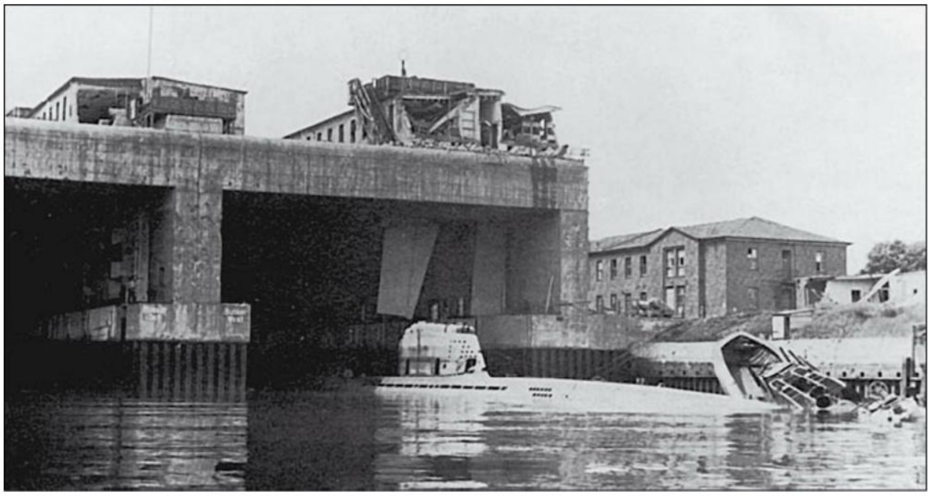
°C and a pressure of 36 atm. Combustion gases and water vapor were used to drive the turbine and were then cooled and discharged. The water vapor was condensed and remained in the submarine.

The successful research results led to the ordering of the first experimental submarine with this drive in 1938. The Germania shipyard received the order. The boat, marked V-80, was completed two years later. It had a static buoyancy of just 80 tons and a three-man crew, but made it possible to explore the real possibilities of the new propulsion system.

The results were actually very promising: During one trip, the V-80 reached a record speed of 28.1 knots underwater. The biggest problem was mainly the high price of the oxidizer. However, the test results were sufficient to make the decision to build a new submarine of the aforementioned Type XVII, this time intended for combat use. The order for the construction of the first boat (the U-791) was placed in 1942, but for various reasons this order was soon canceled. However, four more boats were built: the U-792, the U-793, the U-794 and the U-795. They were relatively small units with a length of 52.1 meters and a static underwater buoyancy of approximately 330 tons (for comparison, the Type VII submarines had a static underwater buoyancy of up to 865 tons, and the Type IX submarines from 1,232 - 1,804 tons, depending on version).

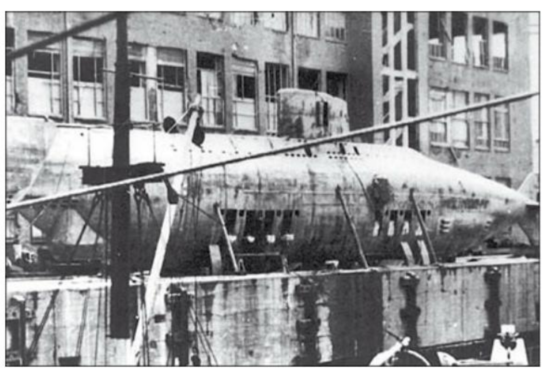
Apart from two Walter turbines (with a maximum output of 2,500 hp each), they were also driven conventionally: each of them was equipped with a diesel engine, which was used on the surface - albeit with a relatively small output of 210 hp with two “reserve electric motors” with an output of just 75 hp.

The main engines had a working pressure of 30 atm and the combustion chamber temperature was around 550 °C.



A Type XXI submarine in May 1945 in front of the bunker at the Hamburg shipyard.
(Photo: Federal Archives)

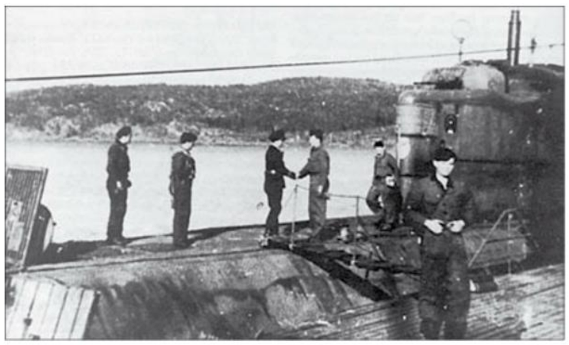
They were the first submarines to achieve a much higher speed underwater than on the surface (approx. 26 knots), with a record range of around 150 nautical miles. However, they could only swim underwater for that long and that fast once, and not every time after recharging their batteries, as was the case with conventional submarines. Therefore they were not seaworthy and were intended to serve mainly in the North Sea.



A Type XVII submarine taken over by the Americans after the war. (Photo: NARA)

They were put into service with the Navy at the beginning of 1944, but they only reached operational readiness in the last months of the war, which is why they never took part in hostilities. In the

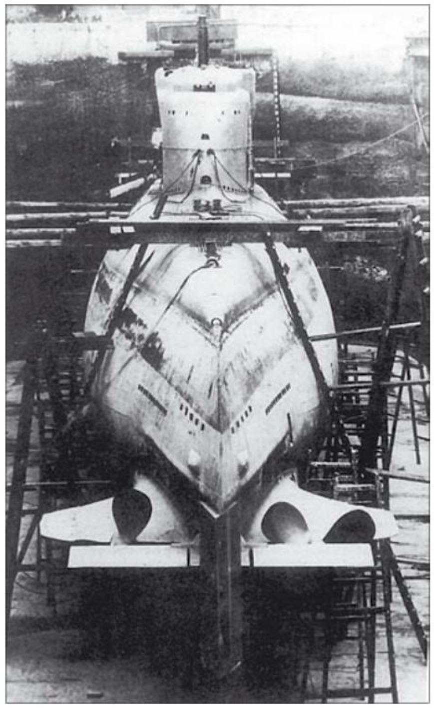
In the first half of 1944, three more units were ordered with slightly higher static buoyancy and a reduced underwater speed of 21 knots. They were completed that same year, but were not used. The Germans themselves blew them up towards the end of the war (the officer responsible for this operation was later sentenced to seven years in prison by a British court!).



One of the Type XXI submarines in Norway, April 1945. (Photo from the author's collection)

Even before this happened, three more Type XVII-G and XVII-K submarines as well as 100 (!) larger Type XVIII ocean-going units were ordered, but these were never to be completed.

Its proven, revolutionary drive was further developed after the war in the USA, Great Britain (where Walter himself had been taken) and the USSR. The USSR was the only country in which submarines powered by Walter turbines were added to the arsenal after the war.



A Type XXI submarine in ship dock, stern view. (Photo from the author's collection)

The relatively small Type The efficiency of the turbines is best demonstrated by a comparison with the diesel drive, which consumed the last quarter of the total amount of fuel and enabled a range on the water surface that was approximately 20 times greater than the first-mentioned drive system.

The drive was further developed until the end of the war and was intended to be used in several new submarine types: XVIII, XXIII, XXIV, XXVI-A and XXVIII. The first two mentioned had a range suitable for ocean use - the Type The type XXVI-A was intended to represent a connection between the classic solution and the Walter turbines, with the latter only being used in dangerous situations. However, none of these submarines were completed, despite intensive research to increase the because turbine efficiency 72,73 This research was necessary contributed. the propulsion simply implied the fundamental limitations of submarines.

There were two reasons for this: Firstly, a submarine (e.g. Type VII or IX) could not escape from a destroyer underwater because it was significantly slower - even twice as slow. Secondly, submarines could only swim underwater for a short time, usually only a few hours, which made them relatively easy to detect, e.g. B. by aircraft that constantly patrolled both the North Atlantic and the access routes to the ports.

The propulsion parameters have been improved in several ways. The very modern submarines Type XXI (seaworthy) and Type XXIII were equipped with classic propulsion systems (diesel engines plus electric motors), but were of a completely new generation and allowed a radical change in tactics. The Type XXI developed a speed of up to 17.2 knots underwater, and was once able to cover 340 miles, i.e. 630 kilometers, powered by the batteries alone! Such a distance was much greater than all of its predecessors or competitors. Not only could it easily outrun a typical destroyer, descend to the record depth of 330 meters (as one of the tests showed) and attack its targets without surfacing (passive rangefinder), but it was also particularly difficult to detect underwater.


A Type XXIII submarine. (Photo from the author's collection)

One example was tested in 1946 by the American Navy, whose ships could not detect the submarine even from a distance of 200 meters. Coating the snorkels with the “stealth” material naturally also led to a completely new quality on the surface or at periscope depth.

Generally speaking, this was a leap from the level of the 1940s to the

...

1960s. This shows how much could be achieved through the successful exploitation of thoroughly revised, but entirely conventional and broadly known concepts.

The submarine was equipped with a completely revolutionary fire control system that allowed it to carry out effective attacks even while completely submerged. The target positions were determined by converting bearings from very precise bearing receivers, after which the submarine fled at a maximum speed at which the enemy sonar devices were completely ineffective (they only worked really well up to a speed of 12 knots). In practice, there was no way at all to detect the attacking submarine, whereas with older types at the end of the war this was almost unavoidable: they were discovered by sonar devices and, moreover, had to extend the periscope before the attack, which the enemy usually used could be discovered with the help of radar devices. But even with this attack variant, the Type XXI was enormously superior to the enemy, because its extended snorkel could not be detected by any radar device due to the special coating.

Another attack variant that was intended to be used at longer distances was the detection of target positions using a deployable radar. It was intended to use torpedoes equipped with homing devices (e.g. magnetic torpedoes).

The last of the fatal weaknesses of older submarines was also eliminated, namely their relatively high sensitivity to air attacks, which resulted in part from the inability to quickly detect aircraft. This problem was eliminated by using an onboard radar. In addition, unlike its predecessors, when confronted with a single patrol aircraft (the most typical situation), a Type XXI submarine had very great chances of victory, as it was equipped with two anti-aircraft turrets with four 20 mm rapid-fire cannons, which could also be coupled with the radar device. If they also turned out to be inadequate, the submarine was able to submerge in record time (just 18 seconds).

The Type XXI was such a radical leap in quality that – in what seemed almost impossible – it tipped the scales even further in favor of the Germans.

It was the first modular submarine - the hull was divided into eight sections, which were simply connected to each other in the ship's dock. This simplified production, but (or above all) also led to the “relocation” of almost all production steps to the ship docks most at risk from bombing. It was also the first ship to have a single hull with all the equipment and devices installed inside. Previously, submarines were built with a rigid (long and narrow) inner hull, which was first enclosed by ballast containers and only then by an outer hull. This made it possible to significantly increase the space inside the hull and, among other things, introduce numerous improvements for the crew: each crew member had a whopping 17 m2 of space , there was also air conditioning and washrooms - all things that older crews needed could only dream. The crew members were able to shower normally, while the sailors who served on Types VII and IX, which were filled with salty wetness and musty smells, were usually unable to wash for several months, which led to many illnesses.

To supplement the Type XXI submarine fleet, new Type XXIII “coastal submarines” were planned, which were of the same state of the art, but were about twice smaller and had a shorter range.

The German attempts to solve the drive problem went in a different direction:

It was a diesel engine with no air supply
worked, in the so-called closed circuit.

This was by no means a new concept - the first attempts at implementation dated back to 1915-1918, but there were several dozen

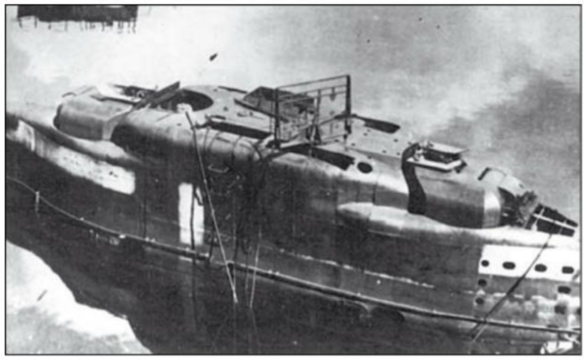
Years passed before technological development had progressed far enough. In 1939, the Third Reich launched a comprehensive research program in this area, with the following companies being commissioned, among others:

- Zeppelin GmbH, where under the leadership of Dr. Durr to this goal Diesel engines from Daimler-Benz were modified;
- the Germania Werft in Kiel – a shipyard responsible for the final phase of the was responsible for work;
- the Research Institute for Motor Vehicles – an institute that carried out the majority of the research work and calculations (Prof. Kamm, Dr. Huber);
- the Junkers-Bessar companies and the Sotow Aviation Academy (in Berlin), which specialized mainly in new torpedo engines (Prof. Holfsleber) and had very valuable experience in this new field;

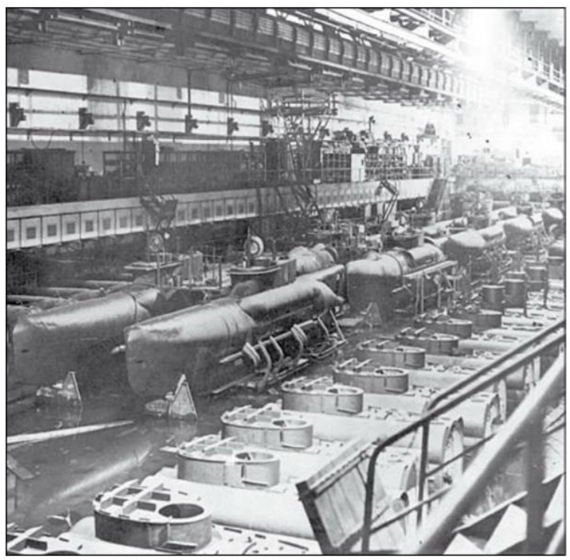
- the engineers Dipling and Schlefler from Berlin, who previously developed special engines for fast assault boats and brought with them great knowledge in the field of increasing the efficiency of internal combustion engines.

What principle was this innovative type of drive based on?

Diesel engines that work in a closed circuit are similar in design to classic diesel engines, where the fuel is not mixed with air, but with oxygen, which is supplied from the pressure or cryogenic system. The gases resulting from combustion (carbon dioxide and water vapor) are cooled, causing some of the water vapor to condense and the remaining $CO_2$ to dissolve easily in the seawater. Only in this form do the combustion products leave the submarine, which only has a propulsion system (possibly an additional special electric drive for slow “creeping up”) that is used both on the water surface and under water. In this way, the swimming time underwater could be extended to several days and, in the case of the most modern projects at the time, even to several weeks.



Command tower of a sunk Type XXI submarine - you can see two anti-aircraft turrets with a radar antenna in between. (Photo: US Army)



Unfinished miniature submarines of the *seal type.* (Photo: US Army)

Replacing electric motors and massive batteries with energy sources with significantly higher efficiency brings decisive advantages.

For this purpose, Daimler Benz engines, mainly of the DB-501 type, were modified in the early 1940s. In 1942, two Type IX-D submarines were redesigned, with the original MAN engines (two each) with an output of 2,000 - 2,500 hp being replaced by new, but not yet modified, engines from Daimler-Benz.
These were significantly smaller, and since each submarine was to be equipped with six, it was necessary to examine how best to redesign the propulsion component. In this way

In practice, the configuration that came closest to the target configuration could be tested. This also made it possible to estimate the properties of the future configuration.

As it turned out, the top speed only increased by 2 - 2.5 knots to around 23 knots (on the water surface), although the total power increased from 5,000 hp to 9,000 hp.

It was the first attempt to adapt the new propulsion system for use in production submarines, although before this work was completed it was decided to modify one of the Type XVII submarines, which would be the first to be equipped with the final closed-cycle engines (However, this took a long time, which is why this submarine was never completed - only some elements of the new system were installed without the engines themselves). It received the marking XVII-K. It was planned that this submarine would carry 23 tons of diesel fuel and around nine tons of compressed oxygen in 16 bottles, which corresponded to a range of around 1,100 - 2,600 nautical miles on the water, depending on speed. The range under water, however, would be approx. at a maximum speed of 16 knots.
110 – 120 miles. This submarine, which was quickly given the tactical designation U-798, was sunk by the Germans themselves at the beginning of May 1945.

Of course, it was just a test design without armament. The first type in which the new engines were to be installed in series was the miniature submarine *Seehund,* which was not much larger than a torpedo. This involved lengthening its fuselage by one meter and replacing the compressed oxygen tanks with cryogen tanks, which were much easier to handle. The *seal* had a very short range and the loss of oxygen due to evaporation did not pose a significant problem. However, this project was also not realized and so none of the engines of the type described built in the Third Reich were ever used at sea.

However, the research work associated with the new idea continued and, despite everything, produced interesting results. In particular, problems came to light with the use of a new fuel mixture in the DB-501 engines. Attempts were made to eliminate them and to perfect and develop all peripheral devices.

This involved, among other things, modifying the main source of the problem, namely the system for regulating the injection of diesel fuel and oxygen (in which there was not always high pressure - initially it was 400 atm, but as the tank was drained the pressure fell to 1 atm). Nevertheless, the ratio between injected fuel and oxygen had to remain the same.

Engine damage occurred due to the water present in the compressed oxygen. The oxygen pressure system, in which small leaks were discovered despite the great care taken in producing the weld seam, was also technically very difficult to implement. However, there were no problems with the exhaust gas compressor, which was supposed to discharge the combustion gases to the outside - even at great depths, of course.

A special oxygen compressor was also being developed, which would have made it possible to dispense with some of the pressure vessels, as the oxygen supplies could be replenished on the open sea.

The entire research program described was intended to enable the construction and start of series production of several new types of submarines with the designations XXIX-K (sea-worthy), XXXIII (coastal-worthy, but with an underwater range of 3,000 km!) and XXXIV (coastal-worthy). The underwater range of the first two models would have been shocking at the time of World War II - it would be at least several times greater than any competing solution. This clearly shows the importance of the concept described.

72,74

In summary, the question can be asked: How could it come about that despite such outstanding technical achievements, the situation in the Navy did not improve? This is a very interesting question that few people know the answer to. Of the Type XXI submarines alone, 118 were completed between June 1944 and April of the following year (although a total of 1,300 had been ordered) - but none of them managed to sink a single ship. The main problem was that the two modern models XXI and XXIII were much more complex than the previous models. The sailors had to be highly qualified professionals. But that's exactly what was missing.

The training took a long time and was only carried out in one facility in Gdynia (Gotenhafen). In the end, most of

They (1,100 people) were trapped in the Danzig/Gdynia encirclement at the beginning of 1945 by the Soviet January offensive. They were to be evacuated by sea; however, the ship they were taken on was sunk. It was the famous *Wilhelm Gustloff ...*

## Concrete ships

Another interesting and little-known fact about the German Navy is that, as part of the desperate attempts to rebuild the fleet, such incredible (and arguably pointless) concepts as building concrete ships were pursued.
However, they were not pure theory. The shipyard that was involved in this was located in Darÿowo (Rügenwalde) on the Baltic Sea coast. Today the hulls of two such ships are still part of the harbor embankment in Darÿowo; On a military map, one of them is marked with a dashed line as a body with dimensions of 90 x 15 m. Göring once tried to implement a similar idea. At the time when the Allied Air Force was concentrating on, among other things, the destruction of locomotives as one of the "bottlenecks", the Reich Marshal put forward the concept of mass production of concrete locomotives.[13] However, the idea was not well received, although this does not mean that the leaders of the Third Reich fundamentally acted according to rational criteria. Such dilemmas as the Me-262 bomber versus the Me-262 fighter, or V2 rockets versus anti-aircraft missiles are evidence of this. A comparable example are super-heavy tanks.

In this context, I would like to recall the comments in my introduction.

## Recoilless weapons

Now that we've gotten to the curious ideas, we can also briefly consider certain interesting concepts in the area of barreled weapons, ammunition and rockets - although they seem to make a lot more sense compared to the ones mentioned above. Many such examples can be found, among other things, in recoilless weapons. It is often overlooked that

Even the *bazooka* at the time of the Second World War was, despite its simplicity, an extremely innovative solution. This weapon destroyed hundreds, if not thousands, of enemy combat vehicles. It was cheap and simple, consisting mainly of an over-caliber bullet, a primer and a launcher (steel tube).

Nevertheless, the functional principle itself - that the recoil was compensated for by the powder gases escaping from the other end of the tube - was new and was –, something only used in the Second World War. The projectile itself was similarly innovative: up to this point, a slow-moving projectile had never been able to penetrate 10 - 20 cm thick vehicle armor. The turning point came with a special explosive charge, the so-called HEAT bullet, which has a conical sleeve lined with copper or steel - the so-called shaped charge insert. This is deformed by the explosion, creating a jet of liquid metal with a speed of up to 10 km/s. It is precisely this beam that penetrates the armor.

This principle now made it possible to construct an entire family recoilless weapons.

The recoilless cannon is a light special artillery weapon. The concept emerged long before the outbreak of World War II, but the most turbulent development occurred at the turn of the 1930s and 1940s. Such solutions were developed in various countries (including in Poland shortly before the outbreak of war by the engineer Czekalski), but a particularly large number of models were developed in the Third Reich.

A soldier with the Panzerfaust 60 grenade launcher. (Photo: ADM)

In a recoilless grenade launcher, the barrel is simply open from both sides, while the gun has a breech that allows the powder gases to spread easily to the rear. Its sole purpose is to block the bullet in the barrel and initiate the detonator. The bullet casing is made from a combustible material or from thin perforated sheet metal. The chamber is designed in such a way that the powder gases pass through the rudimentary breech (the bearing has a larger diameter than the caliber) and enter the rear part of the tube, which is usually terminated with a specially profiled nozzle.

The lack of recoil force allows the design to be greatly simplified, including by eliminating the recoil device, which is the main advantage of a recoilless cannon. In this way, the light infantry has a replacement for a classic artillery weapon, e.g. B. can be used by airborne troops, mountain troops and reconnaissance subunits. This enables them to destroy fortified points of resistance (bunkers) and enemy combat vehicles (since the beginning of the 1940s, i.e. since the introduction of HEAT projectiles, as the projectile muzzle velocity of the recoilless cannon is too low for this core projectiles could be fired effectively).

The *Panzer Terror.* (Photo from the author's collection)

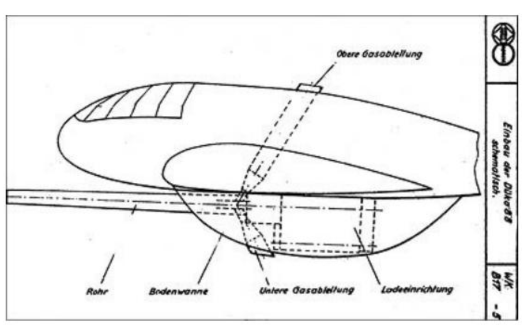
So now we come to the main disadvantage of the recoilless gun: the low kinetic energy of the projectiles and thus also the short effective range, which does not exceed 1,000 m when shooting straight ahead. This arises from the principle of operation itself - the “leaking” of the cartridge chamber and the lightweight tube design.

Nevertheless, it was an advanced weapon at the time and was invaluable for many applications. The “boom” that could be observed in this area immediately after the end of the war is evidence of this. It was only several dozen years later that this weapon began to gradually lose its importance due to the introduction of mobile launchers for guided anti-tank projectiles.

The wartime German recoilless cannons can be divided into two main groups: the relatively conventional designs that entered the arsenal, and the less conventional designs that did not progress beyond the field trial or planning stage.

Of course, the most interesting is the second category.[75,76,77]

These projects were as follows: 1. A 150 mm cannon, which was probably designed in 1942 (as the marking suggests) and was intended to be an addition to the two types mentioned above. It was known as the LG 42 and LG 292 Rh and was developed by the same specialists who designed the 75mm and 105mm cannons: engineers Wind and Dr. Biermann (who also designed a bullet weighing 45 kg). Neither the total weight nor the firing range are known. All we know is that the barrel was 2,145 mm long and the bullet muzzle velocity was probably 290 m/s. Only a few prototypes were made.



Original drawing of the installation of an 88mm recoilless cannon under the fuselage of an aircraft. (Drawing: Rheinmetall).

2. The 88 mm cannon DKM-43, developed in Sommerda for the Kriegsmarine as a possible armament for patrol cutters and other small units. Her tube was 2.8 meters long and the total weight was 350 kg. The range is unknown, but the high bullet muzzle velocity (600 m/s) suggests a firing range of over 10 km. Firing tests at the test site were positive, but the cannon did not go into series production.

It had an unusual design that was completely different from other recoilless cannons. 78 The aim was to modify the existing, highly proven anti-aircraft/anti-tank gun of this caliber. Would it be possible to convert it into a recoilless cannon without changing the existing basic design characteristics?

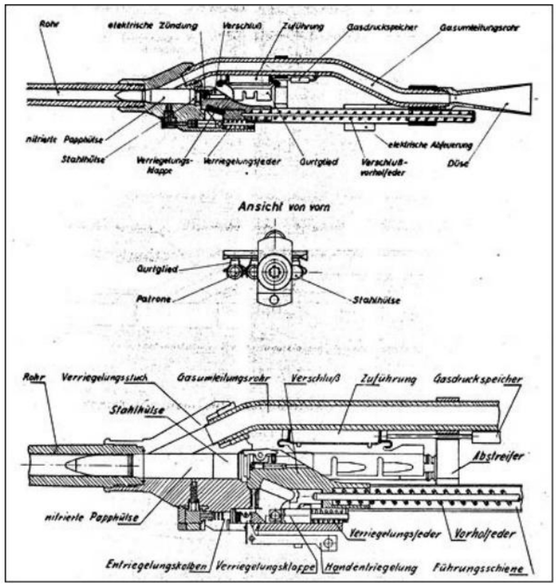
It turned out that was possible.

A second bearing was simply placed behind the cannon, in which a second charge exploded when fired, and the resulting recoil compensated for the cannon's recoil. However, an unsolvable problem was the situation in which the two explosions could not be precisely synchronized or a charge was not ignited.

3. As a development version of the above design, an aircraft cannon (!) of the same type was intended to fire the same type of ammunition. However, when it turned out that it was too heavy and the aircraft could not withstand such a powerful explosion (of course it was mainly due to the gas jet behind the cannon), the work was interrupted. The tests were carried out at the test site near Treuburg with a modified Ju-87c aircraft. It fired at various tanks that had been set up on the test site. However, when the recoil-compensating charge failed to explode during a flight, it was severely damaged. Part of the streamlined gun housing was pushed backwards, damaging the aircraft's tail.

78

4. A heavy 280mm recoilless cannon developed for the Kriegsmarine in 1944. It was intended to serve as coastal defense before the planned landing of troops in France, was intended to arm the heavy bunkers and was supposed to weigh a whopping 28 tons! Since the troop landing took place before the work was completed, it was canceled. The project was designated DKM-44 (Jet-Cannon-Marine, model from 1944).




Original cross sections of the MK-115 automatic recoilless autocannon.

The above unfinished projects represent rather a search for an optimal combination of the advantages of recoilless cannons with the advantages of other types of artillery armament. They are not among the truly groundbreaking achievements, which, however, also existed...

This refers to the recoilless automatic rapid-fire cannon, which was designed in the last years of the war as an aircraft armament and was intended to be mounted in the aircraft wings. It is therefore the realization of a completely unusual and even more groundbreaking concept, as special cartridges with a partially self-burning case (cardboard soaked in cellulose nitrate) were designed for this weapon. Only the base of the case, which sealed the rear part of the chamber when the shot was fired, was made of metal. This autocannon was marked MK-115.

The starting point for the work was the research results on an earlier, experimental recoilless 50 mm aircraft cannon as well as the following specifications from the Air Force Ministry:

• Caliber: 55 mm

• Projectile muzzle velocity: 600 m/s • Projectile weight: 1.5 kg;

• Minimum rate of fire: 300 rounds/min • Use of carbon steel • Feed: right or left side • Shot initiation: electrical • Possibility of putting the case bases back into the cartridge belt The Rheinmetall-Borsig company took on the task and presented a project for a Autocannon with the following characteristics: 1. The main motto was simplicity, also from a technological point of view. Therefore, the tube was designed as a monoblock and was connected to a cast cartridge chamber by a thread.

2. The main component of the weapon was the cartridge chamber, with which the barrel, the breech block, the reloading and feeding mechanisms, the gas diversion tube used to remove the powder gases, etc. were connected.

3. The shutter was also designed as a monoblock and cast from ordinary carbon steel. The cartridges were fired electrically.

4. One of the most original and unique solutions was the weapon automatic feed system. The shot was fired with the barrel locked, which was of course essential with this cartridge energy (locked in the classic meaning of the word, see point 5). The so-called semi-rigid breech was used - its recoil was delayed by a special device that was triggered by the powder gases discharged laterally through an opening in the chamber (the sleeve did not seal the chamber along its entire length). In the gas pipe connected to the chamber there was a small metal piston, the inertia of which provided the necessary delay in unlocking the barrel. This system

So it worked completely differently than the well-known device (which was used, for example, in automatic carbines, including the MP 43 assault rifle, which went into production around the same time, i.e. in 1943), the principle of which was based on the discharge of Gases through a side pipe opening. This is triggered at a precisely defined time, namely when the projectile passes through the side barrel opening At of the MK-115 machine cannon.

Unlocking impulse instantaneous, and the rate of fire depended solely on the inertia of the butt and the breech. One reason for choosing this solution was that access to the cartridge chamber was not restricted by the (burning out) case. The priority was to ensure that the reloading cycle was relatively quick, since, in contrast to automatic carbines, the pressure of the powder gases does not remain particularly stable until the bullet exits because the barrel is open from the start. This was ensured by the gas diversion tube, which was responsible for recoil compensation (it was terminated with a nozzle located in the extended tube axis). In this way, the breech recoil was caused directly by the base of the case, on which the powder gases acted, and not (as in the carbines) by the piston rod, which is supplied by the gases discharged from the side tube opening. After the shot, the breech removed the metal case base, removed the next cartridge during the return movement, which was carried out with the help of a spring, and inserted it into the cartridge chamber.

5. The problem of removing duds (defective cartridges) from the barrel was also solved in an interesting way. In the connecting tube between the cartridge chamber and the rear-mounted nozzle there was a small opening that led to the pressure container in which some of the powder gases were kept under pressure. When necessary, this container supplied the compressed air system responsible for reloading, which was triggered electrically.

Before the end of the war, only a prototype of the MK-115 autocannon was built and partially tested. Of course, the tests were carried out exclusively on the ground. The Germans only came to the conclusion that the weapon worked and actually produced no measurable recoil. Only single cartridges were fired because during the automatic loading tests it turned out that the base of the case was too weakly connected to the combustible part of the case, which led to damage to the cartridges. There was no longer enough time to fix this error ...

It was also not investigated how the air blast and shock wave generated behind the autocannon after firing affected the aircraft's design and engines - this weapon was intended for eventual use in aircraft.

This autocannon would be a complicated but still attractive alternative to unguided rocket launchers. The main advantages would be greater accuracy (the projectiles are fired from a rifled tube with a higher initial speed than rockets) and higher rate of fire, which would increase the probability of hitting the target. 75-77 Generally speaking, recoilless weapons proved to be very valuable.

Only thanks to these weapons did the German infantry have access to an effective anti-tank weapon that was produced in large numbers and increased the armor despite of combat more constant vehicles until the end of the war. Strength This clearly set them apart from all other armies at the time.

An important and comparably effective addition to this weapon was the *Panzerschreich* anti-tank rifle .

# Unusual ideas

A source of much important data about less conventional German concepts is the archive of the Reich Research Council.[79] One of the documents contains, among other things, information about a previously unknown variant of the weapon mentioned.

This document is extremely interesting and found its way into the archives of the “Rat” from the Technical SS and Police Academy. It's on the 18th. Dated January 1945, it contains a list of many different types of then-modern weapons, with Part “A” describing those whose development had been completed and Part “B” describing those still in development. This document can be found unabridged on the next pages, but my comment only refers to the most interesting excerpts.

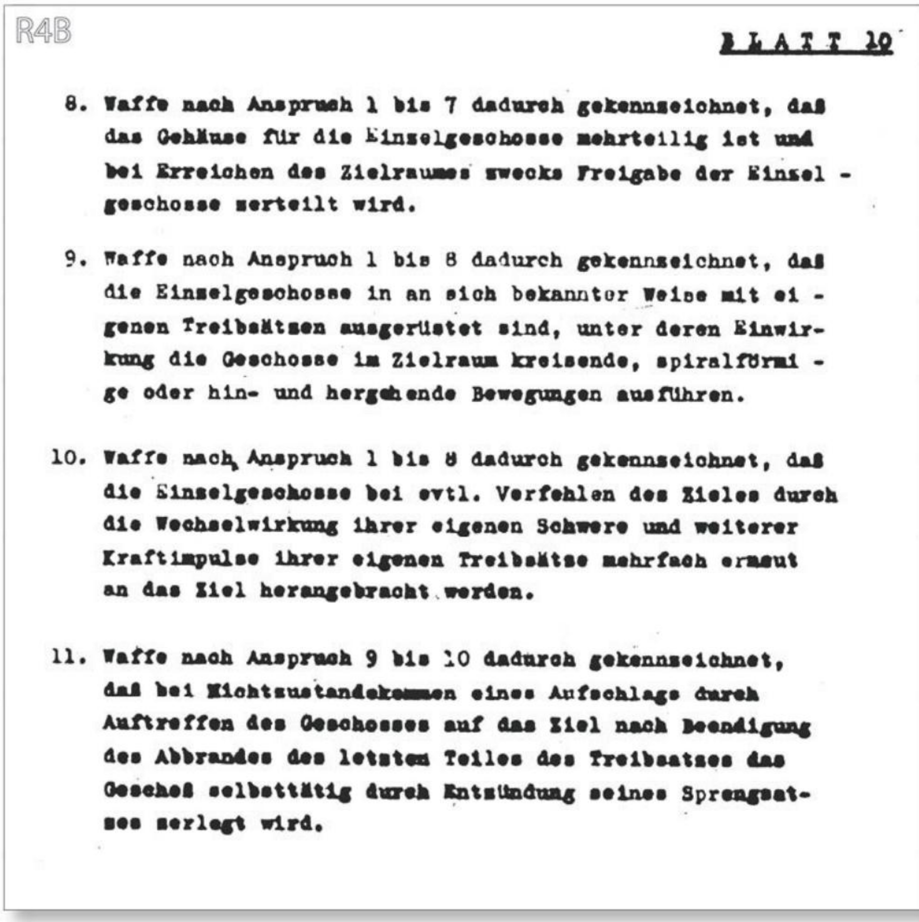
Point A-3 contains rather curious information about the Panzerschreck rocket tank rifle . It says there:

> “Inspired by the development work on the flamethrower [Item A-2] made of cardboard [impregnated?], the academy undertook the development of making the barrel and protective shield of the Panzer Terror out of cardboard . The development is complete. The devices made of cardboard meet all the requirements quite satisfactorily. The cardboard device is even more resistant to deformation due to impact or pressure than the sheet metal device [the launcher was made of 2.5 mm thick sheet steel].
> By switching to cardboard, a weight reduction of two kilograms and a saving of 5.5 kg of metal per device is achieved.”

The *Panzerschreck* was a light but very effective anti-tank weapon for the infantry. The rocket projectile, which was equipped with a HEAT warhead, penetrated steel armor up to 220 mm thick, which meant that all tanks existing at the time could be destroyed (caliber: 88 mm). The weapon was also simple and cheap, which allowed it to be used in very large numbers. This is confirmed, among other things, by an analysis from 1951:[19]

> “The entire bullet is unusually light and can be manufactured very cheaply from elements that do not require any surface treatment (except for the fuse catch and the threaded connection). The lack of any precise fits allows the mass production of pressed parts.”

In the further part of the R2 document we find the next interesting information under point A-5. A detonator is described there that was intended to be used for acts of sabotage and was triggered in the dark. It was supposed to be attached to trains together with the explosive charge - the explosion would occur as the train entered a tunnel. In this way, both the train and the tunnel could be destroyed. Under point B 1, however, a different, barometric igniter (pressure igniter) is described. It was intended to be used primarily for one-ton bombs which were used to bomb enemy bomber formations. It is stated that tests were carried out on the Me-262. I don't know if this concept could be realized, but a one-ton bomb could actually have destroyed an entire bomber formation. It also says that this detonator is much more precise than the previous ones.




BLATT 10

8. Waffe nach Anspruch 1 bis 7 dadurch gekennzeichnet, daß das Gehäuse für die Einzelgeschosse mehrteilig ist und bei Erreichen des Zielraumes zwecks Freigabe der Einzelgeschosse zerteilt wird.

9. Waffe nach Anspruch 1 bis 8 dadurch gekennzeichnet, daß die Einzelgeschosse in an sich bekannter Weise mit eigenen Treibsätzen ausgerüstet sind, unter deren Einwirkung die Geschosse im Zielraum kreisende, spiralförmige oder hin- und hergehende Bewegungen ausführen.

10. Waffe nach Anspruch 1 bis 8 dadurch gekennzeichnet, daß die Einzelgeschosse bei evtl. Verfehlen des Zieles durch die Wechselwirkung ihrer eigenen Schwere und weiterer Kraftimpulse ihrer eigenen Treibsätze mehrfach erneut an das Ziel herangebracht werden.

11. Waffe nach Anspruch 9 bis 10 dadurch gekennzeichnet, daß bei Nichtzustandekommen eines Aufschlags durch Auftreffen des Geschosses auf das Ziel nach Beendigung des Abbrandes des letzten Teiles des Treibsatzes das Geschoß selbsttätig durch Entzündung seines Sprengsatzes zerlegt wird.

The remaining sections of the document contain not only curiosities, but above all information about weapons that fully deserve the description “groundbreaking”. Point B-5 describes a new type of cannon that was intended as an alternative to the famous V3 - a multi-chamber cannon from Miÿdzyzdroje (Misdroy). However, this complicated device did not prove successful; the design was also incorrectly calculated and could not withstand the target pressure.

But point B-5 also describes a solution that makes much more sense makes an impression. This cannon would not look much different from a classic long-range cannon, although many powder charges were intended to be initiated one after the other. They would move along with the bullet in special containers and would be ignited electrically, inductively (through the tube wall). In order to increase the bullet muzzle velocity, it was even considered to replace the powder with a special explosive (detonating) explosive, as this could have increased the gas expansion velocity to up to 4,000 - 5,000 m/s. This research project is practically unknown and unfortunately no detailed technical data was provided...

One of the attached documents (R2F) also describes a cannon in which hydrogen is described as the agent for projectile acceleration. These experiments were carried out by Prof. Reyner, also from the Technical SS Academy in Brno. In this context, it was expected that the bullet muzzle velocity would increase to 1,600 m/s. The first prototype was scheduled to be completed in spring 1945.

Point B-6 seems to be a continuation of B-5 - it presents a more perspective plan, which, however, was well within the range of technical possibilities. The construction of a cannon for liquid fuel is described (oxygen in combination with a petroleum derivative).

From today's perspective, it can be said that this solution was actually the most advanced. For example, the document highlights the following advantages:

• simple construction

• high energy efficiency • no sleeve

• no igniter

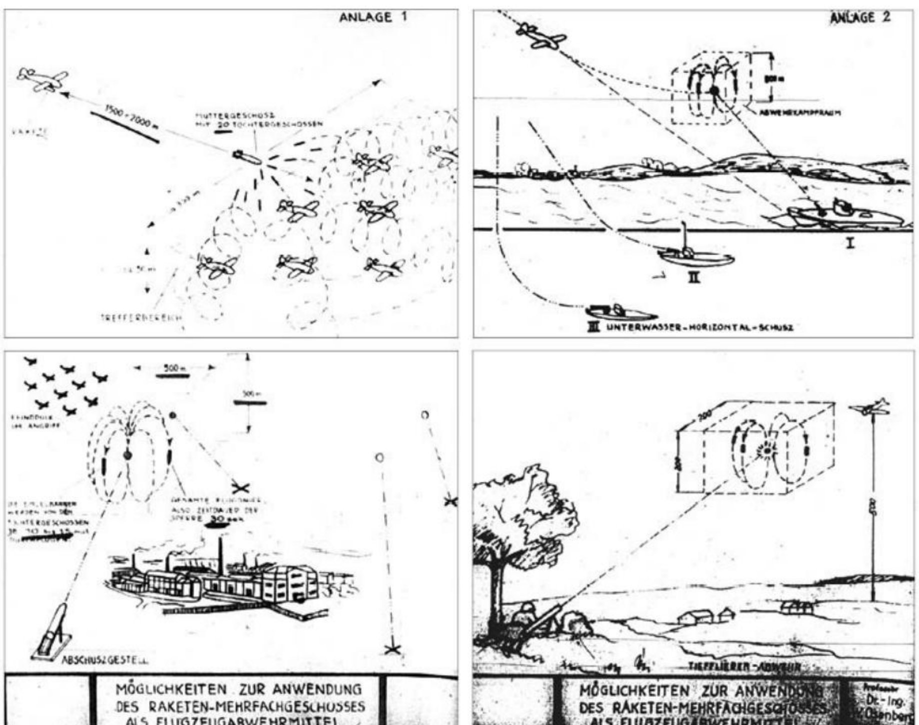
• Increasing bullet muzzle velocity Both items B-6 and B-5

confirm, probably for the first time, that this thoroughly groundbreaking work was actually carried out.

The same applies to point B-7, the design work (not at all theoretical!) on an automatic pistol for caseless cartridges describes. It was developed at the request of the Security Service (SD) because it enabled almost complete soundproofing. Normally this is never possible with an automatic weapon because the chamber is opened at a time when there is still a relatively high pressure in the barrel so that the case can be removed. This feature was particularly important for the security service, *"because the second, third and fourth shots are often necessary in any operations with this weapon,"* as can be read in the document.

It also says:

> "The status of the work is such that the shelling should take place in January or February [1945]. The preliminary tests promise a positive result."



Zeichnungen als Anlage des R5-Dokuments.

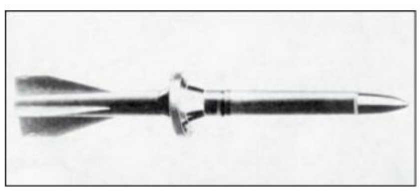
It was only in the mid-1980s that the successful production of small quantities of this type of weapon finally began. It was the G11 carbine for caseless ammunition from Heckler and Koch.

Despite fundamental advantages over a classic carbine (two to three times higher fire efficiency when using a similar ammunition mass, lower weight of the weapon) it was not included in the weapons arsenal due to ammunition standardization at NATO. It had a caliber of 4.74 mm, and it only escaped the name “machine gun” because of the high energy of the projectile.

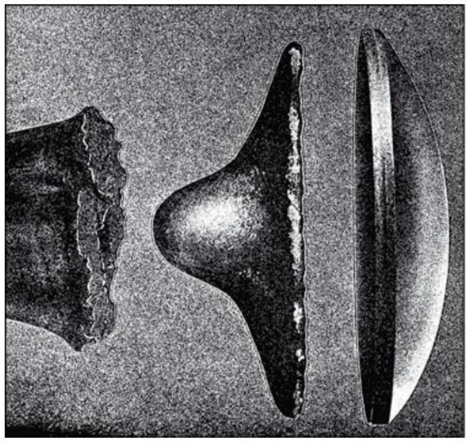
Another document describes the little-known preparations for combat use of some air-to-air missile projectiles with a caliber of 214 mm. They weighed 100 kg and were equipped with a 40 kg mine/incendiary warhead containing 400 pre-formed fragmentation charges. These bullets were tested by the Jäger Regiment from Parchim (JG-10). The first batch arrived there at the end of 1944. A technical drawing of the bullet was printed.

Document R4 also refers to unguided anti-aircraft weapons. It is a patent specification for many proposed anti-aircraft versions of the *Panzerfaust* and *Panzerschrei models.* Three versions can be seen in Prof. Osenberg's original drawings: a rocket version, a recoilless version and a mortar version.

The drawings are interesting in that they represent completely different concepts than the final model of the *Fliegerfaust* rocket launcher, which was produced in small numbers. The drawings mentioned can be found on the previous pages as figures R4C and R4D.



Another concept that turned out to be groundbreaking: a sub-caliber projectile stabilized by guide fins that was developed for a 280 mm cannon - thereby increasing the range to 150 km! (Photo from the author's collection)



Individual phases of explosive bullet formation - a compilation of images from Rheinmetall.

Technische SS - und Polizei-Akademie

R2A

Berlin, den 18. Januar 1945.
[illegible]
Fernsprecher: [illegible] 11940 - 13944
[illegible] Nr. 251
Fernruf: [illegible] Nr. 13940
[illegible] Nr. 251

Geheime Reichssache!
zu Tcb z 966/45 (g.Rs.)

Anlage.

A. Abgeschlossene Arbeiten.

1. MG-Lafette mit Fahrgestell.

Die Lafette mit Fahrgestell ist am 12. und 13. Dezember 1944 in Suhl dem Sonderausschuss Infanteriewaffen vorgestellt worden und hat sich beim Beschuss sowohl mit dem MG 34 als auch MG 42 bewährt. Z.Zt. wird vom Heereswaffenamt die Lafette auf Truppenbrauchbarkeit geprüft.

2. Einstossflammenwerfer.

Der von der Akademie zusammen mit dem Heereswaffenamt entwickelte Einstossflammenwerfer befindet sich in Grossfertigung. Die Akademie hat nunmehr die Entwicklung dahingehend weiter betrieben, dass der Einstossflammenwerfer statt aus Blech aus Pappe gefertigt wird. Die abgeschlossenen Versuche haben ergeben, dass die Ausführung aus Pappe allen Anforderungen entspricht.

Die Metalleinsparung beträgt pro Werfer 485 g bei einem Gesamtgewicht des Werfers von 1625 g.

3. Panzerschreck.

Angeregt durch die Entwicklungsarbeiten des Flammenwerfers aus Pappe hat die Akademie die Entwicklung betrieben, Rohr und Schutzschild des Panzerschrecks aus Pappe zu fertigen. Die Entwicklung ist abgeschlossen. Die aus Pappe gefertigten Geräte entsprechen allen gestellten Anforderungen durchaus befriedigend. Das aus Pappe gefertigte Gerät ist sogar gegen Deformieren durch Stoss oder Druck widerstandsfähiger als das Blechgerät. Durch die Umstellung auf Pappe wird eine Gewichtsverminderung von 2 kg und eine Einsparung von 5,5 kg an Metall pro Gerät erreicht.

4. Mehrstossflammenwerfer.

Die Entwicklung eines Einkessel-Mehrstossflammen[illegible]werfers für 8-10 Flammstösse wurde abgeschlossen. Es wurde an Stelle des mit Stickstoff gefüllten Druckbe[illegible]ters eine Pulverpatrone verwendet, die sich im Öl[illegible] des Werfers befindet und durch einen Abreisszünder be[illegible]tätigt wird.

Dieses mittels Pulverdruck arbeitende Mehrstossflammenwerfergerät ist fertigungs-, bedienungs- und [illegible]schubmässig (Fortfall der Stickstoffflasche) sehr viel einfacher als das Stosstruppgerät 41.

5. **Verdunklungszünder.**

Für den Sicherungsdienst wurde ein Lichtschalter für Sabotagezwecke entwickelt, der eine Sprengladung bei Eintritt der Dunkelheit zum Entzünden bringt (z.B. zum Sprengen von Tunnels usw.).

6. **Entlastungsmine.**

Die Entlastungsmine ist eine Mine, die, wie der Name sagt, dann zur Auslösung kommt, wenn ein auf ihr liegender Gegenstand entfernt wird. Sie eignet sich besonders für Sabotagezwecke, Verminung von Häusern und dergleichen. Für die Verwendung dieser Mine ergeben sich, auf Grund ihrer Konstruktion, unzählige Möglichkeiten.

Die Entlastungsmine ist dringend von den ϟϟ-Jagdverbänden gefordert worden. Der Vorläufer dieser Mine war sprengstoffmässig gesehen leichter und hat sich bereits im Einsatz bewährt.

Von der Akademie ist die Fertigung von monatlich 100 - 200 Stück aufgenommen worden. Die ersten 100 Stück werden am 17.1.1945 ausgeliefert.

## B. In Entwicklung befindliches Gerät.

1. **Barometrischer Zünder.**

Diese Zünderart ist seit langer Zeit bekannt, konnte aber wegen zu grosser Ungenauigkeit bisher nicht mit Erfolg eingesetzt werden.

Es gelang in wenigen Wochen in Zusammenarbeit mit O.K.L. einen voll brauchbaren Zünder zu entwickeln.

**Verwendung:** a) Bekämpfuhg feindlicher Pulks durch Abwurf von 1000 kg-Minenbomben.

Bedienung des Zünders ist derart verein-facht worden, dass der Pilot lediglich [illegible] Höhe des feindlichen Pulks, aber in sich[illegible] rem Abstand von diesem, einen elektrisc[illegible] Kontakt zu betätigen hat. Er kann dann [illegible] einer beliebigen Zeit und aus beliebige[illegible] Höhe seine Minenbombe abwerfen. Sie wir[illegible] genau in Höhe der feindlichen Maschinen[illegible] knallen.

b) Für alle Geschosse, die in einem besti[illegible] Abstand vom Erdboden zum Zerknallen ge[illegible] werden sollen.

Z.Zt. finden Abwurfversuche statt mit einer Masch[illegible] des Baumusters Me 262.

2. **Stahlvergütung.**

Durch ein neu entwickeltes, sehr einfaches Wärmebe[illegible] handlungsverfahren ist es gelungen, die Zähigkeit von chrom- usw. armen Stahlen wesentlich zu verbessern.

2 cm-Geschützrohre, die nach bisherigen Härteverfahren bei 5 g Sprengstoff aufrissen, hielten nach dem neuen Verfahren bis 11,5 g.

Das Verfahren wird z.Zt. in Zusammenarbeit mit Ministerium Speer und Heereswaffenamt fabrikationsreif gemacht.

3. Munitonswirkung im Ziel.

Auf Veranlassung des Heereswaffenamtes und des O.K.L. wird das Eindringen von verschiedenen Geschossformen im Ziel mit neuartigen Mitteln untersucht. Wichtig für Verbesserung der Munition und für die Vereinfachung von Abwehrkonstruktionen.

Für Kaliber vis 10,5 cm und mittlere Auftreffgeschwindigkeiten werden Ergebnisse in Kürze vorliegen.

4. Beton-Handgranate und Papp-Handgranate.

Angeregt durch den Engpass Sprengstoff wurde die Entwicklung von Handgranaten aufgenommen, die bei gleicher Splitterwirkung mit weniger Sprengstoff auskommen.

1. Ausführung Splitterbeton.

Der Handgranatenkörper wird aus einer Mischung von Beton und Schrottabfällen gegossen und benötigt zur Zerlegung wegen des geringen Energiewufwandes zum Zerreissen der Hülle und der bereits fertigen Splitter etwa 1/2 bis 1/3 (80–40 g) von der sonst in der Stielhandgranate benötigten Sprengstoffmenge (180 g). Bei dem Vergleich der Beton-Handgranate und der normalen Handgranate hat sich gezeigt, dass mit einem Splittergewicht von ca. 300 g bei 50 g Sprengstoff die Wirkung der Beton-Handgranate der normalen Handgranate überlegen war. Der Nachteil besteht im Gewicht der Granate. Bei Wurfversuchen lag die Reichweite etwa 10 m kürzer. Der Vorteil dieser Beton-Granate besteht darin, dass sie leicht in Heimarbeit herzustellen ist und so für Volkssturmverbände besonders gut geeignet ist. Sie lässt sich in Verbindung mit dem Zugzünder ZZ 42 auch als Schützenmine verwenden. Bei dieser Verwendung spielt das Gewicht keine Rolle.

2. Papp-Handgranate.

Zu der Ausführung der Handgranate in Pappe ist bis auf das Gewicht das Gleiche wie zu der Ausführung aus Beton zu sagen. Die Papp-Handgranate benötigt voraussichtlich bei gleichem Gewicht wie die eingeführte Stielhandgranate nur etwa 1/3 Sprengstoff bei gleicher Spreng- und Splitterwirkung.

Durch diese Entwicklungen wird ausser der Einsparung an Walzblech- und Sprengstoffkapazität wegen der einfachen Fertigung die Produktion wesentlich gesteigert.

5. Wesentliche Erhöhung der Anfangsgeschwindigkeit von Geschossen.

Auftrag des Reichsluftfahrtministeriums.
Es sind zwei Wege beschritten worden und zwar:

a) Geschoss mit Kaskaden-Kartusche,
d.h. ein Artillerie-Geschoss wird mit mehreren Kartuschen versehen, die nacheinander im Geschützrohr zur Zündung gebracht werden. Die erste Kartusche wird wie üblich gezündet, die weiteren, die ja mit dem Geschoss mitfliegen, müssen durch die Rohrwand des Geschützes hindurch gezündet werden.

Die Versuche haben ergeben, dass durch einen Induktionsstrom eine einwandfreie Zündung durch die Rohrwand hindurch möglich ist.

b) Antrieb durch Detonationsgase.
Ersatz des Pulvers zum Antrieb durch Sprengkörper. Die Schwadengeschwindigkeit der Detonationsgase liegt bei 4–5000 m/sec.

Die Versuche sind sehr schwierig; es scheint aber mit Hilfe von Hohlraumsprengkörpern eine Lösung möglich zu sein.

6. Kraftstoff-Kanone.

Hierunter wird eine Waffe verstanden, die an Stelle von Pulver mit Diesel- oder Otto-Kraftstoff unter Zusatz von Sauerstoff genau wie ein Motor arbeitet, nur wird an Stelle des Kolbens ein Geschoss vorwärtsgetrieben.

Gelingt es, eine ausreichende Beschleunigung des Geschosses zu erreichen, so sind die Vorteile sehr gross z.B.

einfache Konstruktion,
geringer Energiebedarf,
Wegfall der Kartusche,
Wegfall des Zündhütchens,
grössere Schussgeschwindigkeit.

7. Automatische Pistole mit kartuschfreier Munition.

Die Entwicklung einer solchen Waffe wird besonders vom Sicherheitsdienst gefordert.

Bei dieser Waffe handelt es sich im wesentlichen um eine Pistole, die voll automatisch schallgedämpft schiesst. Bei den bisherigen Konstruktionen war ein automatisches Schiessen nicht möglich, da beim Öffnen des Verschlusses die Waffe unverändert knallt. Zur Erreichung des genannten Zieles musste also gesorgt werden, dass die Waffe während ihrer Funktion vollkommen geschlossen bleibt. Diese Bedingung kann nur dadurch erfüllt werden, dass eine Munition verschossen wird, die ohne Rückstand (Kartusche) [illegible] verlässt – kartuschfreie Munition –. Die Munition [illegible] dem Prinzip der Rakete aufgebaut.

Der Stand der Arbeiten ist so, dass im Januar [illegible] bruar der Beschuss erfolgen soll. Die Vorversuche [illegible] chen ein positives Ergebnis.

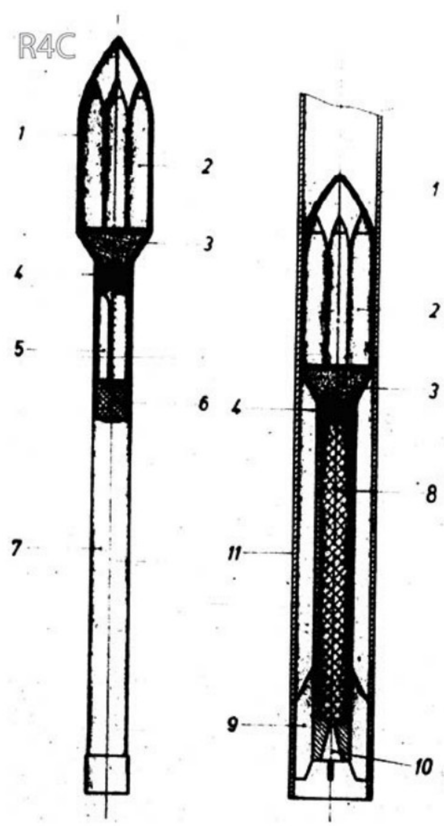
R2E

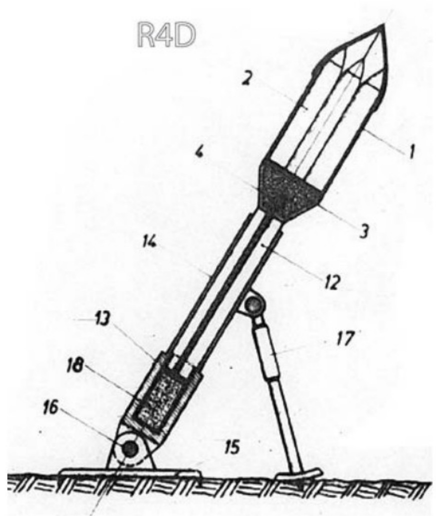


Die Forderung einer solchen Waffe ist deswegen gestellt worden, weil bei irgendwelchen Unternehmungen mit dieser Bewaffnung oft der zweite, dritte und vierte Schuss notwendig wird.

8. Pionier-Zugzünder ZZ 42.

Der bei der Wehrmacht eingeführte Pionier-Zugzünder besteht aus einem Bakelit- bzw. Stahlgehäuse. Der Zünder wird als Zug- und Zerschneidezünder verwendet. Von der Akademie ist die Entwicklung betrieben worden, das Gehäuse dieses Zug- und Zerschneidezünders aus Pappe zu fertigen, wodurch Bakelit bzw. Stahl eingespart wird.




R4D
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002404

**B e r i c h t** über die Besprechung bei GL-Flak E
am 22.8.1944 in Berlin.

Gegenstand der Besprechung: Die Erzielung einer hohen $V_0$ durch neuartige Waffen.

Von den in der letzten Besprechung im Juni behandelten Möglichkeiten wurden neuerdings behandelt:

Progressive Pulverladung: Die Entwicklung leidet unter geringfügigen Herstellungsschwierigkeiten, so dass praktisch nichts geschieht. Erhofft wird eine $V_0$-Steigerung auf 2000 m/sek. durch die Mischung von Pulver und zeitlich nachdetonierendem Sprengstoff.

Mehrfach-Ladungen: Die Anwendung von mehreren nacheinander zur Entzündung zu bringenden Pulverladungen würde ausführlich besprochen, doch scheint ein Erfolg nur bei Verwendung extra langer Rohre, d.h. der Entwicklung eigener Geschütze gegeben zu sein. Praktisch geschieht auf diesem Gebiet nichts.

Wasserstoff-Kanone: Ein von Prof. Reyner entwickeltes Wasserstoff-Geschütz wird bei der Technischen Akademie der SS in Brünn Vorversuchen unterzogen, die gegenüber Pulvertreibmitteln eine Wirkungsgradverbesserung von 1 : 1,7 ergaben. Man erwartet eine $V_0$ von 1600 m/sek. Die Fertigstellung einer Erprobungsreifen-Konstruktion dürfte aber noch 6 bis 9 Monate dauern.

F-Mine: Prof. Schardin berichtete über die weitere Entwicklung seiner Mine, deren Wirkungsgrad mit 30 - 40 % bereits den von Geschützen erreicht hat. Die tatsächlichen Fluggeschwindigkeiten der Stahlscheiben liegen wohl weit unter den 3000 m/sek. der Modellversuche bei 1800 m, doch konnte er einen neuen Effekt studieren. Statt der homogenen Scheibe verwendete er eine aus 120 Stückchen bestehende Einlage, die bei Detonation in ganz engen Streuwinkel mit ca 2000 m/sek. abgeschossen wurden, also eine ideale Schrotwirkung für Schrapnellgeschosse ergaben. Die weitere Entwicklung der F-Mine soll [illegible] mit uns in Richtung einer Jäger-Mine zur Bomberbekämpfung mit Brandschrapnell's erfolgen. Konstruktiv und fertigungstechnisch wurden eine Reihe von zu bearbeitenden Aufgaben mit einzelnen Sachbearbeitern von GL-Flak durchgesprochen.

Lindau, den 24. August 1944
Dr.Doe/Si.

R4A

BLATT 9

PATENTANSPRÜCHE

1. Waffe insbesondere zur Bekämpfung von Flugzeugen dadurch gekennzeichnet, daß das Geschoß aus einem eine Mehrzahl von Einzelgeschossen aufnehmenden stromlinienartig gestalteten Hohlkörper besteht, der aus einem Rohre mittels eines Treibsatzes, eines Raketenantriebes oder einer Treibladung ausgestoßen und nach dem Zielraum überführt wird.

2. Waffe nach Anspruch 1 dadurch gekennzeichnet, daß der die Einzelgeschosse aufnehmende Hohlkörper an seinem rückwärtigen Ende ein Leitwerk trägt, das in ein mit einem Treibsatz ausgestattetes Abschußrohr eingesetzt ist (Figur 1).

3. Waffe nach Anspruch 1 dadurch gekennzeichnet, daß der die Einzelgeschosse aufnehmende Hohlkörper an seinem rückwärtigen Ende einen Raketenantrieb mit Leitflächen trägt, wobei der Abschuß aus einem Führungsrohr heraus erfolgt. (Figur 2)

4. Waffe nach Anspruch 1 dadurch gekennzeichnet; daß der die Einzelgeschosse aufnehmende Hohlkörper an seinem rückwärtigen Ende ein Führungsstück und daran anschliessend einen Treibspiegel trägt, wobei der Abschuß aus einem Rohr mittels einer Treibladung erfolgt (Figur 3).

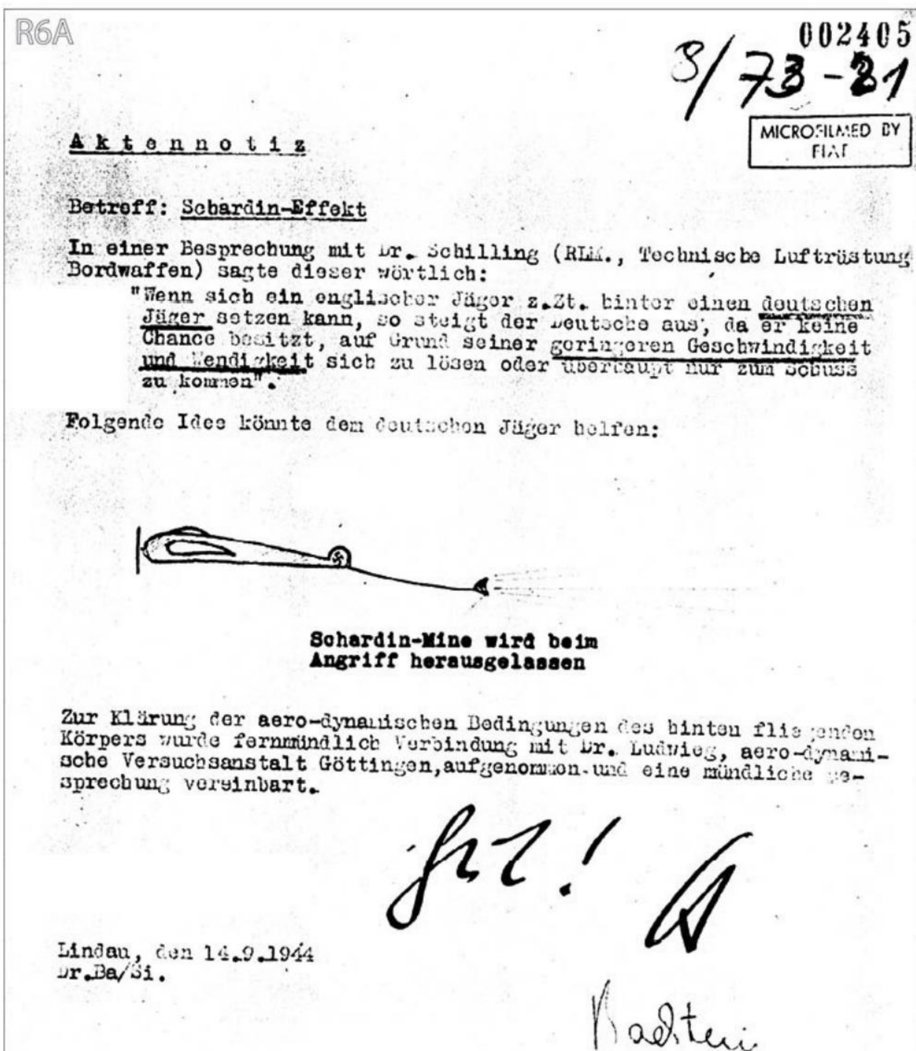
5. Waffe nach Anspruch 1 bis 4 dadurch gekennzeichnet, daß das Abschußrohr als Handwaffe ausgebildet ist.

6. Waffe nach Anspruch 1 bis 4 dadurch gekennzeichnet, daß das Abschußrohr auf einem Gestell mittels Richtmitteln einstellbar nach Art eines Werfers oder Düsengeschützes angeordnet ist.

7. Waffe nach Anspruch 1 bis 6 dadurch gekennzeichnet, daß der die Einzelgeschosse aufnehmende Hohlkörper einen Sprengsatz mit einem einstellbaren Zeitzünder enthält.

Prof. Osenberg (Head of the Council's Planning Department) was the originator of even stranger, but entirely sensible, concepts described and illustrated in document R5. It talks about unguided, circling anti-aircraft missiles! With them it would be possible to set up a kind of “anti-aircraft fire barrier” that would maintain itself independently for a certain period of time. The rocket projectile is therefore more likely to hit an air target compared to a straight trajectory hit, all the more so because various fragmentation warheads were developed in parallel - warheads that distributed autonomously circling projectiles in the target area. Osenberg wrote that the first version would be ready for testing at the end of February 1945, but series production in small numbers (500 units) should begin in early May. This only applied to the air-to-air version with a “large number” of sub-projectiles that could complete about 10-15 loops within about 30 seconds.

There is nothing to indicate that the Germans managed to conduct firing tests with any of these versions. After the war, however, this concept was no longer developed further.



R6A

002405

3/73-21

MICROFILMED BY FIAT

**Aktennotiz**

Betreff: Schardin-Effekt

In einer Besprechung mit Dr. Schilling (RLM., Technische Luftrüstung Bordwaffen) sagte dieser wörtlich:

"Wenn sich ein englischer Jäger z.Zt. hinter einen deutschen Jäger setzen kann, so steigt der Deutsche aus, da er keine Chance besitzt, auf Grund seiner geringeren Geschwindigkeit und Wendigkeit sich zu lösen oder überhaupt nur zum Schuss zu kommen".

Folgende Idee könnte dem deutschen Jäger helfen:

**Schardin-Mine wird beim Angriff herausgelassen**

Zur Klärung der aero-dynamischen Bedingungen des hinten fliegenden Körpers wurde fernmündlich Verbindung mit Dr. Ludwieg, aero-dynamische Versuchsanstalt Göttingen, aufgenommen und eine mündliche Besprechung vereinbart.

Lindau, den 14.9.1944
Dr.Ba/Si.

R6B

002406

Akt. Nr. 1.9.44 **Geheim**

8/73-20

**Aktennotiz**

**Betreff: Flakentwicklung**

**Vorgang: Teilnahme an der Sitzung der GL/Flak E 1 am 20.6.1944**

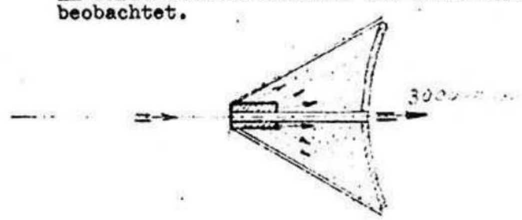
Die Besprechung diente dazu, die Möglichkeiten zu erörtern, von denen eine beträchtliche Steigerung der Geschossgeschwindigkeiten erwartet werden kann.
Dabei wurde zunächst der Erfolg der auf der vorhergegangenen Sitzung beschlossenen Arbeitsverteilung besprochen. (Siehe Anlage, Seite 3).

Zu Punkt 1: Die Berechnung ist durchgeführt. Einzelheiten wurden nicht besprochen.
Zu Punkt 2: Es ist noch nichts geschehen. Angeblich fehlen Unterlagen.
Zu Punkt 3: Die Wasag beschäftigt sich seit Jahren mit diesem Problem. Erfolge wurden nicht genannt.
Zu Punkt 4: Professor Regener ist damit beschäftigt. Es soll beschleunigt werden.
Zu Punkt 5: Rohre sind noch nicht bestellt.
Zu Punkt 6: Inneneinrichtung ist noch nicht angegeben.
Zu Punkt 7: Noch nicht durchgeführt.

Als Ergebnis: Es ist seit der letzten Sitzung vor 2 Monaten kaum etwas geschehen.

In der weiteren Besprechung wurden wesentliche Bemerkungen nur von 2 Teilnehmern gemacht.

1. Oberbaurat Steinhardt OKM A Wa A I r, Eberswalde 3151/810.
   Die Marine entwickelt ein Versuchsgeschoss von 745 g, 3,7 cm Kaliber, Rohrlänge 130, Höchstdruck 15 000 Atm. in Zusammenarbeit mit Basset, Frankreich.
   2 Rohre sind bei Krupp bestellt.
   Die Treibladung liefert Basset.
   Voraussichtlicher Schusstermin 1. Oktober. Wir werden eingeladen.
   Berechnete $V_0$ = 2 000 m/sek.
2. Mitarbeiter von Professor Schardin.
   Im ballistischen Institut von Professor Schardin wurde folgendes beobachtet.

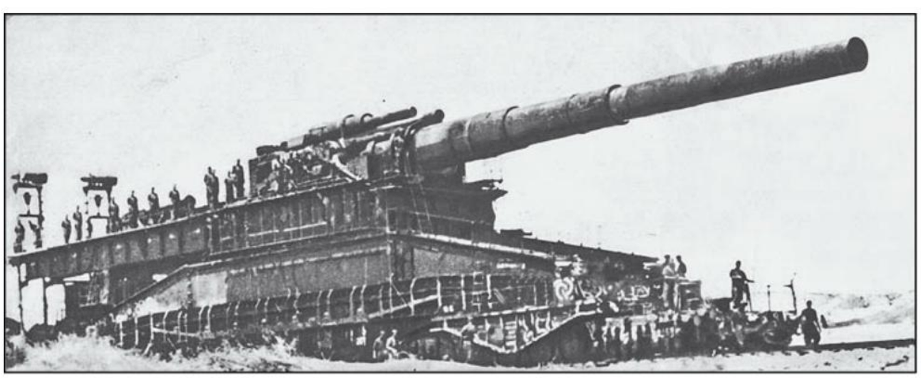


Die Sprengladung wird zur Detonation gebracht. Dann tritt eine ähnliche Wirkung wie beim Hohlladungsprinzip auf.
Die Eisenschale wird innerhalb weniger Zentimeter auf 3000 m/sek. beschleunigt.
Dabei kann man nach 150 m noch eine Tragfläche treffen mit einer Streuung von ± 0,5 m.

However, things were different with an idea described in the set of documents marked R6. These documents refer to the concept of "explosive formation (and acceleration) of projectiles," referred to in wartime German nomenclature as the "Schardin effect." This discovery began in in the United States, when in 1936 the physicist RW Wood observed the formation of a spherical fragment, a mini-projectile, from the concave face of a detonator, which he accidentally threw into the oven (an investigation was opened because this fragment killed a person).

However, only the Germans took advantage of this phenomenon during the war by designing a whole family of anti-tank charges. This research was already at an advanced stage in 1940. In 1944, Osenberg wrote that he had succeeded in achieving a very high initial velocity of the bullet of 3,000 m/s and limiting its dispersion to approximately 0.5 meters at a distance of 150 m.


The super heavy mortar Thor. (Photo: The Wehrmacht)

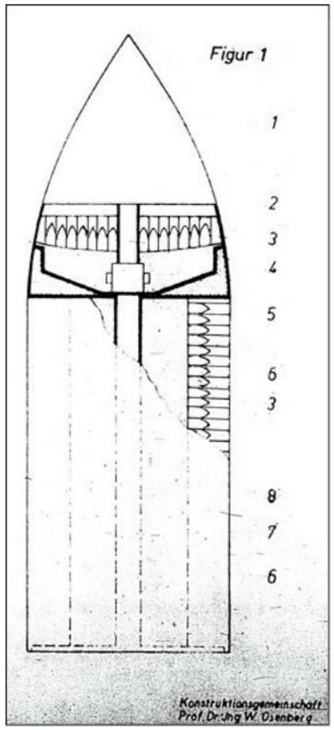


The super heavy (800 mm) cannon Gustav in Rügenwalde. It certainly wasn't the best solution from an economic point of view, but it still had some unique advantages. One of the most important was that the bullet was in extreme

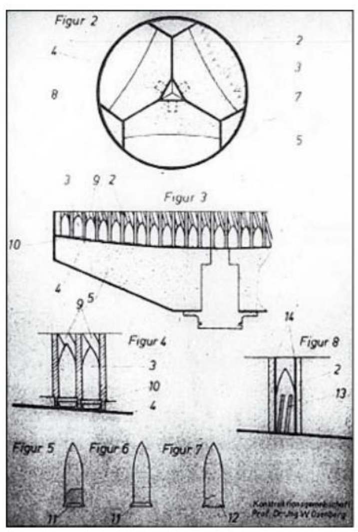
Depth - usually 35 - 40 meters (!) - below the earth's surface exploded. Normally this was not necessary, but during an attack on key defenses this feature became invaluable. *Gustav,* among others, was able to destroy the ammunition depot of the Sevastopol Fortress in 1942. (Photo: *The Wehrmacht)*

The particularly little-known facts include, among other things, the development of the "Schardin the mine", which was a intended to be towed by fighter aircraft as a self-defense weapon, and of a two-part projectile: a plate deformed by the explosion was intended to accelerate a second projectile stabilized by guide fins (see drawings on the previous pages). An anti-tank warhead of this type was also developed on behalf of the Navy.

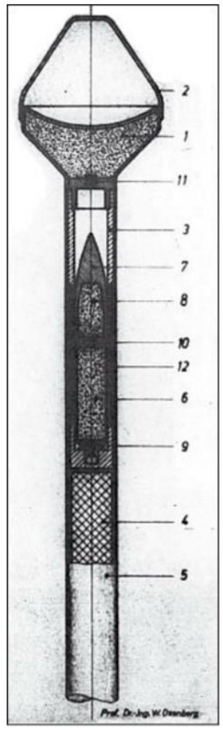
However, Professor Osenberg's ingenuity did not end there! The set of documents marked R7 describes yet another unusual idea (which was also further developed after the war) in the form of a patent specification including drawings. This time it was about an anti-tank weapon transported by aircraft, a comprehensive development of the *bazooka,* which differed from its predecessor in, among other things, that the projectile fired from a recoilless tube did not only consist of a HEAT explosive charge (which in this case was specifically designed to penetrate Concrete), but also a second recoilless projectile designed to penetrate the interior of the target through the opening created by the first charge.
This second projectile had a delay fuse and was stabilized during flight by guide fins that were folded out after the shot was fired.




R7




Drawings that accompanied the patent specifications.



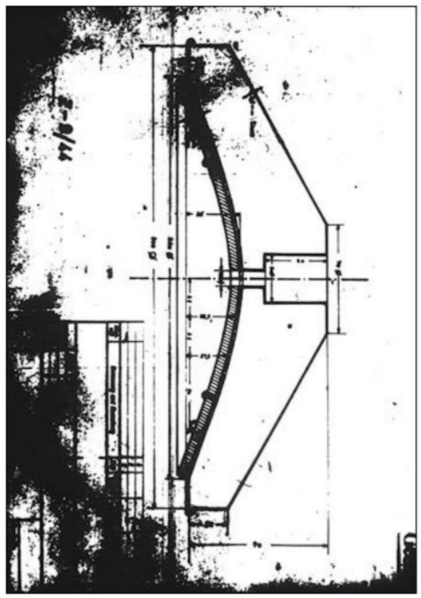

R8

It is unknown whether the Germans were able to test this weapon until 1945; however, the results obtained after the war indicate that it was literally a technical "scoring hit". A whole group of very effective weapons was created for destroying bunkers, air raid shelters and runways - the projectiles exploding under the concrete slabs of runways usually cause irreparable damage. The set of documents marked with the symbol R8

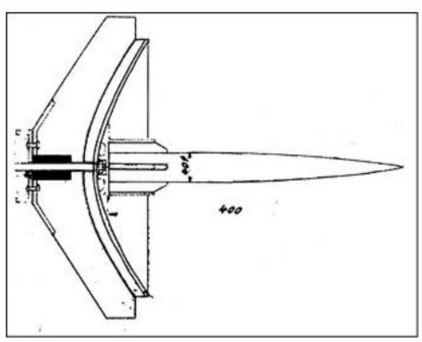
...

describes yet another (and by no means the last) invention Osenbergs. Here we are again dealing with a precise patent specification, this time accompanied by a report on the tests carried out on a test site.

It describes an artillery fragmentation projectile with a completely atypical design, which was characterized by a much greater range and fragmentation penetration ability than usual. Its shell is divided into four parts or plates: a front plate and three side plates. Each of these plates has dozens to more than a hundred drawn (grooved) openings in which the formed splinters are already located. These fragments were actually miniature bullets with a rotation stabilization during the flight. This solution was certainly much more expensive than a cast shell, but a significant increase in effectiveness on certain targets was undeniable. The practice of military technical development shows that it is often cheapest to increase the effectiveness of a particular weapon system by modernizing its ammunition. There are many examples in history that show that spending in this area has always been worthwhile.



This drawing by Professor Schardin looks deceptively similar to the projects from the 1980s. Unfortunately, their quality leaves a lot to be desired.

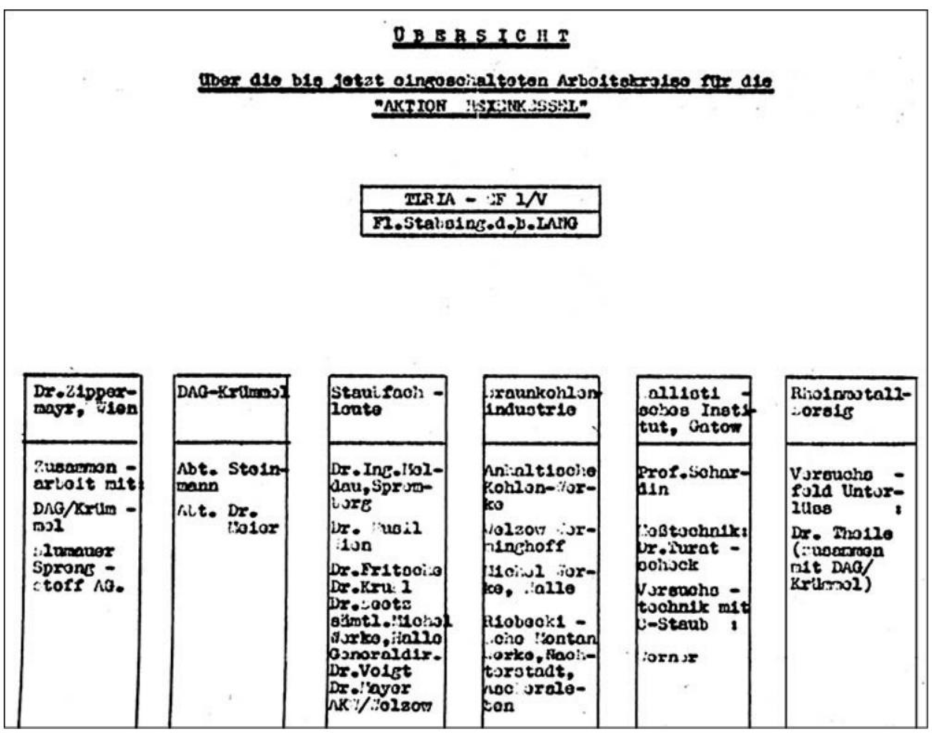



A modified project based on the explosive acceleration of an anti-tank core projectile stabilized by guide fins.

The first tests with this ammunition were carried out near Redlin on January 24th and 26th (probably in 1945). Around

To make it easier to follow the splinter flight lines, a frozen lake with an approximately 35 cm thick layer of ice was chosen as the test surface, on which the “targets” were placed: a vertically placed plywood panel measuring 6 x 5 meters and behind it a wing of the Focke Wulf 190, a few armored metal plates with a thickness of 5 mm and an area of 0.5 m2 each and two empty fuel rubber containers with a wall thickness of 10 mm. 150 meters in front of this "structure" a 1 meter high wooden block was placed, on top of which was a warhead of the type mentioned with the marking 240/5. The warhead weighed 39 kg. With the help of an optical device it was guided to the target and then ignited electrically. His efficiency was amazing.

Although the splinter trajectories were generally scattered in an angular cone of 26°, 38 alone hit the vertically positioned “protective shield”. Two pieces of shrapnel penetrated the wing of the FW-190. Two pierced the wall of the fuel tank and remained inside, one of which was an ignition shrapnel. One of the armor plates showed impact marks, but it was not penetrated. At the explosion site, however, a hole was created in the ice with a diameter of 1.5 meters.




Organizational diagram for the *cauldron project.*

Four more tests were later carried out, gradually reducing the distance to the target and placing a container filled with fuel. An ever-increasing number of hits could be observed. Although some of the fragments were supposed to ignite, the fuel did not catch fire. The armor plates were not penetrated either, although they were clearly deformed at the closest distance of 45 meters. The final test was carried out with a rocket projectile equipped with the 240/5 warhead and fired from a low-flying FW-190 fighter aircraft. The rocket became unstable after a few hundred meters of flight and fell to the ground at a distance of around 1,300 meters from the launch site, bounced back up and got stuck in a tree - the proximity fuse did not fire. This is how the story of one of Prof.'s most interesting ideas ended.

Osenberg …

The next project document describes the *cauldron,* ie the work on carbon aerosol charges - an excellent addition to the description in one of the earlier chapters. It's a report about a conversation with a certain engineer Lang about the progress of the work. It suggests that this should be carried out with high priority, as only then could concrete results be achieved in a short time. It is stated that success requires further intensification of scientific research. Since the document is dated February 17, 1945, it is obvious that the Germans had no chance to put this discovery into practical use before the end of the war.

However, this letter provides lasting confirmation that the Reich Research Council was intensively committed to the realization of the *cauldron project,* which is so little known today . The printed organizational chart for this project is enclosed with the document. Document R10 of February 9, 1945,

which documents the commitment of the “Council” to research into combating enemy bombers by jamming their engines, navigation and radio equipment, can be classified in a similar way.

R11 is probably the most interesting document printed here. It is an excerpt from a comprehensive collection of reports relating to information about new German weapons that emerged on the other side of the front (e.g. through publication). The defense – the military intelligence – regularly provided the “Council” with such data.

The reproduced page contains two interesting messages: J-9180 and J-9181. They deserve to be reproduced as a whole. Here is the content of the first report from December 7, 1944:

> “Allied airmen on the Italian front have encountered a new German secret weapon designed to make bombing raids impossible by paralyzing the attacking bomber planes. The new weapon is described as a fantastic 'ice air chariot', a fighter aircraft that sprays clouds of 'dehydrated frozen air' in front of Allied aircraft as they bomb in formation.
>
> The intent is that the 'frozen air' will mix with the rarefied atmosphere and turn the entire environment into a death trap by causing ice to form on the bombers, stopping the controls and forcing the entire aircraft to spin.”

R11

001484

J 9179 "Daily Mail" über die steigende deutsche Flugzeugproduktion.
(Daily Mail vom 14.12.1944)

An der Westfront hört man jetzt sehr häufig die Befürchtung, daß sowohl die Front wie London demnächst auch bei Tage von Raketenflugzeugen beschossen werden würden.
Die Zahl der an der Westfront erscheinenden deutschen Raketenflugzeuge sei im Steigen begriffen. Man höre, daß die deutsche Flugzeugindustrie immer noch in der Lage sei, bis zu 1500 Kriegsflugzeuge im Monat herzustellen und das werde eine sehr starke Belastung der englischen Offensive bedeutem.

J 9180 "Eisluftwagen" lähmt Bomber.
( Neue deutsche Geheimwaffe.
(Aftonbladet vom 7.12.1944)

Alliierte Flieger an der italienischen Front sind auf eine neue deutsche Geheimwaffe gestossen, die bezweckt, Bombenangriffe dadurch unmöglich zu machen, daß die angreifenden Bombenflugzeuge gelähmt werden. Die neue Waffe wird als ein phantastischer "Eisluftwagen" beschrieben, ein Jagdflugzeug, das Wolken von "dehydrierter gefrorener Luft" vor den alliierten Flugzeugen ausspritzt, wenn diese Bombenangriffe in Formationen vornehmen.
Die Absicht besteht darin, daß die "gefrorene Luft" sich mit der verdünnten Atmosphäre vermengt und die ganze Umgebung dadurch zu einer Todesfalle macht, daß sie Eisbildung überall auf den Bombenflugzeugen verursacht, die Kontrollapparate stoppt und das ganze Flugzeug zum Spinnen zwingt.

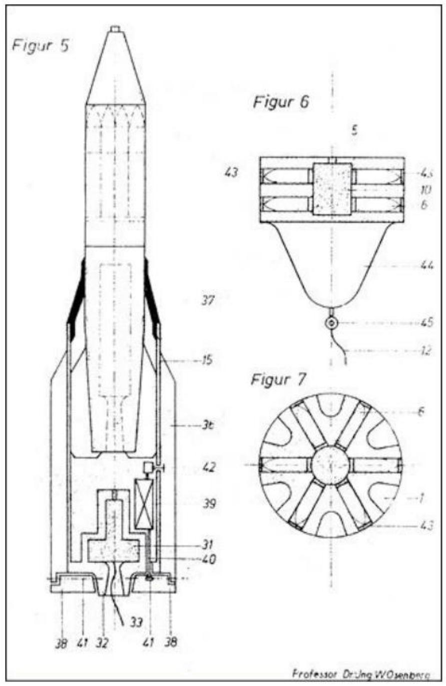
J 9181 Neue deutsche Waffe.
( Interradio Sonderdienst vom 13.12.1944)

Es wird mitgeteilt, daß an der Westfront heute eigenartige Silberkugeln, die durch die Luft flogen, gesichtet worden sind. Man nimmt an, daß die Deutschen eine neue Geheimwaffe anwenden, während es noch nicht möglich war zu ermitteln, wie diese neue.... Geheimwaffe arbeitet. Die neue Waffe wird wahrscheinlich der ..... ... der ernsten Verteidigung sein.

- 6 -

The above information is consistent with Allied intelligence reports, with the one exception that the main agent was not “frozen air,” but a special gas mixture that produced a very low temperature as it expanded. Confirmation of another weapon mentioned in report J-9181 can also be found in other sources (the information comes from the German ones

Radio interception measures):




One of Prof. Osenberg's unusual concepts - the project of a two-stage rocket projectile, which in turn would fire smaller projectiles. (Photo: ALSOS)

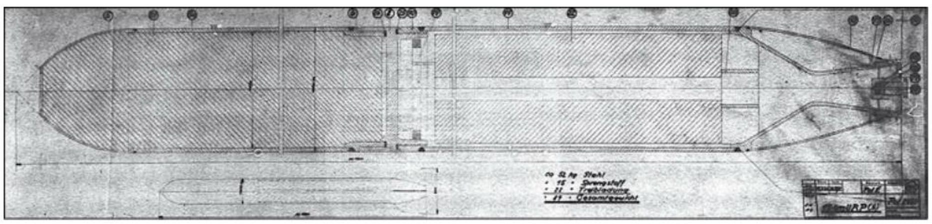
*Weird music* – the barrel of the cannon shooting upwards. (Photo: NARA)

"It is reported that strange silver bullets flying through the air were seen on the Western Front today. It is believed that the Germans are using a new secret weapon, while it has not yet been possible to determine how this new secret weapon works. The new weapon will probably be the... [sic]

be of serious defense."

Many innovative ideas of this kind were particularly implemented in the area of anti-aircraft weapons, where the pressure of technical progress was extremely great. One of the most important, but at the same time least known, measures was the coupling of anti-aircraft guns with radar devices, which led to the construction of a radio-location-based fire control system.

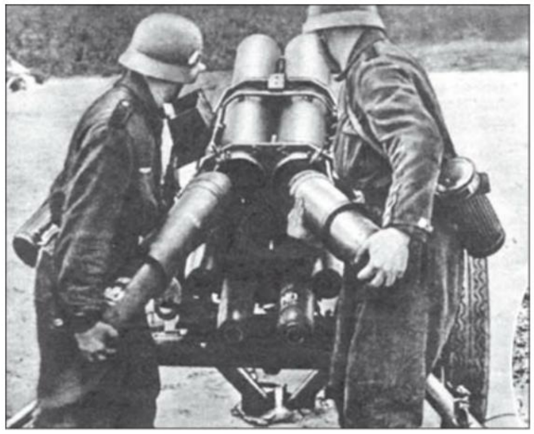
This solution proved to be excellent. One of the Allied pilots remembered it: 97



One of the numerous German responses to the Soviet Katyusha project. (Photo: ALSOS)

"This was my second combat flight. I couldn't forget what the old fighter pilots said: 'They usually shoot your ass off the second time.' We were over the target. The first projectiles exploded precisely between the machines. This wasn't a barrage. The latest radio-controlled 105 mm cannons fired. […]

A huge cloud of explosions bloomed right in front of us. We dove into it and felt the rumble of shrapnel tearing through the hull. I saw a bullet hit the lead bomber directly. The sides of the hit fortress expanded like a balloon.
The hull miraculously returned to its original shape, but large parts fell away and tongues of fire emerged from the slashed seams.
The burning machine began to drift to the left."



Rocket artillery played an important role in the German army, with the WGr system shown playing the main role. (Photo: *The Wehrmacht)*

A WGr missile volley. (Photo: *The Wehrmacht)*

Another ingenious solution was used to arm fighter aircraft. The German aviators eventually discovered that it was very difficult to notice a formation of enemy bombers when flying directly below them - especially at night. They therefore came up with the idea of mounting 20 mm cannons perpendicular to the fuselage axis on the Bf-110 fighter planes (behind the cockpit) so that they could fire upwards. This also made it easier to hit the bomber, as its silhouette had a much larger area than, for example, the bomber. B. when attacking from behind. This weapon was given the unofficial code name *Weird Music.* It was used together with new onboard radars (SN-2 *Lichtenstein)* , which were less sensitive to interference and the metal foil strips scattered by Allied bombers.

The debut of this combination coincided with the air raid on Nuremberg (March 30, 1944). In total, the Allies lost 95 of the 795 bombers that night and the Germans only lost a few night fighters.

96

## New generation handguns

The concepts described in this chapter were mostly purely experimental in nature and not always superior to existing designs - which is an inevitable "by-product" of any research. Of course, that wasn't always the case - only research makes it possible to find groundbreaking solutions. I would like to introduce such a weapon below. 80,81 During the Second World War,

the Germans implemented many “historical” types of weaponry that were already well known. The top spot is occupied by the MG-42 machine gun, which many consider to be the perfect handgun of this class (although the crucial step, i.e. the roller locking system, was "taken" from engineer Szteke's pre-war Polish patent, which he had developed for his self-loading rifle ). The 7.62 mm caliber MG-42 is still manufactured under different names (MG-2, MG-3) in several countries and used by several dozen armies around the world. The Walther PP and PPK pistols, which are still popular today, were very successful. The FG-42 automatic rifle was also an original, successful design that was developed specifically for paratrooper troops. The already mentioned pistol for caseless ammunition was an advanced weapon.

However, I would now like to talk about a slightly different handgun, which in my opinion was just as groundbreaking, but less well known: the MP-43 carbine, thanks to which (in view of the increasingly scarce raw materials) completely new technological standards were introduced, which... represented a real qualitative breakthrough. Since it was manufactured primarily using forging and pressing processes, it required many times less material and energy than previous models, which were primarily manufactured using metal-cutting processes.
He gave the soldier a qualitatively new level of fire. Let's start

However, at the origins...

In the interwar period, infantry armament in almost all countries of the world consisted mainly of repeating rifles. Based on the experience gained during the First World War (a trench warfare), such a solution was considered optimal for several reasons. The advantages of the rifles included great accuracy, range and bullet penetration, but a disadvantage was their low rate of fire. This type of armament was therefore well suited for low-intensity combat when the fire was carried out over a long period of time at a distance of several hundred meters.

To complement rifles, submachine guns were gradually introduced - light automatic weapons that increased infantry firepower when attacking (in the absence of opportunity for accurate aim) and were also more useful in close combat. The combination of rifle and submachine gun seemed advantageous. However, after analyzing the first clashes of the Second World War, the opposite conclusion was reached. This became particularly clear after the German attack on the USSR. On the Eastern Front, the infantry used small arms mainly at a distance of 100 - 200 meters. Under such conditions, neither the long range of rifles nor high bullet penetration was necessary. On the one hand, the potential of this weapon remained largely unused, but on the other hand, it was de facto low anyway due to the low rate of fire. In addition, the distance of 100 – 200 meters was too great for submachine guns. Their effectiveness was very low at such distances. The analyzes carried out after the war showed that for every dead or injured German soldier there were around 40,000 spent cartridges for PPS and PPSh submachine guns. It was similar with the German models MP-38, MP-40 and the Bergmann machine guns. At such distances, pistol bullets simply weren't effective enough - hitting a helmet didn't always mean the bullet penetrated it, and a direct hit didn't always exclude a soldier from further combat.

This problem was particularly glaring for the German commanders, as the enemy usually outnumbered them. The needs formulated after analyzing the military requirements led to the

Development of a new type of handgun - the so-called carbine, which –, combined certain properties of the submachine gun (speed of fire) and the rifle (effective fire range). Since it was assumed that the key element on which the characteristics and design of the new weapon would depend was the cartridge, the Germans initially focused on its development. This resulted in a shortened version of the Mauser 7.92 x 57 mm rifle cartridge.

Cartridges of this type are now referred to as medium cartridges. It should be noted that the Germans were not the first to develop such a cartridge: this was achieved in 1892 by the Czech ballistician Karel Krnka, who was supposed to make a corresponding cartridge for the rifle developed by the Swiss gunsmith FW Hebler. The rifle was a third shorter and lighter than the Swiss army rifle of the time. However, their work was soon forgotten. In 1918, the German first lieutenant Piderit published an elaboration that included a project to put into production a cartridge similar to the Czech one. In 1927, the Mauser company developed a 7 mm medium cartridge and produced it in small numbers. In the 1930s, various production facilities worked on a handgun for these cartridges.

The Walther company was the first to register its prototype for testing in 1938. After numerous modifications, the weapon was given the marking MKb-42(W) – Maschinenkarabiner-42. Since then, the name “carbine” has been used. Although the MKb-42(W) was not tested further (to later appear under a different marking in a version adapted for new cartridges), research work on the new cartridge was continued due to an official Army order dated April 18 continued in 1938. Despite a reduction in the mass of the primer charge by 50% (compared to a rifle cartridge), the effective firing range of weapons for this cartridge was significantly greater than that of submachine guns for cartridges of the 9 mm Parabellum type. The 7.92 x 33 mm short cartridge in the version released for production was developed by the GECO company between 1934 and 1938. It was the first medium cartridge in history to be included in the arsenal. Their production began a year after the outbreak of war in two versions: with a lead and mild steel core.

| | Parabellum 9 mm | Course cartridge | Mauser rifle cartridge |
|---|---|---|---|
| Cartridge weight (g) 10.5 – 12.5 16.5 – 16.8 24.1 – 26.2 | | | |
| Shot mass (g) 7 – 8 7.9 – 8.2 11.53 – 12.83 | | | |
| Ignition charge mass (g) 0.32 – 0.36 1.57 – 1.59 3.15 – 3.25 | | | |
| Cartridge length (mm) 29.7 80.5 | | 47,8 | |
| Sleeve length (mm) 19 56.8 | | 33 | |
| Shot length (mm) 15.5 28 | | 25,6 | |
| Muzzle velocity (m/s) | 390 – 400 690 – 700 765 – 911 | | |
| Projectile initial energy (J) | 580 – 590 | 1.880 2.010 | 3.374 – 5.324 |

The second of the new carbines, the MKb-42(H) from Haenel, was developed for the new cartridge from GECO. The main designer of the MKb-42(H) was the famous Hugo Schmeisser, which certainly contributed to the fact that this design proved to be better than the MKb-42(W). However, both models worked according to the same principle: the automatic system was powered by partial utilization of the powder gases, which were discharged through a side opening in the tube. Similar to most modern carbines, the gas line was located above the barrel. Locking was done via a tilt-barrel lock. The weapon's great weight and high complexity compared to a submachine gun were unavoidable due to the large bullet muzzle energy - which required the barrel to lock when firing - as well as the large recoil force and high temperature of the powder gases; Because of the last two points, the weapon had to be built very massively (so that the barrel was less likely to overheat).

Comparison of the three most important types of cartridges used by the German infantry. Left to right:

1)Parabellum 9 mm – for pistols and submachine guns (e.g. MP-40)

2) Short cartridge – medium cartridge for the MP-43

3) Mauser rifle cartridge

(Photo: I. Witkowski)

Initially, the MKb-42(W) and MKb-42(H) were produced in small numbers and subjected to comparative tests on the Eastern Front. They were dropped with parachutes for an encircled and cut-off infantry unit, which managed to escape the encirclement and then expressed its opinion about both types of carbines. It was clear from this that Haenel's design was better. Haenel then received a pre-order for 8,000 of this weapon, the marking of which had since been changed to MK-43. The order was completed in a record time of three months.

Elite units, mainly the Waffen-SS, were equipped with the MK-43. Afterwards, production was paused for a period of time due to high production costs, which were higher than the MP-40. The advantages of this pioneering type of weapon, such as the carbine, were of course not as obvious back then as they are today. However, after analyzing the reports from the front that came from users of the MK 43, the skeptics' arguments were refuted and production began again, this time on a large scale.

In order to standardize the naming of infantry handguns, a new designation was introduced: MP-43; it was soon changed to MP-44. Since the carbine was not a submachine gun, as the abbreviation suggested, the weapon was eventually designated StG-44 (Assault Rifle, Model 44). In practice, all markings were used alternately, with MP-43 being the most common
war.

The infantry equipped with the MP-43 had much greater firepower at their disposal and could use different tactics. The short cartridge made the weapon very accurate, and the bullet had much greater killing potential. Although it was an automatic weapon, the weapon could easily be operated by a single soldier. The bullet had three times the kinetic energy of the 9mm Parabellum for the MP-40. Fire could also be opened from the barrel during an attack, without the need to support the butt on the shoulder. Most of the carbines produced were equipped with an attachment for firing anti-infantry grenades.

Tests were also carried out with curved barrel ends were mounted on adapted versions of this weapon. A barrel end could be mounted on the StG-44V, which made it possible to fire from an angle of 30° - 40° in relation to the main axis of the weapon. The StG 44P had a barrel end for firing from an angle of 90°. Both devices were called *Krummlauf* and were equipped with additional aiming devices. However, during the tests it became clear that the concept was flawed and did not promise good results. Line units were probably not equipped with the two designs mentioned, so they were probably not used in combat.

A soldier of the German Ski Division armed with the MP-43, early 1944. (Photo: CAW)

The MG-42. (Photo: *The Wehrmacht)*

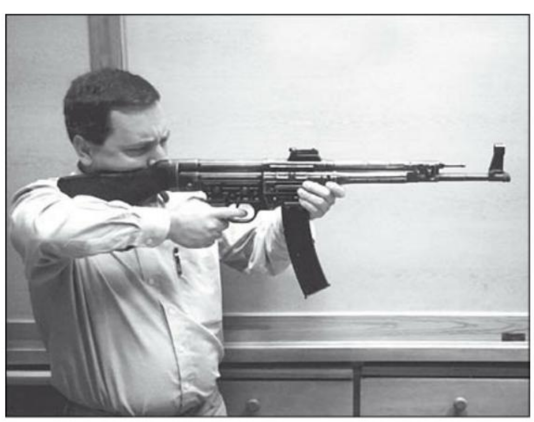
Die Maschinenpistole MP-40. (Photo: I. Witkowski)

As the Germans gained experience with the MP-43, their design was systematically improved: many examples had, among other things, the ability to mount optical sights, and since the beginning of 1945 also night vision sights (!) that worked in the near infrared and the name Target device 1229 *Vampire* received. At the end of the war, several modernized versions were developed: the MP-45(M), the "Device 06-H" and the StG-45(M). The advantages of the MP-43 remained, but its design was somewhat simplified to reduce manufacturing costs.

Work on the StG-45(M) was the most advanced. It was equipped with a two-piece roller locking shutter. Shortly before the end of the war, the design team and the existing prototypes were evacuated to Spain, where the work was completed.

The result was the design of the CETME-58 carbine, which is still used in the Spanish army today, as well as the G-3 rifle, manufactured by Heckler and Koch and under license in 15 countries and used by armed forces in approximately 50 countries becomes.

Die Maschinenpistole MP-43. (Photo: I. Witkowski)



The family of weapons designed for the short cartridge was characterized by a sophisticated design concept. The MP-43 was highly valued by the Allied soldiers as a loot weapon. The carbines captured by the Red Army were handed over to the GDR People's Police as armament; Ammunition production therefore continued even after the end of the war.
These weapons served for many years until they were replaced by the Kalashnikov. In Finland, the Suomi carbine was developed, which was based directly on the StG-44. The cartridges were almost the same, although the caliber was reduced to 7.62 mm. The MP-43's groundbreaking design underlies all modern carbines and rifles, such as: B. the AK-47, the FN FAL and the L1-A1.

The MP-43 became increasingly popular among soldiers because accuracy wasn't the only thing important to them. The weapon had almost exactly the same weight as the German main submachine gun MP-40 (4.7 kg / loaded: 4.9 kg). In contrast to weak pistol ammunition, a bullet fired from the MP-43 still penetrated any helmet of the time at a distance of 600 m. Thanks to technological progress, a copy now cost just 70 Reichsmarks in 1944.

The exact number of copies produced is not known, we know However, by the end of the war there were at least 425,000 pieces.[80]

In the introduction I quoted from the “Weissenborn Report”, which contains statements by the former deputy head of the Weapons Office in the Speer Ministry. Weissenborn, in whose opinion the MP-43 was the best infantry handgun in the world, left a lot of information about the still little-known aspects of its production: “In the spring of 1943, the then Colonel

> Kittel, head of the weapons research department of the Army Weapons Office, gave a lecture on the automatic Carbine, model 43, for so-called medium cartridges. The lecture took place in the technical department of the Speer Ministry, and the listeners came from the inner circle around Hauptdienstleiter Saur, the head of this department. Retaining the standard German caliber of 7.92 mm, the automatic carbine represented a significant improvement compared to the

Submachine gun MP-40. This pistol used by the German army was intended for 9 mm pistol ammunition, and its effective firing range did not exceed 150 m. The magazine attachment was extremely unsatisfactory. If the magazine was moved while firing, this resulted in unstable firing. Apart from that, the MP-40 reacted very sensitively to dirt.

In contrast, the automatic carbine, Model 43, was accurate at a distance of up to 600 meters; its 30-round magazine was rigidly attached. It was less sensitive to contamination and was suitable for single and continuous fire with medium cartridges - a shortened version of the usual rifle cartridge.

Based on personal experience on the Eastern Front and many conversations with regimental commanders, Colonel Kittel came to the conclusion that only the introduction of this weapon could stop the new Soviet offensive:

'In a situation where there are no opportunities to reinforce the Eastern Front, the combat effectiveness of every single German soldier must be increased at all costs through the introduction of a small weapon with a higher rate of fire.' The specialists in the field

of rifle manufacturing involved in the discussion had no doubt that the automatic carbine represented a major advance and fully agreed with Colonel Kittel. Nevertheless, the rapid introduction of the new weapon was neither technically possible nor was there approval from above, as an order from the Führer's headquarters called for the cessation of the production that had begun, while another order stopped any discussion of the MP-43 during the situation briefing at the Führer's headquarters (FHQ) banned. What's more: A short time later, the Main Weapons Committee, the body that had control over the armaments industry, was ordered by Hitler to immediately stop production of the carbine, while the MP-40, which was generally known for its disadvantages, was being produced at the same pace as before should be, ie around 15,000 pieces per month.

However, the Main Arms Committee did not carry out this Führer order and even increased production to 5,000 units per month by classifying the carbine as a submachine gun (later it was given the name 'Sturm Pistole-44' / StG-44). Both the head of the weapons and armament department in the Army Weapons Office and his party colleague Saur from the Speer Ministry demanded that the Führer's order be carried out. However, at the insistence of Colonel Kittel and the officers from the line units, the Main Arms Committee also persisted in its cause and maintained production of around 5,000 units per month. This led to a discussion with Hitler. Two soldiers who won the Knight's Cross on the Eastern Front were also involved. Finally, Hitler issued a new order demanding the immediate production of 30,000 carbines per month. A few weeks later he was already demanding 50,000 pieces, after a few months 90,000, and soon even 120,000 per month. Before that happened, however, the industry's potential had been squandered for over a year. […]

One consequence of the lack of planning and technical management was the increasing shortage of medium ammunition for the MP-43, which grew month by month. The supply of normal handgun ammunition was also insufficient, which was, among other things, the result of the increased production of carbines. This soon led to the need to stop mass production of the MP-43, which had been increased with such effort to 50,000 units per month.

Many thousands of copies of this weapon, which had been tirelessly manufactured day and night, had to be scrapped, even though the front units were begging for every copy. At the same time, Allied bombers leveled a factory in Poznaÿ that manufactured machines for the production of small arms ammunition. […]“

## Infrared technology

A classic example of the search for solutions to problems, which ultimately led to the development of a completely new technical area, was the question of infrared technology. Even before the war, interesting results were recorded in this area, the prerequisites for the stormy development

However, this technology only emerged during the war. One of the most important impulses was the desire to create an alternative to the radar device. In this area the Allies had a slight superiority.

This is not the first time that radically new technologies have emerged simply to replace existing solutions. The new production technologies used in the MP-43 were also introduced out of necessity rather than consideration. Plastics were also largely seen as a stopgap solution

...

However, let's return to infrared technology. I don't want to describe all the types, as there were a lot of them. That's why I present this complex in an abbreviated form. Infrared devices can generally be divided into three groups:

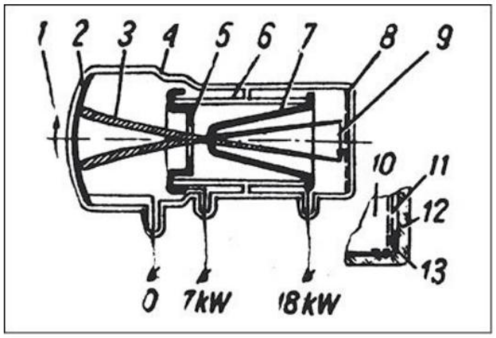
1. Night vision devices as “active” observation and aiming devices. They require illuminating the target/area with infrared rays emitted by a special spotlight;
2. Thermal direction finders and thermal imaging devices (“passive”). The target does not have to be illuminated; the devices simply receive the thermal radiation generated by

the target itself; 3. Thermal direction finders as elements of homing warheads for bombs and missiles. They are described in the second part of the book.

The main group was the devices mentioned under point 1. There were about a dozen different types, a selection of which I describe below. 64,82,83,84 Most German night vision

devices were based on image converters (photomultipliers) that were developed by the Reichspostforschungsinstitut and manufactured in small numbers. His laboratories were initially located in Berlin, but due to the threat of air raids they were moved to Hassenbach.

The devices manufactured there were in no way inferior to their many post-war counterparts from the 1960s and 1970s. Of course, the functional principle remained the same, and the design characteristics did not change. The following description of a night vision converter from 1984 could equally apply to the devices from the 1940s: [88]

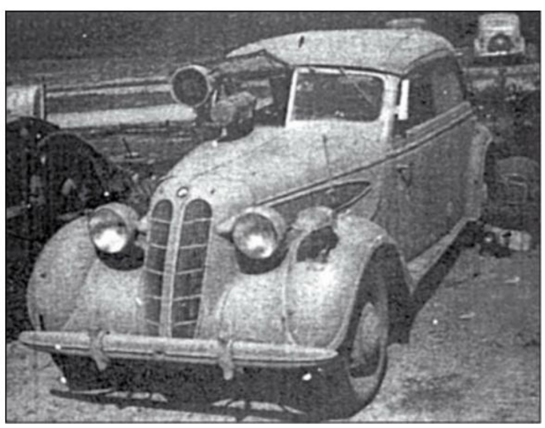



Cross section of a typical image converter; You can find a short description in the text. (Photo: CIOS)

“The core of every active night vision device is an electron-optical image converter (Figure 1). The infrared image of the observed object is focused on its photocathode (2). The typical photocathode with a coating of silver-added cesium oxide used in the transducers of these devices is a receiver for short-wave infrared radiation in the wavelength range between 800 and 1,200 ÿm. The infrared rays falling on the photocathode lead to the emission of electrons, which - accelerated and focused by the electrostatic field generated inside the converter tube - produce an electronic image (9) of the object on a screen (8) coated with the appropriate phosphor. Under the influence of the electron beams, the screen emits visible radiation, which can be observed through the eyepiece of the night vision device.

The image shows the typical construction of an active night vision device in cross section. The complex multi-lens lens with a large relative aperture is particularly striking here.
This design is necessary because as many beams of rays as possible must be collected on the photocathode in order to produce a good quality image and achieve the maximum viewing distance.”


The Uhu system on a half-track reconnaissance vehicle. (Photo: CIOS)



The FG 12/52, mounted on a BMW passenger car. (Photo: CIOS)

The devices manufactured by the Reichspostforschungsinstitut also had infrared-sensitive coatings made of cesium oxide mixed with silver, which were vacuum-evaporated by evaporating a hot spiral. Externally, the entire converter was similar to a large electron tube. Its anode, ie the layer visible through the eyepiece onto which the image was projected, was given a coating of green glowing luminophore, which consisted of a mixture of zinc sulfide and zinc selenium. Two main types of transducers were produced: with a diameter of 160 mm (600 - 700 pieces annually) and 70 mm (over 200 pieces annually). The entire work was carried out with relatively modest resources - the laboratory in Hassenbach only had 40 scientists and technicians on staff.

The second manufacturer of these devices was the company AEG, which produced 400 image converters with dimensions similar to those mentioned above. However, only 186 passed the quality test with a positive result (the image quality was examined). It was found that 78 pieces were suitable for the production of aiming devices, the rest were intended to be used in various observation devices - mainly for drivers. The AEG company was a global pioneer in this field - the first image converter was tested there as early as 1934!

The abbreviation "Biwa" was often used for image converters.

Let us now turn to the descriptions of some models of night vision devices designed in the Third Reich.

### Target device ZG

1221 This target device was intended for anti-tank guns and used a converter from AEG. The optical elements were manufactured by the Zeiss company (including 1,000 lenses). The markings visible on the target device indicate that it was factory adjusted to a firing distance of 250 m.

The sharpness was adjusted by electrostatic focusing of the electron beam. An integral part of the system was an infrared spotlight with a diameter of 36 cm, which was used to illuminate the target. Several hundred examples of a test series were delivered to ground troops so that they could carry out tests; the work was then interrupted. There is no data on whether the device was eventually used in combat.

The MP-43 with the *Vampire* night vision sight (weapon without magazine) (Photo: CIOS)

Aiming device vampire

The *Vampire* is one of the most interesting German devices from the group described. This aiming device was intended for automatic carbines of the MP-43 / MP-44 type. The dimensions of the night vision device itself were comparable to the larger optical sights: it was approx. 35 cm long and just over 6 cm in diameter and weighed including the small infrared emitter (a 35 watt lamp covered with a filter). only 2.3 kg.

However, the backpack set, which consisted of a battery and high-voltage converter and weighed almost 14 kg, was heavier - this hurdle could not be overcome long after the war. The heavy weight was not only due to the power consumption, but also to the need to convert the battery voltage to high voltage - in this case 11 kV, in order to be able to power the imager.

This device was added to the arsenal in small numbers and performed surprisingly well. Although it was a little too heavy for the soldiers on the front line, it was an ideal invention for guard troops. Under these conditions, it was no problem that the battery only lasted for three to five hours of continuous operation, as they were quickly replaced could. The manufacturer of the *Vampire* was the Leitz company, which used the small “post converters” – a total of 300 complete sets were delivered.

After the war, the British tested a specimen of the *Vampire* and concluded that the image was “very bright and contrasting.” The summary of the research results states the following:

> “At a distance of 30 meters, silhouettes of standing and lying people were clearly visible; at a distance of 50 meters only standing people were clearly visible, while lying people were difficult to distinguish from the background; At a distance of 80 meters, standing people were difficult to see, especially if they were moving.”

Many of the approaches incorporated into the *Vampire* were the starting point for similar work carried out in other countries after the war, with the Russians completely copying this set of equipment and subsequently incorporating it into the arsenal of their own army and the armies of other Warsaw Pact members.

The FG 12/50 on the turret of the Panther tank . (Photo: CIOS)

### Eagle I and Eagle II

Based on solutions that have proven successful in the *Uhu* ground system , comparable anti-aircraft solutions have been developed as a kind of counterpart to the short-range radar device.

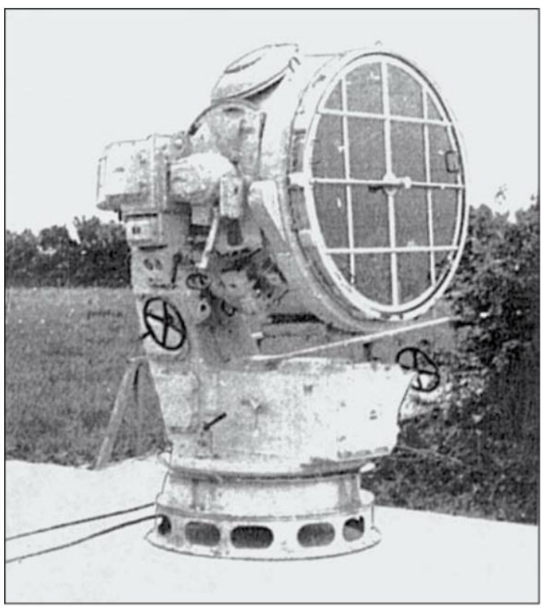
There were small changes to the optics - the focal length was shortened from 40 to 25 cm, which resulted in an increase in the field of view, and instead of one eyepiece, two (of the same type as binoculars) were used. More than 500 such optical systems were produced, although this device was never included in the arsenal. Here the radar device was able to prevail because the present solution could not determine the distance to the target, although the effective range (according to German sources) was exceptionally large and was around 25 km. However, it was not specified which one

This information referred to the type of aircraft, although it can be assumed that they were large bombers.

seal

The *seal* is one of the most interesting and best German night vision devices. It was developed for the Navy at the beginning of the war in Vendome, France, where American officers found one of these devices along with an operating manual that was dated "October 1941".

This night vision device was intended to be installed on ships (although it was essentially a portable device). Its main purpose was probably to detect foreign aircraft at night. Here we are again faced with an attempt to develop an alternative to the radar device - although the Germans also had important successes in this area.

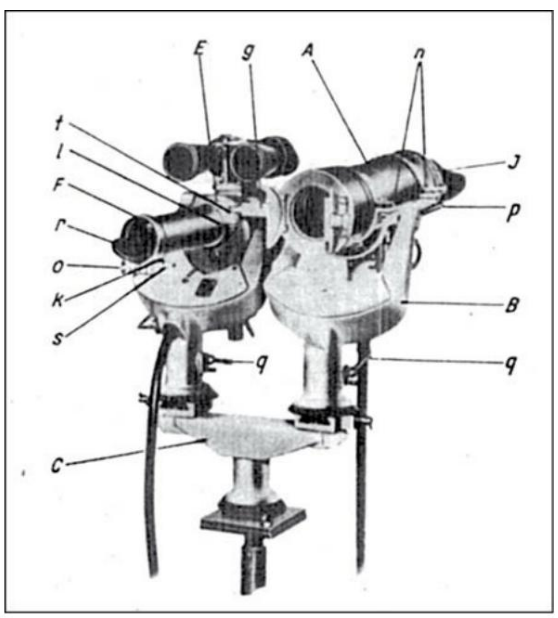


Large infrared spotlight with a diameter of 1.5 meters used in the Navy. (Photo: CIOS)

The night vision device (the receiver) itself weighed 11 kg and was supposed to be powered with the help of the ship's installation through a 15 meter long cable and a stationary voltage converter weighing 20 kg.
Various infrared spotlights could be used in the device: a

portable that could detect targets at a range of 10 km, one
with a diameter of 50 cm, which doubled the range, or a
large one with a diameter of one and a half meters, making the
The reach is infinite practical ins (in
The original operating instructions said: “up to the geographical limit
“Reach”) could be increased. Although it is known that these devices are in series
It is not entirely clear where this was made. In the American one
Report on the *seal* states that probably
the Goertz company was heavily involved in its development.

Before the war, this company was, along with Siemens, a pioneer in the field of
Television technology and not groundbreaking one fewer
Electron microscope, the first model of which was manufactured by Siemens in 1938
originated. A side note was the leading position of the Third Reich
in this field the main reason for the subsequent rapid development of
Night vision and thermal imaging devices. In fact, that is fundamental
Functional principle of an image converter in a night vision device, i.e. how it is created
of the image due to electrostatic or electromagnetic
Focusing the electron bundle, exactly the same as in the case of
Electron microscope.




The *seal.* (Photo: CIOS)

However, let us return to the *seal* ...

In the study report on the “intercepted” specimen, the Americans described it almost exclusively in superlatives: easy operation, resistance to unfavorable conditions (especially water resistance), good resolution, large field of view (22°), high sensitivity and opacity of the filter attached to the lens to visible light. The only drawback was the inability to quickly replace the image converter - this process took about an hour and required a specialist. The *Seal* was equipped with a modified image converter with a beryllium cathode, which made it possible to achieve a much higher contrast than before, which was desirable in the case of detecting air targets. It was probably the converter from AEG with a diameter of approx. 75 mm. One of the development versions of this night vision device was the *Seehund III,* intended for submarines (radars for locating aerial targets were intended only for Type XXI submarines). In May 1943, 1,250 of these devices were ordered, although only about 400 were ultimately delivered.

The *Seehund III* differed significantly from its predecessor - above all, it was smaller. The lens diameter was only 5 cm, which probably had a negative effect on the range. However, he had a larger field of vision.

## Spanner

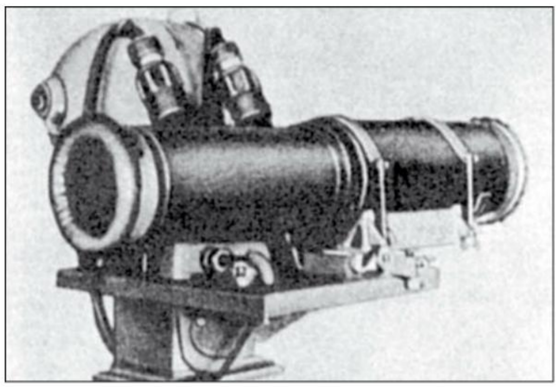
In 1941, an attempt was made to design a passive night vision device (without an illuminating headlight) that would react to the hot engine exhaust gases of Allied bombers. Night fighters were equipped with these devices, which is why around 600 units were delivered in 1941. However, the concept did not prove successful in combat conditions and the devices were withdrawn.

The (passive) thermal imaging devices formed a separate group.

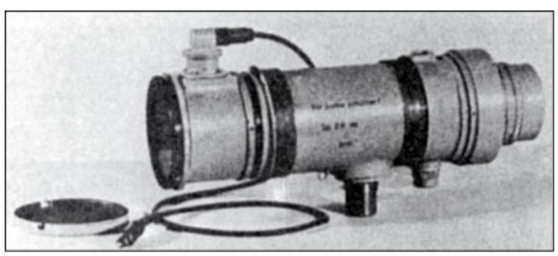
Many readers will certainly be surprised by the fact that they were based on semiconductor elements. One of the British intelligence reports even mentions experiments using silicon! 89 However, semiconductors of a different type were used in the infrared detectors.

They were sensitive to waves with a length of a few micrometers, to which the image converters of the night vision devices did not react. This wavelength roughly corresponded to the heat emitted by objects that had a temperature of several dozen degrees Celsius.

The operating principle of all German thermal imaging detectors was based on the so-called internal photoelectric effect. It is based on the fact that after absorbing photons, the semiconductor no longer behaves like an insulator, but rather like a conductor - the electrons are “lifted” from the valence band into the so-called conduction band.



Der *Spanner* I. (Photo: CIOS)



The *Peeping Tom IIA.* (Photo: CIOS)

“Holes” are created in the semiconductor and conduct electrical current. The simplest detector consists of a crystal of the corresponding chemical compound and two electrodes. If it is part of an electrical/electronic circuit, when the detector is illuminated with thermal radiation, an electrical impulse is created, which is reported visibly or acoustically on the monitor.

Currently, individual detectors are no longer used in observation and target thermal imaging devices. A certain intermediate stage, which predominated in the 1980s were row detector systems. Such a row was responsible for one image dimension, while the second image dimension was created through the use of a so-called scanner - a system of rotating mirrors (e.g. a rotating cuboid covered with a reflective layer) through which the row of detectors received radiation as if it were scanning the individual parts of the field of vision. The fax is, in a sense, a similar device, but in it it is not the object image that is drawn past the row of miniature detectors, but rather the object itself.

The latest generation of thermal imaging devices is designed like a video camera - no mechanical scanners are used, but rather two-dimensional detector systems (which externally resemble integrated circuits). Therefore, one might think that building a thermal imaging device with meaningful image quality is not possible if only a single detector is available. However, this is not the case.

The Germans tried to compensate for this deficiency by using more “sophisticated” scanning systems. This achieved an image quality that was in no way inferior to the image quality on the monitors of typical radar devices at the time.

At that time, thermal imaging devices were dominated by the much more advanced radar devices, but the Germans knew full well that their real heyday was yet to come, that the technology behind them was promising and that it was undoubtedly worth investing in the development of this technology.

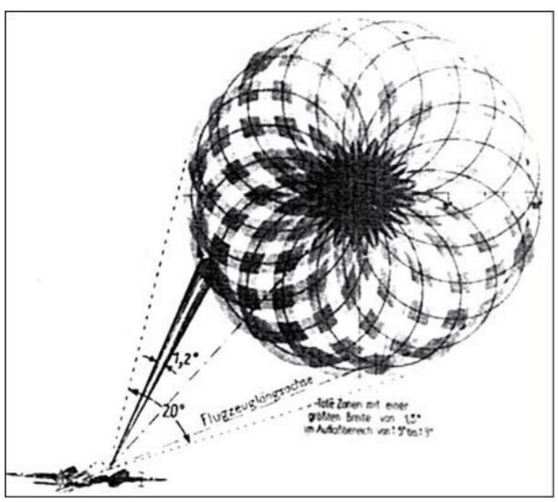
At least a dozen types of detectors have been developed in the so-called mid-infrared range. Two companies were commissioned to develop and test produce them: Elektro-Akustic (Elac) from Kiel and Zeiss-Ikon from Jena - one of the branches of the Zeiss Group, which, it should be noted, is still a magnate in the production of thermal imaging devices today.

Among other things, Elac began limited production (planned to produce 1,000 units per month) of a series of detectors based on lead sulfide crystals (PbS). 90 They achieved their greatest sensitivity with waves with a length of 2.5 micrometers, that is, with the so-called first atmospheric window: The atmosphere does not allow the entire infrared range to pass through, but only certain "areas" - waves with a length of about two to five and eight to twelve micrometers. there has been a

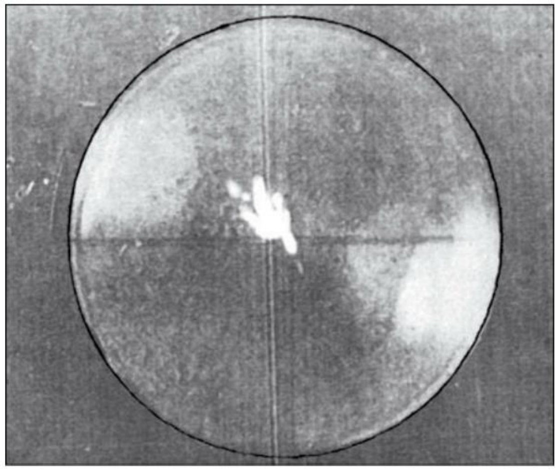
A whole range of sensors with dimensions of 3 x 3 mm and also round sensors with a diameter of 30 mm have been developed. The larger ones were of course more sensitive, but the finished device therefore had a much lower resolution. In accordance with the theoretical assumptions, the Germans very quickly discovered that the sensitivity of the detector can be increased even fifty times if it is cooled to a temperature of minus 40-50 degrees Celsius. In this way, the thermal radiation generated by the detector itself is eliminated.

Therefore, a special cooler with the code name *Eskimo* was developed, which worked on a carbon dioxide basis. This resulted in an almost enormous increase in sensitivity for the time - the detector alone (ie without optics for focusing) reacted to radiation with an output of 25 millionths of a watt! [82] By the end of the war, around 500 semiconductor components of this type had been produced in the laboratories of the Elac company alone; an undetermined number were also manufactured in the electronics company Kast and Ehringer in Stuttgart.

The latter company was also engaged in the production of the second type of detectors, which had been developed in Elac's laboratories. Synthetic lead selenide crystals (PbSe) were used here.
They differed from the above-mentioned solution mainly in that they responded to infrared from the longer wave range (four to five micrometers) emitted by objects with a lower temperature. Their sensitivity was comparable to sulfide crystals.



*Kiel III* – original diagram from scanning the field of view… (Photo: CIOS)



… as well as the image of the target on the screen. (Photo: CIOS)

The key to Elac's success in this field was basically one person - the director of its infrared technology department, Dr. Coachman. He began developing the optimal technology for producing sulfide detectors as early as 1930 and thereby became a pioneer in the field of semiconductor technologies.

The second leading manufacturer of these devices, the Zeiss-Ikon company, also developed several models, all of which were based on lead sulfide. In general, they did not come close to Elac's detectors and were mainly used for less demanding systems, e.g. B. in alarm systems that "guarded" the port entrances (the *radiation barrier system),* as well as in devices for secret communication between ships; this solution was based on a directed infrared beam (the *Puma system).* However, intensive research has been carried out on these devices and their most important parameters have been continuously improved: For example: B. the ratio between sensitivity and noise level increases twenty-fold. Nevertheless, by the end of the war they were slightly inferior to the detectors from Kiel and Stuttgart. The Zeiss laboratories also experimented with a newer type of detector based on thallium bromoiodide. It is known that this detector received the KRS-5 marking, but no technical data is available. Independent work was also carried out on this complex of questions at the Physics Institute in Göttingen. Zeiss was able to shine in another equally important area, namely the development of optical systems: lenses and corresponding optical materials (normal glass transmits electromagnetic waves from the visible range and, for example, the ultraviolet range, but not from the mid-infrared range, which we can see for ourselves in a greenhouse or a vehicle exposed to the sun without air conditioning ). Zeiss worked with the IG Farben group in this area

together.

Ultimately, eight “types of glass” were developed that were naturally free of “classic” silicon dioxide. Chemical compounds such as thallium bromide, iodide and chloride as well as silver bromide and chloride were mainly used. At least several hundred kilograms of this “glass” were produced and ground into classic lenses. However, they had certain disadvantages - first of all, they were very expensive, and their mechanical and chemical resistance was lower than that of conventional glass.

For this reason, and also due to the simplified manufacturing process, lenses with a large diameter were primarily used as mirror lenses or Mirror lens lenses executed. However, when there were no lenses, filters (mainly interference filters) had to be made of “special glass”.

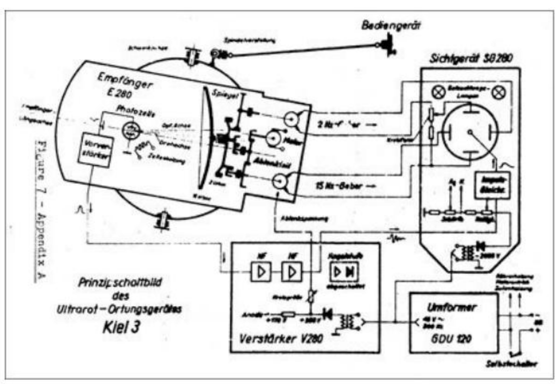
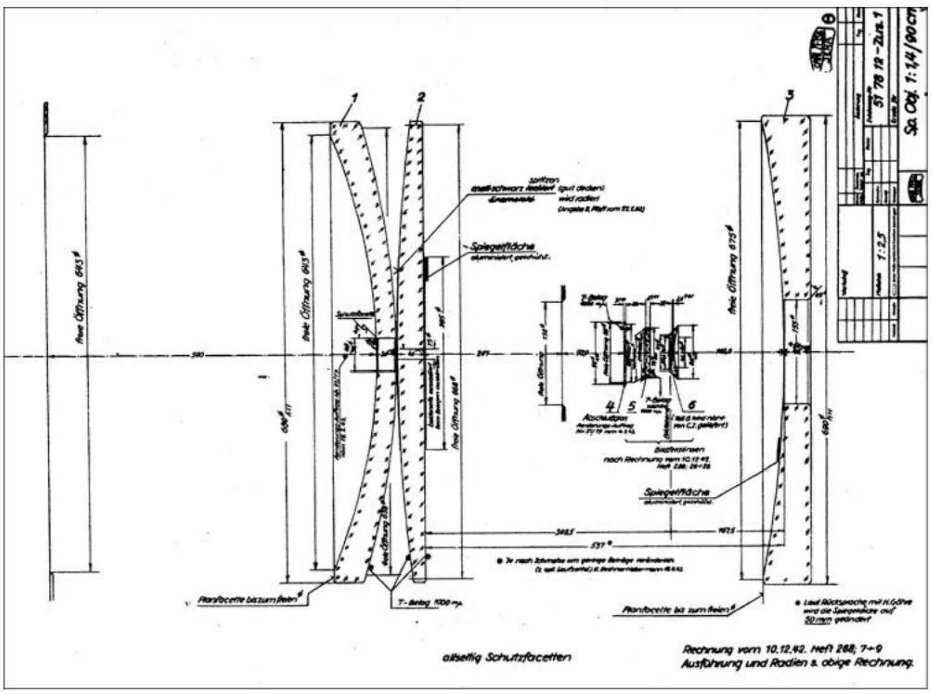



Diagram of the *Kiel* III system. (Photo: CIOS)

At the same time, research work of a similarly groundbreaking nature was carried out in the chemical field. The aim was to develop special camouflage colors for the infrared range in order to prevent detection by night vision devices. Considerable resources were invested in this, although the enemy never started using night vision devices, at least not on a large scale. The companies and institutions cooperating in this area included the Danish companies NVK and CPVA, a special office marked with the letters FEP (research, inventions, patents) that was probably located at the Reich Research Council, and the company Ludeck and Kohe from Berlin. If we compare that to the total number of companies and institutions that worked on the development of night vision and thermal imaging devices, this list is quite short. In addition to those already mentioned, there are also the following companies and institutions: the Reich Aviation Ministry (RLM), the Naval High Command (OKM), the companies GEMA, Osram and Stohl, the Institute for Applied Physics at the University of Cologne as well as the physics institutes in Prague and in Leipzig.

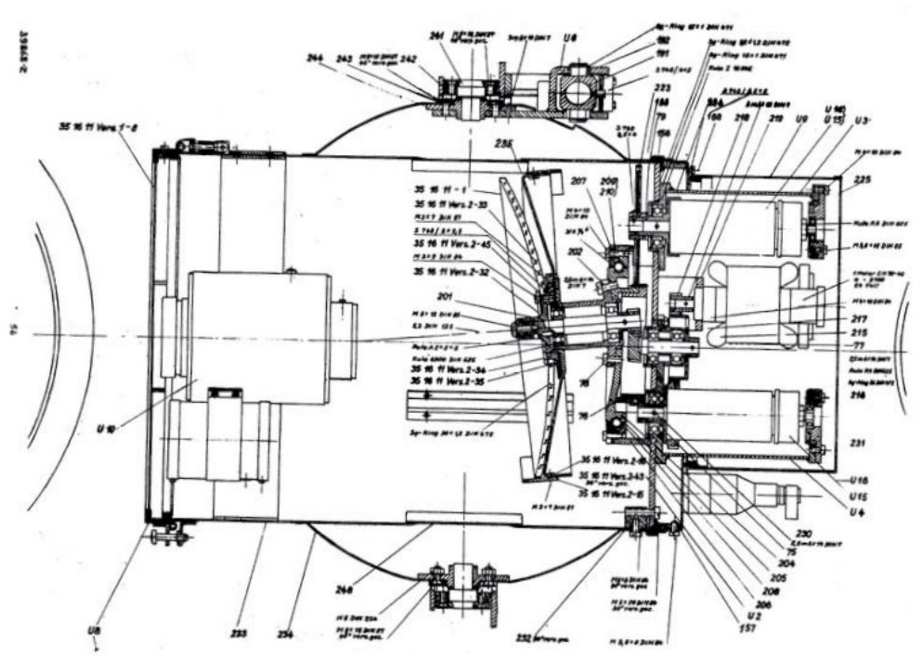



The *Kiel III* – one of the head versions. (Photo: CIOS)

However, let us return to the description of camouflage coatings - research in this area was successfully completed as early as 1943. Several types of special paints were developed, including under the code name *picket fence,* and later also *garden fence.*

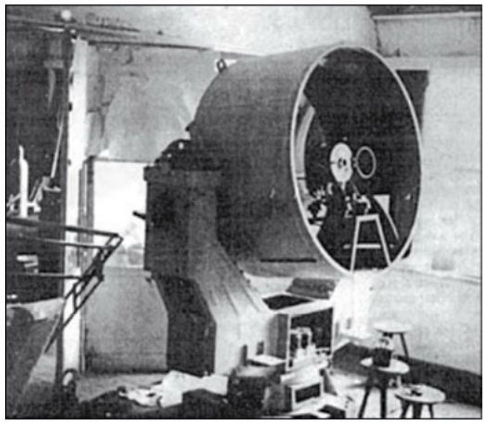
They absorbed at least 96% of the infrared radiation from the range that night vision devices can receive (wavelength: about one micrometer).

These paints were primarily intended to be used to mask submarines, although over time it became apparent that their lack of resistance to seawater was a problem. However, this was of no major importance since radar and sonar equipment anyway posed the main threat to submarines. The Germans no longer had time to exploit the achievements in this area during the war; only decades later did the correctness of the implemented solutions become apparent.



The *Kiel III* – cross section of the infrared telescope. Although this is just one of many system components, reflecting only a fraction of the work in this area, it shows how much has been invested in the development of infrared technology. (Photo: CIOS)

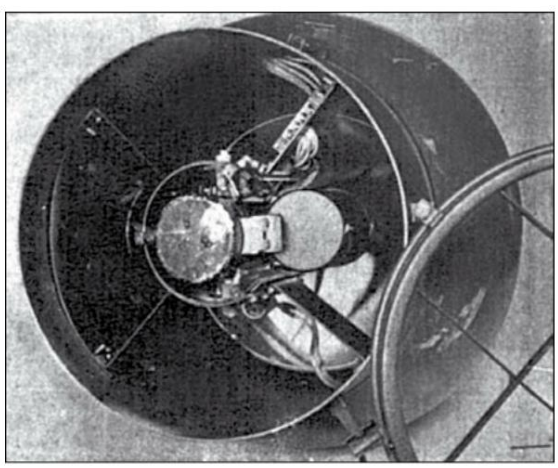
After this introduction, we can now move on to describing specific thermal imaging systems...



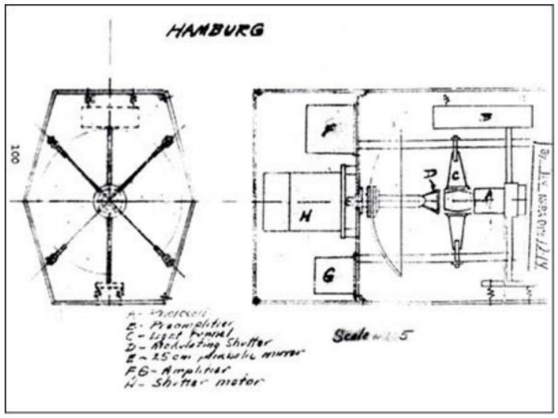
The WPG head. (Photo: CIOS)

The Germans themselves considered the thermal direction finder called *Kiel* to be their most useful and best device from this group. It was designed for night fighters to detect enemy bombers - in other words, it was used for target detection. This was done passively and was insensitive to the increasingly emitted interference that radar devices were exposed to.

The *Kiel* detected a single four-engine “Lancaster” bomber at a distance of 4-5 km. The tests carried out proved its usefulness in other applications - small ships with a displacement of 1,500 tons were “noticed” at a distance of 7 km, and factory chimneys at a distance of 10 km.



View of the optical system after removing the infrared filter – *Kiel.* (Photo: CIOS)



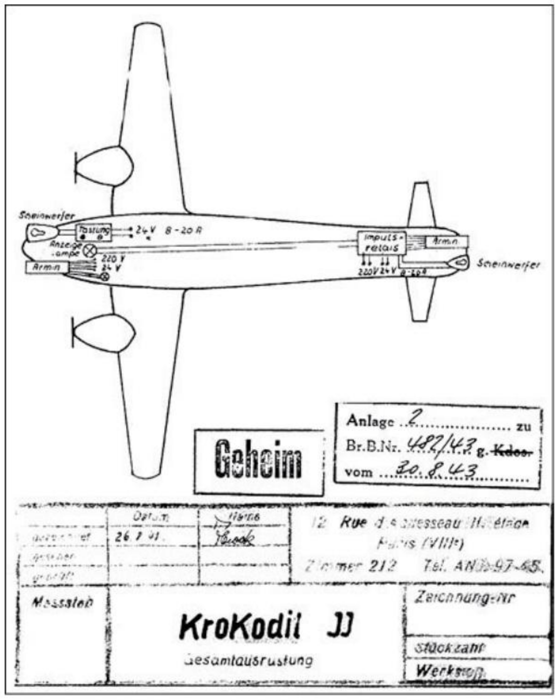

The Hamburg system. (Photo: CIOS)

The *keel* had a relatively light and short mirror lens, a paraboloid mirror with a diameter of 23 - 25 cm. To scan the field of view, this mirror rotated around the axis of the entire device at a speed of 100 revolutions per second and at the same time around a second, slightly inclined axis at a speed of two revolutions per second. In this way, the focused infrared rays in the focal plane described a specific curve (rosette) that covered the entire field of view. Several versions of this system were developed *(Kiel I* - *Kiel* IV), which differed mainly in the field of view. The most successful version was the *Kiel III,* which was characterized by a field of view of 20° and a resolution of one degree.

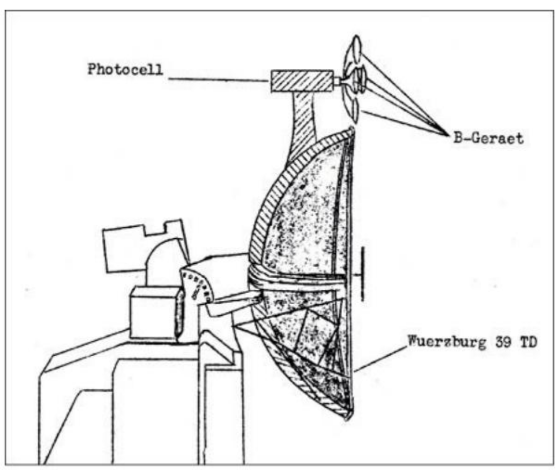
There was also the *Kiel I* version with a lens lens, which was a further development of an older thermal direction finder from Elac called the *Kormoran .* However, work was stopped fairly quickly due to an avoidable defect: about a third of the radiation was absorbed by the objective lens.

The *Kiel III* was also available in two variants - one of which used a 3 x 3 mm detector from Elac, while the other *(Kiel III* Z) used a similar detector from Zeiss. Both were cooled with solid carbon dioxide transported in a special container. In the course of the tests carried out by the Air Force's test command at Stade Airport and at the test site in Rechlin, among others, only the *Kiel III Z* could be classified as ready for series production. However, the production speed was modest. The only game (approx

20 - 30 units) were received by the night fighter squadron stationed at Goslar Airport at the turn of the year 1944/45. The devices were mounted on the bow nose. 82.90




Scheme for installing the *Armin / Krokodil* thermal target detection system on a night fighter. (Photo: NARA / ALSOS)




Mounting a heat direction finder on the antenna of the Würzburg radar device. (Photo: NARA)

At the same time as *Kiel,* a whole family became significantly larger and for the Heat direction finder intended for ground use has been developed, which is used both for

The aim was to detect aircraft and ships. They were given the names *heat tracking device* (WPG) and *night measuring device* (NMG), whereby the second device was intended as a supplement to the first - it served as a spatial image rangefinder. The entire system was the largest night vision system ever built during the Second World War. The diameter of the ellipsoid mirror (WPG lens) was a full one and a half meters (an ellipsoid is a body that is created by rotating the ellipse around one of the axes; in a similar way, a paraboloid and a hyperboloid are created, on the basis of which other mirror optical systems are made) .
With its long range resulting from the large mirror collecting area and high detector sensitivity, as well as the ability to measure target distance, the WPG/NMG system was the most complex attempt to create an alternative to radar. An alternative, mind you, that worked passively and was therefore much more difficult to detect by the enemy and difficult to disrupt. The most important system component - the *heat detection device* - was developed by Elac and Zeiss at the same time, similar to the *Kiel III .* The capabilities of both variants were similar, although the Elac prototypes were characterized by a slightly longer range, which is why work on the Zeiss model was stopped relatively early - probably in 1941, when the prototypes were examined. The competition, on the other hand, received the first orders between 1943 and 1944, which meant the start of series production. At that time, 90 WPG systems were ordered, all as ground variants for detecting ships. By the end of the war, only twelve were delivered, three of which could be installed in the bunkers on France's west coast before the Allies landed. Since only the optical system was located above the bunker ceiling, such a device, which rotated around its vertical axis and was slightly tilted horizontally, from the outside almost resembled a radar device or rather a large anti-aircraft searchlight. The control system and most of the electronic devices were located a few meters below.

| Lfd. Nr. | Forschungsstelle: | Forschungsaufgabe: |
|---|---|---|
| 1 | Geheimrat Sommerfeld, München | Theoretische Bearbeitung physikalischer Probleme der F.T. (Ausbreitung und Akustik Schallfeld). |
| 2 | Prof. Harms, Würzburg | Spezielle Probleme der drahtlosen Peiltechnik, Peilverhinderung. Besondere Aufgaben der Rückstrahltechnik (Strahlun charakteristik, Erdbodeneigenschaft, Richtantennen für Extrem-Kurzwellen) Fu M.G.-Abwehr. |
| 3 | Prof. Ott, Würzburg | wie 2) und teilweise 1) |
| 4 | Prof. Joos, Jena<br>Prof. Zahn } Göttingen<br>Dr. Hellwege } | Absorption elektrischer Wllen (Fu M.G. - Abwehr) |
| 5 | Prof. Brückmann, Wien | Spezielle Geräteentwicklung und Untersuchungen über Phasenschieber (Anwendung für Rückstrahlgebiet). |
| 6 | Prof. Schumann, München | Röhrenentwicklung für ultrakurze und Dezimeter-Wellen. Spezielle Geräteentwicklung (z.B. Goniometer für F.T.Peilun |
| 7 | Prof. Karolus, Leipzig | Modulation von Quecksilberhöchstdrucklampen für Lichttelephonie. Bildwandler im langwelligen Infrarot. |
| 8 | Prof. Füchtbauer, Bonn | Forschung auf dem Gebiet der Fotozellen in langwelligen Infrarot. |
| 9 | Prof. Zinke, Institut für Schwingungsforschung Berlin. | Breitbandantennen |
| 10 | Firma Siemens | Längstwellenkommandoübertragung für Torpedofernlenkung. |
| 11 | Kaiser-Wilhelm-Inst. für Metallforschung<br>Forschungsanstalt Graf Zeppelin<br>Inst.f.Nachrichtentechnik der T.H. Stuttgart | Magnetische Feldstärkemessung mit Hilfe hochfrequenztechnischer Methoden |
| 12 | Firma Gema Berlin | Klystron |

- 2 -

| Lfd. Nr. | Forschungsstelle: | Forschungsaufgabe: |
|---|---|---|
| | In eigenen Forschungsstellen der Kriegsmarine bearbeitete Forschungsaufgaben : | |
| 13 | Prof. Pungs, Braunschweig<br>Leiter einer Arbeitsgruppe beim N V K | UK - und Dezimeter-Wellen-Technik. Untersuchungen der Peilungen kleinerer Höhenwinkel (Erdbodeneinfluss). Untersuchung von Breitbandantennen und elektrischen Kompensatoren. |
| 14 | Prof. Scherzer Darmstadt<br>Leiter einer Arbeitsgruppe beim N V K | Durchführung spezieller Aufgaben der Rückstrahltechnik. Theoretische Arbeite über Breitbandantennen, Empfängerentwicklung, Empfangsmessgeräte. |
| 15 | N V K | Längstwellenkommandoübertragung für Torpedofernlenkung. |
| 16 | N V K | Ausbreitung von elektromagnetischen Wellen der Frequenzen 30 - 100 kHz. |
| 17 | Arbeitsgruppe Stuttgart der Entmagnetisierungsgruppe des O.K.M. | Magnetische Feldstärkemessung mit Hilfe hochfrequenztechnischer Methoden. |
| 18 | Marine-Observatorium Greifswald | Höhenwindmesser und Radiosonden |
| 19 | F E P III | Trichterantennen für Zentimeter-Wellen, Gruppenstrahler, Unterdrückung von Nebenwellen bei Trichterantennen. Möglichst scharfe Bündelung von Zentimeterwellen. |

A German list of (selected) research projects in the field of radar devices, control technology, etc. (Photo: NARA / ALSOS)

At least five other types of heat direction finders based on semiconductor components were developed during the Third Reich, although two of these devices can be proven to have been developed during the war and to have proven themselves in practice. These were the *Würzburg B* and *Armin models.*

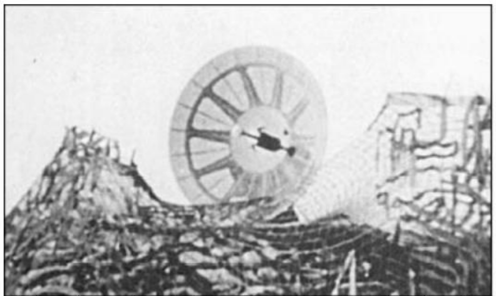
The first was essentially a “thermal imaging accessory” for the large radar device for detecting air targets, *Würzburg-Riese,* and was intended to be used in the event of severe interference with radar reception. The heat direction finder was installed on the tip of the paraboloid mirror of the radar device, which had a diameter of three meters. Despite the small objective diameter (25 cm mirror), the range was relatively large - the British "Lancasters" were detected at a distance of 15 - 20 km. There were four detectors in the mirror focus, which corresponded to four control lamps on the control panel. When all lights flashed uniformly, the system was aimed directly at the target. This device was probably designed by the Berlin company GEMA, the same one that manufactured radar devices. It was tested on the test site near Rechlin and near Kühlungsborn.

*Armin ,* on the other hand, was a heat direction finder for night bombers developed by Elac. It was intended to warn of approaching enemy fighter planes and was characterized by a very complicated multi-lens system, the task of which was to ensure a large field of view (120°) and at the same time to scan it with sufficient precision , so that an approximate target silhouette could be detected on the monitor (despite using a single detector). However, this was only possible if the target was no more than two kilometers away. Two versions of optical systems were tested in parallel and the heat direction finders equipped with them were labeled accordingly as *Armin I* and *Armin II .* The tests were completed in 1944, but series production did not take place.
One of the reasons for this was the expected very high costs of the optical elements.

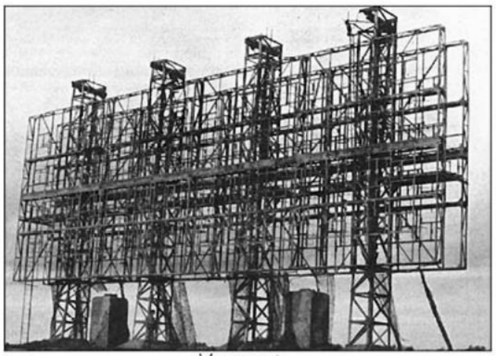
82,90 Separately, some types of bolometric thermal imaging devices have been developed based on a different physical phenomenon: that the electrical resistance of some materials changes after they absorb infrared photons. None of these devices went into series production, and most of them did not provide any competition for the heat direction finders above

However, among them was a truly revolutionary system - revolutionary because it could already be described as a (simple) thermal imaging camera. It did not display the “usual” spot on the monitor, but rather the full image of the objects in the viewing area. The device, known as *the Potsdam-L,* was used for reconnaissance and was intended to be installed on aircraft to detect ground targets at night.

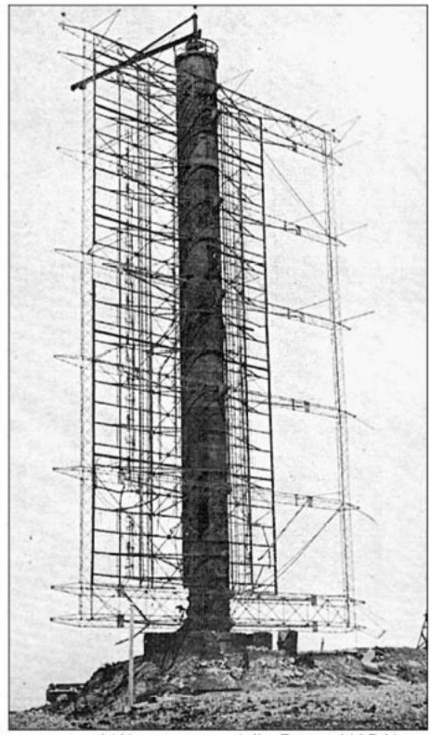
The device was based on a simple optical system and a scanner with a tilting (oscillating) mirror that projected an infrared beam onto a special metal foil that acted as a photoresistor.
The current flowing through the film then powered a lamp, whose focused light was directed in the opposite direction of the infrared beam. The light beam was reflected on the back of the mirror and projected onto a glass plate that served as a screen and was covered with a thin layer of phosphorus (and therefore glowed not only when the beam hit, but also for a short time afterwards). In this way, an image composed of lines was created on the screen. This image ran at a speed proportional to the aircraft's flight speed. This effective, but not particularly complicated device was not constructed by a large corporation, but by a single person, a certain FE Leybold from Clansthal in the Harz Mountains. The American intelligence report on the *Potsdam-L* shows that, similar to other groundbreaking inventions, all prototypes were destroyed or well hidden before the arrival of Allied troops. However, the operating instructions fell into the hands of the Americans, and they were also able to interview some witnesses about it. 82



Einige deutsche Radargeräte mit großer Reichweite: *Würzburg* …



… *Mammut* …



… und *Wassermann*. (alle Fotos: NARA)

Despite the spectacular nature of the construction mentioned, it was not the only thermal imaging camera designed in the Third Reich. The American report shows that there were at least two other models.

82

They were named *Eva* and *Fernactinometer* (they were described as "thermal picture-forming devices"). Unfortunately, we only have further information for the first model. Since the description is very short, I will give it as a whole: 90

> "The *Eva* device was built by Prof. Czerny from Frankfurt. It provides a rough thermal image of the object using interference colors that arise on a thin layer of liquid. The device was examined by the NVK. The observed image appeared on the screen within three to eight seconds. The range was 200 to 300 meters."

The thin layer of liquid was probably between two glass plates, as with most interference filters. However, this is where the guesswork ends, and in reality the principle of operation of this invention remains unknown. This puzzle is quite fascinating, esp

if we take into account that the camera probably had no moving elements and at the same time provided a color image, which was a sensational achievement in itself at the time.
We also know nothing about how the Germans planned to use this device, although there was certainly the tempting idea of using it as a thermal imaging targeting device for ground troops.

However, despite the sparsity of available data, one can still make a cautious assumption regarding *Eva* 's umbrella . It is difficult to imagine that the image was created directly due to infrared absorption (due to the low radiation power). What we do know is that Prof. Czerny was a pioneer in the use of bolometry in this area - he studied materials that changed their resistance under these conditions. It is therefore possible that an electric current flowed through the thin layer of liquid described: at the points that were illuminated at a given moment, the resistance and thus also the temperature would change. The whole thing would function somewhat like an “amplifier” of the heat received. In this case we would not only be dealing with a thermal imaging camera, but with a prototype of a color liquid crystal display (LCD) (a similar effect can be observed with simple plaster thermometers that are stuck to the forehead: a very heat-sensitive liquid crystal layer changes its color and " “shows” the corresponding number). The device descriptions above represent only a very modest summary. In reality, it was a large-scale research program that was a catalyst for progress in many areas,[one] such as: B. in semiconductor physics or in the development of new materials for the production of optical elements. Recently I came across z. B. in one of the Reich Research Council documents intercepted by the American “ALSOS mission” there was a reference to “light telephony” that worked in the infrared band. 85 Could this have been a kind of forerunner of today's fiber optic telephony?

## aircraft carrier

I have decided to leave an overview of the new weapon concepts that were promoted in the Third Reich and are the subject of this chapter to add another, also little-known topic, which will hopefully also arouse interest. It's about the plans to build German aircraft carriers.

On December 8, 1938, a large celebration took place at the “Deutsche Werft” in Kiel in the presence of Hitler, Göring, Admiral Raeder and countless other dignitaries, which received wide publicity in the German press. “The German Reich is grasping for naval supremacy,” wrote the *Völkischer Observer* that day . The Navy's first aircraft carrier was launched, which was intended for use on the Baltic Sea and was characterized by a displacement of 21,214 GRT. He was christened *Graf von Zeppelin* and was supposed to represent the pinnacle of technology at the time. It should - because at that time there was still a lot left to complete. However, everything indicates that it would have been a very dangerous unit indeed.

She was e.g. B. equipped with the largest steam turbines to date, which enabled her to reach a speed of up to 34 knots.

Three years later it was equipped with radar devices that were modern for the time to detect air and sea targets. The planned artillery armament was already impressive: sixteen 150-mm cannons with a range of 27 km, ten 105-mm cannons, 22 automatic 38 large-caliber anti-aircraft machine guns. 86 After the victorious Polish campaign, Hitler became 37mm anti-aircraft guns as well as personally interested in the fate of *Graf von Zeppelin* because, in his opinion, he could play an important role in the planned invasion of Great Britain. At a staff conference called on the matter, he ordered that all work be completed in record time and that the ship be put into active service by mid-March 1940.

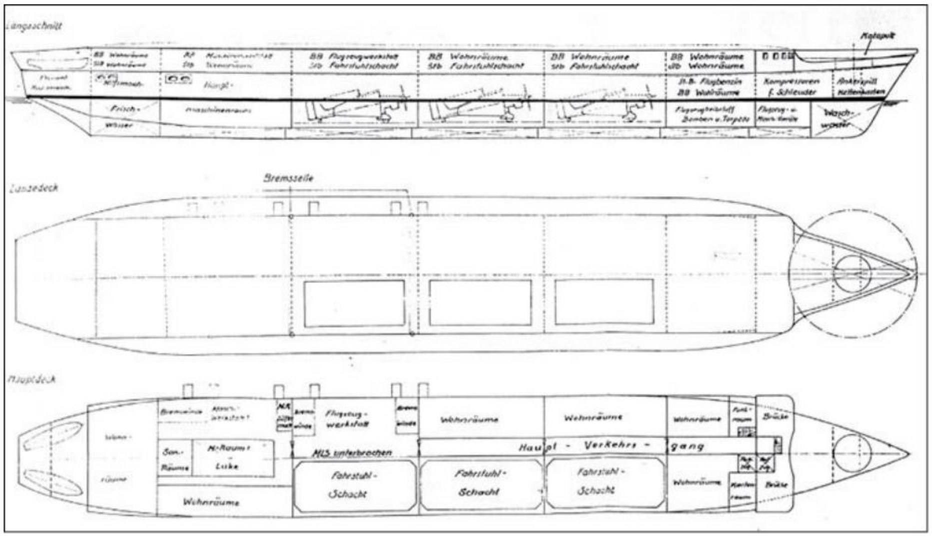
However, this deadline was not met, mainly due to problems with the supply of large-caliber guns and many other equipment. In addition, the issue of aircraft allocation was still unresolved. As it became clear only after the war, this was mainly the “merit” of Göring's intrigues. Luftwaffe Marshal Erich Milch could remember witnessing a conversation in 1940 in which Göring haughtily announced the following to the OKL chief of staff, General Jeschonek: 86

"Jeschonek, I tell you, Raeder will sooner resign than create his own air force under my nose. The Admiral should know that only I in the Reich decide the fate of the Luftwaffe!"

Hitler found out about the dispute and decided to end it on March 12 by giving Göring specific orders. The Kriegsmarine was to receive 50 Bf-109F fighters, four Ju-87c Stuka dive bombers and thirteen Fi-167 Storch reconnaissance aircraft. These machines should be modified accordingly.

In addition, it was planned to build a twin unit *(Peter Strasser) .* The Navy leadership also proposed converting the passenger ships *Europa* (54,904 GRT), *Potsdam* (19,293 GRT), the former French unit *De Grasse* (20,396) and the heavy cruiser *Seydlitz* into aircraft carriers. However, all of these plans failed, this time without any intervention from Göring. In the first days of 1943, the entire plan to expand (or rebuild) the fleet was reassessed, and submarine construction became a top priority. The unfinished *Graf von Zeppelin* was towed to Stettin, where it remained until the end of the war.

Although this information is interesting, it is relatively well known and I would not have included it here if it were not the backdrop to a much lesser known aspect of the whole story. A few years ago, while looking through the files of the Personal Staff of the Reichsführer-SS, I came across extensive correspondence and projects about construction plans for an alternative aircraft carrier fleet! [87]




Original plans of the “small aircraft carrier”. (Photo: AAN)

In this case, the initiative came from Dr. Heinrich Dräger, company owner and owner of the “Dräger” shipyard in Lübeck. His proposal is dated January 27, 1942. What is interesting in this context is that Dräger found unexpected supporters in Heinrich Himmler and the head of his personal staff, SS-Obergruppenführer Karl Wolff. It was about building an entire fleet of small aircraft carriers with a displacement of 3,500 tons, a length of 101.6 m, a width of 17 m and a draft of just four meters. The proposal aroused the interest of the SS and was discussed in ever-widening circles for almost two years, even though Dräger intended to equip each unit with only six to seven aircraft!

The matter only died a “natural death” at the end of 1943, after a devastating verdict from the Navy, in which, among other things, the flight deck was too short (90 m). The KFT *(small aircraft carrier)* project had no military significance, but it clearly demonstrated Himmler's ambitions.

## Unusual energy sources

In the ceaseless hunt for potentially groundbreaking technologies, much more unusual concepts than those mentioned so far have begun to be tested. Many such examples – both alleged and real

– can be found in the comprehensive topic of “new energy sources”. In the book by Prof. Mark Walker, a historian who has analyzed German work in the field of nuclear physics, we find, for example: B. the The following description (page 91 of the 1999 edition): [91]

> “Many participants in the nuclear energy project were tasked with the irrational search for miracle weapons. Werner Heisenberg and other top German physicists were required to evaluate proposals for inventions. Although Heisenberg was besieged by inventors throughout his life, such emotionally charged contacts with amateur scientists became increasingly dangerous during this phase of the war.
>
> As the war situation worsened, the National Socialist leadership became increasingly interested in the creative potential of every German, especially the soldier who served at the front.

Then follow some examples of pointless inventions. We continue reading:

> “In at least one case, however, Heisenberg did not get rid of an inventor so easily. In July 1943, the Ministry of Armaments and War Production asked Heisenberg to evaluate the invention of an engine that would operate without any fuel. The Ministry admitted that this amounted to the existence of a perpetual motion machine, but independently insisted that Heisenberg carefully analyze this proposal, which had been sent in by an engineer named Günther. Heisenberg responded two days later that the author's claim that energy could be created from nothing was untenable, adding that the proposal was written so incoherently that he had difficulty reading it all the way through. A few months later the ministry made another announcement. Günther was so disappointed by Heisenberg's skeptical attitude that he objected directly to Hitler.
>
> The ministry spokesman asked Heisenberg to reconsider the matter. He was even asked to arrange a meeting with Günther.” There were many such

examples. Even if most of them are pure

were a waste of time, we cannot ignore this phenomenon when analyzing technical progress in the Third Reich - for the simple reason that it sheds light on the mechanisms of this progress.

Der Reichsgeschäftsführer

Geheim

An
Reichsführer-SS
Persönlicher Stab
Berlin SW 11
Prinz Albrecht-Str. 8

Betr.: Angelegenheit Karl Schapeller, Aurolzmünster
Bezug: Dort.Schr.v.16.9.42 AR 22/39/42
Anl.: 1 Vorgang

Als Anlage gebe ich den mir von dort übermittelten Vorgang zurück. Über die zur Untersuchung heranzuziehenden Professoren wurde mit dem Reichssicherheitshauptamt Übereinstimmung erzielt. Zur Verfügung gestellt haben sich :
1.) Prof.Dr. Bothe, Heidelberg,
2.) Staatsrat Prof.Dr. Esau, Berlin.

Auf Vorschlag von Staatsrat Prof. Dr. Esau wird zunächst Prof. Dr. Bothe sich mit der Angelegenheit befassen, er wird noch im Januar zur Rücksprache nach Berlin kommen. Die Angelegenheit wird in Fühlungnahme mit uns weiter bearbeitet.

SS-Standartenführer

Eingang: 11. JAN 1943

Selected documents from the files of the Personal Staff of the Reichsführer-SS describing the work of Karl Schappeller. (See also following pages)

In the files of the Personal Staff of the Reichsführer-SS I came across a classic example of such charlatanry. An entire briefcase is dedicated to a certain Karl Schappeller, who claimed that he could obtain unlimited amounts of energy from ordinary water. The source of this energy should be some unspecified nuclear reactions. The documentation of course includes a device description, but it is so unclear that it is impossible to find out what it is actually about. You can find an excerpt from this documentation on the following pages. What is crucial, however, is that even though such ideas were incompatible with common sense, they were not rejected out of hand. Schappeller's supposed discoveries were assessed by Prof. Abraham Esau, who wrote the following: 92

"Material or ideological support for Schappeller would be irresponsible – he has a pathological personality, his ideas are completely confused and arise from the purest imagination."

However, sometimes it turns out that it is definitely worth having ideas that obviously came from the realm of fantasy, not to be rejected, because the benefit resulting from the realization of an authentic novelty the possible costs that had to be borne in cases of imposture, completely outweighed.

An example of this are the inventions of Hans Coler most likely an authentic and groundbreaking discovery represented. They were not only used in the Third Reich during the war investigated, but also after the war by the British Intelligence service. If originated The result is comprehensive intelligence report documenting this discovery and confirms their authentic character.[93]

**A b s c h r i f t**

**Bericht über das Vorhaben Schappeller**

Die Unterredungen mit Schappeller Vater und Adoptivsohn im Schloß Aurolzmünster und die eingehende Besichtigung des Schlosses am 11.1.43 ergaben folgendes:

1. Natur des Projektes. Sch. Vater hat eine angeborene Neigung zu naturphilosophischen Betrachtungen. Jedoch mangelt es ihm an Denkdisziplin, und seine Kenntnis physikalischer Tatsachen beschränkt sich auf einige allereinfachste Schulexperimente. Daher haben seine Überlegungen lediglich den Charakter verschwommener und unfruchtbarer Spekulationen über Vakuum, Feuer, Magnetismus u.ä.

Von diesen Spekulationen ausgehend, behauptet Sch. Vater, ein neues Verfahren zur Energiegewinnung gefunden zu haben. Die technische Ausarbeitung dieses Verfahrens hat er seinem Adoptivsohn übertragen, der früher bei einigen elektrotechnischen Firmen tätig war. Nach diesem Verfahren sollen unbegrenzte Energiemengen aus der Atomenergie gewöhnlichen Wassers entnommen werden können. Hierfür ist eine Apparatur geplant, die nach längerem Widerstreben folgendermaßen beschrieben wurde. Eine Hohlkugel aus Eisen ist auf der Innenwand mit zwei halbkugelförmigen Wicklungen aus hohlem Kupferdraht ausgekleidet. In den Polen der Wicklungen trägt die Hohlkugel innen zwei Eisenzapfen ("Magnetpole"), mit denen je ein Ende der Wicklungen verbunden ist. An die freien Enden der beiden Wicklungen soll der zu betreibende Elektromotor angeschlossen werden. Die hohlen Wicklungsdrähte sollen mit einer geheimnisvollen Substanz gefüllt werden, die einmal als "Oel", dann wieder als "Elektrolyt" bezeichnet wurde; auch sollen noch besondere Stoffe beigemischt werden, und das ganze soll in nicht näher beschriebener Weise präpariert werden. Der verbleibende Raum in der Eisenkugel soll mit einer besonderen Asche ausgefüllt werden. Bevor jedoch dieser Apparat arbeiten könnte, müßte er "geladen" oder "gezündet" werden, indem man ihn für eine gewisse Zeit mit den beiden "Magnetpolen" an eine starke Dynamomaschine anschließt. Die Energieerzeugung selbst soll dann so vor sich

-2-

Akt. Nr. Geh. /

gehen, daß man den einen "Magnetpol" über ein "Element" mit einem Wasserbehälter, dem Meerwasser o.dgl. verbindet. Das "Element" soll jedoch kein gewöhnliches galvanisches sein, es soll z.B. drei Elektroden enthalten. Die Energie soll durch Zersetzung des Wassers frei werden, jedoch wiederum nicht durch gewöhnliche elektrolytische, sondern eine besondere Art von Zersetzung. Die Energie soll "in Form von Elektronen" durch den Apparat "angesaugt"werden.

Die so erzeugte Energie soll von einer grundsätzlichen neuen Art sein, sie wurde u.a. als "komprimiertes Feuer", "geballtes Vakuum", "glühender Magnetismus", "freier Magnetismus", Solenoidkraft" bezeichnet, der Vorgang der Energieerzeugung als " Zerlegung des elektrischen Stromes".

Das ganze kann nur als barer Unsinn bezeichnet werden. Irgend ein gesunder physikalischer Gedanke steckt nicht dahinter.

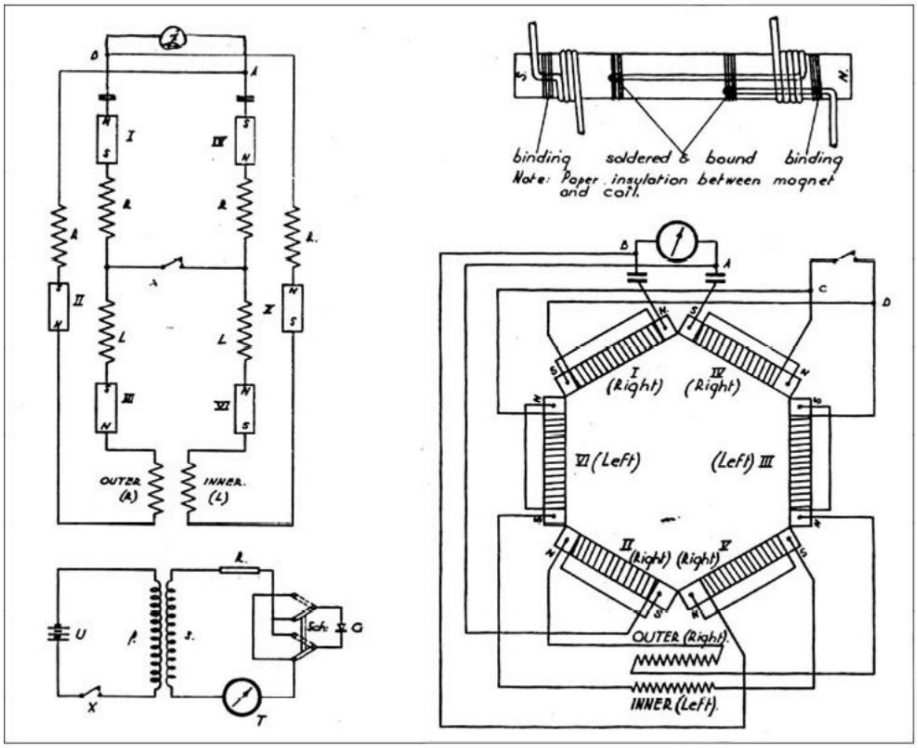
2. Bisherige Vorbereitungen. Irgend welche Experimente sind zugegebenermaßen bisher nicht ausgeführt worden. An apparativer Ausstattung fanden sich bei der Besichtigung des Schlosses nur je ein alter Strom- und Spannungsmesser billigster Type, sowie etwas einfaches Werkzeug und Material für Lichtinstallation. Einige weitere Gegenstände sind angeblich dem Konkurs zum Opfer gefallen. Eine Laboratoriumseinrichtung hat jedoch offensichtlich nie bestanden, obwohl seit 1928 gegen 700 000 RM verbraucht wurden. Nach der Beschreibung der "Maschine" hätte es möglich sein sollen, für einen kleinen Bruchteil dieser Summe die nötigsten Einrichtungen für einen Versuchsbetrieb zu beschaffen. Daß dies nicht geschah, wird von den Sch. damit entschuldigt, daß angeblich die Verwendung dieser Gelder (für die Instandsetzung des Schlosses u.ä.) durch die Geldgeber vorgeschrieben war.

Konstruktionszeichnungen der "Maschine" sind ebenfalls nicht vorhanden. Angeblich haben sie existiert, sind aber aus Anlaß einer politischen Verfolgung schon in der Zeit vor dem Anschluß der Ostmark verbrannt worden. Neue Konstruktionspläne wurden inzwischen nicht angefertigt.

3. Ziele. Sch. Vater gibt an, mit seinen Bestrebungen

The report is entitled: “An invention by Hans Coler that is connected to a supposed new energy source”. This report can currently be found in British and American archives (although it is claimed that it is only part of it - the original was said to have over 150 pages more and also described its use in powering various weapons systems). Although the spelling “Hans Coler” predominates in the title and the document itself

The German spelling “Kohler” (which sounds more credible) also appears elsewhere. However, I will stick to the spelling as it appears in the relevant documents.




Circuit diagrams from the BIOS report on Coler's invention.

In the first chapter of the report we read the following introduction:

“Coler is the inventor of two devices that make it possible to generate electrical energy without a chemical or mechanical source. Since the German Admiralty [it is obviously about the High Command of the Navy - OKM; Note d.
Author's] officially showed interest, it was assumed that the investigation [of the devices] might prove worthwhile, although otherwise it would have been concluded that it could only be a case of fraud.

Therefore, Coler was paid a visit and questioned. It turned out that he was willing to cooperate and reveal all the details of his devices. He agreed to produce a small model [of the invention] called the 'magnetic current apparatus'.

to build and put it into operation from the materials we provided, whereby he would work exclusively in our presence. With this device, which consisted entirely of permanent magnets, copper windings and (firmly connected) capacitors, he was able to generate a voltage of 450 millivolts [0.45 V] over several hours. The next day, when the experiment was repeated, 60 millivolts were measured for a short period of time.

The device was brought along and is being further examined.

Coler also talked about another device called a 'power generator' that could supply 6 kilowatts of electricity indefinitely using a few watts of power from a dry battery. There is currently no example of this device in existence, but Coler agreed to build it from the materials provided, which would take him about three weeks.

The opportunity was taken to Dr. To interrogate F. Modersohn, who accompanied Coler for ten years and financed his work. He confirmed Coler's story in every detail. However, none of them was able to put forward even a theory that could explain the operation of these devices in accordance with generally accepted scientific views."

Another part of the report contains a summary of the most important technical characteristics of both devices (detailed descriptions including technical drawings are printed in the appendix). This information forms the background to the history of both inventions. Here is its translation:

1. The "magnetic current device" The device is made up of six

permanent magnets that

are connected to each other in a special way, so that the circuit includes both the magnets themselves and the winding. As can be seen from the diagram, these six magnets (coils) are arranged in the shape of a hexagon and form the part of the circuit that includes two small capacitors, a switch and two selenoid coils, one coil being inserted into the other. To put the device into operation, you must:

The circuit is interrupted by the switch, the magnets are pushed apart slightly and the adjustable coil is moved to different positions, whereby a few minutes must pass between the individual settings. The magnets are then pushed further apart and the coils are adjusted again.
This process is repeated until the voltmeter shows that a critical distance of the magnets has been reached. Now the switch is closed and the process continues at a slower pace. After that, the electrical voltage gradually reaches the maximum value and should be maintained indefinitely. According to the explanations, the highest voltage achieved was 12 V. The "magnetic current device" was developed by Coler and von Unruh (who died) in 1933. Franz Haid from the Siemens-Schukert company later joined the research and built a functional model himself in December 1933. This device was designed by Dr. Kurt Mie from the Technical University in Berlin and Mr. Fehr (Haber's assistant at the KWI) assessed. He concluded that the device was working and that they were unable to detect any tampering. A model locked in a room at the Norwegian embassy in Berlin in 1933 was found to work for three months. Since then, no further research has apparently been carried out on the device. [really??? – Note d. author]

2. The "power

generator" This device is made up of magnets, flat coils and copper plates connected to each other, with the primary circuit being powered by a small dry battery. The output of the secondary circuit was used to supply a set of lamps. According to the explanations, the electricity generated significantly exceeded the power consumption and was available for an infinitely long time.
Details of this circuit and a theory of its operation have been given (they are summarized in Appendix I). In 1925, Coler Prof. Kloss from Berlin
demonstrated a small 10-watt version of the device. Kloss appealed to the government to conduct an in-depth investigation, but was denied

– similar to the patent application – rejected on the grounds that it would be a "perpetuum mobile". Professors Schumann (Munich), Bragstad (Trondheim) and Knudsen (Copenhagen) also saw this version of the device. The Kloss and Schumann reports have been translated in Appendices II and III. In 1933, Coler and von Unruh built a slightly larger model that delivered 70 watts of power. It was Dr. F. Modersohn, who received confirmation of their experiments from 1926 from Schumann and Kloss. Modersohn ultimately came to the conclusion that this invention should be supported and founded a company (Coler GmbH) to continue the research and development work. At the same time, Coler was financially supported by a Norwegian group, which led to a dispute between the two groups. Due to his connections to the Rheinmetall-Borsig company and his contacts with Hermann Göring [actually with the Hermann Göring Werke company (renamed Salzgitter after the war) - note from Author], however, Modersohn gained the upper hand. Later (1937) Coler built a larger version for the company that could deliver six kilowatts of power. In 1943, Modersohn was able to interest the research department of the Naval High Command (OKM) in the device. Senior building officer Seysen was commissioned to lead the research, Dr. H.

Fröhlich was delegated to work with Coler (from April 1, 1943 to September 25, 1943). Fröhlich was convinced of the reality of the phenomenon [under investigation] and began to research the basic operating principle of the device. There are many indications that he concentrated on studying the energetic transformation processes that occurred when the induction circuits were opened and closed. At the end of this time he was transferred to BMW, where he took on solving aerodynamic problems. He is currently working in Moscow.

In 1944, the OKM signed a contract with the company Continental Metall AG to carry out further research and development work, which, however, was not carried out due to the general condition in which the country was. 1945 was the device was destroyed by a bomb in Koÿobrzeg (Kolberg), Coler was evacuated. Since then, Coler has worked sometimes as an engineer and sometimes as a laborer. Modersohn strengthened his connection to the Rheinmetall-Borsig company. He became its director and worked for the Russian authorities as an expert consultant in the field of chemical engineering.

In addition, the further part of the British report at the

In a summary of the interrogation protocol, Coler stated that, in his opinion, the magnetic field strength emitted by the magnets did not decrease when the device was operated. In other words, there was no "consumption." Coler claimed that it was a new, previously unknown type of energy, which he aptly called "space energy."

However, the most interesting part of the British intelligence report is undoubtedly the description of their investigation of a copy of the generator that was already built in Great Britain. The device had no housing so that there could be no doubt that no power source was hidden inside. The British also attached great importance to eliminating the possibility that the generator was actually drawing energy from external, artificial electromagnetic fields due to induction (e.g. from the wires present in the area). Therefore, it was placed far away from all live lines so that the remaining fields were not sufficient for induction - all that was needed was to carry out simple calculations. Nevertheless, the generator worked perfectly. For the British, this result was "inexplicable".

In the "Conclusions" section we read the following:

1. It can be assumed that Coler was not a fraud but an honest experimenter, therefore Fröhlich's assessment from the report for Seysen in this matter should be viewed with due respect.

2. The result obtained corresponded to reality in that it could be verified with the installations available, but no attempt was made to explain this phenomenon.

3. It is assumed that further research has been carried out by an expert in the field of electromagnetism theory

and that Coler's offer to build a "power generator" should be taken up.

Shocking?

The question of Coler's inventions is an interesting and important example of a concept being realized despite being inconsistent with scientific theory at the time - something that seems almost unthinkable today. It should not go unmentioned that the incompatibility with the knowledge of the time does not necessarily mean incompatibility with the current state of affairs. A series of discoveries in recent years suggest that Coler's case could have been about exploiting the so-called quantum fluctuation of the space-time continuum. This represents the source of the so-called zero point energy. Here is an excerpt from a modern popular science article on this topic: 94

> “The existence of a cosmological constant that is not zero [the 'cosmological constant' is a parameter that in physics describes the size of the zero-point energy - note d. Author's], can be interpreted as the presence of such a homogeneous medium, which, although invisible, collects within itself a certain amount of matter or its equivalent energy. This energy is also called 'zero point energy'. Quantum field theories state that the zero point energy can be either zero or very large.
> Since in this second case the cosmological constant would have to take a value that would many times exceed all observed limitations, the assumption that it is equal to zero seems most reasonable. […] However, the latest observed data say something different.” They say something **completely**

different As our press reported ...
at the end of 1999 (shortly after the British monthly *Nature)* , zero-point energy [95] represents a whopping 70% of the total energy in the universe! So it turns out that we are surrounded by an unimaginably large sea of energy, the existence of which only a few previously knew, and that, contrary to school knowledge that was dominant just a few decades ago, this sea is the dominant energy in nature. It is therefore difficult to follow the following

to avoid an almost rhetorical question: Could the discovery of the method of drawing on this infinite sea of energy be considered a millennium breakthrough?

Work in this area is currently ongoing in various countries.

# In the second part you read:

## Weapons that could have changed the course of the war

THE STORMY DEVELOPMENT OF JOINTED WEAPONS

The fire lily

The Waterfall (C-2)
The Typhoon

The Henschel Hs-117 (Butterfly)
The Rhine Daughter

The adder

Air-to-air missiles

Air-to-surface and surface-to-surface missiles

Guided bombs

Heat source homing heads

FIGHTER AIRPLANES WITH PILOT JET DRIVE

BIOLOGICAL WEAPONS

CHEMICAL WEAPONS

NUCLEAR WAFFLES

GERMAN PROJECTS IN CONSIDERATION OF THE AMERICAN

TECHNOLOGY DRAINAGE ( PAPERCLIP AND OPERATIONS ***LUSTY)***

## Decisive for the war: The ultra-secret project “Die Bell jar"

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CIOS = Combined Intelligence Objectives Sub-Committee
common message goals) pursued the same goals

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One of the numerous German responses to the Soviet Katyusha project. (Photo: ALSOS)

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