W/C Newman

Telephone SPOG. Ext. 9. Maj. C BLACK RE & E SECRET.

SPOG/400

Subject:- Some Operational aspects of the German A-4 Rocket Organisation.

Commander, 307 Inf Bde.

Herewith copy of a report made by Scientific Advisors to the Air Defense Division, Supreme Headquarters, A.E.F. on operational aspects of the German A-4 rocket organisation.

This report is based on the interrogation of a number of PW now working on Operation "BACKFIRE".

W.S.J. Carter

W.S.J. CARTER,
Colonel, GS,
Special Projectile Operations Group.

C/o 307 Inf Bde
B.L.A.
20 July 45.
WSJC/WGAP

Copy to:-
Col. W.J.RAHY. C.B.E. ✓

C O P Y S E C R E T

NOTE: ALL INFORMATION IN THIS REPORT HAS BEEN OBTAINED FROM PRISONERS OF WAR AND SHOULD THEREFORE BE READ WITH THE USUAL CAUTION.

SOME OPERATIONAL ASPECTS OF THE GERMAN A-4 ROCKET ORGANIZATION

CONTENTS

Introduction.

1. This report is based on the interrogation of a number of prisoners held in preparation for Operation BACKFIRE. There is reason to believe that most of the information obtained is substantially correct and that the errors lie only in detail, figures and dates. The interrogation was conducted in order to assist in the interpretation of the findings of various teams which had been studying the CROSSBOW operation in the U.K. and on the Continent. For this reason only certain selected topics were discussed and then often only in outline. Much more information on these and other topics could undoubtedly be acquired by further interrogation. A list of the prisoners interrogated, indicating the main type of information obtained from them is given in Appendix "A".

The A4 Rocket.

2. Only one kind of A4 rocket had been used in operations. Any differences between rockets were only differences of content (e.g. control apparatus) and not in external dimensions. Similarly only one type of warhead was fitted, containing "60/40" mixture. (Amatol?). No aluminised fillings were used in operations although they may have been in trials work. Oblt RALLE (Chief of a technical battery) stated that it had been the practice to pack extra explosive charges into the empty GERAETRAUME when radio control was not being used. It was the general opinion, however, that until more sensative, or proximity, fuzing could be developed no advantage would accrue from increase in explosive effect since only increased crater size would result. Only one basic fusing system had been used, although minor adjustments had been made to the sensitivity.

Launch and Burning.

3. During launch and burning the rocket goes through the following stages :-

(i) VORSTUFE. Fuels descend into the burner under gravity only and are ignited. The stage lasts 3-5 seconds.

Turbines are then set running.

(ii) 8-TONNESTUFE (8-ton stage) lasts 1/10 sec., occurs only as a result of the order in which switching is carried out.

(iii) HAUPTSTUFE (25-ton stage). Full thrust in operation, rocket takes off. Operative until about 3 secs. before fuel cut-off (BRENNSCHLUSS).

(iv) 8-TONNESTUFE (8-ton stage). Reduced thrust operative for roughly the three secs. prior to BRENNSCHLUSS. Change over from HAUPSTUFE is operated by the I-GERAET or by radio from the radio BRENNSCHLUSS ANLAGE (B/S).

(v) BRENNSCHLUSS. Fuels are cut off either by I-GERAET or B/S.

For ignition a chemical igniter was first used. This was later replaced by the PYRO ZUENDUNG (a type of Catherine Wheel). The turbine takes about 2 secs. to reach full power after starting. The function of the final 8-ton stage is to give more accurate control of velocity at BRENNSCHLUSS. The rocket did not, and had never, taken off in the 8-ton stage. According to P/W (Lt ZIMMERMANN) this would be impossible since the thrust at that stage is not sufficient.

4. Acceleration at take-off is roughly 1 g, and it rises to about 5 g just before BRENNSCHLUSS. For the first 40 secs. after take-off the alcohol tank is pressurised by air flowing through the pipe leading from the warhead. After 40 seconds this source of pressure is insufficient and compressed air stored in the GERAETRAUM is used. After BRENNSCHLUSS the tabs on the fins are held centrally. It was not intended that the rocket should spin after BRENNSCHLUSS.

Flight Path Controls.

5. HORIZONT (pitch) and VERTIKANT (line and roll) Gyros.

Two types of gyro were used in the field. These were made by ANSCHUTZ and L.G.W. (LUFTWAFFE GERAET WERKE). Oblt GRAETZ considered the L.G.W. type was inferior. There was no great difference in the performance of the two products. The use of two varieties was due to production difficulties due to bombing.

6. PROGRAMWALZ.

The "PROGRAM" for pitch was as follows :-

Vertical climb 4 secs.

Curved Path 47 secs.

Rocket held at
Constant inclination until BRENNSCHLUSS.

No attempt has been made to control the PROGRAM from the ground (e.g. by control of the ratchet motor by the L/S beam modulations).

7. I-GERAET.

Two types were used in operations - mechanical (gyro) and electro-mechanical (electrolytic cell). They were fired indiscriminately, either type of I-GERAET being used with LEITSTRAHL (L/S). Trials had shown the electro-mechanical to be better, but Oblt GRAETZ was critical of the way in which the trial had been conducted. The method of assessment had been by proximity of pairs of rounds, and a somewhat arbitrary elimination of rounds had been made. The electro-mechanical variety required more careful handling and its performance was probably not so good in the hands of operational troops. Three subtypes of the No.1 I-GERAET (gyro) had existed. The Mk.I was only designed for ranges up to 250 kms, and was therefore useless against LONDON. The Mk.II increased this range. Mk.III included a few minor modifications, details of which were not sought from P/W. In the beginning I-GERAET gave trouble, but latterly they worked perfectly and almost none was rejected. The tolerances were never reduced.

8. Radio BRENNSCHLUSS (B/S).

The B/S ANLAGE consisted of 2 vans. The original siting requirements were that it should be within 500 metres of a point 12 kms behind the firing position on the line of fire. Later this was extended to a square 2 x 4 kms with centre 5 kms behind the firing site. The schematic layout of B/S, with the various code names of the components is shown in Fig. 1a. Operation is entirely automatic.

9. LEITSTRAHL (L/S).

The L/S ANLAGE consisted of two aerial arrays served by a single transmitter van (HAWAI). The van must be situated 8-16 kms behind the firing site, dead on the line of fire. No tolerance was allowed. The distance between the aerials had a tolerance of 6 mm, and the height difference was not to exceed 20 cms. This latter tolerance could be exceeded if the dipoles were set slightly askew to the perpendicular to the line of fire. The original requirement was for flat ground in a 600 x 800 metre square, arranged as shown in Fig 1b. This was later reduced to a flat rectangle of 100 x 300 metres about each dipole.

A L/S receiver was sited about 1 km in rear of the firing site and used to align the L/S beam. This was referred to as KOBLENZ. The only siting requirement was a free radio path from the L/S ANLAGE clear from obstructions such as walls, trees of HT cables which would interfere with reception.

10. The general principle of the L/S is to use two dipoles energised with a phase difference of about 120°. When at the correct distance apart these produce single asymmetrical forward and backward looking lobes. By altering the phase relations between the dipoles, the lobe may be switched on either side of a line perpendicular to the line joining the two dipoles. In one position the carrier frequency is modulated at 5 kcs and in the other at 7 kcs. The pulse width and interval between pulses are both 1/50 seconds. The L/S receiver (VICTORIA GERAET) receives these pulses and controls the rocket so as to keep the signal strength received from either lobe equal. The horizontal polar diagram is shown in Fig. 1c.

11. The troops in the field disliked using radio controls as they greatly complicated the organisation and procedure due both to the number of extra personnel required and to the difficult siting requirements. Oblt GRAETZ said that both Gen. DORNBERGER and H.A.P. 11 favoured radio controls. He said that graft had played a large part in the case of DORNBERGER'S opinion, and H.A.P. 11 were enthusiastic because it kept another side of their establishment in touch with the weapon.

Range Capabilities.

12. Originally methyl alcohol was used as fuel. The average maximum range with all fuel burnt was 295 kilometres with a 100% zone of ± 35 kilometres. Hence for the rocket to reach the target in 100% of cases without having run out of fuel before BRENNSCHLUSS the target must not be more than 260kms away from the firing site. Allowing a 10 km safety factor this fixes the maximum operational range at 250 kms. Faulty rounds are neglected and the range distribution is assumed to be Gaussian.

13. Originally the minimum operational range was 120 kms, being determined solely by the fact that the range tables (compiled by Oblt. GRAETZ) did not go below this range. Since the range between THE HAGUE and ANTWERP was less than this range tables were prepared for ranges down to 80 kms. These ranges were never in fact used. 80 kms is the absolute minimum for the rocket in its present form since the minimum burning time is fixed at 45 secs by the existing switching motor (ZEITSCHALTWERKE).

14. Use of ethyl instead of methyl alcohol adds 17 kms to the maximum range. With ethyl alcohol 50% of rockets aimed at a range of 312 kms will achieve the required velocity before expending the available fuel. The range to the 'STADTMITTE' of LONDON was of this order. Ethyl alcohol was used in all rockets fired against LONDON from early in October onwards. In order further to improve the maximum range performance of the rocket it was decided at the beginning of December to increase the thrust by increasing turbine speed. This was accomplished by alteration of the setting of the pressure reducing valve of the turbine to raise the pressure by 4 atmospheres above the normal value (varied 25 - 36 Atm). The expected increase in range was approximately a further 18 kms. Thus from THE HAGUE the average maximum range was to be 330 kilometres. With this system roughly 60 - 70% of rockets should before running out of fuel achieve the necessary velocity to arrive at the LONDON aiming point. Rockets may go as far as 360 - 380 kms allowing all fuel to burn, and ranges as high as 425 kms are on record. So far as is known optimum range considerations were not taken into account in choosing firing areas.

Effect of increase in turbine speed on misfires.

15. In practice, the increase of 4 atmospheres at the turbine seriously increased the proportion of rounds which disintegrated or otherwise failed during the period of burning. The cause of this was not cleared until the beginning of February, and for 2 or 3 weeks during January the additional pressure applied was 2 atmospheres instead of 4. The range table data used, however, assumed the full increase and therefore these rounds may be expected to have fallen short (see later section on trajectory).

16. In the rocket there is a centrifugal switch attached to the turbine which will cause BRENNSCHLUSS if the turbine races. Racing will occur if the A-STOFF should vapourise in the pipe leading to the turbine, owing to the decrease in resistance offered to the pumps. Increase in the r.p.m. of the turbine increased the chance of this happening, and hence of misfires. To correct this the pressure in the A-STOFF tank was increased from 2 to 2.1 atmospheres. Attached to the rocket is a relay which can be operated to shut off the fuels while the rocket is still on the table if it is seen that the flame is not burning correctly. Increased vibration due to the increased r.p.m. of the turbine caused this relay to operate from vibration alone after take off. An arrangement was therefore made to de-energise the relay on take-off. In general increased vibration probably gave rise to, or at least aggravated, several other causes of misfire of which about eleven are known to Oblt. GRAETZ.

17. Effect of increased thrust on the trajectory.

Originally, before the r.p.m. of the turbine were increased, the angle at all burnt was 47° to the vertical. Increase in the r.p.m. decreased the angle to about 42° using the same PROGRAM. This resulted in a much higher trajectory, and the range tables were therefore recomputed. As noted above, in order to decrease the number of misfires, the turbine was not given the full pressure increase during January. The new range tables were, however, used to compute the I-GERAET and B/S settings. The fall of shot during this period would therefore be biassed short. Oblt. GRAETZ estimated that the angle at all burnt would have a 100% zone of $\pm 5^{\circ}$ about the mean. Variations were generally thought by the P/W to be due to variations in thrust performance rather than in the functioning of the PROGRAMWALZ.

Accuracy of performance.

18. Thrust and BRENNSCHLUSS.

Kine-theodolites had been deployed at the HAGUE towards the end of the operation. Only a cursory investigation of the results was undertaken. The Kine-theodolites were deployed by HAUPTM. BECK and he was assisted by Lt. THIES (P/W). The latter knew nothing of the results. Oblt. GRAETZ had visited the HAGUE and seen the results. He had noted that in line the rockets tended to follow a sinusoidal course with roughly a half-period of 40 secs and an amplitude about 300 metres. In good visibility rockets could be followed out to about 150 km. Lt. LOHMANN, who was in charge of KTs at AHAUS, said, however, that the films were not readable beyond BRENNSCHLUSS although visual following was possible. Oblt. GRAETZ would not say whether the sinusoidal path was indeed a fact and not merely a function of the recording. It was also found that BRENNSCHLUSS showed considerable spatial dispersion which was considered was due to variation in thrust performance. Low trajectories were due to low thrust performance. The type of variation is shown in Fig. 1d. Thrust varied between rockets, and also during the burning of individual rockets. This situation might have been improved by having proper regulation of A and B STOFF supply. (See para 22). There was a kink in the acceleration curve due to the changeover to supersonic speeds.

Fall of Shot.

19. The German ballisticians had considered the fall of shot pattern would be Gaussian, but Oblt. GRAETZ considered that it would be platykurtic. He gave the following estimates of performance :-

	Type of Control	50% Zone at 250 kms
LINE	Mechanical	± 8 kms
	L/S	± 2 kms
RANGE	I-GERÄET I	± 8 kms
	I-GERÄET II	
	B/S	± 8 kms

H.A.P. 11 claimed that B/S was the most accurate method of range control, but it was considered that the limited nature of their trials did not make their results significant. The Regt Commander of GRUPPE SUED (MAJ SCHLESIGER) estimated that the proportion of shots which had fallen in the neighbourhood of the launching site at 8-9%. He thought GRUPPE SUED was better in this respect than GRUPPE NORD.

Airburst and Air Break-up.

20. Three types of event were recognised:

1. Deep crater - due to faulty fuze-action.

2. Small crater - correct fuze-action.

3. Airburst and air breakup.

Air breakup was considered to be partly due to weakness in the region of the GERÄETRÄUME and of the conical part of the front of the B-STOFF tank. This becomes critical when the rocket strikes the atmosphere on descent, the structure collapsing and the outer cover being stripped off. To overcome this the relevant parts were strengthend.

21. The causes of air detonation were not properly known. OBLT GRÄETZ suggested that the causes were:

(a) Shattering of the glass nose and consequent operation of the fuze.

(b) Instability of the exploder.

(c) Spontaneous ignition of the explosive owing to high temperatures (600-700 degrees C).

He gave as his estimate of performance against the U.K.:

25% Air breakup

5% Air burst

60 - 70% In London.

The glass wool was introduced by H.A.P. 11 to reduce airbreakup, but OBLT GRÄETZ did not consider it to have been of much use.

Suggestions for improvement of the A-4 - Oblt CRAETZ.

22. Range Accuracy.

1. Minor improvements to the I-GERAET.

2. Making the PROGRAM a function of time and distance (double integration). This would make the rocket follow a single trajectory independent of variations in thrust. No attempt at double itegration has yet appeared in practical form. (Note. Wachm. BRINK had a proposal for improvement in this direction).

3. More accurate thrust control.

4. More satisfactory regulation of the supply of A and B STOFF to the burner.

Line Accuracy.

1. Development of an itegrator for yaw which would correct the rocket on to the required path.

2. Improvement of roll control. Roll in the first vertical part of the trajectory is a major source of error.

3. Maintenance of flight controls after BRENNSCHLUSS.

Increased Range.

1. By regulation of the supply of A and B STOFF (see para. 18). This would ensure more efficient burning and would both increase the maximum range and, by decreasing of the range scatter of burn-outs, increase the accuracy.

2. By the use of bigger fuel tanks.

By these means a range of 400kms could probably be satisfactorily reached.

General.

1. Reduction of misfires and airburst/air break-ups.

2. Increase in explosive effect by use of a more sensitive fuze.

General.

23 Deterioration in accuracy during March 1945.

C. C. C. S. Air Defence Division, SHAEF had found that the concentration of fall of shot showed a statistically significant decrease for all firing units during March as compared with previous results. No technical reasons could be advanced by P/Ws to explain this. Oblt RALLE (O. C. Tech Bty., Gr SUED) suggested that decreased efficiency and application of servicing and firing troops as the reason. He said he had noticed some signs of a decline in the efficiency of his men, but considered the steps he had taken to stop this were effective. He considered that his men were as good as could be expected, although his various shifts varied widely in their enthusiasm and efficiency If this were the reason he would expect the effect to have been less marked in his Bty than in others.

Firing the A4 from trains.

24. Hptm. MUELLER stated that work had been done on this project which was Gen. KAMMLER's idea. The advantages were :

1. All fuels and GERAETE could be stored in the train.

2. Rockets could be set up and prepared in a tunnel and wheeled out when ready to fire.

No such scheme was ever put into operation. The heavy concrete installation at ST. OMER in the PAS DE CALAIS was to have operated in this manner, but when almost complete it was destroyed by bombing.

25. Firing A4 from submersible platforms at sea.

Work had been done on this scheme according to Oblt. GRAETZ. The principle was that a large platform carrying all necessary equipment and fuel was to be towed into position by a U-boat. The whole platform would submerge after firing. Oxygen was to have a separate container. It was hoped to fire at NEW YORK in this manner. Work on this project was broken off in the summer of 1944 by order of Gen KAMMLER.

26. Vapour Trails.

Oblt. GRAETZ considered the wavy disorganisation of vapour trails after formation to be due to meteorological effects. No attempts had been made to suppress vapour trail formation. The enemy had apparently not envisaged the trails being used to pin point sites by ground observation and since they only form above normal operational heights for aircraft it was considered that they could not be used to find launching sites from the air.

Miscellaneous weapons.

27. HOCHDRUCHPUMPE.(TAUSENDFUSSLER) - 705 Bty.

This batterie was under command of Division z.V and attached to 901 Regt. The weapon consisted of a tube some 30 metres length along which were 4 or 5 chambers. The tube was aligned on the target at a Q.E. of approximately 40° being supported on the reverse slope of a hill. The shell is of ordinary artillery shape with no fins, calibre roughly 150 mm. The chambers contain power propellant, and as the projectile passes up the tube the chmbers fire in turn. It was used in operations from the TRIER area (L22) against LUXEMBOURG. Preparations had been made to use it against MULHOUSE during January and February. Oblt. GRAETZ confirmed that this weapon on a larger scale was to have been used from an underground installation in the PAS DE CALAIS (MIMOYECQUES?).

28. RHEINBOTE - 709 Bty.

This batterie was also under command of Div. z.V. and was attached to 902 Regt. It was a three stage [illegible] rocket fired from a MEILERWAGEN with the cradle elevated to the required Q.E. The projectile was roughly 12 metres long, calibre about 200 mm. During flight the powder containers are dropped off when they are used up. It was described by Oblt. GRAETZ as a wildly inaccurate weapon capable of falling at any range from 30 to 320 kilometres. It had been fired at LIEGE and BRUSSELS.

Organisation.

29. The relations of the Division z.V. to higher formations is shown in Fig.2. Fig. 3 shows the internal organisation of the Division at the beginning of the operation, while Fig. 4 shows the detailed organisation of one of its ABTEILUNGEN. Experience in the field showed that three batteries were too great a responsibility for a single ABTEILUNG and on the 20th of January 1945, the division was reorganised. The former ABTEILUNGEN became REGIMENTEN and the BATTERIEN ABTEILUNGEN. The new organisational layout is shown in Fig. 5

Movements of Firing Units.

30. LEHR and VERSUCHSBATTERIE 444

Firing was opened by this batterie on the 8th September 1944, when two rounds were fired against PARIS from FRACTURE (P.5885) in the ARDENNES. While here the batterie was under the tactical control of 836 ABTEILUNG and was supplied by road from EUSKIRCHEN. The batterie then moved to SEROOSKERBE (D.1336) on WALCHEREN ISLAND. The batterie occupied this position from 16th to 18th September. 6 rounds were fired at LONDON, one of which fell in the sea. Rockets came by road from BERGEN OP ZOOM (D.6027) and fuels from GOES (D.3329) in ZUID BEVELAND.

31. Following the air-landings at ARNHEM the batterie withdrew to RIJS (Z.4975), a position it occupied from the 21st September until the 20th October 1944. About 80 rounds were fired in all. 10 or 12 of these were aimed at ANTWERP, 3 or 4 at GREAT YARMOUTH and the remainder at NORWICH. There is no basis in the suggestion that any trials were being undertaken during the firing at NORWICH. The first two rounds fired at ANTWERP were aimed at the town, subsequent rounds at the docks. Both rockets and fuels were originally supplied from STEINWIJK (Z.9167) and latterly from SNEEK (Z.6095).

32. The batterie then moved to THE HAGUE and occupied positions there from the 23rd October till the 27th of January. During the period from 1st November to 20th December the batterie was alone at THE HAGUE. During this period it was strengthened by the attachment of one firing troop. All rounds fired were aimed at a single point in LONDON. Great uncertainty seemed to exist as to the geographical position of this aiming point. While most P/W interrogated considered the "STADTMITTE" to have been the point of aim, one prisoner said it was the dock area.

33. At the end of January the batterie withdrew to KARLSHAGEN to undertake trial firings designed to remove minor faults from the equipment. No firings took place as Gen. KAMMLER had ordered that all rockets produced must be used operationally.

1/485 later to become I/902.

34. This batterie deployed at THE HAGUE at the beginning of the operation and fired at LONDON. On 18th September it withdrew to LEGDEN (A.5782) and fired at TOURNAI, HASSELT, CHARLEROI and ANTWERP until the 17th December when the unit returned to THE HAGUE. It remained there until the general withdrawal at the end of March 1945.

2/485 later to become II/902.

35. This batterie was also initially deployed at THE HAGUE and withdrew on the 18th September to AHAUS (A.5087) where for ten days it fired at TOURNAI, HASSELT, CHARLEROI and MAASTRIGHT. At the beginning of October it returned to THE HAGUE where it remained until the beginning of November. During this period LONDON was the only target. In early November the batterie withdrew to BURGSTEINFURT (A.7395) and remained there until the end of active operations, firing at ANTWERP.

3/485 later to become III/902.

36. This batterie was originally deployed in the AHAUS area and moved to THE HAGUE about the middle of January. It remained there until the end of operations.

-8-

SS WERFER ABT. 500.

37. This batterie deployed at OMMEN (V.1135) about the middle of November 1944 and remained there until the conclusion of the operation. All rounds fired were against ANTWERP except for 11 fired against REMAGEN. All supplies passed through OMMEN, but towards the end oxygen was being brought by road all the way to the firing positions as bombing was seriously interfering with rail communications. The order to fire at REMAGEN came from HITLER, one day's firing only being sanctioned. The target was the area of the crossing and not necessarily the bridge itself. The exact aiming point was not known.

1/836 later to be I/901.

38. At the beginning of the operation this batterie was firing in trials at TUCHEL. It was first deployed operationally about the 23rd of October 1944 at REINSFELD with its firing site near L.3621 and TECHNISCHE Batterie deployed near L.3926. Rockets were unloaded at POELERT (L.4625). ANTWERP was the only target engaged.

39. About the 1st December 1944 the batterie moved to MONTENAUR occupying firing positions along the road between G.009012 and G.018009. The technical batterie was situated along the road between F.997053 and 991028. Rockets were originally unloaded at GOLDHAUSEN (G.0906) and later, after an air attack on HADAMAR (G.2206) at RANSBACH (F.9907). Oxygen was unloaded at WIRGES (G.0307). The fuel batterie was located at first at VIELBALCH (G.0211) and after the 1st February at DERNBACH (G.0306).

2/836 and 3/836 to become II/901 and III/901.

40. These batterien were first deployed together near ROTTGEN, the firing sites being near F.5328 and TECHNISCHE Batterie at F.5231. Rockets were unloaded at HEIDGEN (F.4932). From this position the batteries fired at ANTWERP, LILLE, TOURCOING, ROUBAIX, CAMBRAI, ARRAS, LIEGE and HASSELT. After three weeks the two batteries moved to HACHENBURG and fired from platforms along the road G.023226 - 033028. The TECHNISCHE Batterie was situated at G.060205 and all equipment was unloaded at SELTERS. ANTWERP was the only target engaged from now on. After about 5 days, during which time 30 rockets were fired, both batterien moved to GREIMERATH. The firing platforms were in the vicinity of L.2107 and the TECHNISCHE Batterie L.2309. All stores were unloaded at NIEDER ZEIF (L.2412). 2/836 left towards the end of this period for KARLSHAGEN and 3/836 moved to HERMESKEIL where it had firing platforms in the area of L.5730. The Technical Batterie was situated near L.5227. Rockets were unloaded at DHRONECHEN (L.4625).

41. About 4th December the batterie moved to HACHENBURG and operated from firing platforms along the road from G.047243 - 055270. The TECHNISCHE Batterie was along the road from G.090267 - G.080280. Rockets were unloaded at KORB (G.1028) and taken on VIDAL waggons to the technical battery by way of ALPENROD (G.0926). In snow and when the roads were bad, the crane which moved the rockets from the VIDAL WAGGEN to the MEILER WAGGEN was moved from the vicinity of the technical battery (G.078283) to the firing site (G.055269) so that the rockets could be carried further on the lighter transporter. A route through HACHENBURG instead of ALPENROD was used. Movement of rockets along roads by day was concealed by a smoke screen. Oxygen was unloaded at HACHENBURG and alcohol at SELTERS. The unit remained in the area until the end of the operation.

42. II/902 returned to GRUPPE SUED in January but did not commence firing till the middle of February. Their sites were on the roads running north-west from KIRBURG (G.1330). The battery shared technical and supply facilities with III/901.

Aiming Points

43. Only two aiming points in ANTWERP were used after the first weeks. These were the docks and the STADTMITTE. Aiming points were normally passed as coordinates from Division and the computing section of the battery converted these to range and line, including the necessary corrections for earth's rotation etc. The range ordered was then corrected for the constants of the individual rocket (KINDERKRANK). According to Major SCHLESIGER the aiming points for 836 ABTEILUNG was the town from the 25th October to 1st December. He estimated that after December 1st 700 rounds were fired, of which 500 were aimed at the docks. The aiming point in LONDON is discussed in paragraph 32 above.

44. Organisation of the technical batteries.

The main function of the technical batteries was to inspect the rockets before firing. Inspection was carried out on the VIDEL waggon and after inspection the rocket was moved on to the MEILERWAGEN by crane and taken to the firing site. The technical battery was organised in two shifts, while the firing battery had only one. 20 rockets came im each train together with warheads and carbon vanes. When GRUPPE SUED was in the COBLENZ area the contents of the rocket trains went to the two technical batteries alternately. While normally I-GERAET were fitted at MITTLEWERK, supply often lagged behind and they were fitted by the technical battery.

Filling the rocket with fuel.

45. The first operation is to fill the alcohol tank. This process takes 20 minutes. While this is going on the tubes necessary for oxygen filling are attached to the rocket, a process taking about 10 minutes, and the T-STOFF (hydrogen peroxide) is measured out, a process also taking about 10 minutes. After measuring the T-STOFF tank is filled. After some alcohol had been put in the tank, the sealing ofall pipes and joints is checked. If this is found to be satisfactory oxygen filling cam commence. Originally two oxygen carrying vehicles were used and the process of filling took 20 minutes. Latterly a single larger tanker was used and the filling time was reduced to 10 minutes. Finally the Z-STOFF tank is filled.

46. The procedure by night was the same as that employed by day, but if camouflage were good the rocket might be set up and checked by day and fuelled and fired by night. Towards the end of the operation, when fuels were much delayed in transit, rockets were often set up and inspected so that they could be fired as soon as possible after the arrival of the fuel. This was, however, only dome if it was considered that there would be little or no likelihood of air attack.

Utilisation of Operational Data.

47. Very little use appears to have been made of the data accumulated during the operation. The methods of trajectory measurement described below (para 63) were largely regarded as checks on performance. While it was nominally the duty of W.A. PRUEF 10 to study operational performance, they appear to have done very little. Some investigations were, however, undertaken under the direction Ia Tech at Division. There is no suggestion that the operation was in any way regarded as a large scale trial.

Anti-jamming.

48. Attached to Div. z.V. was FUNK HORCH ABTEILUNG 1192. At the beginning of the operation this had its headquarters at UEDEM (E.9843) and moved om 23rd September 1944 to BRECKERFELD (A.8296). This unit had originally two functions:-

(1) To report and examine any jamming or interference that occurred on operational frequencies.

(2) To transmit camouflage signals in the hope that any jamming would be directed against these rather than the genuine signals.

Frequency Monitoring.

49. Frequency monitoring receivers were situated at Headquarters - "COMPANIE". Communications between firing positions and COMPANIE were by W.T. Fig.6 shows the W.T. Layout. Three monitoring receivers were used. One for the L.S. receiver, one for the VERDOPPLER and one for the control receiver (HONNEF).

50. The layout of the L.S. monitoring receiver is shown in Fig. 7a. On the receipt of a report of interference from listening posts at headquarters, the MODELSENDER which was a copy of the LEITSTRAHL transmitter was switched on. The MODELSENDER and VICTORIA GERAET could be tuned to the range of 9 operational frequencies. Any interference, together with the normal signal, passed through the VICTORIA GERAET. Observation of the microammeter showed whether the unwanted signal would result in deflexions being ordered by the L/S receiver. The character of the interference could be studied with the oscillograph and associated equipment. Operational frequency 3 was always used.

51. To check the effect of interference of the VERDOPPLER the type of system shown in Fig. 7b was used. The fundamental and doubled frequencies were both checked. The effect of any noise on SALERNO could be directly observed and its character examined using the cathode ray tube and ancillary equipment. A similar arrangement was used to study the effect of interference on HONNEF, the audio tone filters being altered to agree with those in the particular control receiver to be used by the battery about to fire. The usual operational frequency for the VERDOPPLER and HONNEF was No. 5.

52. The firing batteries would transmit through GEIGAND or LUCKE (see para. 55) information about the controls to be used. The reports to COMPANIE were in the following form:-

Message No.		Comment
1	X - 90	90 minutes before firing
	Batterie	
	Rot 5	HONNEF frequency 5
	Gruen 5	VERDOPPLER frequency 5
	Gelb 3	LEITSTRAHL frequency 3
	Gruppennummer Schluesselstecker	Indication of audio frequency filters for HONNEF
	Target No.	
2	X - 10	
	Batterie	
3	X - 5	
4	Shot	Transmitted as a long dash.
5	Firing time	
	Batterie	
	Rot 5	
	Gruen 5	
	GELB 3	

Gruppennummer

Schluesselstecker

Target No.

53. The times X - 90 etc. correspond to the following physical events:-

X - 120 Rocket brought to firing position

X - 90 Rocket erect

X - 60 Completion of inspection. Beginning of fuelling

X - 30 End of fuelling

X - 15 Lining up on table.

X - 5 End of final inspection

X - 1 Firing connections made.

54. The deployment at BRECKERFELD was augmented by mobile vans built to monitor the performance of the VERDOPPLER and the L/S apparatus. The former (Ofahn SIMON) was deployed in January at DEDEMSVAART (V.1345) near ZWOLLE and then moved to THE HAGUE. Oscillograph records were taken. The L/S monitoring equipment (Ofahn WROOST) was deployed for a short time near ZWOLLE. No oscillograph records were made. Interference reports from both monitoring units normally went back to COMPANIE by the usual channels and not by W.T. Despite the many elaborate precautions interference was never a serious operational problem.

Camouflage transmissions.

55. In order to sidetrack Allied jamming efforts two stations transmitting special signals were set up. These operated on frequencies slightly removed from the correct operational frequencies and the signals were differently modulated. At the beginning of the operation one "TARNSENDER" station was deployed with each GRUPPE. The TARNSENDER for GRUPPE NORD (Lt. GEIGAND) was originally deployed near HAARLAM (Y.8825). About the middle of September this station moved to BILLERBECK (V.6975) and remained there till the end of the operation. The station with GRUPPE SUED (Lt. LUCKE) was initially at WEILER (L.5690) in the EIFEL, it moved about the 20th September to RUESCHEID (F.8714) where it remained until the 7th. October. The station then moved to OTTWEILER (Q.5889) until the 3rd December when it returned to RUESCHEID where it remained until the end of January. It was then decided to move the station forward to THE HAGUE as it was considered possible that the transmissions were not being heard. The station arrived at THE HAGUE, on the 4th Febuary and remained there until the end of the operation. When the TARNSENDER moved from GRUPPE SUED to THE HAGUE, a W.T. station was left behind for communication with COMPANIE.

56. Each station normally consisted of four transmitters. Two sets of transmitters were deployed at THE HAGUE to correspond with the two main launching areas as it was considered that agent reports of a single set of transmitters might have given a clue to their real function.

57. At each station one transmitter was supposed to resemble the VERDOPPLER one the HONNEF and one the LEITSTRAHL transmission. The three transmitters broadcast at the appropriate times for approximately the correct interval.

The fourth transmitter gave signals which were intended to correspond approximately to the last ten seconds of flight. For this purpose the firing battery had to pass the TARNSENDER the expected time of flight. The character of the broadcasts was invarient, all four transmissions being made regardless of the type of the control gear in the rocket. The frequencies used by the GRUPPE SUED transmitters were changed only once, namely when they were moved to the HAGUE. The GRUPPE SUED transmitters originally transmitted for every rocket fired, but latterly for only about one in every three. Transmissions unaccompanied by rockets were also made so that they could not be used as a form of early warning. This practice was discontinued when the transmitters were deployed at the HAGUE.

58. Communication was normally by W.T. but at the HAGUE, where the transmitters were sited at WASSENAAR and SCHEVENINGEN, line was used. Continuous warning messages of time from fire, in the form X - 90, X - 60 etc. were passed from the battery. Latterly these messages were omitted as there were many other things to do. (It is not clear whether this refers to transmissions from Batterie to TARNSENDER of from there to COMPANIE).

59. The powers of the transmitters were as follows:-

Type of transmission	Power (normal) watts	Power (as used at THE HAGUE) watts
LEITSTRAHL	100-120	100-120
HONNEF	800	100-120
VERDOPPLER	100-120	100-120
FOURTH TRANSMITTER	800	100-120

60. For fall of shot location (see para.68) the VERDOPPLER was sometimes modified to transmit during the whole time of flight. The type of camouflage transmission was not altered in these circumstances. If two sites were launching at nearly the same time the second rocket was not covered by a transmission so that observations of the signals from the first rocket would not be disturbed. The transmissions were made only for whichever battery reported X-10 first.

61. An investigation was made at THE HAGUE by Lt. LUCKE to see whether there was any interference on his camouflage frequencies. Interference was reported by W.T. to COMPANIE in the following form:-

Frequency 30.4 M Hz

Frequency covered 29.8 - 31.2 M Hz

No modulation

1012-1125 hrs.

Not deliberate

Signal strength 3.

Some interference was detected, but its origin was not known.

62. Every evening a summary was given by stations GEIGAND and LUCKE on their activities. This was made by W.T. if possible. Conditions for transmission in GRUPPE SUED were generally unfavourable and line was used instead.

Observation of Fall of Shot.

63. Information on fall of shot was sought by the following methods:-

(a) Agents

(b) Photo reconnaissance.

(c) Optical methods.

(i) Director

(ii) Kine Theodolites

(d) Electrical methods

(i) Use of ORTLER to D/F rocket in flight.

(ii) Use of ORTLER to obtain several relative velocities on the same rocket - TOSCANA system.

The following methods were under consideration:-

(a) Use of EGON

(b) Use of a pulsed as opposed to C.W. ORTLER for D/F work.

(c) Seismic.

No attempt was made at sound ranging. The use of RADAR had been considered by the G.A.F., but they were of the opinion that none of their sets were usfficiently powerful.

64. All methods used for stufying fall of shot were only checks on performance. No attempt was made, except in one case (see para. 66), to correct eigher range or line settings on the basis of the observations made.

65. Agents were only used in LONDON. Time, date and place of fall were recorded. Agents were not employed in ANTWERP where it was considered that photo-reconnaissance gave better results.

66. Reconnaissance flights were flown every 14 days over ANTWERP; attempts were made to fly over LONDON as well. G.A.F. photographic interpretation experts annotated the cover, distinguishing between V1 and V2 and also between old and new craters. No attempts appear to have been made to use spoil patterns to determine the direction of flight of individual rounds. In February DIVISION ordered an increase in range of about 2 kilometres for all ABTEILUNGEN firing against ANTWERP, for photographs had shown the majority of rounds to be falling short. The clear clipses, one corresponding to GRUPPE NORD and the other corresponding to GRUPPE SUED were recognised short of the aiming point.

Optical methods.

67. The first optical method, introduced in January, 1945, involved the use of one director only. This was set up 3-4 kilometres behind the launching position and on the line of fire. The director was layed on a predetermined low elevation such that the rocket would pass through the field of the director 9 seconds after launch. When the rocket was first observed the layer gave a signal and a stop watch was started. The rocket was followed by the director and the azimuth was read at regular intervals. Deviation in line could be calculated using the data for horizontal distance travelled in a given time which was shown in the range tables. In good visibility the rocket could be followed for 80-90 seconds by day and for about 100 seconds by night. Elevation was not recorded.

68. The use of kine-theodolites was developed by Hptm. BECK. They were installed in the HAGUE towards the end of February and at AHAUS at the beginning of March. Two instruments were used, being located behind and on either side of the firing position. Normal methods of calculation were used and from the observations velocity, trajectory inclination and position at BRENNSCHLUSS could be determined. By parabolic extrapolation the position of fall of shot could be estimated. No corrections were made for retardation or meteoroligical conditions. According to Lt. LOHMANN the rockets by day could be photographed to a point just beyond BRENNSCHLUSS. Beyond that the instruments could be layed and approximate measurements taken. By night the rocket could be followed to a position slightly beyond BRENNSCHLUSS. Oblt. GRAETZ stated, however, that

the rocket could be followed to 150 kilometres by the theodolites in good weather conditions. (Comment. These statements are not necessarily contradictory, for Oblt. GRAETZ may have only had laying in mind. If this is so it seems probable that the sinusoidal ground plan track described in para. 17 is probably a laying effect and not something inherent in the rocket). Lt. LOHMANN estimated the accuracy of the precedure to be 200-300 meters. The fire plan was not altered in order to permit optical measurement if the weather was cloudy.

Electrical methods.

69. A modification to the VERDOPPLER will allow it to transmit during the whole time of flight of the rocket. This modified transponder is referred to as ORTLER. In the spring of 1944 experiments were carried out on the Pomeranian coast to develope suitable methods to find direction using this signal. The siting of equipment on the Channel coast was then in mind. FUNK HORCH ABTEILUNG 1192 were trained in the use of this method at BLIZNA in POLAND in November and December 1944.

70. The equipment finally used consisited of three G.A.F. PEILGERAETE Type 80 b 2 and two WEHRMACHT mockups. The sets were deployed in January, the associated W.T. stations being deployed earlier so that they might undertake training. An attempt was made to use the sets during the last weeks of the operation, but no success was achieved. Only shots fired at ANTWERP were followed.

71. The deployment of the equipment was as follows :-

Locality	Comment
STAVOREN (Z.3979) REES (A.5307)	)These two stations came into)action first.
BRECKERFELD (F.8296)	Army type
KOENIGSWINTER (F.6231)	Never worked.
KAUB (M.6503)	

The deployment of a station at THE HAGUE was under consideration. The equipment had a simple Adcock array with an acoustic presentation. The operator worked to obtain minimum signal. Readings of bearing were taken while the rocket was in flight. These were recorded against an arbitrary zero obtained from the relayed "shot" signal passed from the batteries to COMPANIE. To check the timing another signal might be sent out by COMPANIE five minutes after the first.

72. The observations made were passed back as times and bearings. They were then plotted and smooth curves drawn. From the intersections of the bearings from several stations at the same time the path and point of fall could be ascertained. (Comment. Presumably the time at which the signal stopped was also noted).

73. On the basis of the trials in POLAND it was estimated that the 80% elipse of error had a 7-10 kilometre axis in range and a 3-6 kilometre axis in line.

74. The TOSCANA system was developed by Prof. WOLMAN of DRESDEN. This system used three or four SALERNO units. The exact method of deployment is uncertain but was approximate as shown in Fig 7c. The beat notes from the units were taken on to a single strip of film, on which was also printed a 100 cycle note as reference. This latter signal was produced by an equipment known as KLEIN FLORENZ. By an examination of the three or four beat frequencies the trajectory of the rocket could be determined. This system was only deployed in the last weeks of the operation with SS WERFER ABTEILUNG 500.

75. The interference monitoring van deployed at THE HAGUE was latterly used to check the accuracy of rockets carrying I-GERÄTE. Oscillogram records were taken of rockets carrying ORTLER and I-GERÄT. This allowed time of flight velocity at all-burnt and burning time to be measured accurately, but the fall of shot measurements were only rough as they were partly dependent on range table data. SIMON put their accuracy as low as ± 50 kilometers.

Tailpiece.

76. Oblt. GRÄETZ often said to Gen. KAMMLER that the potatoes used in making alcohol would be better used in feeding the population.

4th July 1945.
TT.

APPENDIX A

Notes on P/W Interrogated

Oberst Lt.WEBER	Acting Commander Div. z.V. No specialised technical knowledge.
Maj. THOMSCHKE	Reserve Regimental Commander 902 Regt. Provided no useful information.
Maj. SCHLESIGER	O.C.901 Regt. Information on targets and order of battle.
Hptm. SCHMOLLER	Adjutant Div. z.V. Staff picture.
Hptm. BAUCH	O.C.FUNK HORCH ABT 1192. General picture of functions of unit.
Hptm. MUELLER	c/o Ver. U. Lehr Bat. 444. Details of battery movements and rocket setting up procedure.
Hptm. v. CHLINGSPERG	Staff of 902 Abt. Questioned on site locations and supply.
Oblt. GRAETZ	I.a.Tech. at Div. z.V. Covered all questions of the rocket and its controls.
Oblt. RALLE	O.C. Technical Battery. Details of employment in GRUPPE SUED.
Oblt. BADER	O.C.Technical Battery. Details of employment in GRUPPE SUED.
Lt. LOHMANN	Responsible for optical measurement at HACHENBURG. Knowledge of the procedures used.
Lt. PILS	Responsible for frequency monitoring. Details of TOSCANA and Direction Finding Systems.
Lt. THIES Uffr. DIETREICH	Optical measurement. Added nothing to Lt.LOHMANN's statement.
Lt. LUCKE	i/c SENDEZUG LUCKE. Gave details of activity.
Lt. ZIMMERMAN	Leading engineer at THE HAGUE. Details of rocket performance.
O.Faehnr SIMON	Mobile VERDOPPLER monitoring equipment. Details of activity.
O.Faehnr WROOST	Mobile L/S monitoring equipment. Gave details of activity.
O.Faehnr PRIESNER	B/S monitoring. Gave details.
Fhj.Wacht.BRINK	Maintenance engineer for TARNSENDER. Information on D/F methods and enemy coding principles.

Wachtmstr. BEIWE	Assistant maintenance engineer for TARNSENDER. No additional information obtained.
Wachtmstr. BAASS	Surveyor. Questioned on aiming points.
Gefr. BLASCHE	Operator of L/S monitoring equipment at COMPANIE. Gave details of equipment.
Gefr. DANKWERTS	Operator of SALERNO monitor equipment. Gave details of equipment.

Fig. 1(a).

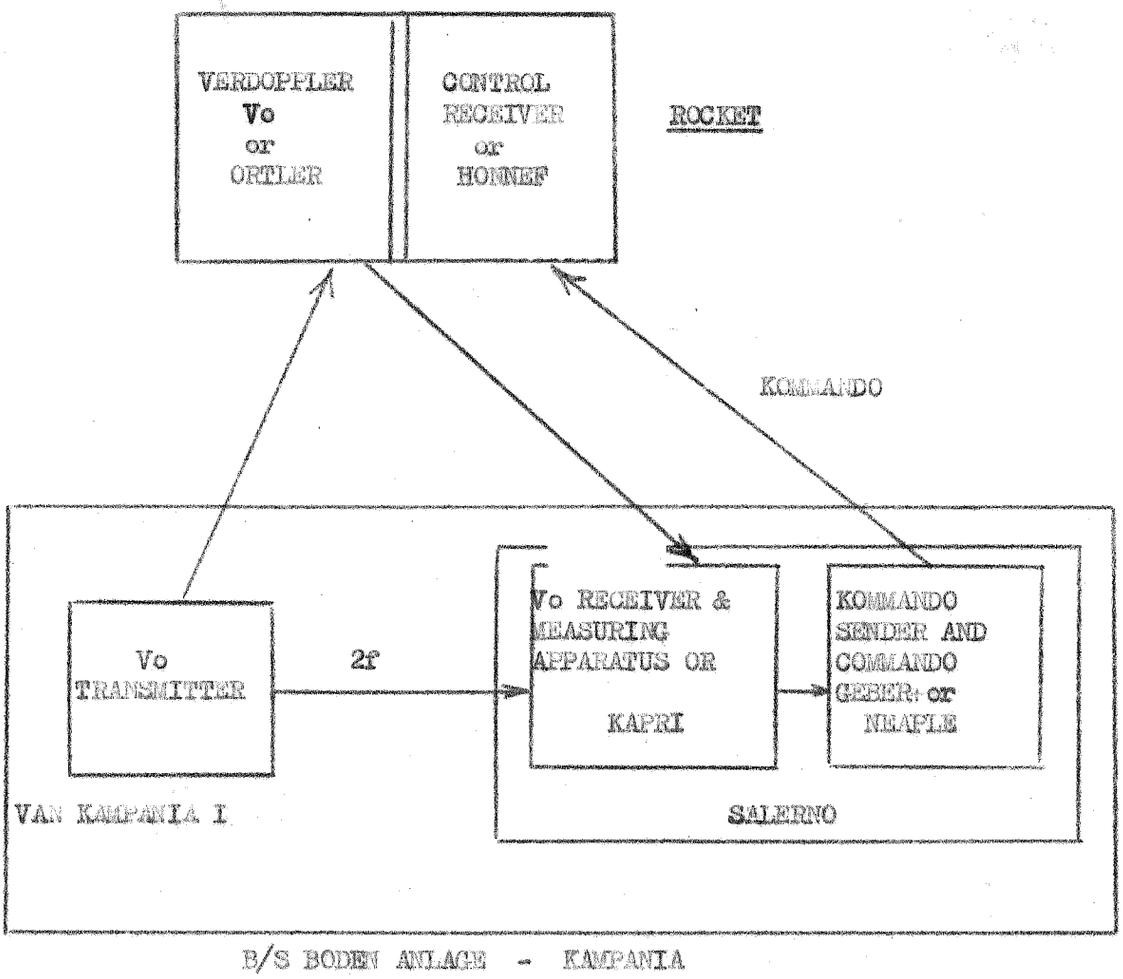


Fig. 1(b).

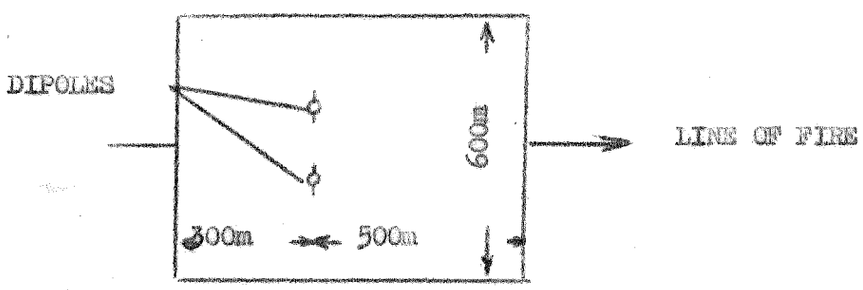


Fig. 1(c).

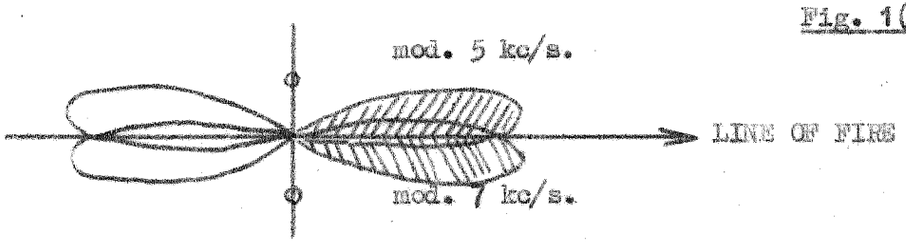


Fig. 1(d).

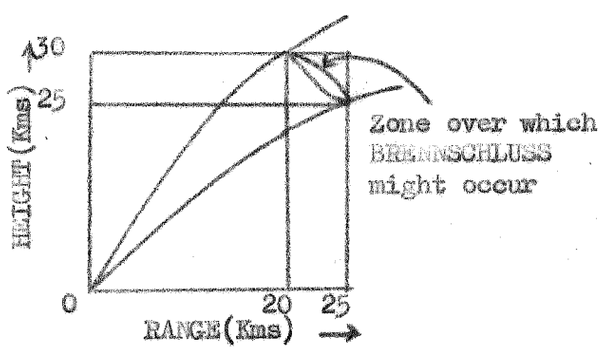


Fig. 2.

E I N G L I E D E R U N G D E R D I V I S I O N z. V.

in die höheren Kommandostellen

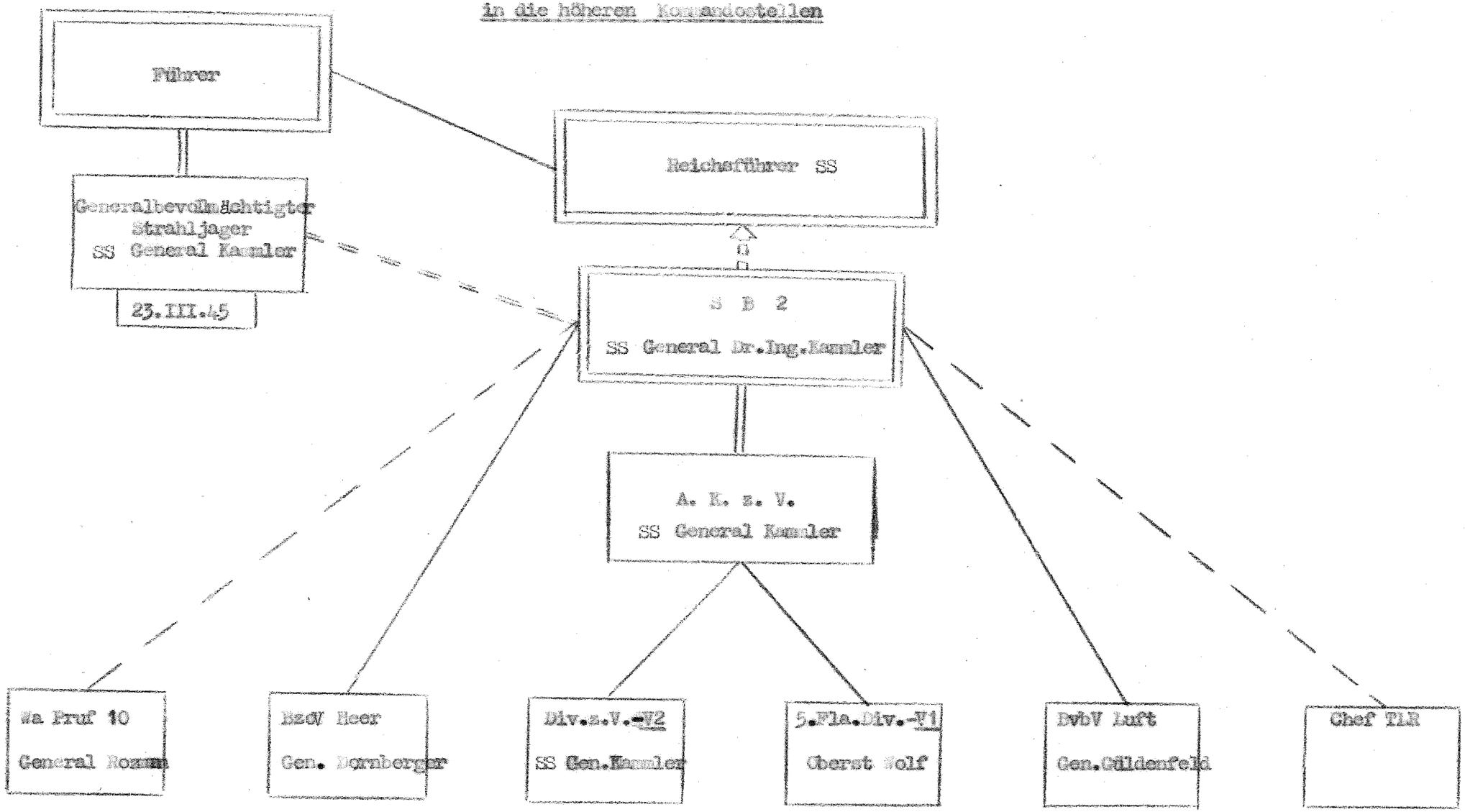
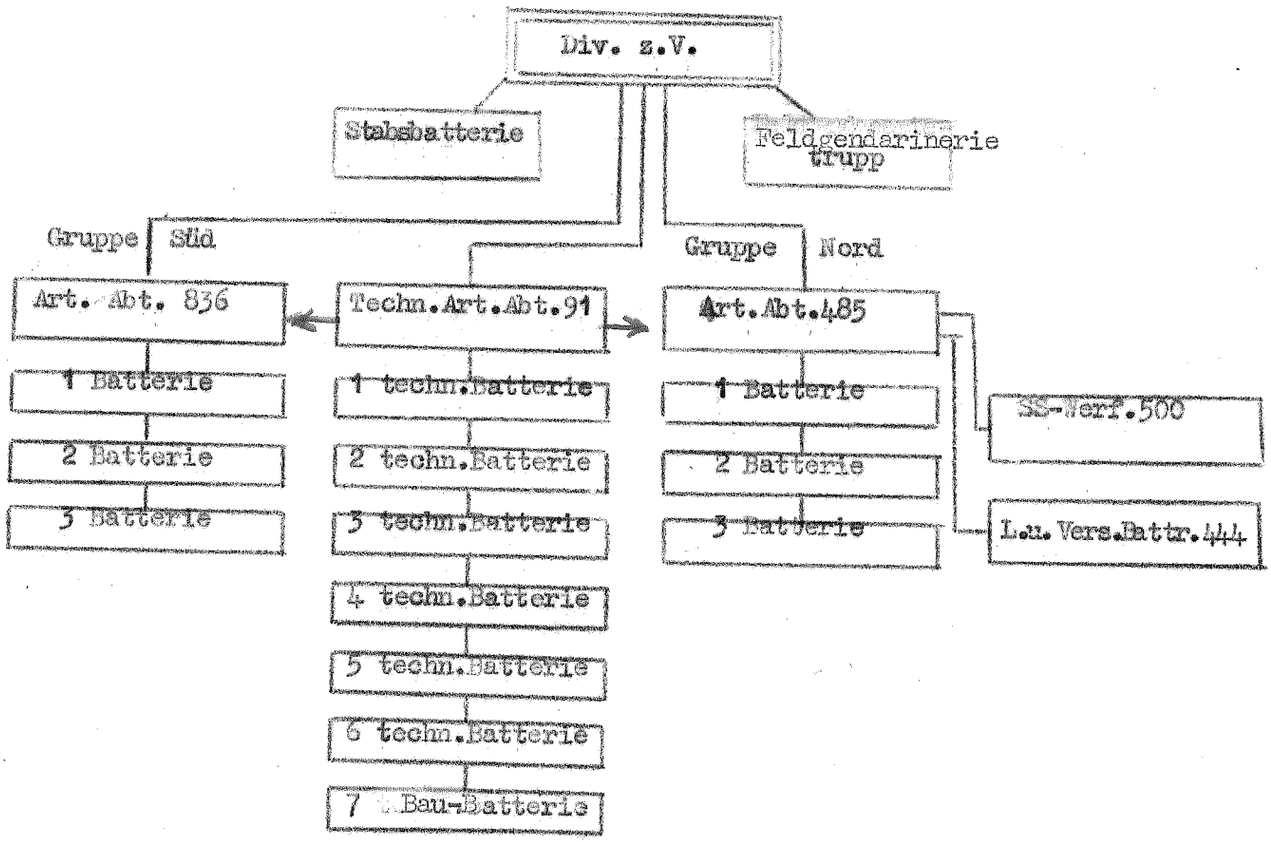


Fig. 3.

GLIEDERUNG der DIV. Z.V. VOM EINSATZBEGINN BIS ZUM 20. 1. 1945



Kf.Abt. 899

1.Geräte Kp

2.Treibstoff Kp

3.Treibstoff Kp

4. Kfz.-Kp

5. W - Zug

Kf.Abt. 900

1 Geräte Komp

2 Treibstoff Kp

3 Treibstoff Kp

4. Kfz.-Komp

5. W - Zug

Nachr.Abt.1191

Verm.Battr.760

Nachsch.Btl.801

Fu.-M.Abt.1192

Bau Pi Btl.211

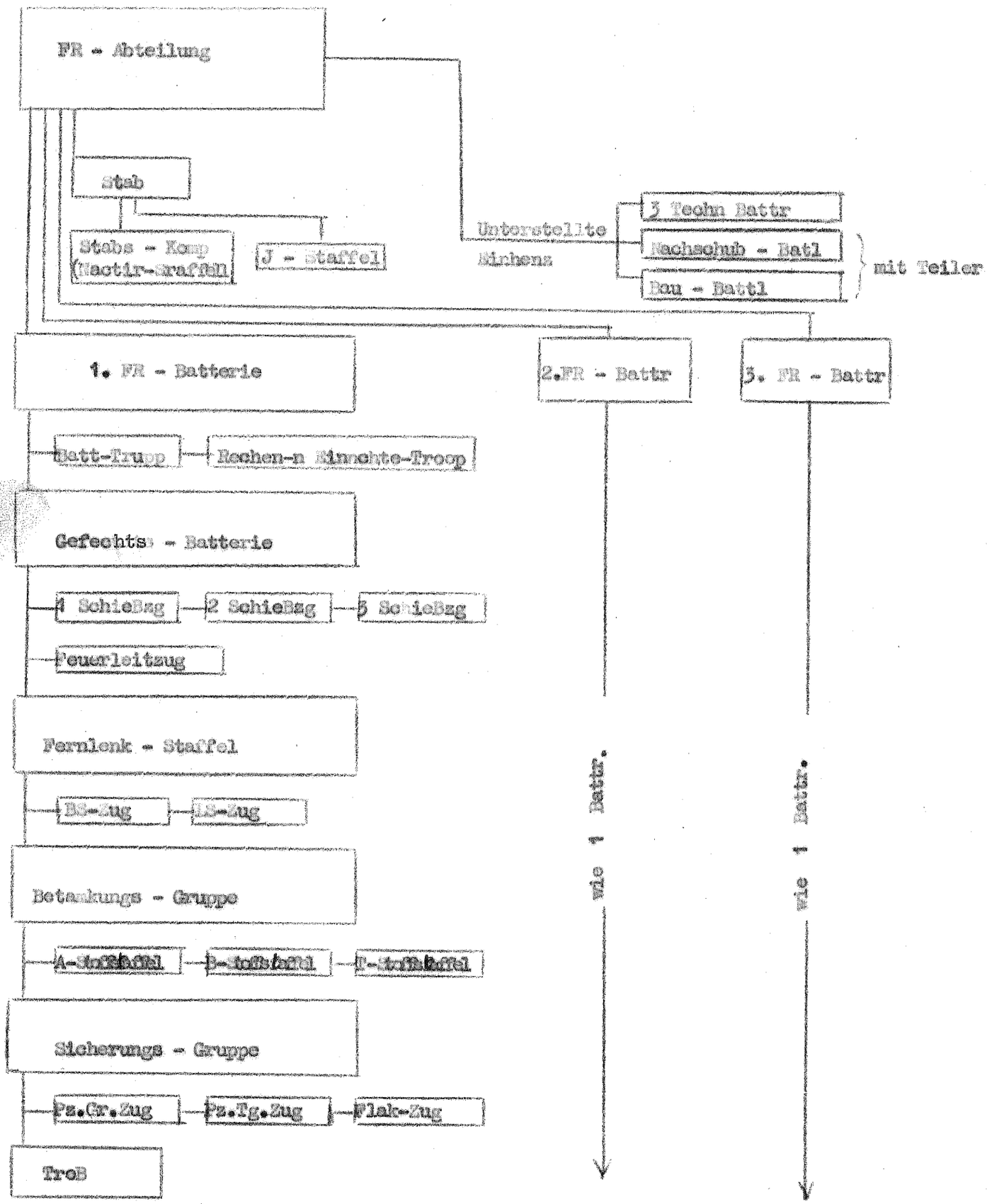
Lds.-Schtz.Btl. 1020

Fig. 4.

Gliederung der FR - Abteilung

von Einsatzbeginn bis zum

20. 1. 1945



Gliederung der Division Z.V. nach ertalgter Umgliederung

ab 20. 1. 1945

Div. Z.V.

Stabs.Battr. Feldgend. Trupp

Gruppe Sud

Gruppe Nord

Art.Rgt.z.V. 901 mit Stab

I.Art.Abtlg. mit Stab

1.schiefsende Batterie

2.Technifche Battr.

3.Treibstoffe Battr.

II.Art.Abtlg mit Stab

4.Schiessende Battr.

5.Technifche Battr.

6.Treibstoff Battr.

III.Art.Abtlg. mit Stab

7.schiessende Battr

8.technifche Battr

9.Treibstoff Battr

10.2cm-Flak-Battr

11.2cm-Flak-Battr

Heeres Art Abt 705 Hochdruckpumpe

Art.Rgt.z.V. 902 mit Stab

I.Art.Abtlg. mit Stab

1.schiefsende Batterie

2.technifche Battr.

3.Treibstoffe Battr.

II.Art.Abtlg mit Stab

4.Schiessende Battr.

5.Technifche Battr.

6.Treibstoffe Battr.

III Art.Abtlg mit Stab

7.schiessende Battr

8.technifche Battr

9.Treibstoff Battr

10.2cm-Flak Battr

11.2cm-Flak Battr

Werf.Abt.500 mit Stab

1.schiefsende Batterie

2.technifche Battr.

3.Treibstoffe Battr.

4.2-cm-Flak-Battr.

Heeres Art 709 Rheinbote

Art.Rgt.z.V. 903 mit Stab

War in Aufstellung, wurde Ende Januar in Arnswalde (Pom.) infanteriftisch. engesetzt.

Nachrichten-Abt.z.V

Funk-Horch Abt.z.V.

Gren.-Batl. Z.V.

Vermessungs-Abt.z.V.

8.8 Flak-Abt. 317

8.8 Flak Abt. 294.

Bau Pi.Btl. z.V.

Kraftfahr-Abt.z.V.

ohne Stab, als selbstandige Einh den Regimentern unterstellt.

Lehr-u.Verfuchs-Battr. 444 trat bei Umigliederung zur lehr-u.Verfuchs-Abteilung beim B.z.b.V Heer.

SCHEMATISCHE DARSTELLUNG DER FUNK-HORCH-ABTEILUNG 1192

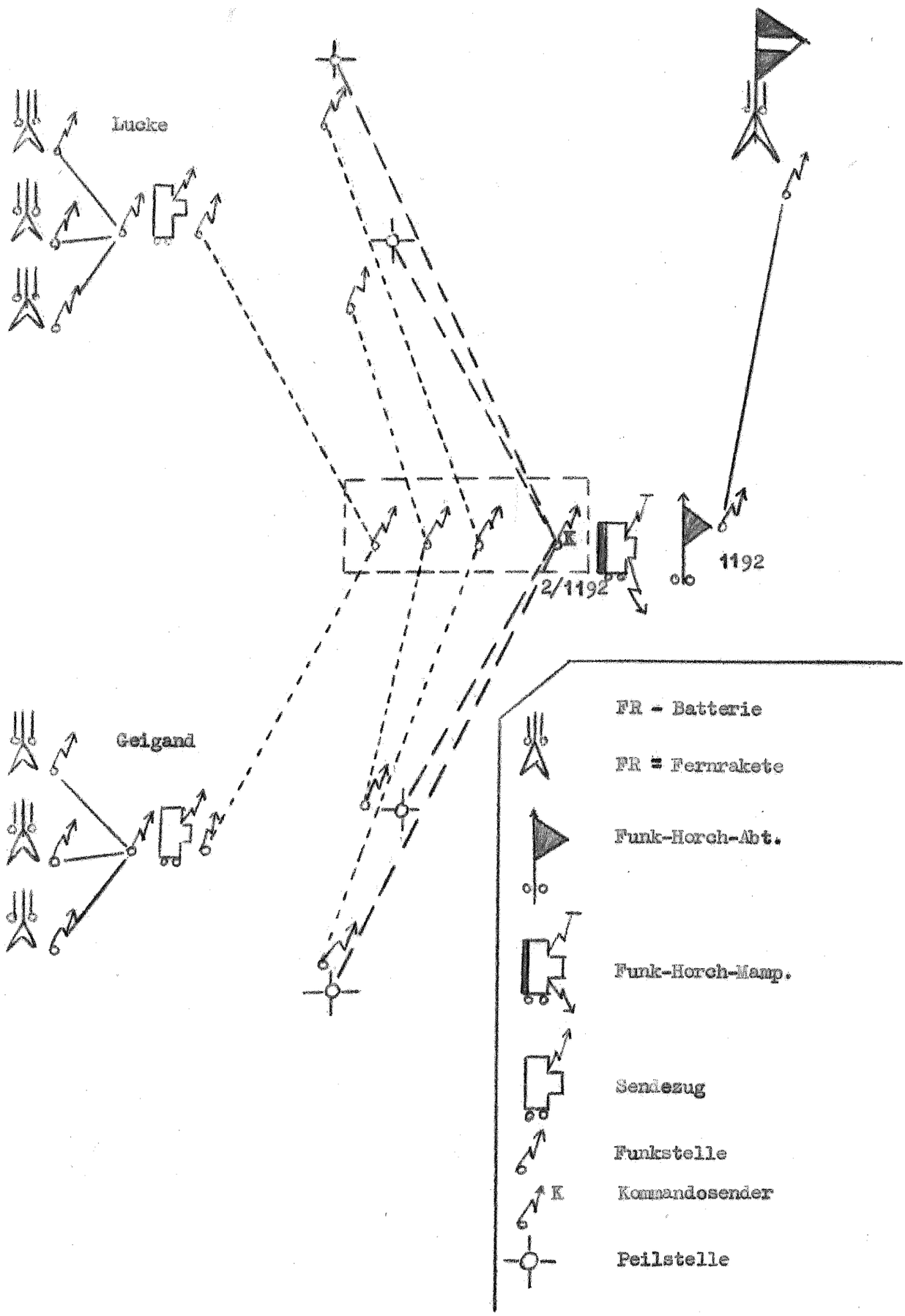
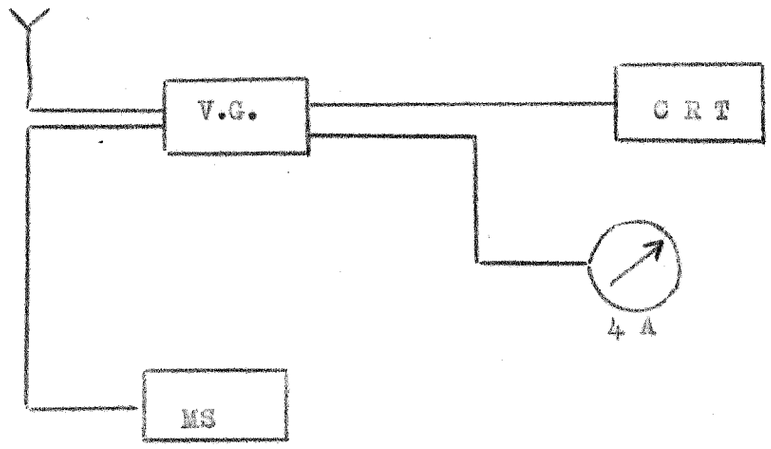


Fig. 7(a)



V.G. = Leitstrahl receiver (VICTORIA Geraet)

CRT = Oscilloscope and other equipment

4A = Micro-ammeter

MS = Leitstrahl Modelsender

Fig. 7(b)

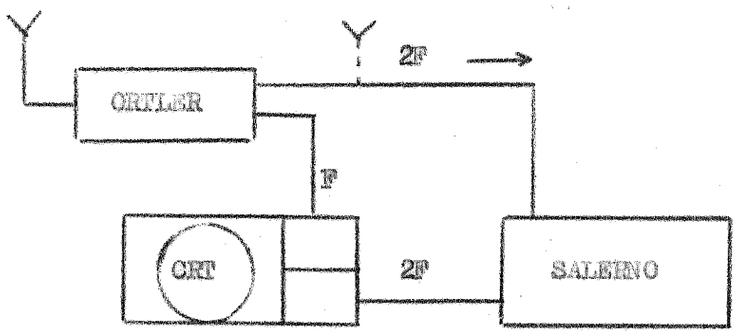


Fig. 7(c)