STABILIZED OPTICAL SIGHT FOR GERMAN TANK GUNS

I. INTRODUCTION

The first evidence that the Germans were interested in stabilized tank guns and sights was uncovered during the interrogation of Stiele von Heydekampf, President of the Panzer Kommission. He claimed that they first became interested after seeing our Medium Tank, M3 equipped with gun stabilizer and used in the African Campaign, and had made some experimental models of stabilizers for both the telescope and gun of a Panther Tank. He contended that the experiments were promising, but could not or would not reveal any further details.

A later investigation of E. Leitz, Wetzlar, disclosed that they had built the optical parts of a stabilized sight for the Panther, but that the gyroscopic parts had been furnished by Fa. Kreiselgerate - Berlin, and that Mr. Ernst Haass of that firm was the inventor and designer.

Mr. Haass was the only person located who was familiar with the complete design and tests of the instrument in question.

Haass claimed that he had "invented" this instrument prior to the war, and had offered his patents to Sperry Gyroscope Company, but their offer did not satisfy him. Meanwhile, there was found at the Leitz Plant, a completed model similar to the German sight, but not as refined, which Ludwig Leitz claimed had been captured on the Russian Front and was being copied and refined by Kreiselgerate and Leitz together.

Probably there is some truth in all of these conflicting accounts. It is very likely that Haass held basic gyroscopic patents which were utilized in the completed instrument. Also, the Germans started working on tank gun stabilization as a result of discovering our progress along these lines, and later became interested in their final product as a result of discovering the instrument claimed to be Russian by Leitz.

II. DISCUSSION

The design work on the stabilizer, with the exception of the optics, which were merely modifications of standard tank fire control equipment, was conducted at Berlin, and Themar/Meiningen, and all of the drawings and experimental models had been destroyed.

The original model of the stabilized sight had no provision for correcting for the inherent error caused by the delay in time between

the impulse to fire and ejection of the projectile when the gun was being accelerated or decelerated in the vertical plane. As a result, the instrument was only useful for observation while the vehicle was in motion.

Later incorporation of what the inventor calls a "pre-ignition device" overcame this difficulty. The "pre-ignition device" is actually a gyroscopic rate-of-turn indicator, sensitive in the vertical plane only, and calibrated to compensate for the time delay according to the rate of angular motion of the gun.

The completed experimental model was installed in a Panther Tank and underwent extensive tests at Kummersdorf Proving Ground, Berlin, in March 1945. Haass claims that these tests were highly successful, and that after Hitler and his aides had witnessed part of the test, he had been instructed to make necessary changes and immediately put the instrument into production. However, the end of the war came before this could be accomplished.

The claimed accuracy of the Panther Tank gun when using this sight is on the order of 1/2 mil. This is a fairly good accuracy. However, this is the word of the inventor and has not been substantiated.

III. CONCLUSION

This method of stabilization is different from that used by us, and if it is as good as claimed, the principle is worthy of consideration. Without substantiation of the inventor's claims, no conclusions of its real value can be made.

IV. REMARKS

Mr. Haass has prepared a short report, complete with sketches, describing in some detail the principal and operation of this instrument. This description is included as Appendix A of this report.

Haass also submitted with his report a proposal to complete drawings and a model, but it is recommended that this proposal be disregarded as the principal is the thing of value. This proposal is included as Appendix C for information.

The only available photographs showing a general view of the complete sight, control box, and motor generator set used for producing the AC current required for operation of the gyroscope, are included in Appendix B.

APPENDIX A

SHORT DESCRIPTION of the stabilizer for the field of view with pre-ignition gyro for the optic in a self-propelled gun:

1. General considerations
2. Task of the apparatus
3. Construction and mode of action
4. Data
5. Results
6. Sketches

1. General Considerations: It is presumed that all the considerations in this description refer only to the angular height of the gun.

There exists the desire and the necessity for the self-propelled gun to pursue the target, once it is sighted when moving, and if possible to fire at it while in motion. This task is opposed by considerable difficulties. When driving over more or less rough ground, the angular height of the gun and the optic fitted to it, change permanetly. The target appears to the observer sometimes above, and sometimes below, the hair line. This is very strenuous and tiring for the observer. For wide firing ranges, a high enlargement factor of the optic was required. However, this high enlargement factor increases still more the difficulties in the observation of the target which danced up and down in the cross hairs. An enlargement factor of two is, therefore, generally used for non-stabilized optics. This is, however, whooly insufficient for a wide firing range. Thus, if the observation of the target is very difficult while in motion, a successful bombardment is impossible while in motion. This difficulty can be eliminated when the gun barrel with the optic is stabilized by a gyro mechanism. This has been done with good success. However, this direct stabilization is suitable only for smaller guns up to 37 mm caliber. For larger guns, very big gyros must be used on account of the sharply increasing moment of inertia of barrel, recoil, and "unwucht" of the barrel. This has the disadvantage of high weight, requirement of a large space, high power requirements, and high manufacturing costs. Those factors cannot be justified by the vehicle. For large caliber guns only, the way to a stabilization of the field-of-view is left open. The field-of-view stabilizer can be built very small, light, accurate, and cheap, because it works practically without a load. Such instruments were built, but at first without pre-ignition gyro. This meant that the observation of the target was now possible without difficulty while the vehicle was moving. The target rests quietly in the crosshair and can be observed with any enlargement factor desired, this also at 10,000-m distance. However, to fire, it was necessary to

stop the vehicle and made the hairline mark of the barrel cover with the hairline mark of the observation. The installation of the pre-ignition gyro represents a further improvement. It is its task to measure the barrel's angular speed, and to effect a correction that corresponds to the firing retardation which has to be considered. This mechanism permits to fire and to hit while the vehicle is in motion. However, if the firing is done from stationary vehicle, the barrel has to be traversed from top to bottom, or reverse, in which case the firing mechanism is automatically released. This thus perfect instrument has already been constructed, and was tested with great success in the beginning of 1945. The firing results showed a mean value of $\pm$ 0.5-m deviation from the target at 1000-m distance.

2. Tasks of Instrument: The instrument has to fulfill two functions:

(a) The exit prism of a telescope that is fitted to the cradle of a gun barrel has to be steered in a manner that it does not follow the changes in angular height that occur when driving over uneven ground. Neither is it to follow the changes in angular height from the sighting axis directed toward the target that occur when the barrel traverses up and down. The gun layer has to keep the target caught in the cross-hairs and keep it there always in spite of upward and downward movements of barrel and telescope.

(b) The instrument is to fire the round by electric contact when the gun barrel traverses upward and downward just at the moment at which the barrel is at the correct angular height for the target. A potential mistake, that may be caused by the firing retardation and angular speed of the barrel, can be eliminated by a correcting mechanism that is dependent on the angular speed.

3. Construction and Method of Functioning:

Construction:

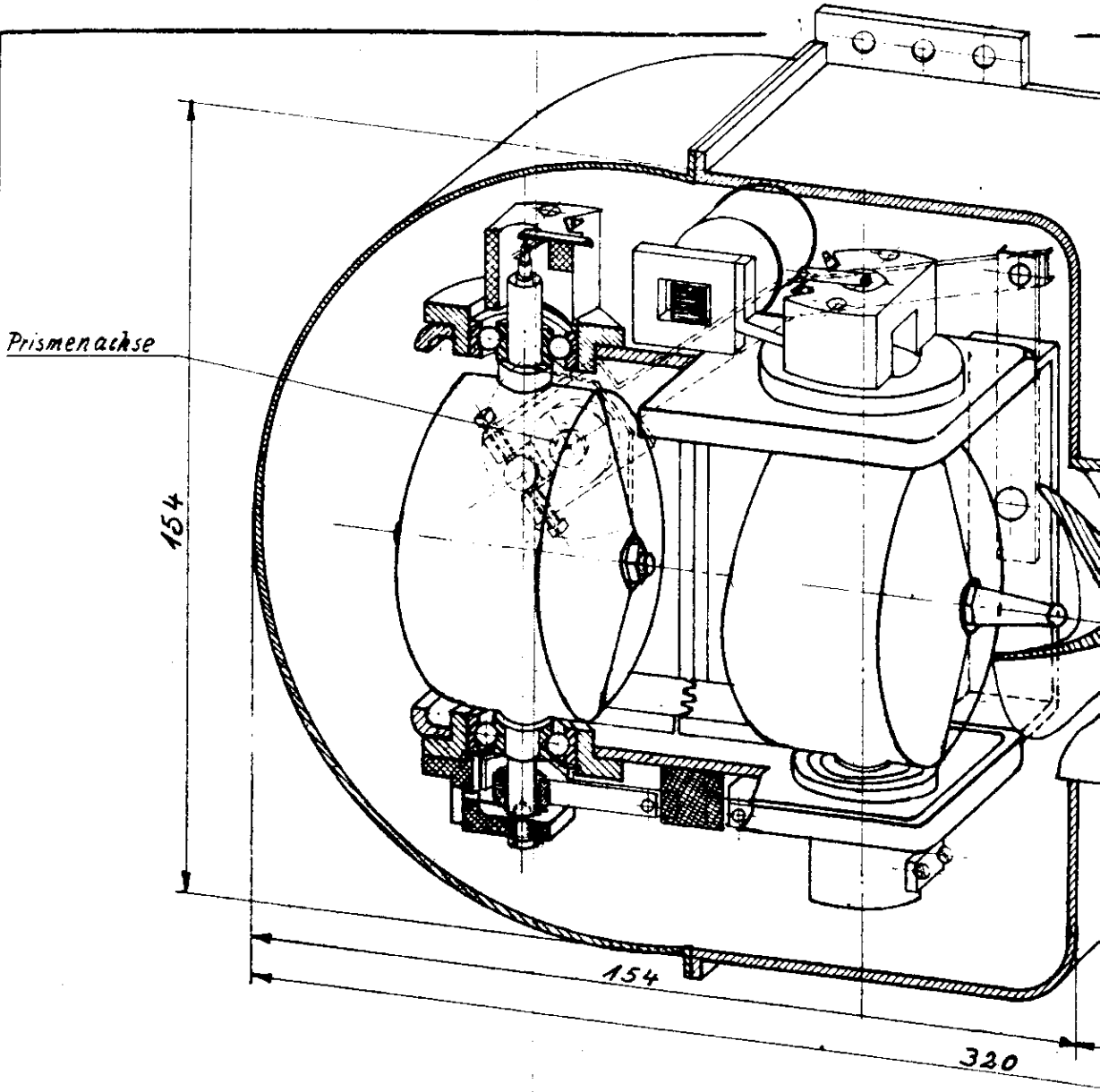
(a) The housing 1 is rigidly fixed to the gun cradle and carries pivoted on the bearings 2 and 3; the gyro carrier 4 with the stabilizing gyros 5 and 6. They are, with their precession pins, placed in bearings 7, 8, 9, and 10, respectively. The coupling of the gyros is effected by segments of gear wheels 11 and 12. The precession pins are connected with the contact mechanism 13 and 14 for the regulation of the servo motor 15, as well as the generators of the correcting torque 16. Over the lever mechanism 17, the angle between housing 1 and gyro carrier 4, is transferred to prism 18 which is located in the telescope. On the axle 19, which is rigidly connected with housing 1, the contact lever 20 is situated, which is necessary for the electric release of the firing mechanism. The lever is turned with a transmission from a small pin of the gyro carrier in accordance with the angular movement between

housing 1 and gyro carrier 4. Directly atop of it, the counter-contact "GegenKontakt" is located, which, with the lever 21 is also situated on the axle 19 and is turned over the needle 22 and springs 23 by the pre-ignition gyro 29, in accordance with the angular speed of the barrel. The screw to regulate the contact 25 is situated on lever 21. The pre-ignition gyro is located in housing 1 with its precession pins 26 and 27. It is tied by a standardized spring mechanism 28 around the precession axis in a suitable inclination. 29 is an arresting device that is affixed to housing 1, and serves to arrest the gyros 5 and 6 in their precession axis, and simultaneously to arrest gyro carrier 4 opposite housing 1. The arresting device can be activated by hand or electricity.

(b) Mode of Functioning: Housing 1 of the stabilization, as well as the optic with the prism that is moved by the stabilization, are rigidly fitted to the cradle of the barrel. The optic is constructed in a manner that the ocular is practically fixed to the turret (to facilitate observation), and the objective to the barrel. The sighting axis is maintained stabilized by the movable prism. Thus housing 1 of the stabilization follows all movements of the barrel, except the recoil.

If a target is sighted, the barrel is brought in the approximate direction of the target with the arresting device pushed home. Together with the barrel housing 1 and atop of the arresting device 9, the gyro carrier 4, together with gyro and prism 18 are moved into this position. After the arresting device 29 has been dissolved, it is possible to correct the position of the gyro carrier 4 and thus that of prism 18, while the target is observed, until the cross hairs are directly on the target. This is done by means of the regulating switch which is located in the steering box. The correcting movement is achieved by adding the effect of the regulating switch to that of the generator of the correcting moment 16, the latter causing a gyrating precession movement around the axles 2 and 3 according to the gyro law Md Jw, and thus moved gyro carrier 4 together with prism 18 into the desired position. The gyro carrier 4 now remains exactly at the same point on account of the stabilizing effect of the gyros, and together with it, over the lever 17 and prism 18. At the upward and downward movements of the gun, which is caused by the motion of the vehicle, the housing 1 is swinging in the bearings 2 and 3. In the transmitting lever, a gear reduction of 2:1 is located to balance the gear reduction 1:2 of the optical prism. The lever transmission is arranged in a manner that it does not cause any mistakes. Contacts 13 and 14 and servo motor 15 constitute an auxiliary mechanism which permits unlimited long observation of the target. If the gyros move out of their zero position, on account of the friction generated on axles 2 and 3, the servo motor 15 is switched on over the contact mechanism 13 and 14, and moves the gyros back into starting position, in accordance with the gyro law,

they thus remain permanently able to operate. The servo motor 15 is built similar to a simple alternating current motor with a short circuit "Läufer". It is located directly on axles 2 and 3 and serves solely as generator of moments, because it makes but small angular movements. The contact lever 20 is joined to gyro carrier 4 with the greatest possible exactness with a gear reduction opposite to housing 1. This lever is necessary to release the firing mechanism. The angle created between housing 1 and gyro carrier 4 is thus reproduced on an increased scale on the contact. Because the round is fired with moving barrel with the apparatus here described, the projectile would be fired at a firing angle different from that desired on account of the firing retardation. At an assumed angular speed of 20° per second, and a firing retardation of $\frac{50}{1000}$ of a second (from the electric release to the shell's leaving the barrel), a mistake $20^\circ \times \frac{50}{1000}$ sec. $= \frac{1000}{1000}$ sec. $= 1^\circ$ would have been caused. Thus, the gun would fire 1° too high when moving upward and 1° too low when moving downward. This corresponds to an altitude difference of ±17.5-meters at 1000-m distance. The lead of the contact, therefore, has to amount to exactly 1° in which case the transmission which is installed in lever 20 has to be taken into consideration. The dependence of this lead angle from angular speed and time of retardation is linear. It is, therefore, necessary to consider the angular speed of the barrel, as well as the firing retardation, by the pre-ignition gyro 24. For this purpose, the pre-ignition gyro 24 is located in bearings 26 and 27 in housing 1. Because housing 1 follows, as already mentioned, all up and down movements of the barrel, the correct relative angular speed of the barrel is always transmitted, irrespective if it has been caused by the driving or by additional manual traversing of the barrel. When the housing 1 executes rotary movements around axle 2 and 3, the pre-ignition gyro executes, according to the gyro law Md = Jw, rotating movements around the precession axle 26 and 27, whose deflection is coordinated to the angular speed around axle 2 and 3, by means of the spring device 28. By a special mechanism, it is possible to change the spring constant and its traction power in a manner as it is required by the exact standardization and timing of the instrument. The deflection of the pre-ignition gyro is linear, dependent upon the angular speed. It is transferred over the needle 22 and tension spring 23 to lever 21 with its "counter contact" "GegenKontakt". This "counter contact" is adjusted by adjusting screw 25 in such a manner that the time of connection between "counter contact" and the switch contact on lever 20 at highest angular speed, and with the necessary certainty, is sufficient to melt the ignition wire. To fire the round, the observer has to operate a push button that is connected in series with the ignition contact and built into the steering box. If under those conditions, the gun is traversed through the proper firing position, the round is fired through the levers 20 and 21. If the firing is done from a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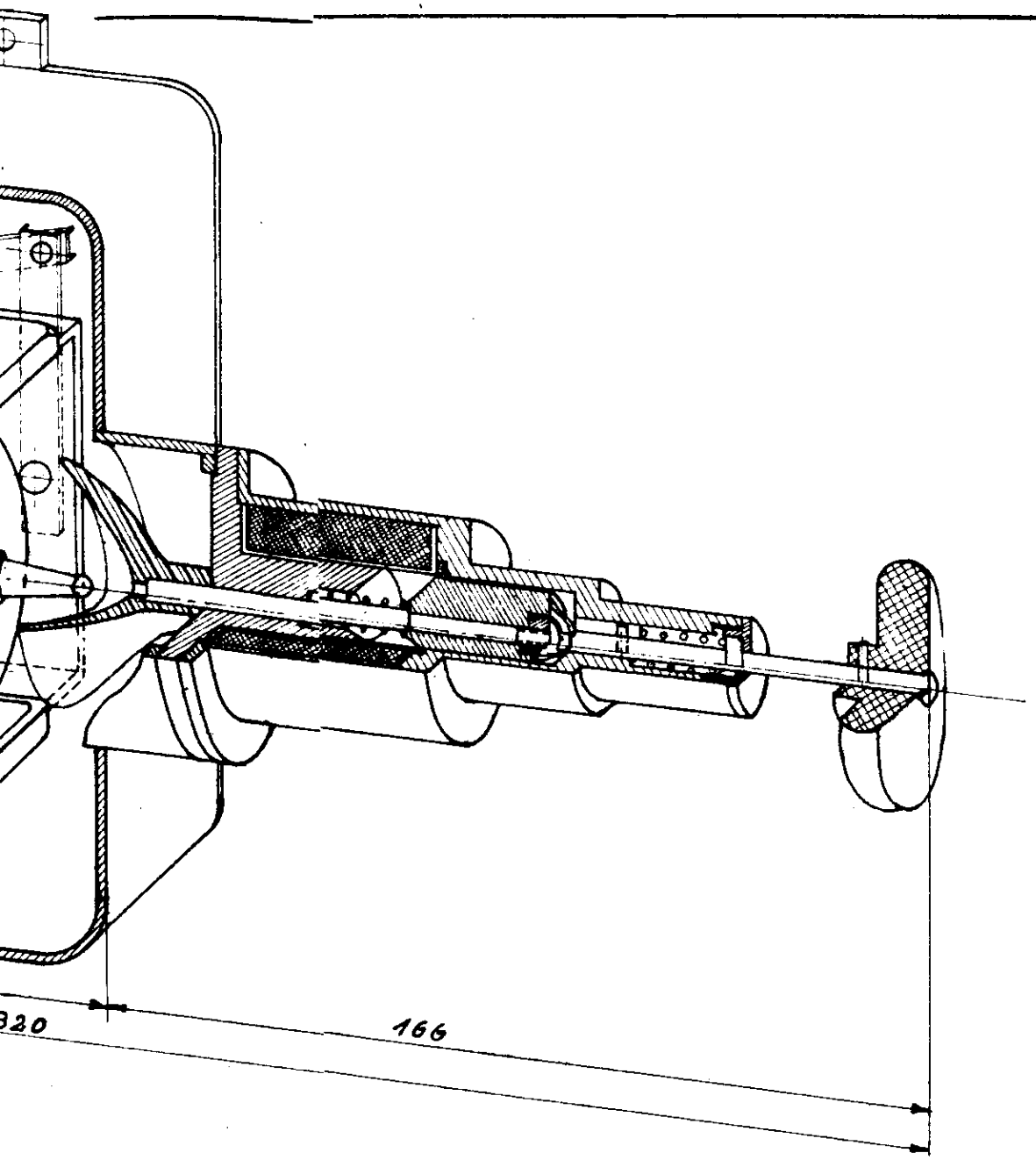

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Blickfeldstabilisierte Optik mit Vorzünderkreisel.

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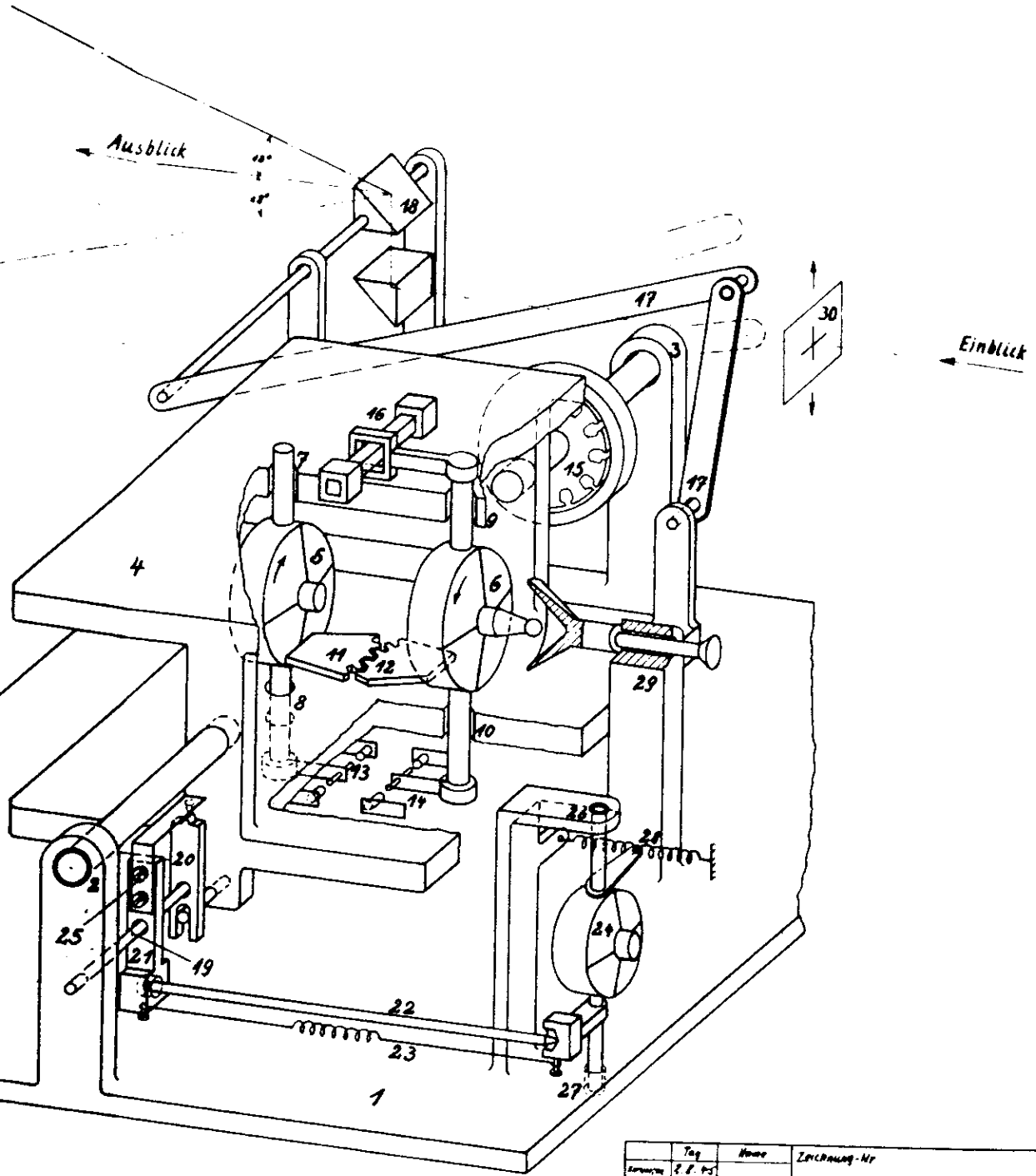

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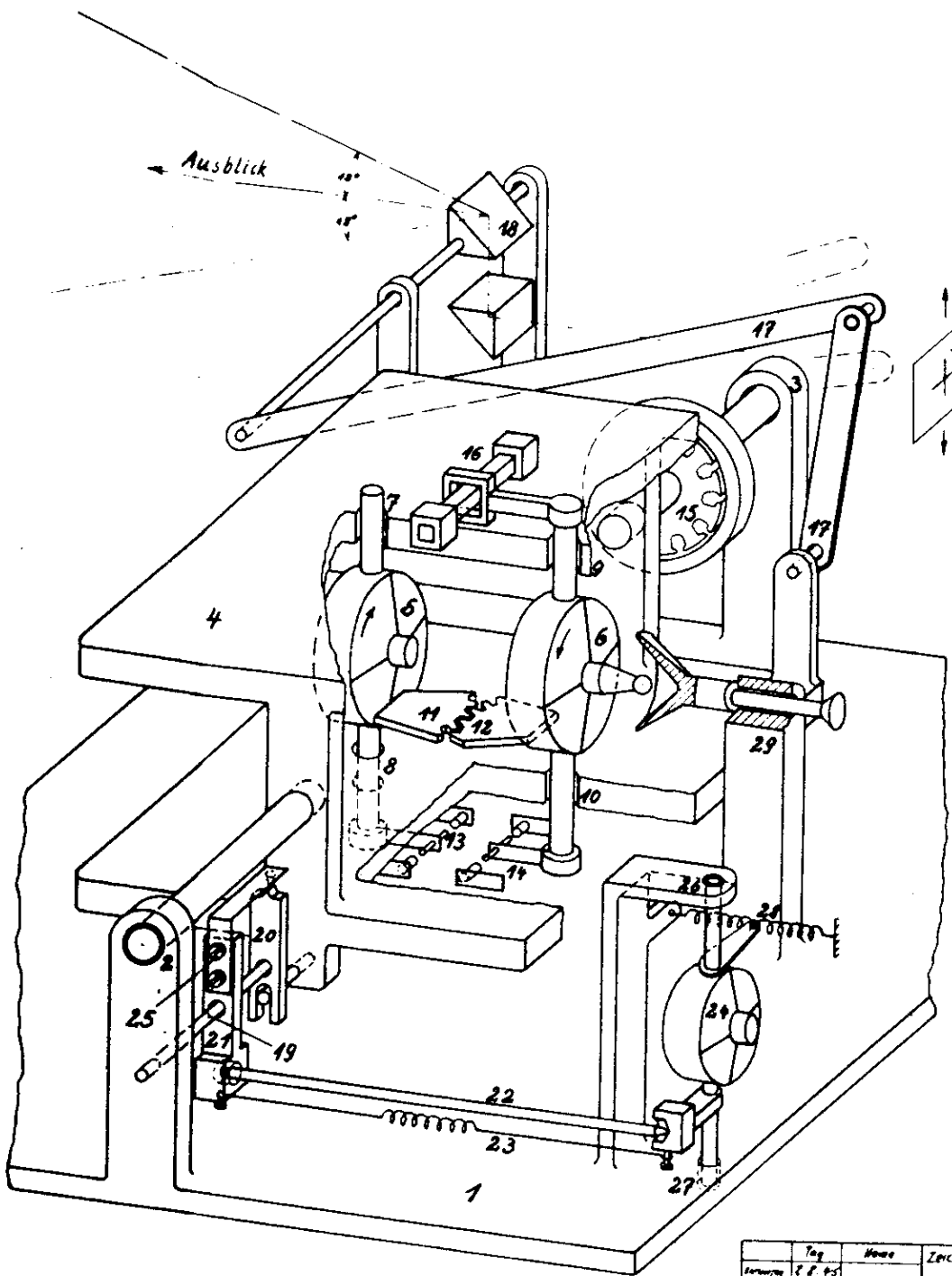
Blickfeldstabilisierung für Optik mit Vorsatzdrehkreisel

Schematische Darstellung



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Blickfeldstabilisie

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standing vehicle, the barrel has to be traversed by hand through the firing position in order to fire the round.

In principle, it would be possible to stabilize the tyro carrier 4 with one gyro only. The two-gyro system which has been chosen removes one axis of sensibility "Emptindickkeitsachse" from the instrument. Its location is chosen so as to make the instrument insensible against all lateral movements of the gun or the vehicle. Rotating movements of gun or vehicle around the axis of the barrel do not influence the arrangement of the gyros because those rotating movements are done around the rotation axes of the gyros. The instrument described, therefore, has but one axis of sensibility which coincides in the present case with the elevating mechanism.

For the sake of completeness, it may be said that the vehicle 30 which is located in the telescope is arranged suitably for shift, and that after fixing of the target distance, a corresponding angle of elevation is adjusted on this vehicle.

4. Figures and Data: To the complete instrument belongs, aside from the stabilization with pre-ignition gyro which is joined to the gun's cradle, the steering box which is located in comfortable proximity to the observer. It contains the necessary fuses and switches for the operation of the apparatus, e.g. correcting switch for elevating and lowering of optical sighting axis, switches for light and power supply, as well as switches for firing and the arresting device. Furthermore, a transformer is necessary which transforms the direct current from the battery into alternating current. The tension of the alternating current is 36-volts at 500-cycles. The gyros rotate at 28,000 RPM. The whole consumption of energy amounts to 120 watts on the direct current aside. Clean observation up to 6000-m is guaranteed at 3- and 6-fold enlargement. The angles of elevation of which this instrument is capable are $\pm$ 18°.

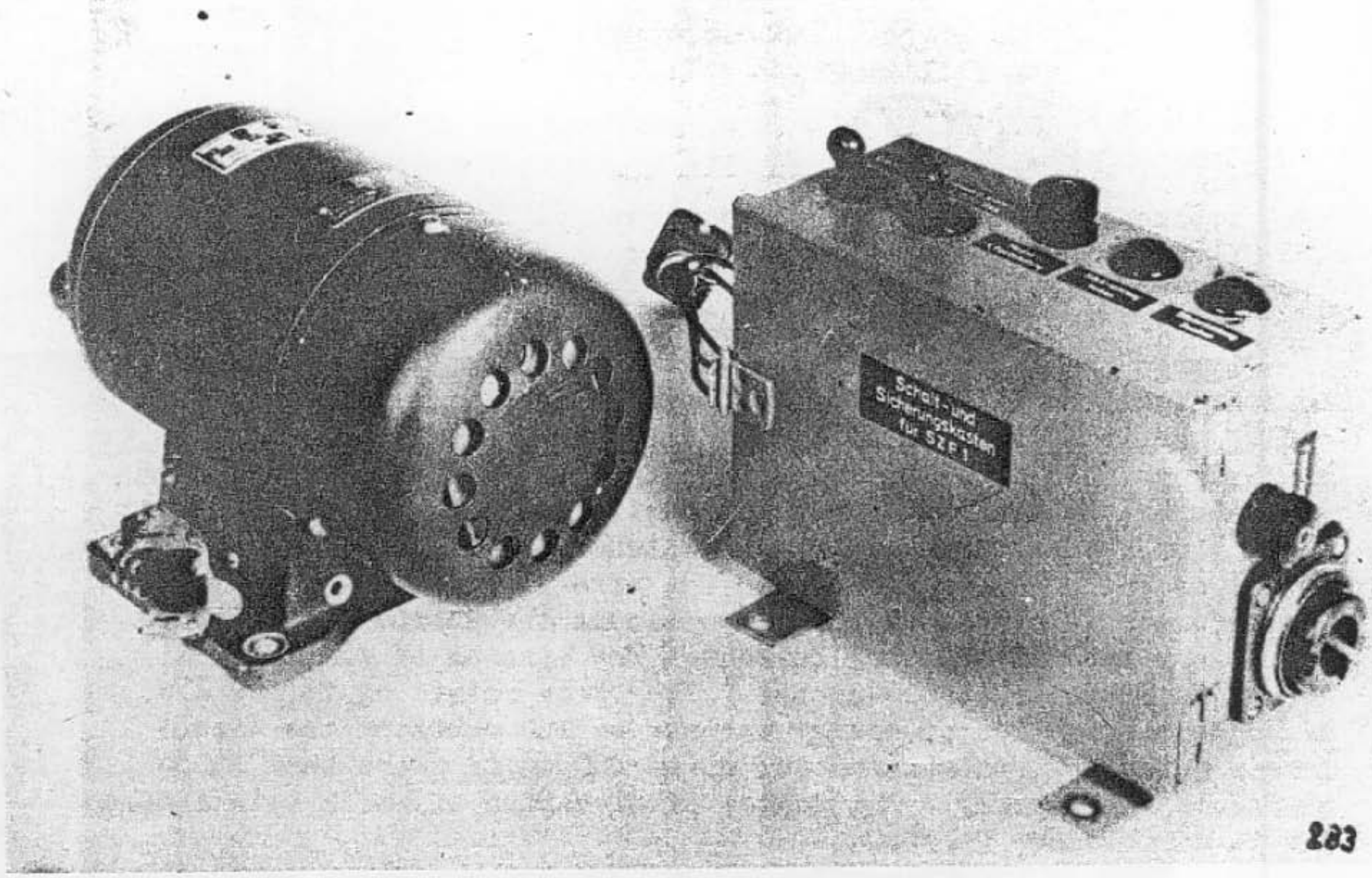
5. Results: At the first trials the instrument was tested for many hours on an artificial course. Faultless observation was possible without the observer tiring in the least. The instrument is simple and sturdy and works without the least failure.

It is completely insensitive, on account of its good arrangements of the gyros, against all movements of the gun or vehicle that are beyond its elevation.

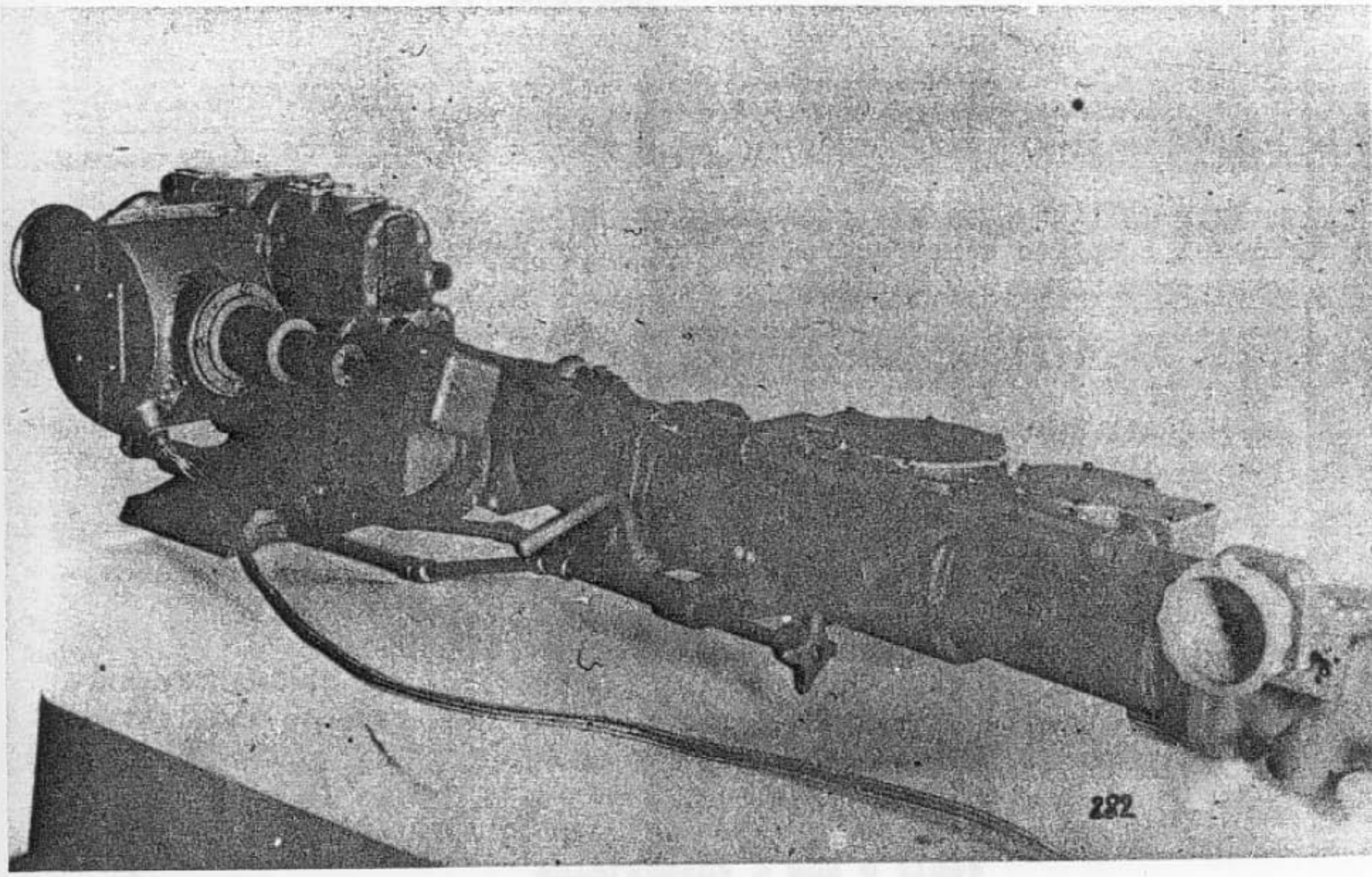
The firing resulted in a mean value of 10 rounds each in a deviation of $\pm$0.5-m from the target at 1000-m distance, corresponding to an angular value of 0.5-mil.

APPENDIX B

Complete Sight, Box, Control and Motor Generator.



Control Box and Generator



General View of Sight

APPENDIX C

Wetzlar
August 4, 1945
Stoppelberger
Hohl 9

E. Haass

OFFER

For the construction of a stabilizer for the field-of-view with pre-ignition device for the optics of a self-propelled gun.

With reference to the conversations with Major Christopher, we offer the complete construction of the above mentioned stabilizer at a total cost of 25,000 Marks.

The complete construction consists of:

All Sketches
All drawings of individual parts
All assembly and group drawings
The main assembly installation drawings
All stock lists, material list, and other compilations necessary for the manufacture
All switch and wiring plans,
As well as all manufacturing instructions for the manufacture of important individual parts, their measurements and instructions for the installation.

All the above mentioned particulars can be supplied in three months, if the work already finished is taken into consideration.

The measurements of the apparatus are:

Length	154-mm
With arresting device	166-mm
Width	160-mm
Height	160-mm

It is intended that the construction is fitted to the telescope SZF2 of E. Leits, Wetzlar. This telescope has the following data:

Enlargement 3 and 6 times
Exit pupil 5-mm
Over-all length about 680-mm

with optical joint installed, for view with immobile turret at a traverse of the gun barrel of

The functioning of the apparatus can be seen from enclosed description and schematic drawings.

We should like to point out that the above mentioned constructions are, on instructions from Major Christopher, worked on since the beginning of July and have progressed well. In this connection, we ask for a speedy order.

The manufacturing costs for a finished apparatus, except the optic, will amount in series production to 1500 Marks, according to calculations already done.

The manufacture of a prototype would be more expensive on account of manual and individual manufacture.

We as if the manufacture of prototypes is also under consideration.